Continued Migrant Mobility: Analyzing the geographic mobility of immigrant populations beyond the international migration context

Neal Marquez

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Reading Committee:

Sara Curran, Chair

Emilio Zagheni

Peter Catron

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Abstract

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Neal Marquez

Chair of the Supervisory Committee:
Professor Sara Curran
Department of Sociology

The late 20^{th} century rise in international migration to the United States (US) brought with it an abundance of novel scholarship and theorizing regarding what drives movement across international borders. Conversely, studies of internal migration, and internal mobility more generally, have not received the same abundance of attention, despite being a much more common form of mobility and having many commonalities with international migration. This dissertation contributes to the body of work that analyzes more frequent forms of migration and mobility and linking it to instances of international migration. By studying the ”continued mobility” of immigrants, I highlight how immigrants continue to face pressures which shape their mobility in a way that is unique from native populations. I draw on literature from the domains of internal migration and international migration to highlight how international and internal mobility are tied to one another. In the first chapter, I analyze how the changing relationship of in- and out-migration between Mexico and the US has contributed to an acceleration of aging of the Mexican-born population in the US. While

previous studies have noted that migrants coming from Mexico tended to be older in more recent years, I find that the vast majority of the aging among the Mexican population in the US can be attributed to declines in the ratio of in-migrants to out-migrants. Accelerated aging will have many impacts on the Mexican-born population, including contributing to internal mobility declines as older individuals are less likely to migrate than younger individuals. Second, I analyze how aging and changes in the socio-demographic positioning of the Mexican-born population have contributed to US internal migration decline. I find that internal migration rates of the Mexican-born population have substantially fallen in the past two decades, far more than has been observed in other populations. While aging of the Mexican population explains some of this decline, the effects have been observed across all socio-demographic groups within the Mexican-born population and highlight how factors used to explain migration decline in the US more generally are insufficient to explain the decline observed in the Mexican population. In the final chapter, I move away from studying migration to focus on day-to-day mobility, or activity space. This study compares the activity space patterns of both migrant and native populations and finds that the activity space of immigrant populations is segregated from native populations in a way that is unique from other measures of segregation.

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Chapter 1

INTRODUCTION

International migration has been on the rise since the late 20$^{\text{th}}$ century alongside a growing body of research examining what drives mobility across international borders (Haas et al., 2020). While the number of international migrants is higher now than it has ever been in the past, international migration is still a relatively rare event. International migration is a selective process and less than 5% of the population lives in a nation-state outside of the one in which they were born (Ellis, 2012). Compounding this problem of rarity, data about international migration are often lacking, due to monitoring systems being absent (Massey, 1987), or of poor quality, because of inconsistent definitions across countries and over time (de Beer et al., 2010). Taken together, the relative rarity of international migration events and the questionable quality of data makes international migration a difficult phenomenon to examine empirically. In spite of this, international migration remains a topic of repeated study (Haas et al., 2020).

Receiving considerably less attention in the academic literature are alternative forms of mobility that occur within the bounds of a single nation-state. Mobility is an ongoing process as individuals move between physical locations constantly in their day-to-day lives (Cagney et al., 2020). These movements can be relatively small and short-lived, such as movements between residence, work, school, social gatherings, etc., or more long-distance permanent moves, such as changing place of residence within a country. Relative to international migration, this within-country mobility occurs much more frequently, making it easier to observe (Skeldon, 2017). Furthermore, data on internal mobility are often more abundant and of better quality than international migration data, as reporting systems tend to be managed by one agency rather than by multiple agencies from different nation-states. In spite of these factors, international migration receives more academic attention compared to other more common forms of mobility (Ellis, 2012). In order to help bring attention to other forms of mobility, several authors have advocated for ways in which research concerning international migration might be linked to more general forms of mobility (Ellis, 2012).

In this dissertation, I bridge the gap between general studies of mobility and international migration studies by focusing on the continued mobility of immigrant populations. Continued mobility, for this dissertation, refers to short- or long-distance geographic movement, which occurs among immigrant populations after the initial international migration event. The barriers to mobility that immigrant populations face with regard to international migration do not cease once the border is crossed. Migrants continue to face hurdles in their ability to gain residence in desirable neighborhoods (Hall and Stringfield, 2014), healthcare (Martinez et al., 2015), and access to a number of social services (Borjas, 2011), all of which impact their geographic mobility. By leveraging data on the continued mobility of migrant populations, this dissertation analyzes the ways in which the mobility of immigrants changes over time and differs from native populations. I begin this dissertation with a brief rationale for why studying the continued mobility of immigrants can inform our understanding of what drives mobility more generally, including international migration. I then give a brief outline of each dissertation chapter and how they contribute to the mobility literature. This introduction is then followed by each dissertation chapter in full. I conclude with a discussion of the findings of this dissertation and future directions of research.

1.1 International Migration and Continued Mobility

While research concerning internal mobility has largely been isolated from research regarding international migration (Skeldon, 2017), migration scholars have long been advocating for a more unified approach (Salt and Kitching, 1992). King and Skeldon (2010) point to the great number of commonalities between internal migration, residential moves within a country, and international migration. Distance, legal, linguistic, and cultural barriers all can be part of both international as well as internal migration. In addition, international migration is often linked to internal migration, with forces impacting one also affecting the other (Ellis, 2012). Literature linking internal and international migration is relatively sparse; studies on linked migration flows require information about international and internal movements often captured by different data systems.

A disproportionate amount of this linked internal/international migration literature considers migration involving Mexican-born individuals moving within Mexico and between Mexico and the US (King and Skeldon, 2010). Moves within Mexico and from Mexico to the US have been found to be closely related to one another. For example, in a study of migrants in Oaxaca, Zabin and Hughes (1995) found that most individuals migrated to another state within Mexico prior to emigrating to the US, a process often referred to as step-wise migration (Paul, 2011). Evidence of step-wise migration was also found along the Mexican border, as individuals would migrate across Mexico to border states before migrating to the US (del Rey Poveda, 2007). Beyond step-wise migration, links between international and internal migration exist in the form of shared pull factors, factors which draw migrants to a particular location from other locations. Davis et al. (2002) find that networks are an important factor in determining both international and internal migration of Mexican migrants and other studies have found the presence of a network in a particular destination will pull individuals to either an internal or international destination, highlighting potential competing risks (Lindstrom and Lauster, 2001).

The aforementioned literature makes connections between international and internal migration using data collected from respondents in Mexico and linking those respondents either to previous migration events or to connections currently in the US. Leveraging the fact that Mexico and the US have had the largest migration flow between any two countries in recent history, survey questions pulled from the Mexican population can also inform researchers about a sizeable portion of not just internal migration but also international migration between Mexico and the US (Massey et al., 1987). It stands to reason then that drawing comparisons between international and internal migration can be done by also focusing on the Mexican population residing in the US. Indeed, several studies have taken this approach and analyzed internal migration in the US as it relates to US internal migration of Mexican-born migrants. Most of this research has centered on the topic of new destinations–locations that saw large increases in the Mexican-born population in the late 20th and early 21st century (Singer, 2004; Flippen and Farrell-Bryan, 2021). The rise of new destinations sparked a debate about whether Mexican-born individuals were moving to new locations in the south and southeast directly from Mexico (i.e., international migration) or from traditional destinations in the US (i.e., internal migration). Evidence of both internal (Card and Lewis, 2005; Ellis and Goodwin-White, 2006) and international migration (Riosmena and Massey, 2012) highlighted that international and internal migration in the US are intrinsically linked.

1.2 Overview of Chapters

This dissertation continues the discussion of the interconnectedness of international migration and other forms of mobility in several ways. Each of the papers analyzes the mobility patterns of international migrants who reside within the US. I leverage the fact that immigrants are subject to a different set of migration and mobility forces than native populations and that these differences manifest in measurable ways across different forms of mobility. Each paper focuses on a different scale of mobility ranging from international migration to daily mobility but each paper deals with factors that relate international migration, and the status of international migrants, to other forms of mobility. Furthermore, these studies differ from previous studies in that they are predominately concerned with declines in mobility rather than increases in mobility. As mentioned previously most research linking internal and international migration focus on Mexican-born individuals migrating to the United States which, until recently, has been increasing over time. In these papers, I will be analyzing mobility on the decline and the isolation of populations. In my first two chapters, I focus predominately on the Mexican-born population while the third chapter looks at the mobility of migrants more generally.

In chapter one, I analyze how recent declines in net international migration from

Mexico to the US have contributed to a dramatic aging of the population. If net-migration remains low, we should anticipate a dramatic aging effect of Mexican-born individuals who remain in the US. The aging of the Mexican-born population will have many consequences, not the least of which, will be a difference in the likelihood of individuals internally migrating in the US. In chapter two, I analyze how recent declines in internal migration within the US have been much more dramatic among the Mexican-born population compared to the native-born population in the US. I analyze the drivers of migration decline and compare how the Mexican-born population's internal migration decline in the US is unique from migration declines observed among other populations including the native-born population. In the last chapter, I analyze the geography of day-to-day mobility of foreign-born populations, activity space, and how it differs from native populations. In this study, I focus on the ways in which those who are foreign-born are isolated from native-born populations even in their day-to-day mobility, often referred to as activity space. I specifically analyze the ways in which mobility patterns of immigrants and native populations are segregated from one another in a way that is unique from other forms of segregation.

As a point of clarification, the first and last chapter of this dissertation use the I pronoun as they are my own personal interpretation of the work conducted in chapters 2-4. Chapters 2-4 use the we pronoun as they are the product of work contributed by myself as well as my dissertation committee.

Chapter 2

MIGRATION AND AGING OF THE MEXICAN-BORN POPULATION IN THE US

2.1 Introduction

Over the past half-century, migration from Mexico to the United States (US) has been characterized by several phases (Garip, 2016) that reflected the ever-changing social (Massey, 1988), economic (Monras, 2020), and legal relationships (Jones, 1995) between the two countries. Large peaks in migration in the 1960s and again in the 1990s led to substantial increases in the Mexican-born population in the US, making the Mexican-born population the largest immigrant population in the US (Budiman et al., 2020). In this paper, we refer to the Mexican-born population as any US resident who was born in Mexico; therefore, we include both 1st and 1.5 generations of Mexican immigrants. More recently, since at least 2010, out-migration from the US to Mexico has outpaced in-migration from Mexico to the US. This has led to annual declines in the Mexican population observed for the first time in the past three decades (Gonzalez-Barrera, 2015). Many scholars and policy analysts have focused on how migration volume leads to population growth or decline of Mexicans in the US; considerably less attention, however, has been paid to the influence of migration on the aging of the immigrant population.

Given that first-generation immigrant populations can only be sustained by continued migration, changes in the migration rate and composition of new migrant populations are the most meaningful sources of change for the demographic profile of immigrant populations. For instance, in the absence of any in-migration, we would expect young immigrant populations, such as the Mexican-born population, to substantially age because aging would only be impacted by mortality. International migration is typically biased toward young working-age populations (Massey and Espinosa, 1997) and the growth of young populations would decelerate the process of population aging. Declining rates of in-migration from Mexico to the US would then accelerate population aging. On the other hand, out-migration may lead to even more rapid population aging if those out-migrating are also young relative to the median age of the total population, or a slowing of population aging if those out-migrating are older than the median age of the total population. Recent studies of return migration to Mexico from the US have found the mean age of those returning tends to be younger than the mean age of the population remaining in the US (Masferrer and Roberts, 2012), suggesting that out-migration too contributes to accelerated population aging.

While concerns of population aging have been made with respect to the Mexican population in the US and the relationship between migration and population aging is well known, the degree to which recent changes in migration rates of the Mexican-born population have altered population aging has not been quantified. Understanding how declining migration rates, due to policy or changing economic relationships, impact population aging is vital for understanding the broader impact that changes in migration flows have on the Mexican-born population. Furthermore, the relationship between migration and population aging is important if we are to anticipate what the demographic structure, social positioning, and population needs of the Mexican-born population will be in the near future. The Mexican population has, historically, been thought of as a young population with respect to the US population (Johnson and Lichter, 2016); however, this may change in the coming years, depending on the nature of migration between the two countries.

To quantify the degree to which migration impacts population aging, we conduct a series of counterfactual simulation analyses to understand how changing migration and life expectancy rates impact the changes in the age composition of the Mexican-born population. Using data from the US Census and the National Health Interview Survey with Linked Mortality Files, we model mortality and migration rates for two periods characterized by differing volumes and composition of migration from Mexico to the US. For these two periods, we then estimate the impact migration had on population aging via counterfactual scenarios, by creating simulations of alternative timelines where migration is either not present or resembles a different time period. We compare the difference in population aging from true migration events to the counterfactual scenarios to assess both how migration from Mexico to the US contributes to population aging for the Mexican-born population as well as how changing migration volume and composition have accelerated the aging process. We assess our results and conclude with remarks about how future trajectories of population aging of the Mexican-born population are likely to occur and implications for health and social policy.

2.2 Background

2.2.1 Migration and Population Aging

Population aging has implications not just for social science research but also for public policies. As populations age, concerns about higher rates of morbidity, increased healthcare utilization, lower financial savings, and workforce participation increase (Bloom and Luca, 2016). An intimate understanding of the process of population aging is essential not only for understanding current population needs but also for forecasting the needs of populations in the near future.

Demographers have long been concerned with the process of population aging and changes in demographic composition more broadly. In demographic theory, the concept of a *stable population* has informed the way in which demographers conceptualize population aging as a function of mortality, fertility, and migration (Preston et al., 2000). For this study, a stable population refers to a population that approaches a fixed growth rate and a constant age structure over time; thus, the population does not experience any long-term population aging. The stable population was first conceptualized by Alfred Lotka in the early 1900s and–as originally formulated–only considered a closed population (i.e., one in which migration does not occur) (Bacaër, 2011) . The conditions for a stable population only require that age-specific birth and death rates remain constant. As long as this condition is satisfied, a population will eventually reach a constant growth rate and have no population aging.

In the latter half of the 20th century, demographers and mathematicians began to explore how migration could substitute for fertility in generating a stable population. Espenshade et al. (1982) first showed that when fertility levels are below replacement, a fixed volume and age structure of immigrants will generate not just a stable population but also a stationary population, one that is fixed in its size over time. Mitra (1983) and Cerone (1987) extended these findings to show that when fertility levels are above replacement, a fixed volume and age structure of immigrants will also generate a stable population with a fixed growth rate. In (Alho, 2008), the impact of net-migration was evaluated rather than immigration. The authors established that a stable population is generated when the net-migrant count is proportional to the birth count. These studies showed that migration can act as a demographic force to stabilize the aging process of a population. While the stable population case is a useful heuristic for understanding how demographic processes can stabilize the age of a population, establishing how migration can contribute to deceleration of the population aging process requires an alternative approach.

Population aging has been a concern for many states as mortality and fertility rates continue to decline and accelerate the aging process (Goldstein, 2009). A natural question then arises of how can migration slow population aging. The findings thus far have been mixed. Within the US, the level of immigration required to substantially slow population aging is far greater than any level seen in recent history (Espenshade, 1994) and changes in the fertility rate of a population generally have a much greater impact than migration does (Goldstein, 2009). This is not to say that migration can not impact population aging, but rather that the impact is dependent on a number of factors. For example, Alho (2008) demonstrated that, for populations experiencing rapid natural decline (i.e., declining fertility and mortality rates), migration can decelerate population aging to a measurable degree. In the case of analyzing a migrant population in isolation (e.g., the Mexican-born population in the US), population aging is only impacted by migration; mortality and fertility can be thought of as 0, thus increasing the significance and importance of migration. Furthermore, the ratio of new net migrants to the total migrant population is much higher than the ratio of new net migrants to a country's total population. The larger the ratio of net migrants to the population that it is contributing to, the greater the impact the net migrant population will have on changes to the age of the population (Espenshade, 1994).

How can we then measure the impact net-migration has on aging for a migrant population? One way to analyze the effects is to account for aging as a function of the growth rates of age-specific populations, as demonstrated by Preston et al. (1989). In this framework, an aging population is defined as one in which the growth rate of those older than the current median age of the total population exceeds the growth rate of those younger than the current mean age of the total population. In the discrete case, the growth rate of age a is determined by the current size of the population at time t, the population which will survive into this age group in the future, $t + x$, and the number of individuals contributing to age group a from net-migration between time t and $t + x$. Using this formulation we can see that the impact of migration on aging is dependent on the initial size of the population to which it is contributing. Moreover, even under a constant volume and age distribution of migrants, the impact of aging will differ depending on the current size of each age-specific population. Preston et al. (1989) present methods to calculate the effect that a particular rate and composition of net-migration have over time; however, these values are difficult to contextualize without analyzing another population to compare the impact of migration on aging.

An alternative method to establish the effect of migration is through the use of counterfactual scenarios. The use of counterfactual scenarios to demonstrate the impact of a particular demographic process, mortality, fertility, or migration, on population change has been used since the mid 20th century (Hermalin, 1966). Counterfactual scenarios allow analysts to use a what-if framework to assess how a given population might have been different in size and demographic composition under alternative circumstances. The use of counterfactual scenarios is particularly salient for analyzing the impact of migration given that migration is a demographic process that is particularly sensitive to government regulation and that migration volume can change rapidly (Espenshade, 1994). Several studies have used counterfactual scenarios to demonstrate the degree to which migration impacts population aging (Bijak et al., 2008; Alho, 2008). A general takeaway from these studies has been that migration only has a modest impact on population aging, especially compared to fertility and mortality. In both instances however, population aging was analyzed for the total population rather than only the migrant population. With regard to aging of the migrant population rather than the total population, the effects of migration will necessarily be much larger but have not been quantified in the literature. Furthermore, for a migrant population that has experienced rapid changes in net-migration over a short period of time (e.g., the Mexican population in the US), logical counterfactual scenarios present as the different "waves" of net-migration that have occurred.

2.2.2 Mexico US Migration Waves

For the majority of the last four decades, migrants from Mexico continue to make up the largest migration stream to the US. As of the 2018 American Community Survey, it is estimated that the Mexican immigrant population exceeds 10 million individuals, making it the largest immigrant population in the US (Budiman et al., 2020). While the size of the Mexican population in the US has grown substantially over the past 50 years, the magnitude and nature of migration flows between Mexico and the US have varied greatly (Garip, 2016). Prior to 1986, migration from Mexico to the US had been characterized by both high in- and out-migration with large numbers of working-aged individuals migrating to seek economic opportunities and returning after accumulating wealth (Masferrer and Roberts, 2012). The cyclical nature of migration between Mexico and the US has led to Mexico substantially contributing to the young age workforce (Massey and Espinosa, 1997). During this period, young age individuals from Mexico could migrate to the US, work for a number of years while accumulating wealth, and move somewhat freely between the two countries. Shifting political dynamics between the US and Mexico contributed to a change in the migration flows between the countries. The passage of the Immigration Reform and Control Act of 1986 (IRCA) led to increased spending on Border Patrol enforcement by the US in order to curb undocumented migration (Massey et al., 2015). Despite the passage of IRCA, migration from Mexico to the US continued, in part due to declining economic conditions in Mexico in the early 1990s (Monras, 2020). As migration continued, the total Mexican-born population residing in the US sharply increased, with the population more than doubling from 2.2 to 4.4 million between 1980 and 1990 and doubling again from 4.4 to 9.3 million between 1990 to 2000.

Those migrating from Mexico to the US during this time period were largely young adults. Migration forces at the time were highly selective for working-aged individuals (Massey and Espinosa, 1997) and about 60% of those migrating to the US between 1980 and 1992 were between the ages of 19 and 34 (Durand et al., 2001). Return migration at this time was equally selective, with younger male migrants more likely to emigrate than older and female immigrants (Masferrer and Roberts, 2016). As the total Mexican population doubled from 1980 to 1990 and again from 1990 to 2000, the age structure of net migrants (i.e., the balance of those coming in and those leaving) became highly influential on the median age of the Mexican population during this time. Thus, during this period, the young working-age population was the driving factor in shaping the young demographic structure that has characterized the Mexican population over the past 3 decades (Johnson and Lichter, 2016).

By the latter half of the 1990s and the early 2000s, several important patterns began to alter both the volume and demographic composition of Mexican migrants coming to the US. First, border surveillance investments by IRCA contributed to a drop in the number of individuals return migrating to Mexico. According to estimates drawn from the Mexican Census and Mexican Population Count, the number of return migrants observed in the past 5 years declined from 346,214 to 280,051 to 238,331 for the years 1995, 2000, and, 2005, respectively (Masferrer and Roberts, 2012). The impact was greatest among undocumented immigrants for whom the initial migration process now represented a higher risk endeavor than in previous years because of IRCA (Parrado and Ocampo, 2019). As a consequence of declining return migration, Mexican migrants to the US began aging in place, contributing to a greater degree of population aging.

Second, in addition to a change in return migration behaviors, the demographic composition of migrants shifted in the 1990s and early 2000s. With the passage of IRCA, there were notable increases in the percentage of migrants who were women and children as migrations related to family reunification increased (Garip, 2016).

With more women–mostly young–and children migrating, the effect of migration decelerated the aging of the Mexican population. At the same time, with more Mexican families being reunited in the US, return migration becomes less common. During this time period, most return migrants continued to be male and single (Masferrer and Roberts, 2012). With families staying behind, their initial contributions resulted in a deceleration of population aging, however, with low rates of return migration and in the absence of continued young migration, aging in place, even of individuals who are currently young, will contribute to a graying of the total population over time.

The migration relationship between Mexico and the US was again altered in the wake of the Great Recession. The Great Recession created a gap in job availability in the US that impacted both native and foreign-born populations (Cadena and Kovak, 2016). The lack of job availability led to a drop in in-migration of the Mexican-born population while out-migration increased. By 2010, the estimated 5-year return migration count skyrocketed to nearly 1 million individuals, more than twice any return migrant count observed in the past 20 years (Masferrer and Roberts, 2012). Compounding the impact of the recession on net-migration decline was a suite of policies that were increasingly hostile toward migrant populations. Programs such as the Secure Border Initiative of 2006 greatly increased spending on border patrol and the Real ID Act of 2005 resulted in new ways to identify and criminalize migrants. With these increased surveillance efforts, a staggeringly high number of Mexican immigrants were deported during the Bush and Obama administrations–2 and 3 million immigrants, respectively (Gutiérrez, 2019). The combination of poor economic conditions in the US and increased hostility toward migrants also deterred potential Mexican migrants from moving to the US. Taken together, the recession and an increase in hostile policies toward migrants led to an overall decline in the size of the Mexican population in the US, with more Mexican-born individuals leaving the US than entering (Gonzalez-Barrera, 2015). While this finding has been well documented, the impact of this process on population aging among the Mexican immigrant population has not been well established.

In this analysis, we aim to fill several gaps in the literature related to the effect of migration on population aging. We conduct an empirical assessment of the impact that changing migration volume and demographic composition have had on the population aging process of the Mexican Population in the US. By estimating the volume of net-migration between Mexico and the US, this study quantifies the degree to which recent changes in migration have impacted population aging. Population researchers have previously highlighted that the Mexican population in the US has been aging and migration scholars have pointed to how changes in migration composition might be impacting aging. Nevertheless, the magnitude by which aging has been accelerated due to changing migration patterns has not been studied, nor have the mechanisms by which migration alters aging (i.e., changing volume or changing composition) been analyzed specifically. Drawing on multiple sources of population and demographic data, we calculate age-specific mortality and international migration rates for the Mexican-born population for two ten-year periods with markedly different migration patterns: 1990-2000 and 2000-2010. Using the 1990 and 2000 census populations as baselines, we then conduct counterfactual migration scenarios to demonstrate how the Mexican-born population would have aged under different migration settings. Using these counterfactual scenarios, we divide the aging process into four components: the proportion explained by mortality, the proportion explained by the volume of net-migration, the proportion explained by the demographic structure of net-migration, and the proportion explained by the interaction of volume and composition.

2.3 Methods

2.3.1 Data and Demographic Estimates

Population data on Mexican-born individuals were taken from the 1990 and 2000 US Census 5% micro-data samples and the 2010 1-year American Community Survey (ACS). Micro-data samples are required in order to calculate the age and sex distribution of the Mexican-born population given that full data census tables do not provide such information for immigrant populations by country of origin. Following the 2000 census, the ACS replaced the long-form census and, as a result, detailed information such as country of birth is only available through the ACS. Using population weights provided by both the census and the ACS, counts of populations were tallied by sex and 10-year age groups (starting from 0-9 and ending with a terminal group of age 90+) for each year of data (1990, 2000, and 2010). In addition, for each census year, we used population weights to generate a synthetic cohort of individuals that matches the age distribution for that year but where the exact age of individuals is known. In the synthetic cohort, N_i individuals are created which exactly match the age and sex of each sampled individual i, where N_i is the population weight for individual i.

Mortality data for the Mexican-born population was taken from the National Health Interview Survey Linked Mortality Files (NHIS-LMF). The NHIS is an annual cross-sectional household interview survey conducted by the National Center for Health Statistics with the goal of tracking population health. The survey samples nearly 35,000 households and 87,500 individuals each year and collects socio-demographic variables not recorded by other health surveillance systems such as country of origin. While the survey does not conduct follow-ups, death records from the National Death Index are linked to survey responses via probabilistic matching to create the NHIS-LMF. Although linkages are known to be imperfect and incomplete, the quality of data has been assessed to be sufficient for comparative studies of mortality and the data have been used in a number of previous studies to assess the age-specific mortality rate of the Mexican-born population (Fenelon, 2017; Fenelon et al., 2017).

For our study, we model age- and sex-specific 1-year mortality probabilities for the two time periods of 1990-1999 and 2000-2009. Using survey responses from all Mexican-born individuals who were eligible for mortality linkages, we constructed a data set of person-years beginning with the first year that an individual was surveyed and ending with 2010 or the year of death for the individual, whichever came first. A total of 574,896 person-years were observed with a total of 4,941 deaths. From these data we model mortality in a Bayesian framework as a function of age, sex, and time period, where the age of an individual is categorized into ten-year age groups (a), sex is dichotomized to female and male (s), and time periods are dichotomized into years 1990-1999 and 2000-2009. We model the one-year probability of death as follows:

$$\begin{aligned} D^i_{a,s,t} &\sim \text{Binomial}(\theta_{a,s,t}) \\ \text{logit}(\theta_{a,s,t}) &= \beta_{a,s,t} \\ \beta_{a,s,t} &\overset{\text{iid}}{\sim} \mathcal{N}(0, 1000) \end{aligned} \tag{2.1}$$

Where $\theta_{a,s,t}$ represents the one-year probability of death for a given individual of age-group a, sex s, and time period t. We fit this model using a Laplace approximation to the posterior with the INLA R package. To capture the uncertainty of each estimate of one-year probability of death $\theta_{a,s,t}$, 1,000 samples from the posterior distribution are drawn for each parameter estimate.

