# Migration, Commuting, and the Spatial Distribution of Public Spending*

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**Abstract**

How much do people value public spending? I answer this question using an extended gravity framework that jointly accounts for migration and commuting. Leveraging South Korean census data and national tax reforms as exogenous variation, I estimate the elasticity of residential choice with respect to local government spending to be about one. Public goods are valued, and congestion effects indicate partial rivalry. Embedding the framework in a general-equilibrium setup, I characterize the welfare-maximizing spatial tax redistribution that balances fiscal externalities shaped by workers' spatial mobility. Ignoring either migration or commuting biases key elasticity estimates and misinforms place-based policy design.

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**Keywords**: migration, commuting, quantitative spatial model, endogenous amenities, local public finance, intergovernmental transfers, redistribution.

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# 1 Introduction

How much do people value local public spending? Despite the central role of public goods in shaping the spatial distribution of economic activity and welfare, little is known about how residents respond to differences in local government spending when deciding where to live and work. Quantifying this response is challenging because location choices reflect not only the benefits of local public goods but also the costs and opportunities associated with moving and commuting across space. In this paper, I develop and estimate an extended gravity framework that jointly models migration and commuting in the spirit of Tiebout (1956) to infer how people value local government spending. Using uniquely rich administrative census data from South Korea that record each worker's previous and current residence and workplace, I estimate key elasticities governing spatial mobility and show how local public spending shapes the spatial distribution of workers and aggregate welfare.

The extended gravity framework I build to guide the empirical analysis extends the standard two-dimension gravity model to jointly characterize workers' migration and commuting decisions. It incorporates three distinct spatial linkages—migration, commuting, and job finding—that interact with local factors such as wages, housing prices, and government spending. The probability that a worker lives in one district and works in another depends not only on the direct costs of migration and commuting but also on how these frictions jointly shape access to local labor markets and amenities. This formulation implies that the observed spatial distribution of workers reveals information about how people value local public goods, how sensitive they are to housing and labor market conditions, and how spatial frictions constrain their choices. Estimating this extended gravity equation allows me to disentangle these forces and quantify the relative importance of each margin of mobility in determining where people live and work. I show the quantitative relevance of these margins and demonstrate throughout the paper how imposing restrictive assumptions standard in the literature about spatial mobility biases estimates of key elasticities governing spatial mobility and, in turn, generates diverging general equilibrium implications of local public spending.

South Korea provides an ideal empirical setting to implement this framework to study how much people care about local public spending and its welfare implications. The restricted-access Population Census (2005, 2010, and 2015) provides uniquely detailed microdata that allow me to observe the joint distribution of workers' migration and commuting decisions across districts—the administrative units at which local public spending is determined and varies. This structure enables me to capture both margins of spatial mobility in a nationally representative manner.[1] Furthermore, the national tax reforms in 2008 and 2012 generate plausibly exogenous variation in residential appeals characterized by local government spending, home prices, and residential density, while the simple and centralized fiscal structure—featuring uniform income tax rates and

[1] The goods and services provided by local governments in South Korea are directed toward residents rather than firms and are therefore best understood as amenity-enhancing. Accordingly, I do not model local government spending as directly affecting firms' production functions. Incorporating such a channel would be straightforward but lies beyond the scope of this paper.

well-defined intergovernmental transfers—eliminates the potential confounding influence of local governments' endogenous tax or spending decisions. Although this simplicity limits local fiscal autonomy, it creates a clean environment to study how fiscal resources are distributed across space and how workers respond to variation in local public spending and other place-specific economic conditions.

I begin by developing a partial equilibrium model of workers' location decisions that jointly incorporates migration and commuting. In the model, workers are heterogeneous with respect to their place of origin (or previous residence) and draw idiosyncratic preference shocks for each pair of residence and workplace. Each worker decides where to live and where to work by comparing expected utilities across all pairs, taking local amenities, cost of living, housing prices, local government goods and services, and after-tax wages, as well as the costs associated with spatial mobility as given. These mobility costs take the form of iceberg-type frictions that depend on distance and encompass three components: migration costs between the origin and the new residence, commuting costs between residence and workplace, and job-finding costs linking origin and workplace.

A key implication of this model is an extended gravity equation that generalizes the standard two-location gravity model. In this formulation, the joint probability that a worker from an origin chooses where to live and where to work depends not only on the characteristics of the residence and workplace but also on the interaction among migration, commuting, and job-finding frictions. In this sense, this extended gravity equation provides a unified empirical framework that connects spatial frictions, local economic conditions, and worker allocation across space and jointly accounts for migration (Bryan and Morten, 2019; Morten and Oliveira, 2024) and commuting decisions (Ahlfeldt et al., 2015; Monte et al., 2018).

The extended gravity equation yields several intuitive insights. Workers are more likely to reside in districts offering higher amenities, greater provision of local public goods, and lower housing costs, and they are more likely to work in places that offer higher after-tax wages. Crucially, unlike models that focus on either migration or commuting alone, this framework highlights that the costs of migration, commuting, and job finding jointly shape the spatial distribution of workers. It also introduces two new measures of spatial accessibility that extend concepts in the existing literature (e.g., Donaldson and Hornbeck, 2016; Morten and Oliveira, 2024): augmented labor market access ($ALMA$), which captures the value of local labor market access net of commuting and job-finding costs, and augmented migrant market access ($AMMA$), which measures how attractive each commute is once both commuting and relocation costs are considered. These extensions emphasize that spatial frictions vary systematically across locations and interact with local conditions, implying that workers' access to economic opportunities depends jointly on where they live, where they work, and where they come from.

To quantify the role of spatial frictions in shaping where workers live and work, I estimate the key distance-elasticities implied by the extended gravity framework using the Population Census data from South Korea. The estimates show that all three forms of spatial frictions—migration, commuting, and job finding—are important and increase systematically with distance. A one-kilometer

increase in migration distance reduces the probability of migration by about 3.3 percentage points, while the same increase in commuting distance lowers the probability of commuting by roughly 4.5 percentage points. The probability of finding a job farther away declines by about 1.6 percentage points per kilometer. These effects are stable over time and align with the direction of elasticities implied in related studies of worker mobility in other settings, such as Bryan and Morten (2019) for migration, Ahlfeldt et al. (2015) for commuting, and Manning and Petrongolo (2017) for job finding.

The comparison with standard one-margin models highlights the quantitative relevance of jointly modeling migration and commuting. When migration is analyzed in isolation, as in much of the existing literature, the distance elasticity of migration is biased toward zero because higher returns from local labor markets at the destination partly offset longer migration distances. Conversely, when commuting is modeled without accounting for the initial distribution of workers and the indirect mobility costs associated with migration and job finding to enable new commutes, the elasticity of commuting is biased away from zero—appearing more negative. Together, these results demonstrate that omitting either spatial margin systematically misstates how sensitive workers are to distance and, by extension, how responsive they are to local government spending and other place-based policies.

To evaluate how much people value local government spending, I estimate how workers' residential choices respond to local government spending, housing prices, and residential density. Appealing to the extended gravity framework, I derive an econometric specification that isolates the residence-specific factors in shaping spatial mobility while controlling for origin and workplace factors and spatial frictions. To address potential endogeneity concerns arising from omitted variables and measurement error, I take an instrumental variable approach by exploiting two national income tax reforms in South Korea—in 2008 and 2012—and historical residential density to construct instruments. Conditioning on workplace and origin fixed effects ensures that any direct effects of the national tax reforms on after-tax wages and initial distribution of workers are absorbed, leaving no residual pathway from the reforms to residential choices other than through their impacts on local government spending and residential conditions. Likewise, historical residential density captures long-run persistence is plausibly orthogonal to contemporaneous shocks to location choice.

The estimation results show that local government spending plays a central role in shaping the spatial distribution of workers, thus implying that they value local public goods. The estimated elasticity of workers' spatial mobility implies that a 1 percent increase in local government spending raises the likelihood that a district is selected as a residence by roughly 1 percent. The implied degree of rivalry in public goods and services is about 0.8, indicating that these goods are congestible but not purely private or public. The estimated housing demand elasticity is around $-0.5$, consistent with previous studies for both the U.S. and Korea. Beyond these quantitative findings, the results underscore the importance of jointly modeling migration and commuting when studying spatial mobility and economic activities are spatially linked.

To move beyond partial equilibrium, I embed workers' joint migration-commuting choices into

a quantitative spatial general equilibrium model that links the extended gravity framework, production, floor-space allocation, and a stylized public finance system mirroring South Korea's institutional rules. The model is disciplined by the gravity-based elasticities estimated earlier, complemented by calibration and recovery of unobserved local fundamentals. It matches a range of non-targeted moments, including the cross-sectional distribution of employment and local tax revenues, and the fiscal policy objectives.

I use this quantitative framework to evaluate redistribution across localities. Varying the extent to which redistributive intergovernmental transfers finance local budgets reveals a welfare tradeoff between intra-district and inter-district fiscal spillovers. Too much redistribution from fiscally strong places over-attracts residents to net-receiving areas; too little redistribution amplifies intra-district spillovers in high-revenue places and intensifies spatial disparities. I show that aggregate welfare is maximized at an intermediate level of redistribution, where these opposing spillovers balance and the dispersion of net fiscal benefits across districts is minimized.

Finally, counterfactuals that impose common simplifications in the literature show why jointly modeling migration and commuting matters for policy evaluation. If commuting across districts is shut down, a higher extent of redistribution is recommended because agglomeration pressures concentrate workers in high-productivity districts. If migration and job finding are frictionless, lowering the extent of redistribution raises welfare because inter-district spillovers otherwise encourage residence in net-receiving districts despite longer commutes. Together, these experiments demonstrate that any place-based policy—not only fiscal transfers—may reallocate both where people live and where they work, and that ignoring either margin can lead to biased welfare conclusions.

My paper builds on several strands of the urban and public economics literature that study how government policies shape the spatial distribution of workers. A large body of work emphasizes how tax differentials across space affect migration across state and national borders (Kleven et al., 2014; Akcigit et al., 2016; Moretti and Wilson, 2017). In the tradition of Rosen (1979) and Roback (1982), other studies infer the value of local public services, such as school quality or regulatory environments, from housing prices (Cellini et al., 2010; Black, 1999; Chay and Greenstone, 2005).[2] Only a handful of studies directly estimate how much workers value government spending. Using a spatial general equilibrium framework, Suárez-Serrato and Wingender (2014) exploit population-based allocation rules in federal funding and Census-induced variation to estimate the effect of federal spending on local economies in the U.S., while Fajgelbaum et al. (2019) use cross-state tax differences and spatial proximity to identify preferences for government expenditures.

This paper departs from and extends these approaches in several important ways. First, I use a much finer spatial resolution—district-level data in South Korea—allowing me to jointly model migration and commuting patterns to estimate how workers value local government spending. Second, I propose a new identification strategy that exploits national income tax reforms as a source of plausibly exogenous variation in local fiscal capacity to estimate the elasticity of worker

[2] Gelbach (2004), for example, focuses on low-income women in the U.S. and finds that interstate migration among welfare-eligible populations is largely unresponsive to differences in benefit levels across states.

mobility with respect to government spending. Third, I quantify the effect of residential density on worker mobility, following the urban economics literature on agglomeration and congestion forces (Ciccone and Hall, 1996; Combes and Gobillon, 2015; de la Roca and Puga, 2017), to assess the degree of rivalry in local public goods provision. Finally, I use a quantitative spatial general equilibrium model to evaluate the welfare consequences of intergovernmental fiscal redistribution and to characterize the welfare-maximizing degree of redistribution across localities.

This paper also contributes to the literature on fiscal decentralization, which has often focused how changes in local governments' fiscal autonomy shape economic and social outcomes.[3] While most studies focus on the broad consequences of decentralization, fewer empirically analyze the specific policy instruments—such as local taxation and intergovernmental transfers—that underpin it. Classic work by Wildasin (1980) demonstrates that the spatial distribution of local government spending can generate fiscal spillovers and potentially inefficient household sorting, while Fajgelbaum and Gaubert (2018) and Albouy (2012) characterize optimal transfer schemes for efficient and equitable allocations. I extend this line of inquiry by quantifying the welfare-maximizing extent of redistribution (i.e., how much local revenue to use for spatial redistribution) in a setting where workers are mobile across space. Using a quantitative spatial general equilibrium model calibrated to South Korea's fiscal system, I show how redistributive transfers interact with local tax bases and spatial frictions to determine aggregate welfare. The framework developed here provides a general empirical tool for evaluating fiscal decentralization and revenue-sharing policies in other institutional contexts.

Lastly, this paper methodologically contributes to the economic geography literature on quantitative spatial models.[4] While a growing body of work examines migration and commuting decisions, these dimensions of mobility have largely been studied in isolation. On the migration side, Bryan and Morten (2019) highlight migration costs as a key friction driving labor misallocation in Indonesia, and Morten and Oliveira (2024) quantify how transportation infrastructure affects spatial allocations in Brazil through trade and migration.[5] A common simplification in this literature is to assume that individuals live and work in the same location. In contrast, studies of commuting, such as Ahlfeldt et al. (2015) on Berlin and Tsivanidis (2019) on Bogotá, analyze within-city spatial frictions but typically assume costless migration or job finding across locations.[6] To my knowledge, this paper is the first to develop a spatial equilibrium model that jointly incorporates bilateral migration and commuting decisions, capturing the full set of spatial frictions workers face. By doing so, I show that accounting for both margins of mobility is essential for accurately estimating key elasticities of spatial mobility and for understanding how local public spending influences the

[3] For example, Fisman and Gatti (2002) show that greater fiscal decentralization reduces corruption, while Bianchi et al. (2019) find that it increased female labor force participation through local expansion of childcare facilities. For a comprehensive review, see Oates (1999).

[4] See Redding and Rossi-Hansberg (2017) for a review of quantitative spatial models.

[5] Related studies analyze migration in settings such as the U.S., Vietnam, and Brazil using spatial equilibrium frameworks (e.g., Piyapromdee, 2021; Albert and Monras, 2022; Balboni, 2025; Pellegrina and Sotelo, 2025). My framework abstracts from the dynamic elements in Caliendo et al. (2019) to focus on cross-sectional spatial allocation.

[6] Monte et al. (2018) incorporate both commuting and migration, but model migration frictions as idiosyncratic rather than systematic distance-based costs as I do here.

spatial allocation of workers. Moreover, the framework emphasizes the role of the public sector as an endogenous source of local amenities—a dimension underexplored in the existing quantitative economic geography literature.

The remainder of this paper is structured as follows. In Section 2, I describe the data sources and the key aspects of the South Korean economy. In Section 3, I present a partial equilibrium model in which workers choose where to live and where to work in the presence of local government goods and services as well as the costs associated with spatial mobility. Section 4 estimates reduced-form elasticities measuring the distance-elasticities of migration, commuting, and job finding. Then, I estimate the elasticities of worker mobility with respect to local government spending, residential density, and home prices in Section 5. In Section 6, I embed the partial equilibrium model presented in Section 3 into a general equilibrium setup, describe how I parameterize the model, and quantify the welfare consequences of spatial fiscal redistribution. Section 7 concludes.

# 2 Data and Empirical Background

In this section, I describe the data I use and key institutional features of the South Korean economy that enable the estimation of workers' valuation of local government spending based on their spatial mobility. Specifically, Section 2.1 introduces the main data sources and construction of key variables. Section 2.2 defines the geographic units and documents migration and commuting patterns in South Korea. Section 2.3 then outlines the structure of the public finance system and the national income tax reforms in 2008 and 2012, which provide exogenous variation for estimating the key elasticities of spatial mobility.

## 2.1 Data

The observed spatial distribution of workers reflects decisions along two dimensions of geographic mobility—migration and commuting. Hence, my empirical analysis requires data that meet three conditions. First, the data must record where individuals previously lived, currently live, and work. Second, measures of local government spending must vary at the same level of spatial aggregation at which individuals make their migration and commuting decisions. Third, the data must be spatially representative to allow aggregation to the national level. South Korea is one of the few countries that satisfy all three conditions.

The primary data source is the restricted-access 2005, 2010, and 2015 Population Census of South Korea.[7] I restrict the sample to working male household heads aged 25–60 who commute less than 180 kilometers round trip.[8] The resulting sample includes roughly 3.5 million households.

[7]The Population Census of South Korea is conducted every five years and samples approximately 20% of the entire population.

[8]Migration decisions are typically made at the household level, and in over 90% of Korean households, the head is male. Female labor force participation remains among the lowest in the OECD (Lee, 2017). The age restriction ensures that individuals have completed education and compulsory military service. Fewer than 1% of workers report one-way commutes exceeding 90 kilometers.

The Census questionnaire records the district of residence five years ago, the current district of residence, and the district of workplace. Using these three pieces of information, I construct a dataset that captures the joint spatial distribution of workers across migration and commuting dimensions.

Data on local government finances come from the administrative *Yearbook of Local Public Finance* published by the Ministry of Interior and Safety. From this source, I collect detailed information on total local government revenue, including its decomposition into local income tax receipts and intergovernmental transfers. These data allow me to compute the share of intergovernmental transfers that each locality receives from the national government in each year. In addition, I obtain district-level land price indices from the Ministry of Land, Infrastructure, and Transport, available for 2005, 2010, and 2015. The index measures the average land price in a given year, normalized to 2004.

To complete the parameterization of the quantitative spatial model, I supplement these data with additional district-level characteristics. Two key variables are wages and housing prices.[9] Because the Population Census does not report income or wealth, I use the 2015 Economic Census—which covers the universe of establishments—to compute the average annual wage in each district. For housing prices, I use the national registry of housing transactions maintained by the Ministry of Land, Infrastructure, and Transport (2006–2015). I estimate district-level prices per unit of floor space in 2015 using a repeated-sales (Case–Shiller) approach, following Ahlfeldt et al. (2015). Finally, I calculate the pairwise distances between district centroids to construct migration and commuting cost matrices. In addition to these core variables, I collect auxiliary data on local characteristics such as land use and the number of firms for cross-validation and over-identification exercises.

## 2.2 Spatial Mobility in South Korea

Although South Korea occupies only about 1% of the geographic area of the United States, its population in 2015 was approximately 51 million—about 16% of the U.S. population. The spatial unit of analysis in this paper is the *district* (*Si–Gun–Gu*), the smallest administrative unit with local governing authority. I refer to these district-level governing entities as local governments and focus on 222 contiguous mainland districts, excluding those on Jeju Island.[10] The average district population is 224,310 (91,471 households), roughly twice the population of an average U.S. county.

Workers in South Korea spend, on average, 7.3% of their workday commuting between their residence and workplace—a figure comparable to those reported in Monte et al. (2018) for the United States and in Schafer (2000) for a cross-country sample of 26 economies.[11] Panel A of Table 1 reports summary statistics on commuting patterns for 2005, 2010, and 2015. About 27% of residents work outside their district of residence, while roughly 30% of workers commute into a

[9] A complete list of additional variables and data sources is provided in Appendix A.

[10] A few districts that split or merged during the sample period are also excluded.

[11] See also Redding and Turner (2015) for broader discussions of commuting and transportation costs.

district from elsewhere. Panel (a) of Figure 1 plots the fraction of residents commuting to other districts against the distance between residence and workplace. The probability of commuting declines monotonically with distance, consistent with the notion that commuting costs increase with distance (e.g., Ahlfeldt et al., 2015; Monte et al., 2018; Tsivanidis, 2019).

With respect to migration, about one in seven households in South Korea relocates across district borders each year, corresponding to an annual inter-district migration rate of approximately 13%.[12] Aggregated at the provincial level (16 multi-district regions), the annual migration rate is about 5%, comparable to the inter-county migration rate in the U.S. (Molloy et al., 2011). Panel B of Table 1 reports five-year migration probabilities at the district level. On average, 19% of district residents have migrated from another district within the past five years, and 18% have moved out during the same period. Panel (b) of Figure 1 shows that migration probabilities decrease with distance from the origin, consistent with gravity-type patterns documented in Bryan and Morten (2019) and Morten and Oliveira (2024).

Figure 2 illustrates the spatial relationship between the number of households (left panel) and total local government expenditure (right panel) across districts. Districts with larger populations tend to have higher local spending, suggesting that either residents are attracted to places offering generous public goods and services, or that local governments in more populous areas spend more due to larger tax bases. These patterns highlight the interdependence among key residential determinants such as wages, housing prices, amenities, and government spending. For instance, higher local spending can increase population by improving amenities, which in turn raises housing demand, prices, and tax revenues.

Finally, Figure 3 provides suggestive evidence that workers are willing to migrate farther and commute longer to reside in districts with higher local government spending and lower housing costs. This reinforces the central motivation of this paper: to quantify how much individuals value local public expenditures through their spatial mobility, while accounting for both migration and commuting behavior in their spatial location choices.

### 2.3 Public Finance System

In 2015, total local government expenditure in South Korea accounted for approximately 8 percent of national GDP. Two main sources financed this spending: local income taxes and intergovernmental transfers, which represented about 14 percent and 72 percent of total local revenue, respectively.[13] Panel C of Table 1 summarizes local government expenditures across 222 mainland districts in 2005, 2010, and 2015. The average total local expenditure was 363 million U.S. dollars, and the average per capita local expenditure was 7,638 dollars, ranging widely from 906 to

[12] Annual migration rates are calculated using restricted-use administrative records of all migrants in South Korea from 2005 to 2015. These data are not used in the main analysis because they lack workplace information.

[13] The remaining 14 percent of local revenue came from non-tax sources such as fees, charges, and fines, as well as a negligible amount of borrowing (around 0.06 percent on average). Throughout the paper, I refer to the sum of local income taxes and intergovernmental transfers as local government revenue or expenditure.

29,622 dollars.[14] The degree to which districts depend on local income taxes versus intergovernmental transfers varies considerably across space, with the share of income tax revenue in total local revenue ranging from just over 2 percent to more than 50 percent.[15]

Local government spending in South Korea is primarily used to finance goods and services that benefit residents directly. These include public health, social welfare programs, housing and urban development, and local infrastructure such as roads, parks, and public utilities. In contrast to national government spending, which funds defense, foreign affairs, and nationwide programs, local expenditure mainly targets the provision of community-level public goods that improve the quality of life within each district. This distinction is central in my analysis, as it allows me to interpret local government spending as residents' consumption of publicly provided goods and services.

