PEOPLE'S MOBILITY, LABOR MARKET DISEQUILIBRIUM, AND RURAL DEVELOPMENT

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PEOPLE'S MOBILITY, LABOR MARKET DISEQUILIBRIUM, AND RURAL DEVELOPMENT

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We live in an era of mobility: moving of products, service, information, ideas, knowledge, culture and – most importantly – people. People's mobility connects places and is affected by the difference between places. Rural areas are losing young working adults to urban areas, but they are also attracting amenity-led urban in-migrants at the same time. The rural-urban connection by people and the rural-urban divide in development needs to be examined in a comprehensive research framework linking people's mobility with places.

This research creates a new spatial disequilibrium framework to analyze both commuting and migration. This framework integrates the individual mobility theory and location theory, and uses the county pair as the unit of analysis to link people from both the sending place and the receiving place. The spatial disequilibrium includes the local labor market mismatch in skill and employment within the sending place, as well as the regional disequilibrium between the sending place and the receiving place in the labor markets, housing markets, and amenity markets.

The empirical study uses the Group Logit model to examine factors driving people's commuting and migration between metro and nonmetro counties. In this way, this research implements the new spatial disequilibrium framework on rural

development. This research finds that the local labor market imbalance drives people's flow: if residents cannot find a skill matched job, or cannot find a local job they will move out. This research also find that homeownership and amenity cost impede rural residents' mobility, while homeownership in urban areas and a higher quality of amenity in rural areas motivates urban residents to move to rural communities.

This research provides several recommendations for rural development policy. Rural development could 1) decrease the local labor market mismatch, including helping residents find skill matched jobs, and encourage high skill entrepreneurship, 2) combine place-based policy and people-based policy to increase the commuting capacity of rural residents, including regional transportation infrastructure, and flexible transportation services, 3) sustain amenity-led development, including increasing rental housing and affordable housing, and encouraging urban in-migrants to participate in local development. The interaction between spatial disequilibrium and people's mobility could form a more balanced rural-urban system which could sustain rural development in the long term.

BIOGRAPHICAL SKETCH

Xue Zhang was born in Daqing, China. She received her bachelor and master's degree in International Trade and Economics from the Harbin Institute of Technology in 2011 and 2013 respectively. She finished her master's degree in Regional Science from Cornell University in 2016, and then started her doctoral studies in Cornell University under the guidance of Dr. Mildred Warner, Dr. Kieran Donaghy, and Dr. Daniel Lichter. She is interested in the relation between demographic transition, economic development structure, and regional development disparities. She pays attention to the linkage between people's mobility, rural development, and community development policy. Her research also explores age-friendly community development, sustainable development, equity, and community development policy.

To my parents for their endless love and support

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Professor Mildred Warner does not only teach me how to be scholar, most importantly, she teaches me how to be a better person. She is a nice and kind person. She cares about students. I went to her place for Thanksgiving almost every year. As an international student, I don't have any family members in the US. Her family makes me feel I am not alone. The warm and kindness shown by her and her family makes the winter in Ithaca full of joy and happiness. I want to pursue a career in academy. I will treat my students the way she treated me. I think that is the most important character of an extraordinary scholar like Mildred - all the publications,

lectures could be gone one day, but the knowledge and the kindness will be passed down from generation to generation.

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CHAPTER 1

INTRODUCTION

1.1 Objective

With the development of technology and infrastructure, people's increasing mobility between rural and urban areas creates new rural development challenges and opportunities. Rural counties are losing young adults to urban areas due to the lack of job opportunities. (Johnson & Winkler, 2015; Yankow, 2003). On the other hand, rural areas with rich natural amenities attract urban retirees and the creative class (Lambert, Gale, & Hartley, 2008; McGranahan & Wojan, 2007). The flow of people functions as a bridge connecting the labor market, housing market and amenity market between rural and urban areas. This research presents a new mobility framework to address two challenges in rural development studies. 1) Most rural research focuses on addressing rural development problems from either the supply side or the demand side, such as lacking high skilled labor, lacking job opportunities, and the brain drain, etc. Rural studies omit the importance of mismatch between supply and demand. 2) Most research on the connection between rural and urban is typically from an urban perspective (Little, 2001; Olson & Munroe, 2012). This study argues that rural development is neither isolated nor is simply a complement to urban development. Instead, rural development needs to be considered in a more comprehensive framework, which links people's mobility with the mismatch within the local market and the disequilibrium between rural and urban counties.

Commuting and migration are two types of people's mobility. However, the empirical study of migration is typically separated from the study of commuting.

Intercounty migration has steadily declined since 1949 (Figure 1-1). The explanation of the domestic migration decline omits the role of commuting. The two main theories explaining people's mobility, individual mobility theory and location theory, argue that people move to maximize utility. The study of long-distance commuting could provide an alternative explanation of the migration decline. Like migration, long-distance commuting, could be related to the disequilibrium between places in the labor market, housing market and amenity market (McKenzie & Hoath, 2014, 2017; Storey, 2010). This research acquires data from the Journey to Work dataset and County to County migration from 2009 to 2013 to compare commuting and migration between counties. This empirical study fills the research gap by including the role of commuting in a study of migration.

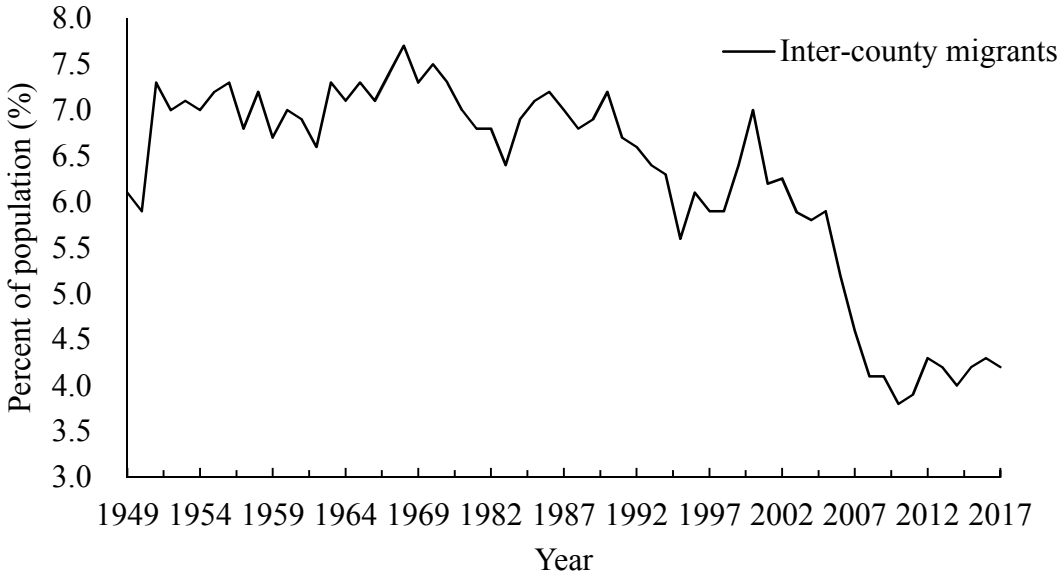


Figure 1-1 Percentage of migrants from 1949 to 2017
Data source: U.S. Census Bureau, Current Population Survey

This research creates a new spatial disequilibrium framework to explore rural development approaches in a rural-urban mobility context. This new research

framework connects the individual mobility theory and location theory at the place level, and uses 'mismatch' and 'disequilibrium' to explore factors driving people's mobility. The spatial disequilibrium framework includes two aspects. The first one is the mismatch between supply and demand in the local labor market. The second one is the disequilibrium between places in the labor market, housing market, and amenity market. Conventional individual mobility theory contributes to the understanding of individual/families' behaviors. The new spatial disequilibrium framework extends the individual level study to a group of people, and links people's mobility with locational attributes. Location theory focuses on the impact of disequilibrium between places on people's mobility. This new spatial disequilibrium framework expands location theory by including the mismatch within the local market. Thus, this study builds a comprehensive framework integrating individual mobility theory and location theory to explore the relation between people's mobility (commuting and migration), markets (labor market, housing market, amenity market), the mismatch between supply and demand within the local market, and the regional disequilibrium in the labor market, housing market, and amenity market between two places.

This research analyzes factors driving the number of out-commuters and the number of out-migrants between metro counties and nonmetro counties. Counties are connected by the flow of people. However, lots of empirical studies only focus on the characteristics of people, or the attributes of one place. The connection between people and place, and the connection between places are rarely studied in a comprehensive model. To fill the research gap and capture these connections, this study creates county pairs as the unit of analysis. In the commuting analysis, each observation includes the

number of out-commuters, and the attributes of both the residential county (sending county) and the workplace county (receiving county). In the migration analysis, each observation includes the number of out-migrants, and the attributes of the origin county (sending county) and the destination county (receiving county). These county pairs capture the importance of place and the connection between places, as represented by peoples' mobility.

This research builds upon individual mobility theory, location theory, and the rural development literature, with county-level data in the US to explore the following questions: Which framework could combine migration and commuting to explain the interaction between people's mobility and place? What factors can differentiate people's commuting and migration? What are the differences in people's mobility between rural and urban counties? What is the relation between people's mobility and rural development?

1.2 Research outline

To answer the above questions, the following chapters include 6 parts:

Chapter 2 is the literature review. This chapter discusses the research on rural-urban interdependence, the theoretical gaps of individual mobility theory and location theory, and the justification of a spatial disequilibrium framework in explaining people's mobility from six aspects: 1) the importance of considering both commuting and migration; 2) the importance of comprehensively including the labor market, housing market and amenity market in the analysis, 3) the importance of linking people and place; 4) the importance of considering the mismatch between supply and demand within the local labor market; 5) the importance of analyzing the spatial disequilibrium

between two places, and 6) the importance of using method to connect people and place, as well as connect the locational attributes of two places.

Chapter 3 builds the theoretical framework - the spatial disequilibrium framework. This chapter discusses the unique unit of analysis in the research – the county pair. Then, this chapter uses the county pair to build the theoretical framework: the local labor market mismatch within the place, and the regional disequilibrium between the sending place and the receiving place. This chapter uses the Chinese "Yin/Yang" symbol to conceptualize the relation between local labor market mismatch, county-to-county disequilibrium and people's flow, and the importance of using the county pair to connect people and place. This chapter illustrates the local labor market mismatch as the difference between supply and demand in skills and employment. The regional disequilibrium is the difference between the sending place and the receiving place in the labor market, housing market, and amenity market.

Chapter 4 creates proxies for the local labor market mismatch, and the regional disequilibrium between the sending place and receiving place in the labor market, housing market and amenity market. The local labor market mismatch in skill is divided into low skill mismatch and high skill mismatch. The local labor market mismatch in employment is divided into professional service employment mismatch and low skill service employment mismatch. The regional disequilibrium between the sending place and the receiving place is measured by the differences in pull and push factors in the labor market. The regional housing market disequilibrium between two places is represented by homeownership. The regional amenity market disequilibrium is captured

by the difference in the natural amenities and amenity cost between the sending place and the receiving place.

Chapter 5 presents the analysis. This chapter uses the county pair to capture rural-urban interdependence. This chapter examines the difference between commuting and migration in adjusting the local labor market mismatch as well as adjusting the regional disequilibrium in the labor market, housing market, and amenity market. This chapter explores the rural-urban difference in people's mobility. This chapter shows how the theoretical framework, the spatial disequilibrium, helps explain people's mobility. While the labor market has a similar impact on people's mobility in both metro and nonmetro counties, the impact of the housing market and the amenity market on nonmetro residents' mobility is different from the impact on metro resident's mobility.

Chapter 6 presents the discussion. This chapter compares the spatial disequilibrium framework with the more static location theory, and discusses a dynamic "Yin/Yang" equilibrium: the optimal balance between equilibrium and disequilibrium. Then, this chapter relates the main model results in Chapter 5 to a comprehensive rural development approach. The spatial disequilibrium framework suggests a balanced rural development approach: retain and increase rural population without pushing out residents. This chapter suggests that rural communities could help residents to find a skill matched job or a local job to retain rural population. Also, rural development approaches could increase the commuting capacity of residents and encourage the high skill entrepreneurship. This chapter suggests that a sustainable amenity-led rural development could benefit from an increase in rural rental housing and affordable

housing, and encourage the participation of urban in-migrants in local development to promote a high skill economy. This chapter also includes study limitations, the extension of the spatial disequilibrium framework on other models, and implications for future study.

Chapter 7 is the conclusion section. This chapter links the model results with the theoretical contribution and empirical contribution of this study. This chapter summarizes the main contribution of this research: 1) the new spatial disequilibrium framework including the mismatch within a place and the disequilibrium between two places, 2) the unit of analysis-county pair- as the connection between people and place, and, 3) the exploration of rural development approaches under the mobility framework linking rural-urban difference and rural-urban connections.

The road map is shown in Figure 1-2.

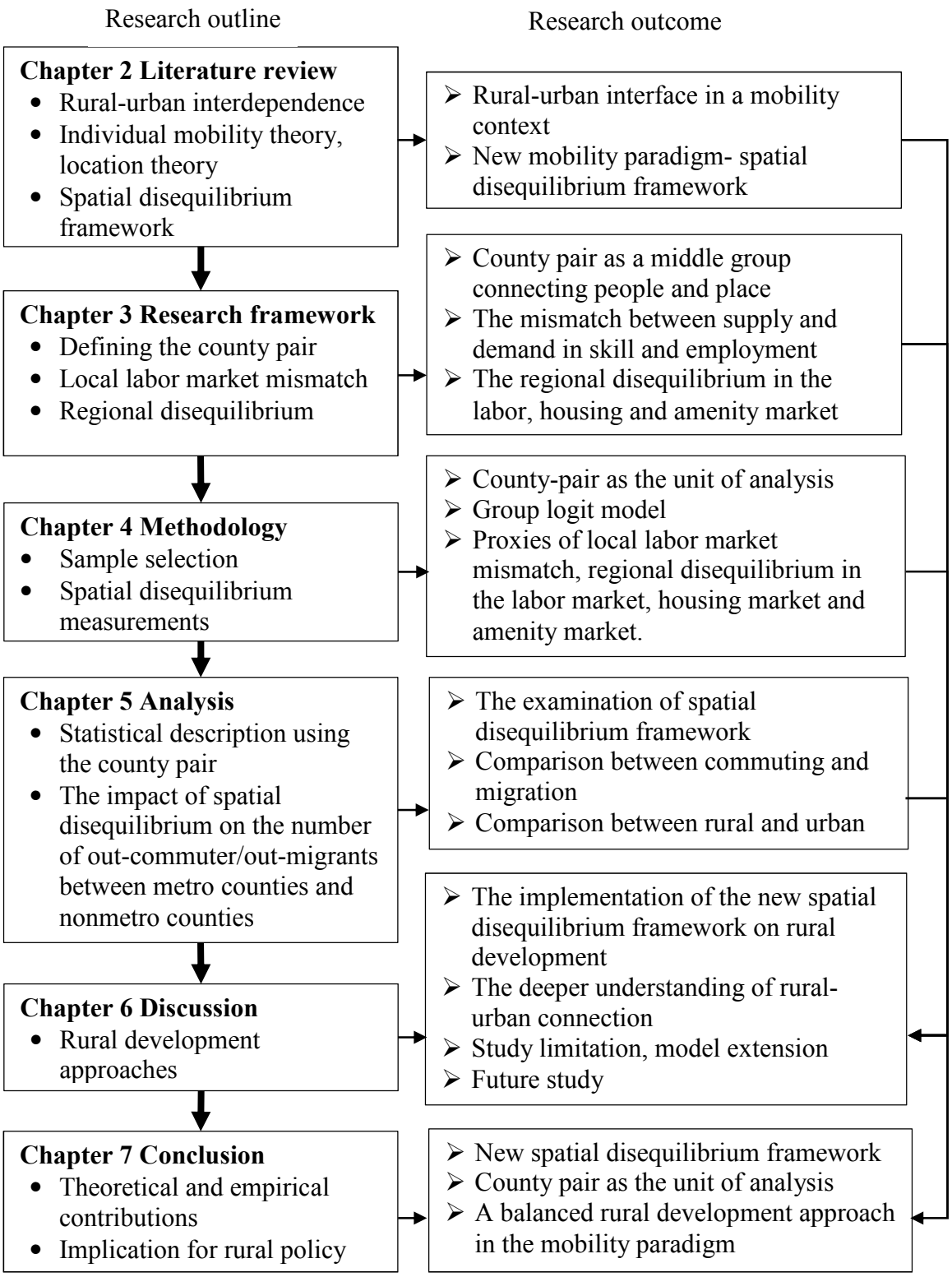


Figure 1-2 Research road map

CHAPTER 2

LITERATURE REVIEW

This chapter discusses the literature on rural-urban interdependence in a mobility framework and discusses the two main theories explaining people's mobility: Urry's (2002) individual mobility theory, and the traditional location theory focusing on the role of place, which stems from Krugman (1991). Then, this chapter discusses the importance of creating a new research framework to fill the theoretical and empirical research gaps in explaining people's mobility by linking people and place.

2.1 People's mobility and rural-urban interdependence

People's mobility, both commuting and migration, increases rural-urban interdependence (Lichter & Brown, 2014). The boundary between urban and rural is becoming blurry. Lichter and Brown (2011, 2014) outline the new urban-rural interface: the increasing interdependence and influence between urban and rural in economic, social and political relations. The new urban-rural interdependence is related to the declining transportation cost and communication cost, the innovation in technology, economic restructuring, and the increase in income and natural amenity preference (Irwin et al., 2009). The migration pattern between rural and urban at the county level in the US shows that metro core areas are not the conventional places attracting all ages of people, since family-age adults are attracted by suburbs, and older adults are more likely to move to small metro and rural areas since 1950 (Johnson & Winkler, 2015). Migration by race shows reduced segregation as more Hispanics and Blacks move to White-dominated suburbs and fewer Whites migrate from the minority-dominated metro core (Johnson & Lichter, 2016; Johnson & Winkler, 2015; Lichter, 2012).

Commuting networks between rural and urban also exhibit a complex spatial system involving people, business, communities, and amenities (Goetz, Han, Findeis, & Brasier, 2010).

The agglomeration economy affects rural-urban mobility. Rural areas are losing young adults to urban areas. The city is a cluster of people and economic activities (Fujita & Thisse, 2013) and the urban agglomeration economy attracts rural labor. High-skilled labor in underdeveloped rural areas migrates to urban areas due to the lack of job opportunities (Stephens, Partridge, & Faggian, 2013). Proximity to urban increases the rural 'brain drain'. However, proximity to urban also increases out-commuters from rural to urban, which could increase residential employment and population growth in rural areas (Partridge, Ali, & Olfert, 2010; Wu, Weber, & Partridge, 2017).

Rural areas with abundant natural amenities attract workers who prefer to live in rural areas with scenic landscapes (McGranahan, 2008), and recreational opportunities (Marcouiller, Clendenning, & Kedzior, 2002), and commute between urban and rural areas (Renkow & Hoover, 2000). Global economic restructuring significantly increases urban professionals' wages and real estate values, which provides them enough capital to escape the city and pursue higher natural amenities in rural areas (L. Nelson & Nelson, 2011; P. Nelson, 2005). Retirement-based in-migrants are mainly baby boomers reaching retirement age (L. Nelson & Nelson, 2011; Rupasingha, Liu, & Partridge, 2015). Thus, rural areas with abundant natural resources could attract urban amenity in-migrants (Chi & Marcouiller, 2013; Kuentzel & Ramaswamy, 2005).

The amenity-led rural development approach suggests that rural areas could attract in-migrants of the creative class and high-skilled labor (Lambert et al., 2008; McGranahan & Wojan, 2007). The in-migration of the creative class affects rural development from two perspectives. First, the creative class attracts recreation firms and increases the demand for services (Olfert & Partridge, 2010). Those new job opportunities could increase employment in rural areas, but these are often low-skill and low-paid jobs. Second, the creative class increases the entrepreneurial climate (Deller & McConnon Jr, 2009; Goetz & Rupasingha, 2009). Goetz and Rupasingha (2014) analyze the factors driving self-employment in counties from 2003 to 2011, and find that retaining and increasing educated population could increase self-employment in rural areas nonadjacent to metropolitan areas. Deller and Conroy (2016) identify new firms from the National Establishment Time Series, and find that start-ups have a higher survival rate in rural areas than in urban areas, because start-ups in rural areas have a lower opportunity cost, and face less competition. Thus, rural areas are more suitable for creating new businesses.

A rural-urban mobility framework is required for rural development. The increasing interaction between rural and urban through people's mobility shifts the effect of agglomeration on rural development. Rural development could involve a balanced approach integrating the city-region framework and amenity-led development, and focusing on both the balance of local resources and the balance between rural and urban development. For example, although it is important to increase human capital to promote regional development (Goetz & Rupasingha, 2004; Henry, Barkley, & Li, 2004), education policy or work policy typically lead to a brain drain, because rural

areas lack opportunities (Yankow, 2003). However, the recent datasets show that there are more commuters from nonmetro counties to metro counties than migrants [1]. The increasing commuting between rural and urban creates opportunities for rural development. However, a mobility framework is missing in the current research to link rural-urban interdependence with dynamic demographic change.

To sum up, I argue that the study of rural-urban relation needs a new framework which explores the relation between people's mobility and rural development to address the following questions: the increasing connection between rural and urban enlarges the effect of the agglomeration economy on rural development. As more people commute rather than migrate from rural to urban areas, what and how could rural development retain population? At the same time, given increased preference for natural amenities, how do rural communities take advantage of the urban in-migrants to develop local businesses? Can we build a framework to explore the linkage between people's mobility and local development from a rural perspective? The next section will review the theory explaining people's mobility, and discuss a new framework linking people's mobility with regional development that might fill current gaps in theoretical and empirical studies.

2.2 Theory explaining people's mobility

People's mobility can be explained by mobility theory at the individual level, as well as by location theory at the place level. However, a framework linking people and place is missing in the research. This section reviews both theories, and raises attention to

[1] Data are acquired from County to county migration 2009-2013 and Journey to work 2009-2013

people's mobility in connection with place and recognizes the importance of spatial heterogeneity.

Mobility theory can be summarized as individuals or households moving to maximize utility. The utility is subject to personal characteristics and locational attributes. The main mobility theory includes two branches. The first one is Urry's (2002) mobility paradigm, which views people's mobility as personal demand for physical proximity to specific people, places or activities which they feel obligatory, appropriate or desirable. Based on Urry's (2002) mobility framework, an employment-related geographical mobility framework includes the relation between migration and daily commuting, and raises attention to long-distance commuting (Cresswell, Dorow, & Roseman, 2016; Haan, Walsh, & Neis, 2015). The second one is life-course theory, which is commonly used in empirical studies. The life-course theory links mobility with individual/families' changing needs and preferences, and views life as the composition of interlinked careers (Coulter, van Ham, & Findlay, 2016).

Other mobility theories are developed based on Urry's (2002) mobility paradigm and life-course theory. For example, Kull, Coley, and Lynch (2016) combine the utility of moving with the theory of residential attainment, which states that family movement aims to increase residential advantage related to "safe and high-quality homes, neighborhoods, and school districts, and other proximity resources" (p. 423). Buckle (2017) views residential mobility as an alternate living experience of place and home, which is incorporated within the life-course framework. Mobility emphasizes the importance of individual/families' preference in moving. The empirical studies find that individual/families' mobility is related to age, change of marital status, employment

status, family structure, and housing attributes and jobs (Clark & Withers, 2007; Geist & McManus, 2008; Stovel & Bolan, 2004). However, mobility could also be a response to the restriction of places rather than individuals' preference (van Ham, Mulder, & Hooimeijer, 2001). The role of the labor market, housing market, and amenity market in pushing or pulling people is usually omitted in the individual mobility research. Also, the changes in life course are related to people's mobility, as well as the change in place. People's mobility connects the places where people flow-in and the places where people flow-out. The attributes within the place and the differences in the attributes between places should be included.

Location theory fills the gaps of mobility theory in explaining the relation between people's mobility and place. The conventional Core-Periphery model builds a general equilibrium framework to illustrate the dynamic relation between migration, wage differences, and agglomeration between places (Krugman, 1991). In the model, real wage difference triggers migration (Krugman, 1991). The assumption of the Core-Periphery is that consumers' utility is determined by the consumption of traded goods (Krugman, 1991). However, non-trade goods, such as natural amenities, home ownership, and family ties, are omitted in the analysis. The non-traded goods lead to commuting which allows people to live in the preferred location and work in other places with higher wages.

Other research extends the Core-Periphery model. Wrede (2013) uses a general equilibrium framework to analyze the impact of human capital on commuting and migration between the core and the periphery regions. In the framework, people commute or migrate to maximize utility, which is subject to the wage, the cost of land,

and the commuting cost at the place level (Wrede, 2013). That framework finds that high skill workers live and work in core regions, low skill workers live and work in the periphery, and the middle-skill workers' choice is related to the locational preference: either living in the periphery and working in the core or living and working in the core (Wrede, 2013). Also, places with more high skill job opportunities attract high skill labor in peripheral regions. More low skill job opportunities in the core can also attract low skill labor from the periphery. Wrede's (2013) general equilibrium framework captures the relation between people's mobility and spatial difference in wage, land price, and living expense. However, the impact of the difference between supply and demand inside the local labor market is still missing. Also, the Core-Periphery model only includes two places, which does not fit the reality: people could move between the combination of any two places, not just two places.

Long-distance commuting is examined in location theory. Borck, Pfluger, and Wrede (2010) use the 'footloose entrepreneur' model and the 'footloose capital model' to analyze the relation between agglomeration economy, residential location choice, and long-distance commuting. Although Borck et.al 's (2010) model provides the theoretical framework and numerical simulation, the model views migration and commuting as sequential actions rather than viewing migration and commuting equally. Borck et.al (2010) assume that individuals choose the residential place first, then choose to commute or not. Location theory focuses on the explanation of migration, and views commuting as a compromising decision.

Unlike location theory, which uses the real wage difference to explain people's mobility, search theory unpacks the real wage into the labor market and housing market

as well as considering commuting and migration simultaneously. Search theory argues that people are looking for a combination of residential place and workplace based on the wage structure and accessibility of affordable housing. (Haas & Osland, 2014). vanOmmeren, Rietveld, and Nijkamp (2000) analyze the interaction between commuting, migration, and commuting distance via search theory, and assume that individuals make decisions in the labor and housing market to maximize utility. vanOmmeren et al. (2000) discuss individuals' behavior - commuting or migration - from two perspectives: 1) wage, place utility, commuting distance, and benefits, and 2) moving costs, arrival rates and the firing rate. They conclude that people will accept jobs before moving closer to the workplace, and the housing market in the workplace has a significant effect on individuals' commuting decision. Their research justifies the spatial mismatch theories: the imbalance between job opportunity and affordable housing inhibits people's mobility.

However, search theory still underestimates the role of commuting, and views it as a temporary solution. vanOmmeren, Rietveld, and Nijkamp (1997) use search theory to explore commuting in the labor market and housing market, and argue that commuting is temporary, and people will commute a shorter distance if they receive more job offers. The spatial heterogeneity is underestimated in search theory. For example, some jobs only exist in some places, such as extraction, forestry, and mining. Also, people could prefer non-traded goods in a specific location, such as natural amenities, and homeownership. Commuting could be a permanent strategy for families to balance income and amenity preference, rather than a temporary solution (Rouwendal & Meijer, 2001; Sandow & Westin, 2010; Viry, Ruger, & Skora, 2014). However, both

location theory and search theory do not recognize the importance of commuting in maximizing individual and family utility.

The increase in the number of commuters and in commuting distance is due to the improvement of transportation, restriction of the housing market and the development of new technology (Andersson, Lavesson, & Niedomysl, 2018; Han, Goetz, Kim, & Lee, 2013; Sandow & Westin, 2010). Families view long-distance commuting as a solution to balance jobs and amenities, especially with the increase in dual-worker households (A. Green, 1997). Long-distance commuting, such as Fly-in/Fly-out, Drive-in/Drive-out, Bus-in/Bus-out, provide workers with more job opportunities and higher salaries (McKenzie & Hoath, 2014, 2017; Storey, 2010). At the individual level, long time commuting is related to higher wages, homeownership, and marriage (Davies, Greenwood, & Li, 2001; Morris & Zhou, 2018; Rouwendal & Meijer, 2001). At the place level, Lundholm (2010) analyzes the interregional migration and labor market size in Sweden from 1970 to 2001, and finds that long-distance commuting plays an important role in the labor market, maximizing the return to human capital regardless of the labor market size. Economic restructuring in rural areas also can trigger the increase of long-distance commuters. For example, the shutdown of local forest industries in rural communities in Canada increases the long-distance forestry commuters (Ryser, Markey, & Halseth, 2016). It is important to relate both commuting and migration to regional development.

2.3 A spatial disequilibrium framework

A new mobility framework linking people's mobility and place is needed to explain both commuting and migration. The new framework should fill the research gaps in explaining people's mobility from six aspects.

First, the new framework needs to simultaneously consider commuting and migration. Commuting and migration are normally studied separately, although they share common elements. Both are related to young adults, people with higher educational level, job accessibility, homeownership, and amenities. A general framework examining both commuting and migration can explore the different roles of the labor market, housing market, and amenity market in explaining people's mobility. For example, both commuters and migrants are driven by labor market disparities. However, current research focuses on either migration or commuting. A general framework is required to link commuting and migration to answer the following question: what are the differences between commuting and migration? How are they related to the local labor market and the labor market difference between places?

In the housing market, whether homeownership restricts people's mobility or not needs an analytical framework including both commuting and migration. Historically, the housing market restricts people's mobility through home mortgage and homeownership (Tobey, Wetherell, & Brigham, 1990). Recent studies also show that the housing market is the main reason for the decline of domestic migration in the US, such as the increased housing cost in the early 2000s (Withers & Clark, 2006), the housing crash between 2005 to 2010 (Otterstrom, 2015), the increase in household debt (Cooke, 2013), and the unstable housing market with a dramatic decrease of home value

from 2008 to 2009 followed by a rapid increase of home value from 2013 to 2014 (Ravuri, 2016). However, the housing market may not impede the mobility of richer people. For example. L. Nelson and Nelson (2011) study the in-migration of high-wage urban professionals to rural areas, and argue that economic restructuring and the rise of information and technology industries increase real estate values in urban areas, which allows those professionals to afford out-migration to rural areas with more natural amenities. Therefore, it is essential to include the housing market in a comprehensive framework linking people's mobility with place and considering rural-urban difference.

It is also important to include both commuting and migration in the analysis of the amenity market. The amenity-led rural development approach focuses on attracting urban in-migrants to relocate to rural areas with more natural amenities (Chi & Marcouiller, 2013; Olson & Munroe, 2012). However, how is this related to rural out-migrants, in-commuters and out-commuters? Research shows that urban in-migrants are related to rural job creation (Ferguson, Ali, Olfert, & Partridge, 2007; Partridge et al., 2010). However, will the new job be taken by local labor or by in-commuters? Also, the increase in urban in-migrants could increase rural housing values, which could push out rural residents (L. Nelson & Nelson, 2011; Rupasingha et al., 2015). Thus, how do rural communities retain population and sustain the amenity-led development?