As the NHIS-LMF only includes individuals over the age of 20, mortality rates for individuals under the age of 20 cannot be calculated. As a proxy, we use age- sex-specific mortality rates for Hispanic individuals under the age of 20 taken from the CDC Wonder database. Rates are converted to one-year mortality probabilities using standard life table methods (Preston et al., 2000). We do not calculate any measure of uncertainty for these estimates and simply always use a single point estimate. Given that, relative to other age groups, the mortality rate of this population tends to be extremely low, it is unlikely that small differences in mortality have a meaningful impact on the total age composition of the population at later dates.

Data detailing the demographic patterns of migration between the US and Mexico are lacking (Massey, 1987). While some researchers have estimated the age- and sex-specific migration flows between groups of countries in Europe using solely migration data (Raymer et al., 2011), comprehensive data between Mexico and the US is lacking. As such, rather than rely on migration data to make migration estimates, we rely on the residual method approach. The residual method leverages the demographic balancing equation, namely that the difference between one focus population between two periods of time can be explained by fertility, mortality, and net-migration. The residual method has been applied by a number of research settings to estimate the characteristics of migrants between Mexico and the US (Van Hook et al., 2006). When focusing solely on the Mexican-born population, the method is simplified in that fertility does not play a role in the population change over time and thus only mortality and migration need to be accounted for. In this study, we estimate the net-migration count from 1990 to 2010 by applying the calculated rates of annual mortality to a synthetic cohort start population, either 1990 or 2000, simulating mortality events, and removing deaths from that start population over a 10-year period. Specifically for each individual in the synthetic cohort start population we calculate a 10-year probability of death as follows

$$P(D_i = 1|a, s, t) = p_i = (1 - \prod_{x=0}^{9}(1 - \theta_{a+x,s,t}))$$

Where a is the age of the individual i at the start of the time period, s is the sex, and t is the time period of mortality probabilities. We take a single draw from a Bernoulli distribution with probability p_i where 0 means the individual survived the 10-year period and 1 means the individual died. We repeat this process for all individuals and remove from the synthetic dataset all individuals who died. The resulting population is then aged by ten years and 10-year age and sex tabulations are calculated. From the resulting population, we arrive at an estimate of the 2000 and 2010 populations had no migration occurred. We then take the difference between the mortality-only simulation and the true population for each 10-year age and sex group and use the difference as an estimate of the net-migration that occurred between the two time periods.

In order to capture the uncertainty of the mortality estimates and propagate them forward to our migration estimates, we repeat the above-outlined process 1,000 times. Using draws from the posterior for our estimates of $\theta_{a,s,t}$ we recalculate 10-year probabilities of death p_i as well as re-draw from the Bernoulli distribution, repeating the process of deaths and survivors from the start population 1,000 times. The result of the 1,000 simulation process leaves us with 1,000 hypothetical net-migrant estimates between 1990-2000 and 2000-2010 as well as 1,000 hypothetical mortality rates to accompany each hypothetical net-migrant estimate.

2.3.2 Simulation Framework

To assess the impact that migration had on population aging of the Mexican-born population, we generate a series of counterfactual scenarios altering migration rates and re-evaluating the age of the Mexican-born population. We draw on recent work assessing migration's impact on aging via counterfactual scenarios while also including the uncertainty from the mortality and migration estimates (Bijak et al., 2008; Alho, 2008).

No Migration Simulations

To form a baseline scenario, we take as our first counterfactual population, the population that is the result of zero net-migration. This counterfactual population is the population that is the result of applying age- and sex-specific 10-year mortality probabilities to the 1990 and 2000 synthetic start populations, simulating mortality events, removing those who experienced a mortality event, and aging the remaining population by 10 years. We repeat this process 1,000 times using age- and sex-specific 10-year mortality probabilities drawn from the posterior distribution of the mortality probability estimation process. For all 1,000 simulations of the 2000 and 2010 mortality-only simulations, we calculate the resulting mean age of the population and the percent of the population that is over the age of 65. The mean age of the population and the percent of the population over 65 are also calculated for the true observed 2000 and 2010 Mexican population and the differences between the two values are accepted as the effect of migration on these two age-related statistics. The mean and 95% confidence intervals are calculated for each statistic using the 1,000 simulations.

Alternative Migration Simulations

While mortality-only counterfactual simulations allow us to account for how migration as a whole contributes to population aging, migration patterns between the US and Mexico are rapidly changing. Both the demographic composition and the volume of migration impact the aging process of the Mexican-born population. As such, we conduct three sets of counterfactual scenarios using the Mexican-born population in 2000 as our baseline to disentangle the contribution of each of these factors to population aging. Our first simulation addresses the question of what would have occurred had migration had the same volume and distribution of net migrants in 2000-2010 as what was observed in 1990-2000. First, we take the 1,000 simulations of net-migration 10-year age- and sex-specific tabulations of net-migration for 1990-2000. For each simulation and each cell table, we sample a number of individuals equal to the net-migrant count from the true 2000 population that matches the 10-year age and sex of the cell table. This sampling generates a synthetic net-migration cohort that matches in volume and demographic distribution the estimates of the 1990-2000 net-migrant population. Each of these simulated net-migrant populations is then added to the mortality-only simulations for the 2010 population. Together, these simulated populations represent the counterfactual scenario of the Mexican population observed in 2010 had migration counts and composition remained constant from the 1990-2000 period while mortality rates were as observed for this period. We label this counterfactual scenario the high-migration young-age scenario.

As stated earlier, between 1990 and 2010 a number of factors led to dramatic changes in the volume and composition of the population migrating between Mexico and the US. To disentangle how both volume and distribution contributed to changes in the aging of the Mexican-born population, we conduct two additional counterfactual scenarios. In the first scenario, we take 1,000 simulations of the 10-year age- and sex-specific tabulation of the 1990-2000 net migrants and scale the table such that the total population size matches the number of net migrants observed in the 2000-2010 period. From the 1,000 adjusted tables, we sample a number of individuals from the true 2010 synthetic cohort population that match the table demographics and add this sample to the mortality-only simulations for the 2010 population. This counterfactual scenario represents the case where the total net-migration demographic composition was as actually observed in 2000-2010 but with the demographic structure of the 1990-2000 migrants. We label this counterfactual scenario the low-migration young-age scenario.

In the second scenario, we take 1,000 simulations of the 10-year age- and sex-specific tabulation of the 2000-2010 net migrants and scale the table such that the total population size matches the number of net migrants observed in the 1990-2000 period. From the 1,000 adjusted tables, we sample a number of individuals from the true 2000 synthetic cohort population that match the table demographics and add this sample to the mortality-only simulations for the 2010 population. This counterfactual scenario represents the case where the total net-migration demographic composition was as actually observed in 1990-2000 but with the demographic structure of the 2000-2010 migrants. We label this counterfactual scenario the high-migration old-age scenario.

We compare each of the counterfactual scenarios above–high-migration young-age, low-migration young-age, and high-migration old-age–to the true observed 2010 population which can be thought of as the result of migration that is low-migration old-age. The difference between the aging effects of the true 2010 population and the high-migration old-age scenario represents the effects on aging only due to migration volume. The difference between the aging effects of the true 2010 population and the low-migration young-age scenario represents the effects on aging only due to migration composition. Lastly, the difference between the aging effects of the true 2010 population and the high-migration young-age scenario represents the joint effects on aging due to both migration composition and volume.

All analyses were run using R version 4.2.1.

2.4 Results

From 1990 to 2010 the Mexican-born population grew substantially from 4.4 million individuals to 11.8 million individuals. Between 1990 and 2000, we estimate that 180,286 (95% CI 67,334-193,384) deaths occurred among the population while 5,096,704 (95% CI 5,083,753-5,109,803) more migrants were added to the population through positive net-migration. Between 2000 and 2010, we estimate that 339,716 (95% CI 327,400-353,827) deaths occurred among the population while e 2,978,50 (95% CI 2,966,190-2,992,616) more migrants were added to the population through positive net-migration.

Figure 1 shows the age and sex distributions of the Mexican-born population in 1900, 2000, and 2010. From 1990 to 2000 the Mexican-born population increased by

112%-from 4,409,033 to 9,325,452 individuals. Between 2000 and 2010, the population continued to grow; however, that growth was much more modest, only an increase of 28%, moving from 9,325,452 to 11,964,241 individuals. For all years, the number of Mexican-born males exceeded that of Mexican-born females. The ratio of males to females declined from 1.22 in 1990 to 1.15 in 2010. Furthermore, although males outnumbered females across the population as a whole, Females outnumbered males in all age groups 65+ by 2010. The median age of the Mexican-born population was 31.7, 32.6, and 38.0, in 1990, 2000, and 2010, respectively. The proportion of the population aged 65 and older was 4.84, 4.07, and 6.26, in 1990, 2000, and 2010, respectively.

Figure 2 shows the age- and sex-specific 10-year mortality rates for the Mexican-born population from the two time periods of this analysis. Age groups younger than 20 are not shown in the graph as the data were not derived from the NHIS-LMF data and have low values compared to other age groups. For each age group, female mortality was lower than male mortality. Mortality in the 1990-1999 period tended to be lower in younger age groups and nearly the same in older age groups when compared to the mortality rate of 2000-2009.

Figure 3 shows the age- and sex-specific 10-year migration counts for the Mexican-born population from the two time periods of this analysis. Total migration dropped by 39.5% from the 1990-1999 period to the 2000-2009 period as migration fell from 5,119,435 persons to 3,096,493 persons. Migration counts in 1990-1999 were generally higher for younger age populations and lower for older age populations than in 2000-2009. In 1990-1999, migration counts tended to be higher for males compared to females across almost all age groups. In the 2000-2009 period, migration counts

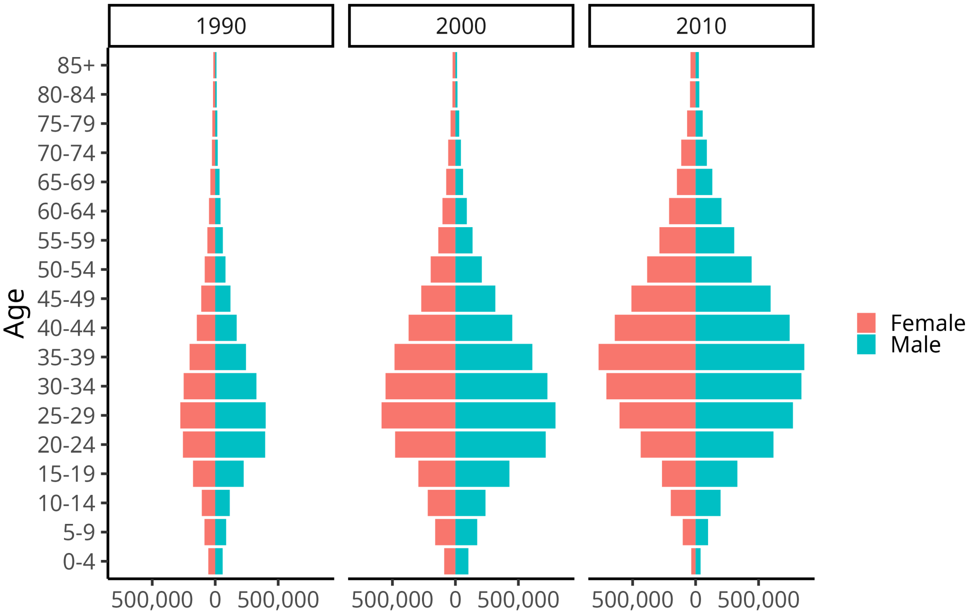

Figure 2.1: Population pyramids for the Mexican-born population over three census periods, 1990, 2000, and 2010. From 1990 to 2000, the Mexican population substantially increases in size but remained relatively young. From 2000 to 2010, the population grew at a much slower rate while aging occurred more rapidly.

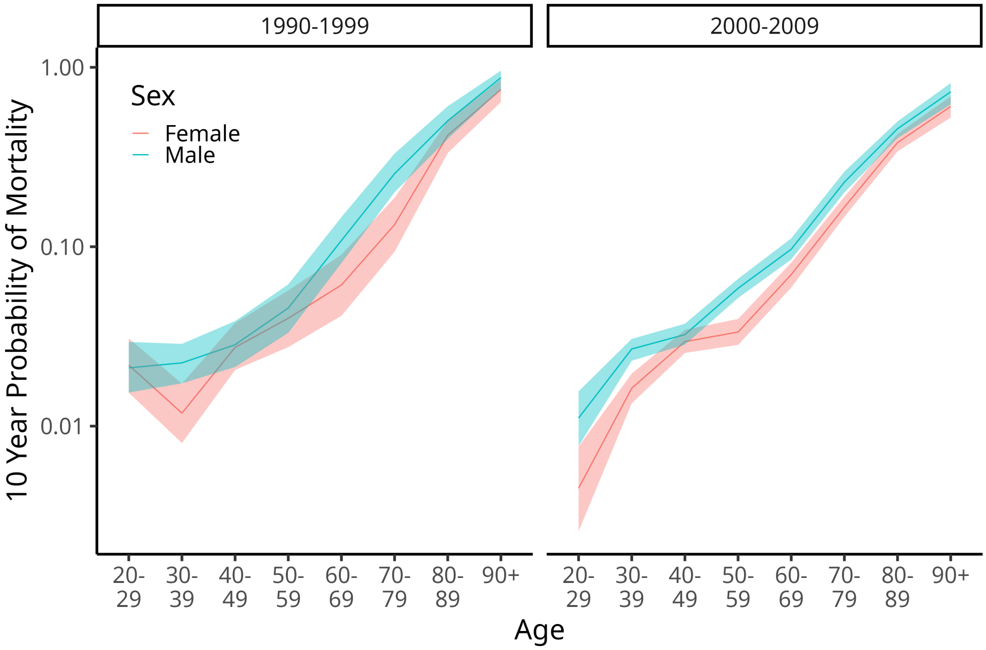

Figure 2.2: Age-specific mortality rates for the Mexican population in the US. Age-specific rates are calculated separately for males and females for two separate 10-year periods, 1990-1999 and 2000-2009.

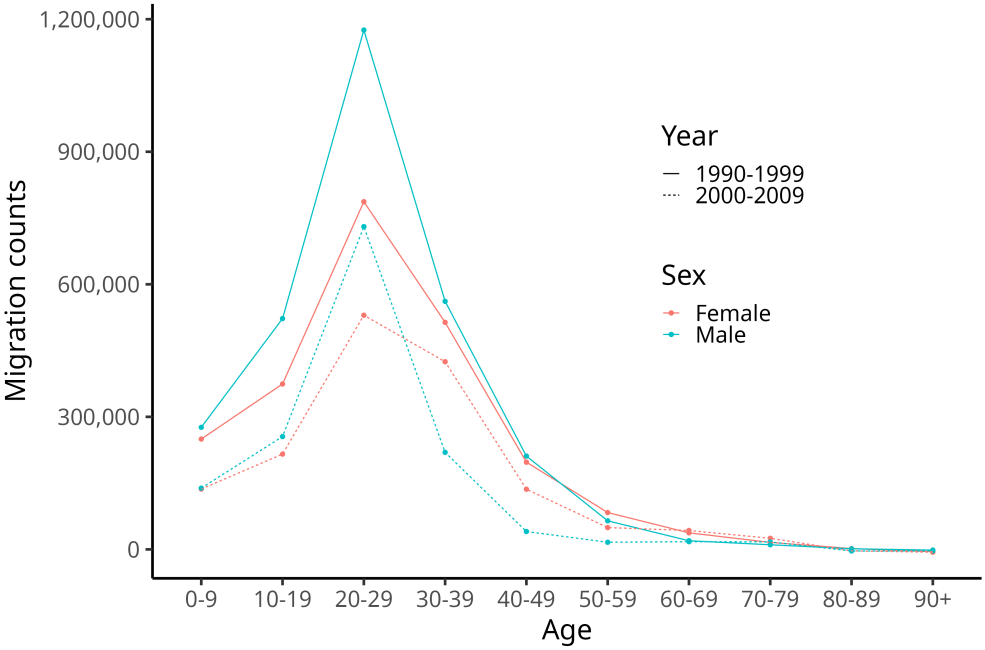

Figure 2.3: Age-specific migration counts for the Mexican population in the US. Age-specific counts are calculated using the residual method from mortality counts estimated from NHIS-LMF.

tended to be higher for males in younger age groups and higher for females in older age groups. Note that, in older age groups, net-migration tends to be negative, with more people migrating from Mexico to the US than in the other direction.

Figure 4 again shows the population pyramids for the Mexican-born population for the years 2000 and 2010, this time comparing the population from the mortality-only counterfactual scenarios. In 2000, the population estimate was 9,325,452 in the observed data while the estimate was only 4,204,937 in the mortality-only counterfactual scenario. In 2010, there were 11,964,241 in the observed data while there were only 8,864,415 in the mortality-only counterfactual scenario. The median age of the Mexican-born population was 40.8 and 41.9 in the 2000 and 2010 counterfactual sce-

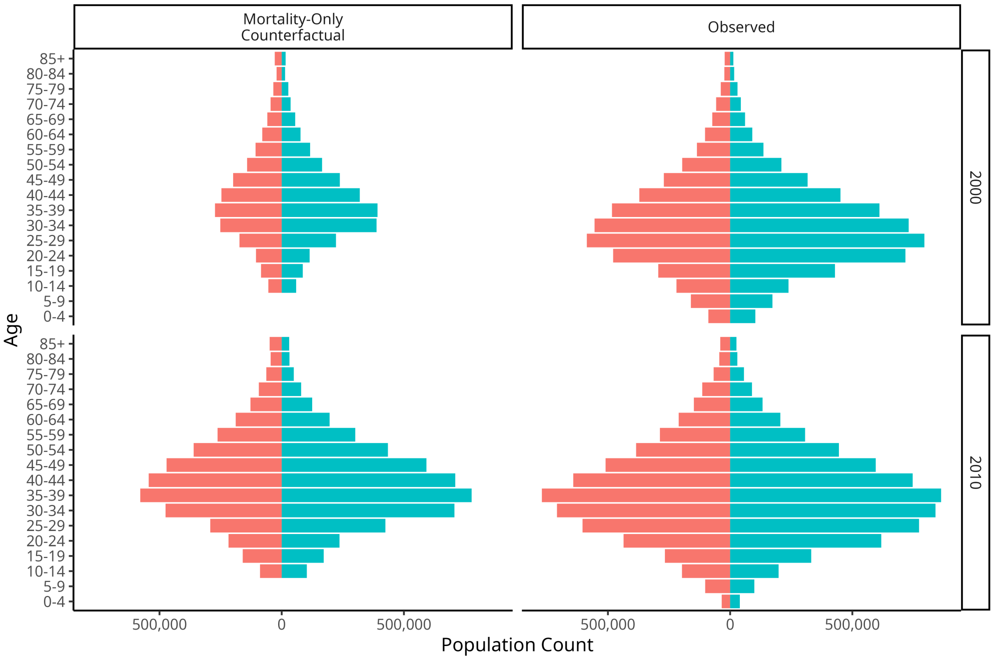

Figure 2.4: Population pyramids for observed and no migration counterfactual scenarios for the Mexican-born population. In both 2000 and 2010, the observed amount of population aging was substantially less than what would have occurred had no net-migration happened, and mortality rates remained constant.

narios, respectively. In the absence of migration, the population median age increase from the previous census period was 9.1 years from 1990 to 2000 and 9.3 years from 2000 to 2010. Using these values, we find that migration slowed population aging by 8.2 years from 1990 to 2000 and 3.9 years from 2000 to 2010.

Figure 5 again shows four population pyramids, all for 2010. The bottom right panel is the estimated 2010 Mexican-born population taken from the ACS. The top left panel represents the counterfactual scenario where the 2000-2010 volume and distribution of migrants is the same as was observed from 1990-2000. The median age in the high-migration young-age scenario was 36.1 (95% CI 36.1-36.2) with the percentage of individuals 65 and older being 5.24% (95% CI 5.17-5.31). The top right represents the low-migration young-age scenario, where the migration total volume is equal to what was observed from 2000-2010 but the age distribution resembles what was observed from 1990-2000. The median age in the low-migration young-age scenario was 37.9 (95% CI 37.9-38.0) with the percentage of individuals 65 and older being 6.02% (95% CI 5.95-6.08). The bottom right represents the high-migration old-age scenario, where the migration total volume is equal to what was observed from 1990-2000 but the age distribution resembles what was observed from 2000-2010. The median age in the hi-migration old-age scenario was 36.2 (95% CI 37.9-38.0) with the percentage of individuals 65 and older being 5.59% (95% CI 5.55-5.62). From these counterfactual scenarios, we find that changing migration patterns from the 1990-2000 period to the 2000-2010 period led to a 1.9-year increase in the median age of the Mexican population with 95% of the aging explained by the change in volume of net-migration rather than the age distribution of migrants.

2.5 Discussion

Our analysis documents what many other studies have theorized but not quantified: that migration from Mexico to the US has a significant effect on the population aging process of the Mexican-born population. In the absence of migration, our study finds that the Mexican-born population would have aged 9.1 years between 1990 and 2000 and 9.3 years between 2000 and 2010–much greater than the actual observed aging of 0.9 years and 5.4 years, respectively. Migration as a process keeps the Mexican-born population young by bringing in new, younger individuals and, also, by out-migration of older populations that return to Mexico.

Migration's impact on population aging, however, is waning, and a reduction in

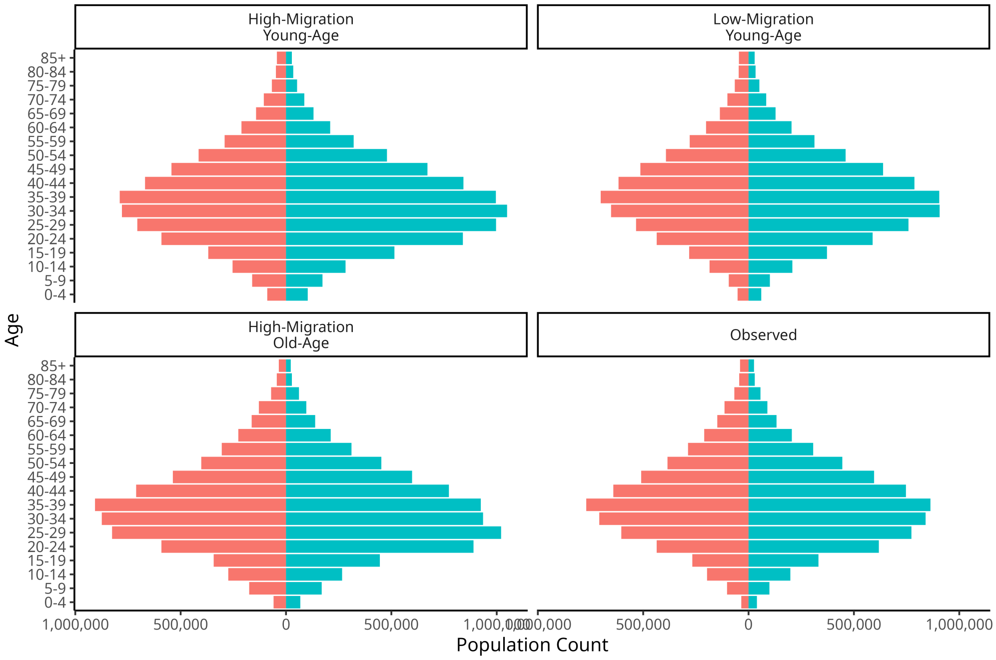

Figure 2.5: Population pyramids for observed and migration counterfactual scenarios for the Mexican-born population in 2010. Counterfactual scenarios show that aging of the Mexican population was predominately driven by a decline in migration rather than a change in the composition of migrants.

the migration volume and increasing age of migrants has led to an increase in how much the Mexican population has aged over time. From 1990 to 2000, migration led to a population age reduction of 8.2 years; however, from 2000 to 2010, the reduction in median population age was only 3.9 years. Previous literature has established that, in addition to the migration rate being reduced from 1990-1999 to 2000-2009, the age and sex of migrants also shifted during this time period due to increases in migration driven by family reunification and greater out-migration of the working-age population. Our analysis highlights that, indeed, both the decline in the volume as well as the increase in age had an impact on the increase in population aging observed in the Mexican-born population. The effect sizes of these processes are, however, uneven. A much greater effect is attributed to the change in migration volume compared to the age structure of those who were migrating. Had the migration volume and age structure remained unchanged from 1990-1999 to 2000-2009, the Mexican-born population would have only aged 3.5 years from 2000 to 2010. Had there been changes to the migration volume but not to the age distribution of the 1990-1999 migration cohort, the Mexican-born population would have aged by 5.3 years, only .1 year less than what was actually observed.

Calculating the degree to which migration contributes to population aging of the Mexican-born population is difficult because of the lack of data that exists surrounding migration estimates. Our study is able to circumvent that limitation by using nationally representative survey data on the mortality of the Mexican-born population, leveraging the tenants of the demographic balancing equation, and using demographic simulation. We were thus able to incorporate uncertainty into our estimates of migration and be more confident about migration's impact on population aging. Such a methodological approach need not be limited to the Mexican population nor just international migration, as state-to-state internal migration can likely be similarly estimated given that the NHIS-LMF provides state-level indicators for mortality as well.

Given that several groups have recently estimated that migration from Mexico to the US has continued to decline (Gonzalez-Barrera, 2015), it is likely that we will see an even greater rate of aging in the coming years. The most recent reports of aging of the Mexican-born population estimate that Mexican's median age was 43 as of 2018 (Budiman et al., 2020). While the median age of the Mexican population is younger than that of European and Canadian migrants, the rate at which the Mexican population is aging makes it likely that they will pass the median age of other groups in the next several decades so long as low rates of migration continue. This change would represent a dramatic shift in the Mexican-born population in terms of their social positioning. With regard to the well-being of the Mexican population, aging processes put Mexican migrants in a particularly vulnerable position due to their immigrant status. Morbidity rates have been found to be higher for Mexican-born individuals than native individuals at older ages, meaning that, although Mexican migrants have longer life expectancy compared to their native-born peers, they tend to have worse health at older ages (Hayward et al., 2014; Levchenko, 2021).

A number of factors are likely contributing to this worsening health at older ages. Low rates of healthcare utilization throughout the life course likely play a role, given that the Mexican-born population tends to not have the same level or ease of access to health providers as native populations (Montes de Oca et al., 2011). In addition, research shows that, due largely to a lack of savings (Aguila et al., 2021), Mexican-born individuals have higher rates of employment at older ages when compared to the native population, which likely results in additional physical stress that leads to worsening health. Though labor force participation rates at old age are higher for the Mexican population compared to other populations, aging still brings about retirement for many individuals. With respect to the labor force, the aging of the Mexican population means a larger share of the population will not be actively employed–a trend which will ultimately reduce the uncharacteristically high labor force participation rate of the population (Aponte, 1996). Such a shift will have a large impact on employment sectors that rely heavily on the Mexican-born labor force such as agricultural and service industries (Ellis and Wright, 1999).

Continued aging of the Mexican population will also have strong implications for demographic research. Currently, the Mexican population is largely thought of as relatively young and exhibiting characteristics of young populations, such as being highly mobile and with a high fertility rate. As the median age of the Mexican population increases, we should expect to observe strong declines in both fertility and mobility.