The institutional framework for local public finance in South Korea is defined by three national laws: the *Income Tax Act*, the *Local Tax Act*, and the *Local Subsidy Act*. Together, these laws establish a nationally uniform progressive income tax schedule and the rules governing fiscal decentralization and redistribution. Local tax bases—essentially the number of residents and their income levels—determine how much revenue each local government collects under these national rules. The local public finance system originated from the *Local Autonomy Act*, first enacted in 1949 and reinstated in 1991 after a three-decade suspension under military rule. The Act sought to"strive for democracy and efficiency of local autonomous administration and to ensure balanced development of local areas" (Local Autonomy Act, 1991). Subsequent legislation in 1994, including the Local Tax Act and Local Subsidy Act, codified the tax and transfer system while maintaining nationally uniform tax rates.

Under this system, local governments have little discretion over fiscal policy. They neither set their own tax rates nor independently determine the size or composition of their budgets. Instead, the national government specifies the share of locally collected tax revenue that is retained at the local level and the portion that is pooled nationally for redistribution through intergovernmental transfers. These transfers are then allocated back to localities according to transparent, formula-based progressive rules that depend on factors such as population, fiscal capacity, and administrative needs. Although this centralized structure may appear restrictive, it offers a clean environment for analysis. Because local governments make no endogenous decisions regarding taxation or expenditure, differences in local public spending arise entirely from exogenous institutional rules and variation in local tax bases. This institutional simplicity allows me to abstract from modeling strategic fiscal behavior by local governments and focus instead on how spatial differences in public spending affect worker mobility and welfare.

The *Local Subsidy Act* specifies that the objective of intergovernmental transfers is to promote balanced regional development by supplementing local governments with limited fiscal capacity. In practice, the redistribution rules favor districts with lower income levels, weaker tax bases, and higher population density. Comparable fiscal equalization systems exist in several other coun-

[14] For convenience, I express monetary values in U.S. dollars throughout the paper.

[15] Figure A.1 in the Appendix shows the spatial distribution of local government revenues.

tries, including Germany, Canada, Australia, and India. While the United States lacks a single nationwide equalization program, many federal transfers—such as the Earned Income Tax Credit, Supplemental Nutrition Assistance Program, Medicare, and Medicaid—implicitly reduce disparities in fiscal capacity across states and localities.

# 3 Discrete Choice Model of Migration and Commuting Decisions

In this section, I present a discrete choice model in which workers make decisions about migration and commuting. In the model, each worker chooses where to live and where to work, taking into account after-tax wages, residential floor space prices, and the provision of local public goods and services.

My framework differs from the spatial equilibrium models commonly used in recent studies of worker mobility in that it combines several distinct features that have typically been modeled separately. Specifically, following Albouy (2012) and Fajgelbaum et al. (2019), I incorporate the provision of goods and services by local governments, and, at the same time, I integrate both commuting decisions (Ahlfeldt et al., 2015; Tsivanidis, 2019) and migration decisions (Bryan and Morten, 2019; Morten and Oliveira, 2024) within a unified framework. In doing so, the model captures the joint determination of residential and workplace choices while accounting for spatial frictions that arise from both short- and long-distance mobility.

In essence, the model considers residential location decisions while allowing workers to reside in areas distinct from their workplace locations, so that workers living in the same residential area may face different wage opportunities depending on where they work. Moreover, by incorporating information on workers' previous locations, the model allows for an analysis of how migration and job-finding costs shape commuting decisions and the overall spatial allocation of labor. Worker mobility is subject to iceberg costs arising from three types of spatial frictions: migration, commuting, and job finding. The key implication of the model is an *extended* gravity equation that characterizes the distribution of workers by their initial residence, current residence, and workplace location.

## 3.1 Model Environment

Workers are born in, or initially assigned to, an origin location denoted by $o$. The initial distribution of workers across origins is given by $\pi_o$. Each worker is assumed to inelastically supply one unit of labor. The economy consists of a total measure $R$ of workers (interchangeably referred to as residents) and is composed of $J$ discrete spatial units, indexed by current residence $r$, workplace location $m$, and origin $o$.[16]

As residential areas, districts are characterized by local amenities $B_r$, per-unit floor space prices $Q_r$, and local government goods and services $g_r$. As workplaces, districts are characterized by wages

[16]To meaningfully distinguish between residential location, workplace location, and origin, the spatial unit must be sufficiently granular (e.g., cities and townships in the U.S. or boroughs in London).

$w_m$. Workers commuting to district $m$ receive after-tax income $(1-\tau_m)w_m$, which they allocate to private consumption of a single final good $c_{rm}$ and residential floor space $h_{rm}$ in their residential district $r$.[17]

In addition, worker mobility across space involves iceberg-type costs in three dimensions: migration costs $D_{or}$, commuting costs $D_{rm}$, and job-finding costs $D_{om}$. I assume that each of these components depends on the time-invariant geographical distance between the corresponding locations, such that longer distances are associated with higher costs. These costs are summarized by a composite disutility index,

$$D_{orm} = \varepsilon_{orm}^{-1} D_{or} D_{rm} D_{om},$$

where $\varepsilon_{orm}$ is a stochastic error term following a log-normal distribution with mean equal to 1.

After observing an idiosyncratic utility shock for each potential residence-workplace pair $(r, m)$ $z_{irm}$, each worker from origin $o$ chooses the combination that maximizes utility, taking into account after-tax wages, floor space prices, local government goods and services, local amenities, and the iceberg costs of mobility.

### 3.2 Worker's Migration and Commuting Decisions

The preferences of worker $i$ are defined over amenities, consumption of the single final good, consumption of floor space for housing, public goods, and the iceberg costs associated with migration, commuting, and job finding. The direct utility of worker $i$ who chooses to move from origin $o$ to a new residence $r$ and commutes to a workplace $m$ is $z_{irm}u_{orm}(c_{rm}, h_{rm})$, where $c_{rm}$ is consumption of the single final good (numeraire) and $h_{rm}$ is consumption of floor space for housing.

First, $u_{orm}(c_{rm}, h_{rm})$ corresponds to the systematic component of the preference and follows the Cobb-Douglas form:

$$u_{orm}(c_{rm}, h_{rm}) = \frac{B_r}{D_{orm}} \left(\frac{c_{rm}}{\beta}\right)^{\beta} \left(\frac{h_{rm}}{1-\beta}\right)^{1-\beta} g_r^{\lambda}. \tag{1}$$

Amenity fundamental $B_r$ captures intrinsic residential characteristics that make district $r$ more or less attractive to live in (e.g., the weather, beaches, and scenic views). The parameter $\beta$ determines the share of expenditure on the final consumption good.[18] Following Albouy (2012) and Fajgelbaum et al. (2019), real government expenditure enjoyed by each worker living in district $r$ $g_r$ is equal to local government expenditure $G_r$, normalized by a function of the total number of workers living in district $r$, $R_r$:

$$g_r = \frac{G_r}{R_r^{\theta}}, \tag{2}$$

where the parameter $\theta$ controls the extent to which local government goods and services are rival and ranges from 0 if non-rival (pure public good) to 1 if rival (publicly provided private good); the

[17] Given national income tax rates $\tau(\cdot)$, the wage associated with workplace $m$ determines the applicable income tax rate, $\tau(w_m) \equiv \tau_m$.

[18] Davis and Ortalo-Magné (2011) provide empirical evidence supporting the constant housing expenditure share, using the U.S. as a case study.

parameter $\lambda \geq 0$ captures the weight of local government goods and services in preferences relative to consumption of the single final good and floor space for housing.

Given the unit price of floor space for housing $Q_r$ and after-tax wage $(1-\tau_m)w_m$, the budget constraint is $c_{rm} + Q_r h_{rm} = (1-\tau_m)w_m$. The Cobb-Douglas preference implies that a $\beta$ share of after-tax wage is allocated to the consumption of the single final good and the rest to the consumption of residential floor space. Therefore, the indirect utility of worker $i$ from origin $o$ choosing to live in district $r$ and commute to district $m$ is $V_{iorm} = z_{irm} v_{orm}$, where

$$v_{orm} = \frac{B_r(1-\tau_m)w_m}{D_{orm} Q_r^{1-\beta}} \left(\frac{G_r}{R_r^{\theta}}\right)^{\lambda}. \tag{3}$$

The systematic component of the indirect utility increases in local amenities $B_r$, wage $w_m$, and local government expenditure $G_r$, while it decreases in per-unit price of floor space $Q_r$, residential population $R_r$, and spatial frictions $D_{orm} = \varepsilon_{orm} D_{or} D_{rm} D_{om}$. Following the standard approach in the spatial literature, I further define the composite iceberg cost arising from migration, commuting, and job finding $D_{orm}$ as follows:

$$D_{orm} = \varepsilon_{orm} \exp(\rho d_{or} + \kappa d_{rm} + \delta d_{om}), \tag{4}$$

where $d_{jk}$ is the distance between district $j$ and $k$; the parameter $\rho$ controls the size of migration cost with respect to distance between previous and current residences $d_{or}$; the parameter $\kappa$ controls the size of commuting cost with respect to distance between residence and workplace $d_{rm}$; the parameter $\delta$ controls the size of job-finding cost with respect to distance between previous residence and workplace $d_{om}$; and $\varepsilon_{orm}$ is an independent stochastic error following a log-normal distribution with mean equal to 1. The composite iceberg cost enters the indirect utility function multiplicatively. Therefore, there is an isomorphic formulation in which after-tax wages and amenity values are reduced due to the costs of migration, commuting, and job finding.

Second, $z_{irm}$ is an idiosyncratic preference shock that captures the idea that each individual worker has idiosyncratic reasons to find a residence and a workplace more or less attractive. I model this heterogeneity in preference in the spirit of McFadden (1974) and Eaton and Kortum (2002). This preference shock is drawn from an independent Fréchet distribution:

$$\Pr(z_{irm} < z) = \exp(-T_r M_m z^{-\epsilon}), \tag{5}$$

where the parameter $T_r > 0$ determines the average utility of living in district $r$; the parameter $M_m > 0$ determines the average utility of working in district $m$; and the shape parameter $\epsilon > 1$ governs the dispersion of the utility draw.[19]

Then, the distribution of workers living in district $r$ and working in district $m$, conditional on

[19]The indirect utility $V_{iorm}$ is Fréchet distributed since $V_{iorm}$ is a monotonic function of the Fréchet distributed idiosyncratic preference shock $z_{irm}$. The maximum utility is itself Fréchet distributed by the stability postulate.

their initial residence $o$, is characterized by the following extended gravity equation:

$$\pi_{rm|o} = \underbrace{\left( \frac{\tilde{B}_r(1-\tau_m)\tilde{w}_m}{\varepsilon_{orm} \exp(\rho d_{or} + \kappa d_{rm} + \delta d_{om}) Q_r^{1-\beta}} \left( \frac{G_r}{R_r^{\theta}} \right)^{\lambda} \right)^{\epsilon}}_{\Phi_{orm}} \Phi_o^{-1}, \text{ where } \Phi_o = \sum_{r'=1}^{J} \sum_{m'=1}^{J} \Phi_{or'm'}. \quad (6)$$

Because some of the unobserved local characteristics (i.e., $T_r$ and $M_m$) always appear in the gravity equation together with unobserved local amenities $B_r$ and wages $w_m$, I define the following composite terms denoted by a tilde: adjusted amenities $\tilde{B}_r = B_r T_r^{1/\epsilon}$ and adjusted wages $\tilde{w}_m = w_m M_m^{1/\epsilon}$.[20]

### 3.3 Implications of the Extended Gravity Equation

Similar to the standard two-location gravity models in the literature, the extended gravity model presented in Equation 6 yields several key implications. First, workers are more likely to reside in locations with higher amenity values and greater local government expenditure, as well as lower per-unit housing prices and lower degrees of rivalry in public goods provision. Second, workers are more likely to commute to workplace locations offering higher after-tax wages. However, unlike standard models that focus on a single spatial margin, this framework emphasizes the joint influence of migration, commuting, and job-finding costs. These dimensions of spatial frictions and their interaction with local characteristics jointly determine the probability that a worker with origin $o$ chooses to live in district $r$ and work in district $m$.

In the remainder of this section, I discuss the further implications of the extended gravity equation for traditional gravity models that study migration and commuting independently. To proceed, I rewrite Equation 6 by grouping the location-specific factors by residence $\phi_r$, by workplace location $\phi_m$, and by previous residence $\phi_o$:

$$\pi_{orm} = \frac{\phi_o \phi_r \phi_m}{(\varepsilon_{orm} D_{or} D_{rm} D_{om})^{\epsilon}}. \quad (7)$$

#### Migration Flows based on the Extended Gravity Equation

Based on Equation 7, the expression for the spatial distribution of workers by their origins and current residences (i.e., migration flows) is expressed as follows by aggregating both sides over workplace location $m$:

$$\pi_{or} = \frac{\phi_o \phi_r}{D_{or}^{\epsilon}} \underbrace{\sum_{m=1}^{J} \frac{\phi_m}{(\varepsilon_{orm} D_{rm} D_{om})^{\epsilon}}}_{ALMA_{or}\varepsilon_{or}}. \quad (8)$$

[20] In Appendix C.1, I discuss how the gravity equation (Equation 6) is derived. It is also general enough to produce the gravity equations summarizing the spatial distribution of workers that the literature on commuting and migration have considered based on economic geography models (Ahlfeldt et al., 2015; Bryan and Morten, 2019; Morten and Oliveira, 2024; Monte et al., 2018; Moretti and Wilson, 2017). In Appendix C.2, I show the theoretical correspondence between the extended gravity equation presented in this paper and the gravity equations used in the migration and commuting literature.

The key difference between the expression above (Equation 8) and the one commonly used in the migration literature is the additional term $\sum_{m=1}^{J} \phi_m/(\varepsilon_{orm} D_{rm} D_{om})^{\epsilon}$. This term can be decomposed into a stochastic component, $\varepsilon_{or}$, and a systematic component, which I refer to as the *augmented labor market access* ($ALMA$).

$ALMA$ shares a similar structure with the labor market access ($LMA$) measure in Morten and Oliveira (2024) and, more generally, with the market access framework in Donaldson and Hornbeck (2016), but includes an additional factor $D_{om}$.[21] In the previous models of migration in the spatial literature, $LMA$ takes a unique value for each current residence (destination), capturing the benefit of accessing the local labor market net of commuting costs. In contrast, $ALMA$ allows $LMA$ to vary by previous residence (origin), accounting for heterogeneous job-finding costs and capturing the benefit of accessing local labor markets net of both commuting and job-finding costs. Therefore, $ALMA$ captures the idea that workers from different origins may value the same local labor market differently.[22]

### Commuting Flows Based on the Extended Gravity Equation

The literature on commuting often employs a gravity equation that summarizes the spatial distribution of workers in terms of their residential and workplace locations. By summing $\pi_{orm}$ in Equation (7) over initial residences $o$, I obtain a gravity equation that characterizes workers' commuting patterns:

$$\pi_{rm} = \frac{\phi_r \phi_m}{D_{rm}^{\epsilon}} \underbrace{\sum_{o=1}^{J} \frac{\phi_o}{(\varepsilon_{orm} D_{or} D_{om})^{\epsilon}}}_{AMMA_{rm}\varepsilon_{rm}}. \tag{9}$$

Again, the key difference between the gravity equation above (9) and the one traditionally considered in the commuting literature is the additional term $\sum_{o=1}^{J} \phi_o/(\varepsilon_{orm} D_{or} D_{om})^{\epsilon}$. This term can be decomposed into a stochastic component, $\varepsilon_{rm}$, and a systematic component, which I refer to as the *augmented migrant (worker) market access* ($AMMA$).

$AMMA$ captures the average appeal of a particular commute (between a residence and a workplace) for workers, net of the costs associated with migration and job finding. Accordingly, two types of costs determine commuting patterns. The first is the direct commuting cost, $D_{rm}$, which measures the difficulty of physically traveling between residence $r$ and workplace $m$. The second is an indirect cost that reflects the difficulty of moving to residence $r$ and securing a job in workplace $m$ from a previous residence $o$ to enable the commute. Similar to direct commuting costs, these indirect costs reduce the attractiveness of a commute. Therefore, $AMMA$ measures

[21] If $D_{om} = 1$ (or equivalently $\delta = 0$), then $ALMA_{or}$ only varies across $r$ and boils down to $LMA_r$. Similarly, if $D_{rm} = 1$ (or equivalently $\kappa = 0$), then $ALMA_{or}$ only varies across $o$ and boils down to $LMA_o$. In both cases, $ALMA$ is no longer a bilateral factor, but a location-specific factor.

[22] The extent to which workers benefit from the labor market of a given residence may depend on where they migrate from, for example, through migrant networks that facilitate job finding for workers from certain origins relative to others (Card, 2001; Cadena and Kovak, 2016).

how accessible each commute is on average for workers originating from different places and varies at the commute-pair level. On the one hand, commutes with higher values of $AMMA$ tend to attract more workers, as they are associated with lower effective barriers to spatial mobility. On the other hand, costly commutes yield lower $AMMA$ values, reducing their appeal, due to compensating differentials.

# 4 Estimation and Results: Gravity

In this section, I take a step toward evaluating how much spatial frictions quantitatively explain the spatial distribution of workers observed in the Population Census of South Korea. The empirical relevance of the extended gravity equation (Equation 7) presented in this paper depends on both the composition of spatial frictions—migration, commuting, and job finding—and the relative contribution of each component to the observed spatial distribution of workers.

As defined in Equation 4, I impose a structure on each bilateral linkage in the extended gravity equation such that these linkages depend on the distance $d_{jk}$ between localities $j$ and $k$, following approaches similar to those in Morten and Oliveira (2024) for migration costs and Ahlfeldt et al. (2015) for commuting costs.[23] Taking into account that the data are available for 3 cross-sectional years (2005, 2010, and 2015), I augment Equation 7 by introducing time subscripts:

$$\pi_{orm,t} = \frac{\phi_{r,t}\phi_{m,t}\phi_{o,t}}{\varepsilon^{\epsilon}_{orm,t}\exp(\rho\epsilon d_{or} + \kappa\epsilon d_{rm} + \delta\epsilon d_{om})}. \tag{10}$$

Focusing on one margin of spatial friction at a time, I estimate the distance elasticities of migration, commuting, and job finding—corresponding to the reduced form parameters $\rho\epsilon$, $\kappa\epsilon$, and $\delta\epsilon$, respectively—based on the extended gravity equation.

## 4.1 Distance Elasticities of Migration, Commuting, and Job Finding

### Distance Elasticity of Migration

I take the logarithmic transformation of both sides of Equation 10 and obtain the following specification:

$$\ln \pi_{orm,t} = \phi_{rm,t} + \phi_{om,t} - \rho\epsilon d_{or} + \varepsilon^{mig}_{orm,t}, \tag{11}$$

where the current residence-workplace fixed effects interacted with year dummies, $\phi_{rm,t}$, capture time-varying location-specific factors at the current residence $\ln \phi_{r,t}$, the workplace $\ln \phi_{m,t}$, and the cost of commuting $-\kappa\epsilon d_{rm}$. The origin-workplace fixed effects interacted with year dummies, $\phi_{om,t}$, capture time-varying location-specific factors at the origin $\ln \phi_{o,t}$, as well as the cost of job finding $-\delta\epsilon d_{om}$.

[23] The motivation for imposing the same distance-based structure on job-finding costs as on migration and commuting costs is that finding a job is more difficult for workers located farther from potential job sites, consistent with the evidence in Manning and Petrongolo (2017).

The coefficient $\rho\epsilon$ represents the semi-elasticity of migration with respect to migration distance. The expected sign of $-\rho\epsilon$ is negative, as workers are less likely to migrate to more distant locations. The final term, $\varepsilon^{mig}_{orm,t}$, corresponds to the logarithm of the stochastic error $\varepsilon_{orm,t}$ scaled by $\epsilon$, and is assumed to be orthogonal to migration distances.[24] I allow the error terms to be correlated across migration pairs.

Column 1 of Table 2 reports the estimation results. The estimated distance elasticity of migration is $-0.0328$, which is statistically significant at the 1% level. This implies that a one-kilometer increase in migration distance decreases the probability of migration by 3.28 percentage points.[25] The magnitude of this estimate is much larger than those typically reported in the literature. For instance, Bryan and Morten (2019) estimate the elasticity of migration with respect to distance to be $-0.553$ for the U.S. and $-0.717$ for Indonesia. Rescaling my semi-elasticity estimate by the average migration distance (75.34 kilometers), the implied elasticity of migration with respect to distance is $-2.47$, more than four times larger in magnitude. The large difference arises because the migration patterns alone do not account for the fact that the values of local labor market access at each destination may differ across worker origins (i.e., $ALMA$ in Equation 8).

To rule out the possibility that this large difference is an artifact of my data or the South Korean empirical context, I follow the standard strategy in the migration literature and estimate the semi-elasticity of migration strictly based on migration flows:

$$\ln \pi_{or,t} = \tilde{\phi}_{r,t} + \tilde{\phi}_{o,t} - \rho\epsilon d_{or} + \varepsilon^{mig}_{or,t}, \tag{12}$$

where the current residence and origin fixed effects interacted with year dummies ($\tilde{\phi}_{r,t}$ and $\tilde{\phi}_{o,t}$) capture push and pull factors specific to each origin and destination that affect migration flows. One of the factors captured by $\tilde{\phi}_{r,t}$ is the appeal of each residence in terms of how well it connects to different workplace locations characterized by varying income potentials—uniform across all migrations regardless of origin.

To consistently estimate the semi-elasticity of migration with respect to distance $-\rho\epsilon$, the error term $\varepsilon^{mig}_{or,t}$ must be orthogonal to the migration distance $d_{or}$. The gravity equation helps to unpack this error term. Based on Equation 8 with time subscripts on all terms except distances, $\varepsilon^{mig}_{or,t}$ corresponds to $\ln(ALMA_{or,t}\varepsilon_{or,t}) = \ln\sum_{m=1}^{J} \frac{\phi_{m,t}}{(\varepsilon_{orm,t} D_{rm} D_{om})^{\epsilon}}$. An estimate that omits the effect of $ALMA_{or,t}$ on migration flows would be biased toward zero because $ALMA_{or,t}$ is positively correlated with both migration distance and observed migration flows.