Second, the framework needs to comprehensively consider the role of the labor market, housing market and amenity market in explaining people's mobility. The labor market and housing market are commonly included in mobility research, while the amenity market is underestimated. Urry's mobility theory analyzes people's mobility reasons at the individual level. The change of job and homeownership are the main

motivators driving people's mobility (De Jong, 2000; Prout, 2008; Wolf & Longino Jr, 2005). Location theory and search theory also focus on the interaction between the housing market and the labor market, and use the disequilibrium between places to explain people's mobility (Coulter et al., 2016; vanOmmeren et al., 1997). The conventional spatial mismatch theory has been focused on the lack of job opportunities in the urban core and the housing discrimination in the suburb for minority/low skill workers who are stuck in the urban areas (Hellerstein, Neumark, & McInerney, 2008). In this research, I combine the disequilibrium and mismatch frameworks to look at rural commuting and migration. They appear to be the trade-off between higher wages and homeownership in affecting people's mobility decision-commuting or migration. However, rural scholars point out that natural amenity is the main driver of people's mobility from urban to rural areas (L. Nelson & Nelson, 2011; Partridge, Rickman, Olfert, & Ali, 2012; Rupasingha et al., 2015). Thus, it is important to develop a framework including the labor market, housing market, and amenity market to explain people's mobility.

Third, the new mobility framework should link people and place. Empirical studies on people's mobility either use individual-level data to analyze personal characteristics or aggregated data at the place level to explore the impact of locational attributes on people's mobility. Personal characteristics include age, race, education, ethnicity, family structure, employment status, migration history, poverty status, and life-cycle changes (Clark & Lisowski, 2017; Cushing & Poot, 2004; Urry, 2012). Location motivators include social factors (e.g. safety, social inclusion, social cohesion, culture, language, etc.), local amenities (e.g. climate, entertainment), neighbors'

characteristics (age, race, income, education), public services, infrastructure, tax rate, public goods, public policy, health care, educational resource, and regulations (environmental regulations, immigration regulations) (Cushing & Poot, 2004). However, the empirical study lacks an efficient way to link personal characteristics with locational attributes.

It is difficult to link people and place, because individual mobility is different from people's mobility at the place level. Individuals choose either to commute or to migrate, while places with more commuters are more likely to have more migrants. At the individual level, long-distance commuting motivates individuals to change jobs or relocate (Kronenberg & Carree, 2012). Also, individuals choose to either commute or to migrate due to the housing market restriction (Eliasson, Lindgren, & Westerlund, 2003). At the place level, more commuters may accompany more migrants. For example, Brown, Champion, Coombes, and Wymer (2015) study the long-distance commuters (more than 20 km), short-distance commuters (less than 20 km) and migrants in rural England. They find that rural in-migrants keep the original workplace and become long-distance commuters. Similar results are found in Canada (Axisa, Newbold, & Scott, 2012; Romani, Surinach, & Artiis, 2003). Han et al. (2013) examine the overlaying of commuting and migration in the US between 1995 and 2000, and find that people move to a place and then commute to the workplace. The new mobility framework needs to find a middle ground between personal characteristics captured by the individual level data and the locational attributes captured by the aggregated data at the place level to link people and place.

Fourth, the new framework could use mismatch as the main concept to analyze the local labor market. Most studies use the employment rate or unemployment rate to measure the impact of mobility on the local labor market. For example, Renkow (2003) examines intercounty commuting, and migration in North Carolina from 1980 to 1990, and finds that the increase of in-commuters contributes to more than half of the employment growth in metro counties, and for rural counites, the out-commuters has the largest impact on the employment growth. Migration has a smaller impact on employment growth than commuting (Renkow, 2003). Niebuhr, Granato, Haas, and Hamann (2012) analyze the relation between mobility and labor market disparities in Germany between 1995 and 2005, and find that labor mobility decreases unemployment disparities, and migration has a larger impact than commuting.

However, employment/unemployment are vague measurements from two aspects. First, they do not separate labor by skills. High skilled workers move more than low skilled workers (Faggian, McCann, & Sheppard, 2007; Overman et al., 2009). Places with more educated workers could attract firms and households, leading to the increase in in-migrants (Glaeser & Resseger, 2010; Glaeser & Shapiro, 2003; Partridge et al., 2012). Second, both measurements capture the labor market as a whole and do not include the difference between supply and demand in skill and labor. Workers mobility, both migration and commuting, respond to underemployment caused by the difference between labor supply and demand (Simpson, 1992; van Ham et al., 2001). Also, labor mobility is related to the difference between education and the skill required by occupation. For example, compared to workers with jobs matching their educational level, workers who are overqualified for their jobs earn lower wages (Chevalier, 2003;

McGuinness, 2006), are less satisfied with their jobs (Quintini, 2011; Tsang, Rumberger, & Levin, 1991), and are more likely to move to seek other job opportunities (Tsai, 2010; Waldorf & Do Yun, 2016). To capture the difference between supply and demand, the new framework could extend the conventional concept of spatial mismatch to a local level. The mismatch could include both the mismatch between education and occupation and the mismatch between labor supply and demand in the high skill job as well as in the low skill job. Thus, the mismatch concept can solve the problems of using a single variable to capture the local labor market, by differentiating education levels and job skills.

Fifth, a general framework including the regional disequilibrium in the labor market, housing market and amenity market between places is needed. Most empirical studies only link people's mobility with locational attributes in either the sending place (where people out migrate/commute out) or the receiving place (where people in migrate/commute in), and omit the linkage between places. In fact, people's mobility can be viewed as a bridge connecting the sending place and the receiving place. People's inflows can contribute to the cultural diversity of the receiving place, as well as take away job opportunities in the local labor (McKenzie & Hoath, 2014, 2017). For example, Partridge, Rickman, and Li (2009) analyze the impact of commuting and migration on labor demand in rural areas, and find that in-commuters and in-migrants compete with residents for local job opportunities, which could push residents to find jobs outside the rural areas, or become unemployed. Both in-commuters and in-migrants are related to economic growth; but the economic growth will increase housing prices, which put financial pressure on residents (McKenzie & Hoath, 2014,

2017). For example, the amenity-led in-migrants from urban to rural areas may lead to rural gentrification, which both brings more job opportunities to attract people to move in and increases housing value to push residents to move out (Costello, 2007; L. Nelson & Nelson, 2011).

People's outflows are also related to both the sending place and the receiving place. The difference in wage and job opportunities drives rural residents' outflow to urban. The out-commuters living in rural communities, but working in surrounding large cities create the 'bedroom community'. Research shows that 'bedroom communities' have less economic growth than communities with fewer out-commuters (Goetz et al., 2010; Olfert & Partridge, 2010). The out-migrants from rural to urban cause the severe 'brain drain', which inhibits rural development (Fujita & Thisse, 2013; Rodríguez-Pose, 2018). Therefore, it is important to build a general regional disequilibrium framework including the connections between two places and the connections between markets. The regional disequilibrium can explore the complicated relation between regional disparities on people's mobility and explore rural development challenges and opportunities in the rural-urban interdependent context.

Six, a methodology linking people and place is needed in mobility research. Both individual data and place data are used in the analysis. Discrete choice modeling is commonly used in the individual level analysis, such as logit regression (Clark, Deurloo, & Dieleman, 2006), multinomial logit regression (Barcus, 2004), and Probit regression (Romani et al., 2003). At the place level, Poisson regression and conditional logit regression are commonly used. For example, Shen (2016) use a Poisson regression to analyze regional migration in China from 2000 to 2005, and find that more than 90%

of the migration between provinces can be explained by demographic structure, economic development, and climate. Davies et al. (2001) use a conditional logit approach to analyze state to state migration in the US between 1986 to 1996, and find that inter-state migration is related to economic opportunities, mobility cost, and amenities.

The concept of local labor market is missing in the conventional mobility model. The conventional model linking people's mobility with place is the gravity model which assumes that the number of people moving between places is equal to the population in the origin multiplied by the population in the destination and divided by the distance (Erlander & Stewart, 1990). The gravity model provides the simplest way to predict people's mobility, but it lacks theoretical support and only uses population to capture spatial attributes (Simini, Maritan, & Neda, 2013). Also, although the gravity model includes the population of both the sending place and the receiving place, the two places are still independent (LeSage & Pace, 2008). Based on the gravity model, other empirical studies measure the disequilibrium between places. For example, Greenlee and Wilson (2016) analyze the impact of spatial disequilibrium in wage, education, employment, demographic structure and distance on the migration flow between two counties. However, the mismatch within places is omitted in that research. It is essential to build variables capturing both the mismatch within a place and the regional disequilibrium between places. What is needed is a methodology to illustrate this disequilibrium.

To sum up, in this research I argue that the new spatial disequilibrium framework should explore what factors within local market and what factors between

the sending place and the receiving place drive people's mobility. The spatial disequilibrium links people's mobility with the attributes of the local labor market mismatch, and the regional disequilibrium in the labor market, housing market and amenity market (Figure 2-1). This framework has three contributions: 1) embed the spatial dimension in the conventional mobility analysis, 2) connect people and place, 3) view people's mobility as the connection between the sending place and the receiving place instead of the conventional contiguous model of connection by geographic adjacency.

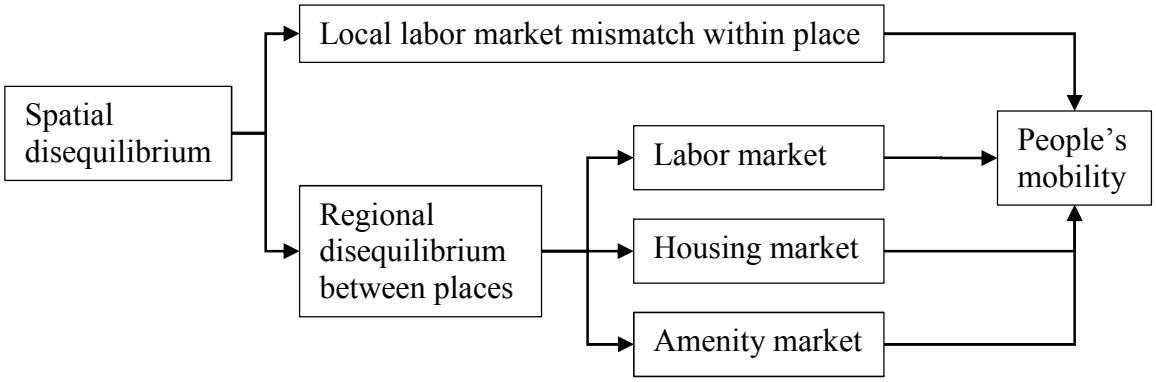


Figure 2-1 Research framework

The next chapter will build the theoretical framework. The spatial disequilibrium framework will help to address the following key questions: what is the difference between commuting and migration in response to the local labor market mismatch and regional disequilibrium? How do labor market, housing market and amenity market differences between rural and urban affect people's mobility? How could this spatial disequilibrium framework help rural development in terms of retaining and increasing population?

CHAPTER 3

A GENERAL SPATIAL DISEQUILIBRIUM FRAMEWORK

In this chapter, I create a new theoretical framework to explain the impact of spatial disequilibrium on people's mobility. I use 'county pair' as a mechanism to connect people's flow with both the sending place and the receiving place. People's mobility includes commuters and migrants. The attributes of places are captured by the labor market, housing market, and amenity market. Then, I build the spatial disequilibrium framework to analyze the relation between people and place, and the relation between places. The spatial disequilibrium framework includes the local mismatch within a place, and the regional disequilibrium between places.

My framework links location theory and mobility theory and fills the gaps between these single theories in the explanation of mobility of people across places. Urry's (2002) mobility theory explains individual mobility as the need of physical proximity to specific people, places or activities. Mobility theory provides the foundation for understanding people's flows. However, from the perspective of regional development, individual mobility theory underestimates the impact of locational attributes on people's mobility. The important role of the labor market, housing market, and amenity market affect people's need of mobility. On the other hand, location theory explains the linkage between people's mobility and locational attributes (Krugman, 1991). In the location theory, people's mobility is triggered by the real wage difference between two places (Baldwin & Forslid, 2005). However, location theory only considers the disequilibrium between places, the mismatch within places is omitted. Thus, my new spatial disequilibrium framework fills the research gap of Urry's (2002)

mobility theory by including the linkage between people and place, and fills the gaps of location theory by including the mismatch within the local market.

3.1 What is a "county pair"?

People's flows blur the boundaries between places. For example, the migration between urban and rural increases rural-urban interdependence and social relations (Lichter & Brown, 2011). People's mobility connects two places and is related to the attributes of both the sending place and the receiving place. However, current studies either focus on the individual level to explore the relation between individual characteristics and mobility reasons, or focus on one place (either the sending place or the receiving place) to examine the impact of locational attributes on the total number of migrants and the total number of commuters. The county pair can fill the research gap by being a mechanism to connect people and places (Figure 3-1).

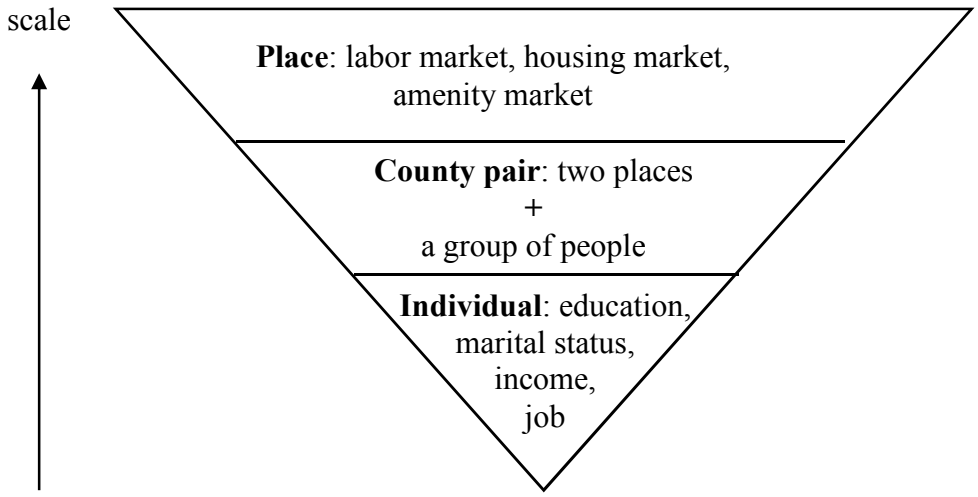


Figure 3-1 County pair is a mid-level concept between individual level and place level studies

As shown in Figure 3-1, most studies focus on either the individual level or place level, which are commonly separated in the research. The individual study

explores personal factors driving individual mobility, such as education, marital status, income, etc. The locational attributes are too broad to be included in the individual study, because lots of individuals could come from the same place. On the other hand, the place level study explores the general attributes of places driving the total number of migrants or commuters and focuses on place attributes, such as the labor market, housing market, or amenity market. The place level study omits the differences among people.

This research creates a middle ground to link people and place: the county pair. Each county pair has two places: the sending place and the receiving place, and a group of people: the number of people who commute and the number who migrate between these two places. The county pair increases the scale level from individual to a group of people. The group of people makes the analysis of the place more efficient than the individual level study. The group of people also creates some differences among people, which is omitted in most place level studies. The county pair articulates the relationship between two specific places: the sending place and the receiving place. This specificity is rarely studied in the commuting and migration literature. Thus, county pairs can integrate the individual characteristics and the place level characteristics to create a mechanism linking people and place, partially keeping the difference among people, and building connections between two places.

In a rural-urban setting, the county pair captures the rural-urban interdependence (Figure 3-2). Figure 3-2 shows that N urban counties and M rural counties create M*N county pairs. Those county pairs have the number of commuters and migrants who move between rural and urban, and the attributes of both rural and urban areas.

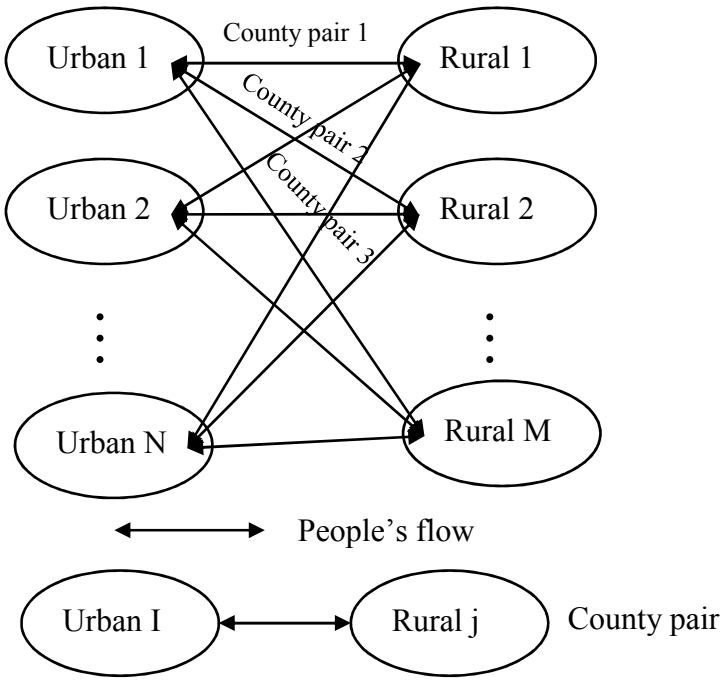


Figure 3-2 Rural-urban county pair

While the county pair explicitly connects people and place and captures the difference between the sending place and the receiving place, it is missing the attributes within the place. To fill this gap, this research extends the traditional concept of spatial mismatch to a place level, and uses mismatch to measure the difference between supply and demand within the local labor market. By integrating the local labor market mismatch and the county pair, this research creates the spatial disequilibrium framework which incorporates both the mismatch within the place and the disequilibrium between places. Both of these will be described in the following sections.

The spatial disequilibrium framework captures rural-urban distinction by measuring the differences between rural and urban. This framework also captures rural-urban interdependence, because the framework focuses on the factors (labor market,

housing market, and amenity market) in rural relative to urban which may attract people to migrate or commute. So, the dynamics between places are highlighted.

3.2 Local labor market mismatch

The mismatch within the local labor market is defined by the difference between supply and demand in labor skill and employment. The labor skill supply-demand difference is the education-occupation skill mismatch, which measures the difference between skill supplied by labor and the skill demanded by occupation. The employment supply-demand difference is the resident-firm employment mismatch, e.g. the local demand relative to local supply of labor, measured by the proportion of residents working in local industry.

The education-occupation skill mismatch captures the vertical dimension of the labor market (Figure 3-3). This mismatch generates overeducated labor or undereducated labor, which motivates the vertical mobility: upward mobility or downward mobility. The employment mismatch illustrates the horizontal dimension of the local labor market (Figure 3-3). This mismatch creates labor surplus (local labor supply is greater than labor demanded by the local business) or labor deficit (local labor supply is less than the labor demanded by the local business). Labor surplus and labor deficit motivate labor to move out or move into the local labor market. At the point of local labor market equilibrium, the local labor market does not drive people's mobility, because all the workers can find skill-matched occupations, and there are enough skill-matched jobs for all workers (Figure 3-3). Any other points except the labor market equilibrium point denote the combination of the education-occupation skill mismatch and the resident-firm mismatch. Those points motivate people's mobility.

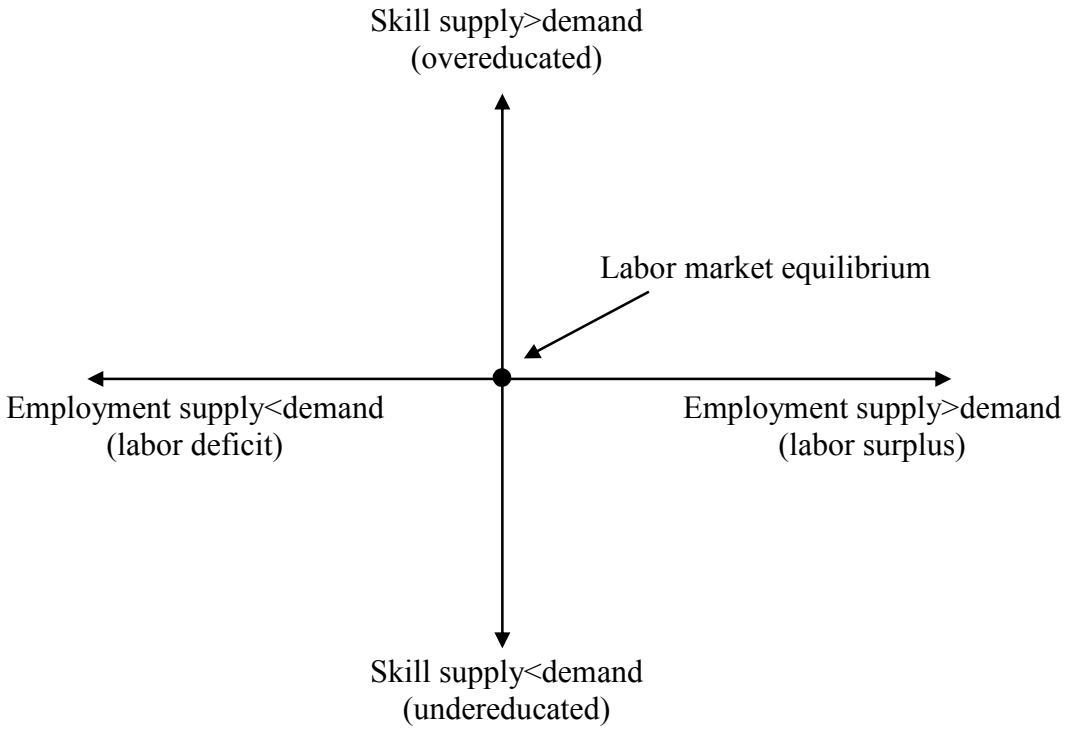


Figure 3-3 Local labor market disequilibrium framework

This mismatch framework includes both labor skill and employment to get a comprehensive picture of the local labor market. The relation between people's mobility and education-occupation skill mismatch, overeducated and undereducated, is studied in the mobility literature (Aleksynska & Tritah, 2013; Poot & Stillman, 2016; Villarreal, 2016). The impact of resident-firm employment mismatch on people's mobility is also studied, especially in rural research (Olson & Munroe, 2012; Partridge & Rickman, 2008; Rupasingha et al., 2015). However, the education-occupation skill mismatch and resident-firm employment mismatch is commonly studied separately. Also, even research includes the education-occupation skill mismatch or the resident-firm employment mismatch, commuting and migration are usually omitted. It is important to consider both mismatches, because either mismatch alone may not enough to motivate

people's mobility. For example, the education-occupation skill mismatch motivates workers to change jobs, if workers can find a local job, then they won't move. The resident-firm employment mismatch also motivates people to find other jobs, but if the workers are more competitive than other workers due to the skill, then they won't move either. Thus, the impact of local labor market mismatch on people's mobility needs to include both education-occupation skill mismatch and resident-firm employment mismatch.

This framework is important for rural studies to explore the brain drain. The endogenous growth theory, which focuses on increasing human capital does not always work for rural communities, because rural educated workers may migrate to urban areas for more job opportunities (Stephens et al., 2013). This makes it difficult for rural areas to increase entrepreneurism and increase high-skill jobs (Drabenstott, 2001). The brain drain undermines the incentives for rural communities to invest in education (Roscigno, Tomaskovic-Devey, & Crowley, 2006). However, rural communities still need to upgrade their labor skills to move forward (Gibbs, Kusmin, & Cromartie, 2004; Swaim & Teixeira, 1991). My local labor market mismatch framework can help address the dilemma: how to increase the residents' educational level to develop the local economy without causing a brain drain? The local labor market mismatch framework shows that the balance between labor skill supply and demand, as well as the balance between employment supply and demand, could reduce people's out-flow (Figure 3-3).

The local labor market mismatch links people's mobility with local attributes. However, it is still missing the linkage between places. My unit of analysis, the county pair, can fill this gap (Figure 3-4).

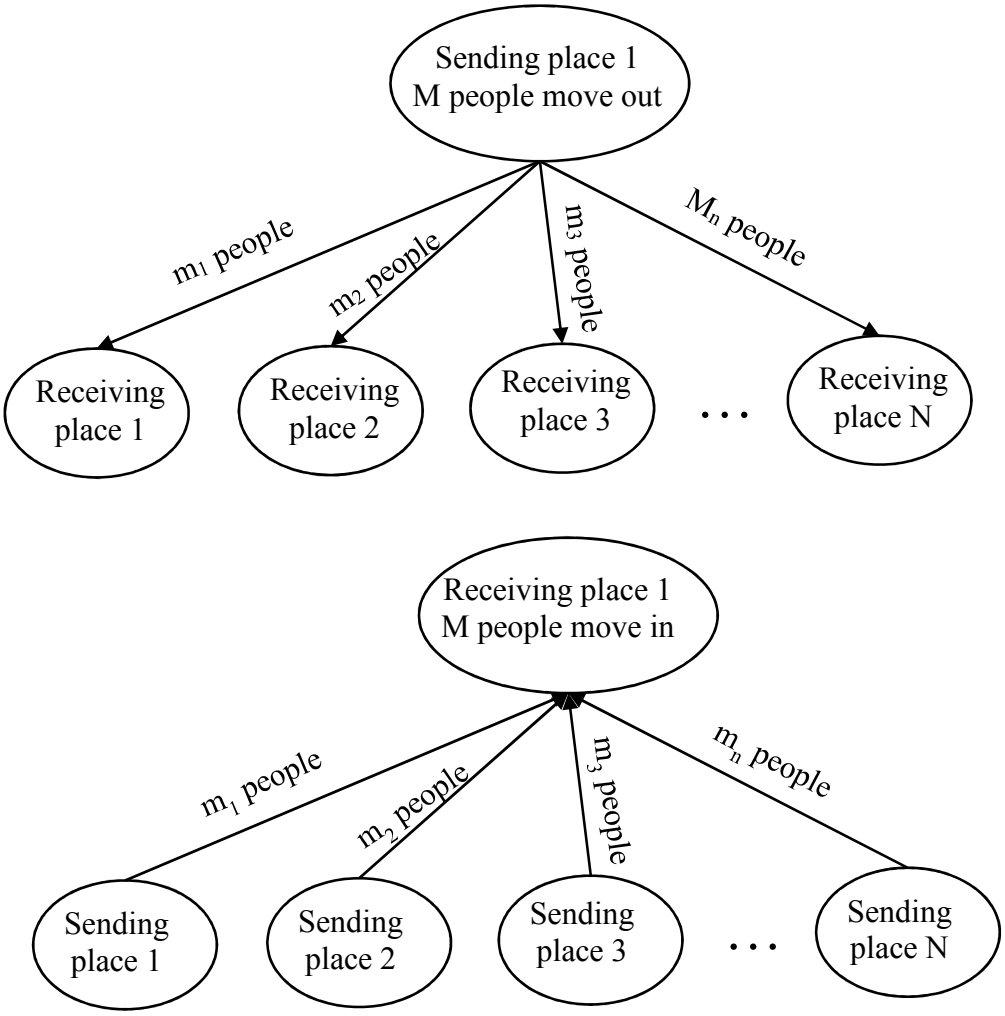


Figure 3-4 County pair-linking sending and receiving places

For each sending place (e.g. sending place 1 in Figure 3-4), the local labor market mismatch can explain why M people move out. Also, for each receiving place (e.g. receiving place 1 in Figure 3-4), the local labor market mismatch can explain why M people move in. The county pair can separate M people into N groups of people ($\sum_{i=1}^{N} m_i = M$). Each group is different. For example, the group of m_1 people is different from the group of m_2 people. The county pair links the sending place 1 with the receiving places from 1 to N to explain why m_1 out of M move from the sending

place 1 to the receiving place 1, and why m_2 out of M moves to the receiving place 2, etc. Like the sending place, the county pair can explore why receiving place 1 has m_1 out of M people moving from sending place 1, and why m_2 out of M move from sending place 2, etc.

In the next section I will use the county pair to build the regional disequilibrium framework which helps explore the relation between people's mobility and the difference in local labor market mismatch between the sending place and the receiving place. Besides the labor market mismatch, there are other forms of mismatches within the local market, such as the mismatch between the rent and income within the local housing market, and the mismatch between types of amenity and personal preference within the local amenity market. My research only includes the local labor market mismatch, since people's mobility, both commuting and migration, is mainly driven by the labor market. However, my research will include the housing market and the amenity market in the regional disequilibrium framework.

3.3 Regional disequilibrium

Regional disequilibrium focuses on the difference between the sending place and the receiving place. Location theory states that the real wage difference between two places will drive people's mobility (Baldwin & Forslid, 2005). This research unpacks the real wage difference into the regional disequilibrium in the labor market, housing market and amenity market between two places.

The first part of the regional disequilibrium links the local labor market mismatch framework with the county pair. The local labor market mismatch framework helps explore why people move out from the sending place, or why people move into

the receiving place. However, that framework cannot connect the sending place and the receiving place. The county pair can fill this gap by linking two places to explore the spatial disequilibrium across places.

The regional labor market disequilibrium framework looks at the difference in the local labor market mismatch between the sending county and the receiving county in each county. This disequilibrium measures which place has a greater local labor market mismatch:

$$Regional\ labor\ market\ disequilibrium_{ij} = local\ labor\ market\ mismatch_i - local\ labor\ market\ mismatch_j$$

Thus, through the county pair, I connect local mismatch with regional disequilibrium and thus connect people and place characteristics (Figure 3-5).