Our analysis is not without its limitations. First, both data sources used in this analysis, the ACS and the NHIS-LMF, are nationally representative surveys of the US population conducted using household random samples. While in theory these surveys should be representative of the US population, and subgroups such as the Mexican-born population residing in the US, evaluations of surveys in the US have reported under-representation of some groups, and in particular foreign-born Hispanic young adult males (Jensen et al., 2015). Survey weights are meant to correct for some portion of this, however, weights are not constructed separately for the foreign-born population for surveys conducted by the US Census Bureau. As such, surveys are likely biased in their estimates for the size and mortality rates of the Mexican-born population. Second, our use of the demographic balancing equation to estimate net-migration allows us to calculate an estimate of net-migration without explicitly measuring the migration process. A downside to this approach is that this study does not capture how flows independently contribute to population aging. Net-migration is the sum of the in-migration and out-migration flows of individuals moving between Mexico and the US. Both of these contribute to population aging in unique ways; however, this study is unable to capture those contributions. Migration flows are considerably more difficult to measure and estimate compared to net-migration; however, methods to estimate migration flows do exist, even for data-limited contexts such as the US (Abel, 2013; Abel and Sander, 2014; Raymer, 2007). Future studies should seek to decompose the impact of in- and out-migration on total population aging for the Mexican-born population.

Migration from Mexico to the US has been characterized by peaks and valleys over the last century, driven by various changes in push and pull factors between the two countries. It is likely that migration rates will, at some point in the future, rise again and reduce the process of population aging that is currently occurring. If current international migration trends continue, we should anticipate a mean population age increase of nearly five to six years every decade. The future graying of the Mexican population will greatly impact the health and wealth status of Mexicans in the US and accommodations should be made to prepare for such aging.

Chapter 3

MEXICAN INTERNAL MIGRATION IN THE AGE OF MIGRATION DECLINE

3.1 Introduction

Recent declines in internal migration in the United States (US) have sparked a debate about what might be driving increased immobility (Foster, 2017). Over the past half-century, internal migration rates have steadily declined, with state-level migration falling by more than 50% across the US population. Proposed factors accounting for these declines in migration range from socioeconomic factors, such as changing rates of homeownership (Molloy et al., 2011), costs of immigration, and the return on investment of immigration (Molloy et al., 2014), to demographic factors, such as the aging of the US Population (Karahan and Rhee, 2014) and a rise in the foreign-born population (Molloy et al., 2011). A primary assumption in studies related to the decline in internal migration is that factors driving migration decline impact populations in a similar way. For different subgroups, however, the factors affecting migration may differ due to a difference in risks and benefits associated with migration.

Studies analyzing internal migration decline have differentiated between foreign-born and native-born populations, however, large differences in migration patterns are likely to present within the foreign-born population as well. Foreign-born sub-populations have been previously found to have highly varying international and internal migration patterns by country of origin due to differences in incentives for migration (Hall et al., 2011), risk of migration (Ellis et al., 2014), and ability to migrate (Johnston et al., 2013). One such group is the Mexican-born population. In the late 1990s and early 2000s, the internal migration rates of the Mexican-born population were often studied in the context of high internal migration, driven by movement towards new destinations in the US South which were not seen among all immigrant populations (Singer, 2004). Whether the Mexican-born population was also uniquely impacted in their internal migration rates by the great recession and increasing hostility towards migrants, however, has yet to be analyzed.

Studies examining declines in internal migration rates as well as factors contributing to such a decline in the Mexican-born population are lacking. The Mexican-born population is often thought to be a highly mobile population; as such, it is essential to understand how their internal migration patterns have changed in the wake of more broad migration declines in the US. This understanding will inform migration research and aid local governments and agencies in understanding what drives the migration decline of the Mexican-born population.

In this study, we aim to analyze the changing rates of internal migration of the Mexican-born population in the US and how those changes differ from other US populations. We focus on internal migration patterns observed in the past 20 years when internal migration has been on the decline across the US as a whole. This study expands on previous studies in three ways: 1) We show that, while many racial, ethnic, and nativity groups have experienced declines in internal migration in recent years, the decline has been most pronounced for the Mexican-born population living in the US While internal migration rates of the Mexican-born population exceeded that of all other comparison groups in the early 2000s their current rates of migration are now significantly lower than that of other groups. 2) Declines in internal migration are not limited to a particular geographic level of analysis but, rather, are found at the state, metropolitan, and census-constructed Migration Public Use Micro-Area level. 3) Though migration rates have fallen across the US geography both rates to and from the US South have seen the greatest decline. 4) Socio-demographic shifts have contributed to a lowering of internal migration, similar to what has been observed across the US population as a whole, however, a bulk of the migration decline observed in the past 20 years is independent of these socio-demographic shifts.

3.2 Background

3.2.1 US Internal Migration Declines

Studies of internal migration in the US focus heavily on the dramatic decline in migration in recent years. Across multiple scales of geography and among native and foreign-born populations alike, migration rates within the US have fallen. It has been reported that internal migration rates in the US fell by more than 50% since the mid-20th century (Foster, 2017). The social forces driving this decline in internal migration in the US are well studied and center on two sets of factors.

The first set of factors relates to the changing population composition. These factors explain declining migration rates as a function of the growth of socio-demographic sub-groups that are less likely to migrate and relative declines of groups that are more likely to migrate. From a demographic perspective, the US population has aged significantly as individuals have a longer life expectancy and fewer children than in previous years (Bureau, 2018; Bongaarts, 1999). Older aged populations tend to migrate less often than their younger counterparts for a number of reasons and a portion of the decline in internal migration may be attributed, at least in part, to a growing share of the population being older than in previous years (Foster, 2017). While having fewer children has historically been associated with being more mobile at the family level, having fewer children also means that, at a population level, aging will occur at a faster rate, leading to greater growth of historically less mobile, older populations. In addition, the increasing diversity of the US has led to a decline in the relative share of the population who is non-Hispanic White, henceforth referred to as White (Frey, 2020). Historically, the US White population has had greater rates of internal migration than non-White populations in part due to the relatively lower returns to migration experienced by non-White populations (Leibbrand, 2019). Thus, growth of the non-White population had been thought to decrease US mobility as a whole.

In addition to demographic factors, there has also been growth among groups with social and economic characteristics that are less likely to migrate. For example, homeownership rates had generally been increasing over the past half-century (Paulin, 2018). For homeowners the costs associated with moving become greater when compared to non-homeowners because of the time and financial requirements necessary to move to a new location (Oswald, 2019). Thus, as a greater share of the population becomes homeowners in the US, we would anticipate migration rates to decrease. Similarly, the share of US households made up of more than one earner has also been increasing (Bailey et al., 2004). As many households move together (Chen, 2006), migration events require not just one individual to find new employment but several individuals, again making the cost of migration higher. Taken as a whole, these demographic and socioeconomic factors are found to contribute to a substantial portion of the migration decline (Foster, 2017).

The second set of factors relates to changes in the social and economic environment which alter migration rates of the US population at a larger scale. Molloy et al. (2011) finds that although shifts in population composition have contributed to migration declines, almost all sub-populations in their analysis experienced declining rates of migration from 1980 to 2010. In other words, all age, race, ethnicity, and nativity groups demonstrated declines in migration. Authors point to a number of broad explanations, predominately economic, that explain the declining rate of migration across sub-populations. These include increasing similarity between employment offerings across geographies in the US (Kaplan and Schulhofer-Wohl, 2017), higher housing costs (Michaelides, 2011), and a decrease in the number of individuals transitioning job types (Molloy et al., 2014). While it is certain that these factors impact migration rates for the US as a whole, the degree to which they impact sub-populations likely differ and warrant additional investigation.

It should be noted that several authors have analyzed migration rates by nativity, race, and ethnicity, and highlighted how different groups have experienced migration declines in the past half-century. As mentioned previously, Molloy et al. (2011) found that migration declines in the US were observable across a number of racial, ethnic, and nativity groups however the degree to which migration declines were observed was not explored. (Foster, 2017) found that White populations experienced a migration decline greater than that of other groups, however, nativity was not explored. With regards to nativity, some studies have found that migration rates tend to be lower for foreign-born populations, however, the degree to which this is true depends on which data source is analyzed (Foster et al., 2018). Even so, these studies examine non-native populations as a whole, missing the heterogeneity of migration experiences that exist among foreign-born populations. For the Mexican-born population, understanding the factors that drive international migration can help explain when internal migration is likely to occur.

3.2.2 International Migration and the Mexican Population

Historically, Mexican-born individuals residing in the US have had higher rates of recent migration than native-born populations (Massey and Espinosa, 1997). An argument for this pattern is that Mexican migrants are predominately economic migrants and as such are more sensitive to changes in the economy and adjust their migration trajectories accordingly (Card and Lewis, 2005). In the international context, in the past half-century migration away from Mexico was driven in part by a growing young labor force who received a lower return on investment for the labor in Mexico. At the same time, the shortage in the US labor force in agricultural and construction sectors led the US to look beyond native populations to fill missing positions. Mexican individuals filled this labor gap by migrating through both documented (i.e., via national programs such as the Bracero and visas like the H2-A/B) and undocumented means (Henderson, 2011). Economic forces brought Mexican migrants to the US, however at the same time growth of these populations was sustained in part due to social forces, namely the strength of social connections between growing locations of the Mexican population in the US and locations within Mexico.

The growth of Mexican populations in the US has not been geographically evenly distributed but instead concentrated in particular geographic regions. Early growth of the Mexican population was centered in the southwest and as the population grew in these areas, immigrant enclaves began to arise. Immigrant enclaves offer immigrants a more streamlined transition into a new host country through shared language and culture among neighbors, raising social capital that may be transformed into material capital otherwise unavailable to migrants in other settings (Phillips and Massey, 2000). The existence of a network of compatriots residing nearby who speak the same language and have the ability to connect individuals to social resources and employment leads to a cyclical migration system where Mexican-born individuals favor migration to places where other Mexican-born individuals reside, above and beyond what economic opportunities may exist (Palloni et al., 2001; Kritz et al., 2011). Because of this cycle, while migration events are common among the Mexican-born population, their destinations are more limited compared to other populations migrating within the US (Singer, 2004; McConnell, 2008).

Beyond these economic and social forces, Mexican-born individuals residing in the US are susceptible to changing politics which may put them at legal risk depending on their migration documentation status. A well-known example of this at the national level is the Immigration Reform and Control Act of 1986 (IRCA). In addition to establishing financial penalties for employers actively recruiting undocumented workers, IRCA also increased spending on immigration enforcement to further deter undocumented migration (Jones, 1995). More recently, international migration from Mexico to the US has become increasingly politicized with attacks on policies meant to protect immigrant populations, such as the Deferred Action for Childhood Arrivals, as well as politicians advocating for more extreme measures to be taken in order to deter migration from Mexico to the US (Johnson, 2019). This increased politicized attention to immigration related to the Mexican population has put them at legal risk in a way that other groups do not experience (Hughey, 2017).

3.2.3 International Theory to Internal Migration

Though much of the migration research related to the Mexican-born population has been focused on international migration, internal migration has seen more attention relatively recently. Much of this focus has been in the context of new destinations, that is locations in which migrants had not historically settled, but began to settle in toward the late 1990s and early 2000s (Singer, 2004). For the Mexican immigrant population, these new-destination locations are predominately located in the Southeast and Midwest (Kandel and Parrado, 2005; Hernández-León and Zúñiga, 2000). An early question was where Mexican individuals were migrating from prior to arriving at new destinations. One theory was that migration to new destinations was driven by migration directly from Mexico to the US This theory found evidence in the unique geographic connections which were made between new arrival destinations in the US and new sending destinations from Mexico (Riosmena and Massey, 2012).

An alternative theory was that Mexican migrants to new destinations were not coming from Mexico directly, but instead were coming from traditional destinations. The hypothesis was that new destinations offered economic advantages over traditional destinations including more abundant employment opportunities and lower rent-to-wage ratios (Card and Lewis, 2005). In a process often referred to as secondary or step migration (Paul, 2011), Mexican individuals were occupying new location locations because of the economic advantages that were to be found in these new locations (Johnston et al., 2013).

Though economic conditions were found to open up new streams of internal secondary migration of the Mexican-born population, networks have also been found to play a role in internal migration streams. Hernández-León and Zúñiga (2003) found that pioneering migrants to new destinations brought along with them their social capital and networks. This allowed for new destination enclaves to quickly grow in both population and capital. Johnston et al. (2013) argued that while declining economic prospects in traditional destinations were the initial motivator for out-migration from those locations and helped established new destinations, the development of social capital in new destinations is certainly a driving force of continued migration to these new destinations. Theories pertaining to social and economic rationals need not be mutually exclusive either as researchers have found that, in regards to internal migration, immigrant populations tend to favor locations that maximize both economic and social support (Kritz et al., 2011).

For the Mexican population, internal migration is also subject to political and legal pressures similar to that of international migration. While increased border security does not physically restrict mobility within the US, hostility towards migrants may increase the risk of migration if safety and security cant be assured. In this way, migration may be restricted by increasing negative sentiment towards migrants reflected in local policies. In contrast, negative laws may also increase migration away from locations if laws become overly hostile. Indeed, early writings related to the growth of new destinations discussed the possible impact that California Proposition 187, a proposition that would formalize screenings to limit undocumented people from accessing certain public goods, had in pushing Mexican migrants away from California (Martin, 1995). With the passage of the 2008 Legal Arizona Workers Act, an act put into place mandating employers to use an authentication system to validate the legal status of their workers, Arizona too saw increased out-migration from non-citizen non-native Latinos (Ellis et al., 2014).

3.2.4 Mexican Internal Migration in the Age of Migration Decline

The previously mentioned research focuses on explanations for increasing Mexican-born migration during the period from 2000 to 2007. However, in recent years, international migration from Mexico has declined precipitously and US internal migration has continued to decline. While it is likely that the internal migration rate of the Mexican population has fallen along with the internal migration rates of the foreign-born population in the US, no study has documented such a decline. Given that the Mexican population has unique migration pressures compared to both the US native-born and other foreign-born populations, it is worth examining how recent internal migration trends have changed, especially after the US great recession and increasing immigrant hostility. Given that Mexican migrants are predominately economic migrants whose migration experiences have been subject to political scrutiny, we expect that migration declines may be greater than observed for other groups.

In this study, we examine recent changes in the internal migration rates of the Mexican-born population residing in the US. Our study has three main goals. 1) We examine how internal migration rates of the Mexican population have changed over the past 20 years in comparison to native populations and other groups. We examine changes at multiple geographic levels of internal migration to ensure consistency of results. 2) We examine regional shifts of in- and out-migration at the state level for Mexican, native, and other foreign-born populations, examining how migration rates have changed and how those changes differ from other populations. 3) We focus on the Mexican-born population and examine how changes in the population composition characteristics have contributed to migration decline.

3.3 Data and Methods

3.3.1 Data

In order to analyze rates of internal migration in the US, we use the American Community Survey (ACS) microdata. The ACS is an annual household survey that was intended to be a more cost-efficient and regular manifestation of the census long-form. Aside from small changes to the questions that had been asked, the primary difference between the census long-from and the ACS is the sample size. While the long-form was a 1 in 6 sample, the ACS is a 1 in 50 sample of households in the US From this sample, a smaller subset of individuals is randomly selected for microdata release such that the final sample size of a single year of ACS is about 1% of the US population. The ACS microdata reports information on demographic, economic, nativity, and household information, and much of the data are collected through in-person interviews. When information cannot be obtained through interviews, various methods of imputation are used. In addition to person and household level characteristics, sampling weights are provided such that survey methods may be employed to account for random sampling error. Data from the 2000 to the 2018 ACS are used for the analysis.

For each individual, an assignment of a racial, ethnic, or nativity group is given. Individuals who are born outside the US in the analysis are placed into 1 of 4 groups based on their place of birth. These categories include Mexico, Central America, other Latin America, and a remainder category for all other foreign-born individuals. Individuals born in the US are further designated into a racial or ethnic group of Non-

Hispanic White, Non-Hispanic Black, Non-Hispanic Asian, Non-Hispanic Other, and Hispanic. Each of the 9 racial-ethnic-nativity groups described are mutually exclusive and all survey respondents receive one categorical designation.

For each individual, we define 5 migration variables designating whether that individual migrated in the past year. Each of the 5 variables designates a specific type of migration across different designated boundaries. All 5 levels are nested within each other such that if migration was observed at a higher level that it was also marked as being observed at all lower levels as the requisite boundaries required to move at lower levels are met by crossing boundaries at higher levels. The highest level of geographic scale is international. For each respondent, we denote whether they were living in a country other than the US in the previous year and assign a 1 for those who were and for those who were not. The next level is regional. To assess regional migration, we divide US states into several categories using a classification system outlined by Riosmena and Massey (2012). The classification divides US states into one of 6 categories based on region and historical Mexican migration history. The categories are Borderland, Great Lakes, South, Northwest, Great Plains, and Other. For each individual, we again assess whether they were living in a region other than the one they are currently living in and mark a regional migration event for individuals who were not living in the same region. The same process is then repeated for states to indicate state-level migration.

The next geographic level is metropolitan, where we assess whether an individual who currently lives in a metropolitan region was living in that same region 1 year ago. It should be noted that not all areas of the US are designated into a specified metropolitan area and we include as a migration event both individuals who are currently living in a metropolitan area who were not in the year prior, as well as individuals who are currently living outside of a metropolitan area but were living within one the year prior. The last geographic scale is the migration public use micro area (MPUMA). Public use micro-areas (PUMA) are mutually exclusive US Census-defined geographic areas that partition a state into areas containing no less than 100,000 individuals and are the most detailed geographic information that the US Census releases in micro-data products. MPUMAs are made up of one or more PUMAs combined together. MPUMAs are created such that additional information about migration given does not yield potentially publicly identifying information about respondents. MPUMAs are the smallest level of geographic information pertaining to migration that the US Census releases micro-data products. For each individual, we indicate an MPUMA-level migration if that individual lived in an MPUMA other than the current one in which they reside in.

In addition to migration data, additional data pertaining to what may be driving migration decline is pulled for all Mexican-born individuals. For each individual, we extract age, sex, whether the respondent is a parent to a child under the age of 5, whether the respondent has a mortgage, if they are in the labor force, if the respondent is part of a multi-earner household, years of education, the year that they migrated to the US, and the labor sector they are a part of if they are employed.

3.3.2 Descriptive Statistics and Analysis

To assess the degree to which declines in internal migration rates for the Mexican-born population differ compared to other populations, we calculate annual in-migration proportion for each of the nine racial-ethnic-nativity groups and six geographic levels of migration. Because geographies are nested within each other, migration proportions will be greater as geographic specificity increases. Thus international migration will be less than regional, which in turn is less than state migration, all the way down the most detailed level of geography, MPUMA, which will have the greatest proportion of migrants within a given year-racial-ethnic-nativity combination. For each estimate of migration proportion, survey weights are used to account for sampling error through confidence intervals as described in Lumley (2010).

For Mexican migrants, we conduct an additional exploratory analysis, analyzing rates of out-migration per region per year. For each Mexican respondent, we calculate the rate of out-migration of individuals for each of the 6 regions of the US. This analysis differs from the previous one in two ways. First, we calculate out-migration rates rather than in-migration proportions. This allows us to focus on those who have left rather than those who came to a location. Second, we compare out-migration rates by region to assess which regions decline may be contributing most greatly to more general migration decline.

Lastly, we conduct an analysis specifically examining how changes in the Mexican population's socio-demographics have contributed to migration decline. For our analysis, we constructed a data set of all individuals who were born in Mexico and were aged 15 and older. We only analyzed individuals older than age 15 as migration decisions related to migration for individuals younger than 15 are likely to be a function of their guardian rather than their own individual decision-making. For each individual, the outcome variable of interest for this study is state-level migration in the past year. For each individual in the analysis, information on age, sex, having a child aged 5 or younger, home ownership status, and residing with a partner were extracted from the surveys and used as explanatory variables. In addition to these variables, we also imputed a variable for all individuals that acts as a stand-in for documentation status.

Previous research has established the importance of legal status on migration patterns (Menjívar, 2006). Specifically for recent research on the Mexican-born population residing in the US, the impact of the Immigration Reform and Control Act of 1986 (IRCA) dramatically shifted the nature of migration from Mexico to the US Since 1987 a much larger share of migration events have been conducted via undocumented means (Massey et al., 2014). The implications of an individual's documented status can have a major impact on their ability to securely participate in a number of social forums, including health care, schooling, employment, and receipt of social services, to name a few (Menjívar, 2008). While the impacts of one's legal status on a number of outcomes have been well-documented, many data collection efforts such as the US Census and the ACS, do not collect information on legal status. In order to assess if changes in the total number of migrants who were undocumented played a role in changing migration rates, we impute an individual's documented status using an imputation method used in previous research (Hall and Stringfield, 2014). While not a 100% accurate stand-in for documented status, this method has been used in several studies and provides some insight as to whether group-level changes in documented status impact migration rates.

To assess the degree to which changes in the previously mentioned characteristics of the Mexican-born population contributed to migration decline, we used a variation of the regression decomposition method first outlined by Kitagawa (Kitagawa, 1955). Specifically, we run survey-weighted Bayesian binomial regressions with an event of inter-state migration in the US occurring in the past year as the outcome of interest. Predictor variables were age, binary indicators for whether the respondent was male, whether they had a child under age 5, whether the respondent was a homeowner, whether they resided with a partner, and the imputed value for documented status. Two separate regressions were run, one using only data from before 2008 (baseline) and another using data from 2008 forward (treatment). 2008 was chosen as our cutoff year because of the significance of the great recession on impacting migration rates. Multiple years of survey data were used for each regression and weights for the analysis were scaled such that the sum of each year's weights is equal to all other years in the analysis, as has been done in previous demographic research when combining multiple years of survey data (Elliott et al., 2018).

After regressions were run, beta estimates for each predictor variable i were used for calculation in a non-linear variation of the Kitagawa decomposition for logit transformed regressions (Bauer and Sinning, 2008). For each variable, we assessed the impact that the variable had on differences in the population migration rate between the baseline and treatment periods. Variables could impact migration rates in one of two ways: through compositional shifts or through behavioral shifts. For example, if the Mexican-born population significantly aged between the two time periods such that most of the population is now in an age group that migrates less often, this would be considered migration decline due to compositional shifts. If, however, within an age group the population does not change very much but instead, we observe a decline in the migration rate of this specific age group, this would be considered a decline due to behavioral shifts. In this way, we can assess if population changes contributed to the bulk of the migration decline, or if changes within sub-groups' migration rates had more of an impact. Credible intervals for all decomposition measures were constructed by taking samples from the posterior of the beta estimates.

3.4 Results

3.4.1 Descriptive Results

Table 3.1 shows descriptive statistics of the Mexican-born population from select years of analysis covering the study period. In the first row, we include estimates of the total Mexican population in the US as calculated by Pew research (Noe-Bustamante et al., 2019). While the ACS is a weighted representative household survey, survey error leads to inaccuracy of population estimates. We note that while the ACS estimates the Mexican population to have continued to grow from 2000 to 2015, Pew estimated that the Mexican population declined from 2010 to 2015 as out-migration outpaced in-migration (Gonzalez-Barrera, 2015).

In the second section of the table, we include characteristics of the Mexican-born population calculated from the ACS. The tenfold increase from 2000 to 2005 in the number of Mexican individuals who were surveyed was largely due to a change in the ACS survey methodology which led to a greater number of individuals surveyed together rather than from an increase in the Mexican-born population itself. The mean age of the Mexican population surveyed increased substantially over the study period from 35.4 in 2000 to 42.9 in 2015. For comparison, the mean age of the native US population was estimated to be 35.5 in 2000, slightly older than the Mexican population, but only increased to 37.8 in 2015, 5.1 years younger than the Mexican population. The percentage of the Mexican population who was male decreased over time alongside the percentage of the population who lived with a child under the age

Year	2000	2005	2010	2015
Pew MX Pop Est	8,664,000		11,708,000	11,508,000
ACS Characteristics				
Individuals Surveyed	7,313	76,046	89,565	89,759
Individuals Represented	8,173,805	10,271,702	11,293,675	11,502,956
Mean Age	35.4	37.1	39.7	42.9
Proportion Male	55.6	55.9	53.7	52.2
Proportion with Child	24.4	25.5	22.0	17.1
Proportion Home Owner	42.3	46.8	46.6	47.0
Proportion Undocumented	36.4	44.0	48.1	47.0
Regional Distribution (%)				
Borderland	69.7	66.4	64.0	64.5
Great Lakes	9.0	9.1	8.9	8.8
South	8.4	10.2	11.0	10.6
North West	4.8	6.0	6.4	6.5
Great Plains	4.5	5.0	5.4	5.6
Other	3.7	3.5	4.3	4.0
Interstate Migration Rate (Per 1,000 Individuals)				
Borderland	2.2	2.5	2.7	1.5
Great Lakes	9.3	2.8	2.2	1.6
South	27.1	12.5	6.5	4.4
North West	44.2	26.6	10.7	12.8
Great Plains	3.3	11.7	10.6	4.9
Other	0.0	3.6	3.5	3.0

of 5. The percentage of the Mexican-born population who were homeowners changed from 42% to 47% from 2000 to 2015, increasing but remaining substantially below the home ownership percentage of the US native population, 65% in 2015. The estimated percent of the Mexican population who was undocumented increased from 36.4% in 2000 to 48.1% in 2010, before declining to 47.0% in 2015.

The third and the fourth sections of table 3.1 show the regional distribution and the state in-migration rates of the Mexican population respectively. The proportion of the Mexican population who resided in the Borderland states and Great Lakes states decreased from 2000 to 2015 while the proportion of the population who lived in all other areas increased over time. In-migration rates increased for Great Plains states and Other states but declined for all other state groupings. The in-migration rate remained the highest in the North-West and was next highest in the Southern states in 2000 and 2005, and the Midwest states in 2010 and 2015. Overall state migration rates more than halved from 2000 to 2015, going from 6.9 individuals per 1,000 to 2.8 individuals per 1,0000.