Column 2 of Table 2 reports the results from estimating Equation 12. Consistent with the expected direction of omitted variable bias, the estimate is much smaller in magnitude: workers are willing to migrate longer distances when they face higher returns from the local labor market at

[24] The error term may capture random measurement error in migration distances. Although exact migration distances are not observed, the magnitude of potential measurement error is likely to be small, as the geographical units are defined more finely than in most previous studies.

[25] In the appendix, Table A.1 presents the estimated distance elasticity of migration based on Equation 11, beginning without any fixed effects and sequentially adding them. In the final column, I show that the distance elasticity does not vary across the sample periods.

the destination. After rescaling by the average migration distance, the implied distance elasticity of migration in my setting is $-0.535$, close to the U.S. estimate of $-0.553$ reported by Bryan and Morten (2019).

### Cost of Commuting with respect to Distance

"'latex I estimate the semi-elasticity of commuting with respect to distance using the following specification:

$$\ln \pi_{orm,t} = \phi_{or,t} + \phi_{om,t} - \kappa\epsilon d_{rm} + \varepsilon^{com}_{orm,t}, \tag{13}$$

where the origin-current residence fixed effects interacted with year dummies, $\phi_{or,t}$, capture time-varying location-specific factors at the origin $\ln \phi_{o,t}$ and current residence $\ln \phi_{r,t}$, as well as the cost of migration $-\rho\epsilon d_{or}$. The origin-workplace fixed effects interacted with year dummies, $\phi_{om,t}$, capture time-varying location-specific factors at the workplace $\ln \phi_{m,t}$, as well as the cost of job finding $-\delta\epsilon d_{om}$. The parameter $-\kappa\epsilon$ represents the semi-elasticity of commuting flows with respect to commuting distance. Because workers are less likely to commute longer distances from their residence, the sign of this semi-elasticity is expected to be negative. The stochastic error term $\varepsilon^{com}_{orm,t}$ is assumed to be orthogonal to commuting distances, and I allow the errors to be correlated across commuting pairs.

The estimated distance elasticity of commuting is $-0.045$, reported in Column 3 of Table 2, and is statistically significant at the 1% level.[26] This estimated elasticity is smaller in magnitude than the estimates available in the literature. For instance, Ahlfeldt et al. (2015) estimate the same semi-elasticity using inter-district commuting flows in Berlin, Germany, in 2008—roughly contemporaneous with the time period considered in this paper—and find an elasticity of $-0.07$ (with distance also measured in kilometers).

Given the notable difference in magnitudes, I follow the conventional approach in the commuting literature and use the probability of commuting, $\ln \pi_{rm,t}$, as the dependent variable to estimate the following specification:

$$\ln \pi_{rm,t} = \tilde{\phi}_{r,t} + \tilde{\phi}_{m,t} - \kappa\epsilon d_{rm} + \varepsilon^{com}_{rm,t}, \tag{14}$$

where the residence and workplace fixed effects interacted with year dummies ($\tilde{\phi}_{r,t}$ and $\tilde{\phi}_{m,t}$) capture factors specific to residential and workplace locations that affect commuting decisions, such as local living costs and wages. To consistently estimate the semi-elasticity of commuting with respect to distance, $\kappa\epsilon$, the error term $\varepsilon^{com}_{rm,t}$ must be uncorrelated with distance $d_{rm}$.

Similar to the migration case, the logarithmic form of Equation 9 with time subscripts has a direct correspondence with Equation 14. The error term $\varepsilon^{com}_{rm,t}$ corresponds to $\ln(AMMA_{rm,t}\varepsilon_{rm,t}) =$

[26] In the appendix, Table A.2 presents the estimated distance elasticity of commuting based on Equation 13, starting without any fixed effects and gradually adding them. In the final column, I show that the distance elasticity does not vary meaningfully across the sample periods.

$\ln \sum_{o=1}^{J} \frac{\phi_{o,t}}{(\varepsilon_{orm,t} D_{or} D_{om})^{\epsilon}}$. An increase in $\ln AMMA_{rm,t}$ raises the probability of commuting. Estimating $\kappa\epsilon$ without controlling for the effects of $\ln AMMA_{rm,t}$ on commuting flows would lead to an upward bias in magnitude (bias away from zero) if higher direct commuting costs are associated with higher indirect costs of commuting—due to migration and job-finding frictions.

Column 4 of Table 2 reports the estimated semi-elasticity based on Equation 14. The estimate is $-0.074$, which is more negative than the estimate in Column 3, consistent with theoretical expectations, and close in magnitude to the benchmark estimate reported in the literature.

**Cost of Job Finding with respect to Distance**

I estimate the semi-elasticity of job finding with respect to distance. I derive the estimating equation by taking the logarithmic transformation of Equation 10:

$$\ln \pi_{orm,t} = \phi_{rm,t} + \phi_{or,t} - \delta\epsilon d_{om} + \varepsilon^{jf}_{orm,t}, \tag{15}$$

where the commute-pair-by-year fixed effects $\phi_{rm,t}$ capture the net benefits of living in $r$ and working in $m$, $\ln \frac{\phi_{r,t}\phi_{m,t}}{D^{\epsilon}_{rm}}$ (e.g., housing prices, wages, and commuting costs); the migration-pair-by-year fixed effects $\phi_{or,t}$ capture the cost of migration $-\rho\epsilon d_{or}$ as well as time-varying origin-specific factors, $\ln \phi_{o,t}$. The parameter $\delta\epsilon$ is expected to be positive because it is harder to find jobs that are farther away from where workers migrate. The last term, $\varepsilon^{jf}_{orm,t}$, captures random noise. I allow the errors to be correlated across job-finding pairs.[27]

Column 5 of Table 2 reports the estimated distance elasticity of job finding. A one-kilometer increase in the distance between the origin and workplace location decreases the probability of job finding by 1.57 percentage points. This estimate is statistically significant at the 1% level and economically meaningful.[28]

## 4.2 Implications

Taking the extended gravity framework to the spatial distribution of workers in South Korea, I find that three distinct dimensions of spatial linkages between localities—costs of migration, commuting, and job finding—are important determinants of the spatial distribution of workers. In particular, these linkages are systematically explained by distance. The estimated distance elasticities are negative and stable over time.[29] I make two important distinctions from the previous

[27] To the best of my knowledge, there is no existing estimate of the decay parameter $\delta\epsilon$ (i.e., the elasticity of job finding with respect to distance) in the literature. That said, my estimate of the spatial decay of job finding can be interpreted as a reduced-form parameter combining the effects of distance on both job matching (employment) and job application (intent for employment). Manning and Petrongolo (2017), using a spatial model of job search with U.K. data on the demand and supply sides of the job search process, find a relatively strong decay of job applications with distance. Marinescu and Rathelot (2018) also report similar findings (implied semi-elasticity of job application to distance equal to 0.02) in the U.S. context.

[28] In the appendix, Table A.3 presents the estimated distance elasticity of job finding based on Equation 15, starting without any fixed effects and gradually adding them. In the final column, I show that the distance elasticity does not vary meaningfully across the sample periods.

[29] This finding, particularly regarding migration, is consistent with the assumption on migration frictions in Caliendo et al. (2019), who extend the sectoral mobility costs framework of Dix-Carneiro (2014). Ahlfeldt et al.

literature on migration and commuting. First, a residence does not necessarily have to be a place for both living and working. Second, where workers come from matters not only for determining where they live, but also for where they work today.[30]

I find substantial biases in the estimated distance elasticities of migration and commuting reported in the existing literature because of the lack of data on the joint distribution of migration and commuting. The estimated elasticities of migration in prior studies are likely biased toward zero because migration costs are positively correlated with the benefits from changing residences ($ALMA$), which are heterogeneous across workers depending on their origins.[31] In contrast, the available estimates of the distance elasticity of commuting are likely biased away from zero (more negative) because omitting the appeal of commuting net of the indirect costs arising from migration and job finding that make certain commutes feasible ($AMMA$) leads to an overstatement of workers' sensitivity to commuting distance.

Although not explicitly discussed in the paper, the results also shed light on the timing of mobility decisions. Intuitively, there are two possible sequences in how workers decide where to live and where to work. First, a worker may decide on a residence (including the option to stay) and then search for a job. If this timing were true, the semi-elasticity of job finding should be estimated to zero once controlling for the commuting-pair fixed effects. Second, a worker may find a job first and then decide where to live and commute from. If this alternative timing were true, the semi-elasticity of commuting should be estimated similarly with or without fixed effects that account for job-finding costs conditional on the migration-pair fixed effects. Neither of these alternative timing assumptions is consistent with the estimated distance elasticities and the observed spatial distribution of workers. The findings altogether imply that a rigid timing assumption is too restrictive to explain the observed spatial distribution of workers. Consistent with these results, the model presented in this paper allows workers to make migration and commuting decisions jointly.

# 5 Estimation and Results: Valuation of Government Spending

In this section, I infer how much people value local government spending through the spatial mobility of workers characterized by the extended gravity framework (Equation 6). To do so, in Section 5.1, I derive an econometric specification with a rich set of fixed effects that allows me to focus on residence-specific factors and their contributions to the spatial mobility of workers. I estimate the reduced-form elasticities of spatial mobility with respect to local public spending, residential density, and floor space prices. I also discuss potential endogeneity issues relevant for identification and propose a set of instrumental variables that exploit episodes of national tax

(2015) make the same assumption about the semi-elasticity of commuting and apply the spatial decay of commuting estimated from the commuting patterns of workers in Berlin in 2008 to explain commuting before and after the division and reunification of East and West Germany.

[30] Similarly, Pellegrina and Sotelo (2025) find that the origins of agricultural workers affect the types of crops they cultivate after migrating to a different region in the context of Brazil.

[31] Through the lens of the model put forth in this paper, this heterogeneity arises due to commuting and job-finding frictions.

reforms and historical residential density as sources of exogenous variation in local government spending, housing prices, and residential density. In Sections 5.2 and 5.3, I present the estimation results and discuss the interpretation and robustness of the estimated reduced-form elasticities.

### 5.1 Econometric Specification

I multiply both sides of the extended gravity equation (Equation 6) by the initial distribution of workers ($\pi_o$) and then take the logarithmic transformation. This yields the following econometric specification, where time subscripts are introduced as appropriate to accommodate the panel structure of the data:

$$\ln \pi_{orm,t} = \phi_{om,t} + \phi_{or} + \phi_{rm} + \underbrace{\lambda\epsilon}_{\beta_G} \ln G_{r,t} \underbrace{-\theta\lambda\epsilon}_{\beta_R} \ln R_{r,t} \underbrace{-(1-\beta)\epsilon}_{\beta_Q} \ln Q_{r,t} + \zeta_{orm,t}. \tag{16}$$

The coefficients on log local government spending ($\beta_G = \lambda\epsilon$), log residential density ($\beta_R = -\theta\lambda\epsilon$), and log floor space prices ($\beta_Q = -(1-\beta)\epsilon$) represent the reduced-form elasticities of spatial mobility with respect to each factor and are functions of the underlying structural parameters. The job-finding-pair fixed effects interacted with year dummies, $\phi_{om,t}$, flexibly capture workplace-specific factors (e.g., after-tax wages and average utility from working in district $m$), origin-specific factors (e.g., the initial distribution of workers), and the iceberg cost of job finding. The migration fixed effects, $\phi_{or}$, and the commuting fixed effects, $\phi_{rm}$, capture the time-invariant costs of migration and commuting, as well as the intrinsic residential and workplace characteristics that make a location more or less attractive to live or work in. Finally, the error term $\zeta_{orm,t}$ includes the remaining factors in Equation 6, such as time-varying adjusted amenities and stochastic components of the iceberg costs.

The errors in Equation 16 may exhibit two forms of correlation. First, there is the classic clustering concern discussed in Moulton (1990). Second, serial correlation may arise over time within the panel dimension, as emphasized by Bertrand et al. (2004). To address these concerns, I report standard errors that are robust to heteroskedasticity and allow for multi-way clustering. Specifically, I allow the error terms to be correlated across previous residences and across workplace locations that share the same current residence within a given year, as well as serially correlated within each panel unit (a triplet of previous residence, current residence, and workplace location) over time.

#### Fixed Effects

The close correspondence between the econometric specification (Equation 16) and the gravity equation from the structural model (Equation 6) helps clarify potential confounders and the resulting biases.

First, the job-finding fixed effects interacted with year dummies control for the benefit of working

in $m$ net of the job-finding cost from the previous residence $o$:

$$\phi_{om,t} = \ln\left(\frac{(1-\tau_{m,t})^{\epsilon}\tilde{w}_{m,t}^{\epsilon}}{\exp(-\delta\epsilon d_{om})\pi_{o,t}}\Phi_{o,t}^{-1}\right).$$

Workers are more likely to choose workplaces offering higher net benefits. Given higher returns from a particular workplace, workers may be willing to accept lower levels of local government spending at their residential locations. Moreover, a worker's valuation of a given workplace depends on their origin because they often rely on networks formed at their origin to access better-paying jobs (Card, 2001; Cadena and Kovak, 2016). Failing to control for heterogeneity in the attractiveness of nearby workplaces that varies by origin would therefore bias the OLS estimate of $\beta_G$ downward.

Next, higher net labor market access attracts residents, generating a positive correlation between residential density and labor market returns that biases the OLS estimate of $-\beta_R$ upward. Workers with higher after-tax wages can also afford higher housing prices. Similarly, omitting the job-finding-by-year fixed effects biases the OLS estimates of $\beta_R$ and $\beta_Q$, since residential density and home prices partially reflect proximity to attractive workplaces for workers of a given origin.

Second, omitting the migration-pair fixed effects, $\phi_{or} = -\rho\epsilon d_{or}$, and the commuting-pair fixed effects, $\phi_{rm} = -\kappa\epsilon d_{rm}$, is likely to bias the OLS estimate of $\beta_G$ downward. While migration and commuting costs limit worker mobility, workers may choose residences with higher local government spending to compensate for these costs. Districts that are attractive places to live tend to have higher housing prices and residential densities. Thus, migration and commuting costs are likely positively correlated with both residential density and housing prices—a classic compensating differential. Consequently, the OLS estimates of $-\beta_R$ and $-\beta_Q$ would be biased downward.[32]

**Endogeneity**

Even after conditioning on the rich set of fixed effects discussed above, the OLS estimates of $\beta_G$, $\beta_R$, and $\beta_Q$ are subject to multiple sources of endogeneity. The error term, $\zeta_{orm,t} = \ln \tilde{B}_{r,t}^{\epsilon}\varepsilon_{orm,t}^{-\epsilon}$, includes the time-varying values of adjusted residential amenities. Failure to control for local amenities conflates their influence on workers' spatial mobility with the effects of local government spending, residential density, and housing prices.

For example, local government spending and local amenities are likely negatively correlated in this empirical setting because redistributive intergovernmental transfers in South Korea are progressive and favor areas with lower amenity values, *ceteris paribus*. This negative correlation would bias the OLS estimate of $\beta_G$ downward. In contrast, districts with higher amenity values attract more migrants, leading to higher residential populations and thus an upward bias in the OLS estimate of $-\beta_R$. Similarly, since higher amenity values are capitalized into housing prices in

[32]Local government expenditure, residential density, and housing prices are themselves correlated. It is useful to think through the potential directions of bias using standard omitted variable logic—that is, by considering the relationships between omitted variables, the dependent variable, and the endogenous regressors. However, to fully characterize the direction and magnitude of omitted variable bias, one must take into account the full covariance matrix among the endogenous variables and their joint relationship with any omitted variables.

the spirit of hedonic pricing, the OLS estimate of $-\beta_Q$ would be biased upward toward zero.

Additionally, there is a potential concern regarding measurement error in $Q_r$. Home price data are unavailable for 2005, 2010, and 2015, so I use land prices as a proxy. Under the assumption of classical measurement error, the OLS estimate of $\beta_Q$ would be attenuated. Moreover, because all endogenous regressors are correlated with one another, any single source of endogeneity will bias all other coefficients. Hence, addressing these endogeneity issues requires an instrumental variables strategy, which I describe in the following section.

**Instrumental Variable Approach**

There were two major reforms to the national income tax schedule during the sample period examined in this paper—one in 2008 and another in 2012. Both reforms occurred between the Population Census years used for analysis (2005, 2010, and 2015). The 2008 amendment to the Income Tax Act lowered income tax rates across income brackets: from 11% to 8.8% for the low-income group (annual income below 12,000 USD), from 22% to 18.7% for the middle-income group (12,000–46,000 USD), and from 33% to 28.2% for the high-income group (46,000–88,000 USD).[33]

In 2012, the national government further reduced tax rates to 6.6% for the low-income group, 16.5% for the middle-income group, and 26.4% for the high-income group. Importantly, these tax reforms did not alter the extent or the rules governing redistributive intergovernmental transfers stipulated in the Local Subsidy Act.[34]

I exploit the differential implications of these national tax reforms across districts as a source of exogenous variation, alongside the historical values of residential density. The key intuition is that, conditional on origin and workplace fixed effects—which capture both direct changes in after-tax wages and indirect changes through multilateral resistance terms—workers have no incentive to relocate solely to benefit from differential tax rates. However, national income tax cuts can indirectly affect residential choices by influencing local conditions such as government spending, housing prices, and residential density. Similarly, historical residential density explains persistent local characteristics but should not directly influence current residential choices.

For each district $r$ and year $t$, I construct two instrumental variables that exploit the 2008 and 2012 tax reforms:

$$IV_{r,t}^{b} = \tau_{b,t}\pi_{b|r,2000}, \tag{17}$$

where $\tau_{b,t}$ denotes the national income tax rate in year $t$ for income group $b$ (low and high). The values of $\tau_{b,t}$ differ across years because the reforms occurred between Census periods (2005, 2010, and 2015). I further leverage variation in the predetermined distribution of workers by income

[33] Until the second amendment in 2012, the income tax schedule had four brackets. The 2012 reform introduced an additional bracket for the highest earners. For this analysis, I focus on the lowest three brackets, which include more than 95% of South Korean workers according to the Ministry of Strategy and Finance. The 2008 reform also slightly adjusted the income cutoffs to account for inflation, as the previous revision occurred in 1994. Since then, the cutoffs for the lowest three brackets have remained constant.

[34] Figure A.2 in the appendix compares the distributional rules in 2005, 2010, and 2015. The estimated slopes comparing each year's distribution rule to that of five years earlier are approximately one, indicating little change over time.

group. Since income distributions are not directly observed at the district level, I use educational attainment as a proxy. Specifically, I construct $\pi_{b|r,2000}$—the share of workers residing in district $r$ in 2000 with low (high school) or high (some college or higher) educational attainment.[35]

The instruments $IV_{r,t}^{low}$ and $IV_{r,t}^{high}$ capture predicted tax contributions of low- and high-income groups based on the predetermined educational composition of residents in 2000. Their relevance follows directly from the budgetary structure of local governments: expenditures rise with tax contributions. To satisfy the exclusion restriction, the instruments must not directly influence residential location choices except through their effects on local government spending, housing prices, and residential density. The variation in the proposed instruments stems from two sources.

First, changes in tax rates over time. Conditional on wages ($\phi_{om,t}$), workers face the same tax rates regardless of their residence or workplace, implying that tax reforms do not directly affect location choices. Second, cross-sectional variation in educational composition across districts in 2000. Although my model does not explicitly account for sorting by skill level, prior studies have shown that workers tend to sort by education or skill, as the local skill mix shapes residential amenities (Eeckhout et al., 2014; Diamond, 2016; Fajgelbaum and Gaubert, 2018). The validity of my instruments remains intact as long as the tax reforms were not correlated with subsequent changes in educational composition within districts. In Appendix B.3, I provide evidence that the reforms were orthogonal to such changes, supporting the robustness of this identification strategy to potential sorting by education.

The third instrument, $IV_{r,t}^{R}$, is based on historical residential density, following Ciccone and Hall (1996) and de la Roca and Puga (2017). I use the log number of households in district $r$ thirty years earlier ($\ln R_{r,t-30}$), taking advantage of available data for 1975, 1980, and 1985. The validity of this instrument relies on the assumption that historical residential density does not directly influence current location decisions.[36] This assumption would fail if workers based their current decisions on population levels from 30 years earlier rather than on more recent data. Historical density is typically considered relevant due to population inertia, as local housing stocks and infrastructure persist over time (Combes and Gobillon, 2015). It is also plausibly exogenous to current economic conditions, given that major historical and institutional shifts—such as the series of military dictatorships that lasted until 1987—fundamentally reshaped South Korea's economic geography.

[35] There is no universally accepted standard for dividing populations into three education-based groups, especially in contexts where non-schooling is rare. The correlation between income and education distributions tends to be strongest at the tails of each distribution, whereas the income contribution of individuals in the middle of the education distribution is less clear. For this reason, I focus on the fractions of high school dropouts (approximately 25%) and individuals with four-year college degrees or higher (approximately 25%). Accordingly, I use tax rates for the low- and high-income groups to construct the instrumental variables. Using the middle-income tax rate or an average of the middle- and high-income tax rates produces qualitatively similar results.

[36] The relevance of historical residential density as an instrument can be justified using the demographic balancing equation from demography (Preston et al., 2000).

## 5.2 Estimation Results

Table 3 summarizes the estimation results from Equation 16. Column 1 reports the OLS estimates of the elasticities of spatial mobility with respect to local government expenditure, residential density, and home prices.[37]

First, the estimated coefficient on log local government expenditure implies that workers are 0.09 percent more likely to choose a residential location if local government spending there increases by 1 percent. However, this estimate is likely biased downward because redistributive intergovernmental transfers are progressive and thus negatively correlated with local amenities omitted from the regression. Second, the estimated elasticity of spatial mobility with respect to residential density is 0.59, suggesting relatively strong agglomeration forces. Lastly, the estimated elasticity of worker mobility with respect to home prices is statistically insignificant and economically small. These OLS estimates are contaminated by measurement error in home prices and omitted variable bias from unobserved local amenities that both attract residents and correlate with the included regressors.