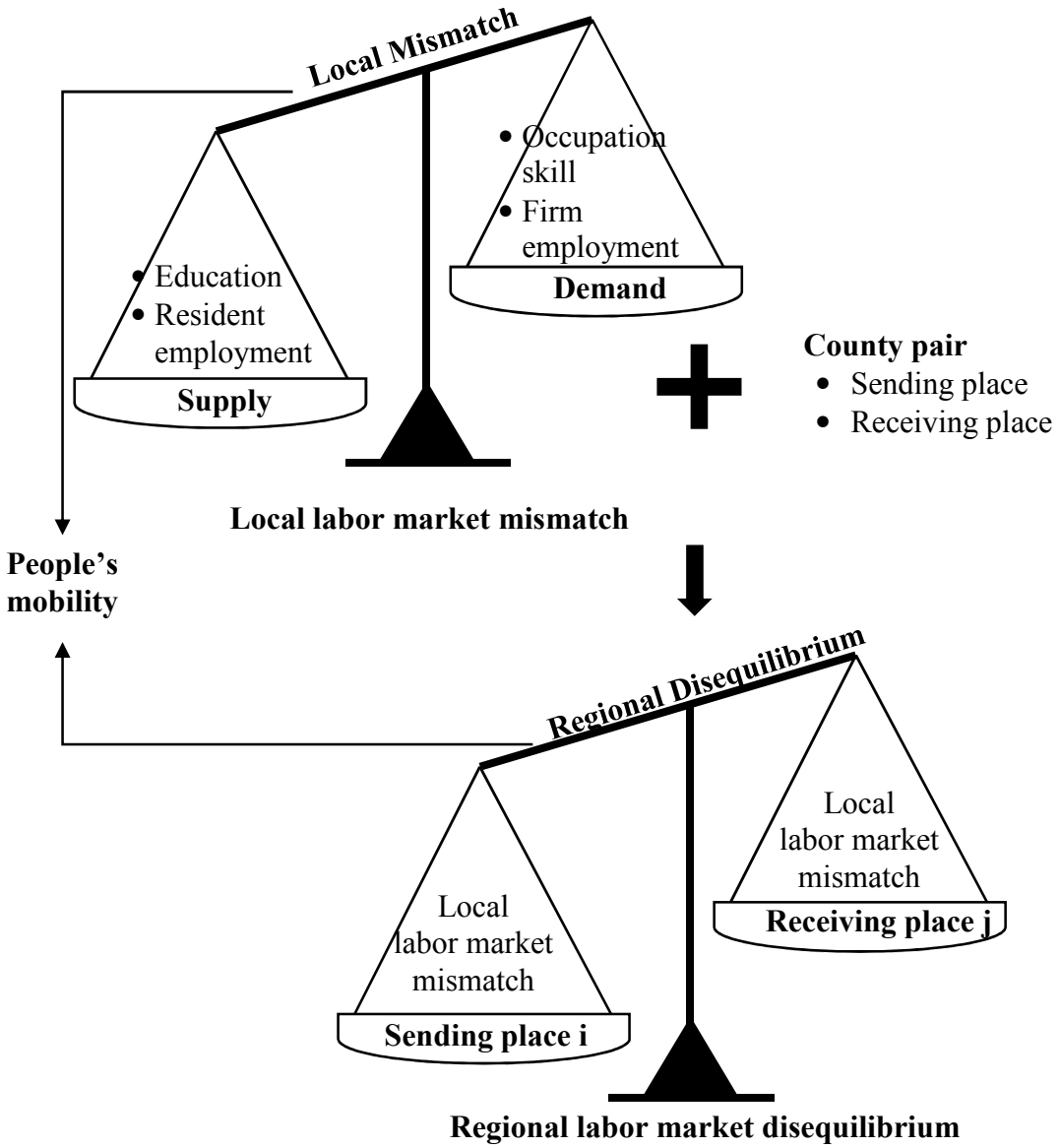


Figure 3-5 Spatial disequilibrium framework

This framework creates a new way of thinking about disequilibrium for regional scientists. We can refer to the "Yin/Yang "symbol (Figure 3-6), which illustrates both the difference and the interdependence. As regional scientists, we think about social issues based on the place, such as income inequity, regional development disparities, and labor mobility. The social issues are the reflection of the "Yin/Yang" symbol. For

example, the income inequity is caused by some people earning more ("Yang") and some people earning less ("Yin"). The development disparity is because some places are better ("Yang") and some places are worse ("Yin"). The social issues show the existence of both "Yin" and "Yang", because either "Yang" or "Yin" will not lead to social issues. Also, the social issues are the result of the imbalance between "Yin" and "Yang".

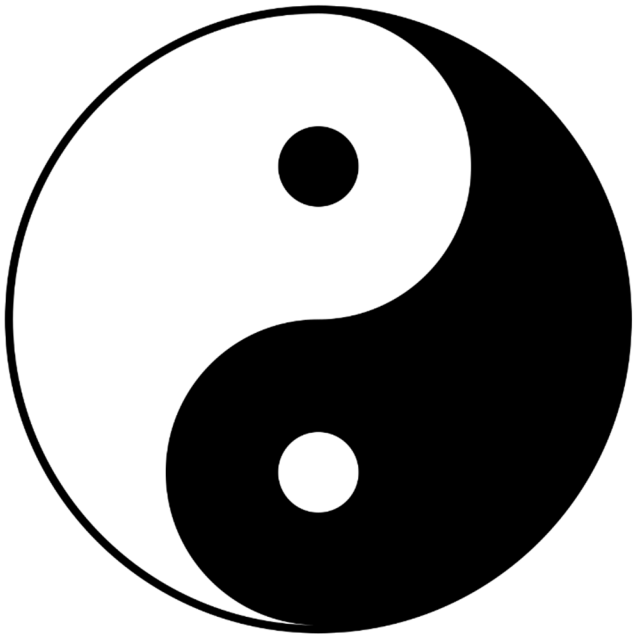


Figure 3-6 Yin/Yang symbol

I implement the classic location theory in regional science to explain people's mobility. The "Yin" and "Yang" can be view as two places. The difference between "Yin" and "Yang" motivates people's mobility between them. Meanwhile, people's flows could be viewed as the bridge to connect and adjust the "Yin/Yang" differences. When "Yin/Yang" reaches the equilibrium and forms as a whole circle, people stop moving. Initially, "Yin" and "Yang" could be separated. But "Yin" and "Yang" are attracted by each other, because of the difference between them (Black and White) and

the interdependence between them (complementary shape). Location theory illustrates the connection between the big white part and the big black part of the "Yin/Yang" symbol. However, location theory omits the little black circle within the "Yang" and the little white circle within the "Yin". That is the beauty of the "Yin/Yang". I think the little "Yin" inside "Yang" and the little "Yang" inside "Yin" breaks the initial harmony of the "Yin" and "Yang" and then pushes them to find each other. In the equilibrium, "Yin" and "Yang" can form the perfect circle. In this research, the difference within "Yin" and "Yang" is captured by the local labor market mismatch, and the difference between "Yin" and "Yang" is captured by the regional disequilibrium. The attraction between "Yin" and "Yang" is generated by the mismatch and the disequilibrium, and is reflected by people's flows.

This regional disequilibrium framework can examine rural-urban connections. Reconsidering the brain drain problem, the lack of job opportunities pushes out rural residents to look for jobs, but why do some go to urban area 1, but some go to urban area 2? Urban also has its own local labor market mismatch. How does that affect the number of in-migrants/in-commuters from different rural areas? This framework provides a new way of thinking about mobility. It is not only local factors within rural or urban areas which drive people's mobility, but also the different factors between urban and rural areas that attract people. This helps us determine which factors in rural can be improved to retain population, compared to urban.

So far, the regional disequilibrium framework includes the disequilibrium of the local labor market mismatch between places. The labor market also includes other characteristics driving people's mobility, such as wage, employment rate, labor

participation. For example, if the receiving place has a higher wage than the sending place, people are more likely to move to the receiving place. Both the local labor market mismatch and the regional labor market disequilibrium are positively related to people's mobility. Both commuters and migrants are attracted by a better labor market, such as more skill matched occupations, more job opportunities, higher wages, etc. However, the role of the housing market and the amenity market in people's mobility are still missing. People's mobility is related to not only where they work, but also where they live. Compared to the labor market, the housing market and the amenity market have different impacts on commuting and migration. For example, people who own a house are more likely to commute and less likely to migrate. A higher amenity cost in the receiving place will increase the number of in-commuters and decrease the number of in-migrants, because both commuters and migrants are less likely to afford to live in the receiving place. Therefore, it is important to include both the housing market and the amenity market in mobility research to differentiate commuting and migration.

Controlling for the housing market and amenity market is essential in the rural-urban mobility research. The cost of housing and amenity may not stop urban in-migrants to rural areas. Studies show that homeownership can provide financial support for urban retirees moving from metro counties to nonmetro counties (Rickman & Rickman, 2011; Sultana & Weber, 2007). Also, rural areas with higher amenity cost could be a sign of better amenity, which attracts urban creative classes to move in (Isserman, Feser, & Warren, 2009; McGranahan & Wojan, 2007). Therefore, a comprehensive framework including the labor market, housing market, and amenity market is important to explore the rural-urban commuting and migration.

My research extends the regional disequilibrium framework by including more factors in the labor market, housing market and amenity market (Figure 3-7). The spatial disequilibrium framework focuses on the local labor market mismatch as well as regional labor market disequilibrium. The role of the housing market and amenity market is conceptualized the simplified in this research. The framework includes the homeownership to illustrate the housing market, and both the natural amenity scale and amenity quality to capture the amenity market (see chapter 4 for details).

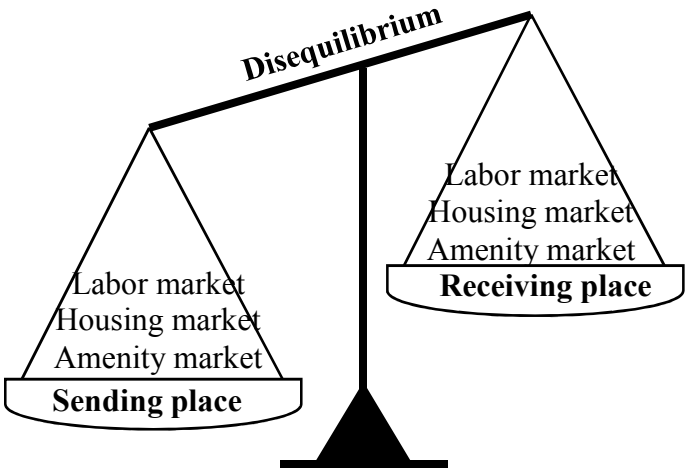


Figure 3-7 Regional disequilibrium framework-labor, housing, amenity markets

This regional disequilibrium framework, linking people's mobility with the difference in the labor market, housing market and amenity market between two places, could help explore rural development approaches in terms of increasing and retaining populations. For example, with the emergence of amenity-led rural development, in-migrants, especially urban retirees and creative classes, are attracted by natural amenities, as well as the labor market and housing market differences between rural and urban areas (Kim, Marcouiller, & Deller, 2005; Lichter & Brown, 2011). Rural development approaches need to be place-based, but should be 'place-tailored' so that

policy adjusts to spatial heterogeneity, focuses on people, and increases the quality of life (Garcilazo, Martins, & Tompson, 2010; Kraybill & Kilkenny, 2003). As indicated by Olfert and Partridge (2010), the promising rural development approaches increase the connection between rural and urban to help rural areas access agglomeration economies, as well as increase amenities and local entrepreneurial capacity. This research is the first to build a framework to examine the connection between rural and urban, and the connection between people and place. For example, by examining the relation between local labor market mismatch and people's mobility, this research can explore how rural development policy might increase rural educational level without causing people to move out. By examining the relation between people's mobility and the rural-urban disequilibrium in the labor market, housing market and amenity market, this research can explore how to improve amenities to attract urban in-migrants without pushing out rural residents.

To sum up, my spatial disequilibrium framework, including both the local labor market mismatch and the regional disequilibrium, develops a comprehensive framework to explore factors driving people's mobility. I articulate the county pair as the unit of analysis connecting people and place. The framework is shown in Table 3-1. The next chapter will create measurements for the spatial disequilibrium framework.

Table 3-1 Spatial disequilibrium framework

		Dependent variables:	
		# out-commuters and # number out-migrants	
County pair	From	Rural	Urban
	To	Urban	Rural
Independent variables			
Local labor market mismatch (sending county)			
Education-occupation skill mismatch		Education-occupation skill mismatch in rural	Education-occupation skill mismatch in urban
Resident-firm employment mismatch		Resident-firm employment mismatch in rural	Resident-firm employment mismatch in urban
Regional disequilibrium (differences between sending place and receiving place)			
Local labor market mismatch is greater in the sending county		If rural has greater local labor market mismatch	If urban has greater local labor market mismatch
Labor market		Rural-urban labor market difference	
Housing market		Rural-urban housing market difference	
Amenity market		Rural-urban amenity market difference	

CHAPTER 4

METHODOLOGY

This chapter uses the county to county migration and commuting data to examine the spatial disequilibrium framework, and explore factors driving people's mobility between metro and nonmetro counties. This research uses the county pair as the unit of analysis to link the number of out-commuters and the number of out-migrants with the sending county and the receiving county. As shown in Chapter 3, the spatial disequilibrium is illustrated by the local labor market mismatch and the regional disequilibrium in the labor market, housing market and amenity market between two counties. This chapter creates the proxies of the spatial disequilibrium framework, and describes the data in the rural-urban divide. Lastly, this research innovatively uses the Group Logit model to measure the linkage between the group of people with the locational attributes of two places.

4.1 Data

This research uses the county pair as the unit of analysis. The commuting data are acquired from the Journey to Work dataset (2009-2013), and the migration data are acquired from the County to County migration (2009-2013). Those datasets include 50 states and D.C. Each observation has the number of out-commuters and the number of out-migrants from one county to the other county and the county FIPS code of both the sending county and the receiving county (Table 4-1). Table 4-1 shows the basic structure of the county pair: a group of people who commute or migrate between two specific counties.

Table 4-1 Data structure

Sending county	Receiving county	People's mobility	Data source
County A	County B	Number of out-commuters from County A to County B	Journey to Work, 2009-2013
County A	County B	Number of out-migrants From County A to County B	County to County Migration, 2009-2013

However, the locational attributes of the sending county and the receiving county are not included in the Journey to Work dataset and the County to County migration, such as the overall education level, employment, and wage. To measure the labor market, housing market, and amenity market, this research uses the county-level data from American Community Survey 2009-2013, County Business Pattern 2013, and USDA Natural Amenity scale 1999. All the datasets have FIPS code for each county. This research uses the FIPS code to add locational attributes to both the sending county A and the receiving county B. Therefore, each observation includes the number of out-commuters/out-migrants from county A to county B, and the locational attributes of both county A and county B.

This research uses 100 miles as the commuting threshold and deletes the commuting county pairs with more than 100 miles of travel distance. Lots of commuting studies use 100 miles as a distance filter (Artz, Kim, & Orazem, 2016; Burkhardt, 2004; Crowder, Hall, & Tolnay, 2011; Freedman, Lane, & Roemer, 2008; Rosenthal & Strange, 2008). Because migration distance is not as restricted as the commuting distance, this study includes all the migration county pairs. The justification for setting the commuting threshold is in Appendix 1. The calculation of distance is shown in the section 4.4-travel distance. The overall sample includes 101,706 migration county pairs and 16,975 commuting county pairs (Table 4-2). After setting the 100

miles distance filter, the commuting county pairs decrease by about two-thirds, while the number of out-commuters (population) only decreases by 15%. The 100 miles distance filter keeps most of the out-commuters, and excludes the extreme long-distance commuters.

Table 4-2 Sample selection

	Number of observations (County pairs)	Number of out-commuters/out-migrants (population)
Commuting	49,952	4,423,147
Commuting (less than 100 miles)	**16,975**	3,797,857
Migration	**101,706**	3,384,052

Data source: Journal to work 2009-2013, County to county migration 2009-2013
Note: subsample is highlighted in **bold**

To capture the spatial heterogeneity and explore rural-urban relations, counties are divided into metro counties and nonmetro counties. Metro status is defined based on the Core Based Statistical Area from the US Census Bureau. Aggregated mobility data by metro status are shown in Table 4-3. Table 4-3 shows that the number of out-commuters is almost twice the number of in-commuters in nonmetro counties. Metro counties are the hot workplaces for people living in nonmetro counties. Table 4-3 also shows that the nonmetro counties have positive net migrants. This could be due to the increase of the retirement-based migration. Nonmetro counties are losing people to metro counties, but most of the nonmetro residents commute rather than migrate to metro counties.

Table 4-3 Number of migrants and commuters by metro status

		Number of out-commuters	Number of out-migrants
From To	Nonmetro county Metro county	2,487,809	1,689,034
From To	Metro county Nonmetro county	1,310,048	1,695,018
Net mobility (from nonmetro to metro)		1,177,761	-5,984

Data source: County to county migration, Journal to work 2009-2013

To sum up, this section uses the county pair to build the data structure. This chapter will create the proxies for the spatial disequilibrium framework: the local labor market mismatch within each county, and the region disequilibrium between metro and nonmetro counties in the labor market, housing market and amenity market to link people's mobility with the two places (Figure 4-1).

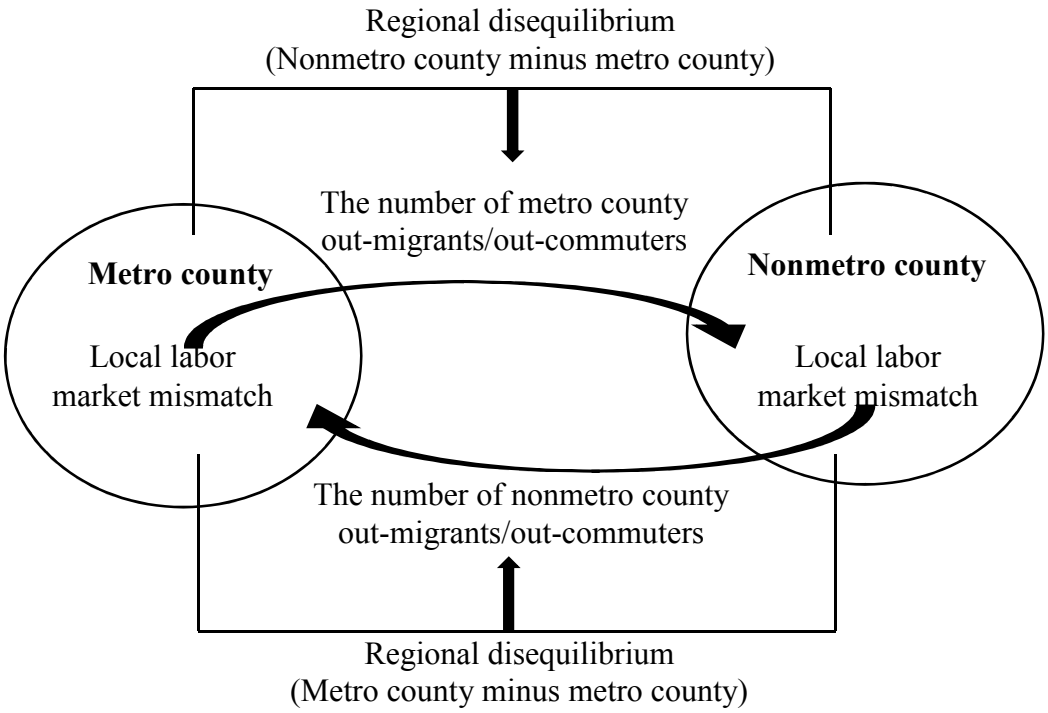


Figure 4-1 Empirical study framework

4.2 Local labor market mismatch measurements

Local labor market mismatch includes two mismatches:1) the education-occupation skill mismatch, which measures the difference between workers' skill supply and the occupational skill demand. 2) the residential-firm employment mismatch, which measures the difference between labor supply and labor demand. Each mismatch is measured only within the sending county. It is because that every county is a sending county. Also, the local labor market mismatch within the receiving county is captured in the regional labor market disequilibrium.

4.2.1 Education-occupation skill mismatch

4.2.1.1 Hypothesis

The impact of education-occupation skill mismatch on people's mobility includes two scenarios: 1. Educational level is higher than the occupational skill. 2. Educational level is lower than the occupational skill. The discussion of each scenario is based on three assumptions: 1. Labor can be overeducated or undereducated. 2. In the labor market equilibrium, education perfectly matches the skill required by occupations (skill supply=skill demand). 3. Labor is more likely to move upward. Workers with a higher educational level than the required skill are more likely to change jobs (Nordin, Persson, & Rooth, 2010; Quintini, 2011). On the other hand, workers with a lower educational level than the required skill are more likely to keep the job.

The education-occupation skill mismatch has two scenarios: skill supply is more than demand, and skill supply is less than demand (Figure 4-2). **In the first scenario (supply>demand)**, the county has a group of overeducated workers. Those workers are more likely to change jobs. If workers find local jobs, then it will decrease outflow. This

implies more local job opportunities. If workers find external jobs, then it will increase outflow. This implies more external job opportunities. **In the second scenario (supply<demand)**, the county has undereducated workers relative to local job skill demand. Those workers are more likely to keep their jobs. If workers are working within the residential county, then it will decrease outflow. This implies more local job opportunities. If workers are working outside the residential county, then it will increase outflow. This implies more external job opportunities. Thus, the mismatch between education and occupation skill will drive people to either change the current job or keep their current job. No matter what decision people make, more local job opportunities are related to fewer outflows, and more external job opportunities are related to more outflows.

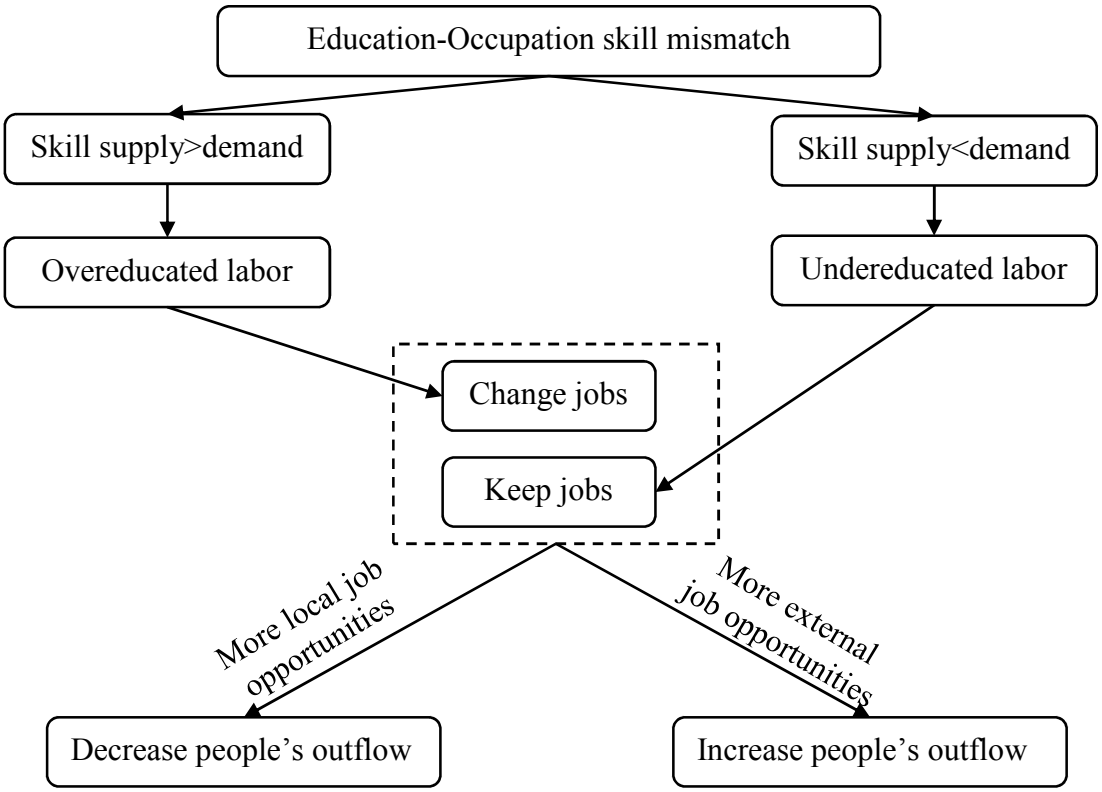


Figure 4-2 Education-occupation skill mismatch framework (sending county)

4.2.1.2 Measurements

Studies on the education-occupation skill mismatch are commonly measured at the individual level. Most of the education-occupation skill variables are created from the questionnaires. For example, " is your educational degree necessary to perform your job?" (Croce & Ghignoni, 2015, p. 28). "Workers are asked whether their education attainment is necessary for their jobs" (Devillanova, 2013, p. 452). Some research uses the unemployment rate (Haan et al., 2015), but the unemployment rate cannot distinguish labor skills. This study uses aggregate data at the county level, and separates the education-occupation skill mismatch into the high skill mismatch and the low skill mismatch. Each skill mismatch is directly measured by the difference between residents' education and skill required by occupations at the county level.

Education and occupation data are acquired from the American Community Survey 2009-2013. Education is measured by the educational level of the population over 25. The occupation, following Partridge et al. (2012)'s research, is measured by the skill level of occupation rather than industry, since people are more likely to move between occupations rather than industries. Also, the occupation data can capture the residential based employment, which is the skill demanded from the residential perspective in response to the skill supplied from the residents (educational level). The high skill mismatch and the low skill mismatch are classified based on the entry-level education data from the Bureau of Labor Statistics [2]. The dataset includes 818 occupations which are aggregated into 13 larger occupation categories (Table 4-4). Table 4-4 shows that the top two highest skill occupations are professional occupations

[2] Data are acquired from https://www.bls.gov/ooh/education-training-and-library/home.htm?view_full

and management occupations, and the lowest skill occupations are food preparation and building/grounds cleaning and maintenance. Most of the high skill occupations require a bachelor's degree or more. Fifteen out of the eighteen food preparation occupations do not require a degree, nor do half of the cleaning and maintenance jobs. Therefore, high education is defined by diploma no less than the bachelor's degree, and low education is defined by no degree.

High skill mismatch = absolute value of (percent of the population over 25 years having at least bachelor's degrees **minus** the percent of the employed civilian population over 16 in professional and related occupations or management, business, and financial operations occupations)

Low skill mismatch = absolute value of (percent of the population over 25 years having a degree less than high school **minus** the percent of the employed civilian population over 16 in food preparation and serving related occupations and building and grounds cleaning and maintenance occupations)

Table 4-4 Entry-level education required by occupations (number of occupations)

	Occupation	No Degree	High school	Some college	Bachelor or higher
High skill	Professional and related	6	18	52	**213**
	Management, business, and financial operations	1	9	2	**54**
Middle skill	Sales and related	9	10	0	3
	Office and administrative support	0	51	3	2
	Transportation and material moving	17	29	5	1
	Protective service	2	16	3	1
	Farming, fishing, and forestry	5	7	0	1
	Construction, extraction, and maintenance	26	71	15	0
	Healthcare support	0	9	8	0
	Personal care and service	4	22	7	0
	Production	14	91	3	0
Low skill	Food preparation and serving related	**15**	2	1	0
	Building and grounds cleaning and maintenance	**5**	5	0	0

Data source: Occupational outlook handbook, Bureau of Labor Statistics,2016

The statistical description of the education-occupation skill mismatch within metro counties and within nonmetro counties are shown in Table 4-5. Metro counties have a significantly higher percentage of the high educated population than nonmetro counties. Metro counties also have a higher percentage of high skill occupations. Compared to metro counties, nonmetro counties have a higher percentage of low educated workers and a higher percentage of low skill occupations. The skill mismatch, both the high skill mismatch and the low skill mismatch, is greater in nonmetro counties than in metro counties. This implies that people living in nonmetro counties are less likely to find a local job matching their educational level. It also implies that the large number of out-commuters from nonmetro counties to metro counties could be related to the greater skill mismatch in nonmetro counties.

Most empirical studies use either people's education or job opportunities to explain people's mobility. However, Table 4-5 shows that counties with more high educated workers have more high skill jobs, and counties with more low educated workers have more low skill jobs. Therefore, people's mobility, as the force adjusting the labor market, could be related to the difference between the skill supply and the skill demand rather than either skill supply (education) or skill demand (occupation).

Table 4-5 Statistical description: education-occupation skill mismatch

Education-occupation skill mismatch		Metro county	Nonmetro county	T-test
Education (%)	High educated population	24.03	17.08	23.70*
	Low educated population	14.66	16.59	-7.29*
Occupation (%)	High skill occupation	32.98	29.22	17.02*
	Low skill occupation	9.51	9.69	-2.11*
Education-occupation skill mismatch	High skill mismatch	9.23	12.22	-25.47*
	Low skill mismatch	5.15	8.15	-18.55*

Data source: American Community Survey 2009-2013
Note: * $p<0.05$

4.2.2 Resident-firm employment mismatch

4.2.2.1 Hypothesis

Resident-firm employment mismatch is measured by the difference between labor supply by residents and the labor demand by local firms within the sending county. The impact of resident-firm employment mismatch on people's mobility is illustrated by two scenarios: 1) the number of resident employees is more than the number of firm employees, 2) the number of resident employees is fewer than the number of firm employees (Figure 4-3). **In the first scenario (supply>demand),** there is more local labor supply than labor demand. The labor surplus accelerates the competition between local labor and nonlocal labor. **In the second scenario,** there is less local labor supply

than labor demand. The labor deficit decelerates the competition between local and nonlocal labor, but the competition still exists. In both scenarios, if residents get the job, then it will decrease the outflow, and this implies that local labor is more competitive than nonlocal labor. If residents do not get the job, it will increase outflow and implies that local labor is less competitive than nonlocal labor. Therefore, the resident-firm employment mismatch illustrates that the competition between resident employees and the nonlocal labor is related to people's mobility.

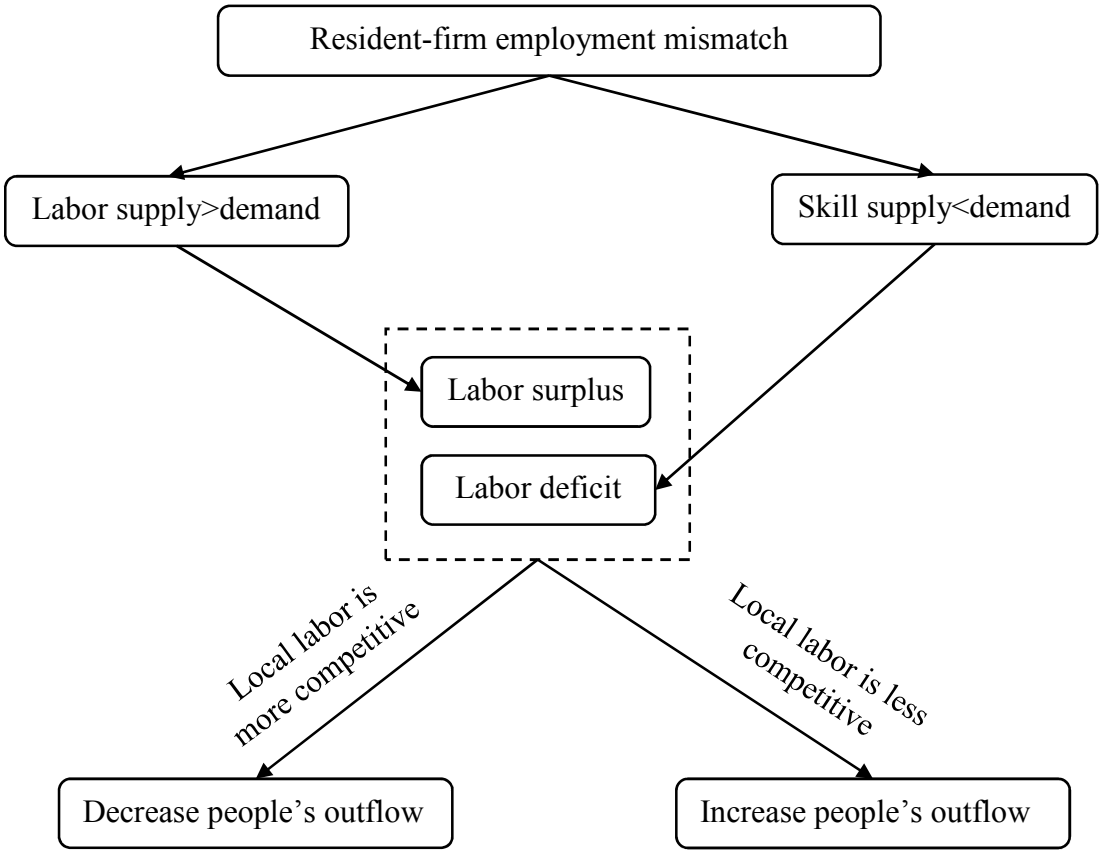


Figure 4-3 Resident-Firm employment mismatch framework (sending county)

4.2.2.2 Measurements

The resident-firm employment mismatch is directly measured by the difference between local labor supply and local labor demand in the same industry. Local labor supply is

measured by residential employment from American Community Survey 2009-2013 (ACS). Labor demand is measured by the firm employment from County Business Patterns 2013 (CBP)[3]. Unlike ACS, CBP does not include the occupation data, so I use the industry category to measure resident-firm employment mismatch.

