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Determinants of Intra-District Residential Mobility – A Case Study of Taipei Metropolitan Area

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This paper verifies the determinants on an intra-district residential mobility pattern with the residential migration theory. By using the intra-district residential mobility to mobility ratio, we examine the patterns based on the variables of household attributes, degree of affordability, housing quality, and place identity. The overall results show that there are significant effects in the metropolitan area. Furthermore, the effects of household attributes and housing quality exhibit a declining pattern from the central business district to the fringe areas, and place identity is crucial to the fringe areas, but insignificant in the central business district (CBD). As for the district time-invariant effect, the fringe areas have higher values than the CBD, and in the case of the time-series effect, it appears that the CBD has a higher value than those in the fringe areas. Thus, we conclude that the residents in the central areas have a negative place identity but are highly affected by the household attributes and housing quality. However, the mobility patterns in the fringe areas show the opposite result. They are more influenced by a positive place identity but less affected by the household attributes and housing quality. Finally, housing affordability has a significant impact for all.

Keywords

Residential Mobility, Housing Affordability, Housing Quality, Household Attributes, Place Identity, Panel Data.

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1. Introduction

Residential migration has long been a subject of study in the literature. Unlike migration across regions, also known as regional migration, where people seek to minimize spatial costs to maximize economic opportunities (Berger and Blomquist, 1992; Potepan, 1994; Zabel, 2012), residential mobility aims to optimize the costs, both economic and social, and benefits of relocation, typically measured by distance (Clark and Dieleman, 1996). Studies on the determinants of residential mobility make valuable contributions by offering dynamic insights into the growth, change, and restructuring of urban areas (Dieleman, 2001). Additionally, labeling people by place identity is an indicator used to differentiate their socio-economic class based on factors such as earnings, education, etc. (Devine-Wright and Lyons, 1997; Westin, 2016; Adams et al., 2017). For instance, Manhattan in New York is an affluent area, and the pop song "Gangnam Style" launched in 2012, is a Korean neologism that refers to a lifestyle associated with the Gangnam District of Seoul in South Korea. Previous studies often focus on either the determinants of mobility patterns at the "urban-scale" or the causal factors for housing relocation at the "individual household" level but rarely address the linkage between them, namely, the residential mobility patterns or behaviors at the district level.

Furthermore, housing crises have been longstanding challenges for many countries over decades, with an estimated impact on 1.6 billion people by 2025 (Garemo et al., 2014). The typical policy response from local administrations to address such issues involves building new public housing through land replotting in fringe areas of the city. However, these policies are often costly and time-consuming due to suburbanization with limited funding and residents who are reluctant to relocate, thus leaving the housing crisis unresolved (Bardhan et al., 2011). With the aging population in developed countries, it raises the important question of whether urban expansion remains a suitable policy for local administrations[1].

Using specific data, our study examines both intra- and cross-district mobility, thus we can determine mobility patterns at the district level and address the research gaps of past papers. Intra-district residential mobility means that migrants only choose the same area to relocate based on the fact that the area has been predominantly their targeted area and accounts for over 30% of the mobility among districts over a period of 13 years, as shown in Table 1. By leaning on the theory of residential mobility and the phenomenon of districts being labelled so that there is social segregation, understanding metropolitan mobility patterns is critical. Our focus is on the patterns of intra-district

[1] The report “Population and Housing Census” was conducted by the Directorate-General of Budget, Accounting and Statistics in 2020, which showed that 7 million citizens live in the Taipei metropolitan area, and the ratio of those over 65 has increased from 10.7% (2010) to 15.9% (2020).

residential mobility and our study asks the three following research questions: 1) What are the determinants of intra-district residential mobility? 2) How do these determinants influence comparisons between the central business district (CBD) and fringe districts in metropolitan areas? and 3) How does district labelling affect residential mobility patterns? It is anticipated that the findings will provide local administration with insights that will foster better resource allocation in housing-related infrastructures or welfare systems to encourage residents to resettle, and sales strategies for real estate developers through a better understanding of the behavioral patterns of local residents in each district.

Therefore, this research examines the determinants of mobility patterns at the district level in a metropolitan area by using 32 administrative districts (districts) within the Taipei metropolitan area (TMA) from 2009 to 2121 with a panel-data analysis as an example [2]. Each administrative district is formed by approximately 200,000 citizens and has its own geographical characteristics and public facilities, such as schools and hospitals. Some facilities prioritize local residents, especially schools. Studies have shown that these public facilities attract residential relocation (Barrow, 2002; Lin, 2004; Wang and Li, 2004; Trojanek and Gluszak, 2018; Hoshino and Kuriyama, 2010).

The remainder of this paper is organized as follows. Section 2 provides a literature review on residential mobility. Section 3 covers the research design, scope, empirical data, and empirical model. Section 4 presents the results and discussions, and Section 5 the conclusion.

2. Literature Review

As optimizing costs and benefits for relocation is crucial for residential mobility, past papers have provided four determinants to understand intra-district residential mobility: place identity, household attributes, housing quality, and housing price and affordability.

[2] Taiwan (Republic of China) is divided into multi-layered statutory subdivisions, and administrative districts are the fundamental units responsible for executing policies set by the city government. Geographically, Taipei City is an enclave of New Taipei City, and the Taipei metropolitan area consists of 12 districts of Taipei City and 20 districts of New Taipei City. Although New Taipei City has a total of 32 districts, 12 districts are in the rural areas and therefore excluded to improve the accuracy of this research work. Sources from Taipei City government website: https://english.gov.taipei/Default.aspx. ; New Taipei City government website: https://foreigner.ntpc.gov.tw/