Columns 2–5 of Table 3 summarize the first-stage and two-stage least squares (2SLS) results. Column 2 shows that log local government expenditure is positively correlated with the predicted tax contributions from both the low- and high-income groups ($IV^{low}$ and $IV^{high}$). The magnitudes of these estimates are similar because both variables are expressed in KRW. The lagged residential density instrument ($IV^{R}$) is also positively correlated with local government expenditure. Column 3 reports that current residential density is positively correlated with the predicted tax contributions but negatively correlated with historical residential density. Conditional on the full set of fixed effects, the negative coefficient on historical residential density implies that districts that experienced faster growth thirty years ago are now growing more slowly. Column 4 presents the first-stage results for home prices, showing positive correlations with both the predicted tax contributions and historical residential density. All coefficients in Columns 2–4 are statistically significant at the 1 percent level.[38]

Column 5 reports the 2SLS estimates of the elasticities of workers' spatial mobility with respect to local government expenditure, residential density, and home prices. The estimated elasticity with respect to local government expenditure is statistically significant and substantially larger than the OLS estimate in Column 1. This increase is consistent with the downward bias in the OLS estimate arising from omitted time-varying local amenities that are negatively correlated with government expenditures but positively associated with residential attractiveness. The 2SLS estimate indicates that a 1 percent increase in local government expenditure raises the probability that workers choose a location as their residence by 1.03 percent.

The estimated elasticity with respect to residential density becomes negative compared to Col-

[37] In the Appendix, Table A.4 presents the OLS results sequentially, beginning with a specification without fixed effects and then gradually adding each set of fixed effects across columns.

[38] To formally assess instrument strength, I compute various F-statistics, including the Sanderson-Windmeijer (SW) conditional F-statistics, which test the explanatory power of the excluded instruments when multiple endogenous regressors are present (Sanderson and Windmeijer, 2016; Stock et al., 2002). The reported SW conditional F-statistics confirm the strength of the instruments across all specifications.

umn 1, although it is statistically indistinguishable from zero. Despite the lack of statistical significance, the change in sign suggests that omitted local amenities introduced a bias toward zero that the 2SLS specification mitigates. Using the structural relationship between the estimated elasticities derived from the model, I estimate the structural parameter $\theta = -\beta_R/\beta_G$, which measures the degree of rivalry in local public goods, via the Delta method. The estimated value of $\theta$ is 0.78 with a standard error of 0.04, which lies within the theoretically permissible range of 0 to 1. The magnitude of this estimate implies a nontrivial degree of rivalry in local government goods and services.

Finally, the estimated elasticity of worker mobility with respect to home prices is $-0.489$, substantially larger in magnitude than the OLS estimate in Column 1. As discussed earlier, the OLS estimate of $\beta_Q$ suffers from two biases: (i) omitted variable bias, because amenity values and home prices are positively correlated, which biases the OLS estimate toward zero; and (ii) attenuation bias due to measurement error in home prices. The 2SLS estimates, which correct for both issues, indicate that a 1 percent increase in home prices reduces the conditional probability of migration by 0.489 percent.

### 5.3 Discussion of the Estimates

The elasticity of worker mobility with respect to government expenditure has not been extensively studied in the prior literature. One notable exception is Suárez-Serrato and Wingender (2014), who estimate an elasticity of 1.46 at the county-group level by exploiting exogenous variation in U.S. federal spending. Similarly, Fajgelbaum et al. (2019) obtain a comparable elasticity estimate based on state-level data on the number of workers in the U.S. Although these studies differ in their sources of variation, time periods, and geographical scope, my estimate of 1.03 is broadly consistent with their findings.[39]

Through the lens of the model, I conclude that local government goods and services are rival but not fully so. However, the estimated congestion parameter for local government goods, $\theta$, may also capture other agglomeration forces.[40] The literature on agglomeration economies emphasizes population or employment density as a determinant of endogenous amenities and productivity (e.g., Ciccone and Hall, 1996; Glaeser and Maré, 2001; Ahlfeldt et al., 2015; de la Roca and Puga, 2017; Domínguez-Iino and Almagro, 2025). The estimated magnitude of this effect is typically positive but modest, with agglomeration parameters ranging between 0.01 and 0.06. Because a tax contribution from an additional resident is shared among all residents, the resulting congestion effect does not fully offset the positive impact on local fiscal capacity. Consequently, the net effect of residential density on worker mobility remains agglomerative.

[39] My estimate of $\beta_G$ is smaller than those in Suárez-Serrato and Wingender (2014) and Fajgelbaum et al. (2019), likely because their analyses capture the effects of government expenditures that benefit both firms and residents, whereas my focus is exclusively on local government spending that provides goods and services only to residents.

[40] A simple isomorphic formulation can make this link explicit. Suppose local amenities $B_r$ are endogenous and depend on amenity fundamentals $b_r$ and residential density $R_r^{\gamma}$, where $\gamma$ denotes the agglomeration force associated with residential density. Then, the reduced-form coefficient on $\ln R_r$ in Equation 16 becomes $-(\gamma - \theta\lambda)\epsilon$ instead of $-\theta\lambda\epsilon$.

My estimate of the housing demand elasticity, $-0.489$, is also consistent with existing empirical evidence. Classic estimates for the United States typically range from $-0.5$ to $-0.7$ (Hanushek and Quigley, 1980; Mayo, 1981), and more recent work continues to find moderately inelastic responses (e.g., Albouy et al., 2016). Studies of the Korean housing market yield similar magnitudes: for example, Kim (2004) reports estimates around $-0.4$ to $-0.6$, and Seok (2021) finds comparable elasticities using micro-data under recent housing-policy regimes.

### 5.4 Implications of the Extended Gravity Approach in 2SLS

Table 4 compares the OLS and 2SLS estimates based on the joint distribution of migration and commuting (Columns 1–2) with the OLS and 2SLS estimates based on migration flows alone (Columns 3–4) and commuting flows alone (Columns 5–6). The 2SLS estimates in Columns 4 and 6 are biased because the exclusion restriction fails to hold in each case.

When migration flows are considered in isolation, the estimated effect of local government spending on the probability of migration is understated. Workers tend to move to locations with greater commuting potential, which compensates for lower levels of local government spending. Without controlling for income potential (or $ALMA$) specific to each origin-destination pair, the instrumental variables become invalid, as tax rate changes simultaneously influence after-tax wages and alter residential characteristics. Conversely, when commuting flows are analyzed independently, the estimated effect of local government spending is overstated. In this case, tax reforms affect the attractiveness of commutes through their impact on workers' mobility incentives (or $AMMA$).

Taken together, these results underscore the importance of jointly accounting for both migration and commuting decisions, especially economic activities are spatially linked. Properly conditioning on all relevant spatial margins is essential to consistently estimate the elasticities of worker mobility with respect to local government spending, residential density, and floor space prices.

## 6 General Equilibrium Model and Policy Experiments

Thus far, I have relied on the extended gravity framework derived from the partial equilibrium model of workers' migration and commuting decisions presented in Section 3 to estimate key elasticities governing spatial mobility. Beyond identifying these elasticities, both the theoretical and quantitative analyses underscore the importance of jointly modeling migration and commuting decisions in understanding the spatial mobility of workers.

In this section, I move beyond partial equilibrium and examine the aggregate implications of the extended gravity framework by embedding workers' location choices into a general equilibrium setting. Having estimated the model, I apply it to evaluate South Korea's spatial fiscal transfer system and to compute, through numerical analysis, the optimal degree of fiscal distribution. Finally, I compare these outcomes with counterfactual results obtained under alternative models that impose simplifying assumptions on spatial mobility.

### 6.1 Quantitative Spatial General Equilibrium Model

In this section, I provide an overview of the quantitative spatial general equilibrium (GE) model, while leaving the full technical details to Appendix D. The goal of building a GE model is to highlight the importance and implications of the extended gravity framework by the revenue-sharing rules of the public finance system in South Korea. The remaining structure of the GE model is intentionally kept parsimonious to preserve quantitative tractability while capturing the key observed spatial outcomes.

First, a tradable final good is produced under perfect competition with a Cobb-Douglas technology combining labor and commercial floor space, with labor share $\alpha$, and is traded frictionlessly across locations. Labor demand and commercial floor-space demand are jointly determined by local productivity $A_j$ and factor prices (wages $w_j$ and floor-space price $Q_j$). The labor market clears when, in each workplace location, total labor demand by firms equals total labor supply from commuting workers, with wages adjusting endogenously to ensure equilibrium across all locations.

Second, each district has a fixed stock of floor space, owned by atomistic absentee landlords, that can be allocated between residential and commercial uses. The equilibrium allocation determines the shares devoted to each use. The residential floor-space market clears when housing demand—driven by workers' expected income and housing expenditure share—equals the residential allocation $(1 - \vartheta_j)$. The commercial floor-space market clears when firms' demand—driven by productivity and floor-space prices—equals the commercial allocation $(\vartheta_j)$. In the absence of land-use regulations, a single floor-space price $Q_j$ clears both markets.

Third, I introduce a stylized government sector that mirrors key features of South Korea's public finance system.[41] The national government sets a uniform income tax rate $\tau$ and revenue-sharing rules governing the degree of fiscal decentralization $\tilde{\chi}$, the local retention rate of tax revenue $\varsigma$, and redistribution weights $\varsigma_j < \tilde{\chi}$. Local government $j$ finances its expenditure $G_j$ through (i) locally retained tax revenue—equal to a fraction $\varsigma$ of income tax collected from residents $TR_j$—and (ii) intergovernmental transfers from the national government, equal to $(\tilde{\chi} - \varsigma)$ times the aggregate national tax revenue weighted by the redistribution parameter $\varsigma_j$:

$$G_j = \varsigma TR_j + \varsigma_j(\tilde{\chi} - \varsigma) \sum_{j'=1}^{J} TR_{j'}. \tag{18}$$

### 6.2 Parameterization of the Model

In Sections 4 and 5, I estimated key elasticities that govern workers' spatial mobility. While most of these estimates are reduced-form parameters, I exploit the structural relationship between the elasticities of spatial mobility with respect to local government spending and residential density to identify the structural parameter capturing the degree of rivalry in public goods provision. Appendix E provides a detailed account of the estimation procedure for the remaining model

[41] The model can be flexibly adapted to alternative public finance systems.

parameters and the recovery of unobserved local fundamentals. Table 5 summarizes the parameter values used to calibrate the model.

The Fréchet shape parameter ($\epsilon$), which has the empirical interpretation of a labor supply elasticity, is estimated by matching the model-implied adjusted wages to the observed wage distribution. The resulting estimate of $\epsilon = 3.43$ closely aligns with the value reported in Monte et al. (2018) (3.3). The labor share ($\alpha = 0.87$) and the housing expenditure share ($1 - \beta = 0.125$) are calibrated using data from the 2015 Economic Census and the 2015 Household Expenditure Survey.[42]

Local fundamentals—amenities ($\{A_j\}$), productivity ($\{B_j\}$), and floor space stock ($\{H_j\}$)—are recovered by inverting the model's equilibrium conditions. Policy parameters characterizing South Korea's fiscal system are directly obtained from statutory sources, including the *Local Tax Act* and the *Local Subsidy Act*. The local retention rate of tax revenue is $\varsigma = 0.09$, and the degree of fiscal decentralization is $\tilde{\chi} = 0.4$. The redistribution weights ($\{\varsigma_j\}$) are recovered as the ratio of each district's intergovernmental transfer to the total intergovernmental transfer pool.

### 6.3 Non-targeted Moments

I assess the model's performance by examining how well it matches non-targeted moments observed in the data. First, Panels (a) and (b) of Figure 4 compare the observed number of workers by employment location with the model's predictions. The correlation coefficient between the two is 0.94, with an estimated slope of 0.91 in Panel (a). Both the slope estimate and the comparison of cumulative distribution functions in Panel (b) indicate that the model successfully captures the spatial distribution of employment across locations.

Second, Panels (c) and (d) compare observed and model-implied local tax revenues by residence. The two series are highly correlated, with a correlation coefficient of 0.92 and an estimated slope of 0.95. The close alignment between the data and model predictions, as shown in the cumulative distribution functions, demonstrates that the model accurately reproduces the spatial distribution of local tax revenues. Since local government spending equals a fixed fraction of local tax revenue plus intergovernmental transfers (which are matched by calibration), the model also performs well in explaining the spatial distribution of local government expenditures.

Third, Panels (e) and (f) evaluate the model's prediction of residential floor space. The model-implied residential floor space is compared with observed land area used for residential purposes (in $1000\,m^2$) from the 2015 Land Use Statistics. The correlation coefficient is 0.52 with an estimated slope of 0.97. Although the correlation is weaker than in other dimensions, this is largely due to measurement error: the observed data report land area rather than floor space, thus omitting variation in building density. Despite these discrepancies, the model performs reasonably well in capturing residential spatial patterns.

In Figures A.3 and A.4 in the appendix, I display the spatial distributions of local productivity

[42] The calibrated housing expenditure share based on the Household Expenditure Survey is consistent with the value implied by the estimated housing demand elasticity in Table 3 and the labor supply elasticity, approximately 0.15.

and amenities recovered from the model and plot them against observed economic indicators. Local productivity is positively associated with the number of firms, and local amenities are positively correlated with home prices. These relationships validate that the recovered fundamentals are meaningfully linked to observable economic outcomes.

Finally, I assess the validity of the recovered local fundamentals using the testable implications of the progressive intergovernmental transfer system. Specifically, redistribution weights should be higher in districts with lower amenities, lower income potential, and larger populations. Table A.6 in the Appendix confirms these relationships empirically. Further discussion of these results is provided in Appendix B.4.

### 6.4 Counterfactual Policy Experiments

In this section, I use the estimated quantitative spatial general equilibrium model embedding the extended gravity framework to evaluate one aspect of South Korea's public finance system. I focus on the policy parameter governing the degree to which local governments depend on redistributive intergovernmental transfers—the *extent of redistribution*—defined as the difference between the overall fiscal decentralization and the local retention rate of tax revenue ($\tilde{\chi} - \varsigma$). I conduct a series of counterfactual exercises varying this extent of redistribution, whose observed value in 2015 is 0.3, between two polar cases. In the first case, local government spending is entirely financed through intergovernmental transfers ($\tilde{\chi} - \varsigma = 0.4$), implying that the national government fully redistributes local tax revenues according to the established redistribution weights ($\{\varsigma_j\}$). In the second case, there is no redistribution ($\tilde{\chi} - \varsigma = 0$), meaning that local governments rely solely on tax revenues collected from their own residents.[43] For each scenario, I numerically compute the resulting consumption-equivalent aggregate welfare, allowing direct comparison of welfare outcomes under varying emphasis on redistribution across localities.

#### Welfare Consequences of Redistribution

Panel (a) of Figure 5 plots the changes in consumption-equivalent aggregate welfare relative to the baseline extent of redistribution (30%). When redistributive intergovernmental transfers are completely eliminated and local government spending is determined solely by locally retained tax revenue (0%), aggregate welfare decreases by 1.2%. At the opposite extreme, when local government spending is entirely determined by intergovernmental transfers (40%), aggregate welfare also declines, by about 0.3%. Varying the extent of redistribution in 1-percentage-point increments reveals that welfare is maximized when the extent of redistribution equals 20%. In other words, reducing the 2015 level of redistribution by 10 percentage points would increase aggregate welfare by approximately 0.12% relative to the baseline.

[43] I do not consider values of $\tilde{\chi} - \varsigma > 0.4$, as this would imply a relative expansion of the local government sector beyond the observed extent of fiscal decentralization. Throughout the counterfactual analysis, I hold all other policy parameters characterizing the local public finance system—including the income tax rate ($\tau$), the overall extent of fiscal decentralization ($\tilde{\chi}$), and the redistribution weights ($\{\varsigma_j\}$)—fixed at their observed or recovered 2015 values.

The extent of redistribution governs the balance between two types of fiscal spillovers—*intra-district* and *inter-district*—that arise from the partial rivalry of local public goods and the national government's redistributive policy. In fiscally strong districts (net contributors), a fraction of residents' tax payments is shared both within the district and, through intergovernmental transfers, with residents of fiscally weaker (net-receiving) districts.[44]

As the extent of redistribution rises, the relative importance of the two spillovers changes in opposite directions. A higher degree of redistribution weakens intra-district fiscal externalities—since a smaller share of locally generated revenue stays within the district—but amplifies inter-district spillovers by increasing cross-district transfers. Conversely, when redistribution is reduced, intra-district spillovers strengthen while inter-district spillovers shrink.

The welfare pattern in Figure 5 reflects this trade-off. When redistribution exceeds 20%, inter-district spillovers dominate and generate inefficiency: transfers from fiscally strong districts raise spending in fiscally weaker ones, attracting workers toward those districts and distorting the spatial allocation of residents. When redistribution falls below 20%, intra-district spillovers become excessive: high-revenue districts internalize a larger fraction of their tax base, attracting even more residents and exacerbating spatial inequality. Hence, the welfare-maximizing redistribution rate of 20% represents the point at which these two offsetting spillover forces—inter-district and intra-district—are in balance.

Panel (b) of Figure 5 further shows that the dispersion of local government spending across districts in black, measured as the standard deviation of the net fiscal benefit per worker (local spending minus own tax contribution), is minimized at the same level of redistribution. This measure summarizes the overall intensity of fiscal spillovers: greater dispersion implies larger external benefits in some districts relative to others, creating stronger incentives for spatial reallocation. At the welfare-maximizing redistribution rate (20%), the dispersion of net fiscal benefits—and hence the overall magnitude of fiscal spillovers—is reduced by roughly 20% relative to the baseline. Together, these results suggest that aggregate welfare is maximized when fiscal decentralization allows for some degree of redistribution but avoids excessive cross-district transfers that distort spatial allocation.[45]

### Counterfactual Results under Alternative Assumptions on Spatial Mobility

In this section, I answer the following question: how would the welfare consequences of varying the extent of redistribution change if either commuting or migration decisions were constrained, as is often assumed in the conventional literature? The primary objective of this exercise is to assess the importance of jointly modeling migration and commuting decisions—a central feature

[44] Two institutional features underlie these spillovers. First, local public goods are not fully rival ($\theta < 1$), so the benefit from a given expenditure is shared among residents. Second, under South Korea's progressive intergovernmental transfer system, net-contributing districts finance part of the expenditures in net-receiving districts, and this fraction increases with the extent of redistribution.

[45] The welfare optimum and the minimum dispersion of fiscal spillovers coincide in this case, reflecting the model's equilibrium condition that the marginal efficiency gain from decentralization equals the marginal equity gain from redistribution.

of the extended gravity framework—by contrasting the results with counterfactual scenarios that impose more restrictive assumptions about spatial mobility. By doing so, I evaluate how the interplay between different types of spatial frictions shapes the aggregate welfare effects of fiscal redistribution. To this end, I conduct the same set of counterfactual policy experiments under two alternative assumptions about worker mobility that are commonly adopted in previous studies of migration and commuting.

First, in the *migration-only* framework, workers are assumed to live and work in the same location. To represent this, I set the semi-elasticity of commuting with respect to commuting distance, $\kappa\epsilon$, equal to infinity; the semi-elasticity of migration with respect to migration distance, $\rho\epsilon$, equal to 0.007; and the semi-elasticity of job finding with respect to its distance equal to zero. Second, in the *commuting-only* framework, migration is assumed to be costless. Accordingly, I set the distance elasticities of migration and job finding to zero, while fixing the semi-elasticity of commuting with respect to distance at $\kappa\epsilon = 0.074$. For each of these two settings, I solve for the new general equilibrium and compute counterfactual changes in aggregate worker welfare under varying degrees of redistribution.

Panel (a) of Figure 6 plots the changes in welfare relative to the 2015 baseline under the assumption of no inter-district commuting. When workers are restricted to reside and work within the same district, eliminating redistribution altogether leads to a larger welfare loss of about 2%. The welfare-maximizing extent of redistribution also rises to roughly 30%. Intuitively, when workers cannot commute to high-productivity districts without relocating, agglomeration intensifies in those districts, amplifying intra-district fiscal spillovers. Consequently, stronger redistribution is required to mitigate spatial inequality and maintain welfare.

Panel (b) of Figure 6 reports the welfare changes under the assumption of costless migration and job finding. In this case, eliminating redistributive intergovernmental transfers yields a sizable welfare gain of about 2.3%. This indicates that, when workers can migrate freely across districts, the need for redistribution diminishes. Without migration and job-finding frictions, workers can easily relocate to districts offering higher productivity and wages. However, in the presence of redistributive transfers, workers are incentivized to reside in net-receiving districts that enjoy positive inter-district fiscal spillovers—benefiting from higher local government spending relative to their own tax contributions—even if this entails longer commutes. Reducing the extent of redistribution in this frictionless setting therefore enhances aggregate efficiency by curbing these distortions.

Taken together, these counterfactual exercises highlight that incorporating both margins of worker mobility—migration and commuting—is crucial for evaluating the spatial implications of any place-based policy, not only fiscal ones studied in this paper. Policies that alter local productivity, housing markets, or infrastructure investment inevitably affect both where people choose to live and where they choose to work. Ignoring either margin risks misrepresenting the true spatial reallocation of workers and, consequently, the aggregate welfare effects of such policies. The extended gravity framework provides a unified structure to capture these interactions, making it a powerful tool for the analysis of spatially targeted interventions more broadly.

# 7 Conclusion

This paper quantifies how much individuals value local public spending by linking their location choices to fiscal conditions. While the importance of local amenities and government services has long been recognized, there is surprisingly little direct evidence on how workers value such spending in equilibrium. To fill this gap, I develop an empirically grounded framework that embeds both migration and commuting decisions into an extended gravity structure. This joint consideration of spatial mobility allows me to disentangle how workers respond to local public goods, housing prices, and residential density while accounting for multiple layers of spatial frictions that jointly shape their observed location decisions.

The empirical setting of South Korea provides a uniquely insightful environment for this analysis. The Population Census data record the full joint distribution of residence, workplace, and origin, enabling me to identify migration and commuting flows from a single data source. Moreover, two major national income-tax reforms in 2008 and 2012 generate plausibly exogenous variation in local government spending, which I exploit to estimate workers' responsiveness to public expenditures. The results show that workers are significantly more likely to choose locations with higher local government spending. I also find that publicly provided goods and services are rival but not fully so, and that workers' responses to housing prices and residential density are consistent with moderate housing demand elasticity and partial agglomeration effects.