Industries are grouped into six categories based on the name of industry between ACS and CBP, including agriculture, service, education and health, manufacturing, professional service, and production. I only selected the low skill service industry to represent the low skill employment and professional service industry to represent the high skill employment (Table 4-6). I did this to simplify the model. It also because there are many missing values in other industry groups.

Professional service employment mismatch = absolute value (number of residents working in the professional service industry minus the number of employees in the professional service industry)/absolute value (total number of employed residents minus the total number of firm employees)

Low skill service employment mismatch = absolute value (number of residents working in the low skill service industry minus the number of employees in the low skill service industry)/absolute value (total number of employed residents minus the total number of firm employees)

[3] If an industry only has a range of employee number, the employee number will be replaced by the mean. For example, 0-19 is replaced by 10.

Table 4-6 Industry matching between ACS and CBP

	ACS	CBP
Low Skill Service	Arts, Entertainment, and Recreation, and Accommodation and Food Services	NAICS 71: Arts, Entertainment, and Recreation
		NAICS 72: Accommodation and Food Services
	Retail Trade	NAICS 44-45: Retail Trade
	Other Services, Except Public Administration	NAICS 81: Other Services (Except Public Administration)
Professional service	Finance and Insurance, and Real Estate and Rental and Leasing	NAICS 53: Real Estate and Rental and Leasing
		NAICS 52: Finance and Insurance
	Professional, Scientific, and Management, and Administrative and Waste Management Services	NAICS 55: Management of Companies and Enterprises
		NAICS 56: Administrative and Support and Waste Management and Remediation Services
		NAICS 54: Professional, Scientific, and Technical Services
	Information	NAICS 51: Information

Data source: American Community Survey 2013, County Business Pattern 2013

The resident-firm employment mismatch within metro counties and within nonmetro counties is shown in Table 4-7. Compared to nonmetro counties, metro counties have a higher percentage of residents working in the professional service industry and the low skill service industry. The development of the professional service industry is also better in metro counties than that in nonmetro counties, since there is a higher percentage of workers hired by local professional service firms. The development of the local low skill service industry does not show a significant difference between metro counties and nonmetro counties. The resident-firm employment mismatch shows that nonmetro counties have a smaller employment mismatch. It implies that firms in nonmetro counties are more likely to hire local labor. Like the education-occupation skill mismatch, the resident-firm employment mismatch captures both the supply side and the demand side of the local labor market. This

research creates a new way of thinking factors driving people's mobility. It is not only the lack of job opportunities pushing people to move out, or more jobs attracting people to move in. It is the difference between labor supply and demand that motivates people's mobility.

Table 4-7 Statistical description: resident-firm employment mismatch

Resident-firm employment mismatch		Metro county	Nonmetro county	T-test
Resident employment (%)	Professional Service[1]	16.06	10.61	37.72*
	Low Skill Service[1]	25.22	23.71	8.92*
Firm employment (%)	Professional Service[2]	13.28	8.88	15.50*
	Low Skill Service[2]	33.62	33.87	-0.59
Resident-firm employment mismatch	Professional Service[1,2]	0.72	0.18	4.23*
	Low skill service[1,2]	0.39	0.25	3.51*

Data source: 1. American Community Survey 2009-2013, 2. County Business Pattern 2013
Note: * $p<0.05$

This section creates the measurements of the local labor market mismatch (Table 4-8). The spatial disequilibrium framework includes the local labor market mismatch within counites and the regional disequilibrium between counties. The next section will create regional disequilibrium measurements.

Table 4-8 Local labor market mismatch hypothesis and statistical description

Local labor market mismatch		Hypothesis	Data	
		# of out-commuter # of out-migrants	Metro county	Nonmetro county
Education-occupation	High skill	+ (more external job opportunity)	9.23	12.22
	Low skill	- (more local job opportunity)	5.15	8.15
Resident-firm	Professional service	+ (more competitive nonlocal labor)	0.72	0.18
	Low Skill service	- (more competitive local labor)	0.39	0.25

4.3 Regional disequilibrium measurements

The regional disequilibrium measures the difference between the sending county and the receiving county in the labor market, housing market, and amenity market.

4.3.1 Regional labor market disequilibrium

The regional labor market disequilibrium uses the county pair to measure the labor market difference between two counties. First, the regional labor market disequilibrium measures the difference in local labor market mismatch between the sending county and the receiving county. Local labor market mismatch is a complicated measurement including both local supply and local demand with respect to skills and jobs. The labor market mismatch variables are proxies, so this research simplifies the measurement of disequilibrium in the labor market mismatch by using dummy variables rather than calculate the real difference between the sending county and the receiving county.

Each local labor market mismatch includes a dummy variable to compare the mismatch within the sending county to the mismatch within the receiving county. If the local labor market mismatch in the sending place is greater than the mismatch in the receiving county, then the dummy variable is coded as 1. Otherwise, it is coded as zero. Therefore, a more balanced receiving county is also coded as 1. The definition of the dummy variable is shown below. Other variables in the labor market disequilibrium are equal to the value in the receiving county minus the value in the sending county.

$$\begin{matrix} Regional\ labor\ market\ disequilibrium \\ in\ the\ local\ labor\ market\ mismatch \end{matrix} = \begin{cases} 1 & \begin{matrix} sending\ county\ has\ a\ greater\ mismatch\ than\ receiving\ county, or \\ receiving\ county\ is\ more\ balanced\ than\ the\ sending\ county \end{matrix} \\ 0 & \begin{matrix} sending\ county\ is\ more\ balanced\ than\ the\ receiving\ county, or \\ receiving\ county\ has\ a\ greater\ mismatch\ than\ the\ sending\ county \end{matrix} \end{cases}$$

The local labor market mismatch impacts people's mobility in two directions: it could be either positively or negatively related to the number of people's outflow (shown in Figure 4-2 and Figure 4-3). Thus, the impact of disequilibrium in the local labor market mismatch on people's mobility is undefined.

The regional labor market disequilibrium measures the difference between the sending place and the receiving place in factors pulling people to move in (pull factors), factors pushing people to move out (push factors), and factors which could work in both directions (other factors). Each variable is calculated by the factors in the receiving county minus the factors in the sending county. If the pull factors in the receiving county are stronger than those in the sending county, then the regional labor market disequilibrium is expected to be positively related to the number of people's outflow. If the push factors in the receiving county are stronger than those in the sending county, then the regional labor market disequilibrium is expected to be negatively related to the number of people's outflow. Other factors could be either positively or negatively related to people's outflow (Table 4-9).

Table 4-9 Labor market disequilibrium hypothesis

Receiving county-sending county	# of out-migration and out-commuting
Pull factors	+
Push factors	-
Other factors	+/-

There are two pull factors: labor participation and wage. Labor participation is measured by the differences in the percentage of population 16 years and over in the labor force between the receiving county and the sending county. The wage for each industry is acquired from County Business Patterns 2013 (Table 4-10). The industries are classified to two groups: high wage and low wage based on the relevance of the

industries and the distribution patterns (Figure 4-4). The high wage group includes the management of companies and enterprises, finance and insurance, information, and professional, scientific, and technical services. Although the distribution pattern of management is much flatter than the distribution of finance and insurance, both industries have similar minimum and maximum average wages (Table 4-10). Also, considering management as a separate group would leave many missing values in the dataset. The low wage group includes other services (except public administration), arts, entertainment, and recreation, and accommodation and food services. The average wage for each group is calculated as follows:

$$Average\ wage = \frac{\sum_i average\ wage_i * number\ of\ employees_i}{\sum_i number\ of\ employees_i}, i = industry\ i$$ [4]

Table 4-10 Average wage in 2013 ($)

		N	Mean	Std.	Min	Max
High wage	Management of companies and enterprises	700	77,044	29,182	19,448	205,058
	Finance and insurance	2436	46,034	15,930	19,800	281,670
	Information	1581	43,451	18,023	9,000	317,012
	Professional, scientific, and technical services	2329	42,876	16,952	9,500	152,323
Average wage for all sectors		**3103**	**35,114**	**8,852**	**15,591**	**126,171**
Low wage	Other services (except public administration)	2745	21,418	6,047	4,917	73,394
	Arts, entertainment, and recreation	1564	20,899	16,870	3,800	413,500
	Accommodation and food services	2876	13,689	5,247	4,235	155,778

Data source: County Business Patterns 2013

[4] For industries that have an employment range but do not have the wage, the number of employees is 0 instead of an estimation of the range.

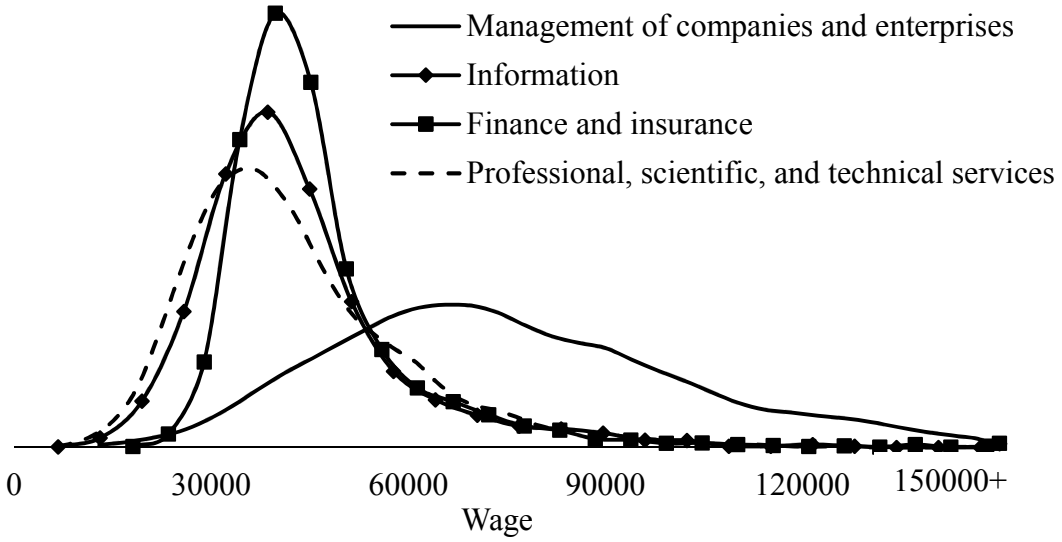


Figure 4-4A Distribution patterns of high wage groups

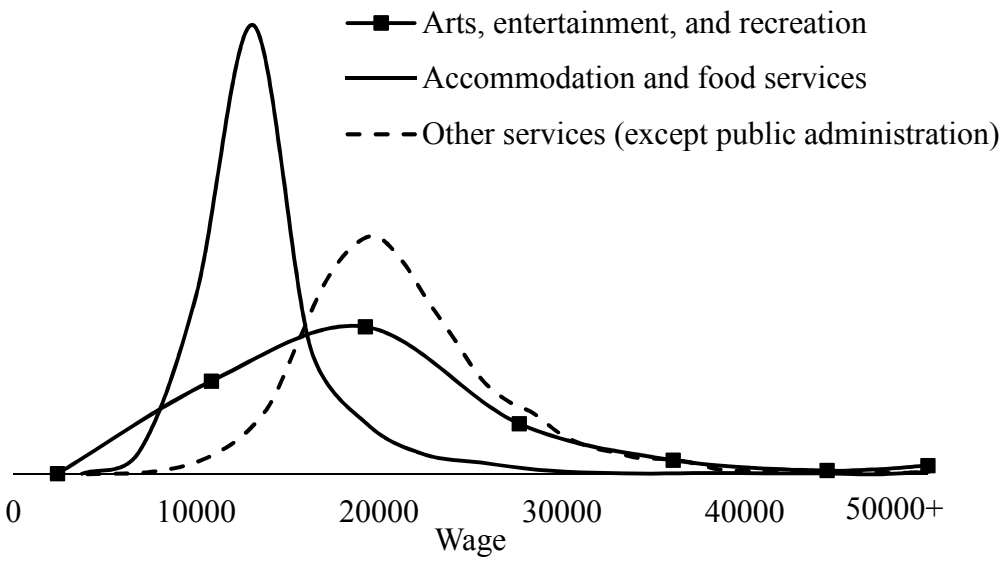


Figure 4-4B Distribution patterns of low wage groups

Figure 4-4 Distribution patterns of wage groups
Data source: County Business Patterns 2013

Two push factors are defined in the labor market: the percentage of households with self-employment income, and the percentage of the unemployed population 16

years and over in the labor force. People are more likely to leave places with a higher unemployment rate. Places with a lower self-employed rate are more likely to have more job opportunities. I expect that people are more likely to commute or migrate to places with a lower unemployment rate and lower self-employment rate.

High education is the other factor, which is measured by the percent of the population over 25 with at least a bachelor's degree. Places with a higher percentage of high educated population could attract firms (Florida, 2004; Glaeser, 2000). The increase in job creation will attract people (Storper, 2013). However, those places also could have more people moving out, because high skill labor is more likely to move (Faggian, McCann, & Sheppard, 2007; Overman, Rice, & Venables, 2009).

The differences in pull and push factors between metro counties and nonmetro counties are shown in Table 4-11. Metro counties have a higher percentage of labor participation, higher wages in both high skill jobs and low skill jobs, and a higher educational level than nonmetro counties. Nonmetro counties have a higher self-employment rate and a lower unemployment rate. Table 4-11 shows that metro counties have stronger pull factors attracting people. However, metro counties also have a higher unemployment rate, which pushes people to look for other job opportunities.

Table 4-11 Statistical description: regional labor market disequilibrium

			Metro county	Nonmetro county	T-test
Pull factors	Labor participation[1]		61.81	58.12	12.93*
	Wage	High skill[2]	52834	38709	25.74*
		Low skill[2]	17758	15383	11.76*
Push factors	Self-employed[1]		10.75	14.18	-17.25*
	Unemployment[1]		9.86	8.90	6.19*
Other factors	High education[1]		24.03	17.08	23.70*

Data source: 1. American Community Survey 2009-2013, 2. County Business Pattern 2013
Note: * $p<0.05$

This research focuses on the impact of local labor market mismatch and regional labor market disequilibrium on people's commuting and migration. This research also integrates the housing market and amenity market into the spatial disequilibrium framework, which is commonly examined separately by current empirical studies.

4.3.2 Regional housing market disequilibrium

This research uses the ratio of owner-occupied housing units to the total number of housing units as the proxy for the housing market disequilibrium. This research expects that homeownership is positively related to the number of out-commuters and is negatively related to the number of out-migrants. If people own a house, then it will increase the migration cost. Thus, homeowners are more likely to commute rather than migrate. Data on homeownership are acquired from ACS. The regional housing market disequilibrium hypothesis and statistical description are shown in Table 4-12

Table 4-12 Regional housing market disequilibrium

		Housing market disequilibrium
Measurement		Percent of owner-occupied households in the sending county
Hypothesis	The number of out-commuters	+
	The number of out-migrants	-
Statistical description	Metro county	61.52
	Nonmetro county	57.72
	T-test	11.57*

Data source: American Community Survey 2009-2013
Note: * $p<0.05$

Table 4-12 shows that metro counties have a higher percentage of home ownership than nonmetro counties. We usually think metro counties have a lower percentage of homeownership than nonmetro counties, because metro counties have more rental housing. However, the higher vacancy rate lowers the home ownership rate in nonmetro counties (Table 4-13).

Table 4-13 Homeownership by metro status

	Metro county	Nonmetro county
Percentage of owner-occupied housing units	61.52	57.72
Percentage of the renter-occupied housing unit	25.54	21.49
Vacancy rate	12.94	20.79

Data Source: ACS 2009-2013

The higher vacancy rate in nonmetro counties could be related to the seasonal in-migrants/workers attracted by natural amenities. Table 4-14 shows the average natural amenity scale based on the homeownership and the vacancy rate in nonmetro counties. Nonmetro counites with a lower percentage of homeownership and a higher vacancy rate have a higher natural amenity value. It shows that it is important to consider both the housing market and the amenity market to get a full picture of nonmetro counties.

Table 4-14 Nonmetro county natural amenity scale

		Percent of home ownership	
		Higher than 57.72 %	Lower than 57.72 %
Vacancy rate	Higher than 20.79 %	0.02	**1.08**
	Lower than 20.79 %	0.35	-0.90

Data Source: USDA Natural Amenity Scale 1999

4.3.3 Regional amenity market disequilibrium

The amenity market is measured by the difference in the natural amenity scale and the average wage between counties. The average wage difference illustrates the difference in amenities (Niebuhr et al., 2012). This research hypothesizes that people are more likely to migrate rather than commute to the receiving counties with better natural amenity. Also, a higher average wage could illustrate the amenity cost, since this research has already controlled for high skill wage and low skill wage. Thus, people are more likely to commute rather than migrate to the receiving county with a higher

average wage. The average wage data are from CBP, and the natural amenity scale data are acquired from USDA (Table 4-15).

Table 4-15 Regional amenity market disequilibrium

		Amenity market disequilibrium	
Measurement	Receiving county – sending county	Natural amenity scale[2]	Average wage ($)[3]
Hypothesis	The number of out-commuters[1]	-	+
	The number of out-migrants[1]	+	-
Statistical description	Metro county	0.27	38,228
	Nonmetro county	-0.08	33,245
	T-test	4.1*	15.78*

Data source: 1. American Community Survey 2009-2013, 2. USDA Natural Amenity Scale 1999, 3. County Business Pattern 2013.
Note: * $p<0.05$

Table 4-15 shows that metro counties have a higher average wage than nonmetro counties. Surprisingly, metro counties also have a higher natural amenity scale. USDA natural amenity scale dataset includes climate, topography, and water area at the county level (Table 4-16). Each natural amenity indicator is standardized. Then the natural amenity scale is the sum of five standardized natural amenity indicators. Table 4-16 shows that metro counties have a warmer temperature and a higher percentage of water area; and nonmetro counties have more sunlight, less humidity and various land surface. The land surface typography includes plains, tablelands, plains with hills or mountains, open hills and mountains, and the hills and mountains. A higher value of the land surface represents the topographic variation. Based on the calculation of the natural amenity scale, counties with a high amenity value have a higher temperature in January, more sunlight hours in January, a lower temperature in July, a lower relative humidity in July, a more diverse land surface, and a higher percent water area. The range of the natural amenity scale is the sum of five standardized values, which is from -6.4 to 11.17.

This research uses the aggregated natural amenity scale, which is used in lots of rural studies (Betz, Partridge, & Fallah, 2016; Rickman & Guettabi, 2015; Rupasingha et al., 2015). Future research could build amenity indicator based on the natural amenity scale to capture more county attributes. For example, Rickman and Wang (2017) use population as a weight to recalculate the natural amenity scale, and then separate the value into 7 groups. Each group is represented by a dummy variable (Rickman & Wang, 2017).

Table 4-16 Natural amenity scale indicators

Natural amenity scale indicators	Metro county	Nonmetro county	T-test
Mean temperature for January, 1941-70	**35.49**	31.36	9.40*
Mean hours of sunlight January, 1941-70	149.01	**153.10**	-3.33*
Mean temperature for July, 1941-70	**76.40**	75.54	4.35*
Mean relative humidity July, 1941-70	**59.46**	54.14	9.96*
Land surface form topography code	8.49	**9.13**	-2.63*
Percent water area	**6.51**	3.44	7.43*

Data source: USDA Natural Amenity Scale 1999

4.4 Travel distance

Distance is an important factor in commuting and migration studies. This research uses the inverse distance to measure spatial connections between counties. The inverse form is commonly used in commuting and migration research, as well as spatial analysis (Acs, Anselin, & Varga, 2002; Anselin, 2002; Crowder et al., 2011; Stephens & Partridge, 2011). The county to county travel distance data are acquired from Google Map API. Google map does not include the travel distance of each county pair. I calculated the values by the distance of the longitude and latitude between county i and county j:

$$Distance = \text{acos}(\sin\left(\pi * \frac{latitude_i}{180}\right)$$

$$* \sin\left(\pi * \frac{latitude_j}{180}\right) + \cos\left(\pi * \frac{latitude_i}{180}\right)$$

$$* \cos\left(\pi * \frac{latitude_j}{180}\right)$$

$$* \cos\left(\pi * \frac{longitude_i}{180} - \pi * \frac{longitude_j}{180}\right)) * 6378000$$

4.5 Group logit model

I use Group Logit model to analyze the linkage between the number of out-migrants/the number of out-commuters and the attributes of both the sending county and the receiving county. The number of out-migrants/the number of out-commuters are viewed as a group of people connecting two places. The Group Logit model can capture the impact of the locational attributes on the movements of these two groups of people, migrants and commuters. For example, the method can examine what factors in county A drive 10 out of 100 workers to move. This research uses the county pair and the spatial disequilibrium framework to link two places. Thus, the group logit model is extended to assess the relation between the number of out-migrants/the number of out-commuters and locational attributes of two places. For example, in 2013, there are 52,542 people in the labor force in Tompkins County, NY (American Community Survey 2009-2013), and there are 1370 people who commute from Tompkins County to Cortland County, NY. The group logit model can calculate what factors in Tompkins County and what factors in Cortland County drive 1370 out of 52,542 people to commute. The group logit model increases the estimation efficiency by addressing the

heteroscedasticity among observations (Horn, Cantor, & Fort, 2015; Mikhailov, Niemi, & Weimer, 2002).

To capture the relation between commuting and migration, the commuting model controls for the number of out-migrants, and the migration model controls for the number of out-commuters. There are two dependent variables in the commuting models: the number of out-commuters from metro to nonmetro counties and the number of out-commuters from nonmetro to metro counties, and two dependent variables in the migration models: the number of out-migrants from metro to nonmetro counties and the number of out-migrants from nonmetro to metro counties. The models are shown below. If county A is a metro county, then county B is a nonmetro county. If county A is a nonmetro county, then county B is a metro county, as I only look at movements between metro and nonmetro counties.

The number of **out-commuters** from county A to county B = f (the skill **mismatch within** county A, the employment **mismatch within** county B, the regional **disequilibrium between** county A and county B in (skill mismatch, employment mismatch, wage, labor participation, unemployment rate, self-employment rate, high education, average wage, natural amenity, and homeownership), **travel distance** between county A and county B, the number of **out-migrants** from county A to county B).

The number of **out-migrants** from county A to county B = f (the skill **mismatch within** county A, the employment **mismatch within** county B, the regional **disequilibrium between** county A and county B (in skill mismatch, employment mismatch, wage, labor participation, unemployment rate, self-employment rate, high

education, average wage, natural amenity, and homeownership), **travel distance** between county A and county B, the number of **out-commuters** from county A to county B).

The group logit model follows two steps (StataCorp, 2013):

The first step is to use the OLS regression to get the predicted probabilities. The OLS regression is:

$$\log\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_i x_i + \varepsilon_i$$

Where p_i is the percentage of out-commuters and the percentage of out-migrants from county i to county j. x_i is the independent variable, and β_i is the coefficient. The percentage of out-flows are calculated by the number of out-commuters/out-migrants divided by the total number of labor participation, because I use the labor participation as the proxy in the group logit model.

Then, I use the estimated coefficient $\widehat{\beta_\iota}$ to calculate the predicted probabilities:

$$\widehat{p_\iota} = \frac{\exp(\widehat{\beta_0} + \widehat{\beta_\iota} x_i)}{1 + \exp(\widehat{\beta_0} + \widehat{\beta_\iota} x_i)}$$

The second step is to re-calculate the OLS regression weighted by the inverse of variance as the analytic weight:

$$Analytic\ weight = n_i \widehat{p_\iota}(1 - \widehat{p_\iota})$$

Where n_i is the number of the population over 16 in the labor force in the residential county i in the commuting model, and the population of original county i in the migration model.

Then I multiply the data of dependent variables and independent variables with the square root of the analytic weight and rerun the OLS regression to get the estimated coefficients.

This chapter creates the measurements of local labor market mismatch within the sending county: education-occupation skill mismatch and resident-firm employment mismatch, and the regional disequilibrium in the labor market, housing market and amenity market between the sending county and the receiving county. This chapter finds that metro counties and nonmetro counties are significantly different. In the local labor market, compared to metro counties, nonmetro counties have a lower educational level, more people working in the low skill occupations, and a greater education-occupation skill mismatch. Metro counties have more people working in both the professional service industry and the low skill service industry. Metro counties also have more employees in the professional service firms. However, metro counties have a greater resident-firm employment mismatch. It implies that labor markets in nonmetro counties are more likely to absorb local labor, but nonmetro counties lack skill matched occupations, compared to metro counties.

The regional disequilibrium measurements show that metro counties have more labor participants, higher wages, lower self-employment rate, higher unemployment rate, more home ownership, and better amenity value than nonmetro counties. The statistical descriptions of metro-nonmetro difference (Table 4-5, 4-7, 4-11, 4-12, 4-15) show that the spatial disequilibrium measurements (education-occupation skill mismatch, resident-firm employment mismatch, pull and push factors) shift the conventional focus on either supply side or demand side to a comprehensive

approaching looking at the differences between supply and demand. This research also looks at places rather than the individual level, which could contribute to the implications for regional development.

The next chapter will use the spatial disequilibrium to examine both commuting and migration. The list of variables created in this chapter are shown in Table 4-17.

Table 4-17 The list of variables

Variable	Measures	Data source
Commuting	The number of out-commuters from county A to county B	Journey to work 2009-2013
Migration	The number of out-migrants from county A to county B	County to county migration 2009-2013
Local labor market mismatch (within sending county)		
Education-occupation skill mismatch		
1) High skill	Absolute value of (percent of the population over 25 years having at least bachelor's degrees minus percent of the employed civilian population over 16 in professional and related occupations or management, business, and financial operations occupations)	American Community Survey (ACS) 2009-2013
2) Low skill	Absolute value of (percent of the population over 25 years having a degree less than high school minus percent of the employed civilian population over 16 in food preparation and serving related occupations and building and grounds cleaning and maintenance occupations)	
Resident-firm employment mismatch		
1) Professional service	Absolute value (number of residents working in the professional service industry minus the number of employees in the professional service industry)/absolute value (total number of employed residents minus total number of firm employees)	ACS 2009-2013 County Business Pattern (CBP), 2013
2) Low skill service	Absolute value (number of residents working in the low skill service industry minus the number of employees in the low skill service industry)/absolute value (total number of employed residents minus total number of firm employees)	
Regional disequilibrium (different between the sending county and the receiving county)		
Regional labor market disequilibrium		
Skill mismatch (dummy variable measures the skill mismatch difference between counties)		
1) High skill	1, the sending county has a greater high education-occupation skill mismatch 0, the receiving county has a greater high education-occupation skill mismatch	ACS 2009-2013
2) Low skill	1, the sending county has a greater low education-occupation skill mismatch 0, the receiving county has a greater low education-occupation skill mismatch	ACS 2009-2013

Table 4-17 The list of variables (continued)

Regional disequilibrium (different between the sending county and the receiving county)		
Regional labor market disequilibrium		
Employment mismatch (dummy variable measures the employment mismatch difference between counties)		
1) Professional service	1, the sending county has a greater professional service resident-firm employment mismatch 0, the receiving county has a greater professional service resident-firm employment mismatch	ACS 2009-2013 CBP 2013
2) Low Skill service	1, the sending county has a greater low skill service resident-firm employment mismatch 0, the receiving county has a greater low skill service resident-firm employment mismatch	
Pull factors	Receiving county minus sending county	
Wage		
1) High skill	Difference in average wage in the industries of management of companies and enterprises, finance and insurance, information, and professional, scientific, and technical services between workplace/destinations and residential place/origins	CBP 2013
2) Low skill	Difference in average wage in the industries of other services (except public administration), arts, entertainment, and recreation, and accommodation and food services between workplace/destinations and residential place/origins	
Labor participation	Difference in the percentage of population 16 years and over in labor force between workplace/destinations and residential place/origins	ACS 2009-2013
Push factors	Receiving county minus sending county	
Unemployment rate	Difference in the percentage of the unemployed population 16 years and over in labor force between workplace/destinations and residential place/origins	ACS 2009-2013
Self-employment	Difference in the percentage of households with self-employment income between workplace/destinations and residential place/origins	ACS 2009-2013
Other factors		
High education	Difference in the percent of population over 25 with at least a bachelor's degree between workplace/destinations and residential place/origins	ACS 2009-2013

Table 4-17 The list of variables (continued)

Regional housing market disequilibrium (sending county)		
Homeownership	Percent of household is owner-occupied in the residential place/origins	ACS 2009-2013
Regional amenity market disequilibrium (receiving county minus sending county)		
Average wage	Difference of average wage between workplace/destination and residential place/origins	CBP 2013
Natural amenity scale	Difference of natural amenity scale between workplace/destinations and residential place/origins.	USDA Natural amenity scale 1999
Distance	Travel distance between residential place/origins and workplace/destinations	Google Map API
People's mobility	Build connections between out-commuters and out-migrants: The commuting model: the number of out-migrants The migration model: the number of out-commuters	Journey to work 2009-2013 County to county migration 2009-2013

CHAPTER 5

ANALYSIS

This chapter explores factors driving people's commuting and migration between metro and nonmetro counties in the US. In the last chapter, I created the proxies of the spatial disequilibrium framework: the local labor market mismatch within the sending county and the regional disequilibrium between counties in the labor market, housing market and amenity market. This chapter uses the county pair as the unit of analysis to connect the sending county and the receiving county.

The spatial disequilibrium framework focuses on the local labor market mismatch and the regional labor market disequilibrium, since both commuting and migration play an important role in responding to the labor market difference between supply and demand, as well as responding to the regional labor market difference. This research also includes the regional disequilibrium in the housing market and amenity market, but with simplified measurements. The housing market disequilibrium is represented by the percent of homeownership in the sending county. The amenity market disequilibrium is measured by the differences in the natural amenity scale and the average wage between the sending county and the receiving county. I use the average wage as a proxy of amenity cost. This average wage is different from the high skill wage and the low skill wage in the measurements of regional labor market disequilibrium. Meanwhile, by controlling for both high skill wage and low skill wage, the average wage could capture the amenity cost difference between places. Future research could include more attributes of the housing market and the amenity market in the spatial disequilibrium framework.

5.1 Data

The research uses the county pair to measure the variables of the spatial disequilibrium framework shown in Table 4-17. In chapter 4, the variables are measured at the county level. In this chapter, the variables are measured using the county pair to connect the locational attributes of the sending county and the receiving county.

The statistical description of the local labor market mismatch within the sending county (either metro county or nonmetro county) and the regional disequilibrium between two counties (the receiving county minus the sending county) are shown in Table 5-1A (the commuting model) and Table 5-1B (the migration model). Both tables show that the county pair illustrates the significant differences between metro counties and nonmetro counties as well as illustrates the difference between the commuting model and the migration model.