3.4.2 Internal Migration Rates

Figure 3.1 shows the US internal migration rates of the Mexican foreign-born population in comparison to the US Hispanic-born population, US-born White population, and other Latin American-born populations. Across PUMA, metropolitan, state, and regional levels, internal migration rates fell by more than 50% for the Mexican-born population from 2000 to 2018. For all other groups, internal migration rates either remained constant or dropped at a rate much less than observed for the Mexican-born population. In 2000 the Mexican-born population had an internal migration rate

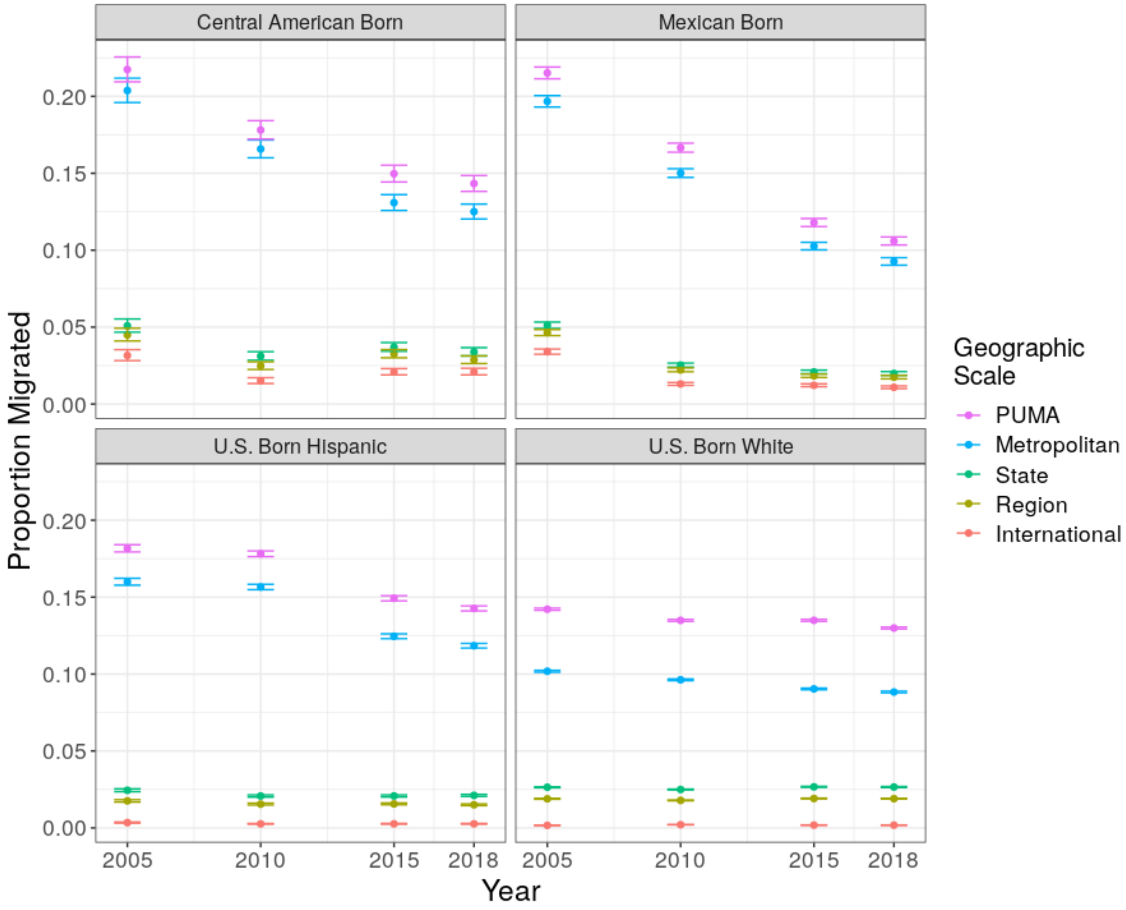

Figure 3.1: Proportion of individuals who have recently migrated to a new geographic location with survey standard errors. Results are reported for four mutually exclusive groups from four years of ACS data.

which was higher than that of the US-born White and US-born Hispanic populations across all geographic levels. With respect to the Latin American-born population, internal migration rates were similar across geographic scales between the two groups.

By 2018, Mexican internal migration rates declined such that they were below that of many other groups. The Mexican-born population had a lower rate of internal migration at the MPUMA level than any other group. In 2018, rates of metropolitan

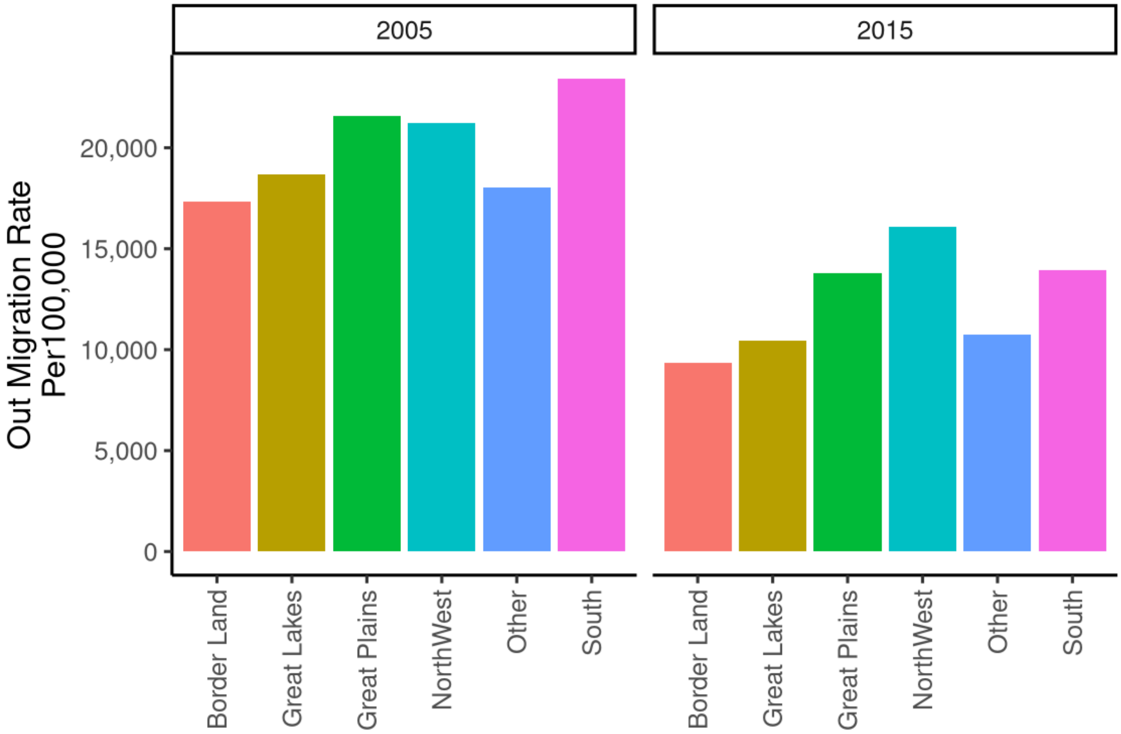

Figure 3.2: State out-migration by region of origin and time period. Though all regions saw declines in their out-migration rates of the Mexican-born population, this decline was most dramatic for the southern region.

internal migration were lower for the Mexican-born population than all other groups except for the US-born White population. Rates of state internal migration were lower for the Mexican-born population than all other groups except for the US-born Hispanic population.

3.4.3 Regional Out-Migration Change

Figure 2 shows regional out-migration for 2005 and 2015. Regional state out-migration fell for all areas however the degree differed from region to region. State out-migration

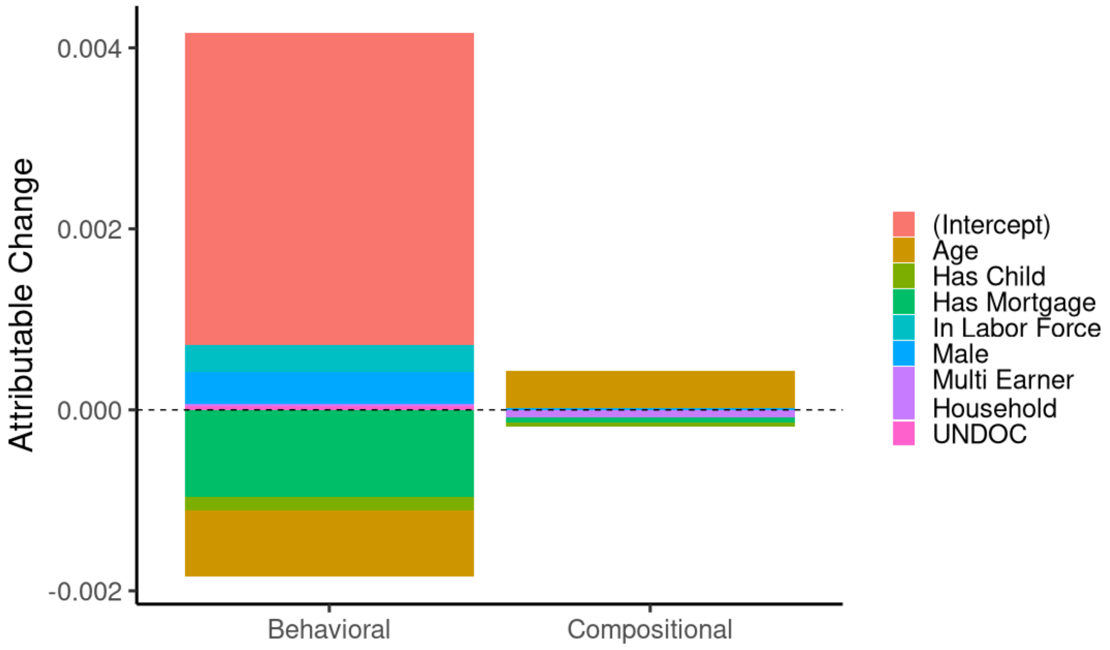

Figure 3.3: Decomposition of behavioral and population composition impacts of US internal migration decline of the Mexican-born population residing in the US. More than 90% of migration decline is attributable to behavioral changes rather than composition changes.

declines for the South saw the greatest absolute decline, with nearly 10,000 fewer migrants per 100,000 individuals, a 40.4% decline. Out-migration rates were also large for the Border Land and Great Lakes states which saw a 46.1% and 44.0% decline respectively. Declines for Great Plains and the North West state regions were more modest with 36.2% and 24.1% declines respectively.

3.4.4 Decomposition

Figure 3.3 shows the results of the decomposition method analysis. A large proportion of the change in state-level internal migration rates of the Mexican-born population rates was found to be factors that impacted all groups, no matter the status of their other socio-demographic variables. Age had the largest compositional effect, explaining 10% of the total net decline. Conversely, aging had a significant net positive behavioral effect, meaning that compared to earlier years, older aged Mexican migrants migrated at a higher rate and represented a larger proportion of the total population than they did in earlier years.

Mexican individuals with a mortgage were also more likely to migrate in the treatment time period than the control period. Being male and in the labor force had negative behavioral effects related to migration from the control to the treatment time period. In other words, those working and males migrated at higher rates in the treatment period than in the control period. All other behavioral and compositional effects were not found to have a significant impact on changing migration rates of the Mexican population.

3.5 Discussion

Our study finds that, from 2000 to 2018, US internal rates of migration of the Mexican-born population fell by more than 50%. This decline is larger than what has been observed for other populations and what has been recorded for the US population as a whole. Previous studies have found that the US saw a 50% decline in state migration rates over a 50-year period from 1960 to 2010 (Molloy et al., 2014). In this study, we find that the Mexican population in the US had state migration rates that declined by the same degree in less than 20 years. The decline was observed not just when examining state-level internal migration, but also migration at the regional, metropolitan, and PUMA level. Perhaps most striking is that while the Mexican-born population had internal migration rates which were substantially higher than that of the US-born populations in 2000, by 2018 their rates of internal migration were significantly lower than that of the US-born populations.

Given that internal migration decline has been substantially higher for the Mexican population when compared to other populations, the question then becomes what has driven such a decline. Previous research has highlighted that internal migration rates may have risen recently due to increases in migration to and from new destinations (Singer, 2004). Our study finds that by 2018, migration rates both in and out of states thought of as new destinations for the Mexican population saw dramatic decreases. In particular states in the South region, such as the Carolinas, Georgia, and Virginia, saw large declines in both in- and out-migration. By 2018 the South become the second largest region in terms of its Mexican population, however, movement to and from these states has substantially fallen off. Previous research has raised concerns about how southern states may have become more hostile towards Mexican migrants as their populations grew (Ocampo and Flippen, 2021), potentially making migration to southern states less attractive. While this analysis finds evidence for decreases in in-migration to southern states, it also finds that out-migration from southern states substantially fell as well. If increasing hostility were greatly contributing to migration shifts, we would expect to see both decreased in-migration and increased out-migration from the South. The decrease in both in-migration and out-migration suggests that other factors are contributing to migration decline.

It should be noted that the Mexican-born population is rapidly changing in ways that are thought to contribute to lower migration. Perhaps most importantly is that the average age of the Mexican population has substantially increased from 2000 to

2018, moving from 35.4 years in 2000 to 42.9 years in 2018. Moreover, the Mexican population has a higher rate of home ownership in 2018 than in 2000. Given that a number of studies have found that these two factors contribute strongly to declining rates of migration in the overall US population, we would expect to find a similar effect in the Mexican-born population. In fact, these factors do not greatly contribute to declining rates of migration for the Mexican-born population. While aging of the Mexican population does explain some of the migration decline, this effect was offset by increases in migration rates of older age populations from 2000 to 2018. Similarly raising home ownership among the Mexican-born population did not contribute to migration decline as home-owning Mexicans were more likely to migrate over time than in previous years.

Instead, the effects of migration decline largely came from shifts in declines to the whole of the Mexican-born population. Nearly 75% of migration decline occurred across all socio-demographic divisions of the population analyzed in this study, age, being part of a multi-earner household, homeownership, sex, etc. About 10% of the decline came from decreases in migration rates of Mexican-born males not observed among females, as well as 5% due to decreases in the migration rate of those in the labor force not seen in those outside of the labor force. These patterns of factors of migration decline are substantively different than what has been observed for the US population as a whole.

3.6 Conclusion

Our study finds that for the Mexican population in the US, internal migration rates drastically fell over the first two decades of the 21st century. Whereas the Mexican population had previously been found to be highly mobile, having internal migration rates which were far greater than that of the US-born population, by 2018 the Mexican population had a lower internal migration rate than the US-born population. Given that the factors which were found to contribute to declining migration rates among the US population more generally were not found to greatly contribute to declines among the Mexican population, this study suggests that the forces which lead to internal migration decline of the Mexican population differ from that of the US population as a whole.

Chapter 4

BEYOND THE IMMIGRANT ENCLAVE: AN ANALYSIS OF ACTIVITY SPACE AMONG INDIVIDUALS LIVING IN IMMIGRANT NEIGHBORHOODS

4.1 Introduction

Spatial segregation of immigrant populations in the US has been well studied in the residential context. Immigrant populations have become more dispersed across the US (Singer, 2004), are increasingly represented among a greater number of metropolitan areas (Lichter and Johnson, 2009), and until recently had been less geographically concentrated within metropolitan areas than in earlier years. Nevertheless, residential segregation persists between immigrant and native-born populations and has increased throughout the latter part of the 20th century (Cutler et al., 2008). It is well documented that, upon arrival, immigrants tend to reside in communities comprised of other immigrants, often referred to as *ethnic enclaves* (Portes, 1987). Even so, theories relating to residential mobility assert that time in the US and gains in social and economic capital mitigate segregation between immigrants and native-born populations. This process is described as spatial assimilation (Allen and Turner, 1996). Yet, a growing body of evidence suggests that residential segregation between immigrant and native populations in the US has increased in the 2000s (Cutler et al., 2008). This trend raises concern about the degree to which immigrants are able to integrate. As such, there is renewed interest in testing current theories of immigrant assimilation and incorporation (Park and Iceland, 2011).

While a bulk of the literature concerning segregation of immigrant populations has focused on residential segregation, residential segregation is only one dimension of the geographic separation of populations. Recent studies of segregation have expanded beyond the residential context and begun to assess how populations may be segregated in the geography of their day-to-day activities, also referred to as *activity space*. The limitations of focusing on a single dimension of segregation, such as residential segregation, have been known for quite some time (Massey et al., 1987) and analyzing activity space segregation offers a way to explore the broader ways in which groups are geographically segregated from each other in their daily routine. It was until recently, however, difficult to measure activity space. Advances in data collection tools that consistently measure GPS locations and the widespread adoption of services that utilize these tools have enabled researchers to observe the spatial mobility patterns of individuals in extreme detail, beyond the bounds of the residential neighborhood (Wang et al., 2018; Phillips et al., 2021). Early work in this area demonstrates that individuals are regularly in locations other than their own residential neighborhood. Moreover, the characteristics of the neighborhoods in which they are active differ from the characteristics of their residential neighborhood (Jones and Pebley, 2014). Individuals are active outside their residential neighborhood for many reasons, including school, work, socializing, and recreation. During this time outside their residential neighborhood, the individuals with whom they interact likely have different socio-demographic characteristics compared to those in their residential neighborhood. If individuals regularly spend time away from their place of residence then residential segregation may not be a telling measure of the degree to which immigrants are spatially segregated from native populations. In such a scenario, activity space segregation would be more telling of the ways in which native and immigrant populations spatially overlap.

The extant body of literature addressing segregation and activity space is growing; nevertheless, segregation and activity space of immigrant populations and residents of immigrant enclaves remain under-explored. Empirical research about activity space segregation in the US predominately examines racial segregation, often with a focus on Black-White segregation (Candipan et al., 2021; Wang et al., 2018; Sampson and Levy, 2020; Jones and Pebley, 2014; Krivo et al., 2013). It is unclear if theories and evidence about assimilation and segregation among racial groups are informative regarding assimilation and segregation of immigrant and native populations. Furthermore, a growing body of literature has called for a deeper investigation into how spatial mobility beyond place of residence isolates populations (Sampson, 2019). If immigrant populations are segregated from native populations in their activity space, the mechanisms driving this phenomenon warrant investigation.

We analyze the activity space patterns of individuals residing in immigrant enclaves and predominately native-born neighborhoods and assess the degree to which residents of one type of neighborhood are exposed to neighborhoods unlike their own. Specifically, we analyze the patterns of activity space across neighborhoods in a major metropolitan US county, King County, Washington, using a large data set of mobile phone GPS digital trace data collected by SafeGraph. Utilizing these data, we quantify where individuals spend their time and how the locations in which they are active relate to their residential neighborhoods. We subsequently describe the strength of the relationships between neighborhoods based on the proportion of time that residents of one neighborhood spend in any other given neighborhood. We specifically are interested in the degree to which neighborhoods that are predominately composed of immigrant residents are connected to neighborhoods composed predominately of native residents via the activity space of their residents. In addition, we examine a number of factors that explain neighborhood relationships (spatial clustering, employment connections, the built environment, etc.) between immigrant and non-immigrant neighborhoods. We conclude with a discussion of our findings and the unique nature of activity space segregation which is not captured in other measures of segregation.

4.2 Background

While the vast majority of research concerning segregation in the US has focused on residential segregation, even the earliest work in contemporary segregation research acknowledged that the separation of populations could be measured in multiple dimensions. For example, school segregation–while intimately related to residential segregation–is a unique dimension of the separation of populations. In Massey et al. (1987), the authors note that, while residential and school segregation are strongly correlated, families with low-socioeconomic status might seek to overcome their residential segregation by enrolling their children in schools largely attended by students from high socioeconomic backgrounds. Schools are but one example of a location other than residency that may permit social interaction with individuals of varying socio-demographic backgrounds. Individuals move through a number of locations during their day-to-day activities; school, work, social engagements, community gatherings, and a number of other activities require that individuals interact with not only the physical space but also the social space, the social groups which occupy any given physical space (Cagney et al., 2020). This complete geographic accounting of how individuals spend their time on a day-to-day basis is the activity space, and it is in the activity space that individuals make social ties and form connections not possible in the residential space alone.

To be sure, a number of studies have measured segregation in contexts outside the residential space, most often measuring how individuals are segregated in school or workplace contexts (Hanselman and Fiel, 2017; Schachner, 2021; Hellerstein and Neumark, 2008; Strömgren et al., 2014). While undoubtedly important, these studies, like studies of residential segregation, focus on a single dimension of segregation and do not describe how individuals of differing socio-demographic backgrounds might be exposed to one another across their daily activities in various socio-geographic spaces. Again, this limitation has been widely acknowledged (Massey et al., 1987); however, it was not until the early 2000s that analytical and technological developments allowed researchers to measure activity space and empirically assess the segregation of activity space. Wong and Shaw (2011) utilize an approach to assessing activity space and exposure between groups on a more comprehensive scale not limited to a single dimension via travel log diaries, a data collection tool commonly utilized in urban planning research (Bricka and Bhat, 2006). Through travel logs of individuals residing in Miami-Dade, Broward, and Palm Beach counties, the researchers record and geocode locations that individuals visited in the 24 hours prior to the household survey. Given that demographic information about respondents was not collected, Wong and Shaw (2011) use the location of the household to identify the census tract and describe how socio-demographic characteristics of the residential neighborhood–

namely race and ethnicity–correspond to the locations individuals visit. This study was among the first to demonstrate the feasibility of using travel log diaries to measure activity space segregation.

Since then, several existing studies about activity space segregation employ the travel log diaries collected under the auspices of the Los Angeles Family and Neighborhoods Study (LAFANS), a representative population survey. Using methods similar to Wong and Shaw (2011), Krivo et al. (2013) find that individuals tend to be segregated into activity spaces that are either socio-economically advantaged or disadvantaged, and that this effect is especially pronounced for Black and Hispanic populations. Jones and Pebley (2014) find that the social, economic, and demographic characteristics of individuals and their residential neighborhoods are strongly associated with the characteristics of their activity spaces. This finding suggests that individuals who are racially and economically isolated in their residential space tend to be similarly isolated in their activity space. Browning et al. (2017) found that as individuals' SES status increased, their likelihood of sharing activity spaces with other SES groups decreased.

Travel log diaries enable researchers to describe how individuals move in space throughout their daily routines; however, they present several limitations. First, representative large-scale samples of travel log diaries are rather costly to collect. The resource and financial costs of conducting a large-scale survey, in general, have been increasing in recent years (Olson et al., 2021) but a travel log diary results in additional burdens associated with collecting a free response question that requires additional layers of GIS processing (Wong and Shaw, 2011). Second, accurate travel log diaries are extensive and highly subject to various forms of heuristics and biases. There are a number of reasons respondents may not list all locations that they visit (Jones and Pebley, 2014; Bricka and Bhat, 2006). For example, data collection methods that rely on recall may be subject to recall bias, a systematic error when participants are unable to remember the particulars of a given event or experience. Potential omissions in a travel log diary have the potential to bias a respondent's documented activity space.

More recently, advances in and adoption of GPS technologies have allowed for less expensive, more robust ways of collecting location information. With the mass adoption of smartphones, many individuals carry devices that have the potential to track human mobility through digital trace data (Hughes et al., 2016). Digital trace data refers to the number of ways in which location information may be obtained from mobile devices that individuals consistently have on their person, including but not limited to: call detail records, dedicated location tracking enabled applications, social media records, WiFi connection records, and web searches (Hughes et al., 2016). To be sure, GPS data collected via smartphone devices is limited to those who carry the devices, raising concerns about whether these data are representative of all individuals and their behavioral patterns (Zagheni and Weber, 2015). Nevertheless, the publicly available nature and large scale of much of these data have made it a valuable resource for academic scholarship. For example, using public data from social media websites such as Twitter, researchers are able to collect and use activity space data on a much larger scale than is possible using travel log diaries.

In Wang et al. (2018), the authors use Twitter data to track mobility and neighborhood isolation across many large metropolitan areas in the US. They find that metropolitan areas greatly differ from one another in their population's spatial mobility patterns. At the same time, general patterns of social isolation emerge across the examined racial groups. They find that individuals from neighborhoods that are predominately Black and Hispanic tend to be more isolated from neighborhoods that are predominately White, a finding which holds even after controlling for the wealth of the neighborhoods.

Some related literature using Twitter data assesses the ”structural connectedness” of cities. Structural connectedness refers to the degree to which residents of one neighborhood in a city are connected to other neighborhoods via their activity space and builds on previous literature of conceptualizing cities as a network of neighborhoods (Neal, 2012; Browning et al., 2017). In Phillips et al. (2021) the authors build off of the concept of structural connectedness to define two new measures of segregation for networks of neighborhoods, the equity mobility index (EMI) and the concentrated mobility index (CMI). EMI and CMI are city-level statistics of segregation that capture the dimensions of segregation pertaining to evenness and concentration, respectively. EMI and CMI allow for city-level comparisons of how segregated one city is from another in its activity space. Candipan et al. (2021) expand on these metrics to develop a new metric, the segregated mobility index (SMI), which explicitly measures racial segregation of activity space. The SMI, too, is a city-level statistic that allows for cross-city comparisons of racial activity space segregation. In their discussion, the authors note that while SMI is correlated with measures of residential segregation across metropolitan areas, it is a unique measure of segregation that captures a new dimension by which individuals of different racial and ethnic groups are separated from one another. This finding suggests that with respect to race, activity space segregation is a unique measure of segregation, separate from residential segregation, and warrants further investigation.

While research focusing on activity space segregation has expanded as a result of the availability of digital trace data, activity space research assessing the immigrant context is lacking. It is well known that immigrant populations tend to be segregated from native-born populations in their residential space (Cutler et al., 2008). A majority of residential segregation research about immigrant populations focuses on the concept of the immigrant enclave (Cutler et al., 2008). Immigrant residential enclaves refer to residential neighborhoods that are over-represented by foreign-born compatriots. Immigrant enclaves offer immigrants from the same country of origin a more streamlined transition into a new host country through shared language and culture among neighbors which may, in turn, result in greater social capital (Portes, 1987; Xie and Gough, 2011). This social capital may be transformed into material capital unavailable to migrants in other settings (Portes, 1987; Xie and Gough, 2011). Immigrant enclaves enable information networks, which permit migration to occur where it previously might not have and allow for continued migration between origin and host countries in a process often referred to as *cumulative causation* (Massey et al., 1993). This process drives the well-documented residential segregation of immigrant and native-born populations (Cutler et al., 2008).

Whether these patterns of residential segregation are also reflected in the activity spaces of immigrant populations and the mechanisms of segregation have not yet been documented. Jones and Pebley (2014) hypothesized that immigrant individuals residing in immigrant enclaves would be less likely to leave their residential neighborhoods because of limited ability or opportunity outside of the enclave, yet, the authors do not empirically assess this hypothesis. Immigrant enclaves offer a streamlined mode of incorporation into the US, wherein migrants may leverage their social capital in a way not possible outside of the immigrant enclave (Logan et al., 2002). While offering initial opportunities, immigrant enclaves spatially isolate migrants, a finding frequently observed in the residential context and likely present in activity space patterns as well. An alternative explanation for the segregation of immigrant and native populations stems from the place stratification literature. In place stratification models, geographic spaces have a hierarchy that maintains their status, in part, through the exclusion of some social groups, such as Black or Hispanic immigrants (Pais et al., 2012). Various mechanisms may contribute to place stratification, but one important distinction from other theories of segregation is that place stratification posits that segregation is contributed to by the behavioral patterns of not just migrant populations but also by exclusionary behaviors of native populations (Logan and Alba, 1993).