Table 1 Mean and Trends of Taipei Metropolitan Area

District	IDMMR		PIA		DR		AH		HQ		HP	
Taipei City	32.01%	(2.53%)	69.16%	(2.26%)	39.35%	(6.93%)	55.42	(0.27)	23.39%	(2.55%)	-24.80	(3.11)
Songshan	29.12%	(2.48%)	68.63%	(2.26%)	44.27%	(7.78%)	55.93	(1.17)	15.69%	(1.56%)	-11.76	(6.22)
Da'an	25.82%	(2.12%)	67.06%	(1.52%)	47.04%	(8.47%)	56.69	(1.13)	13.53%	(1.59%)	0.00	(0.00)
Zongshan	27.37%	(2.37%)	67.69%	(2.11%)	37.64%	(7.38%)	54.80	(1.22)	28.37%	(2.76%)	-17.78	(6.71)
Zhongzheng	23.58%	(3.74%)	68.19%	(1.89%)	46.26%	(7.18%)	55.39	(0.85)	22.52%	(3.65%)	-12.28	(3.41)
Xinyi	26.22%	(2.21%)	69.28%	(1.93%)	38.66%	(7.63%)	56.13	(1.17)	16.36%	(1.44%)	-14.89	(2.54)
Neihu	37.39%	(2.89%)	69.51%	(2.50%)	33.45%	(4.90%)	52.78	(1.37)	37.18%	(2.83%)	-32.46	(3.80)
Nangang	25.77%	(3.51%)	70.81%	(1.82%)	35.36%	(6.02%)	54.16	(1.05)	34.45%	(3.69%)	-30.92	(3.00)
Shilin	35.41%	(2.59%)	70.30%	(3.11%)	37.98%	(7.24%)	56.05	(1.25)	17.20%	(1.67%)	-29.99	(3.63)
Datong	31.32%	(3.14%)	70.68%	(2.16%)	39.31%	(7.05%)	55.75	(0.82)	22.24%	(3.75%)	-27.74	(4.14)
Beitou	42.29%	(2.73%)	69.69%	(3.12%)	37.75%	(6.54%)	54.95	(1.18)	24.07%	(3.14%)	-37.76	(6.01)
Wenshan	39.61%	(2.48%)	69.68%	(2.00%)	37.77%	(6.10%)	54.42	(1.14)	35.67%	(2.83%)	-38.92	(5.71)
Wanhua	33.74%	(2.79%)	69.71%	(2.49%)	37.97%	(7.75%)	56.76	(0.84)	14.16%	(2.78%)	-35.94	(6.29)
New Taipei City	39.97%	(1.94%)	68.09%	(6.84%)	17.65%	(1.38%)	53.15	(0.05)	43.35%	(3.15%)	-52.55	(4.72)
Banqiao	44.96%	(1.99%)	68.05%	(4.37%)	18.83%	(0.73%)	53.53	(1.61)	31.70%	(3.22%)	-44.43	(5.79)
Xindain	39.06%	(2.66%)	64.49%	(4.75%)	14.36%	(1.41%)	54.55	(1.63)	43.60%	(2.88%)	-49.28	(4.95)
Yonghe	28.99%	(1.91%)	65.88%	(4.27%)	18.06%	(1.30%)	55.14	(1.75)	28.36%	(1.46%)	-41.91	(4.13)
Zhonghe	33.09%	(1.76%)	66.81%	(4.21%)	15.16%	(0.74%)	53.89	(1.72)	37.14%	(2.15%)	-46.10	(5.85)
Sanchong	44.62%	(1.29%)	68.28%	(4.46%)	16.53%	(1.31%)	53.88	(1.62)	34.04%	(2.34%)	-47.07	(4.92)
Xizhi	36.90%	(3.02%)	62.81%	(5.06%)	14.65%	(1.63%)	52.10	(1.88)	60.72%	(1.89%)	-54.86	(4.75)
Tucheng	41.19%	(1.30%)	64.95%	(4.50%)	17.05%	(1.64%)	52.17	(1.85)	38.29%	(1.95%)	-52.44	(4.70)
Xinzhuang	49.09%	(0.97%)	66.50%	(4.51%)	19.72%	(1.33%)	51.76	(1.66)	41.23%	(3.75%)	-51.32	(4.65)
Luzhou	41.15%	(1.52%)	64.82%	(5.11%)	18.97%	(2.21%)	51.67	(1.91)	47.43%	(1.25%)	-51.11	(4.67)
Sanxia	43.17%	(3.43%)	64.49%	(4.25%)	21.68%	(2.25%)	52.17	(1.39)	63.97%	(3.76%)	-60.51	(4.98)
Wugu	32.07%	(3.56%)	65.52%	(5.04%)	18.27%	(2.59%)	52.23	(1.12)	57.21%	(4.83%)	-58.69	(5.39)
Bali	34.95%	(6.58%)	65.66%	(4.16%)	16.96%	(2.04%)	52.74	(1.62)	63.91%	(3.24%)	-62.91	(5.05)
Linkou	40.08%	(3.62%)	64.19%	(5.30%)	25.52%	(1.41%)	49.62	(1.47)	80.61%	(6.85%)	-58.14	(4.70)
Shulin	36.46%	(2.17%)	65.47%	(4.05%)	19.74%	(1.73%)	52.15	(1.83)	45.50%	(1.30%)	-57.72	(4.78)
Taishan	34.04%	(2.84%)	66.74%	(4.63%)	20.94%	(1.49%)	51.55	(1.87)	44.15%	(1.67%)	-55.73	(6.02)
Tamsui	43.51%	(2.50%)	63.67%	(4.38%)	16.75%	(1.41%)	52.21	(1.37)	66.69%	(5.92%)	-60.04	(5.40)
Shenkeng	26.79%	(4.64%)	66.53%	(4.64%)	14.61%	(2.77%)	53.52	(1.93)	45.53%	(0.84%)	-58.59	(4.99)
Yingge	40.35%	(3.18%)	67.29%	(3.77%)	19.84%	(2.42%)	52.85	(1.45)	38.29%	(5.04%)	-65.16	(5.67)
Year 2009	34.31%	(7.38%)	71.05%	(1.69%)	28.56%	(8.83%)	52.31	(2.26)	33.47%	(16.13%)	-35.34	(14.18)
Year 2010	32.82%	(7.06%)	71.05%	(1.69%)	27.51%	(9.11%)	51.69	(2.21)	34.46%	(16.24%)	-47.43	(17.97)
Year 2011	32.88%	(7.65%)	71.05%	(1.69%)	26.84%	(9.46%)	51.99	(2.07)	35.21%	(16.15%)	-47.86	(17.49)
Year 2012	32.93%	(7.27%)	71.05%	(1.69%)	26.61%	(9.94%)	52.32	(2.03)	36.11%	(16.32%)	-43.94	(16.87)
Year 2013	32.49%	(7.38%)	71.05%	(1.69%)	26.67%	(10.52%)	53.18	(1.87)	36.93%	(16.84%)	-44.39	(17.93)
Year2014	34.46%	(6.93%)	64.96%	(4.99%)	26.85%	(11.13%)	53.55	(1.79)	37.47%	(16.93%)	-47.05	(20.50)
Year 2015	37.74%	(6.31%)	64.96%	(4.99%)	26.83%	(11.90%)	54.00	(1.72)	37.99%	(17.02%)	-41.20	(18.08)
Year 2016	37.94%	(6.46%)	64.96%	(4.99%)	27.29%	(12.78%)	54.40	(1.66)	38.44%	(16.98%)	-39.83	(17.09)
Year 2017	37.66%	(6.18%)	64.96%	(4.99%)	27.70%	(13.59%)	54.89	(1.62)	38.97%	(17.06%)	-35.30	(18.54)
Year 2018	37.72%	(6.60%)	64.65%	(1.83%)	28.13%	(14.37%)	55.26	(1.60)	39.83%	(17.22%)	-40.97	(16.78)
Year 2019	38.20%	(6.81%)	64.65%	(1.83%)	28.66%	(15.13%)	54.72	(1.58)	40.89%	(17.80%)	-39.37	(16.51)
Year 2020	37.98%	(6.52%)	64.65%	(1.83%)	29.31%	(15.98%)	55.08	(1.60)	41.78%	(17.99%)	-39.20	(17.00)
Year 2021	36.03%	(6.78%)	64.65%	(0.00%)	17.66%	(3.26%)	55.41	(1.63)	42.67%	(18.24%)	-44.02	(18.32)

Note: 1. () Standard deviation.

2.1 Place Identity

Place identity can be understood as a sense of collectivity of a group of people who reside in the same area, characterized by common attributes, perceptions, and socio-cultural interactions. These attributes enable the groups of individuals to differentiate themselves from other groups, and are also facilitated by the physical environment (Lalli, 1992; Hay, 1998; Jorgensen and Stedman, 2001; Gustafson, 2014; Adams et al., 2017; Peng et al., 2020). The residents form interconnected social bonds through familial ties, partnerships, their children, and other social groups (Altman and Low, 1992). Consequently, place identity is constructed through shared attributes, thus forming a collective label for residents and influencing perceptions of residency within the place itself.

Place identity can be perceived positively or negatively at different stages of life, and serve as repositories of memories, feelings, values, and emotions (Devine-Wright and Lyons, 1997). Satisfaction with the social life and public services in a residential municipality significantly influences attachment (Westin, 2016). However, if the area is stigmatized, eliminating such stigma may be challenging, as negative connotations can persist and negatively impact the attachment of residents (Foote, 2003).

Kan (2007) and David et al. (2010) examine how place identity influences residential mobility through socio-cultural interaction, also known as a form of "social-capital". They show that the stronger household or individual social ties deter mobility. Psychological science suggests that the process of mobility is correlated with personality traits, which affect the ability to reconnect socially and well-being (Oishi and Schimmack, 2010). Therefore, understanding the satisfaction and well-being of residents is key to identifying places of mobility and is crucially linked to housing relocation. However, quantitative measurements of these two factors can be challenging.