Table 5-1A Statistical description: commuting model

County pair	# of out-commuters		T-test
	From Metro To Non-metro	From Non-metro To Metro	
Local labor market mismatch (sending county)			
Education-occupation skill mismatch (%)[1]			
High skill	9.25	11.85	-44*
Low skill	4.79	8.36	-42*
Resident-firm employment mismatch (%)[1,2]			
Professional service	0.89	0.19	8*
Low skill service	0.53	0.25	10*
Regional labor market disequilibrium (difference between sending and receiving counties)			
Regional labor market mismatch			
Skill mismatch (1=sending place has a greater mismatch than receiving place)			
High skill	0.31	0.73	-60*
Low skill	0.28	0.73	-65*
Employment mismatch (1=sending place has a greater mismatch than receiving place)			
Professional service	0.68	0.29	56*
Low skill service	0.55	0.44	14*
Pull factors (receiving minus sending county)			
Wage ($1,000) [2]			
High skill wage	-11.30	14.26	-79*
Low skill wage	-1.86	2.45	-55*
Labor participation (%) [1]	-5.12	5.91	-100*
Push factors (receiving minus sending county)			
Unemployment rate (%) [1]	0.73	-0.80	30*
Self-employment (%) [1]	0.98	-1.29	37*
Other factor (receiving minus sending county)			
High education (%) [1]	-7.38	8.78	-100*
Regional housing market disequilibrium			
Homeownership (sending county, %)[1]	62.18	59.91	19*
Regional amenity market disequilibrium (receiving minus sending)			
Average wage ($1,000)[2]	-4.04	5.48	-64*
Natural amenity scale [3]	-0.02	0.02	-2*
Distance (Mile) [4]	61.50	63.90	-7*
Number of the out-migrants	65.88	63.72	1
N	7729	9240	

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API, *: p<0.05

Table 5-1B Statistical description: migration model

County pair	# of out-migrants		T-test
	From Metro To Non-metro	From Non-metro To Metro	
Local labor market mismatch (sending county)			
Education-occupation skill mismatch (%)[1]			
High skill	7.37	10.95	-140*
Low skill	4.25	7.29	-92*
Resident-firm employment mismatch (%)[1,2]			
Professional service	2.54	0.21	23*
Low skill service	0.52	0.28	21*
Regional labor market disequilibrium (difference between sending and receiving counties)			
Regional labor market mismatch			
Skill mismatch (1=sending place has a greater mismatch than receiving place)			
High skill	0.24	0.74	-180*
Low skill	0.33	0.69	-120*
Employment mismatch (1=sending place has greater mismatch than receiving place)			
Professional service	0.72	0.30	145*
Low skill service	0.54	0.46	25*
Pull factors (receiving minus sending county)			
Wage ($1,000) [2]			
High skill wage	-23.24	20.14	-280*
Low skill wage	-3.88	3.18	-180*
Labor participation (%) [1]	-6.42	6.03	-230*
Push factors (receiving minus sending county)			
Unemployment rate (%) [1]	-0.06	-0.27	8*
Self-employment (%) [1]	1.97	-1.60	119*
Other factor (receiving minus sending county)			
High education (%) [1]	-9.71	9.17	-260*
Regional housing market disequilibrium			
Homeownership (sending county, %)[1]	58.92	57.80	20*
Regional amenity market disequilibrium (receiving minus sending)			
Average wage ($1,000)[2]	-8.57	7.44	-220*
Natural amenity scale [3]	-0.75	0.50	-67*
Distance (Mile) [4]	602.62	550.30	13*
Number of the out-migrants	22.71	58.26	-20*
N	55824	43305	

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API, *: $p<0.05$

Both local labor market mismatches are only measured for the sending county, because the mismatches within the receiving county are measured in the regional labor market disequilibrium, and every county could be a sending county in the county pairs. **In the local labor market,** Table 5-1A and Table 5-1B show that in the local education-occupation skill mismatch, both high skill mismatch and low skill mismatch within the sending county, are greater in the commuting county pair than those within the sending county in the migration county pair, especially the high skill mismatch. The high skill mismatch within metro counties in the commuting pair is 1.88 more than the high skill mismatch within the metro counties in the migration county pair (9.25 vs. 7.37). Also, the high skill mismatch within the nonmetro counties in the commuting pair is 0.9 higher than that in the migration county pair (11.85 vs. 10.95). These results suggest commuting could be more responsive to adjust the local skill mismatch within the sending county. **In the regional labor market disequilibrium**, both Table 5-1A and Table 5-1B show that nonmetro counties have a greater education-occupation skill mismatch than metro counties in both the commuting county pair and the migration county pair.

In the local labor market, migration county pairs capture a higher level of resident-firm employment mismatch in the professional service industry within the sending county than the commuting county pair. Table 5-1A and Table 5-1B show that for the metro counties, the professional service employment mismatch within the metro counties in the migration county pair is 1.56 more than that in the commuting county pair (2.54 vs. 0.89). Also, the professional service employment mismatch within the nonmetro counties in the migration county pair is 0.08 more than that in the commuting

county pair. is 0.21 in the commuting pair, compared to 0.29 in the migration county pair. This implies that migration could be more responsive to adjust the local employment mismatch in the professional service industry than commuting. The resident-firm employment mismatch in the low skill service industry within the sending county is not differentiated between the commuting county pair and the migration county pair. **In the regional labor market disequilibrium,** both Table 5-1A and Table 5-1B show that metro counties have a greater resident-firm employment mismatch than nonmetro counties in both the commuting county pair and the migration county pair.

The statistical description of other variables shows that the level of regional disequilibrium between metro and nonmetro counties is lower in the commuting county pair than that in the migration county pair, except for homeownership (Table 5-1A and Table 5-1B). This implies that counties in the commuting county pair have a similar labor market, housing market and amenity market, compared to counties in the migration county pair. This makes sense. People's migration is driven by a greater difference between the sending county and the receiving county. The statistical description of homeownership shows that commuting county pairs have a higher percent of homeownership than the migration county pairs. This also makes sense, because homeownership discourages people's migration but encourages people's commuting.

Each county pair includes two moving directions: from metro to nonmetro counties, and from nonmetro to metro counties. Table 5-1A and Table 5-1B show that the regional disequilibrium is different in each direction. In the commuting county pair, the nonmetro-metro difference is greater in the commuting from nonmetro to metro than

that in the commuting from metro to nonmetro, except for homeownership. This implies that a large gap between nonmetro-metro counties could drive more out-commuters from nonmetro counties. People living in nonmetro counties could have a higher commuting cost, which needs to be offset by a better labor market, such as higher wages, more labor participation, and a lower unemployment rate. In the migration county pair, the metro-nonmetro difference is greater in the migration from metro to nonmetro than that in the migration from nonmetro to metro, except for the unemployment rate (Table 5-1A, Table 5-1B). This implies that a large gap between nonmetro-metro counties could drive more out-migrants from metro counties. People living in metro counties could have a higher migration cost. This could be related to the amenity-led urban in-migrants moving to remote rural areas.

Travel distance in the commuting county pair and the migration county pair shows interesting rural-urban differences (Table 5-1A, Table 5-2B). In the commuting county pair, the average commuting distance from metro to nonmetro is shorter than that from nonmetro to metro (61.50 miles vs. 63.90 miles). In the migration county pair, the average migration distance from metro to nonmetro is longer than that from nonmetro to metro (602.62 miles vs. 550.30 miles). This shows that people living in nonmetro counties commute a longer distance than people living in metro counties, while people living in metro counties move a longer distance to relocate in nonmetro counties. The statistical description future explains the regional disequilibrium data: why the metro-nonmetro difference is larger for the nonmetro out-commuters and the metro-nonmetro difference is larger for the metro out-migrants. The travel data imply

that the commuting cost could be higher for nonmetro residents, and metro residents are more likely to afford migrating a longer distance.

The above discussion focuses on the difference between the commuting county pair and the migration county pair, as well as the difference between metro counties and nonmetro counties. In the last chapter, data are described at the county level rather than described using the county pair. Is there any difference between those two?

This research finds that the county pair can differentiate commuting and migration, compared to data aggregated at the county level. Table 5-1A show that the metro counties in the commuting county pair has a greater high skill mismatch than that in the migration county pair. Also, nonmetro counties have a greater low skill mismatch in the commuting county pair than that in the migration county pair. Table 4-7 (Chapter 4) shows that the skill mismatch at the county level is between the commuting county pair and the migration county pair:

Metro counties high skill mismatch:

commuting county pair (9.25) > aggregated at county level (9.23) > migration county pair (7.37)

Nonmetro counties low skill mismatch:

commuting county pair (8.36) > aggregated at county level (8.15) > migration county pair (7.29)

The regional disequilibrium difference between the county pair and aggregated county level is shown in Table 5-2.

Table 5-2 Statistical description: difference between county pair and aggregated county level

	Metro-nonmetro difference (average)		
	Commuting county pair	Migration county pair	Aggregated county level
Regional labor market disequilibrium (difference between sending and receiving)			
Pull factors (receiving minus sending)			
Wage ($1,000)[2]			
High skill wage	12.78	21.69	14.13
Low skill wage	2.155	3.53	2.38
Labor participation (%) [1]	5.515	6.225	3.69
Push factors (receiving minus sending)			
Unemployment rate (%) [1]	0.765	0.165	0.96
Self-employment (%) [1]	1.135	1.785	3.43
Other factor (receiving minus sending)			
High education (%) [1]	8.08	9.44	6.95
Regional housing market disequilibrium			
Home ownership (sending, %)[1]	61.045	58.36	3.8
Regional amenity market disequilibrium (receiving minus sending)			
Average wage ($1,000)[2]	4.76	8.005	4.98
Natural amenity scale [3]	0.02	0.625	0.35

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999

Table 5-2 shows that compared to the aggregated county level data, the county pair can differentiate the nonmetro-metro difference in wage and regional amenity market disequilibrium,

High skill wage:

Migration county pair (21.64)>county pair (14.13)>commuting county pair (12.78)

Low skill wage:

Migration county pair (3.53)>county pair (2.16)>commuting county pair (2.38)

Average wage:

Migration county pair (8.01)>county pair (4.98)>commuting county pair (4.76)

Natural amenity scale:

Migration county pair (0.63)>county pair (0.35)>commuting county pair (0.02)

Therefore, the data at the aggregated county level are between the commuting county pair and the migration county pair. Research using the aggregated county level data uses the same locational attributes for both commuting and migration. However, the data used in the county pair show that the locational attributes in the commuting model are different from the locational attributes in the migration model. Therefore, the comparison between data at the aggregated county level and the in the county pairs confirms the importance of using county pair in the mobility analysis: it can differentiate commuting and migration.

Compared to the data aggregated at the county level, data described using the county pair can also capture the unique metro-nonmetro differences. Most of the data using the county pair show a similar metro-nonmetro divide as the data at the county level. For example, if a variable has a higher value in metro counties than in the nonmetro counties at the county level (Table 5-2), then the county pair from metro county to nonmetro county will show a negative value (nonmetro minus metro), and the county pair from nonmetro to metro will show a positive value (metro minus nonmetro) (Table 5-1A, Table 5-1B). For example, in the aggregated county level data, the high skill wage in metro counties is higher than that in the nonmetro counties ($52,830 vs.

$38,710). Therefore, in the county pair from metro to nonmetro, the metro-nonmetro high skill wage difference is negative (commuting county pair: -$11,300, migration county pair -$23,240). In the county pair from nonmetro to metro, the metro-nonmetro high skill wage difference is positive (commuting county pair: $14,260, migration county pair $20,140). However, the unemployment rate shows a different result. Table 5-2 shows that the unemployment rate in metro counties (9.86%) is higher than in nonmetro counties (8.9%) at the county level. However, the commuting county pair shows the opposite: the unemployment rate is higher in nonmetro counties than the unemployment rate in metro counties (from metro to nonmetro: nonmetro is 0.7% higher than metro, from nonmetro to metro: nonmetro is 0.8% higher than metro). Also, the unemployment rate is 0.6% higher in nonmetro counties in the migration county pair from nonmetro to metro. This implies that the county pair can capture what cannot be captured at the aggregated county level. The difference between the data at the county level (Table 5-2) and the data at the county pair level (Table 5-1A, Table 5-1B) shows the important role of using the county pair as the unit of analysis: it links metro and nonmetro counties and it differentiates the commuting model and the migration model.

5.2 Model results

I ran Group Logit regressions to estimate factors driving the number of out-commuters and the number of out-migrants between metro counties and nonmetro counties. I expect the local labor market mismatch within counties and the regional disequilibrium between counties will impact people's mobility. I used labor participation as the proxy of the total population for both the commuting model and the migration model. This is because the spatial disequilibrium framework focuses on the labor market. Also, this

research compares commuting and migration which are two main forces responding to the labor market. Therefore, labor participation could be a better proxy than the total population in the model. Results are shown in Table 5-3A and Table 5-3B. Each variable is standardized before running the model. The model also controls the number of out-migrants in the commuting model and controls the number of out-commuters in the migration model to link commuting and migration.

The model shows factors driving people to commuting or to migration from one county to another county. The dependent variable in the number of out-commuters and the number of out-migrants from county A to county B. It could be viewed as the people's outflow from county A, as well as people's inflow to county B. For example, in Table 5-3A, the model results show the high education-occupation skill mismatch within the metro counties is related to more people commuting from metro counties. This result can be interpreted as the high skill mismatch within metro counties is related to more people commuting to the nonmetro counties. Therefore, the model shows that the unit of analysis, the county pair, can build connection between the sending county and the receiving county. The county pair helps explore both out-commuting and in-commuting, as well as both out-migration and in-migration.

Like the interpretation of the dependent variable, there are two ways to discuss the independent variables, because most of the variables are a relative value rather than an absolute variable. For example, the variables in the regional labor market disequilibrium measure the difference between metro and nonmetro. The variables could show an increasing gap between metro and nonmetro counties: a higher level of disequilibrium, or a decreasing gap between metro and nonmetro counties: a more

balanced regional labor market. The local labor market mismatch within the sending county could also show a greater mismatch between supply and demand, or a more balanced supply-demand.

The model shows a complex system. It includes two types of mobility: commuting and migration; two places: metro county and nonmetro county; two directions: from metro to nonmetro and from nonmetro to metro; two types of interpreting the dependent variables: out-commuters/out-migrants and in-commuters/in-migrants; two types of labor: high skill and low skill; two types of local labor market mismatch: skill mismatch and employment mismatch; and two ways of interpreting the model: disequilibrium and balance. This chapter will focus on directly explaining the model results. The next chapter (Chapter 6- 6.2 Rural development approach) will convert the model into a rural focus, and discuss the out-commuters/in-commuters, out-migrants/in-migrants, from rural/to rural, rural labor market mismatch, and rural market disequilibrium/balance.

Table 5-3A Group logit model results-commuting model

County pair	# of out- commuters	
	From Metro To Non-metro	From Non-metro To Metro
Local labor market mismatch (sending county)		
Education-occupation skill mismatch (%)[1]		
High skill	0.11**	0.03
Low skill	0.03	-0.00
Resident-firm employment mismatch (%)[1,2]		
Professional service	-0.02**	-0.07
Low skill service	0.05**	-0.00
Regional labor market disequilibrium (difference between sending and receiving counties)		
Regional labor market mismatch		
Skill mismatch (1=sending place has a greater mismatch than receiving place)		
High skill	-0.00	0.17**
Low skill	0.07**	0.11**
Employment mismatch (1=sending place has a greater mismatch than receiving place)		
Professional service	-0.06**	-0.03**
Low skill service	0.09**	-0.07**
Pull factors (receiving minus sending county)		
Wage ($1,000) [2]		
High skill wage	0.39**	0.26**
Low skill wage	0.13**	-0.03
Labor participation (%) [1]	0.35**	0.18**
Push factors (receiving minus sending county)		
Unemployment rate (%) [1]	0.19**	-0.09**
Self-employment (%) [1]	-0.28**	-0.29**
Other factor (receiving minus sending county)		
High education (%) [1]	0.23**	0.12**
Regional housing market disequilibrium		
Homeownership (sending county, %)[1]	0.04**	0.09**
Regional amenity market disequilibrium (receiving minus sending)		
Average wage ($1,000)[2]	0.22**	0.02
Natural amenity scale [3]	-0.01	-0.03**
Distance (Mile) [4]	0.52**	0.54**
Number of the out-migrants	0.17**	0.35**
N	7729	9240

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API, *: p<0.05

Table 5-3B Group logit model results-migration model

County pair	# of out-migrants	
	From Metro To Non-metro	From Non-metro To Metro
Local labor market mismatch (sending county)		
Education-occupation skill mismatch (%)[1]		
High skill	0.29**	0.08**
Low skill	-0.23**	0.05**
Resident-firm employment mismatch (%)[1,2]		
Professional service	-0.05**	-0.15
Low skill service	0.04**	0.00
Regional labor market disequilibrium (difference between sending and receiving counties)		
Regional labor market mismatch		
Skill mismatch (1=sending place has a greater mismatch than receiving place)		
High skill	0.07**	0.05**
Low skill	0.03**	0.04**
Employment mismatch (1=sending place has a greater mismatch than receiving place)		
Professional service	0.03**	-0.00
Low skill service	0.09**	-0.03**
Pull factors (receiving minus sending county)		
Wage ($1,000) [2]		
High skill wage	0.53**	0.15**
Low skill wage	0.21**	0.00
Labor participation (%) [1]	0.1**	0.32**
Push factors (receiving minus sending county)		
Unemployment rate (%) [1]	0.23**	0.04**
Self-employment (%) [1]	-0.25**	-0.28**
Other factor (receiving minus sending county)		
High education (%) [1]	0.09**	0.16**
Regional housing market disequilibrium		
Homeownership (sending county, %)[1]	0.12**	-0.21**
Regional amenity market disequilibrium (receiving minus sending)		
Average wage ($1,000)[2]	0.09**	-0.22**
Natural amenity scale [3]	0.28**	0.14**
Distance (Mile) [4]	0.46**	0.39**
Number of the out-migrants	0.08**	0.05**
N	55824	43305

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API, *: p<0.05

Table 5-3A and Table 5-3B show that the labor market disequilibrium framework has a similar explanatory power in the commuting model and the migration model (R squares in both models are around 0.6). The results imply that the increase in commuters could be a response to the local labor market mismatch within counties. Thus, commuting could have a similar function as migration in the labor market. This result confirms Partridge et al.'s (2012) research regarding the decline of the traditional role of migration as a response to the labor market demand. This research uses the county pair to show the connection between places, and finds the increase in commuters could be related to the decrease in migrants. Recall the number of out-commuters from nonmetro to metro is much larger than the number of out-migrants from nonmetro to metro counties (2,487,809 vs. 1,689,034). This research shows that it is important to include both commuting and migration to analyze the relation between the labor market and demographic change.

5.3 Local labor market mismatch

First, I will discuss the model results on the local labor market mismatch, which includes the education-occupation skill mismatch and the resident-firm employment mismatch. Each mismatch captures the difference between supply and demand within the sending county.

5.3.1 Education-occupation skill mismatch

Recall the education-occupation skill mismatch measures the difference between skill supply (education) and skill demand (skill required by occupation) in the high skill and low skill occupations. If the skill match is positively related to people's mobility, then it implies more external job opportunities (Figure 4-2). If the education-occupation skill

mismatch is negatively related to people's mobility, it implies more local job opportunities (Figure 4-2).

Model results show the education-occupation skill mismatch in the local labor market is more related to migration than commuting. Table 5-3A and Table 5-3B show that the skill mismatch is significantly related to the number of out-migrants, while only the high skill mismatch is significantly related to the number of out-commuters from metro to nonmetro counties. The education-occupation skill mismatch includes the high skill mismatch and the low skill mismatch. Table 5-3A shows that metro counties with a greater high skill mismatch have more out-commuters (0.11). Table 5-3B shows that the number of out-migrants is driven by the high skill mismatch within metro counties (0.29) and within nonmetro counties (0.08). The results of the high skill mismatch in the commuting model and migration model show that people living in metro counties have more options: commute or migrate from places with a greater education-occupation high skill mismatch. However, people living in nonmetro counties can only migrate if nonmetro counties have a greater high skill mismatch.

The low skill mismatch is only significant in the migration model. It is negatively related to the number of out-migrants from metro counties (-0.23), and is positively related to the out-migrants from nonmetro counties (0.05). A positive sign between skill mismatch and people's outflow implies more external job opportunities, and a negative sign implies more local job opportunities (as shown in Chapter 4, Figure 4-2). The model results above imply that metro counties have more job opportunities for low skill labor. People living in metro counties are willing to stay rather than migrate or commute when metro counties have a greater mismatch in low skill job. Also, the low

skill mismatch within nonmetro counties pushes people to move to metro counties. The results imply that low skill workers in nonmetro counties are more likely to find a job in metro counties while low skill metro labor is more likely to stay in metro counties.

5.3.3 Resident-firm employment mismatch

The resident-firm employment mismatch measures the difference between labor supply (employed residents) and labor demand (firm employees) in the professional service industry and the low skill service industry. If it is positively related to the number of out-commuters or the number of out-migrants, it implies that local labor is less competitive than non-local labor since local labor is pushed out from the local labor market (Figure 4-3). If it is negatively related to people's mobility, it implies local labor is more competitive than non-local labor (Figure 4-3).

The resident-firm employment mismatch has similar results in the commuting model and the migration model: it is only related to people's mobility from metro to nonmetro counties. The results show that only the resident-firm employment mismatch within metro counties is related to people's mobility. This implies a stronger competition among workers in the metro counties than in the nonmetro counties.

The professional service employment mismatch and low skill service employment mismatch show different results. Table 5-3A and Table 5-3B show that the professional service mismatch within metro counties is related to fewer out-commuters (-0.02) and fewer out-migrants(-0.05), and the low skill service employment mismatch is related to more out-commuters (0.05) and more out-migrants (0.04). A positive relation between the employment mismatch with people's outflow implies that local labor is less competitive than nonlocal labor, and a negative sign implies local labor is

more competitive (shown in Chapter 4, Figure 4-3). Therefore, the model results imply that metro counties have more competitive local labor in professional service industry, and less competitive local labor in the low skill service industry.

Recall the results of the education-occupation skill mismatch, high skill labor in metro counties has more choices: commute or migrate, and low skill labor is stuck in metro counties. The results of the resident-firm employment mismatch explain the phenomena by adding the layer of labor competition. The model results imply that the mobility of high skill labor could be driven by intense labor competition in metro counties. Although low skill labor is stuck in metro counties, they may be unemployed because they are less competitive than the nonlocal labor. By connecting the education-occupation mismatch and the resident-firm employment mismatch, this research creates a fuller picture of the labor market. As shown in Figure 3-3 in Chapter 3, the local labor market mismatch framework captures the vertical dimension of labor market (education-occupation skill mismatch: skill supply-demand), and the horizontal dimension of the labor market (resident - firm employment mismatch: employment supply - demand). The empirical study shows that the interaction between these two mismatches could leave metro counties with more competitive professional service labor and more unemployed low skill service workers. The results of the employment mismatch also show that it is necessary to consider both skill mismatch and employment mismatch within the county to understand the relation between local labor market and people's mobility.

5.4 Regional disequilibrium

Next, I look at regional disequilibrium. Recall regional disequilibrium is measured by the difference between the sending county and the receiving county in the labor market, housing market and amenity market.

5.4.1 Regional labor market disequilibrium

The regional labor market disequilibrium is measured by the difference in local labor market mismatch, pull factors, push factors, and other factors between two counties. Each local labor market mismatch includes a dummy variable to compare the mismatch within the sending county to the mismatch within the receiving county. If the local labor market mismatch in the sending place is greater than the mismatch in the receiving county, then the dummy variable is coded as 1. Otherwise, it is coded as zero. Therefore, a more balanced receiving county is also coded as 1.

Table 5-3A and Table 5-3B show that counties with a greater education-occupation skill mismatch than their counterpart have more out-commuters and more out-migrants. A greater mismatch in the sending county than the receiving county is positively related to people's outflow. The model results also show that a more balanced labor market in the receiving county than the sending county is related to more people's inflow. Table 5-3A and Table 5-3B show that nonmetro counties with a greater skill mismatch in high skill is related to more out-commuters (0.17) and more out-migrants (0.05). Nonmetro counties with a greater mismatch in low skill also have more out-commuters (0.11), and more out-migrants (0.04). Metro counties with a greater mismatch in high skill have more out-migrants (0.07). Metro counties with a greater mismatch in low skill have more out-commuters (0.07), and more out-migrants (0.03).

But, a greater mismatch in low skill in metro counties is not related to the out-migrants from metro to nonmetro. Again, this result implies that low skill labor is more willing to stay in metro counties even with a greater low skill mismatch.

The regional labor market disequilibrium in local labor mismatch can also be interpreted as a more balanced receiving county (coded as 1). Table 5-3A and Table 5-3B show that metro counties with a more balanced high skill supply-demand have more in-commuters (0.17) and more in-migrants (0.05) from nonmetro counties. Table 5-3A and Table 5-3B also show that metro counties with a more balanced low skill supply-demand have more in-commuters (0.11) and more in-migrants (0.04) from nonmetro counties. This implies that the larger labor market size in metro counties could offer more skill matched jobs, and the more skill matched job in urban areas attracts both rural out-commuters and rural out-migrants. Table 5-3A and Table 5-3B also show that a more balanced education-occupation skill mismatch in nonmetro counties is also related to more metro in-migrants in both high skill mismatch (0.07) and low skill mismatch (0.03), and is only related to metro in-commuters in the low skill mismatch (0.07). This implies that the decrease in the education-occupation mismatch within nonmetro counties will bring more in-migrants to relocate into rural communities. Also, the decrease in high skill mismatch is not related to in-commuters who may compete with local labor for job opportunities.

The impact of the disequilibrium in the resident-firm employment mismatch on people's mobility can be differentiated by the commuting model and the migration model, as well as by the metro county and the nonmetro county. Table 5-3A and Table 5-3B show that metro counties with a greater employment mismatch in the professional

service industry have fewer out-commuters (-0.06) and more out-migrants (0.03), and a greater employment mismatch in the low skill service is related to more out-commuters (0.09) and more out-migrants(0.09). The results imply that professional service labor is more likely to migrate. However, the conventional spatial mismatch could still exist for the low skill service workers-working in nonmetro counties and living in metro counties. For nonmetro counties, Table 5-3A show that a greater employment mismatch is related to fewer out-commuters in both professional service industry (-0.03) and low skill service industry (-0.07). Table 5-3B shows that in nonmetro counties, only the employment mismatch in the low skill service is related to fewer out-migrants (-0.03), and the greater employment mismatch in the professional service industry is not related to people's outflow. This implies that the difference between labor supply and demand in nonmetro counties could absorb the rural out-commuters by turning them into local labor. It also implies that the out-migrants could be low skill labor, and they are more likely to stay if they can find a local low skill service job.

The regional labor market disequilibrium in the employment mismatch can also be interpreted as the receiving place has a more balanced labor supply-demand (coded as 1). Table 5-3A and Table 5-3B show that nonmetro counties with a more balanced labor supply-demand in the professional service industry have fewer in-commuters (-0.06) and more in-migrants (0.03), and nonmetro counties with a more balanced labor supply-demand in the low skill service have more in-commuters (0.09) and more in-migrants (0.09). A more balanced labor supply-demand in metro counties is related to fewer in-flows. Metro counties with more balanced employment in the professional service industry have fewer in-commuters (-0.03). Also, metro counties with more

balanced employment in the low skill service industry have fewer in-commuters (-0.07) and fewer in-migrants (-0.03). This implies that decreasing the employment mismatch in nonmetro counties could increase in-migrants.

The employment mismatch dummy variable can capture the impact of regional labor market disequilibrium on people's outflow as well as the impact of regional labor market disequilibrium on people's inflow. The results of inflow and outflow imply that decreasing the employment mismatch in the professional service industry could be an approach to increase in-migrants and decrease out-migrants in nonmetro counties. Although the decrease in the low skill service employment mismatch is also related to more in-migrants in nonmetro counties, it is also related to more nonmetro out-migrants.

The regional labor market disequilibrium includes two pull factors: wage and labor participation. People are more likely to commute or migrate to places with a higher rate of labor participation, as expected. Higher wages also attract people. Wage difference in the high skill jobs has the largest impact on people's out-commuting. A higher wage in the low skill jobs is also positively related to people's migration and commuting from metro to nonmetro counties, but is not related to the number of out-commuters and out-migrants from nonmetro to metro counties. This implies that the wage increase in the low skill jobs does not attract commuters and migrants from nonmetro counties. The data of both the commuting model and the migration model show that the low skill wage difference is much lower than the high skill wage difference between counties (Table 5-1A, Table 5-1B). The increase in the wage of the low skill job may not be enough for nonmetro residents to commute to metro counties.

As shown in the distance data, people living in nonmetro counties commute a longer distance than people living in metro counties (Table 5-1A). This implies that the commuting cost of rural residents could be higher than the commuting cost of the urban residents. Therefore, the increase in low skill wage does not offset the commuting cost. Also, Table 5-1A and Table 5-1B show that the wage gap in low skill jobs between metro and nonmetro is smaller than the average wage difference. The average difference is viewed as the amenity cost in this research (see 5.4.3 the regional amenity market disequilibrium for details). This implies that the increase in wage of low skill jobs does not offset the increase in living expense. Thus, a higher wage in low skill jobs in urban is not related to rural out-migrants. It implies that increasing the minimum wage in rural areas could increase people's capacity to move.

The regional labor market disequilibrium includes two push factors: the unemployment rate and the self-employment rate. The self-employment rate is negatively related to people's mobility, as expected. Other research shows that self-employment is positively related to local employment growth, income, and job creation. (Fleming & Goetz, 2011; Goetz, Fleming, & Rupasingha, 2012). This research finds that communities that support self-employment also can retain population in both metro and nonmetro areas.

People are more likely to move to places with a higher unemployment rate, which is different from the hypothesis. Correlation analysis shows that the unemployment rate is positively related to the number of out-commuters in metro counties (0.0309) and the number of out-migrants in nonmetro counties (0.0268), while the unemployment rate is not related to the number of out-commuters in nonmetro

counties and the number of out-migrants in metro counties. This implies that although the unemployment rate is still a pull factor as expected, the unemployment rate may not be the main factor driving people's outflow. I use both the labor participation and the unemployment rate to measure the labor market. The negative sign of the unemployment rate could be because I control for labor participation rate. A labor market with higher labor participation and higher unemployment could be a sign of a healthy labor market (Plane & Rogerson, 1994). My research finds that a slightly higher unemployment rate could be a sign of a healthier labor market, which is related to more in-migrants from metro counties. Although Amior and Manning (2018) argue that the employment rate is enough to measure local job opportunity, it may not be true when using the county pair to measure the job opportunity differences between two places.

High education is the other factor in the regional labor market disequilibrium. Counties with a higher education level have more in-commuters and more in-migrants as well as fewer out-commuters and fewer out-migrants. This implies that high education is a pull factor attracting people at the place level. The data show that the nonmetro counties have a significantly lower percent of high education population than nonmetro core (17% vs 20% in Table 4-5). The model result implies that the lack of high education population in nonmetro counties could be related to people's outflow.

5.4.2 Regional housing market disequilibrium

This research uses homeownership in the sending county to simplify the regional housing market disequilibrium. Homeownership can differentiate people's mobility in metro counties and nonmetro counties. Table 5-3A and Table 5-3B show that nonmetro counties with a higher percent of homeownership have more out-commuters (0.09) and

fewer out-migrants (-0.21), as expected. Table 5-3A shows that metro counties with a higher percent of homeownership have more out-commuters (0.04). However, Table 5-3B shows that more people owning a house in metro counties is related to more out-migrants to nonmetro counties (0.12). This implies that homeownership still plays a traditional role in nonmetro counties (reducing mobility), while homeownership in metro counties can support people's mobility to nonmetro counties.

5.4.3 Regional amenity market disequilibrium

The regional amenity market disequilibrium is measured by the difference in the average wage and the natural amenity scale between the sending county and the receiving county.