Finally, by embedding these estimated relationships in a quantitative spatial general equilibrium model, I assess the broader welfare implications of fiscal decentralization. I find that aggregate welfare is maximized at an intermediate level of redistribution, reflecting a balance between intra- and inter-regional fiscal spillovers. Counterfactual exercises further show that the welfare effects of redistribution depend critically on how easily workers can migrate and commute across space. More broadly, the analysis demonstrates that accounting for both margins of spatial mobility is essential for understanding not only fiscal policies but any place-based intervention that affects where people live and work. The extended gravity framework thus provides a tractable and empirically validated foundation for evaluating how local policy design shapes spatial economic welfare.

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# Figures and Tables

Table 1: Summary Statistics

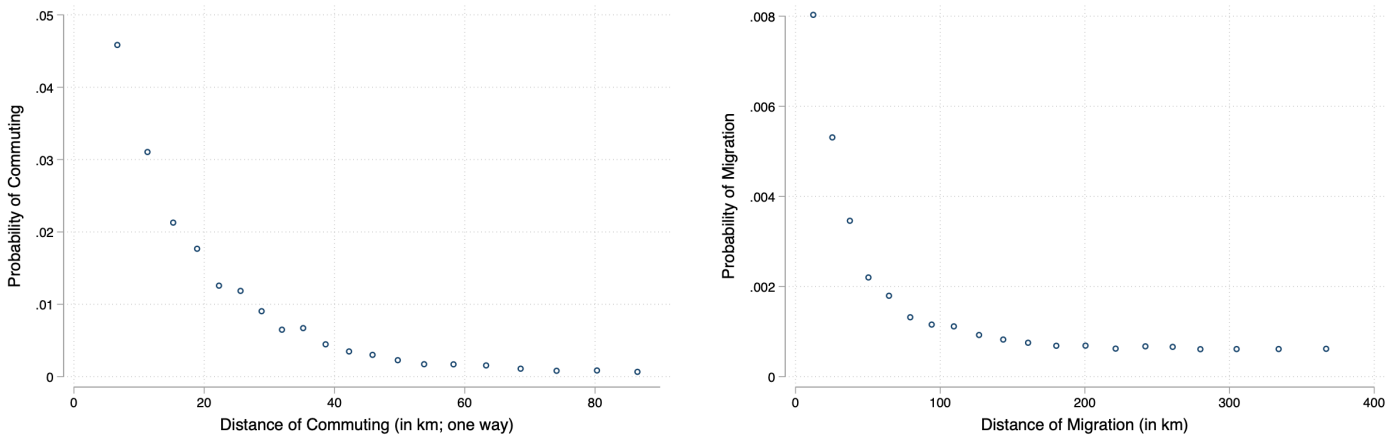
| | (1) Observation | (2) Mean | (3) Std. Dev. | (4) Min | (5) Max |
|---|---|---|---|---|---|
| A. Commuting Patterns | | | | | |
| Commuters from Residence | 666 | 0.273 | 0.237 | 0.000 | 0.773 |
| Commuters to Workplace | 666 | 0.296 | 0.212 | 0.000 | 0.916 |
| B. Migration Patterns | | | | | |
| In-Migrants | 666 | 0.187 | 0.079 | 0.053 | 0.559 |
| Out-Migrants | 666 | 0.180 | 0.071 | 0.048 | 0.443 |
| C. Local Government Budget | | | | | |
| Per-Capita Local Gov't Expenditure | 666 | 3.309 | 2.763 | 0.316 | 15.000 |
| Total Local Gov't Expenditure | 666 | 362,785 | 233,524 | 59,614 | 1,881,082 |
| Intergovernental Transfers | 666 | 242,517 | 128,348 | 24,341 | 799,009 |
| Local Income Tax Revenue | 666 | 64,067 | 95,793 | 1,663 | 779,143 |

*Notes:*This table reports summary statistics for 222 districts based on data from 2005, 2010, and 2015. Panels A and B are constructed from the Population Census of South Korea. The variable *Commuters from Residence* measures the fraction of residents who commute to workplaces outside their district of residence, while *Commuters to Workplace* captures the fraction of workers employed in a district who reside elsewhere. The variables *In-Migrants* and *Out-Migrants* denote, respectively, the fraction of residents who moved into a district within the past five years and the fraction who moved out within the same period. Panel C is based on the Yearbook of Local Public Finance, with all monetary values reported in millions of KRW (approximately 1,000 USD).

Figure 1: Commuting and Migration vs. Distance

(a) Commuting

(b) Migration

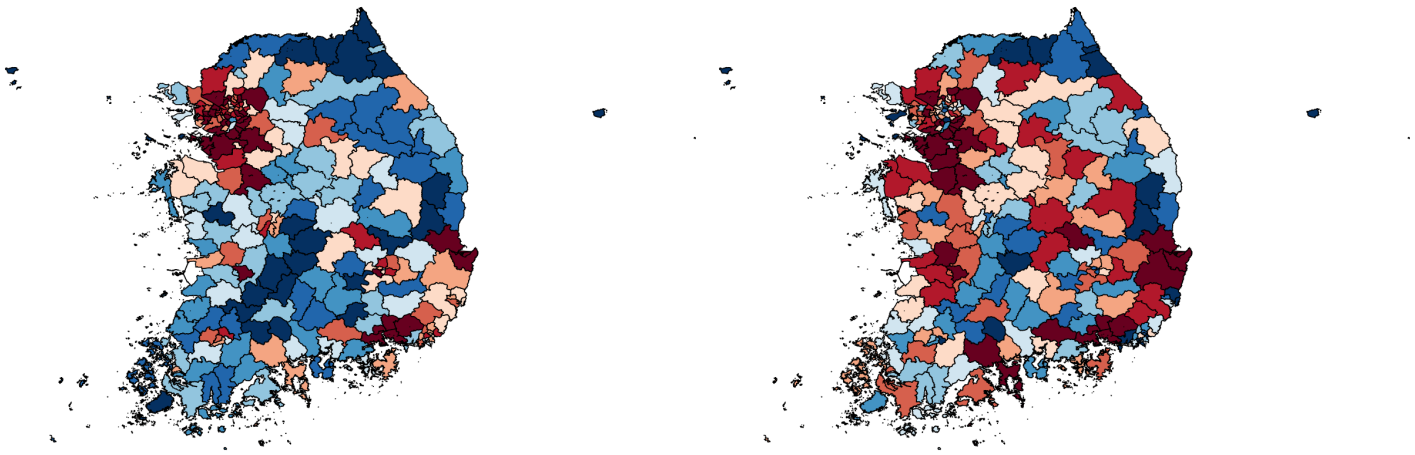



*Note*: This figure illustrates that the probabilities of commuting (left panel) and migration (right panel) decline as the respective distances increase. The probabilities are calculated using data from the 2005, 2010, and 2015 Population Census of South Korea. Each point represents the average probability within a 5th-percentile bin of commuting or migration distance.

Figure 2: Spatial Distribution of Residential Density and Local Government Spending

(a) Residential Density

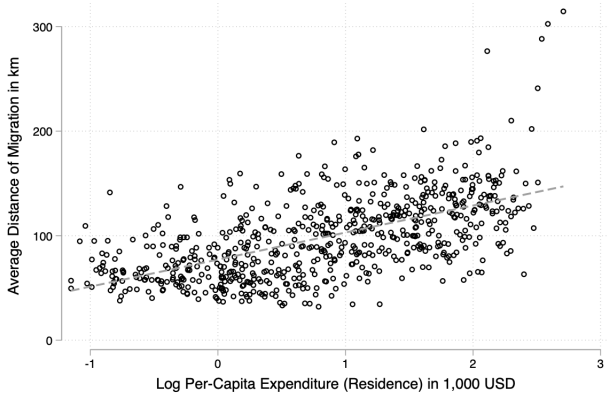
(b) Local Government Spending



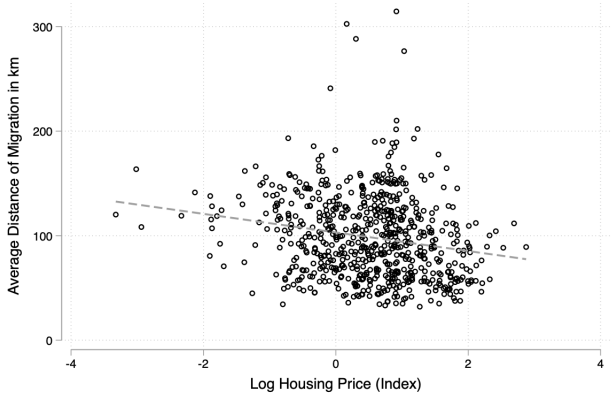
*Note*: This figure displays the spatial distribution of workers by their residential locations (left panel) and local government spending (right panel) in 2015. Districts shaded in red indicate higher values, while those in blue indicate lower values.

Figure 3: Distances of Migration and Commuting vs. Local Government Spending and Home Prices

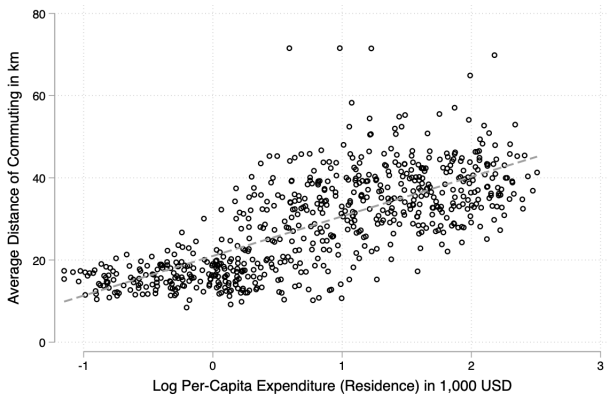
(a) Local Gov't Spending vs. Migration Distance



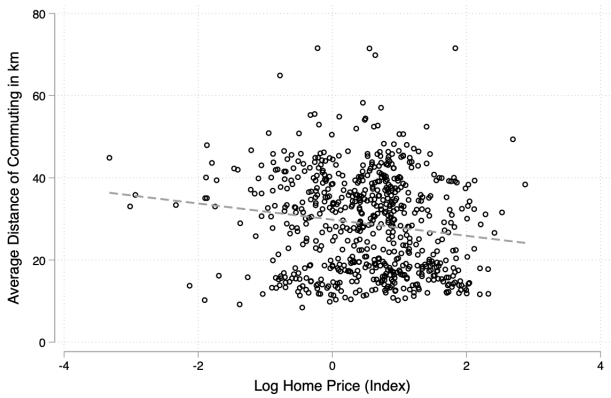

(b) Home Prices vs. Migration Distance




(c) Local Gov't Spending vs. Commute Distance




(d) Home Prices vs. Commute Distance




*Note*: This figure presents the raw correlations between workers' migration and commuting distances and local government spending or home prices. Each observation corresponds to a district-year pair. Panels (a) and (c) on the left plot the average migration distance of residents over the past five years against local government spending and home prices, respectively. Panels (b) and (d) on the right plot the average commuting distance of residents in each district against local government spending and home prices, respectively.

Table 2: Distance Elasticities of Migration, Commuting, and Job Finding

| Dependent Variable: | (1) $\ln \pi_{orm,t}$ | (2) $\ln \pi_{or,t}$ | (3) $\ln \pi_{orm,t}$ | (4) $\ln \pi_{rm,t}$ | (5) $\ln \pi_{orm,t}$ |
|---|---|---|---|---|---|
| Distance of migration, $d_{or}$ $(-\rho\epsilon)$ | $-0.0328^{***}$ | $-0.0071^{***}$ | | | |
| | (0.0009) | (0.0001) | | | |
| Distance of commuting, $d_{rm}$ $(-\kappa\epsilon)$ | | | $-0.0450^{***}$ | $-0.0744^{***}$ | |
| | | | (0.0006) | (0.0009) | |
| Distance of job finding, $d_{om}$ $(-\delta\epsilon)$ | | | | | $-0.0157^{***}$ |
| | | | | | (0.0003) |
| Observations | 257,583 | 70,444 | 257,583 | 20,335 | 257,583 |
| Fixed Effects: | | | | | |
| Commuting Pair × Year ($\phi_{rm,t}$) | Y | N | N | N | Y |
| Job Finding Pair × Year ($\phi_{om,t}$) | Y | N | Y | N | N |
| Migration Pair × Year ($\phi_{or,t}$) | N | N | Y | N | Y |
| Past/Current Residence × Year ($\phi_{o,t}$, $\phi_{r,t}$) | N | Y | N | Y | N |
| Residence and Workplace × Year ($\phi_{r,t}$, $\phi_{m,t}$) | N | Y | N | Y | N |

*Notes*: This table reports the estimated distance elasticities of migration (Columns 1–2), commuting (Columns 3–4), and job finding (Column 5), using data from the 2005, 2010, and 2015 Population Census of South Korea. Each observation in Columns 1, 3, and 5 corresponds to a triplet of previous residence, current residence, and workplace location. The estimations are based on the log-transformed Equation 10 with different sets of fixed effects: commuting-pair-by-year and job-finding-pair-by-year fixed effects in Column 1 (Equation 11); job-finding-pair-by-year and migration-pair-by-year fixed effects in Column 3 (Equation 13); and migration-pair-by-year and commuting-pair-by-year fixed effects in Column 5 (Equation 15). Each observation in Columns 2 and 4 corresponds to a pair of residential locations, with estimation based on Equation 12 and Equation 14, respectively. Standard errors are multi-way clustered and heteroskedasticity robust: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: 2SLS Estimates of Elasticities of Worker Mobility

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | OLS | First Stage | First Stage | First Stage | 2SLS |
| Dependent Variable: | $\ln \pi_{orm,t}$ | $\ln G_{r,t}$ | $\ln R_{r,t}$ | $\ln Q_{r,t}$ | $\ln \pi_{orm,t}$ |
| Local Gov't Expenditure, $\ln G_{r,t}$ ($\beta_G = \lambda\epsilon$) | $0.087^{***}$ | | | | $1.033^{***}$ |
| | (0.027) | | | | (0.356) |
| Number of Households, $\ln R_{r,t}$ ($\beta_R = -\theta\lambda\epsilon$) | $0.593^{***}$ | | | | $-0.807$ |
| | (0.047) | | | | (0.577) |
| Floor Space Price, $\ln Q_{r,t}$ ($\beta_Q = -(1-\beta)\epsilon$) | $-0.002$ | | | | $-0.489^{***}$ |
| | (0.006) | | | | (0.063) |
| Predicted Tax Contribution (low), $IV^{low}_{r,t}$ | | $13.893^{***}$ | $5.623^{***}$ | $60.322^{***}$ | |
| | | (1.344) | (1.016) | (6.101) | |
| Predicted Tax Contribution (high), $IV^{high}_{r,t}$ | | $14.118^{***}$ | $6.762^{***}$ | $21.080^{***}$ | |
| | | (0.742) | (0.608) | (2.902) | |
| Number of Households 30 years ago, $IV^{R}_{r,t}$ | | $0.028^{***}$ | $-0.014^{**}$ | $0.108^{***}$ | |
| | | (0.008) | (0.006) | (0.027) | |
| Observations | 257,174 | 257,174 | 257,174 | 257,174 | 257,174 |
| SW F-stat | | 46.737 | 42.677 | 57.073 | |
| $\hat{\theta}$ | $-6.802$ | | | | $0.780^{***}$ |
| | (5.381) | | | | (0.093) |

*Notes*: This table reports the OLS and 2SLS estimates of the elasticities of workers' spatial mobility with respect to local government expenditure and resident population levels, based on Equation 16. Column 1 presents the OLS estimates. Columns 2–4 show the first-stage results where the dependent variables are the log of local government spending, log number of households, and log floor-space price, respectively. Column 5 reports the corresponding 2SLS estimates. All specifications include the full set of fixed effects discussed in Section 5.1. The sample is constructed from the 2005, 2010, and 2015 Population Census of South Korea, with each observation corresponding to a triplet of previous residence, current residence, and workplace location. Robust standard errors are reported for Columns 1–4, and bootstrapped standard errors (20,000 replications) for Column 5, with multi-way clustering: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Estimation Results based on Migration and Commuting Flows

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Both | | Migration Flows | | Commuting Flows | |
| | OLS | 2SLS | OLS | 2SLS | OLS | 2SLS |
| | $\ln \pi_{orm,t}$ | $\ln \pi_{orm,t}$ | $\ln \pi_{or,t}$ | $\ln \pi_{or,t}$ | $\ln \pi_{rm,t}$ | $\ln \pi_{rm,t}$ |
| Local Gov't Expenditure, $\ln G_{r,t}$ $(\beta_G = \lambda\epsilon)$ | $0.087^{***}$ | $1.033^{***}$ | $0.353^{***}$ | $-1.341^{**}$ | $0.288^{***}$ | 2.139 |
| | (0.027) | (0.356) | (0.042) | (0.576) | (0.050) | (1.706) |
| Number of Households, $\ln R_{r,t}$ $(\beta_R = -\theta\lambda\epsilon)$ | $0.593^{***}$ | $-0.807$ | $1.120^{***}$ | $2.526^{***}$ | $1.118^{***}$ | 0.010 |
| | (0.047) | (0.577) | (0.100) | (0.766) | (0.084) | (1.897) |
| Floor Space Price, $\ln Q_{r,t}$ $(\beta_Q = -(1-\beta)\epsilon)$ | $-0.002$ | $-0.489^{***}$ | $0.042^{***}$ | $0.407^{***}$ | $-0.031^{***}$ | $-1.094^{**}$ |
| | (0.006) | (0.063) | (0.009) | (0.053) | (0.011) | (0.524) |
| Observations | 204,576 | 204,576 | 58,995 | 58,995 | 19,121 | 19,121 |
| Fixed Effects: | | | | | | |
| $\phi_{om,t}$, $\phi_{or}$, $\phi_{rm}$ | Y | Y | N | N | N | N |
| $\phi_{o,t}$, $\phi_{or}$ | N | N | Y | Y | N | N |
| $\phi_{m,t}$, $\phi_{rm}$ | N | N | N | N | Y | Y |

*Notes*: Columns 1–2 report the OLS and 2SLS estimates of the effects of local government spending, residential density, and home prices on worker mobility, where mobility is defined jointly in terms of migration and commuting ($\pi_{orm,t}$). Columns 3–4 present the corresponding OLS and 2SLS estimates based on migration flows alone ($\pi_{or,t}$), while Columns 5–6 report the OLS and 2SLS estimates based on commuting flows alone ($\pi_{rm,t}$).

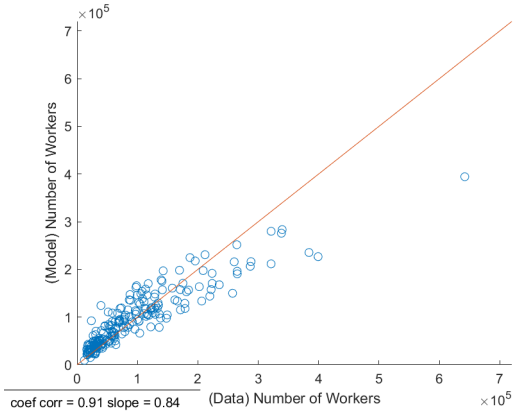
Table 5: Summary of Model Parameter Estimates

| Parameter | Description | Value | Method | Source |
|---|---|---|---|---|
| $\alpha$ | Labor share | 0.868 | Calibrated | Economic Census (2015) |
| $1-\beta$ | Housing expenditure share | 0.125 | Calibrated | Bank of Korea (Q1-Q4 2015) |
| $\epsilon$ | Fréchet shape parameter | 3.429 | Estimated | Fréchet Property |
| $\lambda$ | Preference for local gov't spending | 0.301 | Estimated | Gravity Equation |
| $\theta$ | Net congestion | 0.780 | Estimated | Gravity Equation |
| $\rho$ | Spatial decay of migration | 0.010 | Estimated | Gravity Equation |
| $\kappa$ | Spatial decay of commuting | 0.013 | Estimated | Gravity Equation |
| $\delta$ | Spatial decay of job finding | 0.005 | Estimated | Gravity Equation |
| $\tau$ | Income tax rate | 0.261 | Estimated | GE Condition |
| $\varsigma$ | Local-national revenue Sharing | 0.091 | Observed | Local Subsidy Act |
| $\chi$ | Extent of Redistribution | 0.350 | Observed | Local Subsidy Act |
| $\varsigma_j \forall j$ | Redistribution | -0.074 | Recovered | Local Gov't Budget Balance |
| $A_j \forall j$ | Productivity | 0.010 | Recovered | Profit Maximization + Zero Profit |
| $\tilde{B}_j \forall j$ | Adjusted amenities | -0.007 | Recovered | Spatial Mobility |
| $H_j \forall j$ | Stock of floor space | 0.261 | Recovered | Floor Space Market Clearing |

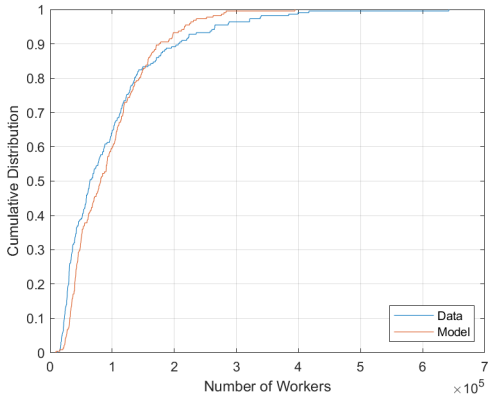
*Notes*: This table reports the estimated structural parameters of the model. Refer to Appendix E for how the parameters and unobserved local fundamentals are estimated, calibrated, and recovered. The housing expenditure share, $1-\beta$, is primarily calibrated using the 2015 Household Expenditure Survey (Bank of Korea). As a cross-check, one can recover $1-\beta$ from the estimated elasticity results in Table 3 together with the estimated value of $\epsilon$, which yields a closely aligned value of 0.14.