Up to now, far too little empirical evidence describes activity space segregation between immigrant and native populations; yet even less quantitative research has established the potential mechanisms driving activity space segregation. This gap should is important to address for several reasons. First, if activity space segregation is largely a function of another type of segregation, this finding would call into question its contribution as a novel subject of study. As mentioned previously, the collection of activity space data is often costly, and if activity space segregation can be largely explained by other dimensions of segregation then investing time and energy into the collection of such data for segregation purposes would be ill-advised. For example, if the activity spaces of immigrant populations living within enclaves are largely within their residential neighborhood, then information about residential segregation would be sufficient for explaining how activity space is segregated. Furthermore, if immigrant populations largely spend time in neighborhoods in close proximity to their residence, then theories pertaining to the importance of residential segregation are likely accurate and more time may need to be invested in re-conceptualizing how the ethnic enclave neighborhood is operationalized. If, on the other hand, activity space segregation of immigrants represents a unique dimension of segregation from residential segregation, more attention should be placed on the degree to which immigrants and natives are segregated from one another in their day-to-day activities.

Another dimension of segregation captured within activity space is workplace segregation. The degree to which the workplace is segregated is often less than residential segregation (Ellis et al., 2004). Nevertheless, workplace segregation in the US has been well documented (Hudson, 2007). Immigrants in the US are more likely to have immigrant co-workers than native-born coworkers (Andersson et al., 2014). A segmented labor market, or dual labor market, partially drives this effect wherein primary markets are disproportionately represented by native populations and secondary markets by immigrant populations (Wilson and Portes, 1980). Additionally, immigrants may also participate in immigrant firms within enclaves, distinct from the secondary labor market and a labor force that is predominately immigrant (Wilson and Portes, 1980). Given that a substantial portion of time is likely spent at the workplace, it stands to reason that activity space segregation is in part driven by workplace segregation. Similar to residential segregation, information about the place of work, and subsequent analysis of workplace segregation, is cheaper to collect and more readily obtainable than data on activity space. Therefore, identifying whether activity space segregation tells us something beyond workplace segregation is important in terms of assessing the returns on investing in the more costly process of collecting activity space data for the purpose of understanding broader segregation between groups.

Another motivating factor for identifying mechanisms driving activity space segregation is that doing so might help to reduce segregation itself. As previously mentioned, residence in immigrant enclaves presents an opportunity for migrants to find employment and build capital more easily than is possible outside the enclave (Logan et al., 2002). However, extended residence in immigrant enclaves has also been found to be a limiting factor for the long-term economic success of migrants. Xie and Gough (2011) find that working in ethnic enclaves has a negative effect on earnings and that those working in mainstream labor sectors tend to have greater economic success. Thus, enabling migrant populations greater opportunities to access spaces outside of enclaves would likely have a positive impact on the earning potential of these populations. While some factors driving activity space segregation of populations may be difficult to change (e.g., the distance between an immigrant enclave and native neighborhoods), other factors such as access to public transit may be more readily modifiable.

In order to fill the gap in empirical literature examining activity space segregation of immigrant and native populations relative to other forms of segregation, the present analysis assesses how the activity space patterns of individuals residing in immigrant enclaves differ from those residing in predominately native-born areas. Specifically, we aim to assess the degree to which individuals who reside in either immigrant enclaves or predominately native neighborhoods leave their residential neighborhoods for daily activities that take place in neighborhoods unlike their own. To answer this question, we use a unique large-scale data set of digital trace data from individuals residing in King County, Washington. King County is a major metropolitan area of the US

Pacific Northwest with an immigrant population that comprises nearly 25% of the total population. Moreover, the immigrant population residing in King County is relatively diverse, with immigrants coming from a number of different home countries (Balk, 2019). To assess segregation, we assess the degree to which immigrant and native neighborhoods are connected with each other via the activity space of their residents, ie structural connectedness. We expand on the work of Phillips et al. (2021) by assessing the driving forces of connectedness between specific neighborhoods within a city, King County, Washington, rather than describing differences across cities. This approach allows us to account for the neighborhood factors that may partially explain the strength of connections between neighborhoods or the lack thereof.

4.3 Methods and Data

4.3.1 Activity space data

The primary data source for this analysis is an app-based digital trace data set from the SafeGraph group. SafeGraph is one of several companies that currently maintain data describing human mobility generated from mobile phone locations through app-based data collection. Data come from cellphone device pings in King County, Washington. Each ping is associated with three variables: a GPS location, a time stamp, and an anonymized device ID. We treat each device as an individual, given that the vast majority of smartphone users in the US have only one device and are typically not shared (Olmstead, 2017). Pings occur at irregular intervals and data collection is, in part, dependent on the ways in which a user interacts with their device. In total 658,531,919 pings were collected from 438,976 devices during the period from October 31st, 2018 to January 31st, 2019 in King County, Washington.

SafeGraph also provides estimated home geographies of individuals at the block group level. Home locations are derived from the total observed patterns of an individual's ping behavior, which are not limited to either Washington state or the three-month time span of the data. We limit the analysis to only those individuals who have an estimated home location within King County. This filtering process leaves us with 190,528,383 observations (pings) from 135,264 devices.

For our analysis, we use the geographically-specific point data from SafeGraph to quantify where individuals spend their time. First, each ping is geo-tagged to the census tract from which the data point originated using the GPS coordinates. In doing so, we lose some geographic precision of the SafeGraph data in exchange for being able to associate points with US census tracts (2019 boundary definitions). Second, we estimate time spent in an area. As data pings are often temporally clustered, simply assuming the number of pings in a given location is representative of where individuals spend time would bias results toward locations that have many pings over a short period of time. To account for this potential bias, we leverage both the spatial and temporal detail in our data. For each individual, we order observed points in time and group together points that are consecutive and originate from the same census tract. For each group of points in the same census tract, we treat the total amount of time spent in that tract as the time difference between the last and first point observed in the group. Thus, if an individual passes into a census tract and only a single ping is recorded in that tract, we assign no time spent in that tract even though the individual was observed in that location at a point in time. Additionally, if an individual has many consecutive pings within a census tract but they occur in a short time period, we only account for the individual being in this location for a short period. On the other hand, for an individual with two consecutive pings in a census tract spread over a long period of time, we assume that this individual spent a large amount of time at this location, despite the low number of pings. We assume that individuals with consecutive pings within a census tract are in the same location, an assumption that may be violated if an individual leaves a census tract and then later returns to that tract with no pings recorded in the meantime. For each individual, we aggregate the total amount of time spent in each census tract and divide it by the total amount of time observed overall census tracts to get the proportion of observed time spent in each tract. Using this approach, each individual observed in the data has a total observation time that sums to 1, divided amongst all neighborhoods where they were recorded in the SafeGraph data. We refer to this metric as *individual proportional time*, which represents the proportional time that individual i spent in neighborhood k as $\mu_{i,k}$. Note that, for many individual-neighborhood pairs, $\mu_{i,k}$ will be 0 as most individuals are only observed in a handful of neighborhoods.

4.3.2 Quantifying Neighborhood Relationships

Our outcome variable of interest is a measure of neighborhood connectedness. As previously stated, the SafeGraph digital trace data measures an individual's activity space and does not describe neighborhood connectedness. To go from individual activity space to neighborhood connectedness, the degree to which neighborhoods are connected with each other in the activity space of their residents, we follow a methodology similar to Phillips et al. (2021) and (Candipan et al., 2021).

To quantify the directional relationships neighborhoods have with one another, we use the recorded activity space of individual proportional time observed in the

SafeGraph data, treating an individual's census tract of residence as an origin and the census tracts they visit as a destination. Specifically, for all N individuals i who have a recorded residence in neighborhood j, we take the sum of their proportional time μ spent in neighborhood k and divide by the total number of individuals from that neighborhood $\mathbb{I}_j$. In other words, for each neighborhood in the analysis, we consider all individuals who reside in a neighborhood and sum the amount of proportional time they spent in every other neighborhood, normalizing the value across destination neighborhoods such that, for each origin neighborhood, the sum of time that residents spend in all neighborhoods in King County sums to 1. This process is similar to the methodology outlined in Phillips et al. (2021) with one major distinction: while Phillips et al. only analyze time spent outside of the home neighborhood, we include time spent in the home neighborhood when measuring neighborhood relationships. Doing so allows us to account for the possibility of geographic isolation whereby isolation refers to neighborhoods whose residents spend the majority of their time in their home neighborhood, rather than in other neighborhoods. Where geographic isolation exists, an isolated neighborhood does not have a strong connection with any other neighborhood in the metropolitan area. Such might be the case for neighborhoods that are high in resources, jobs, and social activities and, thus, it is not often necessary for residents to leave the neighborhood. Alternatively, neighborhoods may be isolated because of their geography or social dissimilarity from other neighborhoods. The specific strength of the relationship from neighborhood j to neighborhood k is defined as follows:

$$\underbrace{\theta_{j,k}}_{\substack{\text{Neighborhood}\\\text{Relational}\\\text{Strength}}} = \frac{1}{N_j}\sum_{i=1}^{i\in\mathbb{I}_j}\underbrace{\mu_{i,k}}_{\substack{\text{Individual}\\\text{Proportional}\\\text{Time}}}$$

Here, $\theta_{j,k}$ is the strength of the relationship residents of neighborhood j have with the neighborhood k. A value of 0 indicates that residents of neighborhood j have no connection to neighborhood k while a value of 1 indicates that residents of neighborhood j spend all of their time in neighborhood k. Note that, for each pair of neighborhoods j and k, we have two measures of neighborhood strength of relationship: $\theta_{j,k}$, the relationship defined by individuals who reside in neighborhood j and spend time in neighborhood k, and $\theta_{k,j}$, the relationship defined by individuals who reside in neighborhood k and spend time in neighborhood j. These measures are independent of one another and a high or low value of one measure does not necessarily correspond to a high or low value of the other. Take, for instance, the case in which neighborhood j is a predominately suburban residential neighborhood and neighborhood k is a nearby neighborhood with a high density of jobs. In this scenario, we might anticipate a high value for $\theta_{j,k}$ but not necessarily for $\theta_{k,j}$. In other instances, values of these two measures may both be high if neighborhoods j and k are in close proximity but each is home to a different essential resource, such as a school, grocery store, or transit stop.

For our analyses, $\theta_{j,k}$ is our outcome variable of interest. For each neighborhood type, we report common network statistics such as in-degree and out-degree. To describe variation in relationships across neighborhoods, we rely on a number of characteristics of both origin and destination neighborhoods, such as the relative size of the immigrant population, as well as characteristics that describe the dyadic relationship between both neighborhoods.

4.3.3 Operationalizing Activity Space Segregation

The primary goal of our analysis is to explain the connectedness of neighborhoods as a function of each neighborhood's characterization as an immigrant enclave or a predominately native neighborhood. To categorize neighborhoods, we pull information on the proportion of the neighborhood population that are immigrants from the Census American Community Survey (ACS) 2015-2019. Using these data, we assign a categorization of immigrant "enclave" neighborhood or "native" neighborhood based on the quartile of the neighborhood's percent of the population who are immigrants. The highest quartile is assigned the category of immigrant enclave neighborhood while the lowest quartile is assigned the category of native neighborhood. The two remaining quartiles are assigned to the category of "mixed."

To analyze neighborhood connectedness in a regression framework, we must account for the unique structure of relatedness in observations in the data. Specifically, we utilize an AME network regression framework, as presented in Minhas et al. (2016), where our outcome variable is neighborhood connectedness, $\theta_{j,k}$. In a traditional regression analysis, an assumption of independence between observations is required in order to ensure unbiased estimates of parameters. In this analysis, however, each observation $\theta_{j,k}$ is linked to each other observation pertaining to neighborhoods j and k. This dependence structure between neighborhoods is accounted for in the AME framework by adjusting for the row and column totals, where rows pertain to all observations concerning neighborhood j and columns pertain to all observations concerning neighborhood k.

To assess the presence of activity space segregation between neighborhood types, we use our neighborhood characterizations of enclave, native, and mixed neighborhoods. From these three categories, we construct a set of variables that describe directional dyadic relationships from origin neighborhood j to destination neighborhood k. For each $\theta_{j,k}$, we assign a label describing both the immigrant population of the origin and destination neighborhoods. As such, each neighborhood relationship takes on one of nine values: native to native, native to mixed, native to enclave, mixed to native, mixed to mixed, mixed to enclave, enclave to native, enclave to mixed, and enclave to enclave. We note that the assigned relational value for $\theta_{j,k}$ will be the inverse of $\theta_{k,j}$. For example, when the relationship for $\theta_{j,k}$ is assigned the value of "enclave to native" the relationship for $\theta_{k,j}$ is assigned to "native to enclave".

For our analysis, we define activity space segregation as the likelihood that there exist stronger connections between dyads that share a similar categorization compared to connections between dyads made of two neighborhoods with different characterizations. We use the neighborhood relationship identifier of "native to native" as our baseline category and focus on the categories of "native to enclave" and "enclave to native" as measures of segregation. We state that segregation of enclave neighborhoods is present if the effects of either "native to enclave" or "enclave to native" are less than 0. Another way of describing this is if either "native to enclave" or "enclave to native" are less than 0, those neighborhood connections are weaker than the connections that exist between native neighborhoods.

In addition to detecting the presence of segregation between enclave and native neighborhoods in activity space patterns, our analytical approach is uniquely suited to assessing the directionality of the segregation. In the case of a point-in-time analysis of residential segregation, it is impossible to tell whose mobility patterns drive residential segregation (Cutler et al., 2008). For our analysis of activity space segregation, we can determine not only whether segregation is present but also whether it is being driven by the mobility behavior of those residing in enclaves not moving to native neighborhoods or those residing in native neighborhoods not moving to enclave neighborhoods. As such, we aim to test the following two hypotheses.

Hypothesis 1 (H1): *Segregation between immigrant populations and native populations exists because those residing in immigrant enclaves are isolated from largely native neighborhoods where their social capital is more difficult to leverage and structural barriers may prevent them from access.*

Hypothesis 2 (H2): *Segregation between immigrant populations and native populations because those residing in native neighborhoods are isolated from immigrant enclave neighborhoods, in line with theories of avoidance such as place stratification.*

4.3.4 Controls and Defining Residential Neighborhood Characteristics

If activity space segregation exists between immigrant and native neighborhoods, a number of factors related to the built environment, employment structures, or differences in economic standing may explain this segregation. To assess the degree to which these factors contribute to immigrant activity space segregation, we utilize a number of control variables. These control variables serve two purposes. First, we use these variables to assess the quality of our activity space data in a univariate regression context. For each of our control variables, we define an expected direction for its relationship with neighborhood structural connectedness. If our data are unbiased measures of activity space, then we should observe a significantly positive or negative relationship between our predictor and neighborhood connectedness. In a univariate regression context, we can assess the expected direction between our control variable and neighborhood connectedness in a way that is difficult to do in a multi-variate regression where correlations between predictor variables may alter the relationship between predictors and structural connectedness. The second purpose of the control variables is to isolate mechanisms that drive activity space segregation between immigrant and native populations. A number of structural factors related to the spatial composition and employment structures of King County, Washington may partially explain neighborhood connectedness between enclave and native neighborhoods. Identifying what those explanatory measures help serves the purpose of identifying if activity space segregation is redundant to other forms of segregation and what structural mechanisms facilitate segregation between immigrants and natives.

The first control variable accounts for the way in which residential positioning impacts activity space behavior. Immigrant enclave neighborhoods are not randomly placed in space but, rather, are spatially clustered (Vicino et al., 2011). Furthermore, the traditional ways of defining neighborhoods in social science literature, using a single census geographic unit like census tract, may not accurately capture the true geographic space of the residential neighborhood (Jones and Pebley, 2014). Adjacent census tracts which are treated as independent neighborhoods in an analysis may actually be part of the same residential neighborhood in terms of how residents interact with one another and occupy space. As such, we expect there to be more contact within immigrant neighborhoods, as defined by census tract, simply because they are in close proximity to each other compared to native neighborhoods which are further away. To account for how residential clustering of immigrant enclave neighborhoods contributes to activity space segregation, we control for the physical distance between neighborhoods using spatial data from the 2019 Census Topologically Integrated Geographic Encoding and Referencing (TIGER) database. The TIGER database provides shape files from which geographic characteristics of areas can be derived. Specifically, we pulled the centroid of each census tract in the King County area from the TIGER database. Using these centroids, we calculated the distance between all pairs of neighborhoods as we anticipate that the strength of relationships between neighborhoods diminishes with increasing distance. If accounting for the clustering of neighborhoods sufficiently explains neighborhood connectedness, then activity space segregation can be described largely as a function of residential segregation. Conversely, if neighborhood connectedness between immigrant enclave and native neighborhoods remains strongly negative in the presence of distance, we assert that activity space segregation represents a unique form of segregation from residential segregation. We thus define our third hypothesis as follows:

Hypothesis 3 (H3): *Neighborhoods are more likely to be structurally connected and less segregated when they are near each other in part due to ease of access. Accounting for the spatial clustering of immigrant neighborhoods through distance measures explains a portion of the total activity space segregation, however, activity space is broader than place of residence, and segregation of immigrant and native populations will persist.*

Public transit offers a mechanism to connect neighborhoods that might not otherwise be easily connected. To account for the ways in which public transit may bolster connectedness between neighborhoods, we control for the presence of public transit in each neighborhood. Specifically, information on transit stops in the King County area was taken from the TIGER database. GPS coordinates of all regional bus, county bus, light rail, street car, and ferry stops were collected for services offered by Sound Transit, King County Metro, Seattle Transit, and the Washington State Department of Transit in the King County area. Using GPS coordinates, we tallied the number of transit stops located in each neighborhood using spatial overlap of transit stop points onto TIGER-defined census tract areas. We also account for the population density of each neighborhood. We pull neighborhood area data, km^2, from the TIGER database while the total population for each neighborhood is pulled from the 2019 ACS. Density is defined as the ratio of population to land area. We anticipate that those neighborhoods with higher population density likely have fewer connections to other neighborhoods because their social needs are met, to some degree, within the home neighborhood. Using these variables, we assess whether activity space segregation persists after the introduction of controls for the built environment and subsequently define the following hypothesis:

Hypothesis 4 (H4): *Neighborhoods that are (a) lacking in public transit or (b) characterized by high population density are less likely to be structurally connected to other neighborhoods. Immigrant enclave neighborhoods are likely to be more population-dense than other neighborhoods with less access to public transit, explaining their activity space segregation from other neighborhoods.*

Beyond physical distance and the built environment, socio-economic factors likely play a role in activity space segregation between immigrant and native populations.

For example, Wang et al. (2018) find that neighborhoods with higher median household income tend to be more isolated from the activity space of individuals in the metropolitan area compared to neighborhoods with low median household income. Previous studies have highlighted the ways in which barriers are created in residential mobility to prevent groups with historically lower incomes from seeking residence among those groups with higher incomes (Pais et al., 2012). Another body of activity space literature suggests that this process is likely at play in other dimensions of geographic segregation beyond the residential space (Jones and Pebley, 2014; Wang et al., 2018). To account for isolation of high-income neighborhoods, we use information about the median household income of each neighborhood using the 2019 ACS. As immigrant neighborhoods tend to be of lower socio-economic positioning relative to native neighborhoods, we anticipate that differences in median household income play a role in the segregation of activity space. Thus, our next hypothesis is as follows:

Hypothesis 5 (H5): *Native neighborhoods tend to be of higher socio-economic standing than immigrant neighborhoods and high-income neighborhoods are difficult to access for those from low-income neighborhoods due to institutional and historical factors. We anticipate that high-income neighborhoods will be more isolated than low-income neighborhoods and contribute to segregation between immigrant enclave and native neighborhoods.*

Lastly, job opportunities in certain neighborhoods likely facilitate neighborhood connectedness and explain which neighborhoods are linked to one another. As previously mentioned, theories concerning the dual labor market hypothesize that immigrants and natives largely occupy different labor sectors. As such, if these labor sectors are geographically segregated, we anticipate activity space segregation to be explained at least in part by labor sector segregation. To account for the activity space segregation of immigrants and natives that may be explained by workplace structures, we use household-to-employer relationship data as a control. Information on location of employment comes from the Longitudinal Employer-Household Dynamics Origin-Destination Employment Statistics 7 (LODES) (US Census Bureau, 2022). LODES data contain pairwise information about census block relationships between home locations (origins) and work locations (destinations). The counts of individuals who report a connection between census tracts were recorded for each directional pair of neighborhoods i and j. While we expect a strong correlation between the number of commutes from neighborhood j to neighborhood k and the strength of activity space relationship $\theta_{j,k}$, the correlation should not be 1. Given that LODES data only measures work commutes, and only work commutes of those who filed taxes (US Census Bureau, 2022), activity space data derived from SafeGraph represents a more complete picture of where individuals spend their time. Nevertheless, by accounting for workplace connections, we can derive the strength of relationships that exists between neighborhoods above and beyond employment relationships. This hypothesis is articulated below:

Hypothesis 6 (H6): *Employment differences contribute to activity space segregation because of the different labor sectors occupied by immigrant and native populations; however, these differences only explain a single dimension of segregation, and, thus, general activity space segregation will persist.*

For all models run we calculate 95% credible intervals for β parameters from posterior distributions using an equal tail approach (Hespanhol et al., 2019). For the purposes of our analysis, we consider the effect of a parameter significant if the credible interval does not overlap with zero. We conducted all of our analyses in R Version 4.2.1.

4.4 Results

4.4.1 Exploratory Analysis

To assess the impact of temporal bias of GPS data collection, we plot the number of data points collected at different points in time during the day. Figure 4.1 shows the mean number of GPS points collected per daily 5-minute interval across the study period and by day of the week. Two prominent patterns arise when inspecting the time of GPS logs. First, time of day is highly correlated with the number of data points collected in an intuitive pattern: (1) data points recorded are relatively few in the very late and very early hours of the morning, when most individuals are likely asleep, and, (2) data points recorded peak around 8 a.m. and again at 5 p.m., corresponding with probable commutes to and from work. The second notable pattern regarding the temporality of GPS logs is the differences in time schedules of data points collected between weekdays and weekends. While weekdays exhibit a strong peak in data points collected around 8 a.m. and 5 p.m., weekends exhibit muted peaks, instead demonstrating a pattern of data points that are more similar to other weekend days than they are to weekdays.

While it is difficult to assess for possible bias of representation with regard to individuals in our data, we can assess how well neighborhoods are represented relative to their total population size. To assess geographic representation, we compare the

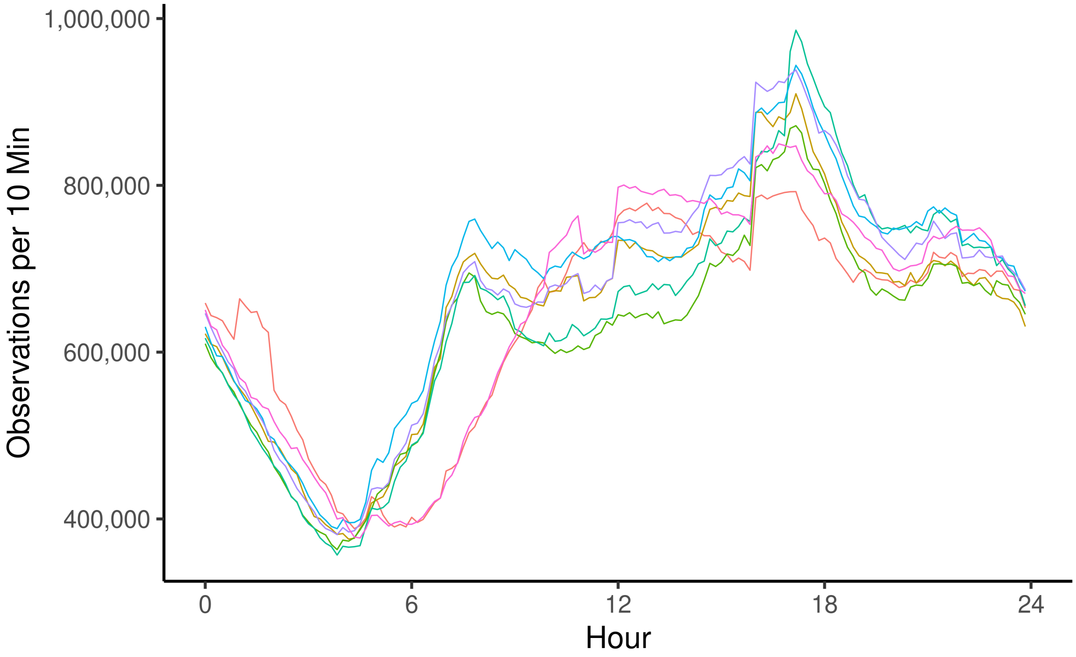

Figure 4.1: Number of GPS pings recorded per 10 min period. The number of pings recorded is temporally auto-correlated and shows patterns that are consistent with common night and day cycles.

number of individuals who have a reported home location in a census tract from the SafeGraph data to the population of the census tract according to the ACS 2019 data. In Figure 4.2, we show this comparison in a graphical form. On the x-axis is the log population of a King County census tract while the y-axis is the log number of unique devices present in our data for that same census tract. While this graphical test is not sophisticated, the presence of a linear relationship between the number of devices and the population count gives us some assurance that our data are relatively geographically representative and has been used in other studies of activity space (Wang et al., 2019). While outliers are present, there is a strong linear relationship between a neighborhood's population count and the number of devices from that neighborhood in our analysis, giving us confidence that, across neighborhoods, representation is similar to the true relative population size.

Figure 4.3 shows the geographic distribution of enclave, native, and mixed neighborhood classifications. Large differences in the spatial distribution of these classifications exist within King County. While native neighborhoods are predominately found in the easternmost and westernmost portions of the county, immigrant enclaves are located more centrally and have greater representation in the cities of Bellevue, Renton, and Seattle. Mixed neighborhoods are concentrated in the northern and southern parts of central King County. Given that we anticipate distance to be negatively correlated with the strength of the relationship between neighborhoods, we expect neighborhoods of different types to have a weaker relationship than neighborhoods of the same type, simply because of their lack of proximity to one another.