The social psychology literature shows that emotions can be determined at the collective level, and social identity and inter-group behavior can be used to identify collective emotions (Tajfel, 1974; Akerlof and Kranton, 2000; Mackie et al., 2000), especially negative emotions such as resentment, aggrievement, etc. Smith et al. (2012) find that cohesive communities experience group-wide aggrievement when they perceive a common threat. Emotions are known to influence voting behaviour in several ways (Valentino et al., 2011; Redlawsk et al., 2017). Protest votes are driven by the desire to retaliate against current politics, which are deemed responsible for the current situation (Mudde, 2004; Van Hauwaert and Van Kessel, 2015; Muller, 2017; Rodrik, 2018; Inglehart and Norris, 2016). According to the classical frustration-aggression hypothesis in psychology, more group-wide aggrievement means a greater desire to retaliate (Miller, 1941).

This phenomenon is exemplified with the increasing total voter turnout in recent elections after economic shocks such as global economic or

technological shocks[3]. Altomonte et al. (2019) find that turnout and protest voting are related, especially during economic downturns, and eruptions of protest voting are found with changes in income distribution or reaction to policies[4]. Hence it can be seen that when individuals perceive themselves, against their expectations, to be poorly treated by the political or economic system, they switch voting allegiance or align with an insurgent party or politician. When such resentment is widespread in the community, there is a higher voter turnout (Altomonte et al., 2019; Whiteley et al., 2018).

As mentioned above, place identity can be considered as how residents commonly perceive the socio-economic status of their community; a positive place identity deters mobility (e.g., affluent areas) whereas a negative place identity would force them to move (e.g., areas with high levels of crime, red-light and industrial districts). Satisfaction and well-being are key to a positive or negative identity. Emotions can be collective and reflected by voter turnout as a way of expressing stress and anger under negative economic conditions. These findings shed some light on the connections among place identity, socio-economics, geography, and intra-mobility. Therefore, the turnout ratio reflects the collective emotions of residents, which can negatively impact place identity. The total voter turnout rate for the chief of the village (PI) in a district, as presented in this paper, can be utilized to quantitatively measure and represent impact on place identity[5].

2.2 Household Attributes

Our research shows household attributes and family life-course events, such as births, deaths, and marital status, generate housing demand and residential mobility. We find that younger households with higher housing affordability better adjust when relocating. Other studies show that the formation or dissolution of households causes housing relocation such as a single-family households who need less living space, or households with children thus putting

[3] The data shows the turnout rates of USA voters in both presidential and midterm elections have increased since 2012 according to the United States Elections Project website: https://www.electproject.org/national-1789-present. In terms of European elections, evidence shows that voter turnout rates have increased from 42.97% in 2009 to 50.66% in 2019 in the European Union, according to the European Parliament website: https://www.europarl.europa.eu/election-results-2019/en/turnout/.

[4] Rico et al. (2017) find that anger expressed over an economic crisis is consistently associated with variations in support for populist parties both between individuals and over time in Spain.

[5] The chief of the village (also named the chief of the "Li") is a public official elected by the people of a certain village (Li). The term village is defined by the local administration (city) and regulated by Article 59 of the "Local Government Act". The main tasks of the chief are to handle village affairs and carry out commissioned tasks. The village chief is used in this study as a figure for anti-place identity or attachment.

more pressure on the need to increase living space (Seek, 1983; Clark, 2013). Generally speaking, elderly households and households with children in Taiwan pursue stability and are less willing to move (Jiang and Wu, 1994; Hsueh and Tseng, 2004). Therefore, household attributes play an important role in the adaptability of household relocation and can be categorized by using the dependency ratio (DR) and the average age of the household head (AH) which is an indicator of the adaptability of the household to relocate in this paper. If districts with larger dependency ratios and older household heads on average have poor adaptability, the possibility of intra-district residential mobility increases.

2.3 Housing Quality

Residential moves can be compelled by personal circumstances or household-adjustment needs related to housing consumption, including space, location, amenities, and quality, often influenced by housing market conditions (Strassmann, 1991; Dieleman et al., 2000; Ommeren and Leuvensteijn, 2005). Peng et al. (2009) suggest that the supply of new dwellings stimulates residential mobility. However, limited land supply in cities often results in a shortage of new housing. Moreover, residential mobility aims to enhance living quality. While housing quality varies among families, studies that measure housing/living quality typically rely on tenant satisfaction. Ahlbrandt and Brophy (1976) identify the different dimensions of tenant satisfaction related to neighbors, neighborhood services, physical unit, security, neighborhood cleanliness, and management, with management being crucial for tenant satisfaction. Subsequent research shows that effective management enhances tenant satisfaction when facilities and the housing environment are maintained, and social networks are preserved to provide safety to communities (Horng and Chang 1993; Bruin and Cook 1997; James and Carswell 2008), thereby providing adequate maintenance of the housing quality that is crucial for increasing tenant satisfaction.

According to the 2021 housing stock database of the "Real Estate Information Platform", the majority of people living in the TMA reside in either units or apartments, which comprise 78.06% of the total housing[6]. In addition, the

[6] The housing stock in Taiwan can be categorized into three types: 21.94% are standalone houses (1~3-storeys), 28.54% are units (4~5-storeys), and 49.52% are apartments (over 6-storeys). The difference between units and apartments lies in the presence of a lift, with units (without lifts) being a popular form of buildings from the 1960s to 1980s, while apartments (with lifts) became prevalent since the 1990s due to land shortages in the TMA. The Real Estate Information Platform is a website founded by the Ministry of the Interior and aims to provide updated housing and real estate information for public sector information disclosure, and the website is https://pip.moi.gov.tw/Eng/Default.aspx?pg=introduction. The calculation of housing stock is updated in Q4 of 2021.

"Condominium Administration Act Building Administration Division", introduced in 1995, mandates the establishment of a "Manager" and "Management Committee" composed of elected inhabitants, to execute decisions made in the unit owner assembly and manage and maintain the condominium[7]. The obligations of the committee include building safety (e.g., fire alarms), facilities maintenance (e.g., lifts), and security (inhabitant safety).[8] Furthermore, housing quality refers to "the building's resistance to natural disasters", given that Taiwan is prone to frequent typhoons and earthquakes. This was especially important after the “921 earthquake” that struck Taiwan in 1999 which left over 2400 people dead. The government subsequently reviewed the seismic resistance of existing buildings[9]. The government then revised seismic design specifications and commentary of buildings in the “Building Technical Regulations”. The fact is that 67.3% of housing stock in the TMA did not meet the new requirements[10].

The limitation of land supply has led to a shortage of new housing supply in the TMA, with only 1.2% of new dwellings entering the housing market over a period of 13 years from 2009 to 2021[11]. This phenomenon is likely common in other metropolitan areas worldwide, where citizens have limited selection from the overall housing stock for relocation. Housing quality encompasses factors such as the resistance of the physical building to natural disasters and the management of the maintenance of the building to ensure the safety of residents and pleasant living conditions.

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[7] The “Condominium Administration Act Building Administration Division” is referred to the Ministry of the Interior at the central level, the municipal government at the special municipality level, and the county/city government at the county/city level. Their website is:
https://law.moj.gov.tw/ENG/LawClass/LawAll.aspx?pcode=D0070118.

[8] The committee must be re-elected periodically, and maintenance must be reviewed annually, supervised by local administration. Hiring professional management companies is one way to ease the burden of the committee. Therefore, calculating the number of "dwellings under management" (properties built after 1994) can be applied to measure overall housing quality in districts.