Figure 4: Over-identifying Moments: Model vs. Data

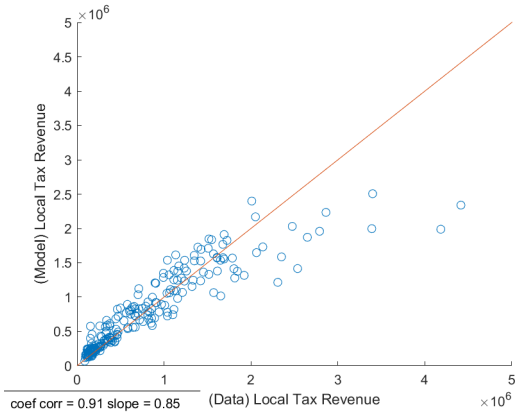
(a) Employment Density



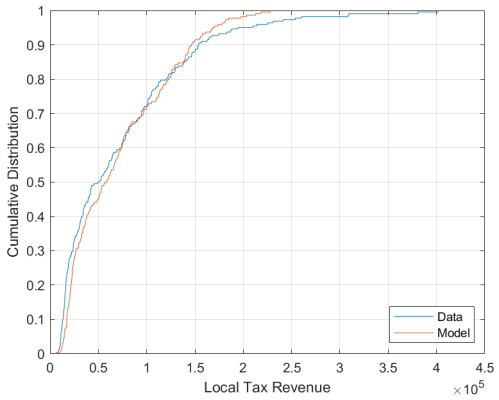

(b) CDF of Employment Density



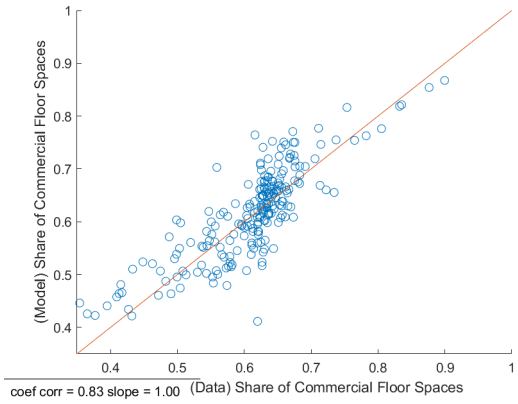

(c) Local Tax Revenue



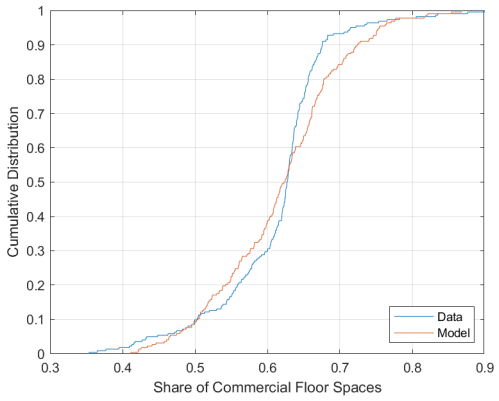

(d) CDF of Local Tax Revenue




(e) Share of Commercial Floor Space



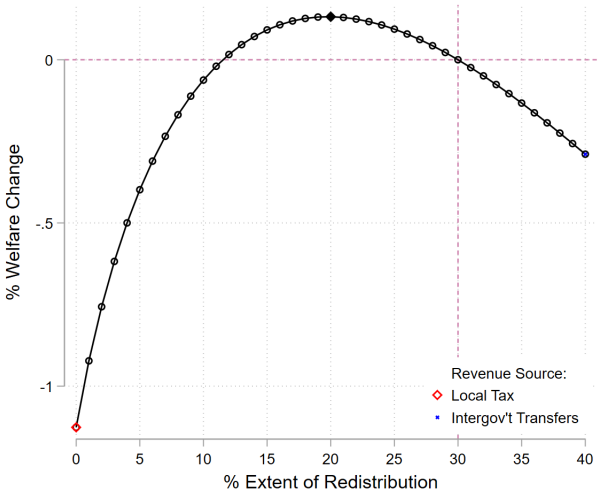

(f) CDF of Share of Commercial Floor Space



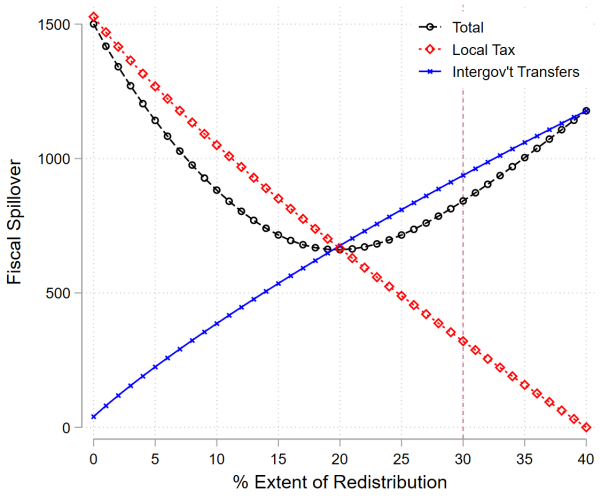

*Note*: This figure compares the 2015 data with the model-predicted non-targeted moments. Panels (a) and (b) display the distribution of workers by employment location, Panels (c) and (d) show local tax revenues collected at each residence (in million KRW), and Panels (e) and (f) present the shares of commercial floor space. The solid 45-degree lines in Panels (a), (c), and (e) indicate perfect alignment between the data and model predictions.

Figure 5: Aggregate Welfare and Fiscal Externalities

(a) Aggregate Welfare

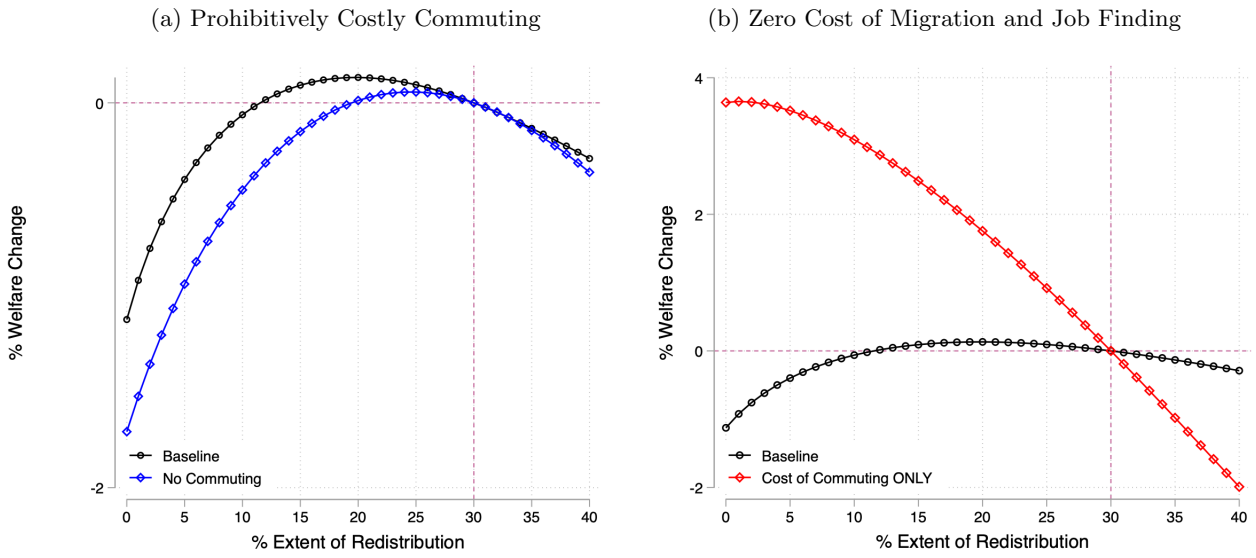



(b) Fiscal Externalities




*Note*: This figure plots changes in aggregate consumption-equivalent worker welfare relative to the baseline welfare level, where the extent of redistribution equals 0.3—the observed value in 2015. The extent of fiscal spillovers is measured by the dispersion of local government goods and services net of individual tax contributions, capturing the degree to which workers in different districts benefit from inter-district fiscal spillovers.

Figure 6: Aggregate Welfare Changes under Alternative Assumptions in the Literature




*Note*: This figure presents welfare changes under two alternative assumptions about spatial frictions and compare them to the changes computed based on the extended gravity framework (as in Panel (a) of Figure 5) in black. In Panel (a), I follow the migration literature and assume that workers cannot work outside their district of residence. I solve for a new 2015 equilibrium assuming distance elasticities of migration, commuting, and job search equal to 0.007, $\infty$, and 0, respectively, and plot welfare changes relative to the 2015 baseline (extent of redistribution = 30%) in blue diamond. In Panel (b), I follow the commuting literature and assume migration and job search are costless, setting their distance elasticities to 0 and that of commuting to 0.074, and again plot welfare changes relative to the 2015 baseline in red diamond.

# The Spatial Distribution of Public Spending, Commuting, and Migration

# Online Appendix

Wookun Kim

## A Data Appendix

### Wages

I construct district-level wages using the 2015 Economic Census of South Korea, which surveys the universe of establishments nationwide. The Census reports the total labor cost and the number of employees for each establishment. For each district, I aggregate these two variables across establishments and compute the average wage as the ratio of total labor cost to total employment.

### Floor Space Prices

Data on floor space prices are obtained from the universe of housing transaction records provided by the Ministry of Land, Infrastructure, and Transport. I use transaction-level data from 2006 (the earliest available year) to 2015. Each record includes information on the property's district, month and year of purchase, year built, lot size, and other characteristics. To obtain representative district-level floor space prices in 2015, I apply a Case-Shiller-type repeated sales approach at the district level. Specifically, I regress the logarithm of unit prices on a full set of fixed effects for year built, month of purchase, and year of purchase (excluding 2015), along with district fixed effects. The estimated district fixed effects (normalized so that their geometric mean equals one) serve as the district-level floor space prices for 2015.

### Additional District-Level Characteristics

I supplement the analysis with district-level statistics from KOSIS (Korean Statistical Information Service). In particular, I use the number of firms in each district to cross-validate the model-implied productivity and amenity values. Additionally, I collect data on the total land area used for residential purposes from the Land Use Statistics published by the Ministry of Land, Infrastructure, and Transport.

### Annual Migration Rates

To gauge the magnitude of migration rates across districts and provinces (groups of districts), I use restricted-access administrative records from the national migrant registry of South Korea. Although these data are not used in the main empirical analysis—because they lack information

on commuting destinations—they allow me to compute annual migration rates and compare their magnitudes to those observed in the United States.

### Labor Share and Housing Expenditure Share

I calibrate the labor share in production and the housing expenditure share using official statistics from the 2015 Economic Census and the 2015 Household Expenditure Survey. The labor share is set to match the ratio of total labor costs to total production costs (including labor and land/building expenses). The housing expenditure share is calibrated as the ratio of housing-related expenses (e.g., rent and mortgage payments) to total household expenditures, averaged across quarterly reports in 2015.

# B Additional Empirical Evidence

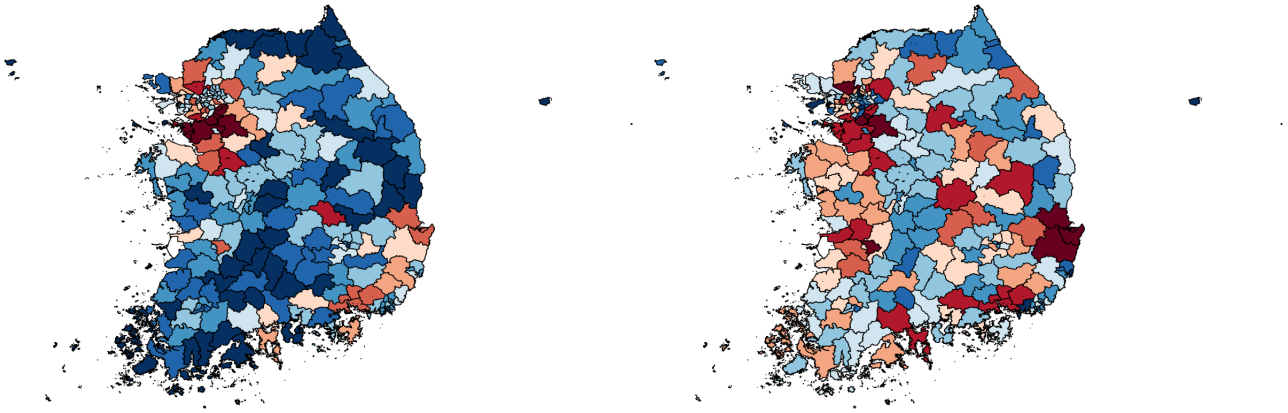
## B.1 Additional Figures and Tables

## B.2 Local Income Taxes and Intergovernmental Transfers

Figure A.1: Sources of Local Government Spending

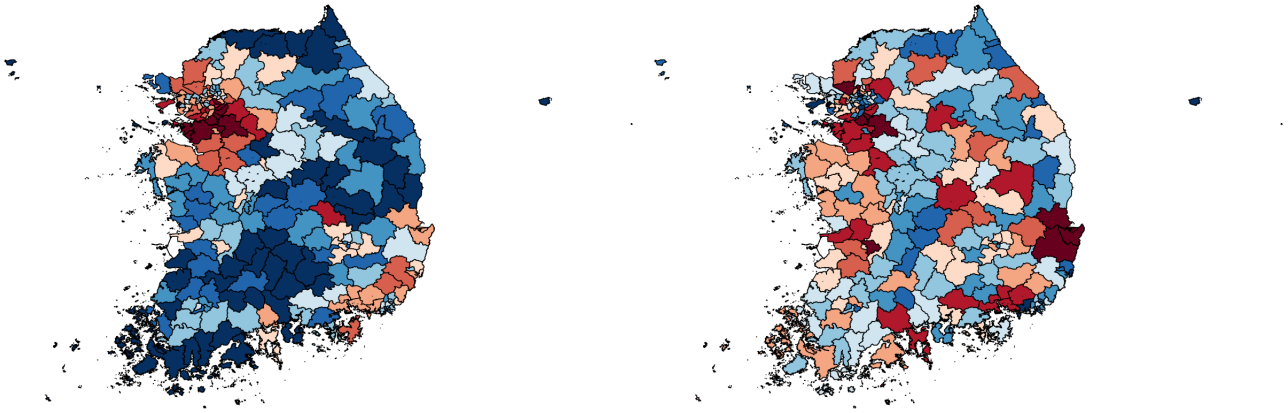
(a) Local Income Tax

(b) Intergovernmental Transfers



(c) Local Income Tax Share

(d) Redistribution Parameters



*Note*: This figure illustrates the spatial distribution of local government spending and its revenue sources in 2015. Panels (a) and (b) display the spatial distribution of local government revenues derived from local income taxes and intergovernmental transfers, respectively. Panel (c) shows the share of local government spending financed by local income tax revenue in each district. Panel (d) plots the redistribution rules, defined as the share of total intergovernmental transfers allocated to each district relative to the aggregate transfer pool across all districts.

Table A.1: Distance Elasticity of Migration

| Dependent Variable: | (1) $\ln \pi_{orm,t}$ | (2) $\ln \pi_{orm,t}$ | (3) $\ln \pi_{orm,t}$ | (4) $\ln \pi_{orm,t}$ |
|---|---|---|---|---|
| Distance, $d_{or}$ $(-\rho\epsilon)$ | $-0.0026^{***}$ | $-0.0044^{***}$ | $-0.0328^{***}$ | $-0.0328^{***}$ |
| | (0.0001) | (0.0001) | (0.0009) | (0.0013) |
| Distance × 2005 | | | | 0.0003 |
| | | | | (0.0019) |
| Distance × 2010 | | | | −0.0004 |
| | | | | (0.0019) |
| Observations | 257,583 | 257,583 | 257,583 | 257,583 |
| Fixed Effects: | | | | |
| Commuting Pair × Year ($\phi_{rm,t}$) | N | Y | Y | Y |
| Job Finding Pair × Year ($\phi_{om,t}$) | N | N | Y | Y |

*Notes*: This table reports the estimation results for the distance elasticity of migration using data from the 2005, 2010, and 2015 Population Census of South Korea. Each observation corresponds to a triplet of previous residence, current residence, and workplace location. The estimation follows Equation 11. Across columns, I progressively introduce fixed effects: no fixed effects in Column 1, commuting-pair-by-year fixed effects in Column 2, and job-finding-pair-by-year fixed effects in Column 3. Column 4 examines whether the estimated semi-elasticity of migration is time-invariant. Standard errors are multi-way clustered and heteroskedasticity robust: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.2: Distance Elasticity of Commuting

| Dependent Variable: | (1) $\ln \pi_{orm,t}$ | (2) $\ln \pi_{orm,t}$ | (3) $\ln \pi_{orm,t}$ | (4) $\ln \pi_{orm,t}$ |
|---|---|---|---|---|
| Distance, $d_{rm}$ $(-\kappa\epsilon)$ | $-0.0083^{***}$ | $-0.0350^{***}$ | $-0.0450^{***}$ | $-0.0460^{***}$ |
| | (0.0004) | (0.0005) | (0.0006) | (0.0009) |
| Distance × 2005 | | | | 0.0008 |
| | | | | (0.0013) |
| Distance × 2010 | | | | $0.0028^{**}$ |
| | | | | (0.0013) |
| Observations | 257,583 | 257,583 | 257,583 | 257,583 |
| Fixed Effects: | | | | |
| Migration Pair × Year ($\phi_{or,t}$) | N | Y | Y | Y |
| Job Finding Pair × Year ($\phi_{om,t}$) | N | N | Y | Y |

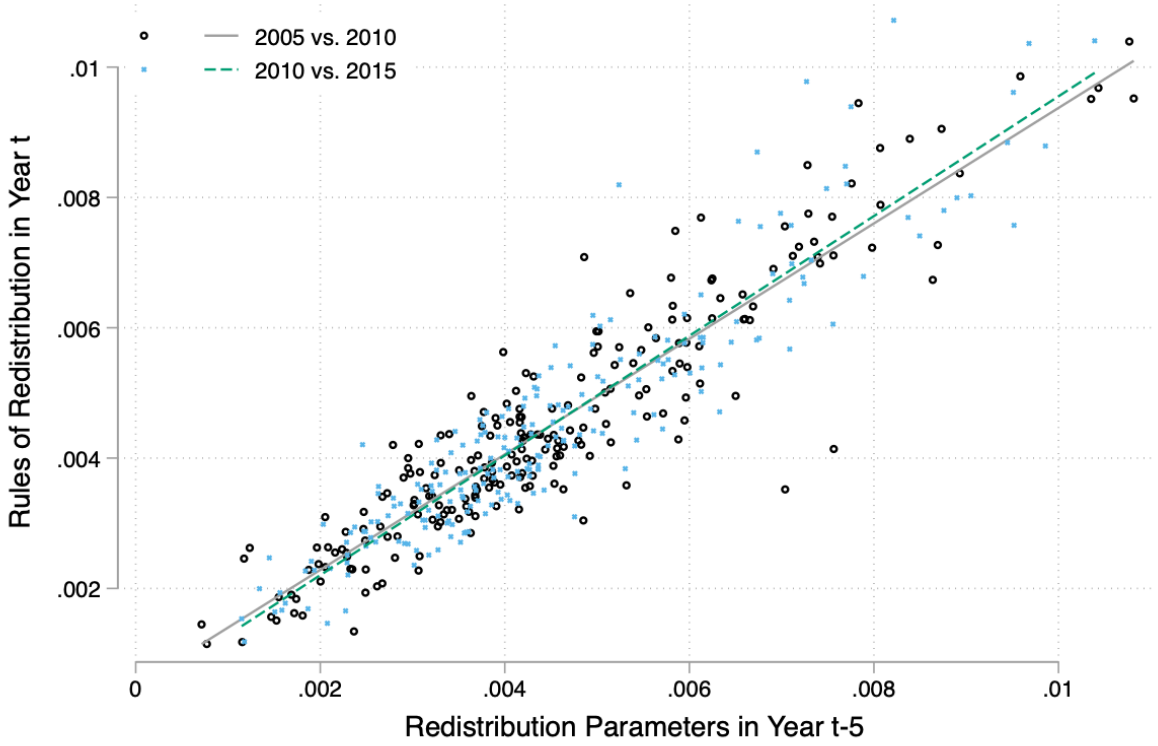
*Notes*: This table reports the estimation results for the distance elasticity of commuting using data from the 2005, 2010, and 2015 Population Census of South Korea. Each observation corresponds to a triplet of previous residence, current residence, and workplace location. The estimation follows Equation 13. Across columns, I progressively introduce fixed effects: no fixed effects in Column 1, migration-pair-by-year fixed effects in Column 2, and job-finding-pair-by-year fixed effects in Column 3. Column 4 tests whether the estimated semi-elasticity of commuting is time-invariant. Standard errors are multi-way clustered and heteroskedasticity robust: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.3: Distance Elasticity of Job Finding

| Dependent Variable: | (1) $\ln \pi_{orm,t}$ | (2) $\ln \pi_{orm,t}$ | (3) $\ln \pi_{orm,t}$ | (4) $\ln \pi_{orm,t}$ |
|---|---|---|---|---|
| Distance, $d_{om}$ $(-\delta\epsilon)$ | $-0.0024^{***}$ | $-0.0040^{***}$ | $-0.0157^{***}$ | $-0.0150^{***}$ |
| | (0.0001) | (0.0001) | (0.0003) | (0.0004) |
| Distance × 2005 | | | | $-0.0015^{**}$ |
| | | | | (0.0007) |
| Distance × 2010 | | | | $-0.0009$ |
| | | | | (0.0006) |
| Observations | 257,583 | 257,583 | 257,583 | 257,583 |
| Fixed Effects: | | | | |
| Commuting Pair × Year ($\phi_{rm,t}$) | N | Y | Y | Y |
| Migration Pair × Year ($\phi_{or,t}$) | N | N | Y | Y |

*Notes*: This table reports the estimation results for the distance elasticity of job finding using data from the 2005, 2010, and 2015 Population Census of South Korea. Each observation corresponds to a triplet of previous residence, current residence, and workplace location. The estimation follows Equation 15. Across columns, I progressively introduce fixed effects: no fixed effects in Column 1, commuting-pair-by-year fixed effects in Column 2, and migration-pair-by-year fixed effects in Column 3. Column 4 tests whether the estimated semi-elasticity of job finding is time-invariant. Standard errors are multi-way clustered and heteroskedasticity robust: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure A.2: Redistribution Parameters over Time




*Note*: This figure compares the rules of redistribution across 2005, 2010, and 2015. For each year, the rule of redistribution is defined as a district-specific policy parameter equal to the share of intergovernmental transfers received by each district relative to the total amount redistributed across all districts. The estimated slopes are 0.982 ($SE = 0.012$) when comparing 2005 to 2010 and 0.988 ($SE = 0.012$) when comparing 2010 to 2015, indicating stability in the redistribution rules over time.