Table 4.1 shows the summary statistics of network connections, both in and out, as well as the means and standard deviations of each of the independent variables in our

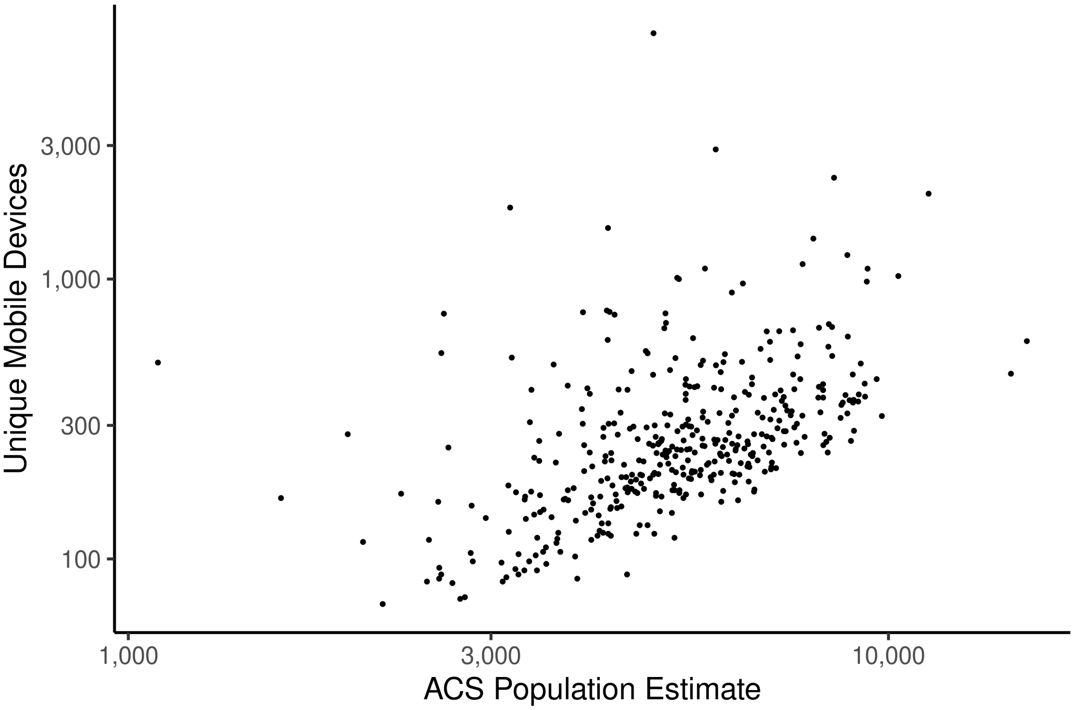

Figure 4.2: Neighborhood ACS population estimates compared to the number of mobile devices from the SafeGraph digital trace data. Population estimates show a fairly linear correlation with the number of mobile devices from the SafeGraph data.

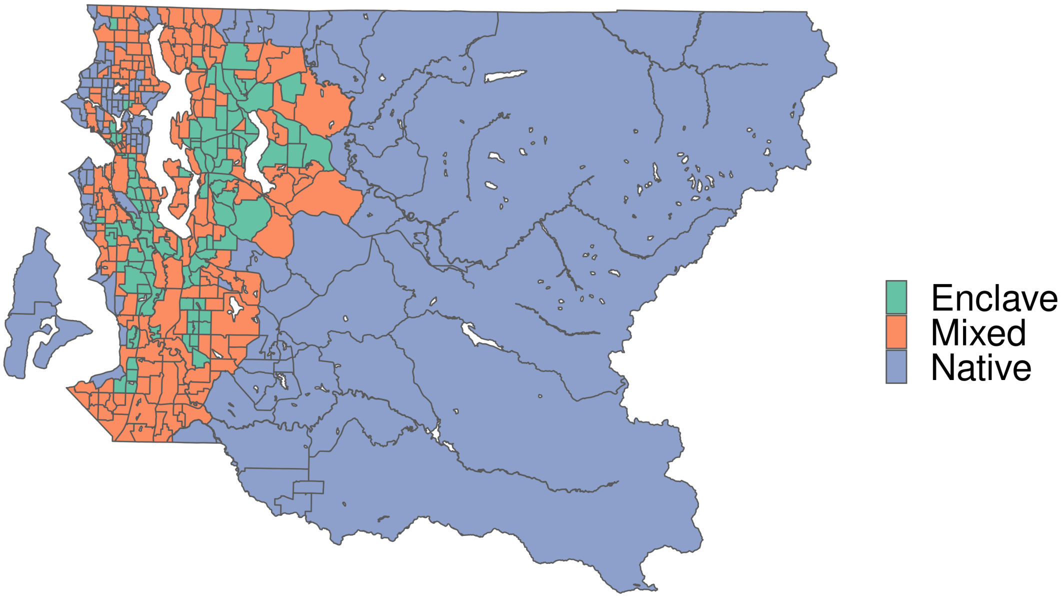

Figure 4.3: Neighborhood immigrant type map of King County. Types of neighborhoods are strongly spatially clustered with Native neighborhoods on the far east and west of the county while enclave neighborhoods are more centrally located in the county.

analysis. Immigrant enclave neighborhoods in King County, on average, have lower median household incomes than either mixed or native neighborhoods; however, substantial variation exists within each group. Enclave neighborhoods have, on average, more transit stops and commute destinations as well as greater population density. This pattern is unsurprising as the neighborhoods that fall in this category tend to be located in more urban environments while native neighborhoods tend to be located in more suburban and rural environments. The out-degree of native neighborhoods is greater than that of either native or mixed neighborhoods, indicating that individuals from enclave neighborhoods spend more of their time away from their residential census tract than individuals from mixed or native neighborhoods. That being said, all neighborhood types have an out-degree greater than .5, indicating that on average residents of all neighborhood types spend the majority of their time outside of the residential neighborhood. In-degree is also higher for enclave neighborhoods, indicating a greater amount of activity space time spent in their geographic boundaries by non-residents than either native or mixed neighborhoods.

4.4.2 Statistical Analysis

Regression results are shown in Figure 4.4 with activity space segregation regression in the first row, univariate control variables in the second row, and control variables with activity space variables in a single model in the third row. The mean estimate of beta coefficients are plotted with 95% Bayesian credible intervals represented by bands. Zero is represented by the dotted line and therefore parameters whose bands do not overlap with zero are considered significant.

	Enclave	Native	Mixed
Neighborhoods	99	100	198
Percent Foreign	0.381	0.0933	0.216
Out-Degree	0.608	0.536	0.570
In-Degree	0.680	0.499	0.553
Population Density	2897.	2378.	2675.
Median Household Income	$91,888	$113,336	$99,730
Transit Stops	16.5	13.6	16.3
Commute Destinations	3,438	970	2,339

Table 4.1: Summary statistics of neighborhood by immigrant typology. Neighborhoods are categorized by the percentage of the population who is foreign-born. Enclaves (high percentage foreign-born population) tend to have lower median household incomes, stronger connections to other neighborhoods (out-degree and in-degree), more commuter lines, and more population density, than native neighborhoods (low percentage foreign-born population).

In the first row, we show the results of a model that describes the strength of network connections only by our primary variable of interest: the description of the immigrant population of the sending neighborhood in relation to the description of the immigrant population in the receiving neighborhood. To conserve space on the graph and focus on the pairing of neighborhoods most pertinent to our analysis, we only show the results of pairs of connections that involve native or enclave neighborhoods. We see that, relative to relationships between native neighborhoods, relationships from enclave to native neighborhoods are significantly weaker in support of Hypothesis 1. In addition, the relationship between native neighborhoods and enclave neighborhoods is also significantly weaker than that between native and native neighborhoods in support of Hypothesis 2. The relationships between native to enclave neighborhoods and enclave to native neighborhoods are not statistically different from one another. Furthermore, the relationships between enclave neighborhoods and between native neighborhoods are not statistically different from one another.

The results of univariate models for each of our control variables are shown in the second row. Distance between neighborhoods had a strong negative relationship with neighborhood connectedness. This is in agreement with Hypothesis 3 and highlights the importance of close proximity as an indicator of strong connectedness between neighborhoods. Public transit has a positive effect on connectedness, in line with Hypothesis 4, however, population density had no effect on structural connectedness of neighborhoods. Median household income of the destination neighborhood has a significant, negative relationship with neighborhood connectedness. This result is in line with Hypothesis 5 and is in agreement with the work of previous studies of activity space which have found that high-income neighborhoods are less accessible compared to low-income neighborhoods. We also find that employment connections have a significantly positive relationship with neighborhood connectedness. This is in agreement with Hypothesis 6 and in line with previous work which claims that a substantial portion of activity space consists of home and work time.

In the last row, we show the result of a model which includes activity space segregation indicator variables as well as all control variables. After the introduction of other control variables, we find that neighborhood connectedness in the native to native category is stronger than other categories of neighborhood pairings. Specifically, when we evaluate our indicators of activity space segregation, enclave to native and native to enclave, we find that–even after the introduction of control variables–neighborhood connectedness between enclave and native neighborhoods remains significantly lower than native to native neighborhood connectedness. This is true when analyzing both native to enclave connections as well as enclave to native connections. This finding is in support of Hypothesis 3-6 and lends general support to the claim that immigrant-native activity space segregation is unique from other dimensions of segregation. All control variables remained significant and all but one control variable remained in the same direction. Public transit was the only variable that changed direction, now having a negative effect on connections after controlling for all other factors.

4.5 Discussion

The present study is the first to document activity space segregation between immigrant and native populations in a major US metropolitan area. We expand on the growing field of activity space research by examining the relationship between neighborhoods that are predominately occupied by immigrant populations and those

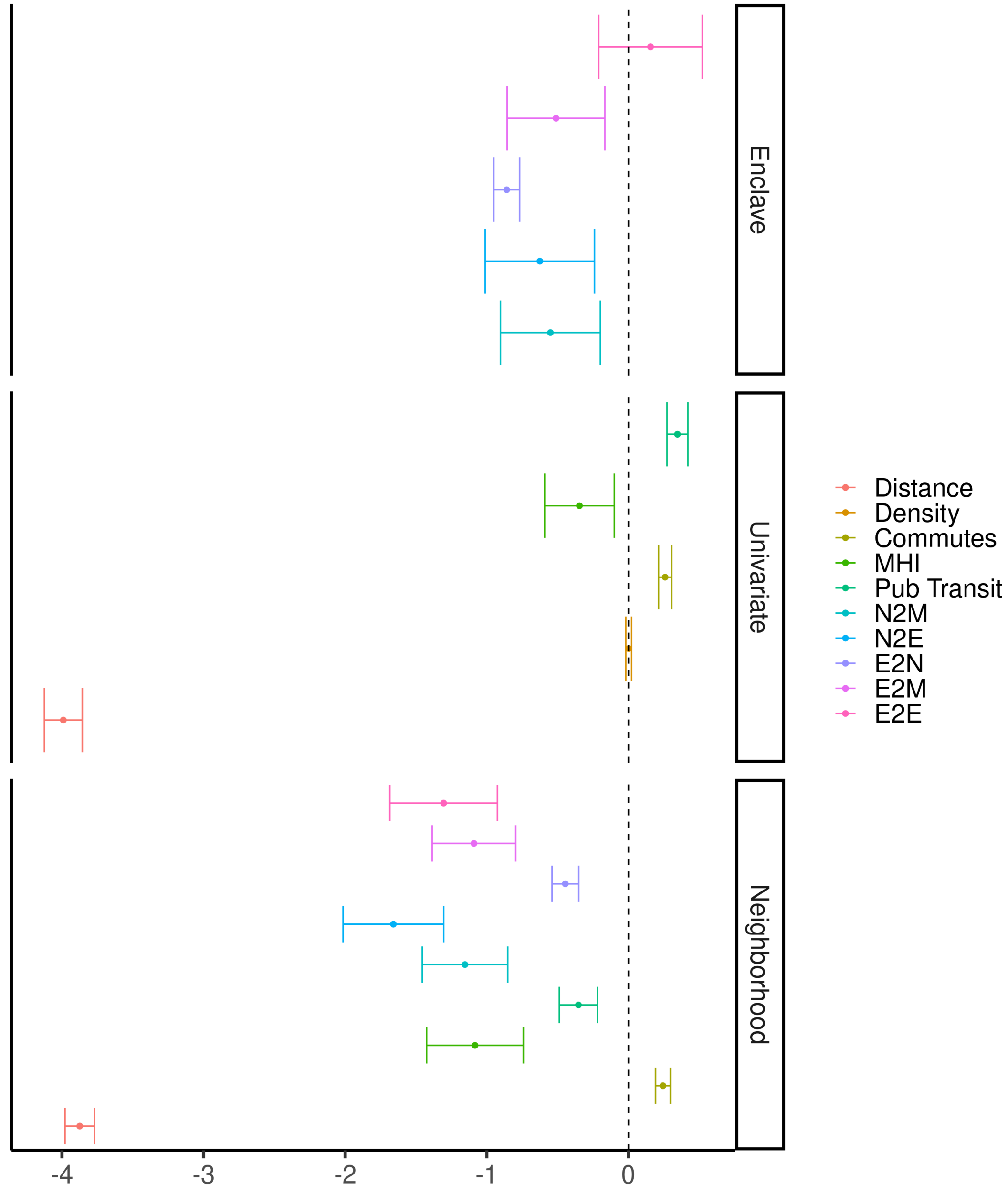

Figure 4.4: Model results from AME network regression. Each row signifies a separate model which was run while the color of each point represents variables. Bands represent 95% credible intervals calculated from Bayesian posterior.

neighborhoods with a predominately native-born population. Using a unique data set of digital trace data, we find that immigrant neighborhoods tend to have fewer activity space connections with native neighborhoods relative to the connections native neighborhoods have among themselves. When we examine the strength of the relationships between immigrant enclave and native neighborhoods, we find that the relationships between enclave to native and native to enclave neighborhoods are weaker than those between native neighborhoods. These findings suggest that the activity space patterns of individuals residing in native and enclave neighborhoods are segregated from one another, paralleling the patterns that have been observed in analyses of residential segregation.

We leveraged a unique data set, SafeGraph digital trace data from mobile phone devices, which–up until now–had not been used for neighborhood activity space research. We showed that these data provide sensible estimates of activity space patterns that follow temporal and geographic patterns that align with our understanding of how and when people move within cities. We show that these data are fairly representative of our analysis population, King County, Washington, as the number of mobile phones from each neighborhood in King County has a strong linear relationship with the number of residents of the neighborhood. In addition, when we use these data to construct measures of neighborhood connectedness between neighborhoods in King County, we find that levels of neighborhood connectedness correspond with previous findings from the activity space literature as assessed by our univariate regressions with constructed control variables. These findings add confidence in our ability to assess the mobility patterns of individuals across neighborhoods in King County.

Previous studies of activity space and neighborhood connectedness have found that neighborhoods have varying degrees of contentedness across metropolitan areas (Phillips et al., 2021) and that the racial and economic compositions of neighborhoods are strongly correlated with the strength of connections between neighborhoods (Candipan et al., 2021). This is the first study to empirically demonstrate that the strength of neighborhood connections is also associated with the degree to which neighborhoods are occupied by native-born or foreign-born individuals. We find that immigrant enclave neighborhoods have weaker relationships with native neighborhoods than native neighborhoods have with other native neighborhoods. Furthermore, we find that this relationship is driven both by individuals from enclave neighborhoods being isolated from native neighborhoods as well as individuals in native neighborhoods being isolated from immigrant enclave neighborhoods. Isolation of individuals residing in native neighborhoods from immigrant enclave neighborhoods supports theories of immigrant avoidance and place stratification. At the same time, the fact that individuals from immigrant enclave neighborhoods are isolated from native neighborhoods supports theories of social capital as a driving factor of immigrant spatial behaviors–namely, that immigrants are largely limited to spaces in which they share nativity with other individuals because these spaces allow them to leverage social capital (Logan et al., 2002).

Lastly, we show that activity space segregation of immigrants and natives is a unique measure of segregation, independent of other forms of segregation, and with its own driving factors. While previous studies have analyzed what explains structural connectedness variation across metropolitan areas (Phillips et al., 2021; Candipan et al., 2021), our study is the first to assess the relationship between neighborhood factors and their likelihood of connectedness to other neighborhoods within a metropolitan area. We find, that although measures pertaining to residential location and workplace commutes do explain some of the variations in the structural connectedness of neighborhoods, immigrant-native segregation still persists even after controlling for these factors. This finding suggests that although activity space segregation is correlated with residential and workplace patterns, and thus segregation, it is also a unique measure of segregation, meriting further investigation as suggested by other scholars (Sampson, 2019; Cagney et al., 2020).

While our study adds to the discussion of activity space segregation as it relates to immigrant populations, there are a number of limitations that should be considered. First, while our goal is to highlight how residents of immigrant neighborhoods and non-immigrant neighborhoods share activity space with one another, we do not actually observe the immigrant status of individuals themselves. An underlying assumption of this analysis is that reason activity space patterns of these neighborhoods are segregated stems from the social factors which have been found to isolate immigrants from non-immigrants in the residential sphere. These factors include employment, social connections, language barriers, etc., which affect the mobility of individuals differently depending on their immigration status. In this study, however, we only observe how individuals living in largely immigrant neighborhoods spend time in largely native neighborhoods. Our findings are important for understanding what describes the social connectedness of neighborhoods, and the impact that immigrant enclave neighborhoods have in describing variation in connectedness between neighborhoods. Nevertheless, future studies should seek to examine spatial activity space segregation of immigrant and non-immigrant populations at the individual level, and how immigrant activity space may differ from native activity space.

A second limitation is that this study uses data that were not collected via survey mechanisms and thus its representativeness comes into question. We highlight in this study that the data has patterns of representation that match the spatial residence representation of King County from representative survey data, has temporal patterns that align with our understanding of human mobility, and has patterns of connectedness that are aligned with other studies and data sources. The use of SafeGraph digital trace data appears to be promising for activity space research; however, future research should continue to assess the benefits and limitations of the data compared to other more traditional forms of activity space data collection.

Immigrant populations have long been shown to be segregated from native populations in their residential patterns and changing patterns of segregation have been used to assess the assimilation pathways of migrants. Our study finds that the segregation of immigrant and native populations extends beyond the residential space and is also reflected in daily activities in a manner that is unique from other forms of segregation. These findings suggest that immigrants are segregated from native populations in ways that are unique from past studies which have focused on residential and workplace segregation and efforts to assess immigrant-native segregation should also focus on activity space.

Chapter 5

CONCLUSION

In this dissertation, I analyze the continued mobility of immigrant populations. Social science research has disproportionately focused on international migration compared to other forms of mobility. Moreover, the literature regarding these two fields are siloed one another, despite international migration sharing many commonalities with other forms of mobility. This dissertation bridges the gap between literature about international migration and other forms of mobility and contributes to the relatively underdeveloped body of empirical research describing internal migration and mobility.

In chapter 2, I analyze how changes in international net-migration rates have drastically altered the demographic composition of the Mexican-born population in the US. Recent declines in net-migration between Mexico and the US have led to a relative stabilization in the number of Mexican-born individuals in the US. The age structure of the Mexican-born population, however, has drastically shifted with median age of the population jumping from 31.7 years in 1990 to 43 years in 2018. My analyses find that most of the population aging that has occurred for the Mexican-born, can be attributed to declines in the net-migration count and not a change to the demographic structure of net-migrants from Mexico to the US, such as a more elderly population coming from Mexico and a younger population leaving. If low net-migration from Mexico continues, the population will continue to substantially age.

This process will greatly shift our understanding of the Mexican-born population from one that, relative to the native-born population, is young, highly mobile, and has high labor force participation, to one that is old, stationary, and characterized by low-labor force participation rates.

In chapter 3, I move to analyzing internal-migration with a focus on how recently observed rates of internal migration decline in the US compare to the Mexican-born population's internal migration rates. Given that the Mexican-born population experiences a different set of push and pull factors that drive international migration, it is likely that the recently observed decline in internal migration should be different for the Mexican population. Indeed, I find that internal migration rates have declined for the Mexican-born population at a rate far greater than other foreign-born populations or the US native-born population. Whats more, factors found to explain migration declines among the general US population as whole do not well describe migration decline for the Mexican-born population. This finding highlights the uniqueness of the internal migration pressures that the Mexican-born population faces which are likely more aligned with Mexican international migration pressures rather than the internal migration pressures of other populations.

In chapter 4, I move to examining day-to-day mobility of immigrant populations in a major metropolitan area in the US, King County, Washington. In this study, I compare the activity space patterns from predominately foreign-born to predominately native-born neighborhoods to evaluate differences in day-to-day mobility patterns. To do so, I use a novel source of mobility data, SafeGraph digital trace data, which tracks the mobility patterns of individuals in a detailed geographic and temporal degree not possible with previous data collection efforts. I find that activity space patterns of immigrant and native neighborhoods are significantly segregated from one another, and are segregated from one another in a way that is unique to what is typically observed in residential and workplace segregation. I find that immigrant populations are confined to immigrant enclave neighborhoods in their daily mobility and that native populations are isolated from enclave neighborhoods. This finding suggests that the pull effect that enclave neighborhoods have on drawing migrants in through international migration continues to have a substantial impact on guiding the day-to-day mobility of those who reside within the enclave.

Studies of internal and international mobility share many commonalities and greater efforts should be made to link the literature. I show in this dissertation that the continued mobility of those who have gone through an international migration event are subject to pressures in their continued mobility which are distinct from the native population. These pressures are subject to change and may reshape the social and demographic structure of immigrant populations.

BIBLIOGRAPHY

Abel, G. J. (2013). Estimating global migration flow tables using place of birth data. *Demographic Research*, 28(18):505–546.

Abel, G. J. and Sander, N. (2014). Quantifying Global International Migration Flows. *Science*, 343(6178):1520–1522. Publisher: American Association for the Advancement of Science.

Aguila, E., Lee, Z., and Wong, R. (2021). Migration, work, and retirement: the case of Mexican-origin populations. *Journal of Pension Economics & Finance*, pages 1–21. Publisher: Cambridge University Press.

Alho, J. M. (2008). Migration, Fertility, and Aging in Stable Populations. *Demography*, 45(3):641–650.

Allen, J. P. and Turner, E. (1996). Spatial Patterns of Immigrant Assimilation. *The Professional Geographer*, 48(2):140–155. Publisher: Routledge _eprint: https://doi.org/10.1111/j.0033-0124.1996.00140.x.

Andersson, F., García-Pérez, M., Haltiwanger, J., McCue, K., and Sanders, S. (2014). Workplace Concentration of Immigrants. *Demography*, 51(6):2281–2306.

Aponte, R. (1996). Urban Employment and the Mismatch Dilemma: Accounting for the Immigration Exception. *Social Problems*, 43(3):268–283. Publisher: [Oxford University Press, Society for the Study of Social Problems].

Bacaër, N. (2011). Lotka and stable population theory (1907–1911). In Bacaër, N., editor, *A Short History of Mathematical Population Dynamics*, pages 55–58. Springer, London.

Bailey, A. J., Blake, M. K., and Cooke, T. J. (2004). Migration, Care, and the Linked Lives of Dual-Earner Households. *Environment and Planning A: Economy and Space*, 36(9):1617–1632. Publisher: SAGE Publications Ltd.

Balk, G. (2019). New milestone in King County: Immigrant population tops 500,000. *The Seattle Times*.

Bauer, T. K. and Sinning, M. (2008). An extension of the Blinder–Oaxaca decomposition to nonlinear models. *AStA Advances in Statistical Analysis*, 92(2):197–206.

Bijak, J., Kupiszewska, D., and Kupiszewski, M. (2008). Replacement Migration Revisited: Simulations of the Effects of Selected Population and Labor Market Strategies for the Aging Europe, 2002–2052. *Population Research and Policy Review*, 27(3):321–342.

Bloom, D. E. and Luca, D. L. (2016). The Global Demography of Aging: Facts, Explanations, Future. In Piggott, J. and Woodland, A., editors, *Handbook of the Economics of Population Aging*, volume 1, pages 3–56. North-Holland.

Bongaarts, J. (1999). Fertility Decline in the Developed World: Where Will It End? *American Economic Review*, 89(2):256–260.

Borjas, G. J. (2011). Social Security Eligibility and the Labor Supply of Older Immigrants. *Industrial and Labor Relations Review*, 64(3):485–501. Publisher: Sage Publications, Inc.

Bricka, S. and Bhat, C. R. (2006). Comparative Analysis of Global Positioning System–Based and Travel Survey–Based Data. *Transportation Research Record*, 1972(1):9–20. Publisher: SAGE Publications Inc.

Browning, C. R., Calder, C. A., Krivo, L. J., Smith, A. L., and Boettner, B. (2017). Socioeconomic Segregation of Activity Spaces in Urban Neighborhoods: Does Shared Residence Mean Shared Routines? *The Russell Sage Foundation journal of the social sciences : RSF*, 3(2):210–231.

Budiman, A., Tamir, C., Mora, L., and Noe-Bustamante, L. (2020). Facts on U.S. immigrants, 2018. Technical report, Pew Research Center, Washington D.C.

Bureau, U. C. (2018). The U.S. Joins Other Countries With Large Aging Populations. Section: Government.

Cadena, B. C. and Kovak, B. K. (2016). Immigrants Equilibrate Local Labor Markets: Evidence from the Great Recession. *American Economic Journal: Applied Economics*, 8(1):257–290.

Cagney, K. A., York Cornwell, E., Goldman, A. W., and Cai, L. (2020). Urban Mobility and Activity Space. *Annual Review of Sociology*, 46(1):623–648. _eprint: https://doi.org/10.1146/annurev-soc-121919-054848.

Candipan, J., Phillips, N. E., Sampson, R. J., and Small, M. (2021). From residence to movement: The nature of racial segregation in everyday urban mobility. *Urban Studies*, 58(15):3095–3117. Publisher: SAGE Publications Ltd.

Card, D. and Lewis, E. G. (2005). The Diffusion of Mexican Immigrants During the 1990s: Explanations and Impacts. Working Paper 11552, National Bureau of Economic Research. Series: Working Paper Series.

Cerone, P. (1987). On Stable Population Theory With Immigration. *Demography*, 24(3):431–438. Publisher: Springer.

Chen, J. J. (2006). Migration and Imperfect Monitoring: Implications for Intra-Household Allocation. *American Economic Review*, 96(2):227–231.

Cutler, D. M., Glaeser, E. L., and Vigdor, J. L. (2008). Is the Melting Pot Still Hot? Explaining the Resurgence of Immigrant Segregation. *The Review of Economics and Statistics*, 90(3):478–497.

Davis, B., Stecklov, G., and Winters, P. (2002). Domestic and International Migration from Rural Mexico: Disaggregating the Effects of Network Structure and Composition. *Population Studies*, 56(3):291–309. Publisher: [Population Investigation Committee, Taylor & Francis, Ltd.].

de Beer, J., Raymer, J., van der Erf, R., and van Wissen, L. (2010). Overcoming the Problems of Inconsistent International Migration data: A New Method Applied to Flows in Europe. *European Journal of Population = Revue Européenne de Démographie*, 26(4):459–481.

del Rey Poveda, A. (2007). Determinants and consequences of internal and international migration: The case of rural populations in the south of Veracruz, Mexico. *Demographic Research*, 16(10):287–314.

Durand, J., Massey, D. S., and Zenteno, R. M. (2001). Mexican Immigration to the United States: Continuities and Changes. *Latin American Research Review*, 36(1):107–127. Publisher: Latin American Studies Association.

Elliott, M. R., Raghunathan, T. E., and Schenker, N. (2018). Combining Estimates from Multiple Surveys. In *Wiley StatsRef: Statistics Reference Online*, pages 1–10. John Wiley & Sons, Ltd. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/9781118445112.stat08079.

Ellis, M. (2012). Reinventing US Internal Migration Studies in the Age of International Migration. *Population, Space and Place*, 18(2):196–208. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/psp.666.

Ellis, M. and Goodwin-White, J. (2006). 1.5 Generation Internal Migration in the U.S.: Dispersion from States of Immigration? *International Migration Review*, 40(4):899–926. Publisher: SAGE Publications Inc.

Ellis, M. and Wright, R. (1999). The Industrial Division of Labor among Immigrants and Internal Migrants to the Los Angeles Economy. *International Migration Review*, 33(1):26–54. Publisher: SAGE Publications Inc.