This research shows that the impact of the amenity cost on nonmetro residents is different from the impact of the amenity cost on metro residents. Table 5-3A shows that a higher amenity cost is related to more out-commuters from metro to nonmetro counties (0.22), as expected. Table 5-3B shows that a higher amenity cost in metro counties is related to fewer in-migrants from nonmetro counites (-0.22), as expected. However, Table 5-3B shows that nonmetro counties with a higher amenity cost have more in-migrants from metro counties (0.09). The average cost is a proxy for the quality of amenities. This implies that amenity cost does not stop urban in-migrants. Nonmetro counties with a higher quality of amenity could have more metro in-migrants.

The results of the natural amenity scale show that people are more likely to migrate to places with better natural amenities. However, better amenities in nonmetro counties is not related to the number of in-commuters, and is related to more out-commuters, contrary to expectations. There are two potential explanations: 1) the low-

skill jobs generated by higher natural amenities, such as jobs in the tourist industry and jobs in the service industry, are taken by work-oriented in-migrants, which could push local residents to find external jobs; 2) the amenity-led metro in-migrants accelerate nonmetro gentrification, which increases the housing prices and living expense. This could push out rural residents.

To sum up, this chapter discusses the empirical results of implementing the spatial disequilibrium framework on the commuting and migration between metro counties and nonmetro counties. This chapter uses the county pair to connect metro and nonmetro. The statistical description of the commuting county pair and the migration county pair shows that counties connected by the commuting county pair have a greater education-occupation skill mismatch, while counties connected by the migration county pair have a greater resident-firm employment mismatch. The statistical description also shows that the regional disequilibrium in the commuting county pair is lower than the regional disequilibrium in the migration county pair. Compared to the data described at the aggregated county level in the last chapter, this chapter shows that the unit of analysis, the county pair, can differentiate commuting and migration, as well as differentiate the direction of people's flow: from metro to nonmetro and from nonmetro to metro. Therefore, the county pair can connect people and place, as well as connect places.

The empirical study justifies the spatial disequilibrium framework: people's mobility is related to both the local labor market mismatch within the sending place, and the regional disequilibrium in the labor market, housing market and amenity market between the sending place and the receiving place. The model results imply that high

skill labor is more likely to move (either commute or migrate), while low skill labor is stuck in urban. People living in rural have a higher commuting cost, while people in urban can afford long-distance migration. Urban areas are more likely to have more competitive professional service labor and more unemployed low skill service labor. The decrease in local labor market mismatch in rural areas could decrease rural outflow. The next chapter will add a rural perspective on the main results and discuss implications for rural development approaches.

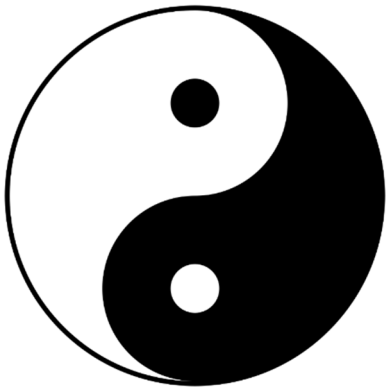
CHAPTER 6

DISCUSSION

This research creates a spatial disequilibrium framework to explore factors driving people's commuting and migration between metro counties and nonmetro counties in the US. The study contributes to the understanding of people's mobility from a spatial perspective, the interaction between people and place, the interface between urban and rural counties, and the implications for rural development in a mobility paradigm. This chapter discusses the contribution of the framework to theory, the implication of the results for rural development, study limitations, model extensions, and recommendations for future study.

6.1 The equilibrium of the "Yin/Yang"

This research finds that both local labor market mismatch and regional disequilibrium generally drive people's mobility. Recalling the "Yin/Yang" symbol, this research justifies that imbalance within "Yin" and within "Yang"(the small circles), and the imbalance between "Yin" and "Yang" accelerate the movement of both "Yin" and "Yang" until "Yin" and "Yang" reach harmony: the whole perfect circle.



The earlier chapter discusses how the "Yin/Yang" difference and connection are related to peoples' movement. It shows a new way of thinking about people's mobility:

it connects two places and is driven by both the difference within the place and the difference between places. What was missing is the discussion of the whole "Yin/Yang". The dynamic connection between "Yin" and "Yang" creates the equilibrium. The mismatch and disequilibrium still exist in the "Yin/Yang" equilibrium. The little black circle within "Yang" and the little white circle within "Yin" represent the labor market mismatch within a place. The whole "Yin" is still different from the whole "Yang", because they have different labor, housing and amenity markets.

When we think about equilibrium, we normally think of it is as a balance, such as the balance between supply and demand, and the balance between input and output. When a system reaches equilibrium, no entities inside the system have the motivation to move. For example, in economics, the interaction between labor supply and labor demand determines the labor price (equilibrium wage). In the equilibrium, no labor wants to enter or exist the labor market, and no firms want to hire or fire people. In location theory, the real wage difference motivates people to move. In equilibrium, there is no real wage difference between two places, and there are no people moving between places. The equilibrium in the "Yin/Yang" is different, because the imbalance still exists. However, what is the difference between the disequilibrium and the equilibrium in "Yin/Yang"? I argue that the level of imbalance in the disequilibrium is different from the level of imbalance in the equilibrium. In other words, the "Yin/Yang" equilibrium includes the optimal level of disequilibrium.

We can think about the "Yin/Yang" equilibrium in a rural-urban context. The rural-urban connection can be viewed as a system, like "Yin/Yang". In the equilibrium, there could still be local labor market mismatch within rural and within urban, as well

as regional disequilibrium between rural and urban. However, there are an optimal number of people commuting and migrating between rural and urban, which connects rural and urban. In the equilibrium, the connection between rural and urban helps rural development and helps urban development. The equilibrium is a form of sustainable balance. People's mobility between rural and urban could produce the externalities for the rural-urban system. The externality could be positive, because people's mobility accelerates the flow of information, knowledge and technology. The externality could also be negative, such as air pollution and traffic congestion. The whole system, rural-urban interdependence, could internalize the externalities. For example, the interaction between in-migrants/in-commuters and residents could help the flow of knowledge, which contributes to both the sending county and the receiving county. On the other hand, air pollution can harm the health of residents in both the sending place and the receiving place. The equilibrium is affected by the externalities. Therefore, the "Yin/Yang" equilibrium is dynamic rather than static. In each stage of the equilibrium, the level of the imbalance could change, and the level of externalities could also change. For example, the mismatch within rural or within urban could change, the same as the regional disequilibrium between rural and urban could change. The change of the disequilibrium is related to the change in people's mobility. The change in people's mobility affects the level of externality. In return, the change of the externalities affects the whole rural-urban system. But, at each stage of the equilibrium, the level of local mismatch within rural and within urban could be optimal, the regional disequilibrium could be optimal, and the number of people who move between rural and urban could be optimal. This could create a positively externality which in return affects the system.

The system will internalize the positive externalities and then search for another equilibrium (Figure 6-1). Therefore, the equilibrium could be interpreted as the optimal level of disequilibrium plus the positively externalities. The change of the positive externalities will motivate the whole system to research another equilibrium with the interaction between people's flow, local mismatch and regional disequilibrium.

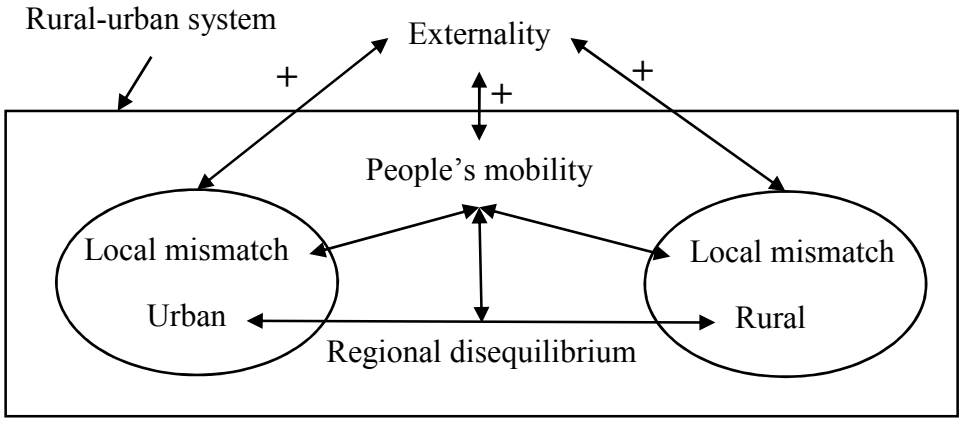


Figure 6-1 Dynamic equilibrium in the rural-urban context

Therefore, I argue that the main difference between the general equilibrium and the "Yin/Yang" equilibrium is that externality is not considered in the general equilibrium, e.g. supply=demand, input=output, while in the "Yin/Yang" equilibrium, the whole system has a positive externality which could benefit the system. The positive externality is created from the interaction between the imbalance within "Yin", the imbalance within "Yang", the imbalance between "Yin" and "Yang", and most importantly, the connection between "Yin" and "Yang". Therefore, the "Yin/Yang" equilibrium is a dynamic process internalizing the positive externality which is created by the interaction between the imbalance in the "Yin/Yang" and the connection between "Yin/Yang."

The previous chapter shows how the spatial disequilibrium framework extends traditional location theory by including the mismatch within the local labor market. Using the "Yin/Yang" symbol, the spatial disequilibrium framework captures the mismatch within "Yin" (the small white circle), and the mismatch within "Yang" (the small black circle). The discussion of the equilibrium of "Yin/Yang" can also contribute to location theory by showing that the mobility cost is nonavoidable. In the location theory, the general equilibrium happens when all people move to one place, or are equally distributed between two places. The equilibrium in location theory is the spatial homogeneity: every place is the same. However, in the "Yin/Yang", the general equilibrium acknowledges the existence of the disequilibrium and the connection between "Yin" and "Yang". The "Yin/Yang" equilibrium is dynamic. In location theory, equilibrium is commonly static: no one moves when the system reaches the equilibrium. This is because the movement creates cost which makes the system not optimal. However, the "Yin/Yang" equilibrium shows that the movement is essential to create the positive externality which makes the system optimal.

The mobility cost is not avoidable because of the uniqueness of the place. However, location theory is missing the concept of a "place". The uniqueness of the place is what is hidden in the place and cannot be fully explained. For example, what is rural? Rural is defined as non-metropolitan from the Census Bureau. Metropolitan is defined by population and population density. However, people carry tons of characteristics and interact with place to do many activities. No matter how many attributes are considered to define rural, it is still a limited definition which serves some specific research purposes. Thus, rural could be viewed as a place, and the 'place'

should be considered as a locational attribute. For example, many researchers use a dummy variable to control for rural. Also, many researchers separate places using metro status. If rural or urban can be fully captured by the locational attributes, then it is not necessary to separate places into rural and urban. This is because the places should be the same after controlling for the locational attributes. Location theory omits the probability that the heterogeneity of a place is just because it is a place. Place itself is an attribute. It is just like the "Yin/Yang". After using black to represent "Yin", and using white to represent "Yang", "Yin/Yang" still exists. "Yin" and "Yang" is not only black/white with complementary shape. It is more likely to be a logistic framework, a philosophy to help people think, but it cannot be fully understood. The understanding of the "Yin/Yang" is based on the knowledge of the person, the question asked by the person, and even the environment surrounding the person, and it could vary across individuals, and vary across time. As said by the famous Chinese philosopher: Lao Tzu: "The Tao which can be expressed in words is not the eternal Tao". The "Yin/Yang," which can be expressed by the "Yin/Yang" symbol, is not the eternal "Yin/Yang". Returning to location theory, the locational attributes can be viewed as the metaphor: they are used to illustrate a place, based on people's knowledge, understanding, and worldview. However, the metaphor is not the true fact of the place. With the acknowledgement of the uniqueness of each place, the flow between places is not avoidable. Therefore, there is mobility cost in the equilibrium.

To sum up, this section discusses the difference between the general equilibrium and the "Yin/Yang" equilibrium. The general equilibrium is static and has no externality, while the "Yin/Yang" equilibrium is dynamic with an optimal level of

imbalance and is interacting with the externality. The optimal level of imbalance is formed by the interaction between "Yin/Yang," the difference between "Yin/Yang," and the "Yin/Yang" connection. In a rural-urban setting, the optimal level of imbalance is composed by the local labor market mismatch within rural or urban, the regional disequilibrium between rural and urban, and the people commuting/migrating between rural and urban.

This research builds on location theory and extends location theory to a broader context. This research will now explore implications for rural development approaches using the dynamic "Yin/Yang" equilibrium. However, the model does not measure the externalities. The externality appears to be a latent variable embedded in the system. It works as a way to think about people's mobility and the dynamic equilibrium. In the local labor market, this research will discuss the impact of the decrease in rural labor market mismatch on people's mobility. In the regional labor market disequilibrium, this research will discuss the impact of a better and more active rural labor market on people's mobility, including a higher wage, more labor participation, lower employment rate, higher self-employment rate, and higher education. The regional amenity market disequilibrium includes the discussion of more natural amenities and a higher amenity quality (higher average wage). The housing market will discuss the impact of homeownership in rural areas on people's mobility.

6.2 Rural development approach

This research finds that mobility in metro counties and nonmetro counties could be differentiated by the labor market, housing market and amenity market. Based on the model results (Table 5-3A and Table 5-3B), the research framework can be converted

into a framework for rural development policy, which examines the relation between the spatial disequilibrium, rural in-commuters/in-migrants, and rural out-commuters/out-migrants (Table 6-1).

Table 6-1 Rural development in the spatial disequilibrium framework

Rural	From urban		To urban	
	# of in-commuters	# of in-migrants	# of out-commuters	# of out-migrants
Local labor market mismatch				
Less education-occupation skill mismatch				
High skill	NA	NA	NS	-
Low skill	NA	NA	NS	-
Less resident-firm employment mismatch				
Professional service	NA	NA	NS	NS
Low skill service	NA	NA	NS	NS
Regional disequilibrium				
Less skill mismatch than metro				
High skill	NS	+	-	-
Low skill	+	+	-	-
Less employment mismatch than metro				
Professional service	-	+	+	NS
Low skill service	+	+	+	+
Increase in wage				
High skill wage	+	+	-	-
Low skill wage	+	+	NS	NS
Increase in labor participation (%)	+	+	-	-
Decrease in unemployment rate (%)[1]	-	+	-	+
Increase in self-employment (%)[1]	-	+	+	+
Increase in high education (%)[1]	+	+	-	-
Increase in amenity cost (Average wage)	+	+	NS	+
Increase in natural amenity[3]	NS	+	+	-
Increase in homeownership in nonmetro	NA	NA	+	-
Increase in homeownership in metro	+	+	NS	NS

Note: +denote a positive relation, - denotes a negative relation, NS denote no relation, NA denotes the variable is not measured in the model

Table 6-1 shows that the decrease in education-occupation skill mismatch within rural counties is only related to fewer out-migrants, while the decrease in the resident-firm employment mismatch is not related to people's mobility. When the local labor market mismatch within rural areas is less than their urban counterparts, the decrease in the education-occupation skill mismatch in rural is related to fewer rural outflows and more rural in-flows. Also, the decrease in the resident-firm employment mismatch in rural is related to more rural outflows and more rural in-flows, except for the decrease in the professional service employment mismatch, which is negatively related to rural in-commuters. This implies that the relation between mismatch and people's mobility between rural and urban shows up when the mismatch within rural is less than the mismatch within urban. Also, it has different effects on commuters and migrants. The impact of the local labor market mismatch in rural development is discussed in sections 6.2.1.

Table 6-1 shows that in the regional labor market disequilibrium, the increase in the high skill job wages, labor participation and education are related to more inflows and fewer outflows. This implies a better and more active labor market can help rural areas retain population. However, the increase in low skill wage is not related to rural out-flows. As shown in the last chapter, the increase in the low skill wage may not be enough to offset the commuting cost and migration cost for rural residents. Lower unemployment rate is positively related to the number of in-migrants/out-migrants, and is negatively related to the number of in-commuter/out-commuters. Rural areas with a higher self-employment rate have more outflows, more in-migrants and fewer in-commuters. The results of the unemployment rate and the self-employment rate imply

that there could be an interaction between commuters and migrants. For example, the decrease in unemployment rate is related to fewer out-commuters, more in-migrants, and more out-migrants. This could be because a better labor market motivates people to work locally. In rural areas, a better labor market could attract the rural out-commuters and turn the out-commuters into local workers. Urban in-migrants can also be attracted by a better rural labor market. However, with more people working locally in rural areas, it could increase the competition in the labor market, then push out rural residents. The discussion of the interrelation between commuters and migrants and how the relation can impact rural development is in sections 6.2.1. and 6.2.3.

Table 6-1 shows that a better amenity market and a higher percent of homeownership is related to more inflows, and more out-commuters. Rural areas with a higher amenity cost have more out-migrants. Rural areas with more natural amenities and more owner-occupied houses have fewer out-migrants. This implies that rural areas with a better amenity quality (amenity cost) could attract people, but may also push out residents. Therefore, how can rural communities pursue amenity-led development to attract people to move in without pushing out residents? The discussion of rural development approaches related to the regional amenity market disequilibrium and the housing market disequilibrium is in sections 6.2.2, 6.2.3.

This research shows that rural development approaches need to be complementary: an approach that fits one goal may inhibit the other goal. For example, a more balanced resident-firm employment in the low skill service industry is related to more in-migrants as well as more out-migrants. Rural areas with a higher amenity cost have more urban in-migrants and more rural out-migrants. This research explores the

complementary approaches by using the same spatial disequilibrium to fully examine people's mobility: in-commuting/out-commuting, and in-migration/out-migration.

6.2.1 Decreasing the local labor market mismatch is the key

The fundamental goal of rural development is to retain and increase population. People 'vote with their feet' in response to the quality of life and socioeconomic conditions in rural areas (Drabenstott, 2001; Olfert & Partridge, 2010; Partridge et al., 2009). Most rural studies focus on increasing urban in-migrants and decreasing rural out-migrants. What is missing in the current research is the dynamic relation between commuting and migration. As shown in the model results (Table 5-3A and Table 5-3B), commuting is positively related to migration. Counties that have more migrants also have more commuters. Research shows that the proximity to urban areas can increase rural out-commuters and then retain rural population, because rural residents choose to commute rather than to migrate (Partridge et al., 2010; Wu et al., 2017). However, for rural communities with urban in-commuters, these workers compete with residents for local job opportunities (Partridge, Rickman, et al., 2009; Renkow, 2003). This research defines rural development as the increase of urban in-migrants, increase of out-commuters, decrease of the in-commuters and decrease of the out-migrants. Therefore, how could rural communities attract people without pushing out residents? This research uses the spatial disequilibrium framework to analyze people's mobility between rural and urban to explore new approaches to retain rural population.

This research shows the impact of local labor market mismatch on people's mobility (Figure 6-2). The y-axis shows the number of out-commuters/out-migrants from rural counties and the number of in-commuters/in-migrants to rural counties. The

initial value of people's mobility is based on Table 4-3. The x-axis shows the level of decrease in local labor market mismatch. The relation between people's mobility and local labor market mismatch within the rural areas is shown on the left side of the dashed line. The impact of the difference in local labor market mismatch between rural and urban on people's mobility is shown on the right side of the dash line. The left figure shows the impact of the decrease in education-occupation skill mismatch on people's mobility; and the right figure shows the impact of the decrease in resident-firm employment mismatch on people's mobility.

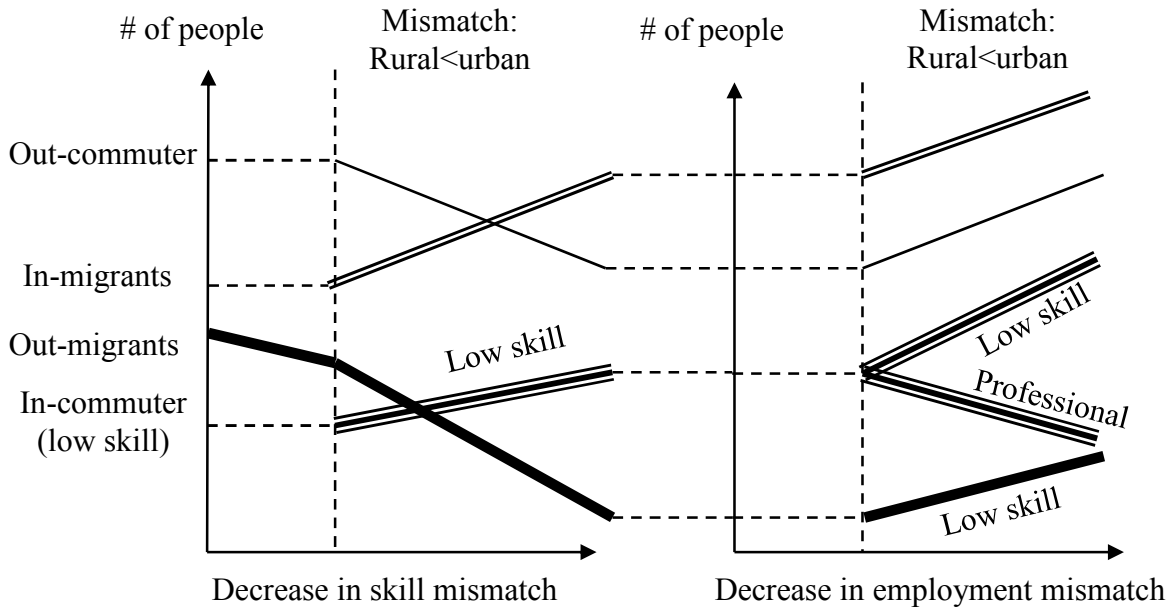


Figure 6-2 Impact of local labor market mismatch on the number of people's mobility

Figure 6-2 shows the threshold effect of the local labor market mismatch on people's mobility. On the left side of the dashed line for both the left figure (decrease in skill mismatch) and the right figure (decrease in employment mismatch), only one line is bolded (out-migrants) in the left figure, this means the decrease in the local labor market skill mismatch is only related to the decrease in out-migrants. When people can

find a skill-matched job, they are more likely to stay, as expected. What I find interesting is that when local labor market mismatch in rural is smaller than that in urban, the local labor market mismatch is related to people's mobility. On the right side of the dashed line, all the lines move upward, including rural out-commuters, rural out-migrants, urban in-commuters and urban in-migrants. Therefore, the impact of mismatch on people's mobility in rural areas shows up only when rural is more balanced than the urban counterpart.

Figure 6-2 shows a threshold effect of the decrease in the local labor market mismatch: it may not affect people's mobility at the early stage, but once the rural local labor market mismatch is smaller than the urban counterpart, it will affect the mobility between rural and urban. This means that we need to think about policy options which increase the matching efficiency between residential education and skill required by occupations, as well as the matching efficiency between local labor supply and local labor demand in rural communities. For example, a small town of Elsa, Texas built a school-based and community-based organization to both train local youth and encourage them to solve local problems (Stark, 2006). This case study shows that the community can decrease the education-occupation skill mismatch by providing skill matched job opportunities to retain educated youth. At the same time, the community targets the local youth, which increases the competitiveness of local youth over other workers, and this decreases the resident-firm employment mismatch.

We also need to focus on the long-term effect of policies: it may not affect rural development in the short term, but will benefit rural development in the long run. For example, Figure 6-2 shows that metro in-migrants are attracted by nonmetro counties

only if the rural local labor market mismatch is smaller than the urban local labor market mismatch. This implies that urban in-migrants are not looking for a labor market with more skill matched jobs or more firms hiring local labor, but are looking for a labor market with more balanced skill and labor supply-demand than their original labor market.

Increasing rural entrepreneurship is another way to decrease rural labor market mismatch. Research shows that overeducated labor is more likely to search for better jobs or become entrepreneurs (Åstebro, Chen, & Thompson, 2011; Stenard & Sauermann, 2016). Thus, encouraging entrepreneurship can help rural areas decrease the local labor market mismatch and help rural development in the long term. This research does not directly measure entrepreneurship, but the self-employment rate could be a proxy. Self-employment is used as a measure of entrepreneurship in many studies (Bender & Roche, 2013; Henderson, 2002; Stephens et al., 2013). My research finds that the increase in self-employment rate is positively related to the number of urban in-migrants, however, it is also related to more rural out-migrants. It could be because I did not measure the skill of the self-employed. Stephens and Partridge (2011) find that self-employment is positively related to employment and income growth in Appalachian areas, but the type of entrepreneurs matters. Therefore, what type of entrepreneurship should rural promote? As shown in Figure 6-2, the decrease in the resident-firm mismatch in the low skill service pushes out residents, but the decrease in high skill employment mismatch does not affect rural out-migrants. This implies the importance of supporting high skill entrepreneurs. However, it is difficult to develop entrepreneurship in rural areas because of lack of resources, such as transportation

infrastructure and high-speed broadband (Henderson, 2002). On the other hand, new firms have a higher survival rate in rural areas because of lower opportunity costs and less competition (Deller & Conroy, 2016). Henderson (2002) suggests three programs to support rural entrepreneurship: 1) increasing the skill of entrepreneurs, through small business development centers; 2) developing community resources, such as Angel investors, and new venture capital funds, and 3) increasing support networks, such as the incubator programs. My research suggests that rural communities should focus on increasing the high skill entrepreneurs and build high skill start-ups. Although the impact of high skill entrepreneurship on rural development is not as strong as the impact on urban, it will still help rural development in the long-term.

This research views in-commuters as the competitors of local labor, so a sustainable rural development approach should decrease urban in-commuters. Figure 6-2 shows that the decrease in the low skill mismatch and the decrease in the low skill service employment mismatch are related to more urban in-commuters, while the decrease in professional service employment mismatch is related to fewer in-commuters. This implies that rural communities should focus on the decrease in high skill mismatch and professional service employment mismatch, which can both retain and increase population without attracting urban in-commuters and pushing out rural residents. As shown in other research, rural communities need to follow the trend of a high-skill economy (Gibbs et al., 2004; G. P. Green, 2007). For example, other research shows that although the investment in education could increase the rural ‘brain drain”, it also could attract rural out-migrants to return to raise their children (Gibbs, 2005). This research suggests educational policy should be linked to local development. For

example, a workforce development network linking training institutions, employers and community organizations, such as community colleges, could lower the education cost and reduce the risk of brain drain (Green, 2003; Green, Galetto, & Haines, 2003). Blended learning, service sharing, broadband access, and attracting teachers to rural areas could promote development of educational services in rural areas (Johnson et al., 2014).

The increase of broadband availability is also important to upgrade the rural economy, since it is essential to knowledge-intensive firms, which are technology-intensive and footloose (Tranos & Mack, 2016). However, strategies related to innovation and creativity, such as high-technology clusters, should not be applied to rural areas without the capacity of innovation and human capital (Barkley & Henry, 1997; Stephens, Partridge, & Faggian, 2013). Thus, this research suggests that increasing the education of rural residents is still important, but rural communities need to explore strategies to retain educated people and increase high skill firms.

6.2.2 Place-based policy increasing proximity to urban

This research shows the different impacts of the spatial disequilibrium on people's outflows between rural and urban counties (Table 6-2). Generally, Table 6-2 shows that most variables are significantly related to urban out-migrants and out-commuters, while most variables in the local labor market mismatch are not related to rural out-migrants and rural out-commuters. The rural-urban divide is shown from three aspects: 1) this research expects that people's mobility is related to both local labor market mismatch and regional disequilibrium. The results show that urban out-migrants are related to both local mismatch and regional disequilibrium, while rural out-commuters are mainly

driven by the regional disequilibrium (Table 6-2). 2) This research expects that the increase in wage is related to people's outflows. Table 6-2 shows that the hypothesis is true for urban, while the increase in low skill wages does not drive people's outflow from rural. 3) This research expects that homeownership and amenity cost are positively related to the number of out-commuters and negatively related to the number of out-migrants. The results from rural are the same as the hypothesis, while both the homeownership and amenity cost are positively related to out-migrants from urban. Therefore, the differences between rural residents and urban residents show that compared to urban residents, rural residents have less capacity to move. This means that we need to think about policies to consider the rural-urban differences to increase people's mobility in rural areas.

Table 6-2 Impact of spatial disequilibrium on people's outflows

	Rural		Urban	
	Out-migrants	Out-commuter	Out-migrants	Out-commuter
Local labor market mismatch				
Education-occupation skill mismatch				
High skill	+	NS	+	NS
Low skill	+	NS	-	+
Resident-firm employment mismatch				
Professional service	NS	NS	-	-
Low skill service	NS	NS	+	+
Regional disequilibrium				
Wage different				
High skill wage is higher in the receiving place	+	+	+	+
Low skill wage is higher in the receiving place	NS	NS	+	+
Homeownership	-	+	+	+
Higher amenity cost in the receiving place (average wage)	-	+	+	+

Note: NS denotes not significant, + denotes a positive relation, - denotes a negative relation based on model results from Table 5-3A, Table 5-3B

The difference between rural and urban brings forward the debate between people-based policy and place-based policy. The people-based approach encourages people to move out of the underdeveloped areas for a higher return on human capital (Olfert & Partridge, 2010; Partridge, Olfert, & Ali, 2009). However, the people-based policy does not fit rural development. The people-based approach aims to increase human capital and improve households' mobility for better jobs, which causes the "brain drain" from rural areas, and leaves rural areas with low-skilled labor and more older adults (Olson & Munroe, 2012). Also, the people-based approach assumes equal opportunities regardless of individuals' workplace and residential place, rather than considering the spatial heterogeneity of rural areas (Barca, McCann, & Rodríguez Pose, 2012). The place-based approach aims to benefit the specific residents in the underdeveloped areas (Kraybill & Kilkenny, 2003; Olfert & Partridge, 2010; Partridge, Olfert, et al., 2009). Place-based policies include enterprise zones targeting places with a higher poverty rate and a higher unemployment rate, community development and locally-led initiatives targeting low-income residents, and infrastructure investments (Neumark & Simpson, 2014). However, Kraybill and Kilkenny (2003) argue that place-based policies could trap poor people in poor places by impeding people's mobility. Also, firms attracted by place-based policy may only take advantage of tax incentives and may recruit outside labor rather than employ residents (Kraybill & Kilkenny, 2003). Therefore, the place-based policy should be 'place-tailored' policy which adjusts to spatial heterogeneity and focuses on people (Garcilazo et al., 2010; Kraybill & Kilkenny, 2003).

This research suggests that a decrease in the commuting cost could help rural communities retain population. Previous research shows out-commuters can increase local income and support local service businesses (Irwin, Isserman, Kilkenny, & Partridge, 2010; Partridge et al., 2010; Partridge et al., 2012; Partridge & Rickman, 2008). What this research finds interesting is the relation between commuting and migration. Decreasing the commuting cost has the potential to decrease rural out-migrants by turning out-migrants into out-commuters. Table 5-3B shows that the local labor market mismatch within rural areas is positively related to the number of rural out-migrants. This implies that people are more likely to migrate if they cannot find skill matched jobs. However, Table 5-3B also shows that homeownership in rural areas helps retain population, and the higher amenity cost in urban inhibits rural residents migrating to urban counties. Those results suggest that the housing market and the amenity market in rural has the potential to retain population, while it is the labor market mismatch which pushes people to move out. Therefore, if the rural residents have more access to the urban labor markets, they could choose to live in rural areas and work in urban areas. Increasing the commuting opportunities for rural residents could help, such as through regional transportation infrastructure and regional development planning (Baldwin & Forslid, 2005; Partridge et al., 2010). Rural areas can also develop flexible transportation services, such as ridesharing, and van pools. (Bond, Brown, & Wood, 2017; Velaga, Nelson, Wright, & Farrington, 2012)

This research suggests a new way of thinking about place-based policy for rural communities: increasing commuting to retain population. Table 6-2 shows that rural residents are less like to commute than urban residents. Policies focusing on commuting

rather than migration could create the middle ground between people-based policy and place-based policy. As the people-based policy increases residents' mobility, the place-based policy could increase commuting to help rural areas. The commuting policy can be more promising in rural, because homeownership in rural and the higher amenity cost in urban inhibits rural residents' migration. It can also help rural communities increase the human capital without losing people.