[9] The data are sourced from the website of the U.S. Geological Survey " M 7.7 - 21 km S of Puli, Taiwan".
https://earthquake.usgs.gov/earthquakes/eventpage/usp0009eq0/executive#shakemap.
Retrieved 23 February 2024.

[10] The Building Technical Regulations fall under the “Building Act” which regulates the establishment of new buildings to meet the requirements that fall within the scope of public security, traffic and health, and improve the appearance of cities. With the publication of new seismic design specifications in 1999, the regulations have become a watershed for building safety in public opinion. The source is from the website of “Laws & Regulations Database of The Republic of China(Taiwan)” https://law.moj.gov.tw/ENG/LawClass/LawAll.aspx?pcode=D0070109

[11] The authors calculate the number of new dwellings from 2009 to 2021 which shows that on average, there are 1.1% in the TMA, 0.8% in TC, and 1.3% in NTC. Based on the Real Estate Information Platform.

Given that the majority of properties in the TMA consist of units and apartments (78.06%), with a high rate of owner-occupancy and the introduction of relevant regulations[12], the ratios of dwellings with management (RDM) among the housing stock in each district can serve as an indicator of overall housing quality. Households will have more options for housing relocation in areas with higher RDM ratios, thus implying that districts with higher RDM ratios will likely encourage households to remain in the same district, which results in increased intra-district residential mobility.

2.4 Housing Affordability

The choice of housing relocation is important to residential mobility decision; it is affected by housing utility, location or transportation utility, and amenities. By following the bid-rent theory (Alonso, 1964), we can observe the patterns in population distribution socioeconomically based on the distribution of housing prices in urban areas.

The bid-rent theory**,** as per Alonso (1964), is used to show the trend of housing or land prices in urban areas, taking the perspectives of both landowners and bidders into consideration. Rosen (1974) proposes the hedonic price theory to differentiate non-homogeneous housing by relating hedonic prices to observable housing characteristics. The stochastic bid-rent theory, developed by Ellickson (1981) and extended by Martínez and Henríquez (2007), encapsulates differences in the taste of bidders and land suppliers. Martínez (1992) shows that the random utility theory and bid-rent theory are theoretically equivalent for modeling land use patterns. Chang and Mackett (2006) suggest a bid-rent network equilibrium model with the use of the game theory. Ma and Lo (2012) combined the stochastic bid-rent theory with resident location choice models, and show their consistency by using an adjustment factor in an equilibrium framework. Various urban models stem from this theory, including deterministic utility maximization under resident budget constraints, as proposed by Li et al. (2012, 2013), to describe land use patterns in linear and two-dimensional monocentric cities.

Studies on housing prices mainly affect household affordability and show that higher housing prices have a negative impact on immigrants (Graves, 1983; Andrienko and Guriev, 2004; Frame, 2008). The 80% owner-occupied housing rate in Taiwan, with 90% in the TMA[13], reflects the financial capability of the residents, which is the main financial support that contributes to the housing affordability of migrants. Lin (2021) shows this as households sell or refinance their original dwellings for housing relocation. Leveraging the bid-rent theory,

[12] The data cover 80% of the housing ownership and are obtained from the National Statistics of Taiwan between 1990 and 2020.

[13] The data cover 80% of the housing ownership and are obtained from the National Statistics of Taiwan between 1990 and 2020.

accessibility becomes a determinant that contributes to housing prices. The applied variable represents price differences among districts with regard to ease of accessibility and the financial capability of residents. The theory contributes to enhancing understanding of the determinants of intra-district residential mobility among migrants, and considers location after making moving decisions based on housing accessibility and financial capability.

Thus, the housing price variance that we apply as a proxy is housing affordability and accessibility, with a higher housing price denoting higher financial affordability, as well as the price of housing. Residential mobility involves optimizing the costs and benefits of relocation, with shorter moving distances helping to reduce social costs (Clark and Dieleman, 1996), thus the intra-district residential mobility ratio rises simultaneously with higher housing price in a district.

Finally, the classification of TC as a CBD area and NTC as a fringe area is based on several reasons. First, the different levels of local administrations vary in focus and funding from the central government of Taiwan. TC, the capital and a special municipality in northern Taiwan since 1949, contrasts with NTC, a special municipality upgraded in 2007, which completely encloses TC[14]. The total production of TC and NTC generates 9.53 trillion (295.43 billion USD) and 4.78 trillion NT dollars (148.18 billion USD), respectively, thus indicating that the economic activities align with the bid-rent theory[15]. The applied variable is the variation of housing prices, which shows the housing price distribution pattern in the TMA, with the highest prices in the central areas and decreasing prices towards the fringe.

Past studies have predominantly focused on residential mobility patterns at the metropolitan area level, often overlooking the district level. Furthermore, differences in mobility motivation that stems from personal and household circumstances have not been comprehensively examined at the macro-level. Thus, we intend to address these gaps by utilizing the TMA as an illustrative example to identify these determinants.

[14] The sources are from website of the Taipei City Government and New Taipei City Government.

[15] The source is from the "Industry, Commerce and Service Census" under National Statistic, R.O.C. (Taiwan) https://www.stat.gov.tw/News.aspx?n=2738&sms=11057

3. Research Design

3.1 Methodology

This study uses a panel-data analysis for the 32 districts in the TMA (TC and NTC), Taiwan for the period of 2009 to 2021. The fundamental panel model is expressed as follows:

$$y_{it} = z_i \alpha + \sum_{k=1}^{k} \beta_k x_{kit} + \varepsilon_{it} \quad (1)$$

where y_{it} represents the intra-district residential mobility to mobility ratio (IDMMR) of district i in period t, x_{kit} represents k variables of district i in period t without intercepts and β_k is the coefficient of the k variables. ε_{it} is the random error term of district i in period t, where $\varepsilon_{it} \sim idd(0, \sigma_\varepsilon^2)$. $z_i \alpha$ represents the heterogeneity and individual-specific effect without the time effect (time-invariance), and could include items such as race, gender, and unidentified characteristics of households. z_i represents an intercept and district (individual-specific) effects. Three models that are carefully selected for our study include the pooled model, fixed-effects model (FEM), and random-effects model (REM). Furthermore, if we wish to observe both the cross-section and time-series, they will be referred to as two-way FEM or two-way REM. To test the appropriate model, two test methods are used: the Lagrange multiplier (LM) test, and a test for the REM based on the ordinary least square (OLS) residual (Breusch and Pagan, 1980), and the method in Hausman (1978), which is a test for the REM or FEM.

Finally, this research seeks to find the determinants in intra-district residential mobility without time effects through an FEM at the district level. By adding a time effect, we can observe the impact on the IDMMR from a macroeconomic perceptive and the real estate market through the time period. Therefore, our study is situated in a two-way FEM to examine the determinants and confirm our hypothesis. The model is as follows:

$$IM_{it} = \alpha + D_i + T_t + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \beta_5 X_{5it} + \varepsilon_{it} \quad (2)$$

where D_i represents the district (individual-specific) time-invariant effect, T_t means the time district-invariant effect, and α is the common intercept of the model. In a two-way FEM, we have to set restrictions on the district and time effects so $\sum D_i = \sum T_t = 0$ to avoid multicollinearity. Subscript i represents district i, t represents year t, X_{1it} refers to the PI, X_{2it} is DR, X_{3it} is AH, X_{4it} is RDM, and X_{5it} is HP.

3.2 Data Sources

The mobility data used in our study have three source platforms which are the vital registration of the household statistics of the TC and NTC statistical databases,[16] "Real Estate Information Platform" of the Ministry of the Interior, and the voter's turnout database of the Central Election Commission of Taiwan.