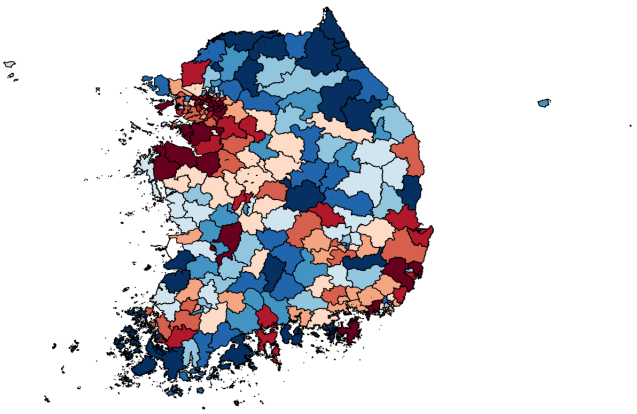
Table A.4: OLS Estimates of Elasticities of Worker Mobility

| Dependent Variable: $\ln \pi_{orm,t}$ | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Local Gov't Expenditure, $\ln G_{r,t}$ $(\beta_G = \lambda\epsilon)$ | $-0.231^{***}$ | $0.096^{**}$ | 0.096 | $0.087^{***}$ |
| | (0.015) | (0.037) | (0.127) | (0.027) |
| Number of Households, $\ln R_{r,t}$ $(\beta_R = \theta\lambda\epsilon)$ | $0.120^{***}$ | $0.063^{**}$ | 0.298 | $0.593^{***}$ |
| | (0.012) | (0.025) | (0.196) | (0.047) |
| Floor Space Price, $\ln Q_{r,t}$ $(\beta_Q = (1-\beta)\epsilon)$ | $-0.042^{***}$ | $-0.011$ | 0.006 | $-0.002$ |
| | (0.013) | (0.031) | (0.030) | (0.006) |
| Observations | 257,174 | 257,174 | 257,174 | 257,174 |
| Fixed Effects: | | | | |
| Job Finding Pair × Year $(\phi_{om,t})$ | N | Y | Y | Y |
| Migration Pair $(\phi_{or})$ | N | N | Y | Y |
| Commuting Pair $(\phi_{rm})$ | N | N | N | Y |

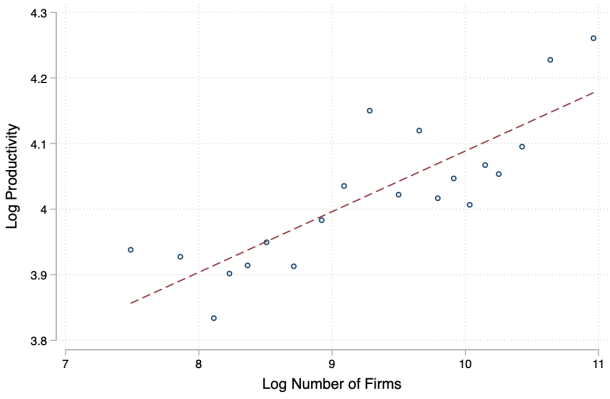
*Notes*: This table reports the OLS estimates of the elasticities of workers' spatial mobility with respect to local government expenditure and resident population levels, based on Equation 16. Column 1 presents the OLS estimates without any fixed effects. Starting in Column and across columns, I introduce additional fixed effects. Column 4 includes the full set of fixed effects discussed in Section 5.1. The sample is constructed from the 2005, 2010, and 2015 Population Census of South Korea, with each observation corresponding to a triplet of previous residence, current residence, and workplace location. Robust standard errors are reported for Columns 1–4, with multi-way clustering: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure A.3: Recovered Values of Local Productivity Fundamentals

(a) Spatial Distribution



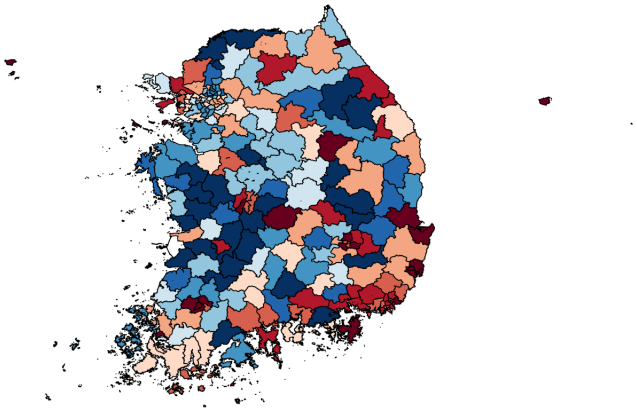
(b) Productivity vs. Number of Firms



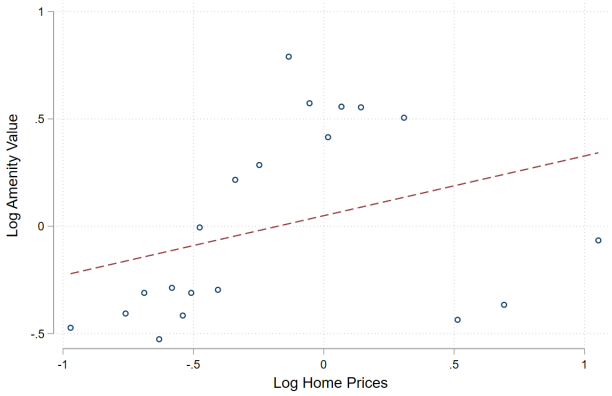

*Note*: This figure illustrates the spatial distribution of local productivity fundamentals recovered from the model using 2015 data in Panel (a) and their correlation with the number of firms observed in 2015 in Panel (b).

Figure A.4: Recovered Values of Local Amenity Fundamentals

(a) Spatial Distribution



(b) Amenity vs. Home Prices




*Note*: This figure shows the spatial distribution of local amenity fundamentals recovered from the model using 2015 data in Panel (a) and their correlation with home prices observed in 2015 in Panel (b).

## B.3 Validity of Instrumental Variables based on the Tax Reforms with Sorting

The quantitative spatial model presented in this paper assumes that workers are born with initial residences and have heterogeneous preferences over locations but are otherwise homogeneous. Hence, I abstract from potential reallocations of workers based on sorting. Nevertheless, residential locations with a greater share of higher-educated (skilled) residents may exhibit higher amenity values relative to other areas (Diamond, 2016). In this case, the error term in Equation 16 would implicitly include the distribution of workers by education, denoted $\pi_{edu|r,t}$.

Even if educational sorting were explicitly incorporated into the model, the validity of the instrumental variables proposed in Section 5.1 would remain intact as long as the fiscal reforms did not systematically alter the relative attractiveness of residential locations by changing their educational composition. Because the Population Census of South Korea provides contemporaneous information on the educational distribution of workers, I can empirically test whether the national tax reforms directly affected the educational composition of residents. To do so, I estimate the following specification:

$$\pi_{b|r,t} = \phi_r + \eta_{b',b}\tau_{b',t} + \zeta_{b,r,t}, \tag{A.1}$$

where the dependent variable $\pi_{b|r,t}$ is the demeaned fraction of workers with educational level $b$ (low and high, which proxy for the low- and high-income brackets in the tax schedule) residing in district $r$ in year $t$; $\phi_r$ denotes residence fixed effects capturing baseline differences across districts; and $\tau_{b',t}$ represents the national income tax rate for income bracket $b'$ in year $t$. Conditional on residence fixed effects, if the estimated coefficient $\eta_{b',b}$ is statistically indistinguishable from zero, I fail to reject the hypothesis that changes in tax rates for income group $b'$ did not affect the educational composition of residents with education level $b$ across districts.

Table A.5 reports the estimation results. None of the coefficients are statistically different from zero, nor are they economically significant. In sum, I conclude that the national tax reforms did not alter the relative attractiveness of residential locations through changes in their educational composition. Therefore, the predicted tax contributions of low- and high-income groups are orthogonal to the contemporaneous distribution of education across districts.

## B.4 Redistribution Weights

The primary objective of the *Local Subsidy Act*, which determines the rules of redistribution, is to promote equitable economic growth across localities. Consequently, the rules of redistribution are expected to favor districts that are intrinsically less attractive to live in (low values of $\tilde{B}_j$) and fiscally weaker (low $TR_j$), thereby encouraging economic development in these areas. Understanding the determinants of the redistribution rules is essential because the counterfactual policy experiments in the subsequent section hold these observed rules fixed.

To formally analyze the determinants of the redistribution rules observed in 2015, I regress the logarithm of the observed redistribution parameter, $\ln \varsigma_j$, on the logarithm of residential density ($R_j$), recovered amenity values ($\tilde{B}_j$), local productivity ($A_j$), and employment density ($L_j$).

Table A.5: Tax Reform Effects on Resident Composition by Education

| | (1) | (2) | (3) |
|---|---|---|---|
| A. Educational Attainment: Low ($\pi_{low\|r,t}$) | | | |
| Tax Rate (Low) $\tau_{low,t}$ | 1.37e-10 | | -1.64e-9 |
| | (0.00115) | | (0.00169) |
| Tax Rate (High) $\tau_{high,t}$ | | 1.62e-10 | 1.19e-9 |
| | | (0.00074) | (0.00104) |
| B. Educational Attainment: High ($\pi_{high\|r,t}$) | | | |
| Tax Rate (Low) $\tau_{low,t}$ | -1.55e-09 | | -1.50e-08 |
| | (0.00058) | | (0.00134) |
| Tax Rate (High) $\tau_{high,t}$ | | -3.88e-10 | 8.96e-09 |
| | | (0.00038) | (.000904) |
| Observations | 666 | 666 | 666 |

Notes: This table reports the estimation results based on Equation A.1. Each estimated coefficient represents the effect of changes in national income tax rates on changes in the educational composition of residents. The sample is constructed from three waves of the Population Census of South Korea (2005, 2010, and 2015). Each observation corresponds to a residence-year pair. Robust standard errors, clustered at the residence level, are reported in parentheses: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Table A.6 reports the estimation results. In Column 1, the coefficient on log residential density is positive and statistically significant, indicating that more densely populated districts receive higher redistribution shares, conditional on geographic size. Introducing the recovered amenity and productivity values in Columns 2 and 3, I find that districts with higher amenity values and productivity receive smaller shares of intergovernmental transfers. Finally, in Column 4, I show that employment density has no statistically significant effect on the redistribution rules.

Table A.6: Determinants of Redistribution Weights

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Dependent Variable: | Redistribution Weights ($\ln \varsigma_r$) | | | |
| Residential Population ($\ln R_r$) | $0.3730^{***}$ | $0.4071^{***}$ | $0.4595^{***}$ | $0.5251^{***}$ |
| | (0.0170) | (0.0183) | (0.0183) | (0.0585) |
| Residential Amenities ($\ln \tilde{B}_r$) | | $-0.1242^{***}$ | $-0.1321^{***}$ | $-0.1324^{***}$ |
| | | (0.0264) | (0.0212) | (0.0211) |
| Workplace Productivity ($\ln A_r$) | | | $-0.6222^{***}$ | $-0.5427^{***}$ |
| | | | (0.0781) | (0.1114) |
| Employment Population ($\ln L_r$) | | | | $-0.0795$ |
| | | | | (0.0694) |
| Area ($\ln Area_r$) | $0.2023^{***}$ | $0.1962^{***}$ | $0.1822^{***}$ | $0.1848^{***}$ |
| | (0.0109) | (0.0113) | (0.0090) | (0.0085) |
| Observations | 222 | 222 | 222 | 222 |
| Adjusted $R^2$ | 0.663 | 0.698 | 0.774 | 0.774 |

*Notes*: In this table, I examine the determinants of the rules of redistribution by regressing them on local characteristics. The dependent variable is the logarithm of the share of intergovernmental transfers received in 2015. Column 1 includes residential density and land area as covariates, and additional local characteristics are sequentially introduced across columns. Each observation corresponds to a district in 2015.

# C Supplementary Theoretical Results

## C.1 Derivation of the Extended Gravity Equation in Section 3

Because indirect utility equals the idiosyncratic component of utility ($z_{orm}$) multiplied by the systematic component ($v_{orm}$ in Equation 3), the utility distribution for a worker from origin $o$ living in district $r$ and working in district $m$ is also Fréchet distributed. Therefore, the cumulative distribution function (CDF) of utility is:

$$F_{rm}(u) = \Pr[U \leq u] = \Pr(z \leq u \times v_{orm}^{-1}), \tag{A.2}$$

where $z \sim G(z) = \exp(-T_r M_m z^{-\epsilon})$. It follows that:

$$F_{rm}(u) = \exp\left(-\frac{T_r M_m B_r (1-\tau_m) w_m}{D_{orm} Q_r^{1-\beta}} \left(\frac{G_r}{R_r^{\theta}}\right)^{\lambda} u^{-\epsilon}\right) \equiv \exp(-\Phi_{orm} u^{-\epsilon}), \tag{A.3}$$

where $\Phi_{orm}$ summarizes all location-specific attributes affecting the distribution of utility. Let $f_{rm}$ denote the corresponding density function. Conditional on origin $o$, workers choose the residence-workplace pair $(r, m)$ that maximizes utility. Hence, the probability of choosing a particular pair $(r, m)$ given origin $o$ is:

$$\begin{aligned}\pi_{rm|o} &= \Pr[u_{rm|o} \geq \max\{u_{jk}\}; \forall j, k] \\ &= \int_0^\infty \prod_{k \neq j} F_{rk}(u) \left( \prod_{j \neq r} \prod_{k} F_{jk}(u) \right) f_{rm}(u)\, du \\ &= \int_0^\infty \epsilon \Phi_{orm} u^{-(\epsilon+1)} \exp\left(-\Phi_o u^{-\epsilon}\right) du,\end{aligned}$$

where $\Phi_o = \sum_{r=1}^{J} \sum_{m=1}^{J} \Phi_{orm}$. Evaluating this integral yields the probability of choosing residence $r$ and workplace $m$ conditional on origin $o$:

$$\pi_{rm|o} = \frac{T_r M_m \left( \frac{B_r (1-\tau_m) w_m}{D_{orm} Q_r^{1-\beta}} \left( \frac{G_r}{R_r^\theta} \right)^\lambda \right)^\epsilon}{\sum_{r'=1}^{J} \sum_{m'=1}^{J} T_{r'} M_{m'} \left( \frac{B_{r'} (1-\tau_{m'}) w_{m'}}{D_{or'm'} Q_{r'}^{1-\beta}} \left( \frac{G_{r'}}{R_{r'}^\theta} \right)^\lambda \right)^\epsilon} \equiv \frac{\Phi_{orm}}{\Phi_o}. \tag{A.4}$$

Because the maximum of a sequence of Fréchet-distributed random variables is also Fréchet distributed, the distribution of the maximum utility for workers from origin $o$ is:

$$F_o(u) = \exp(-\Phi_o u^{-\epsilon}), \quad \text{where} \quad \Phi_o = \sum_{r=1}^{J} \sum_{m=1}^{J} \frac{T_r M_m B_r (1-\tau_m) w_m}{D_{orm} Q_r^{1-\beta}} \left( \frac{G_r}{R_r^\theta} \right)^\lambda. \tag{A.5}$$

From this distribution, the expected utility for workers originating from $o$ is given by:

$$\mathbb{E}[u|o] = \int_0^\infty \epsilon \Phi_o u^{-\epsilon} e^{-\Phi_o u^{-\epsilon}} du = \Gamma\left( \frac{\epsilon - 1}{\epsilon} \right) \Phi_o^{1/\epsilon} \equiv \bar{u}_o. \tag{A.6}$$

## C.2 Isomorphism of the Gravity Equation

I show that the gravity equation is isomorphic to the types of gravity equations derived in the literature on costly movements of people, such as commuting and migration.

### Commuting Literature

The literature on commuting decisions typically assumes costless migration and job finding. As a result, it does not model how workers are initially distributed across space before making their commuting decisions. The underlying assumption is that there are no frictions to migration or job finding beyond idiosyncratic shocks specific to each commuting possibility. In my framework, this corresponds to setting both $\rho$ and $\delta$ equal to zero in the model presented in section 3.

Under this assumption, the distribution of workers by current residence and workplace is independent of their initial residence. Consequently, Equation 6 does not vary by initial origin $o$ and can be expressed as:

$$\pi_{rm} = \frac{T_r M_m \left( \frac{B_r(1-\tau_m)w_m}{D_{rm} Q_r^{1-\beta}} \left( \frac{G_r}{R_r^{\theta}} \right)^{\lambda} \right)^{\epsilon}}{\sum_{r'=1}^{S} \sum_{m'=1}^{S} T_{r'} M_{m'} \left( \frac{B_{r'}(1-\tau_{m'})w_{m'}}{D_{r'm'} Q_{r'}^{1-\beta}} \left( \frac{G_{r'}}{R_{r'}^{\theta}} \right)^{\lambda} \right)^{\epsilon}}, \tag{A.7}$$

where $D_{rm}$ denotes the commuting cost, which is an increasing function of the distance between $r$ and $m$.

Further assuming no wage tax (i.e., $\tau_m = 0$ for all $m$) and no utility derived from local government goods and services (i.e., $\lambda = 0$), Equation A.7 closely resembles the gravity equations derived in spatial models such as those of Ahlfeldt et al. (2015) and Monte et al. (2018).

**Migration Literature**

The literature on migration decisions typically examines movements of people across relatively large spatial units, where workers are assumed to both live and work in the same location after migrating. Accordingly, there is no distinction between workplace and residence in these models, as commuting within a spatial unit is implicitly costless while working outside one's residential area is ruled out. In my framework, this setting can be represented by assuming that the commuting cost to any workplace outside the residential district is prohibitively large, i.e., $D_{rm} = \infty$ for all $r \neq m$. Under this assumption, the migration patterns of workers are summarized by:

$$\pi_{or} = \frac{T_r M_r \left( \frac{B_r(1-\tau_r)w_r}{D_{or} Q_r^{1-\beta}} \left( \frac{G_r}{R_r^{\theta}} \right)^{\lambda} \right)^{\epsilon} \pi_o}{\sum_{r'=1}^{S} T_{r'} M_{r'} \left( \frac{B_{r'}(1-\tau_{r'})w_{r'}}{D_{or'} Q_{r'}^{1-\beta}} \left( \frac{G_{r'}}{R_{r'}^{\theta}} \right)^{\lambda} \right)^{\epsilon}}, \tag{A.8}$$

where $D_{or}$ denotes the iceberg cost associated with migration, which increases with the distance between the origin $o$ and the destination $r$.

Assuming no tax on wages (i.e., $\tau_r = 0$ for all $r$) and no utility derived from local government goods and services (i.e., $\lambda = 0$), Equation A.8 reduces to a structure closely resembling the gravity equations in the spatial migration models of Bryan and Morten (2019) and Morten and Oliveira (2024).

# D Quantitative Spatial GE Model: Details

I model the production of consumption goods and the allocation of floor space between residential and commercial uses. Local government spending is determined by national fiscal policies governing taxation, revenue sharing, and the rules of redistribution. In equilibrium, wages, floor-

space prices, and local government spending are endogenously determined together with the spatial distribution of workers. Finally, I define the spatial general equilibrium of the economy that jointly characterizes these endogenous outcomes.