6.2.3 Sustaining amenity-led development

This research shows that rural areas with more natural amenities and a higher amenity quality attract urban in-migrants. The amenity-led development approach is promoted by rural scholars (Marcouiller, Kim, & Deller, 2004; Olfert & Partridge, 2010; Olson & Munroe, 2012). However, current research does not show the dynamic relation between in-migrants, in-commuters, out-migrants, and out-commuters. This research shows that better natural amenities are related to more in-migrants, and fewer out-migrants. However, a higher amenity cost is also related to more in-commuters and more out-migrants. A better natural amenity could create more low-skill, low-paid service jobs, which attract urban in-migrants, and absorb local labor since rural counties have a lower educational level than urban. The increase of low-skill jobs could increase the rural out-commuters who are looking for a higher skill job. The increase of amenity cost could imply a higher quality of amenity which attracts urban in-migrants. At the same time, a higher average wage attracts more urban in-commuters. However, the increasing amenity cost pushes out residents.

A sustainable amenity-led rural development approach should increase urban in-migrants without pushing out rural residents. There are two policy options. The first one

is to increase the homeownership of low-income families. Rural areas could attract amenity-led in-migrants of the creative class and high-skill labor (Lambert et al., 2008; McGranahan & Wojan, 2007), but these in turn, attract recreation firms and increase the demand for low-paid services (Olfert & Partridge, 2010). Those new job opportunities could increase employment in rural areas. However, it may also increase the housing value, which pushes out rural residents. The housing value could be partly captured by the average wage in the model. This research shows that the increase in amenity cost is related to rural out-migrants and the increase in homeownership decreases the out-migrants. Thus, policies helping families settle down in rural communities could retain population. This research suggests that rural communities can think about policy options like increasing the rental housing and affordable housing.

The second policy choice is to retain the high-skill urban in-migrants to increase entrepreneurship. This research shows that both better natural amenities and a higher amenity cost is related to more urban in-migrants. Although this research cannot get personal information about the migrants due to data limitations, the urban in-migrants attracted by better natural amenity quality could be amenity-led in-migrants from the creative class. As shown in other research, amenities could attract urban retiree migrants, which are positively related to both population growth and employment growth (Cushing & Poot, 2004), and the increase of self-employment in remote rural areas (Goetz & Rupasingha, 2014). Abrams and Bliss (2013) interview the landowning amenity migrants in the remote rural county of Wallowa, Oregon. Wallowa has a high capacity of natural amenity, attracting tourists and amenity migrants, but its remoteness prohibits a large scale of in-migrants and urban commuters (Abrams & Bliss, 2013).

Their research confirms that the amenity landowners include professionals and entrepreneurs (Abrams & Bliss, 2013). They suggest that a working landscape vision, which is an integration of cultivation and natural habitat, is embraced by the amenity-led landowners. Policy options supporting the engagement of urban in-migrants in local activities could help rural development. Other policies increasing the quality of life could help retain urban in-migrants, such as increasing the accessibility of heath care and the coverage of broadband.

The above policy options to retain amenity migration are not new, what this research finds new is the importance of linking the high skill urban in-migrants to local development. Rural communities should not only be the playground of the urban in-migrants. Studies show that the creative class can increase the rural entrepreneurial climate (Deller & McConnon Jr, 2009; Goetz & Rupasingha, 2009). Local governments should explore development approaches to encourage urban in-migrants to participate in local business development.

To sum up, this research suggests three rural development strategies: 1) decrease the skill mismatch and the employment mismatch. 2) increase the mobility of rural residents and explore commuting policy to increase access to the urban labor market. 3) encourage high skill entrepreneurship to upgrade the local economy. The rural development needs to be embedded into rural-urban interdependence (Lichter & Brown, 2014). Recalling the "Yin/Yang" symbol, rural development could be viewed as the process of connecting to urban. The decrease in mismatch could be the force connecting “Yin” and “Yang”, but this research finds a threshold effect. It works only if the decrease in mismatch reaches a certain level. This research also finds the important role

of commuters to connect rural and urban, as well as approaches accelerating the process, such as transportation policy. Lastly, this research suggests that rural development approaches should not focus on complementing urban development. As the "Yin" should be equal to "Yang", the rural community should not be viewed as the periphery in the city-region or exurban. Encouraging high skill entrepreneurship could help rural communities move forward.

6.3 Study limitations

6.3.1 Data limitation

This research uses data at the county level to explore people's mobility. Although the county pair links people and places, the personal attributes of commuters and migrants are missing in this research. Due to the data limitation, there is not a public data source including the personal characteristics in the county-to-county migration dataset. A future study could use restricted data sources that examine the migrants and commuters in terms of educational level, family income, race, occupation, etc. Although county is the smallest unit of analysis in the public data source, county could be diverse including principal cities and outlying areas. Further study could use a smaller unit of analysis.

6.3.2 Model limitation

6.3.2.1 Omitted variables

Although this research creates a complex system to examine the impact of spatial disequilibrium on people's mobility, the research mainly focuses on the labor market. In the empirical study, the amenity market is represented by the natural amenity scale and the amenity cost, and the housing market is represented by homeownership. Future studies should include more attributes to capture the amenity market and housing

market. Amenity market could use the environmental summary from the National Historical Geographic Information System (NHGIS), and crime rate from the Uniform Crime Reports (URC). The housing market could include vacancy rate, median house value, and rent from ACS.

6.3.2.2 Missing connections between the labor market, housing market, and amenity market

This research focuses on the local labor market mismatch within counties. However, the research omitted the mismatch between the local labor market, local housing market, and local amenity market. For example, the mismatch between job opportunities and housing accessibility in the local market is not measured in the model. Other interaction terms could be the mismatch between income and amenity cost, the homeownership/vacancy and job opportunity, and personal demand and amenity within the sending county. A future study could use an interaction term or build a structural equation model to explore the interaction between people and different mismatches within counties and between markets.

6.3.2.3 Endogeneity problem

This research explores the impact of place on people's mobility. However, people's mobility also affects places. Although I use the difference between labor supply and labor demand, and the difference between regional markets, endogeneity could still exist in the model. A future study could use instrumental variables to control for the endogeneity problem. The instrumental variable could be the industry structure, such as industry mix (Rupasingha et al., 2015).

6.4 Model extensions

This research creates a unique spatial disequilibrium framework to explore the linkage between places. The research finds that people's mobility, commuting and migration, is related to local labor market mismatch, as well as the regional disequilibrium in the labor market, housing market, and amenity market between the sending county and the receiving county. This research focuses on the implications of the spatial disequilibrium framework in rural development. This framework can also be generalized in other analyses.

6.4.1 People's mobility between metro core, suburb, micro core and remote rural

The empirical study focuses on the metro and nonmetro counties in the US. Metro counties could be further classified into metro core (have a principal city) and suburb (Table 6-3). Nonmetro counties could be divided into micro core (counties inside micropolitan areas and have a principal city) and remote rural areas (Table 6-3).

Table 6-3 County metro status classification

	Have Principal city	Do not have a principal city
Inside metropolitan area	Metro core	Suburb
Inside micropolitan area	Micro core	Remote rural
Not CBSA	-	Remote rural

Statistical description and model results are shown in Appendix 2. The statistical description shows that suburb and micro core counties have a similar local labor market mismatch. Counties can be distinguished by wage, labor participation and educational level (see Appendix Table A2-1). Model results (from Appendix Table A2-2 to Table A2-5) show that the spatial disequilibrium can be used in a more detailed county classification. Model results also confirm that people are more likely to migrate/commute to places with a smaller education-occupation skill mismatch, and a

greater resident-firm employment mismatch. The results of other variables vary across models. A brief summary of the model results is shown in Appendix 2. Due to the number of models and the complexity of the analysis, this research only analyzes people's mobility between metro counties and nonmetro counties rather than the mobility among metro core, suburb, micro core and remote rural. New data analysis techniques could be used to simplify the model. For example, Robinson and Dilkina (2018) implement machine learning to model human migration.

6.4.2 People's mobility within the same metro status

Although most of people's mobility happens inside the same metro status, this research focuses on the interaction between rural and urban, and the relation between the rural-urban interaction and rural development. Therefore, mobility inside the same metro status is omitted in the research. Table 6-4 shows that 90% of people commute between counties with the same metro status, and 80% of people migrate to counties with the same metro status. To examine the generalization of the spatial disequilibrium framework, this research uses the same methodology on mobility inside the same metro status. Model results of mobility within the same metro status also justify the spatial disequilibrium framework (Appendix 3). The results show that the framework can explain around 60% of people's mobility between counties within the same metro status (Table A3). Table A3 shows that commuting and migration have a similar response to local labor market mismatch as well as regional labor market disequilibrium. Also, homeownership encourages metro residents' mobility, while home homeownership inhibits nonmetro residents' mobility. The model results and a brief discussion are shown in Appendix 3.

Table 6-4 Sample selection

Table 6-4 A Number of observations (county pair)

	Number of observations (County pairs)		
	Same metro status	Different metro status	Total
Commuting	27,868	**16,975**	44,843
Migration	164,181	**101,706**	265,887

Note: subsample is highlighted in **bold**

Table 6-4 B Number of out-commuters/out-migrants

	Number of out-commuters/out-migrants		
	Same metro status	Different metro status	Total
Commuting	31,900,942	**3,797,857**	35,698,799
Migration	13,306,654	**3,384,052**	16,690,706

Note: subsample is highlighted in **bold**

6.4.3 Different commuting distance measures

Distance is a critical factor in commuting and migration studies. This research uses the inverse form. Some studies use other forms, such as non-transformed distance and inverse square distance. The results of other distance measurements are shown in Appendix 4. The main results are the same. However, in the migration model, the R square decreases when using non-transformed distance. This implies a nonlinear relationship between distance and the number of out-migrants.

6.4.4 Different education measurement (high school or less)

In the education-occupation pair, the low education level is defined as no degree based on the entry-level education data. However, studies commonly use high school or less to represent low education. This research still uses no degree as a proxy to keep consistent measurements of education and occupation mismatch based on Table 4-4. Model results using high school or less as the low education measurement are shown in Appendix 5. The results are similar to the results shown in Table 5-4. However, using high skill or less to measure the low skill mismatch could be biased towards education.

As shown in Table 6-5, the percent of low skill occupation is around 10%. The percent of high school or less is around 15% percent, which is slightly larger than the percent of low skill occupation. However, if using the high skill or less as the measurement of low education, the percent dramatically increases to around 50%. Compared to about 10% low skill occupation, the low skill mismatch is dominated by low education. The education-occupation mismatch should equally consider the skill supply (education) and skill demand (skill required by occupation). Therefore, using the original measurements (less than high school) can capture the both supply side and demand side better than the measurement (high school or less).

Table 6-5 Different measurements of the low education-occupation skill mismatch

Low education-occupation skill mismatch		Metro county	Nonmetro county	T test
Low skill Occupation (%)		9.51	9.69	-2.11*
Education (%)	Less than high school, used in the main model (Table 5-4)	14.66	16.59	-7.29*
	High school or less, used in Table A5-1	45.75	53.02	-19.48*
Education-occupation mismatch	Less than high school, used in the main model (Table 5-3A, Table 5-3B)	5.15	8.15	-18.55*
	High school or less, used in Table A5-2	36.33	43.34	-18.07*

Data source: American Community Survey 2009-2013
Note: * $p<0.05$

6.4.5 People's commuting in extremely long-distance

The commuting model sets 100 miles as the distance threshold and omits extreme long-distance commuters. Appendix 6 shows the model results of commuting county pairs with extremely long-distance commuters: 100-150 miles, 150-500 miles, and 500 miles. The labor market disequilibrium framework does not fit well for the extremely long-distance commuting county pairs (lower R-square). It could be related to the small number of out-commuters in each county pair. Those county pairs could be outliers in

the analysis, so the spatial disequilibrium framework, which focuses on the labor market disequilibrium, does not fit the extreme long-distance commuters.

The summary of the model extension is shown in Table 6-6.

Table 6-6 The extension of spatial disequilibrium framework

	Empirical study	Main results
1	People's mobility between metro core, suburb, micro core and remote rural (Appendix 2)	People's mobility is related to local labor market mismatch, regional disequilibrium in the labor market, housing market and amenity market.
2	People's mobility within metro status (Appendix 3)	Spatial disequilibrium framework can explain people's mobility between counties with the same metro status
3	Different commuting distance measures (Appendix 4)	A nonlinear relationship between distance and the number of out-migrants.
4	Different education measurement (high school or less) (Appendix 5)	The main results are the same but using high school or less dramatically increases the mismatch between low education and low skill occupation.
5	People's commuting in extremely long-distance (Appendix 6)	The labor market disequilibrium framework does not fit well for the extremely long-distance commuting.

6.5 Future study

This research argues that rural development should focus on the balance between supply and demand in skill and employment, encouraging entrepreneurship, increasing the links to urban areas, and sustaining amenity-led development to attract and retain rural population. Future research could explore the impact of people's mobility on rural development due to the increased mobility from urban to rural, especially the retiring baby boomers.

Future research could also extend the study from people's mobility to the dynamic demographic transition, and explore the relation between demographic change and rural development. Rural communities are facing a demographic transition-aging

population, losing young people, and increasing ethnic diversity. This research focuses on the phenomena of losing workers to urban areas. Future research could explore the relation between mobility, aging population/ racial diversity and rural development.

The measurement of local government is missing in the study. Future research could use other data sources to measure the role of local government in community development in rural areas under the demographic transition, including planning, economic development policy, government expenditure, and service delivery.

CHAPTER 7

CONCLUSION

This research creates a new spatial disequilibrium framework to explain people's mobility. This new framework integrates the mismatch within the local labor market, and the regional disequilibrium in the labor market, housing market, and amenity market between two places. The unit of analysis, the county pair, innovatively connects the two places and connects people with places. The spatial disequilibrium framework provides a new way of thinking about people's flow as the connection between two places, driven by the difference within the places and the difference between places. This research implements the framework in a rural-urban context, and explores rural development approaches in a mobility paradigm. People's mobility connects rural and urban; and people's mobility is also affected by the rural-urban difference. What can rural communities do to retain population and sustain development?

The new spatial disequilibrium framework fills the literature gaps from five aspects. 1) The framework views commuting as equally important as migration in adjusting the local labor market mismatch and the regional market disequilibrium, which fills the gaps of migration literature. 2) The framework extends the traditional focus of the labor market in explaining people's mobility to a general disequilibrium framework including the impact of the labor market, housing market and amenity market on people's mobility. 3) This general disequilibrium framework uses the county pair to build the relation between people and places, which fills the gaps of the individual mobility theory and the gap of location theory. 4). This research framework uses people's mobility as a bridge of connecting two places, which breaks the limits of

the geographic boundary. It creates a new way of thinking the relation between people and place in a mobility framework. It also shifts the traditional role of equilibrium in explaining the relation between people's mobility and regional development to focus on the importance of mismatch and disequilibrium.

This research innovatively uses the county pair as the unit of analysis. The county pair creates the linkage between a group of people and two specific places: the sending place and the receiving place. The county pair can be viewed as a middle ground between the individual analysis in mobility theory and the place level analysis in location theory. The individual-level study differentiates the personal characteristics of each mover, while the county pair can capture the characteristics of the group of movers and differentiates this group of people with other groups. The place level study only focuses on the locational attributes of either the sending place or the receiving place, while the county pair links those two places and captures both. The county pair is a mechanism connecting people and place. This research also uses the Group Logit model to innovatively measure the county pair.

The empirical study result justifies the spatial disequilibrium framework, which can explain both commuting and migration. The results of the local labor market mismatch show that the high education-occupation skill mismatch drives people's mobility. However, the low skill mismatch traps urban residents. This implies that the high skill labor is more likely to move, while low skill labor is stuck in urban areas. The results of the regional disequilibrium show that rural residents have a higher commuting cost than their urban counterparts, while urban residents can afford a long-distance migration. The homeownership provides the capacity of urban residents to move to

rural. Also, the higher amenity cost in rural implies a better living condition attracting urban in-migrants.

This research converts the spatial disequilibrium framework to a rural development focus. To retain and increase rural population, rural communities need to consider both commuting and migration, and the relation between them. A sustainable rural development approach should increase urban in-migrants and rural out-commuters, as well decrease rural out-migrants and urban in-commuters. Under the mobility framework, this research confirms the 'brain drain' in rural counties. What this research found new is that high skill labor moves to urban areas looking for skill matched jobs rather than just looking for jobs. This research suggests that rural communities could help rural residents to find skill matched jobs and encourage high skill entrepreneurship.

This research suggests a new way of thinking about place-based policy and people-based policy for rural development. As the increase in rural out-commuters could retain rural population, this research suggests that rural communities could use people-based policy to increase residents' mobility, and use place-based policy to increase the access to urban labor market. Regional transportation infrastructure, regional development planning, and flexible transportation services could help. Commuting policy can be more promising in rural areas, because homeownership in rural and the higher amenity cost in urban inhibits rural residents' migration.

This research supports the amenity-led rural development approach, but this research suggests that amenity-led development needs to support a high skill economy. The spatial disequilibrium framework shows the importance of human capital, high skill

occupation and professional service job in people's mobility between rural and urban. The amenity development approach focusing on low-skill, low-paid job won't help rural development in the long-run. This research suggests that rural communities could increase rental housing and affordable housing to retain population, as well as encourage urban in-migrants to participate in local businesses to sustain rural development in the long run.

This research builds a new spatial disequilibrium framework which is set on the Chinese "Yin/Yang" symbol to conceptualize the relation between local mismatch, regional disequilibrium, and people's flow. Although this research is built on the disequilibrium, with people's flow as the response to the disequilibrium, the whole system, disequilibrium plus people's flow, could form a dynamic equilibrium. The "Yin/Yang" symbol shows the coexistence of "Yin" and "Yang", the coexistence of the imbalance within "Yin" (the small white circle) and the imbalance within "Yang" (the small black circle). Like the "Yin/Yang" symbol, this research shows the possibility of the coexistence between disequilibrium and equilibrium. In the context of rural development, this research suggests that the development approaches need to think about the rural-urban connection, as well as the rural-urban difference. Rural development should be connected to urban, but should not only complement urban development. The relation between rural and urban should like the relation between "Yin" and "Yang": interdependence and independent, connected by the mutual benefits.

Development is the adjustment of the disequilibrium and the interaction between people and place. As regional scientists, we need to think about space, not only the disequilibrium between places, but also the mismatch within place. This research

extends the concept of equilibrium as the coexistence between equilibrium and disequilibrium. As the “Yin/Yang” symbol, it is a dynamic equilibrium, built on people’s flow to achieve the optimal balance of the local mismatch and regional spatial disequilibrium.

APPENDIX

Appendix 1 Distance threshold selection

In this research, the unit of analysis is the county pair. However, about 35% of observations have less than 10 out-migrants or out-commuters, and 18% of the county pairs have out-commuters that travel more than 500 miles. As shown in Table A1-1, the number of out-commuters/out-migrants and the travel distance in the county pair are highly skewed. However, after standardizing the number of out-commuters and the number of out-migrants, the county pairs with more out-commuters/out-migrants are outliers (shown in Table A1-2 z score are higher than 3). Thus, using the number of out-migrants/out-commuters as a criterion to select sample could lose the county pairs with most commuters/migrants.

Table A1-1 Statistical description-the number of people's outflows and travel distance

		N	Min	Max	Mean	Median	S.D.	Skewness
Number of out-commuters/ out-migrants	Commuting	49952	1	14059	89	14	362	13.08
	Migration	101706	1	2922	33	14	69	9.18
Travel distance (Mile)	Commuting	49952	13	5188	340	154.67	498	3.35
	Migration	101706	13	5217	636	329.04	729	2.09

Table A1-2 Standardized number of out-commuters/out-migrants

Variable	Obs (number of county pair)	Mean	Std. Dev.	Min	Max
The number of out-commuters	49,952	0.00	1	-0.24	38.63
The number of out-migrants	101,706	0.00	1	-0.47	41.90

An alternative way to decrease the estimation bias is to use geographic location or travel distance between county pairs as a threshold to delete long-distance county pairs. As shown in Table A1-3, American Community Survey has aggregate data at the

county level to show where people commute/migrate. Although half of residents/previous residents commute or migrate inside the same county, those people are not included in the study due to the selection of county pair as the unit of analysis. Among commuters/migrants outside the county, more than three-quarters of those people move inside the state. Therefore, could the state boundary be used as the threshold? There are also other ways to delineate boundaries, such as commuting zone and labor market areas. However, both files stopped updating since 2000. Therefore, this research only focuses on the discussion of the state boundary.

Table A1-3 Percentage of people's outflows

		Mean	Std. Dev.	Min	Max
Commute	Inside county	65.81	18.08	11.1	99.7
	Outside county (88%)	34.19	18.08	0.3	88.9
	Outside state (12%)	4.48	7.65	0	69.9
Migrate	Inside county	54.22	13.78	0	100
	Outside county (75%)	45.78	13.78	0	100
	Outside state (15%)	15.60	10.55	0	100

Data: American Community Survey 2009-2013

Table A1-4 shows that about half of the commuting county-pairs are in the same state, and only 40% of migration county pairs are in the same state. Those same state county pairs can capture about 90% of out-commuters and 60% of migrants. It seems that same state county pairs in the commuting dataset could work. However, those county pairs still include extreme long-distance commuters/migrants (Table A1-5). Although using state boundary as the threshold could be problematic, the average travel distance decreases from 340 miles to 127 miles in the commuting data, and decreases from 636 to 167 in the migration data, which suggests that 100 miles or 150 miles could be used as thresholds.

Table A1-4 Statistical description - all and inside state

	Observation (county pair)		Number of out-migrants/out-commuters	
	All	Same State	All	Same State
Commuting	49952	27171 (54%)	4423147	3792187 (86%)
Migration	101706	39873 (39%)	3384052	1993085 (59%)

Table A1-5 Travel distance (Mile)

	Distance	Obs.	Mean	Std. Dev.	Min	Max
All	Commute	49,952	340.33	498.45	12.70	5188.21
	Migrate	101,706	635.70	728.64	12.70	5216.66
Inside state	Commute	27,171	126.97	97.15	12.70	1746.67
	Migrate	39,873	167.35	115.04	12.70	1792.03

The geographic adjacency of two counties could be the distance threshold (rook distance). Table A1-6 shows that although adjacent county pairs only include 10% of commuting county pairs and 4% of migration county pairs, about 65% of out-commuters and 21% of out-migrants are included in the sample. It also suggests that 50 miles could be considered as the travel threshold.

Table A1-6 Statistical description- all and rook distance

	Observations (county pair)			Number of out-commuters/out-migrants		
	All	Rook	Travel Distance	All	Rook	Travel Distance
Commuting	49952	4855 (10%)	48	4423147	2878623 (65%)	42
Migration	101706	4321 (4%)	48	3384052	699734 (21%)	48

Table A1-7 shows the number of observations (county pairs) and the number of out-commuters/out-migrants(population) in the travel threshold identify by Table A1-4, A1-5, A1-6. Most commuters are in the travel distance less than 100 miles, while most out-migrants travel more than 150 miles. Therefore, this research sets 100 miles as the

travel distance for the commuting model, and did not control the migration distance. The 100-mile commuting threshold is also used in other commuting studies (Artz et al., 2016; Crowder et al., 2011; Freedman et al., 2008; Rosenthal & Strange, 2008).

Table A1-7 Statistical description by travel distance

Travel distance	Commuting		Migration	
	Number of Observations (county pairs)	Number of out-commuters (population)	Number of Observations (county pairs)	Number of out-migrants (population)
< 50 miles	5135 (10%)	2595109 (59%)	4266 (9%)	585707 (13%)
50-100 miles	11840 (24%)	1202748 (27%)	10834 (22%)	595886 (13%)
100-150 miles	7465 (15%)	222349 (5%)	10636 (21%)	381276 (9%)
>150 miles	25512 (51%)	402941 (9%)	75970 (52%)	1821183 (41%)

Appendix 2 Model results for metro core, suburb, micro core and remote rural

Table A2-1 Statistical description

	Metro core	Suburb	Micro core	Remote rural
Local labor market mismatch				
Education-occupation skill mismatch (%)[1]				
High skill	7.42[3]	10.74[2]	10.10[2]	13.23[1]
Low skill	4.16[3]	6.12[2]	6.96[2]	8.30[1]
Resident-firm employment mismatch (%)[1,2]				
Professional service	1.19[1]	0.28[2]	0.28[2]	0.12[2]
Low skill service	0.53[1]	0.25[2]	0.36[1,2]	0.20[2]
Regional labor market disequilibrium (difference between sending and receiving)				
Wage ($1,000)[2]				
High skill	60.03[1]	45.74[2]	42.04[3]	37.16[4]
Low skill	18.83[1]	16.76[2]	16.05[3]	15.10[4]
Labor participation (%)[1]	64.03[1]	61.85[2]	60.18[3]	57.41[4]
Push factors				
Unemployment rate (%)[1]	9.40[1]	9.15[1,2]	9.53[1]	8.64[2]
Self-employment (%)[1]	10.33[3]	11.51[2]	11.41[2]	15.26[1]
Other factors				
High education (%)[1]	27.78[1]	21.06[2]	19.34[3]	16.23[4]
Regional housing market disequilibrium				
Homeownership (%) [1]	58.20[2]	65.04[1]	58.56[2]	57.44[2]
Regional amenity market disequilibrium (receiving minus sending)				
Average wage ($1,000)[2]	40.94[1]	35.75[2]	34.36[3]	32.81[4]
Natural amenity (0-1) [3]	0.75[1]	-0.17[2]	0.15[2]	-0.17[2]
N	556	1,430	610	545

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API

Table A2-1 shows that suburb and micro core counties have a similar education-occupation skill mismatch. Metro core counties have the smallest education-occupation skill mismatch, while remote rural areas have the greatest skill mismatch. In the residential-firm employment mismatch, metro core counties have a significantly greater employment mismatch. Metro core, suburb, micro core and remote rural can be differentiated by wage, labor participation, educational level, and amenity cost (average wage). Remote rural has the highest self-employment rate. The suburb has the highest homeownership.

The results of commuting from metro counties (metro core and suburb) to nonmetro counties (micro core and remote rural) are shown in Table A2-2. The main results still hold in this model: the commuting from metro core/suburb to micro core/remote rural is related to education-occupation skill mismatch, a smaller education-occupation skill mismatch in the receiving counties, higher wages, more labor participation, higher unemployment rate, and higher percentage of homeownership. In the education-occupation skill mismatch, the main model (Table 5-3A, Table 5-3B) shows that people's commuting is related to the high skill mismatch and a more balanced labor market in low skill. This model also shows that the education-occupation mismatch is related to people's commuting from suburb to nonmetro counties. In addition, the commuting from metro core to micro core is related to the low skill mismatch, and metro core residents are more likely to commute to a remote rural county with a more balanced labor market is high skill jobs. The result confirms the argument of this research: rural areas with a more balanced supply and demand in skill could attract people.

Table A2-2 Group Logit model results-commute from metro to nonmetro counties

From	Metro core		Suburb	
To	Micro core	Remote rural	Micro core	Remote rural
Local labor market mismatch (sending)				
Education-occupation skill mismatch (%)[1]				
High skill	0.01	-0.06	0.43**	0.38**
Low skill	0.17**	-0.02	-0.09**	-0.16**
Resident-firm employment mismatch (%)[1,2]				
Professional service	-0.01	-0.05**	-1.16**	-1.38**
Low skill service	0.03	0.05**	0.45	0.59**
Regional labor market disequilibrium				
Skill mismatch (1=sending place has a greater mismatch than receiving place)				
High skill	-0.05	0.18**	-0.07**	-0.02
Low skill	0.12**	0.04	-0.02	0.02
Employment mismatch (1=sending place has a greater mismatch than receiving place)				
Professional service	-0.01	-0.06**	-0.06	0.02
Low skill service	0.09**	0.13**	-0.09**	0.05**
Pull factors (receiving minus sending)				
Wage ($1,000) [2]				
High skill wage	0.38**	0.47**	0.1	0.25**
Low skill wage	0.08	0.17**	0.29**	0.09**
Labor participation (%) [1]	0.22**	-0.01	0.55**	0.25**
Push factors (receiving minus sending)				
Unemployment rate (%) [1]	0.34**	0.19**	-0.08	-0.01
Self-employment (%) [1]	-0.06	-0.02	-0.61**	-0.38**
Other factor (receiving minus sending)				
High education (%) [1]	0.09	0.21**	0.5**	0.33**
Regional housing market disequilibrium				
Homeownership (sending, %)[1]	0.75**	1.0**	0.67**	0.94**
Regional amenity market disequilibrium				
Average wage ($1,000)[2] (receiving minus sending)	0.44**	0.48**	-0.14**	0.06
Natural amenity scale [3] (receiving minus sending)	0.03	0.15**	0.06	-0.04
Distance (inverse, mile)[3]	0.05	-0.14**	0.0	-0.05
Number of out-migrants	0.87**	2.0**	1.7**	1.74**
Constant	-5.47**	-5.97**	-5.12**	-5.85**
N	1784	2198	1544	2203
Adjust-R2	0.71	0.7	0.59	0.61

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API

Note: * p<0.05., ** p<0.01, coefficients are smaller than 0.01 are shown as 0.00

The results of commuting from nonmetro counties (micro core and remote rural) to metro counties (metro core and suburb) are shown in Table A2-3. Similar to the main model (Table 5-3A, Table 5-3B), this model shows that the commuting from nonmetro to metro counites is related to a greater education-occupation skill mismatch within the local labor market, and a more balanced labor supply and demand in nonmetro counties. Nonmetro residents are also more likely to commute to metro counties with higher wages in the high skill jobs, and less unemployment rate. The results of the education-occupation mismatch within the sending counties vary across counties (Table A2-3). The model results imply that similar to migration, commuting could be an alternative way to adjust labor market mismatch and reginal labor market disequilibrium.