Our focus is on intra-district residential mobility, where individuals relocate within the same district or area (people who made their relocation). This process involves two steps: first, the decision to relocate, followed by consideration of destinations. Consideration of destinations involve complex factors such as social networks, personal circumstances, and more (Clark and Dieleman, 1996; Ermisch and Washbrook, 2012; Jones et al., 2004). Consequently, rivalry arises among three stakeholders: intra-district migrants, out-district migrants, and immigrants, particularly regarding housing prices and their affordability. The IDMMR is calculated by the number of migrants in the same district[17] divided by the average of the number of out-migrants and immigrants[18]. Our research questions emphasize the focus on determinants and their reactions (those who make the moving decision) in the different districts under such rivalry (in the same district). Our paper aims to understand the location preferences among residential migrants and comprehend the determinants that influence their chosen location. Therefore, using the IDMMR may provide better accuracy in capturing the patterns. The above independent variables and forecast influences are summarized in Table 2.

4. Empirical Results

4.1 Summary of Taipei Metropolitan Areas

Figure 1, which shows the geography, infrastructure, and socio-economic distributions of the TMA, provides the geographical form of the TMA, with the Taipei Basin surrounded by mountains (in green), and two rivers that merge from the south-west and south-east, eventually joining together in the northwest. TC is located at the center (light red), while NTC (light blue) circles TC. The transportation infrastructure, including the MRT system (line with yellow dots)

[16] In reality, the population data obtained from household registration may differ from the real residential population. As for the "Report on the Internal Migration Survey" in 2012, it has been calculated that the population of household registration reaches up to 90% of the real residential population, based on which the variance is acceptable so the results for our paper remain the same.

[17] The identification of the migration rate in the same district is the change of address in the same district as the household registration obtained from the government database.

[18] The definitions of out-migrants and immigrants include migrants who move in/out of the district, city, country and first-registration/ abandoning of the household registration.

and highways/freeways (yellow and pink colors), is well established. The TMA has been developing since the early 20th century.

Figure 2 depicts six different regions with different development phases. The dark red in the center represents the CBD, where most governments buildings and corporate headquarters were established around 1950, so that the area has the highest housing price. The areas in medium red (TC) and dark blue (NTC) represent the traditional expansion of the CBD during the economic boom of Taiwan in the 1970s, which accommodated industrial factories and residential areas for CBD workers and companies, with median housing prices. The light red areas represent the old city region and traditional fringe areas of the TC, while the regions in medium and light blue denote later expansions of the CBD with mixed industrial and residential areas developed after 1990.

Figure 1 Geography and Infrastructure of Taipei Metropolitan Area

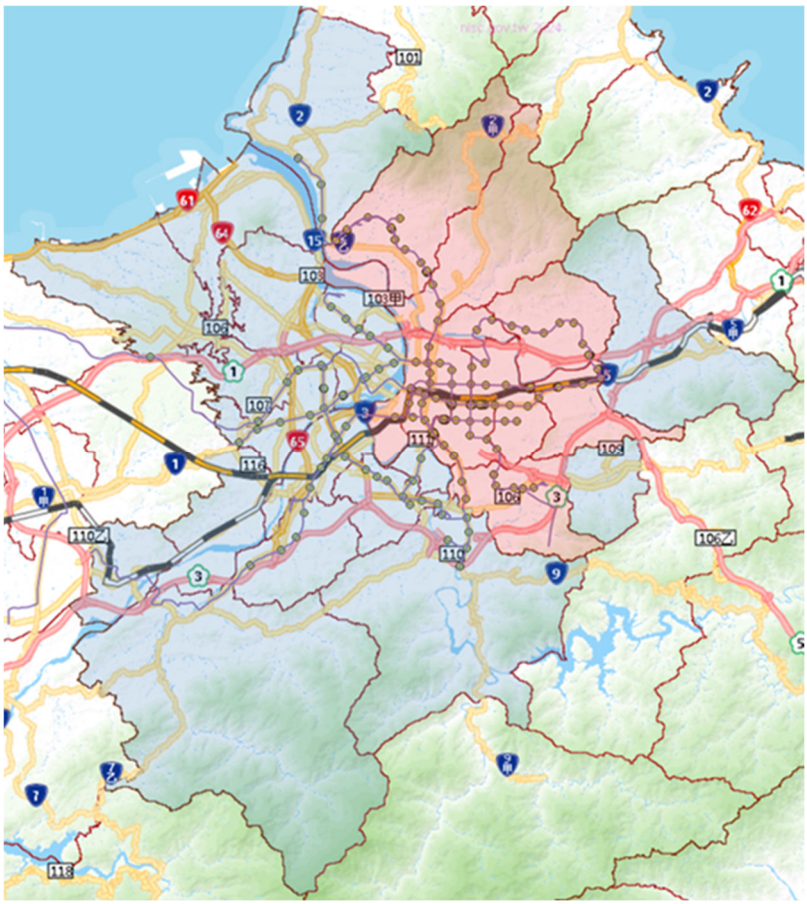
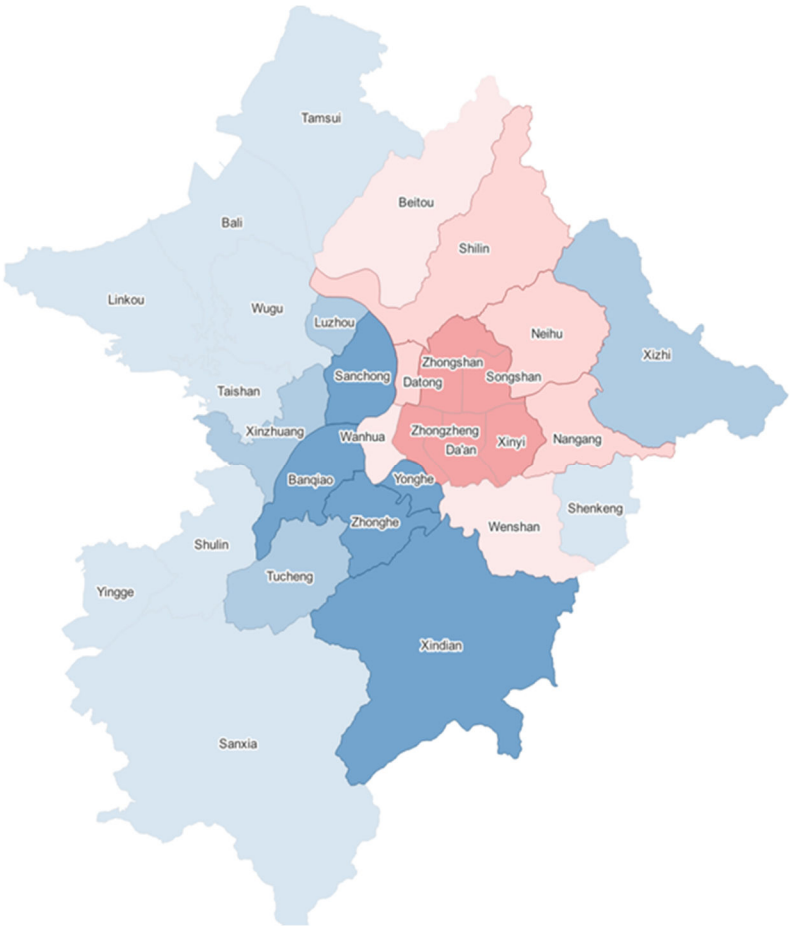


Figure 2 Geography of Districts in Taipei Metropolitan Area



4.2 Descriptive Statistics

Figure 3 shows the determinants in the GIS format and Table 2 is the summary of the two cities and 32 districts. NTC (39.97%) has higher ratios of IDMMR compared to TC (32.01%), thus indicating a preference to remain in the same district for relocation. The variables DR and AH represent household attributes. The DR (39.35%) of TC is double that of NTC (17.65%), and AH indicates that average age (55.42) of those in TC is 2 years older than those in the NTC (53.15), with both variables appearing darker toward the center of Figure 2. DR sharply dropped from 28.56% (2009) to 17.66% (2021) in TC, while AH shows a steady increase for both cities.