## D.1 More on Workers' Location Decisions

I characterize the market-clearing conditions for migration and commuting based on the gravity equation (Equation 6) derived in Section 3. Summing the probabilities of choosing residence $r$ and workplace $m$ conditional on moving from origin $o$ across workplaces yields the probability of migrating to $r$ given origin $o$:

$$\pi_{r|o} = \sum_{m=1}^{J} \frac{\pi_{orm}}{\pi_o} = \frac{\sum_{m=1}^{J} \Phi_{orm}}{\Phi_o}$$
$$= \frac{T_r \left( \frac{B_r}{D_{or} Q_r^{1-\beta}} \left( \frac{G_r}{R_r^{\theta}} \right)^{\lambda} \right)^{\epsilon} \sum_{m=1}^{J} M_m \left( \frac{(1-\tau_m) w_m}{D_{om} D_{rm}} \right)^{\epsilon}}{\sum_{r'=1}^{J} T_{r'} \left( \frac{B_{r'}}{D_{or'} Q_{r'}^{1-\beta}} \left( \frac{G_{r'}}{R_{r'}^{\theta}} \right)^{\lambda} \right)^{\epsilon} \underbrace{\sum_{m'=1}^{J} M_{m'} \left( \frac{(1-\tau_{m'}) w_{m'}}{D_{r'm'} D_{om}} \right)^{\epsilon}}_{ALMA_{or'}}}.$$

Workers are more likely to migrate to districts with higher amenity values $B_r$, greater benefits from local public goods $\frac{G_r}{R_r^{\theta}}$, and lower per-unit floor space prices $Q_r$. Two bilateral determinants also shape migration: the probability of choosing residence $r$ declines with higher migration costs $D_{or}$ but rises with better access to labor markets discounted by commuting and job-finding frictions, $\sum_{m=1}^{J} M_m \left( \frac{(1-\tau_m) w_m}{D_{om} D_{rm}} \right)^{\epsilon}$, which I refer to as the *augmented labor market access* ($ALMA_{or}$). The migration market-clearing condition then requires that the number of workers residing in $r$ equals the total number migrating there from all origins $o$:

$$R_r = \sum_{o=1}^{J} \pi_{r|o} \pi_o R = \sum_{o=1}^{J} \frac{\left( \frac{\tilde{B}_r}{D_{or} Q_r^{1-\beta}} \left( \frac{G_r}{R_r^{\theta}} \right)^{\lambda} \right)^{\epsilon} ALMA_{or}}{\sum_{r'=1}^{J} \left( \frac{\tilde{B}_{r'}}{D_{or'} Q_{r'}^{1-\beta}} \left( \frac{G_{r'}}{R_{r'}^{\theta}} \right)^{\lambda} \right)^{\epsilon} ALMA_{or'}} \pi_o R. \tag{A.9}$$

Next, I derive the probability of commuting to workplace $m$ conditional on living in residence $r$. Taking the ratio of the unconditional joint distribution of workers by residence and workplace to the unconditional distribution of workers by residence gives:

$$\pi_{m|r} = \frac{\sum_{o=1}^{J} \pi_{orm}}{\sum_{m'=1}^{J}\sum_{o'=1}^{J} \pi_{o'rm'}} = \frac{\sum_{o=1}^{J} \Phi_{orm}\pi_o/\Phi_o}{\sum_{m'=1}^{J}\sum_{o'=1}^{J} \Phi_{o'rm'}\pi_{o'}/\Phi_{o'}}$$
$$= \frac{\left(\frac{(1-\tau_m)\tilde{w}_m}{D_{rm}}\right)^{\epsilon} \sum_{o=1}^{J} \frac{\pi_o/\Phi_o}{(D_{or}D_{om})^{\epsilon}}}{\sum_{m'=1}^{J}\left(\frac{(1-\tau_{m'})\tilde{w}_{m'}}{D_{rm'}}\right)^{\epsilon} \underbrace{\sum_{o'=1}^{J} \frac{\pi_{o'}/\Phi_{o'}}{(D_{o'r}D_{o'm'})^{\epsilon}}}_{AMMA_{rm'}}},$$

where terms specific to current residence (e.g., amenities, housing prices, government goods) cancel out from both numerator and denominator. Workers are thus more likely to commute to workplaces offering higher after-tax returns $((1-\tau_m)\tilde{w}_m)^{\epsilon}$ net of commuting costs $D_{rm}$. The conditional probability of commuting also depends on the indirect costs of migration and job search, summarized by $\sum_{o=1}^{J} \frac{\pi_o/\Phi_o}{(D_{or}D_{om})^{\epsilon}}$, which I define as *augmented migrant market access* ($AMMA_{rm}$). The corresponding commuting market-clearing condition requires that the number of workers employed in $m$ equals the total number commuting there from all residences:

$$L_m = \sum_{r=1}^{J} \pi_{m|r} R_r = \sum_{r=1}^{J} \frac{\left(\frac{(1-\tau_m)\tilde{w}_m}{D_{rm}}\right)^{\epsilon} AMMA_{rm}}{\sum_{m'=1}^{J}\left(\frac{(1-\tau_{m'})\tilde{w}_{m'}}{D_{rm'}}\right)^{\epsilon} AMMA_{rm'}} R_r. \tag{A.10}$$

Expected income for workers residing in district $r$ equals the sum of after-tax wages across all possible workplaces weighted by the commuting probabilities:

$$\mathbb{E}[(1-\tau_m)w_m|r] = \sum_{m=1}^{J} \frac{\left(\frac{(1-\tau_m)\tilde{w}_m}{D_{rm}}\right)^{\epsilon} AMMA_{rm}}{\sum_{m'=1}^{J}\left(\frac{(1-\tau_{m'})\tilde{w}_{m'}}{D_{rm'}}\right)^{\epsilon} AMMA_{rm'}} (1-\tau_m)w_m. \tag{A.11}$$

Expected income is higher in places with lower commuting costs $D_{rm}$ and higher $AMMA_{rm}$, reflecting lower indirect frictions to commuting. Since workers allocate $(1-\beta)$ of their income to housing, the residential floor-space demand is:

$$H_r^R = (1-\beta)\frac{\mathbb{E}[(1-\tau_m)w_m|r]R_r}{Q_r}. \tag{A.12}$$

Finally, population mobility implies that the ex-ante expected utility for each origin is equalized across all possible residence-workplace pairs:

$$\mathbb{E}[u_o] = \Gamma\left(\frac{\epsilon-1}{\epsilon}\right)\Phi_o^{1/\epsilon} = \Gamma\left(\frac{\epsilon-1}{\epsilon}\right)\left[\sum_{r'=1}^{J}\sum_{m'=1}^{J}\left(\frac{\tilde{B}_{r'}(1-\tau_{m'})\tilde{w}_{m'}}{D_{or'm'}Q_{r'}^{1-\beta}}\left(\frac{G_{r'}}{R_{r'}^{\theta}}\right)^{\lambda}\right)^{\epsilon}\right]^{1/\epsilon} \equiv \bar{u}_o, \tag{A.13}$$

where the expectation is taken over the distribution of the idiosyncratic utility component. Using this expression, I construct a measure of economy-wide welfare while treating migration and job-

finding costs as sunk. This measure corresponds to the *consumption-equivalent welfare* of workers.

## D.2 Production

The tradable final good is produced under perfect competition and constant returns to scale with a Cobb-Douglas technology:

$$y_m = A_m L_m^{\alpha} \left(H_m^F\right)^{1-\alpha}, \tag{A.14}$$

where $A_m$ denotes total factor productivity, $L_m$ is labor input, and $H_m^F$ is commercial floor space. Profit maximization implies factor prices equal marginal products. Equivalently, the first-order conditions deliver the conditional factor demands

$$L_m = \left(\frac{\alpha A_m}{w_m}\right)^{\frac{1}{1-\alpha}} H_m^F, \tag{A.15}$$

and

$$H_m^F = \left(\frac{(1-\alpha) A_m}{Q_m}\right)^{\frac{1}{\alpha}} L_m, \tag{A.16}$$

so that labor demand is higher where productivity $A_m$ is larger, wages $w_m$ are lower, and commercial space is more abundant; analogously, the demand for commercial floor space is higher where $A_m$ is larger, the floor-space price $Q_m$ is lower, and employment $L_m$ is greater.

In equilibrium, wages $\{w_m\}$ adjust so that labor demand (Equation A.15) equals labor supply implied by the commuting market-clearing condition (Equation A.10) in every location $m$.

## D.3 Floor Space Market Clearing

Each district $j$ has a fixed stock of floor space $H_j$ that can be allocated to residential and commercial uses. Atomistic absentee landlords choose the allocation share $\vartheta_j \in [0,1]$ for commercial use and $(1-\vartheta_j)$ for residential use. Given a single floor-space price $Q_j$ that clears both markets, the residential and commercial floor-space market-clearing conditions are:

$$\underbrace{H_j^R}_{\text{residential demand}} = (1-\beta)\,\frac{\mathbb{E}[(1-\tau_m) w_m \mid r=j]\; R_j}{Q_j} = \underbrace{(1-\vartheta_j) H_j}_{\text{residential supply}}, \tag{A.17}$$

$$\underbrace{H_j^F}_{\text{commercial demand}} = \left(\frac{(1-\alpha) A_j}{Q_j}\right)^{\frac{1}{\alpha}} L_j = \underbrace{\vartheta_j H_j}_{\text{commercial supply}}, \tag{A.18}$$

where $H_j^R$ and $H_j^F$ denote, respectively, residential and commercial floor space, $R_j$ is the number of residents, and $L_j$ is employment in $j$.[46]

[46] The fixed-stock assumption is standard in urban models (Rosen, 1979; Roback, 1982; Tsivanidis, 2019) and, together with a flexible allocation across uses (Ahlfeldt et al., 2015; Monte et al., 2018; Tsivanidis, 2019), isolates the role of spatial reallocation and public spending without introducing slow-moving supply adjustments. While $H_j$

## D.4 National and Local Governments

Consistent with the institutional setting in Section 2.3, I model how local government spending is determined.

**National tax and revenue sharing.** The national government sets a progressive income tax schedule $\tau(w)$ that is increasing in income and applied uniformly across districts; for notational convenience, write $\tau(w_m) \equiv \tau_m$. Local-national revenue sharing implies that a fraction $\varsigma$ of locally collected income tax revenue is retained by the district, while the remaining $(1-\varsigma)$ is remitted to the national government. I refer to $\varsigma$ as the local retention rate.

**Intergovernmental transfers.** To supplement locally retained revenue, the national government earmarks a fraction $\chi$ of the nationally held pool (equivalently, $(1-\varsigma)\chi$ of total local income tax revenue) for redistribution via intergovernmental transfers. District $j$ receives share $\varsigma_j \geq 0$, with $\sum_{j=1}^{J} \varsigma_j = 1$; I refer to $\{\varsigma_j\}_{j=1}^{J}$ as the *rules of redistribution*. The remaining nationally held funds, $(1-\varsigma)(1-\chi)$ of total local income tax revenue, finance national public goods (e.g., defense, diplomacy) that benefit all workers symmetrically regardless of residence or workplace. For convenience, define the *extent of fiscal decentralization* as

$$\tilde{\chi} \;\equiv\; \varsigma + (1-\varsigma)\chi,$$

the fraction of total income tax revenue ultimately spent by local governments (either directly from retention or through transfers).

**Local budget and spending.** Given national fiscal parameters $\left\{\{\tau_m\}_{m=1}^{J},\ \varsigma,\ \chi,\ \{\varsigma_j\}_{j=1}^{J}\right\}$ and equilibrium objects—residential population $R_j$, commuting probabilities $\{\pi_{m|j}\}_{m=1}^{J}$, and wages $\{w_m\}_{m=1}^{J}$—the local government budget in district $j$ satisfies

$$G_j = \varsigma \underbrace{\sum_{m=1}^{J} \tau_m w_m \, \pi_{m|j} \, R_j}_{TR_j} + \varsigma_j \left(\tilde{\chi} - \varsigma\right) \sum_{j'=1}^{J} TR_{j'}, \tag{A.19}$$

where $TR_j \equiv \sum_{m=1}^{J} \tau_m w_m \, \pi_{m|j} \, R_j$ denotes income tax revenue collected from residents of $j$. The first term in (A.19) is locally retained revenue; the second term is the intergovernmental transfer allocated to $j$ from the nationally administered pool.

**Redistribution across districts.** Depending on the rules of redistribution, district $j$ may receive transfers that exceed its contribution to the national pool (i.e., $\varsigma_j > TR_j / \sum_{j'} TR_{j'}$) or fall short of

is fixed in the short run, the allocation $\vartheta_j$ adjusts endogenously. Following the urban literature, absentee landlords simplify incidence without capturing the full GE feedbacks discussed in Redding and Rossi-Hansberg (2017). An extension could allow land-use regulations or zoning wedges that segment $Q_j$ by use, as in Ahlfeldt et al. (2015); Tsivanidis (2019).

it. Hence, the spatial distribution of local spending $\{G_j\}$ reflects cross-district transfers governed by $\{\varsigma_j\}$. This mechanism is structurally akin to lump-sum transfer schemes analyzed in Fajgelbaum and Gaubert (2018) and, more broadly, to place-based policies studied in Glaeser and Gottlieb (2008); Kline and Moretti (2014).

### D.5 General Equilibrium

Given vectors of exogenous location characteristics $\{T_j, M_j, B_j, A_j, d_{jk}, H_j\}$, initial distribution of workers $\{\pi_o\}$, total measure of workers $R$, national fiscal policies $\{\tau_j, \varsigma, \chi, \varsigma_j\}$, and model parameters $\{\alpha, \beta, \lambda, \theta, \kappa, \rho, \delta, \epsilon\}$, a general equilibrium of this economy is defined as a vector of endogenous objects $\{R_j, L_j, w_j, Q_j, \vartheta_j, G_j, \bar{u}_o\}$. These seven components of the equilibrium vector are determined by the migration market clearing (A.9), commuting market clearing (A.10), labor market clearing (A.15), floor space market clearing for residential and commercial uses (A.17 and A.18), local government budget balancing equation (A.19), and population mobility (A.13)

## E Parameterization of the GE Model

I have estimated one structural parameter governing the extent of rivalry associated with benefits from local government spending ($\theta$) in section 5 and five reduced-form elasticities: the elasticities of worker mobility to local government expenditure ($\lambda\epsilon$) and to home prices ($(1-\beta)\epsilon$) in Section 5 and the semi-elasticities of migration, commuting, and job finding with respect to distance ($\rho\epsilon$, $\kappa\epsilon$, $\delta\epsilon$) in Section 4. In this section, I discuss how I estimate the rest of the model parameters and recover unobserved local characteristics for year 2015.

### E.1 Fréchet Shape Parameter

I estimate the Fréchet shape parameter, which is equivalent to the elasticity of worker mobility with respect to wage. I begin by deriving the expression for the probabilities of working in $m$ conditional on living in $r$ and having moved from $o$:

$$\pi_{m|ro} = \frac{\pi_{orm}}{\sum_{m'=1}^{J} \pi_{orm'}} = \frac{\Phi_{orm}}{\sum_{m'=1}^{J} \Phi_{orm'}} = \frac{\frac{\tilde{w}_m^{\epsilon}}{\exp(\kappa\epsilon d_{rm} + \delta\epsilon d_{om})}}{\sum_{m'=1}^{J} \frac{\tilde{w}_{m'}^{\epsilon}}{\exp(\kappa\epsilon d_{rm'} + \delta\epsilon d_{om'})}}. \tag{A.20}$$

I define a composite referred to as adjusted wages $\omega_j = \tilde{w}_j^{\epsilon} = M_j w_m^{\epsilon}$. I rewrite the above equation using adjusted wages and take the log transformation of both sides. Using my estimates of $\kappa\epsilon$ and $\delta\epsilon$ and rearranging such that left hand side consists of only observables, I obtain the following expression:

$$\ln \pi_{m|ro} + \kappa\epsilon d_{rm} + \delta\epsilon d_{om} = -\ln \sum_{m'=1}^{J} \frac{\omega_{m'}}{\exp(\kappa\epsilon d_{rm'} + \delta\epsilon d_{om'})} + \ln \omega_m, \tag{A.21}$$

where I treat $\kappa\epsilon d_{rm} + \delta\epsilon d_{om}$ as data and I observe $\ln \pi_{m|ro}$. The left hand side altogether can be decomposed into two parts: the first term that varies at the current residence and origin level and the second term that varies at the workplace level. Introducing stochastic errors to Equation A.21, I regress the left hand side on the pairwise fixed effects of current residence and origin and the workplace fixed effects. Then, I recover the values of log adjusted wages from the estimated workplace fixed effects. Note that these values are determined independent of $\epsilon$ based on the observed distribution of workers and the costs of commuting and job finding.

The parameter $\epsilon$ controls the variance of log adjusted wages ($\ln \omega_j$) relative to the variance of log observed wages ($\ln w_m^\epsilon$). That is, $\sigma^2_{\ln w_j} = \frac{1}{\epsilon^2}\sigma^2_{\ln \omega_j}$ because the parameters $M_j$ are deterministic. Therefore, I estimate the value of $\epsilon$ by taking the ratio of the standard deviations of log adjusted wages and log wages in the data after normalizing both to have geometric mean equal to 1. The resulting value of $\epsilon$ is equal to 3.43; this means the worker mobility increases by 3.43 percent for a 1 percent increase in wages.

There are several other papers which estimate the same parameter. Defining spatial units as U.S. counties from 2006 to 2010, Monte et al. (2018) finds a point estimate of the shape parameter equal to 3.3, while Ahlfeldt et al. (2015) estimate its value equal to 6.83 based on the inter-district commuting patterns in the city of Berlin in 2008. My estimate falls within the responsible range of the existing estimates in the literature. With the estimated value of $\epsilon$, I recover the structural parameters $(\lambda, \rho, \kappa, \rho)$ from the estimated reduced-form elasticities ($\lambda = \tilde{\lambda}/\epsilon$ =0.253, $\rho = \tilde{\rho}/\epsilon$ =-1.000, $\kappa = \tilde{\kappa}/\epsilon$ =-0.027, $\delta = \tilde{\delta}/\epsilon$ =-0.076). Furthermore, the estimated elasticity of worker mobility with respect to floor space prices reported in Table 3 is equal to $(1-\beta)\epsilon$. Based on the estimate of $\epsilon$ =3.43, the implied value of $1-\beta$ is equal to 0.013, close to the expenditure share estimated using the Household Expenditure Survey ($1-\beta$ =.125).

Based on the structural value of how much people of local government spending ($\lambda$ =0.253), I obtain the valuation of local government spending by computing the compensating variation. At the median values of per-capita local government spending (7,302 USD) and household income (18,180 USD) in 2015, workers are willing to give up 75 cent for a dollar increase in per-capita local government expenditure in their residence.

### E.2 Labor Share in Production and Housing Expenditure Share

First, the labor share ($\alpha$ =.868) is estimated by computing average share of labor cost to the total costs across districts reported in Economic Census in 2015, consistent with the findings of Valentinyi and Herrendorf (2008). Second, I set housing expenditure $1-\beta$ equal to .125 to match the observed housing expenditure share based on Household Expenditure Survey in 2015. This value is corroborated with the reported value reported in OECD (2016).

### E.3 National Fiscal Policy Parameters

The values of the national policy parameters are directly observed in a collection of laws governing local fiscal capacities (the Local Tax Act and the Local Subsidy Act). In 2015, $\varsigma$ =.091 of local

tax revenue retained after tax collection according to the Local Tax Act. The Local Subsidy Act allocates $\chi = .35$ of total local tax revenue delivered to the national government for redistribution. Because I observe the amount of intergovernmental transfers ($IT_j$) for each district, I recover the values for the redistribution parameters as follows:

$$\varsigma_j = \frac{IT_j}{\sum_{j'=1}^{J} IT_{j'}}. \tag{A.22}$$

The last national policy parameter of interest is the tax rates. The tax rates by income brackets are observed in the Income Tax Act as discussed in Section 5.1. However, the observed tax rates cannot be directly used because I do not observe the distribution of wages within each district, nor does the model feature wage dispersion within each locality. Instead, I calibrate a single tax rate $\tau$ by estimating the following equation:

$$\ln TR_j = \ln \tau + \ln w_j^R + \xi_j, \tag{A.23}$$

where $TR_j$ is the total tax revenue paid by workers living in $j$ and $w_j^R$ denotes the total wage earned by the workers (i.e., $w_j^R = w_m \pi_{m|j} R_j$). The estimated value of $\tau$ is .261.

## E.4 Recovery of Unobserved Local Characteristics

### Local Productivity

I recover the values for local productivity using the observed wages and floor space prices. To satisfy the profit maximization and zero profit conditions, equilibrium floor space prices must satisfy:

$$Q_j = (1-\alpha)\left(\frac{\alpha}{w_j}\right)^{\frac{\alpha}{1-\alpha}} A_j^{\frac{1}{1-\alpha}}. \tag{A.24}$$

Therefore, given the observed data on wages and floor space prices in 2015 and the parameter value of $\alpha$, I can recover $A_j$ for each district using the equilibrium condition above (A.24). Figure A.3 plots the spatial distribution of the recovered values of local productivity in Panel (a). The greater Seoul area, the Northwestern part of South Korea, has relatively greater values of productivity, as well as the some of the coastal districts with ports (e.g., the greater Busan area covering the Southeastern coast) consistent with coastal and port advantages studied in Balboni (2025) and Ducruet et al. (2019).[47]

### Adjusted Local Amenities

I recover adjusted amenity for each residence that rationalizes the observed spatial distribution of workers. Similarly to the process described when recovering the adjusted wages, I begin by

[47] The binned scatter plot in Panel (b) of Appendix Figure A.3 shows that the districts with higher levels of productivity have a greater number of firms.

deriving the expression for the conditional distribution of workers by their residences on workplace location and previous residence based on the gravity equation (6):

$$\pi_{r|mo} = \frac{\pi_{orm}}{\sum_{r'=1}^{J} \pi_{or'm}} = \frac{\Phi_{orm}}{\sum_{r'=1}^{J} \Phi_{or'm}} = \frac{\frac{\tilde{B}_r^{\epsilon} G_r^{\lambda\epsilon}}{\exp(\kappa\epsilon d_{rm} + \rho\epsilon d_{or}) Q_r^{(1-\beta)\epsilon} R_r^{\theta\lambda\epsilon}}}{\sum_{r'=1}^{J} \frac{\tilde{B}_{r'}^{\epsilon} G_{r'}^{\lambda\epsilon}}{\exp(\kappa\epsilon d_{r'm} + \rho\epsilon d_{or'}) Q_{r'}^{(1-\beta)\epsilon} R_{r'}^{\theta\lambda\epsilon}}}. \tag{A.25}$$

I take the log transformation of both sides of Equation (A.25) and rearrange such that left hand side only consists of observables:

$$\ln \pi_{r|mo} - \ln \frac{G_r^{\lambda\epsilon}}{\exp(\kappa\epsilon d_{rm} + \rho\epsilon d_{or}) Q_r^{(1-\beta)\epsilon} R_r^{\theta\lambda\epsilon}} = -\ln \sum_{r'=1}^{J} \frac{\tilde{B}_{r'}^{\epsilon} G_{r'}^{\lambda\epsilon}}{\exp(\kappa\epsilon d_{r'm} + \rho\epsilon d_{or'}) Q_{r'}^{(1-\beta)\epsilon} R_{r'}^{\theta\lambda\epsilon}} + \ln \tilde{B}_r^{\epsilon}, \tag{A.26}$$

where I treat the second term in the left hand side as data given the parameter values. Introducing stochastic errors, I regress the left hand side on the pairwise fixed effects of workplace and origin and the residence fixed effects. Then, I recover the values of log adjusted amenities from the estimated residence fixed effects (up to scale). Figure A.4 plots the spatial distribution of adjusted amenities in Panel (a). The metropolitan areas tend to have relatively higher amenity values, reflecting urban amenities. Also, the amenities are higher in the coastal areas, especially the coastal districts in the East and South. Residences with higher home prices tend to have higher amenities. While I do not formally investigate the relationship between weather and the recovered amenity values as in (Rappaport, 2007), I can infer that nice weather is positively correlated with the recovered amenities because coastal areas tend to have mild weather in Summer and Winter relative to inland districts. Therefore, proximity to the ocean in the coastal districts and its positive relationship with nice weather make coastal districts relatively more attractive.