Ellis, M., Wright, R., and Parks, V. (2004). Work Together, Live Apart? Geographies of Racial and Ethnic Segregation at Home and at Work. *Annals of the Association of American Geographers*, 94(3):620–637. Publisher: Routledge _eprint: https://doi.org/10.1111/j.1467-8306.2004.00417.x.

Ellis, M., Wright, R., Townley, M., and Copeland, K. (2014). The migration response to the Legal Arizona Workers Act. *Political geography*, 42:46–56.

Espenshade, T. J. (1994). Can Immigration Slow U.S. Population Aging? *Journal of Policy Analysis and Management*, 13(4):759–768. Publisher: [Wiley, Association for Public Policy Analysis and Management].

Espenshade, T. J., Bouvier, L. F., and Arthur, W. B. (1982). Immigration and the Stable Population Model. *Demography*, 19(1):125–133. Publisher: Springer.

Fenelon, A. (2017). Rethinking the Hispanic Paradox: The Mortality Experience of Mexican Immigrants in Traditional Gateways and New Destinations. *The International migration review*, 51(3):567–599.

Fenelon, A., Chinn, J. J., and Anderson, R. N. (2017). A comprehensive analysis of the mortality experience of hispanic subgroups in the United States: Variation by age, country of origin, and nativity. *SSM - Population Health*, 3:245–254.

Flippen, C. A. and Farrell-Bryan, D. (2021). New Destinations and the Changing Geography of Immigrant Incorporation. *Annual Review of Sociology*, 47(1):479–500. _eprint: https://doi.org/10.1146/annurev-soc-090320-100926.

Foster, T. B. (2017). Decomposing American immobility: Compositional and rate components of interstate, intrastate, and intracounty migration and mobility decline. *Demographic Research*, 37(47):1515–1548.

Foster, T. B., Ellis, M. J., and Fiorio, L. (2018). Foreign-born and native-born migration in the U.S.: evidence from linked IRS administrative and census survey records. *Journal of Population Research*, 35(4):467–498. Num Pages: 467-498 Place: Dordrecht, Netherlands Publisher: Springer Nature B.V.

Frey, W. H. (2020). The nation is diversifying even faster than predicted, according to new census data. Technical report, Washington D.C.

Garip, F. (2016). *On the Move*. Princeton University Press, Princeton.

Goldstein, J. R. (2009). How Populations Age. In Uhlenberg, P., editor, *International Handbook of Population Aging*, International Handbooks of Population, pages 7–18. Springer Netherlands, Dordrecht.

Gonzalez-Barrera, A. (2015). More Mexicans Leaving Than Coming to the U.S.

Gutiérrez, R. A. (2019). Mexican Immigration to the United States. ISBN: 9780199329175.

Haas, H. d., Castles, S., and Miller, M. J. (2020). *The Age of Migration: International Population Movements in the Modern World*. The Guilford Press, sixth edition edition.

Hall, M., Singer, A., De Jong, G. F., and Graefe, D. R. (2011). The Geography of Immigrant Skills: Educational Profiles of Metropolitan Areas. Technical report, Brookings Institute, Washington D.C.

Hall, M. and Stringfield, J. (2014). Undocumented migration and the residential segregation of Mexicans in new destinations. *Social Science Research*, 47:61–78.

Hanselman, P. and Fiel, J. E. (2017). School Opportunity Hoarding? Racial Segregation and Access to High Growth Schools. *Social Forces*, 95(3):1077–1104. Publisher: Oxford University Press.

Hayward, M. D., Hummer, R. A., Chiu, C.-T., González-González, C., and Wong, R. (2014). Does the Hispanic Paradox in U.S. Adult Mortality Extend to Disability? *Population research and policy review*, 33(1):81–96.

Hellerstein, J. K. and Neumark, D. (2008). Workplace Segregation in the United States: Race, Ethnicity, and Skill. *The Review of Economics and Statistics*, 90(3):459–477.

Henderson, T. J. (2011). *Beyond Borders: A History of Mexican Migration to the United States*. John Wiley & Sons. Google-Books-ID: k_39DwAAQBAJ.

Hermalin, A. I. (1966). The Effect of Changes in Mortality Rates on Population Growth and Age Distribution in the United States. *The Milbank Memorial Fund Quarterly*, 44(4):451–469. Publisher: [Milbank Memorial Fund, Wiley].

Hernández-León, R. and Zúñiga, V. (2000). "Making Carpet by the Mile": The Emergence of a Mexican Immigrant Community in an Industrial Region of the U.S. Historic South. *Social Science Quarterly*, 81(1):49–66. Publisher: [University of Texas Press, Wiley].

Hernández-León, R. and Zúñiga, V. (2003). Mexican Immigrant Communities in the South and Social Capital: The Case of Dalton, Georgia. *Journal of Rural Social Sciences*, 19(1).

Hespanhol, L., Vallio, C. S., Costa, L. M., and Saragiotto, B. T. (2019). Understanding and interpreting confidence and credible intervals around effect estimates. *Brazilian Journal of Physical Therapy*, 23(4):290–301.

Hudson, K. (2007). The new labor market segmentation: Labor market dualism in the new economy. *Social Science Research*, 36(1):286–312.

Hughes, C., Zagheni, E., Abel, G. J., Sorichetta, A., Wi'sniowski, A., Weber, I., and Tatem, A. J. (2016). Inferring Migrations: Traditional Methods and New Approaches based on Mobile Phone, Social Media, and other Big Data: Feasibility study on Inferring (labour) mobility and migration in the European Union from big data and social media data. Monograph, WorldPop, Population, Health & Wellbeing, Southampton. Num Pages: 41 Publisher: European Union.

Hughey, M. W. (2017). Bad Hombres? The Implicit and Explicit Racialization of Immigration. *Humanity & Society*, 41(1):127–129. Publisher: SAGE Publications Inc.

Jensen, E. B., Bhaskar, R., and Scopillti, M. (2015). Demographic Analysis 2010: Estimates of Coverage of the Foreign-Born Population in the American Community Survey. Technical Report POP-WP103, US Census Bureau, Washington D.C. Section: Government.

Johnson, K. M. and Lichter, D. T. (2016). Diverging Demography: Hispanic and Non-Hispanic Contributions to U.S. Population Redistribution and Diversity. *Population Research and Policy Review*, 35(5):705–725.

Johnson, K. R. (2019). The New Latinx 'Repatriation'? Removals, Criminal Justice, and the Efforts to Remove Latinx Peoples from the United States. *UC Davis Legal Studies Research Paper*, page 40.

Johnston, M. F., Karageorgis, S., and Light, I. (2013). Mexican Population Growth in

New US Destinations: Testing and Developing Social Capital Theories of Migration using Census Data. *Journal of Ethnic and Migration Studies*, 39(9):1479–1505. Publisher: Routledge _eprint: https://doi.org/10.1080/1369183X.2013.815430.

Jones, M. and Pebley, A. R. (2014). Redefining neighborhoods using common destinations: social characteristics of activity spaces and home census tracts compared. *Demography*, 51(3):727–752.

Jones, R. C. (1995). Immigration Reform and Migrant Flows: Compositional and Spatial Changes in Mexican Migration after the Immigration Reform Act of 1986. *Annals of the Association of American Geographers*, 85(4):715–730. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1467-8306.1995.tb01822.x.

Kandel, W. and Parrado, E. A. (2005). Restructuring of the US Meat Processing Industry and New Hispanic Migrant Destinations. *Population and Development Review*, 31(3):447–471. Publisher: [Population Council, Wiley].

Kaplan, G. and Schulhofer-Wohl, S. (2017). Understanding the long-run decline in interstate migration. *International Economic Review*, 58(1):57–94.

Karahan, F. and Rhee, S. (2014). Population Aging, Migration Spillovers, and the Decline in Interstate Migration. Technical Report 699, Federal Reserve Bank of New York, New York.

King, R. and Skeldon, R. (2010). 'Mind the Gap!' Integrating Approaches to Internal and International Migration. *Journal of Ethnic and Migration Studies*, 36(10):1619–1646. Publisher: Routledge _eprint: https://doi.org/10.1080/1369183X.2010.489380.

Kitagawa, E. M. (1955). Components of a Difference Between Two Rates. *Journal of the American Statistical Association*, 50(272):1168–1194. Publisher: [American Statistical Association, Taylor & Francis, Ltd.].

Kritz, M. M., Gurak, D. T., and Lee, M.-A. (2011). Will They Stay? Foreign-Born Out-Migration from New U.S. Destinations. *Population research and policy review*, 30(4):537–567.

Krivo, L. J., Washington, H. M., Peterson, R. D., Browning, C. R., Calder, C. A., and Kwan, M.-P. (2013). Social Isolation of Disadvantage and Advantage: The Reproduction of Inequality in Urban Space. *Social Forces*, 92(1):141–164.

Leibbrand, C. E. (2019). *Race, Ethnicity, Gender, and the Pursuit of Economic Opportunity in the Age of the Migration Decline*. Thesis. Accepted: 2019-10-15T23:02:12Z.

Levchenko, Y. (2021). Aging into disadvantage: Disability crossover among Mexican immigrants in America. *Social Science & Medicine*, 285:114290.

Lichter, D. T. and Johnson, K. M. (2009). Immigrant Gateways and Hispanic Migration to New Destinations. *International Migration Review*, 43(3):496–518. Publisher: SAGE Publications Inc.

Lindstrom, D. P. and Lauster, N. (2001). Local Economic Opportunity and the Competing Risks of Internal and U.S. Migration in Zacatecas, Mexico. *The International Migration Review*, 35(4):1232–1256. Publisher: [Center for Migration Studies of New York, Inc., Wiley].

Logan, J. R. and Alba, R. D. (1993). Locational Returns to Human Capital: Minority Access to Suburban Community Resources. *Demography*, 30(2):243–268. Publisher: Springer.

Logan, J. R., Zhang, W., and Alba, R. D. (2002). Immigrant Enclaves and Ethnic Communities in New York and Los Angeles. *American Sociological Review*, 67(2):299–322. Publisher: [American Sociological Association, Sage Publications, Inc.].

Lumley, T. (2010). *Complex Surveys: A Guide to Analysis Using R*. Wiley, Hoboken, N.J, 1st edition edition.

Martin, P. (1995). Proposition 187 in California. *International Migration Review*, 29(1):255–263. Publisher: SAGE Publications Inc.

Martinez, O., Wu, E., Sandfort, T., Dodge, B., Carballo-Dieguez, A., Pinto, R., Rhodes, S. D., Moya, E., and Chavez-Baray, S. (2015). Evaluating the Impact of Immigration Policies on Health Status Among Undocumented Immigrants: A Systematic Review. *Journal of immigrant and minority health / Center for Minority Public Health*, 17(3):947–970.

Masferrer, C. and Roberts, B. R. (2012). Going Back Home? Changing Demography and Geography of Mexican Return Migration. *Population Research and Policy Review*, 31(4):465–496.

Masferrer, C. and Roberts, B. R. (2016). The Changing Patterns of Return Migration from the USA to Mexico and Their Policy Implications. In Leal, D. L. and Rodríguez, N. P., editors, *Migration in an Era of Restriction and Recession:*

Sending and Receiving Nations in a Changing Global Environment, Immigrants and Minorities, Politics and Policy, pages 235–258. Springer International Publishing, Cham.

Massey, D. S. (1987). The Ethnosurvey in Theory and Practice. *The International Migration Review*, 21(4):1498–1522. Publisher: [Center for Migration Studies of New York, Inc., Wiley].

Massey, D. S. (1988). Economic Development and International Migration in Comparative Perspective. *Population and Development Review*, 14(3):383–413. Publisher: [Population Council, Wiley].

Massey, D. S., Arango, J., Hugo, G., Kouaouci, A., Pellegrino, A., and Taylor, J. E. (1993). Theories of International Migration: A Review and Appraisal. *Population and Development Review*, 19(3):431–466. Publisher: [Population Council, Wiley].

Massey, D. S., Condran, G. A., and Denton, N. A. (1987). The Effect of Residential Segregation on Black Social and Economic Well- Being. *Social Forces*, 66(1):29–56. Publisher: Oxford University Press.

Massey, D. S., Durand, J., and Pren, K. A. (2014). Explaining Undocumented Migration to the U.S. *The International Migration Review*, 48(4):1028–1061. Publisher: [Center for Migration Studies of New York, Inc., Wiley].

Massey, D. S., Durand, J., and Pren, K. A. (2015). Border Enforcement and Return Migration by Documented and Undocumented Mexicans. *Journal of ethnic and migration studies*, 41(7):1015–1040.

Massey, D. S. and Espinosa, K. E. (1997). What's Driving Mexico-U.S. Migration? A Theoretical, Empirical, and Policy Analysis. *American Journal of Sociology*, 102(4):939–999. Publisher: University of Chicago Press.

McConnell, E. D. (2008). The U.S. Destinations of Contemporary Mexican Immigrants. *The International Migration Review*, 42(4):767–802. Publisher: [Center for Migration Studies of New York, Inc., Wiley].

Menjívar, C. (2006). Liminal Legality: Salvadoran and Guatemalan Immigrants' Lives in the United States. *American Journal of Sociology*, 111(4):999–1037. Publisher: The University of Chicago Press.

Menjívar, C. (2008). Educational Hopes, Documented Dreams: Guatemalan and Salvadoran Immigrants' Legality and Educational Prospects. *The ANNALS of the American Academy of Political and Social Science*, 620(1):177–193. Publisher: SAGE Publications Inc.

Michaelides, M. (2011). The effect of local ties, wages, and housing costs on migration decisions. *The Journal of Socio-Economics*, 40(2):132–140.

Minhas, S., Hoff, P. D., and Ward, M. D. (2016). A new approach to analyzing coevolving longitudinal networks in international relations. *Journal of Peace Research*, 53(3):491–505. Publisher: SAGE Publications Ltd.

Mitra, S. (1983). Generalization of the immigration and the stable population model. *Demography*, 20(1):111–115.

Molloy, R., Smith, C. L., and Wozniak, A. (2011). Internal Migration in the United

States. *The Journal of Economic Perspectives*, 25(3):173–196. Publisher: American Economic Association.

Molloy, R., Smith, C. L., and Wozniak, A. (2014). Declining Migration within the U.S.: The Role of the Labor Market. *National Bureau of Economic Research*, 20065.

Monras, J. (2020). Immigration and Wage Dynamics: Evidence from the Mexican Peso Crisis. *Journal of Political Economy*, 128(8):3017–3089. Publisher: The University of Chicago Press.

Montes de Oca, V., García, T. R., Sáenz, R., and Guillén, J. (2011). The Linkage of Life Course, Migration, Health, and Aging: Health in Adults and Elderly Mexican Migrants. *Journal of Aging and Health*, 23(7):1116–1140. Publisher: SAGE Publications Inc.

Neal, Z. P. (2012). *The Connected City: How Networks are Shaping the Modern Metropolis*. Routledge, New York.

Noe-Bustamante, L., Flores, A., and Shah, S. (2019). Facts on Hispanics of Mexican origin in the United States, 2017. Technical report, Pew Research Center, Washington D.C.

Ocampo, A. and Flippen, C. (2021). Racial Attitudes among Latino Immigrants in Durham, NC. *Social science research*, 94:102504.

Olmstead, K. (2017). A third of Americans live in a household with three or more smartphones. Technical report, Pew Research Center, Washington D.C.

Olson, K., Wagner, J., and Anderson, R. (2021). Survey Costs: Where are We and What is the Way Forward? *Journal of Survey Statistics and Methodology*, 9(5):921–942.

Oswald, F. (2019). The effect of homeownership on the option value of regional migration. *Quantitative Economics*, 10(4):1453–1493. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.3982/QE872.

Pais, J., South, S. J., and Crowder, K. (2012). Metropolitan Heterogeneity and Minority Neighborhood Attainment: Spatial Assimilation or Place Stratification? *Social problems*, 59(2):258–281.

Palloni, A., Massey, D., Ceballos, M., Espinosa, K., and Spittel, M. (2001). Social Capital and International Migration: A Test Using Information on Family Networks. *American Journal of Sociology*, 106(5):1262–1298. Publisher: The University of Chicago Press.

Park, J. and Iceland, J. (2011). Residential segregation in metropolitan established immigrant gateways and new destinations, 1990–2000. *Social Science Research*, 40(3):811–821.

Parrado, E. A. and Ocampo, A. N. (2019). Continuities and Changes in the Processes of Mexican Migration and Return. *The Annals of the American Academy of Political and Social Science*, 684(1):212–226.

Paul, A. M. (2011). Stepwise International Migration: A Multistage Migration Pattern for the Aspiring Migrant. *American Journal of Sociology*, 116(6):1842–86. Publisher: The University of Chicago Press.

Paulin, G. (2018). Housing and expenditures: before, during, and after the bubble : Beyond the Numbers: U.S. Bureau of Labor Statistics. Technical report, US Bureau of Labor Statistics, Washington D.C.

Phillips, J. A. and Massey, D. S. (2000). Engines of Immigration: Stocks of Human and Social Capital in Mexico. *Social Science Quarterly*, 81(1):33–48. Publisher: [University of Texas Press, Wiley].

Phillips, N. E., Levy, B. L., Sampson, R. J., Small, M. L., and Wang, R. Q. (2021). The Social Integration of American Cities: Network Measures of Connectedness Based on Everyday Mobility Across Neighborhoods. *Sociological Methods & Research*, 50(3):1110–1149. Publisher: SAGE Publications Inc.

Portes, A. (1987). *What's an Ethnic Enclave?: The Case for Conceptual Clarity.* Google-Books-ID: 2MDAngEACAAJ.

Preston, S., Heuveline, P., and Guillot, M. (2000). *Demography: Measuring and Modeling Population Processes.* Wiley-Blackwell, Malden, MA, 1st edition edition.

Preston, S. H., Himes, C., and Eggers, M. (1989). Demographic Conditions Responsible for Population Aging. *Demography*, 26(4):691–704.

Raymer, J. (2007). The Estimation of International Migration Flows: A General Technique Focused on the Origin-Destination Association Structure. *Environment and Planning A: Economy and Space*, 39(4):985–995. Publisher: SAGE Publications Ltd.

Raymer, J., de Beer, J., and van der Erf, R. (2011). Putting the Pieces of the Puzzle Together: Age and Sex-Specific Estimates of Migration amongst Countries in the

EU/EFTA, 2002–2007. *European Journal of Population / Revue européenne de Démographie*, 27(2):185–215.

Riosmena, F. and Massey, D. S. (2012). Pathways to El Norte: Origins, Destinations, and Characteristics of Mexican Migrants to the United States. *The International migration review*, 46(1):3–36.

Salt, J. and Kitching, R. (1992). The relationship between international and internal labour migration. In *Migration Processes and Patterns: Research Progress and Prospects*, volume 1, pages 148–162. Belhaven, London.

Sampson, R. J. (2019). Neighbourhood effects and beyond: Explaining the paradoxes of inequality in the changing American metropolis. *Urban Studies*, 56(1):3–32. Publisher: SAGE Publications Ltd.

Sampson, R. J. and Levy, B. L. (2020). Beyond Residential Segregation: Mobility-Based Connectedness and Rates of Violence in Large Cities. *Race and Social Problems*, 12(1):77–86.

Schachner, J. N. (2021). Racial Stratification and School Segregation in the Suburbs: Evidence from Los Angeles County. *Social Forces*, page soab128.

Singer, A. (2004). The Rise of New Immigrant Gateways. Technical report, Brookings Institute, Washington D.C.

Skeldon, R. (2017). Internal and international migration: Separate or integrated systems? In Liu-Farrer, G. and Yeoh, B. S., editors, *Routledge Handbook of Asian Migrations*, pages 173–183. Routledge, London. Num Pages: 11.

Strömgren, M., Tammaru, T., Danzer, A. M., van Ham, M., Marcińczak, S., Stjernström, O., and Lindgren, U. (2014). Factors Shaping Workplace Segregation Between Natives and Immigrants. *Demography*, 51(2):645–671.

US Census Bureau (2022). Longitudinal Employer-Household Dynamics Origin-Destination Employment Statistics.

Van Hook, J., Zhang, W., D. Bean, F., and S. Passel, J. (2006). Foreign-born emigration: A new approach and estimates based on matched CPS files. *Demography*, 43(2):361–382.

Vicino, T. J., Hanlon, B., and Short, J. R. (2011). A Typology of Urban Immigrant Neighborhoods. *Urban Geography*, 32(3):383–405. Publisher: Routledge _eprint: https://doi.org/10.2747/0272-3638.32.3.383.

Wang, F., Wang, J., Cao, J., Chen, C., and Ban, X. J. (2019). Extracting trips from multi-sourced data for mobility pattern analysis: An app-based data example. *Transportation Research Part C: Emerging Technologies*, 105:183–202.

Wang, Q., Phillips, N. E., Small, M. L., and Sampson, R. J. (2018). Urban mobility and neighborhood isolation in America's 50 largest cities. *Proceedings of the National Academy of Sciences of the United States of America*, 115(30):7735–7740.

Wilson, K. L. and Portes, A. (1980). Immigrant Enclaves: An Analysis of the Labor Market Experiences of Cubans in Miami. *American Journal of Sociology*, 86(2):295–319.

Wong, D. W. S. and Shaw, S.-L. (2011). Measuring segregation: an activity space approach. *Journal of geographical systems*, 13(2):127–145.

Xie, Y. and Gough, M. (2011). Ethnic Enclaves and the Earnings of Immigrants. *Demography*, 48(4):1293–1315.

Zabin, C. and Hughes, S. (1995). Economic Integration and Labor Flows: Stage Migration in Farm Labor Markets in Mexico and the United States. *The International Migration Review*, 29(2):395–422. Publisher: [Center for Migration Studies of New York, Inc., Wiley].

Zagheni, E. and Weber, I. (2015). Demographic research with non-representative internet data. *International Journal of Manpower*, 36(1):13–25. Publisher: Emerald Group Publishing Limited.

Appendix A

ADDITIONAL TABLES AND FIGURES

	King County	National
All Households	.908 (.004)	.828 (.002)
Sex		
Female	.893 (.006)	.818 (.002)
Male	.922 (.004)	.838 (.002)
Age		
15-34	.986 (.003)	.969 (.001)
35-44	.984 (.003)	.961 (.001)
45-64	.936 (.005)	.882 (.002)
65+	.730 (.011)	.623 (.003)
Nativity		
Foreign-Born	.935 (.006)	.881 (.001)
Native-Born	.900 (.005)	.820 (.002)
Household Income		
¡$25,000	.706 (.016)	.621 (.003)
$25,000-$49,999	.803 (.013)	.760 (.003)
$50,000-$99,999	.912 (.007)	.881 (.002)
$100,000-$149,999	.968 (.005)	.946 (.001)
$150,000+	.984 (.002)	.962 (.001)

Table A.1: 2018 American Community Survey estimates of proportion of households who own a smart phone. Data is reported for both King County as well as the US national population. Data is linked to head of household and proportion of households which own a smart phone is reported by demographics of head of household. Standard error is reported in parenthesis.

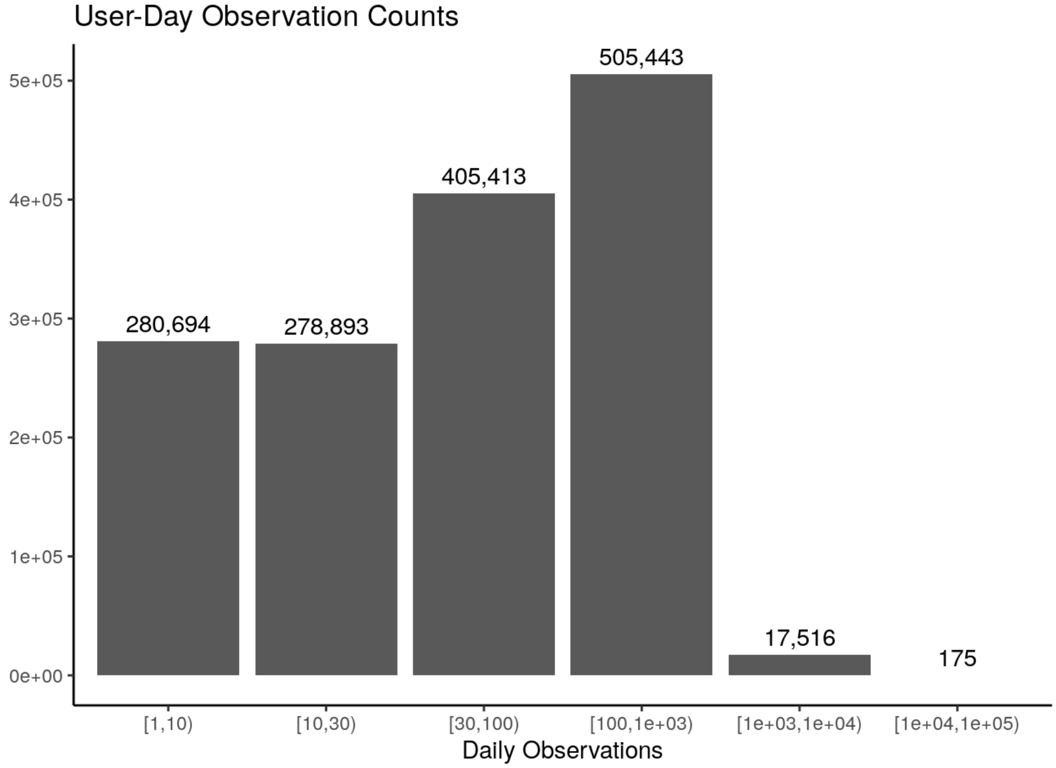

Figure A.1: Count of the number of users observed by how many daily observations were recorded. Most individuals were observed between 100-1000 times a day.