Figure 3 Determinants in GIS format

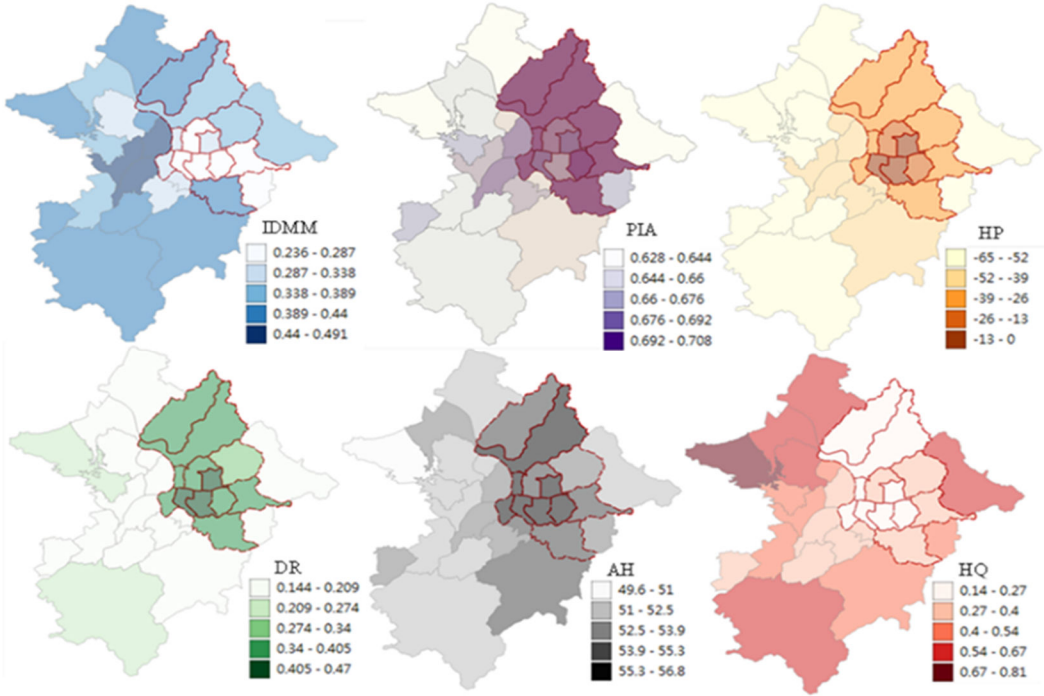


Table 2 Definitions of Factors and Variables

Factor	Variable	Definition	Source	Exp. Sign
Dependent variables				
Intra-district Residential Mobility to Mobility Ratio	IDMMR	The number of migrants in the same district / [(the number of out-migrants + the number of immigrants)/2+ The number of migrants in the same district]	Taipei City and New Taipei City statistical database	+/-
Independent variable				
Place Identity	PI	Voter turnout / total number of votes for the village chief	Central Election Commission	-
Household Attributes	DR	Population of those below 14 and above 65 / population between the ages of 15-64	Same as above	+
	AH	The average age of the head of the household in the district	Real Estate Information Platform	
Housing Quality	HQ	The number of dwellings after the regulations announced in 1995 / the total amount of housing stock	Same as above	+
Housing Affordability	HP	The average housing price of each district – the highest district average housing price of the metropolitan areas	Same as above	+

Notes: IDMMR: Intra-District Residential Mobility to Mobility Ratio, DR: Dependency Ratio, AH: Average Age of Household Head, HP: Housing Price variances, RDM: Ratio of Dwellings with Management, and PI: Voter Turnout

Finally, both results indicate that the citizens in the metropolitan city are aging, as evidenced by AH, and thus the rise in DR is mainly related to elderly people rather than children, especially in TC. The demographic structure of both cities suggests that the majority of their population was born during the baby-boomer generation, but the birth rate remains low. This situation is similar to that in major cities in developed countries. On the other hand, young migrants tend to move to the outskirts of metropolitan areas, thus resulting in a high DR with a young AH geographically.

The HQ in NTC (43.35%) is nearly double that in TC (23.39%) and decreases toward the center. The trend of RDM appears to grow slowly at one percent annually, thus indicating a low housing increase rate due to land shortages in the urban areas. Finally, the PI of TC is 1% higher than that of the NTC, with a decreasing trend. PI negatively impacts IDMMR, as it reflects the dissatisfaction of citizens with their quality of life, particularly in old districts with the highest turnout ratios.

4.3 Empirical Results

Table 3 summarizes our modelling results. Initially, we checked for multicollinearity by using the variance inflation factor (VIF), which shows values below 5, thus indicating that there is no multicollinearity. The LM test indicated significance below 1%, thus rejecting the null hypothesis and confirming individual-specific effects among the districts. The Hausman test shows that the FEM is below the 1% significance level. Additionally, the F-test confirms the model's fit with significance below 1%. The TMA model has a excellent fit with an estimated adj-R^2 of 0.9440, and all of the variables are significant. The most impactful variables are the RDM and DR with positive effects, followed by PI with a negative impact. AH and HP have relatively minor influences.

We separated the districts of the TMA into TC (the central area) and NTC (the surrounding suburbs) to discern potential district effects. Table 4 shows the results. In the TC model, DR, AH, and HP show positive significance levels below 1%, while RDM remains positive at the 5% significance level, and PI has no significant effects. RDM and DR appear to have more positive influence, followed by AH and HP. Conversely, in NTC, AH and RDM show no significant effect, while HP and PI are significant at the 1% level, and DR at the 10% significance level. The coefficients of DR and PI appear to have a more negative impact on the IDMMR, while HP still has a positive influence.

Table 3 Results of Two-way FEMs

Factor	Variable	Taipei Metropolitan Area	CBD (Taipei City)	Fringe (New Taipei City)
Place Identity	PI	-0.1658 (.0000)***	-0.0344 (-0.709)	-0.1652 (.0000)***
Household Attributes	DR	0.1180 (.0000)***	0.1185 (.0000)***	-0.4067 (0.020)*
	AH	0.0057 (.0000)***	0.0086 (.0000)***	0.0013 (-0.519)
Housing Quality	HQ	0.2044 (.0000)***	0.2730 (0.002)**	0.1195 (-0.053)
Housing Affordability	HP	0.0013 (.0000)***	0.0014 (.0000)***	0.0014 (.0000)***
Constant		0.1036 (0.231)	-0.2162 (0.191)	0.5170 (0.000)***
Adj-R2		0.9440	0.9665	0.8853
LM test		1497.58 (.0000)***	436.11 (.0000)***	1004.69 (.0000)***
Hausman Test		111.44 (.0000)***	66.44 (.0000)***	4.57 (0.4704)
F test		109.31 (.0000)***	94.05 (.0000)***	92.43 (.0000)***
Observations		416	169	247
Variable		53.78%	66.82%	49.67%
Individual specific		39.20%	27.15%	39.93%
Time		2.07%	3.25%	2.39%
Overall		95.05%	97.22%	91.99%

Note: ***, **, and * indicate that the coefficient is significant at the 1%, 5%, and 10% significance levels, respectively.