Table A2-3 Group Logit model results-commute from nonmetro to metro counties

From	Micro core		Remote rural	
To	Metro core	Suburb	Micro core	Remote rural
Local labor market mismatch (sending county)				
Education-occupation skill mismatch (%)[1]				
High skill	-0.15**	0.12**	0.07**	0.06
Low skill	0.07**	-0.03	0.02	-0.1**
Resident-firm employment mismatch (%)[1,2]				
Professional service	-0.1	-0.04	0.18	1.07
Low skill service	-0.03	0.01	-0.45**	0.14
Regional labor market disequilibrium				
Skill mismatch (1=sending place has a greater mismatch than receiving place)				
High skill	0.27**	-0.1**	0.12**	0.0
Low skill	0.1**	0.05	-0.04	0.07**
Employment mismatch (1=sending place has a greater mismatch than receiving place)				
Professional service	0.02	-0.09**	-0.02	-0.1**
Low skill service	-0.11**	0.08**	-0.07**	0.0
Pull factors (receiving minus sending)				
Wage ($1,000) [2]				
High skill wage	0.26**	0.45**	0.1**	0.2**
Low skill wage	0.06	-0.13**	0.05	0.03
Labor participation (%) [1]	0.08	0.14**	0.13**	0.15**
Push factors (receiving minus sending)				
Unemployment rate (%) [1]	-0.08**	-0.07	-0.04	-0.04
Self-employment (%) [1]	-0.21**	-0.05	-0.07**	-0.01
Other factor (receiving minus sending)				
High education (%) [1]	0.1**	-0.01	-0.04	-0.08
Regional housing market disequilibrium				
Homeownership (sending, %)[1]	0.78**	0.61**	0.92**	0.8**
Regional amenity market disequilibrium				
Average wage ($1,000)[2] (receiving minus sending)	-0.12**	0.14**	0.13**	0.18**
Natural amenity scale [3] (receiving minus sending)	0.19**	0.04	0.03	-0.05
Distance (inverse, mile)[3]	-0.04	-0.08**	0.01	0.02
Number of out-migrants	1.68**	2.57**	2.69**	3.84**
Constant	-4.78**	-5.29**	-4.24**	-4.68**
N	2013	1522	3031	2674
Adjust-R2	0.56	0.59	0.57	0.56

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API

Note: * p<0.05., ** p<0.01, coefficients are smaller than 0.01 are shown as 0.00

The results of migration from metro counties (metro core and suburb) to nonmetro counties (micro core and remote rural) are shown in Table A2-4. The results show that most variables in local labor market disequilibrium drive people's migration from metro core to micro core, but are not related to people's migration from metro core to remote rural. It implies that the migration from metro core to micro core is more related to the labor market mismatch and the regional labor market disequilibrium, while the migration from metro core to remote rural is more related to the regional amenity market disequilibrium. The main result (Table 5-3A and Table 5-3B) shows a positive relation between the number of migrants and the number of commuters, while the metro core in-migrants is negatively related to remote rural out-commuters. It suggests that increasing urban in-migrants could create job opportunities for rural residents, which decrease the number of out-commuters. This research also suggests that the amenity-led rural development approach could be more efficient for remote rural.

Table A2-4 Group Logit model results-migrate from metro to nonmetro counties

From	Metro core		Suburb	
To	Micro core	Remote rural	Micro core	Remote rural
Local labor market mismatch (sending county)				
Education-occupation skill mismatch (%)[1]				
High skill	0.11**	0.22**	0.21**	0.28**
Low skill	-0.2**	-0.15**	0.05**	0.11**
Resident-firm employment mismatch (%)[1,2]				
Professional service	-0.06**	-0.02	1.58**	-1.69**
Low skill service	0.05**	0.01	-0.16	0.27**
Regional labor market disequilibrium				
Skill mismatch (1=sending place has a greater mismatch than receiving place)				
High skill	0.07**	-0.02	0.06**	-0.04**
Low skill	0.05**	-0.11**	0.02	-0.04**
Employment mismatch (1=sending place has a greater mismatch than receiving place)				
Professional service	-0.03**	0.01	0.11**	0.04**
Low skill service	0.18**	0.07**	0.02	0.01
Pull factors (receiving minus sending)				
Wage ($1,000) [2]				
High skill wage	0.36**	0.62**	0.45**	0.39**
Low skill wage	0.24**	0.19**	0.14**	0.06**
Labor participation (%) [1]	0.03	-0.09**	0.12**	0.1**
Push factors (receiving minus sending)				
Unemployment rate (%) [1]	0.3**	0.13**	0.19**	0.07**
Self-employment (%) [1]	-0.13**	-0.06**	-0.42**	-0.23**
Other factor (receiving minus sending)				
High education (%) [1]	0.11**	0.02	0.37**	0.29**
Regional housing market disequilibrium				
Homeownership (sending, %)[1]	0.62**	0.72**	0.38**	0.57**
Regional amenity market disequilibrium				
Average wage ($1,000)[2] (receiving minus	0.19**	0.1**	0.04	-0.01
Natural amenity scale [3] (receiving minus sending)	0.09**	0.16**	-0.04	0.01
Distance (inverse, mile)[3]	0.26**	0.26**	0.12**	0.14**
Number of out-commuter	0.56**	-0.38**	1.61**	2.13**
Constant	-8.81**	-9.33**	-8.14**	-8.64**
N	20192	20915	7041	7676
Adjust-R2	0.76	0.68	0.67	0.65

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API

Note: * p<0.05., ** p<0.01, coefficients are smaller than 0.01 are shown as 0.00

The results of migration from nonmetro counties (micro core and remote rural) to metro counties (metro core and suburb) are shown in Table A2-5. The results show that the education-occupation skill mismatch pushes nonmetro residents to move to metro counties. The results also show a 'brain drain' from nonmetro counties (micro core and remote rural) to suburb. However, the self-employment rate is negatively related to migration, which implies that encouraging entrepreneurship could help nonmetro counties retain population. The amenity cost (average wage) and homeownership inhibit nonmetro residents' migration. However, the amenity cost and homeownership drive people's migration from metro to nonmetro counties (Table A2-5. The results confirm the research finding that people living in metro counties are more likely to move to nonmetro counties with higher amenity quality (higher amenity cost). Also, homeownership helps the process. However, the mobility cost (amenity cost, homeownership) stop nonmetro residents moving out.

To sum up, this session discusses the implication of the spatial disequilibrium on a more detailed classification of metro status, including metro core, suburb, micro core and remote rural. However, due to the complexity of the analysis (16 models), this part only focuses on the comparison between the main results of the main (Table 5-3A, Table 5-3B) and the model results in Table A2-2, A2-3, A2-4, A2-5. In the future research, more sophisticated analytical skill could be used to simplify the model results, such as machine learning.

Table A2-5 Group Logit model results-migrate from nonmetro to metro counties

From	Micro core		Remote rural	
To	Metro core	Suburb	Metro core	Suburb
Local labor market mismatch (sending county)				
Education-occupation skill mismatch (%)[1]				
High skill	-0.16**	0.11**	0.09**	0.18**
Low skill	0.12**	0.05**	-0.02**	0.03
Resident-firm employment mismatch (%)[1,2]				
Professional service	-0.01	0.21	-0.28	-1.09
Low skill service	0.01	0.0	-0.06	-0.07
Regional labor market disequilibrium				
Skill mismatch (1=sending place has a greater mismatch than receiving place)				
High skill	0.09**	-0.05**	-0.0	-0.05**
Low skill	0.01	0.07**	-0.0	-0.02
Employment mismatch (1=sending place has a greater mismatch than receiving place)				
Professional service	0.02	-0.02	0.01	0.0
Low skill service	-0.03**	-0.02	-0.02	-0.03
Pull factors (receiving minus sending)				
Wage ($1,000) [2]				
High skill wage	0.09**	0.25**	0.15**	0.21**
Low skill wage	0.06**	-0.25**	0.09**	0.19**
Labor participation (%) [1]	0.22**	0.29**	0.3**	0.17**
Push factors (receiving minus sending)				
Unemployment rate (%) [1]	0.0	0.01	0.0	0.1**
Self-employment (%) [1]	-0.08**	-0.14**	-0.19**	-0.14**
Other factor (receiving minus sending)				
High education (%) [1]	0.14**	-0.07**	0.03	-0.08**
Regional housing market disequilibrium				
Homeownership (sending, %)[1]	-0.23**	-0.09**	-0.15**	-0.07**
Regional amenity market disequilibrium				
Average wage ($1,000)[2] (receiving minus sending)	-0.24**	-0.13**	-0.24**	-0.06**
Natural amenity scale [3] (receiving minus sending)	0.1**	0.21**	0.11**	0.08**
Distance (inverse, mile)[3]	0.53**	0.34**	0.46**	0.42**
Number of out-commuter	0.37**	0.59**	0.75**	0.93**
Constant	-7.26**	-7.56**	-7.0**	-7.35**
N	16952	5893	14466	5994
Adjust-R2	0.63	0.52	0.42	0.44

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API

Note: * p<0.05., ** p<0.01, coefficients are smaller than 0.01 are shown as 0.00

Appendix 3 Model results within metro status.

The results of commuting and migration inside the same metro status are shown in Table A3. The spatial disequilibrium framework can be used to explain people's mobility both inside metro counties and inside nonmetro counties. Table A3 shows that commuting and migration have a similar response to local labor market mismatch as well as the regional labor market disequilibrium. People's mobility, both commuting and migration are related to the high skill education-occupation mismatch within the local labor market, a greater low skill education-occupation mismatch in the sending counties than that in the receiving county, a more balanced labor supply and demand within in the local labor market, a higher wage, a higher percentage of labor participation, and a lower self-employment rate. The unemployment rate is negatively related to commuting, but is positively related to migration. Similar to the main result (Table 5-3A and Table 5-3B), the impact of amenity market and housing market on people's mobility can be differentiated by metro status. Peoples living in metro counties are more likely to commute and migrate to metro counties with lower amenity cost (average wage) but a better natural amenity, while people living in nonmetro counties are more likely to commute to nonmetro counties with a higher average wage and a better natural amenity. Also, homeownership encourages metro residents' mobility, while homeownership inhibits nonmetro residents' mobility.

Table A3 Group Logit model results

	Commuting		Migration	
Inside	Metro	Non-metro	Metro	Non-metro
Local labor market mismatch (sending county)				
Education-occupation skill mismatch (%)[1]				
High skill	0.17**	0.09**	0.3**	0.18**
Low skill	-0.52**	0.0	-0.22**	0.02**
Resident-firm employment mismatch (%)[1,2]				
Professional service	-0.04**	-0.41**	-0.14**	-0.06
Low skill service	0.02	-0.02	0.01	-0.01
Regional labor market disequilibrium				
Skill mismatch (1=sending place has a greater mismatch than receiving place)				
High skill	0.12**	0.06**	0.09**	-0.02**
Low skill	0.11**	0.03**	0.05**	0.0
Employment mismatch (1=sending place has a greater mismatch than receiving place)				
Professional service	-0.16**	-0.02**	-0.16**	0.03**
Low skill service	0.04**	0.03**	-0.07**	0.04**
Pull factors (receiving minus sending)				
Wage ($1,000) [2]				
High skill wage	0.43**	0.34**	0.13**	0.28**
Low skill wage	0.22**	0.09**	0.02**	0.02
Labor participation (%) [1]	0.28**	0.16**	0.2**	0.17**
Push factors (receiving minus sending)				
Unemployment rate (%) [1]	-0.09**	0.0	0.12**	0.05**
Self-employment (%) [1]	-0.01	-0.25**	-0.02**	-0.18**
Other factor (receiving minus sending)				
High education (%) [1]	-0.2**	0.49**	-0.16**	0.06**
Regional housing market disequilibrium				
Homeownership (sending, %)[1]	0.4**	-0.16**	0.11**	-0.1**
Regional amenity market disequilibrium				
Average wage ($1,000)[2] (receiving minus sending)	-0.07**	0.17**	-0.06**	-0.01
Natural amenity scale [3] (receiving minus sending)	0.22**	-0.02	0.1**	0.02**
Distance (inverse, mile)[3]	0.82**	0.7**	0.33**	0.31**
Number of out-commuters			0.06**	1.38**
Number of out-migrants	0.15**	1.99**		
Constant	-6.79**	-5.61**	-8.39**	-7.23**
N	54346	24939	123364	36955
Adjust-R2	0.63	0.56	0.67	0.52

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API

Note: * p<0.05., ** p<0.01, coefficients are smaller than 0.01 are shown as 0.00

Appendix 4 Model results using different commuting distance measures

Table A4-1, Table A4-2, Table A4-3, and Table A4-4 use different distance measurements. The main results are the same. However, the impact of resident-firm employment mismatch on people's mobility decreases when using the direct form. Also, the R square decreases in the migration model from nonmetro to metro counties. The results of inverse distance and the inverse distance square are basically the same, but the results of inverse square have a lower R square. Therefore, the inverse form of distance is a better choice: 1) the model can efficiently capture the local labor market mismatch in both education-occupation skill and resident-firm employment 2) capture the non-linear relation between distance and migration.

Table A4-1 Group Logit model results-commuting from metro to nonmetro

	From metro to nonmetro		
Local labor market mismatch (sending county)			
Education-occupation skill mismatch (%)[1]			
High skill	0.11**	-0.01	0.1**
Low skill	0.03	-0.01	0.07**
Resident-firm employment mismatch (%)[1,2]			
Professional service	-0.02**	0.0	-0.02**
Low skill service	0.05**	0.02	0.06**
Regional labor market disequilibrium			
Skill mismatch (1=sending place has a greater mismatch than receiving place)			
High skill	-0.0	0.06**	-0.06**
Low skill	0.07**	0.06**	0.09**
Employment mismatch (1=sending place has a greater mismatch than receiving place)			
Professional service	-0.06**	-0.08**	-0.06**
Low skill service	0.09**	0.03**	0.09**
Pull factors (receiving minus sending)			
Wage ($1,000) [2]			
High skill wage	0.39**	0.37**	0.47**
Low skill wage	0.13**	0.15**	0.1**
Labor participation (%) [1]	0.35**	0.28**	0.46**
Push factors (receiving minus sending)			
Unemployment rate (%) [1]	0.19**	0.15**	0.21**
Self-employment (%) [1]	-0.28**	-0.23**	-0.3**
Other factor (receiving minus sending)			
High education (%) [1]	0.23**	0.24**	0.24**
Regional housing market disequilibrium			
Homeownership (sending, %)[1]	0.04**	0.07**	0.07**
Regional amenity market disequilibrium			
Average wage ($1,000)[2] (receiving minus sending)	0.22**	0.19**	0.22**
Natural amenity scale [3] (receiving minus sending)	-0.01	0.03**	-0.01
Distance (inverse, mile)[3]	0.52**		
Distance (mile)[3]		-0.06**	
Distance (inverse^2, mile)[3]			0.4**
Number of out-migrants	0.17**	0.15**	0.2**
Constant	-5.68**	-2.73**	-5.58**
N	7729	7729	7729
R2	0.66	0.7	0.63

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API

Note: * p<0.05., ** p<0.01, coefficients are smaller than 0.01 are shown as 0.00

Table A4-2 Group Logit model results-commuting from nonmetro to metro

	From nonmetro to metro		
Local labor market mismatch (sending county)			
Education-occupation skill mismatch (%)[1]			
High skill	0.03	0.01	0.07**
Low skill	-0.0	-0.05**	0.02
Resident-firm employment mismatch (%)[1,2]			
Professional service	-0.07	-0.1	-0.06
Low skill service	-0.0	-0.02	0.01
Regional labor market disequilibrium			
Skill mismatch (1=sending place has a greater mismatch than receiving place)			
High skill	0.17**	0.14**	0.16**
Low skill	0.11**	0.07**	0.11**
Employment mismatch (1=sending place has a greater mismatch than receiving place)			
Professional service	-0.03**	-0.03**	-0.04**
Low skill service	-0.07**	-0.06**	-0.07**
Pull factors (receiving minus sending)			
Wage ($1,000) [2]			
High skill wage	0.26**	0.26**	0.26**
Low skill wage	-0.03	0.08**	-0.07**
Labor participation (%) [1]	0.18**	0.23**	0.13**
Push factors (receiving minus sending)			
Unemployment rate (%) [1]	-0.09**	-0.07**	-0.1**
Self-employment (%) [1]	-0.29**	-0.28**	-0.26**
Other factor (receiving minus sending)			
High education (%) [1]	0.12**	0.16**	0.07**
Regional housing market disequilibrium			
Homeownership (sending, %)[1]	0.09**	-0.0	0.13**
Regional amenity market disequilibrium			
Average wage ($1,000)[2] (receiving minus sending)	0.02	0.05**	0.0
Natural amenity scale [3] (receiving minus sending)	-0.03**	-0.01	-0.05**
Distance (inverse, mile)[3]	0.54**		
Distance (mile)[3]		-0.05**	
Distance (inverse^2, mile)[3]			0.39**
Number of out-migrants	0.35**	0.3**	0.39**
Constant	-5.36**	-2.5**	-5.3**
N	9240	9240	9240
R2	0.55	0.61	0.52

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API

Note: * p<0.05., ** p<0.01, coefficients are smaller than 0.01 are shown as 0.00

Table A4-3 Group Logit model results-migration from metro to nonmetro

	From metro to nonmetro		
Local labor market mismatch (sending county)			
Education-occupation skill mismatch (%)[1]			
High skill	0.29**	0.49**	0.45**
Low skill	-0.23**	-0.2**	-0.16**
Resident-firm employment mismatch (%)[1,2]			
Professional service	-0.05**	-0.05**	-0.05**
Low skill service	0.04**	0.03**	0.04**
Regional labor market disequilibrium			
Skill mismatch (1=sending place has a greater mismatch than receiving place)			
High skill	0.07**	0.09**	0.01
Low skill	0.03**	0.01**	-0.02**
Employment mismatch (1=sending place has a greater mismatch than receiving place)			
Professional service	0.03**	-0.01	0.11**
Low skill service	0.09**	0.1**	0.07**
Pull factors (receiving minus sending)			
Wage ($1,000) [2]			
High skill wage	0.53**	0.43**	0.74**
Low skill wage	0.21**	0.36**	0.25**
Labor participation (%) [1]	0.1**	0.24**	0.13**
Push factors (receiving minus sending)			
Unemployment rate (%) [1]	0.23**	0.17**	0.22**
Self-employment (%) [1]	-0.25**	-0.38**	-0.29**
Other factor (receiving minus sending)			
High education (%) [1]	0.09**	-0.24**	-0.01
Regional housing market disequilibrium			
Homeownership (sending, %)[1]	0.12**	0.05**	0.18**
Regional amenity market disequilibrium			
Average wage ($1,000)[2] (receiving minus sending)	0.09**	0.18**	0.01
Natural amenity scale [3] (receiving minus sending)	0.28**	0.18**	0.3**
Distance (inverse, mile)[3]	0.46**		
Distance (mile)[3]		-0.0**	
Distance (inverse^2, mile)[3]			0.22**
Number of out-commuters	0.08**	0.21**	0.15**
Constant	-8.91**	-8.15**	-8.86**
N	55824	55824	55824
R2	0.75	0.74	0.72

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API

Note: * p<0.05., ** p<0.01, coefficients are smaller than 0.01 are shown as 0.00

Table A4-4 Group Logit model results-migration from metro to nonmetro

	From nonmetro to metro		
Local labor market mismatch (sending county)			
Education-occupation skill mismatch (%)[1]			
High skill	0.08**	0.13**	0.13**
Low skill	0.05**	0.06**	0.07**
Resident-firm employment mismatch (%)[1,2]			
Professional service	-0.15	-0.23	-0.13
Low skill service	0.0	-0.01	0.01
Regional labor market disequilibrium			
Skill mismatch (1=sending place has a greater mismatch than receiving place)			
High skill	0.05**	0.01	0.06**
Low skill	0.04**	0.04**	0.03**
Employment mismatch (1=sending place has a greater mismatch than receiving place)			
Professional service	-0.0	-0.01**	-0.08**
Low skill service	-0.03**	0.02**	-0.02**
Pull factors (receiving minus sending)			
Wage ($1,000) [2]			
High skill wage	0.15**	0.2**	0.12**
Low skill wage	0.0	0.02**	-0.03**
Labor participation (%) [1]	0.32**	0.25**	0.25**
Push factors (receiving minus sending)			
Unemployment rate (%) [1]	0.04**	0.03**	0.03**
Self-employment (%) [1]	-0.28**	-0.24**	-0.24**
Other factor (receiving minus sending)			
High education (%) [1]	0.16**	-0.03**	0.2**
Regional housing market disequilibrium			
Homeownership (sending, %)[1]	-0.21**	-0.15**	-0.16**
Regional amenity market disequilibrium			
Average wage ($1,000)[2] (receiving minus sending)	-0.22**	-0.18**	-0.33**
Natural amenity scale [3] (receiving minus sending)	0.14**	0.17**	0.07**
Distance (inverse, mile)[3]	0.39**		
Distance (mile)[3]		-0.0**	
Distance (inverse^2, mile)[3]			0.16**
Number of out-commuters	0.05**	0.12**	0.07**
Constant	-7.49**	-6.98**	-7.31**
N	43305	43305	43305
R2	0.54	0.52	0.48

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API

Note: * p<0.05., ** p<0.01, coefficients are smaller than 0.01 are shown as 0.00

Appendix 5 Model results using different education measures (high school or less)

The main results use the percent of population has a degree less than high school to measure the low education based on the entry-level education required by occupations. Some research includes high school in low education. Table A5-1 compares the statistical description between two measurements. Table A5-1 shows that the low skill education-occupation mismatch is much greater than the original measurement. Also, the percentage of the low skill occupation is much smaller than the percentage of low education, which means the low skill education-occupation mismatch is mainly determined by the low education level rather than the mismatch between education and occupation.

Table A5-1 Statistical description: low education-occupation pair

Education-occupation pair		Metro county	Nonmetro county	T test
Education (%)	High	24.03	17.08	23.70*
	Low (less than high school, used in the main model (Table 5-4)	14.66	16.59	-7.29*
	Low (high school or less, used in Table A5-2)	45.75	53.02	-19.48*
Occupation (%)	High	32.98	29.22	17.02*
	Low	9.51	9.69	-2.11*
Education-occupation (job satisfaction)	High	9.23	12.22	-25.47*
	Low (less than high school, used in the main model (Table 5-4)	5.15	8.15	-18.55*
	Low (high school or less, used in Table A5-2)	36.33	43.34	-18.07*

Data source: American Community Survey 2009-2013
Note: * $p<0.05$

The model result of using high school or less as the measurement of low education is shown in Table A5-2. All the results are the same except the education-occupation mismatch, which implies the consistency of the methodology. When including the high school degree in low education, nonmetro counties with a greater

high skill mismatch have more out-commuters, and metro counties with a greater low skill mismatch have fewer out-commuters. Nonmetro counties have a greater high skill mismatch have more out-commuters, more out-migrants and more in-migrants. Nonmetro counties with a greater low skill mismatch have fewer out-migrants. The new results (Table A5-2) still confirm the main result (Table 5-3A and Table 5-3Ba) that counties with a greater education-occupation mismatch push people out, while counties with a more balanced skill supply and demand are related to more people coming in. The statistical description of the low skill education-occupation (Table A5-1) shows that the original measurement is better than the alternative, it is because using the high school or less to measure low skill could view the skill supply (education) and skill demand (occupational skill) more equally.

Table A5-2 Group Logit model results

	Commuting		Migration	
From	Metro	Non-metro	Metro	Non-metro
To	Non-metro	Metro	Non-metro	Metro
Local labor market mismatch (sending county)				
Education-occupation skill mismatch (%)[1]				
High skill	0.07**	0.07**	0.37**	0.14**
Low skill	0.07**	-0.06**	-0.23**	-0.05**
Resident-firm employment mismatch				
Professional service	-0.02**	-0.06	-0.06**	-0.09
Low skill service	0.05**	0.0	0.04**	0.01
Regional labor market disequilibrium				
Skill mismatch (1=sending place has a greater mismatch than receiving place)				
High skill	0.07**	0.07**	0.37**	0.14**
Low skill	0.0	0.11**	0.06**	0.02**
Employment mismatch (1=sending place has a greater mismatch than receiving				
Professional service	-0.06**	-0.03**	0.05**	-0.0
Low skill service	0.09**	-0.07**	0.09**	-0.03**
Pull factors (receiving minus sending)				
Wage ($1,000) [2]				
High skill wage	0.39**	0.24**	0.53**	0.14**
Low skill wage	0.12**	-0.01	0.2**	0.0
Labor participation (%) [1]	0.36**	0.18**	0.12**	0.35**
Push factors (receiving minus sending)				
Unemployment rate (%) [1]	0.19**	-0.08**	0.24**	0.04**
Self-employment (%) [1]	-0.28**	-0.3**	-0.21**	-0.28**
Other factor (receiving minus sending)				
High education (%) [1]	0.22**	0.07**	0.09**	0.16**
Regional housing market disequilibrium				
Homeownership (sending, %)[1]	0.04**	0.06**	0.16**	-0.21**
Regional amenity market disequilibrium				
Average wage ($1,000)[2] (receiving minus	0.21**	0.01	0.1**	-0.22**
Natural amenity scale [3] (receiving minus	-0.01	-0.03**	0.31**	0.13**
Distance (inverse, mile)[3]	0.52**	0.55**	0.48**	0.39**
Number of out-commuters			0.08**	0.04**
Number of out-migrants	0.17**	0.35**		
Constant	-5.67**	-5.42**	-8.95**	-7.49**
N	7729	9240	55824	43305
Adjust-R2	0.66	0.56	0.74	0.54

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API

Note: * p<0.05., ** p<0.01, coefficients are smaller than 0.01 are shown as 0.00

Appendix 6 Model results of extremely long-distance commuters

This research uses 100 miles as the threshold in the commuting model to avoid extreme long-distance commuting. Table A6-1 and Table A6-2 show the model results of long-distance commuting. The travel distance thresholds are between 100 to 150 miles, between 150 to 500 miles and over 500 miles. Model results show that the explanatory power of the spatial disequilibrium framework decreases as the increase of commuting distance, especially in the commuting model from nonmetro to metro over 500 miles.

In the commuting model from metro to nonmetro, the high skill education-occupation skill mismatch is still related to the metro residents' out-commuting, while the low skill education-occupation mismatch shows that low skill job opportunities in metro counties inhibit people's long-distance out-commuting. A more balanced skill supply and demand in the receiving county is not related to the number of long-distance in-commuters from metro counties. The resident-firm employment mismatch within the local labor market is not related to the number of out-commuter. The impact of a higher education on commuting also decrease, as the increase of commuting distance. In the extremely long-distance commuting, the number of out-commuters is negatively related to the number of out-migrants. It implies that the relation between migration and commuting could be substitution. With the increase of the mobility cost, the connection between two counties becomes either commuters or migrants.

The education-occupation skill mismatch shows up in the commuting model from nonmetro to metro counties. In the main model (Table 5-3A and Table 5-3B), the education-occupation skill mismatch in nonmetro counties are not related to nonmetro out-commuters, while this model shows that both high skill and low skill mismatches

are positively related to the number of out-commuters. It implies that the education-occupation skill mismatch could push people looking for external job opportunities if they can afford long-distance commuting. The percentage of high education shows a different result, compared to the main model (Table 5-3A and Table 5-3B). Nonmetro counties with a higher education level also have more long-distance out-commuters. It confirms the above results that when people can pay for the long-distance commuting, nonmetro residents are more likely to find external jobs. The homeownership also shows a different result. A higher percentage of homeownership is related to fewer long-distance commuters. It seems that homeownership is a barrier of long-distance commute. People in nonmetro counties who are freer to live are more likely to be long-distance out-commuters.

Table A6-1 Group Logit model results-Commute from metro to nonmetro

Commuting	100-150 mile	150-500 mile	>500 mile
Local labor market mismatch (sending county)			
Education-occupation skill mismatch (%)[1]			
High skill	0.2**	0.27**	0.38**
Low skill	0.03	-0.13**	-0.2**
Resident-firm employment mismatch (%)[1,2]			
Professional service	-0.06**	-0.02	-0.01
Low skill service	0.04	0.04**	0.01
Regional labor market disequilibrium			
Skill mismatch (1=sending place has a greater mismatch than receiving place)			
High skill	-0.1**	0.03	0.02
Low skill	0.0	-0.07**	-0.05**
Employment mismatch (1=sending place has a greater mismatch than receiving place)			
Professional service	-0.04	0.01	0.01
Low skill service	-0.01	0.03**	0.07**
Pull factors (receiving minus sending)			
Wage ($1,000) [2]			
High skill wage	0.45**	0.43**	0.48**
Low skill wage	0.17**	0.06**	-0.01
Labor participation (%) [1]	0.1**	0.14**	0.09**
Push factors (receiving minus sending)			
Unemployment rate (%) [1]	0.14**	0.1**	0.1**
Self-employment (%) [1]	-0.31**	-0.16**	-0.1**
Other factor (receiving minus sending)			
High education (%) [1]	0.29**	0.05	-0.0
Regional housing market disequilibrium			
Homeownership (sending, %)[1]	0.2**	0.21**	0.36**
Regional amenity market disequilibrium			
Average wage ($1,000)[2] (receiving minus sending)	0.11**	0.28**	0.16**
Natural amenity scale [3] (receiving minus sending)	0.08**	0.09**	0.1**
Distance (inverse, mile)[3]	1.01**	1.25**	1.86**
Number of out-migrants	0.2**	0.08**	-0.14**
Constant	-8.03**	-8.0**	-7.68**
N	2968	6316	3134
Adjust-R2	0.38	0.4	0.45

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API

Note: * p<0.05., ** p<0.01, coefficients are smaller than 0.01 are shown as 0.00

Table A6-2 Group Logit model results-Commute from nonmetro to metro

Commuting	100-150 mile	150-500 mile	>500 mile
Local labor market mismatch (sending county)			
Education-occupation skill mismatch (%)[1]			
High skill	0.18**	0.04**	0.17**
Low skill	-0.02	0.24**	0.21**
Resident-firm employment mismatch (%)[1,2]			
Professional service	0.28	-0.04	0.09
Low skill service	0.0	0.03**	0.02
Regional labor market disequilibrium			
Skill mismatch (1=sending place has a greater mismatch than receiving place)			
High skill	-0.02	0.04**	-0.07**
Low skill	-0.05**	-0.03**	0.04**
Employment mismatch (1=sending place has a greater mismatch than receiving place)			
Professional service	-0.13**	0.04**	0.01
Low skill service	-0.03	-0.04**	0.05**
Pull factors (receiving minus sending)			
Wage ($1,000) [2]			
High skill wage	0.36**	0.22**	0.23**
Low skill wage	0.22**	0.08**	-0.02
Labor participation (%) [1]	0.45**	0.42**	0.26**
Push factors (receiving minus sending)			
Unemployment rate (%) [1]	-0.13**	0.03	0.05**
Self-employment (%) [1]	-0.13**	-0.07**	-0.08**
Other factor (receiving minus sending)			
High education (%) [1]	-0.26**	-0.23**	-0.07**
Regional housing market disequilibrium			
Homeownership (sending, %)[1]	-0.11**	-0.11**	-0.07**
Regional amenity market disequilibrium			
Average wage ($1,000)[2] (receiving minus sending)	-0.07	-0.08**	-0.11**
Natural amenity scale [3] (receiving minus sending)	0.01	-0.08**	0.0
Distance (inverse, mile)[3]	1.36**	1.43**	1.08**
Number of out-migrants	0.34**	0.13**	-0.09
Constant	-7.36**	-7.12**	-7.18**
N	4481	9998	5471
Adjust-R2	0.63	0.48	0.16

Data source: [1] American Community Survey (2009-2013), [2] County Business Pattern 2013, [3] USDA Natural Amenity Scale 1999, [4] Google Map API

Note: * p<0.05., ** p<0.01, coefficients are smaller than 0.01 are shown as 0.00

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