In terms of the differences among these models, AH, HP, and RDM have positive effects on the IDMMR, with NTC showing little or no significance in relation to AH and RDM. The importance of housing affordability is evident across all of the models, particularly when HP was considered. DR, AH, and RDM have more influence on the metropolitan and inner CBD areas, while DR has a negative impact and AH and RDM have no significant effect on the surrounding suburbs. Differences in the IDMMR may stem from district time-invariant effects, yet these characteristics remain unidentified. Besides factors

like district size and resident characteristics, other patterns in the housing market and household attributes absorbed into the individual-specific effect under the FEM may have contributed to the insignificant results in NTC. Additionally, place identity significantly impacts both TMA and NTC but not TC.

To understand the extent of the influence of the IDMMR through time and district effects, we summarize the three effects of the time and district variables, along with a combination of the total effects. The calculations proceed as follows: 1) The R^2 of the total effect is Equation (2) in this paper, which includes the coefficient of determination of the independent-variables effect, district time-invariance effect, and time-series effect; 2) The R^2 of the independent-variables effect only calculates the effects of the variables in an FEM, thus explaining the influences of the variables on the IDMMR without considering district and time-series effects; 3) The $R^2$of the "district effect" represents the individual-specific time-invariant effect, estimated based on an OLS regression. The regression includes both the independent and district variables, minus R^2 of the independent-variables effects; and 4) Finally, the R^2 for the "time-series effect" is calculated by using Equation (2) after subtracting both the "independent-variables effect" and "district effect." This represents the effect through the time series on the IDMMR.

By comparing these effects, we find that the independent variables have the greatest impact on the IDMMR, followed by district, while the time-series effect has the least impact. In the TMA, the independent variables explain for 53.78% of the IDMMR, while the district effect accounts for 39.20%, and the time-series effect only 2.07%. In TC, the explanatory power of the independent-variables effect increases to 66.82%, with the district effect at 27.15%, and the time-series effect at 3.25%. However, in NTC, the independent variables explain for 49.67% of the IDMMR, the district effect 39.93%, and the time-series effect 2.39%. These results indicate that the independent-variables effects have more influence in the CBD areas, whereas the other variables impact the surrounding suburbs. The "district effect" value is higher in the NTC than TMA and TC (see Figure 4). For the time-series effect, TC has a higher value, which is due to macroeconomic factors, policymaking, and the overall housing market (see Figure 5).

Figure 4 Coefficients of district (individual-specific) effects

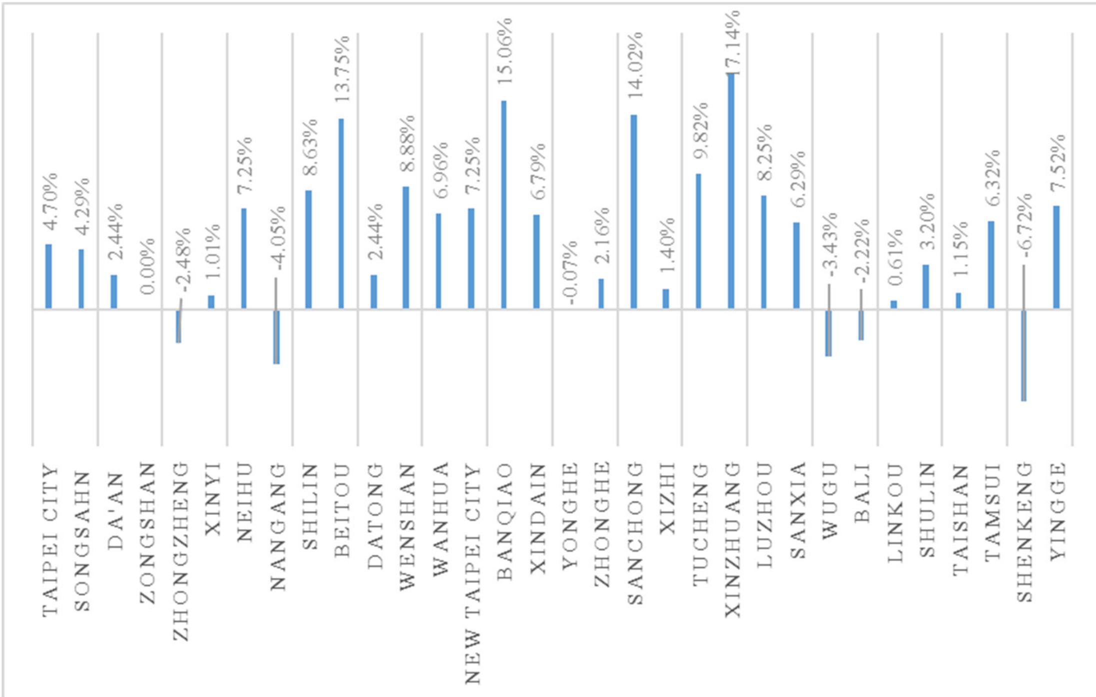
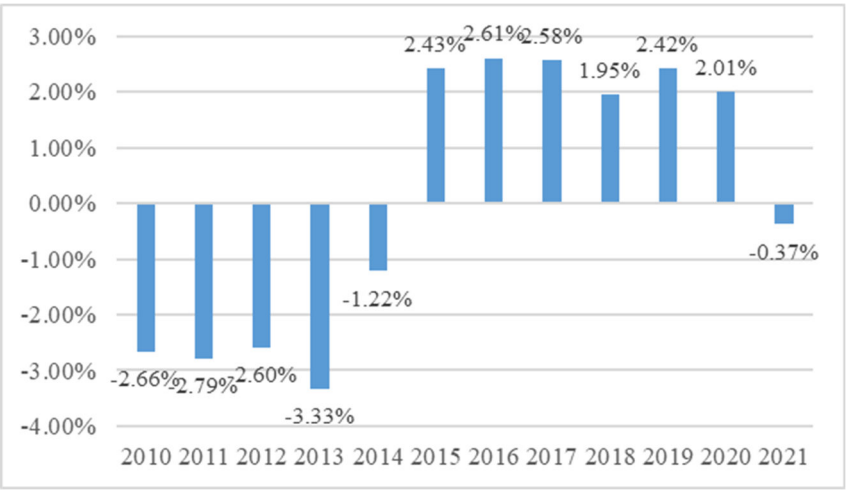


Figure 5 Coefficients of time-series effects



4.4 Discussion

Several findings of this study are discussed as follows.

First, in terms of place identity, we apply the opposite situation for this indicator. This means that a negative impact has positive place identity effects, and the results show that a negative impact has an effect at the 1% significance level in the metropolitan area (TMA) and the surrounding suburbs (NTC). This shows that place identity does affect intra-district residential mobility, which feeds back to the satisfaction of the residents and helps them to feel more attached to the area (Devine-Wright and Lyons, 1997; Westin, 2016). Meanwhile, a positive place identity deters mobility (Kan, 2007; David et al., 2010), thus giving a sense of place labelling to the self, others, and the environment (Jorgensen and Stedman, 2001; Oishi and Schimmack, 2010; Gustafson,2014; Adams et al., 2017). On the other hand, emotions can be collective (Tajfel, 1974; Akerlof and Kranton, 2000; Mackie et al., 2000), and electoral outcomes can reflect the dissatisfaction of residents so that there is a higher voter turnout which is interpreted as aggrievement of cohesive communities when experiencing and facing a common threat who show their dissatisfaction through their votes (Mackie and Samith, 2015; Kselman and Niou, 2011; Valentino et al., 2011; Myatt, 2017; Inglehart and Norris, 2016; Redlawsk et al., 2017). Whiteley et al. (2018), and Altomonte et al. (2019) both address negative collective emotions as an “aggrievement” or a “resentment”, which would spread widely in the community and lead to increased voter turnouts, and affect mobility through such dissatisfaction. Therefore, this shows that if the district has a positive identity that households are more attached to, they would be willing to relocate

within the same district. However, there is n significance found in the CBD areas. Due to the insufficient supply of quality houses (23.39% of the HQ in Table 2) with influence of housing quality (coef. 0.2044***) from our model, migrants are forced to move away from their original area of residence.

Secondly, household attributes, represented by variables such as dependency ratios and the average age of the household head, signify the adaptability of households to relocate. The results indicate a positive correlation with the IDMMR in both the metropolitan and central areas, significant at the 1% level. The results indicate a positive correlation with the IDMMR in both the metropolitan and central areas, significant at the 1% level. Seek (1983) and Clark (2013) highlight that housing adjustments occur due to pressure on living space throughout the changes of the life-course of a family. Elderly households and households with children are often less motivated to move (Jiang and Wu, 1994; Hsueh and Tseng, 2004), and seek stability over relocating due to mobility costs.

However, the relatively low IDMMR in TC raises concerns, possibly due to housing quality and affordability issues. Our analysis suggests that migrants prioritize adequate housing conditions (coef. 0.2044***), yet Table 2 indicates low housing quality at 23.39%. This shortage not only reflects an insufficient supply of quality housing but also a decline in the current housing conditions. Moreover, districts with lower IDMMR ratios have higher housing prices and larger deviations, thus impacting the affordability of quality housing and necessitating moves to other districts.

In the NTC, the dependency ratios show significance at the 10% level, thus negatively impacting the IDMMR, while there is no significant effect on the average age of the household head in the surrounding suburbs (NTC). It is interesting that households in the NTC tend to be younger with fewer dependent family members, as observed in Table 2. Specifically, the dependency ratio exhibits a coefficient of -0.4067, which negatively impacts IDMMR in the NTC. Consequently, household attributes appear to influence relocation decisions, with households showing a willingness to move to districts with a positive place identity (coef. -0.1652***) and accessibility (coef. 0.0014***).

Third, the housing quality has a positive effect at the 1% significance level in the TMA, at a 5% significance level in the central areas (TC), but has no significance in the surrounding suburbs (NTC). As the variable denotes that the ratio represents better quality housing at the district level, households will have more choices for their relocation, which entices households to remain in the same district that feeds back to the residential area often voluntarily and when compelled by housing market conditions (Strassmann,1991; Dieleman et al., 2000; Ommeren and Leuvensteijn, 2005).This also indicates that housing quality is critical, with a high coefficient value for the decision of households to relocate to the TMA and the central area, despite the shortage of land for new

dwelling developments, thereby reinforcing management is a key factor in housing quality (Ahlbrandt and Brophy, 1976; Horng and Chang 1993; Bruin and Cook 1997; James and Carswell, 2008). However, it has no significant effect on the surrounding suburbs that may be affected by other factors.

Fourth, housing prices can be represented by both household affordability and a combination of district accessibility and amenities (Ball and Kirwan, 1977; Zondag and Pieters, 2005; Song and Sohn, 2007). The results reveal positive effects that are significant at the 1% level in the three models. Therefore, households prioritize their housing relocation within the same district based on housing utility, location or transport utility, amenities, and affordability (Ma and Lo, 2012; Li et al., 2012, 2013). Furthermore, we use the variance of housing prices from the highest housing price in the district as an indicator, and the IDMMR is lower in districts in the CBD areas, thus indicating that migrants could be influenced by other factors.

Fifth, in addition to the panel-data analysis that controls the variance for the district and time-series effects, the analysis also enables the observation of the impact of district (individual-specific) and time-series effects on intra-district residential mobility. Figure 4 presents the coefficient for each district. The majority (22 of the 32) of the districts are significant at the 10% level, thus indicating district time-invariant effects, which suggest higher intra-district residential mobility. However, the lack of significant effects in the 10 districts presents an interesting phenomenon. For instance, Da'an and Xinyi, located in the CBD area with the highest housing prices and low housing affordability, suggest that residents may belong to an upper social class, which could manifest their mobility patterns differently. Yonghe and Zhonghe, as old districts close to the CBD with the highest population density, have experienced forced residential mobility across districts, while the 6 other districts are on the fringe of the metropolitan area[19]. The mobility pattern among these districts is largely market-induced.

Figure 5 shows the coefficients of the time-series effects from 2010 to 2020, with 2009 as the reference year. Most years show values above the 10% significance level, expect for 2014 and 2021. These effects reflect the overall metropolitan infrastructure development, housing market conditions, and policy trends. The expansion of the MRT into the fringe areas since 2000 has reduced transportation time to the CBD areas[20]. Urban renewal efforts from 2010 to 2019 aimed to boost local housing supply, thus influencing observed trends. From 2009 to 2014, low home-loan rates due to the ripple effect of US financial crisis led to a dramatic rise in housing prices, which discouraged intra-district residential mobility. Speculation-driven housing markets prompted the

[19] The 10 districts with no significant effects are Da'an, Xinyi, Zhonghe, Yonghe, Wugu, Bali, Linkou, Shulin, Xizhi, and Taishan.
[20] Sources from Metro Taipei and its website https://english.metro.taipei/

Taiwanese government to introduce regulations like a 15% "luxury tax" on house sales after a year, that is, starting in 2012. By 2016, a 45% tax on profits from house sales within a year was implemented. Housing prices stabilized from 2015 to 2020, thus facilitating intra-district residential mobility. The COVID-19 pandemic further heightened mobility concerns, thus reflecting macro-economic and real estate market impacts on housing decisions.

5. Conclusion

Previous studies have either focused on the economic opportunities at the regional level or emphasized the influences of housing relocation individually. With specific data, we further discuss the determinants of residential relocation based on the variances among districts in metropolitan areas and verify the patterns by using the concept of residential mobility. By analyzing the intra-district residential mobility to mobility ratio (IDMMR), which highlights the rivalry among migrants, we have determined household housing relocation attributes by using variables related to the adaptability of household relocation, household economic condition/affordability, housing stock and quality, and place identity.

The empirical results indicate that household attributes and affordability have positive effects on the IDMMR at the 1% significance level. Additionally, place identity reflects the well-being of the residents, with the variable measuring collective unpleasant emotions thus showing a negative effect at the 1% significance level. Thus, place identity also exerts a positive influence. Examining the coefficients of each variable, we find that housing quality, place identity, and the dependency ratio are crucial factors, while family economic conditions have less influence, likely due to the high rate of owner-occupied housing in the TMA. Although districts with higher housing prices (indicating better accessibility and amenities) tend to increase the IDMMR, the ultimate purpose of relocation is to improve living quality. Therefore, housing re-adjustment is triggered by the life course of the household.

Additionally, the significance levels of most districts are at least 10%, thus indicating the presence of district time-invariant effects. The IDMMR tends to be higher in districts located closer to the center of the metropolitan area. However, districts on the fringe of the metropolitan area appear to be insignificant, likely due to the mobility pattern being highly influenced by market forces. From a time-series perspective, it is observed that the economy and real estate market only slightly affect households in terms of housing relocation or re-adjustment in intra-district residential mobility.

For further study, this paper determines the factors that affect mobility patterns in the metropolitan area with more delicate data. Our study finds that place identity has a significant impact on intra-district residential mobility. However,

some variables, such as social network and personal circumstances, cannot be quantitatively measured. Therefore, there is room for further research in this area.

Finally, this study has identified notable differences between the central areas and fringe suburbs. Through a fixed-effects panel-data analysis, certain variable distinctions have been absorbed into the district (individual-specific) time-invariant effects. Consequently, the variance of district effects, particularly in the fringe areas, remains to be fully determined. These findings provide direction for further research on mobility patterns in the metropolitan areas within the field of urban studies.

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