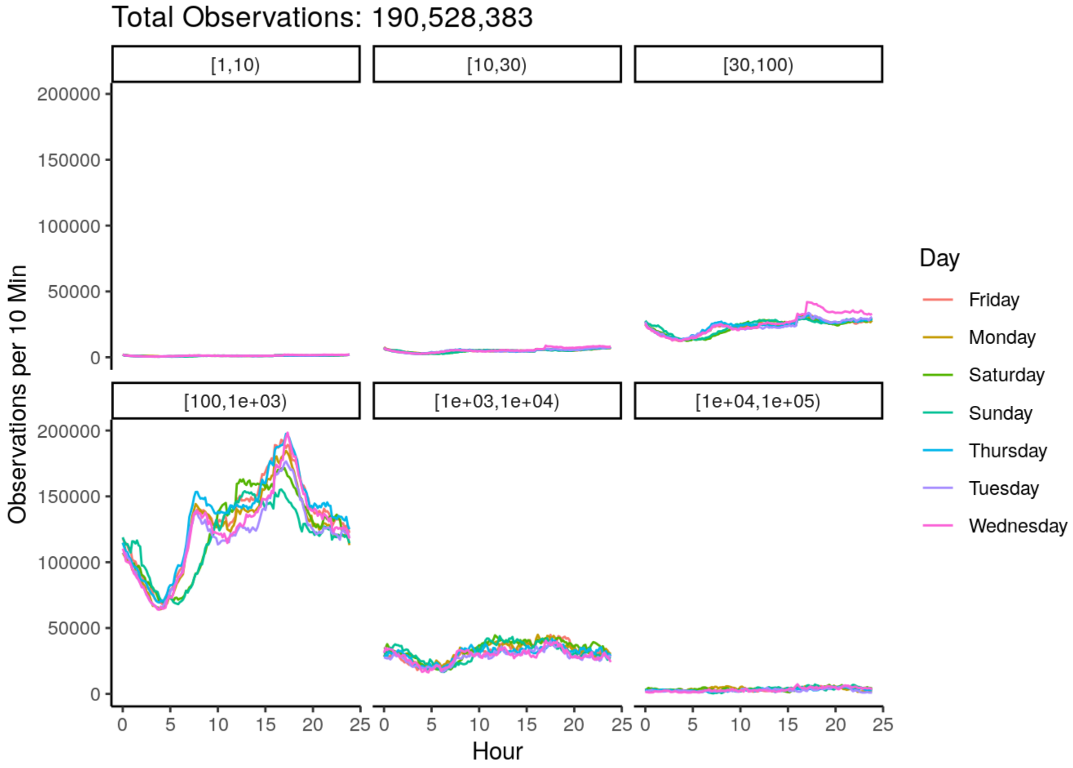

Figure A.2: Observations by time of day, day of week, and how many observations were recorded per day by the user. Most observations occurred during the hours of 15:00-20:00.

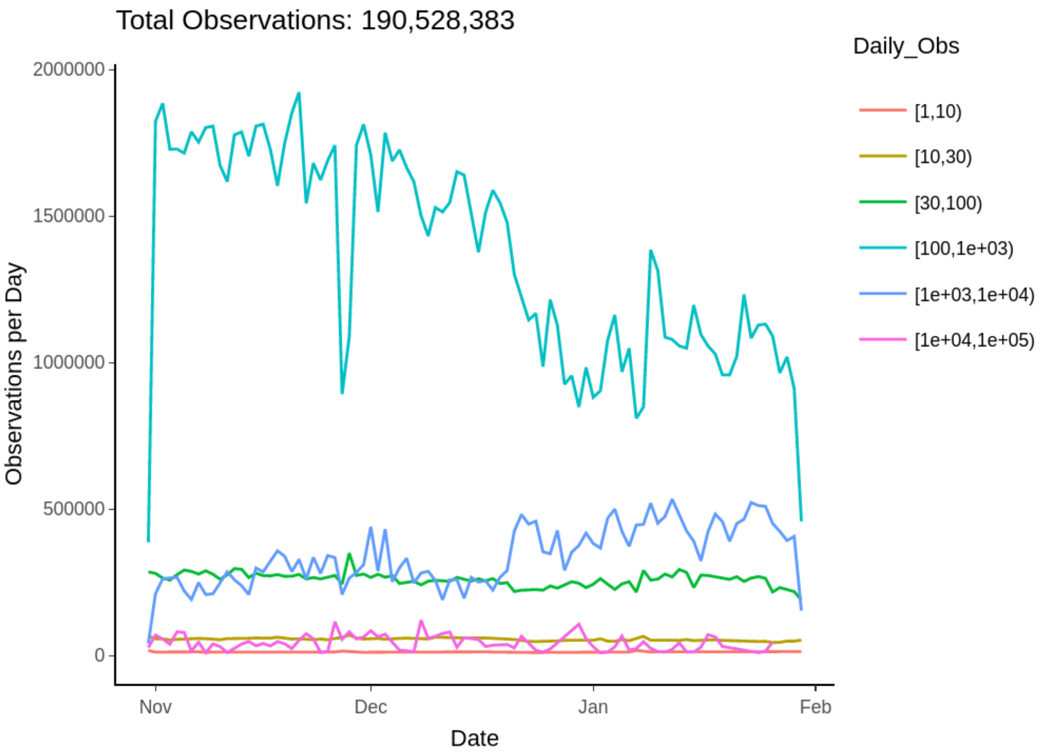

Figure A.3: Observations by day over the duration of the data collection period. Daily observations are grouped by how frequently a user pings in a day. Data points observed fall slightly over the data collection period.

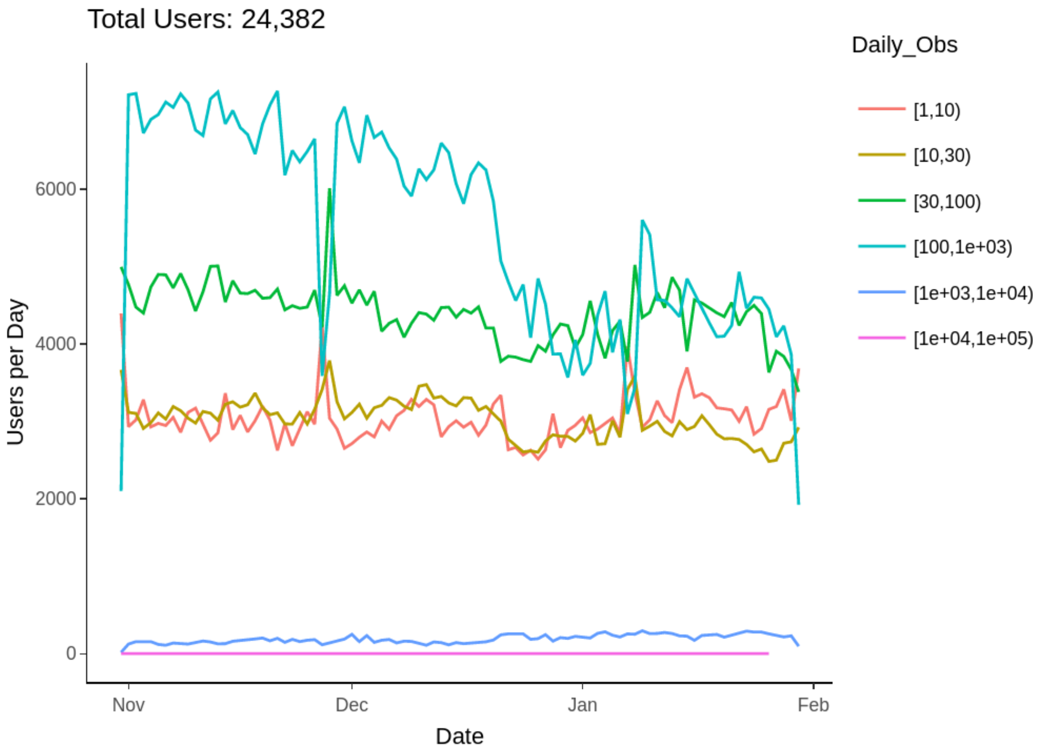

Figure A.4: Users observed by day over the duration of the data collection period. User counts are grouped by how frequently a user pings in a day. Data points observed fall slightly over the data collection period.

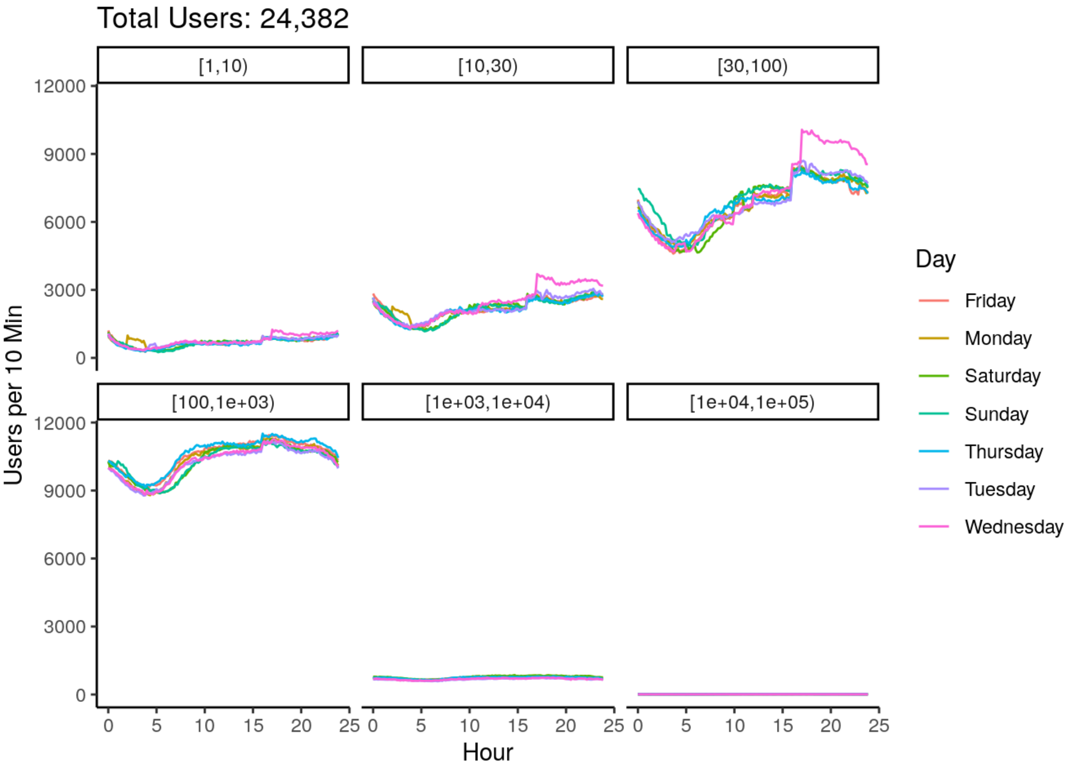

Figure A.5: Number of users by time of day, day of week, and how many observations were recorded per day by the user. Number of users observed peaked at 17:00.

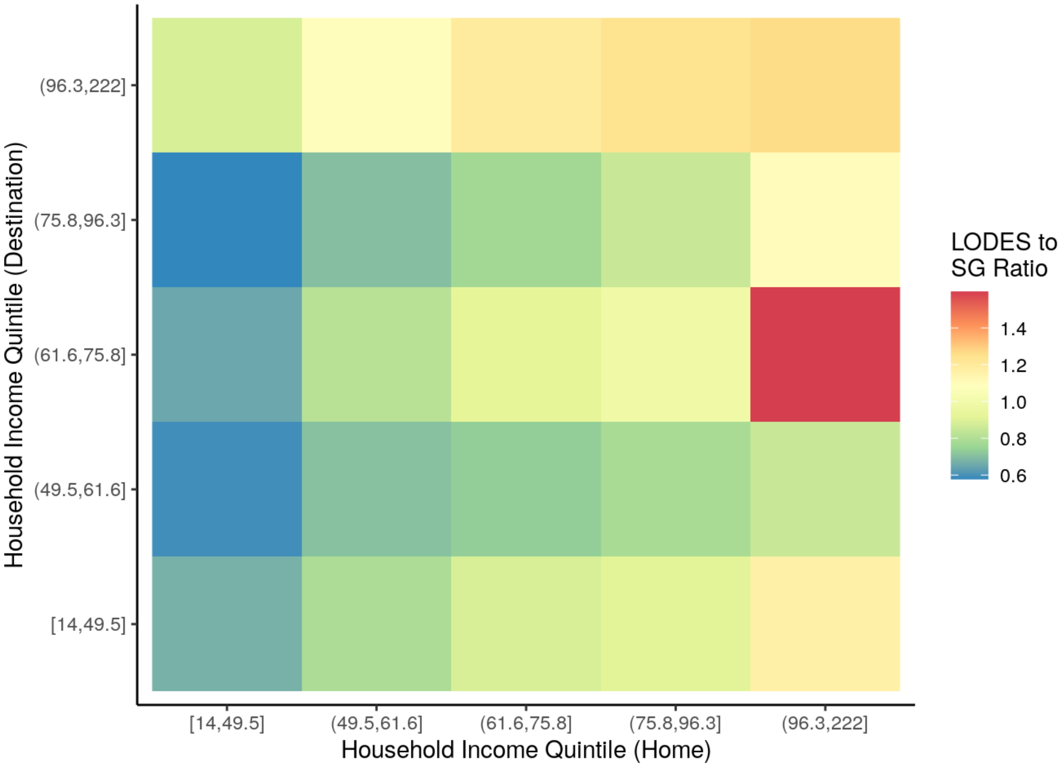

Figure A.6: Ratio of distribution between connections from neighborhoods for Safe Graph and LODES by median household income (MHI) of neighborhood. LODES data represents home to work commutes while Safe Graph represents activity space. Safe Graph data has a greater representation of individuals originating from lower MHI neighborhoods while LODES has greater representation from high income neighborhoods.

Figure A.7: Ratio of distribution between connections from neighborhoods for Safe Graph and LODES by majority racial or ethnic group of neighborhood. LODES data represents home to work commutes while Safe Graph represents activity space. Safe Graph data has a greater representation of individuals originating from majority Black and Hispanic neighborhoods while LODES has greater representation from White and Asian neighborhoods.

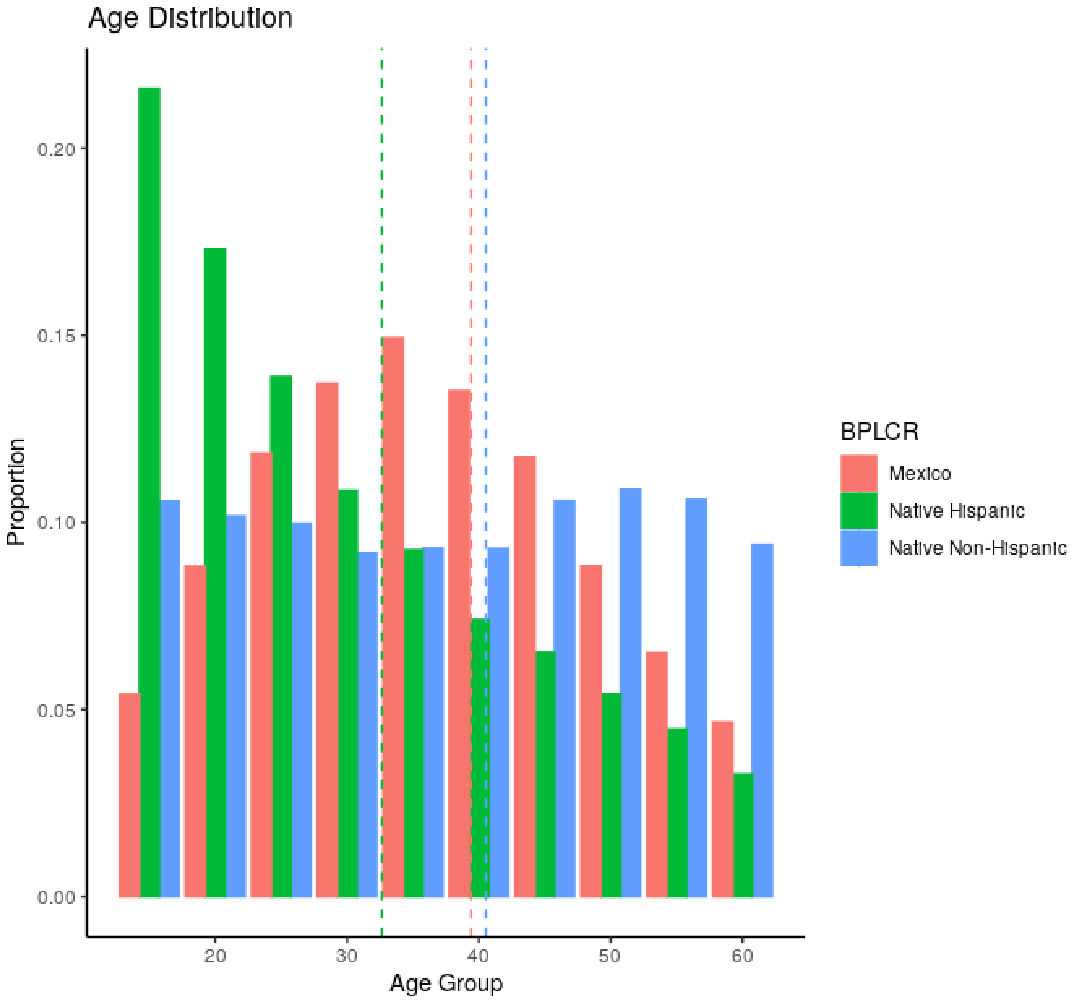

Figure A.8: Age distribution of populations by birthplace and ethnicity for years 2000-2018. Median age of each population is shown in the dotted lines. The native-Hispanic population is substantially left skewed in its age distribution compared to either the Mexican-born or native Non-Hispanic population.

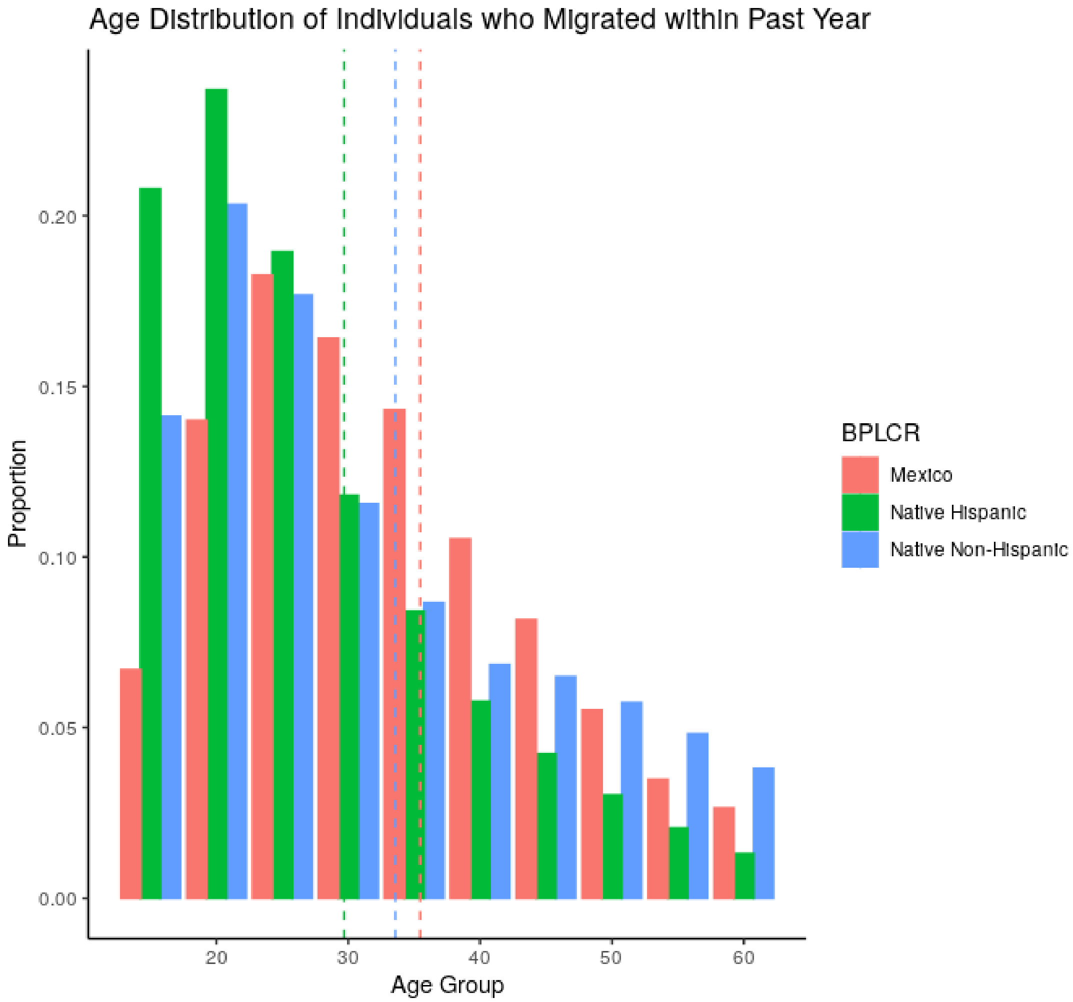

Figure A.9: Age distribution of populations who migrated county in the past year by birthplace and ethnicity for years 2000-2018. Median age of each population migrating is shown in the dotted lines.

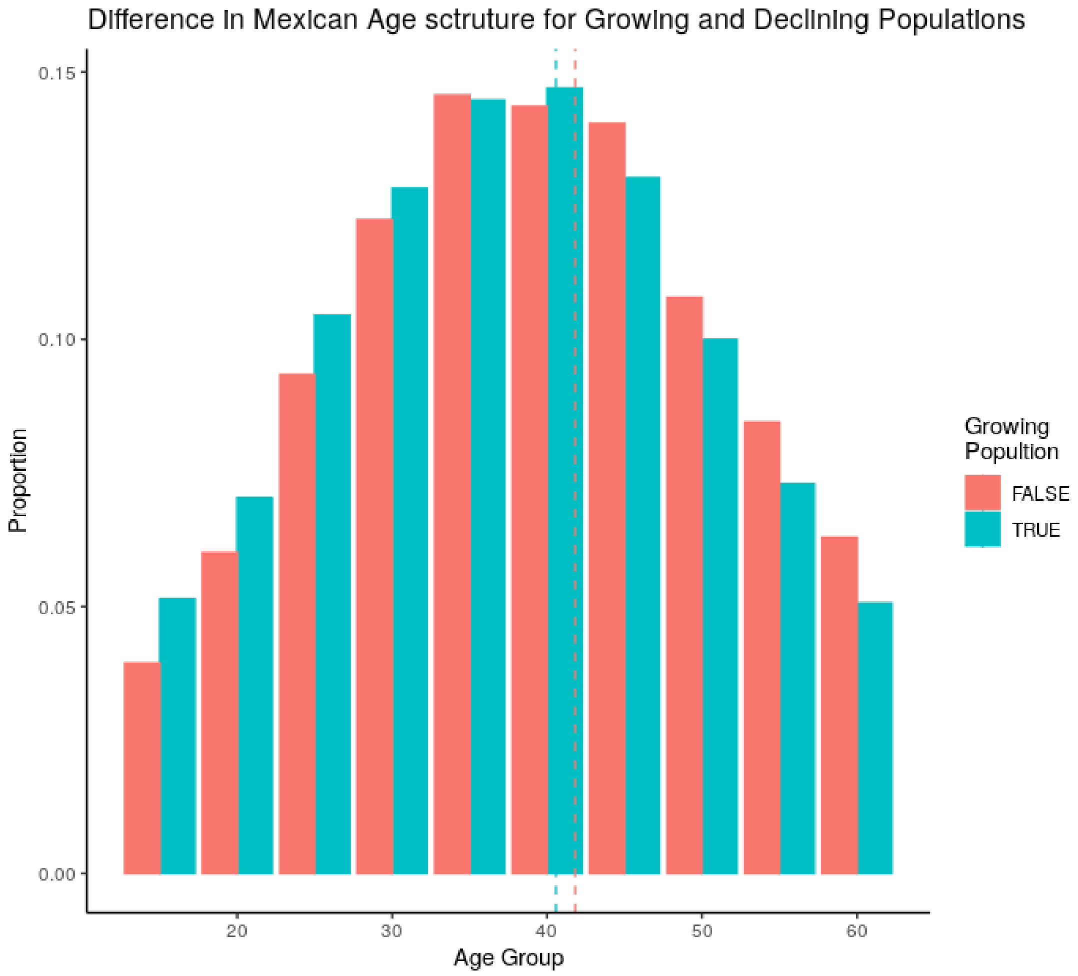

Figure A.10: Age distribution of Mexican-born population in the United States group by counties experiencing population growth or population decline.

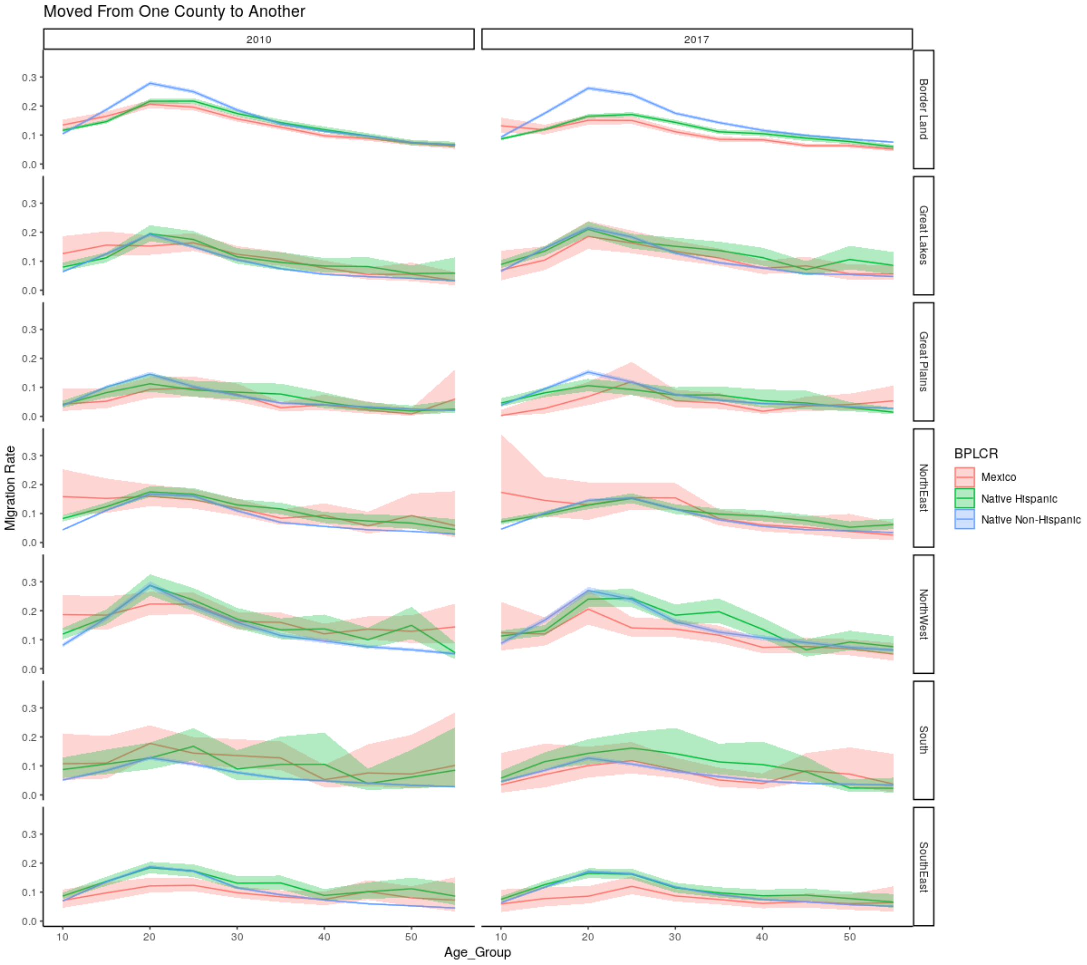

Figure A.11: Age specific rate of county migration by region of destination, birthplace and ethnicity for years 2000-2018. Migration rates have less variance across ages for the Mexican population.

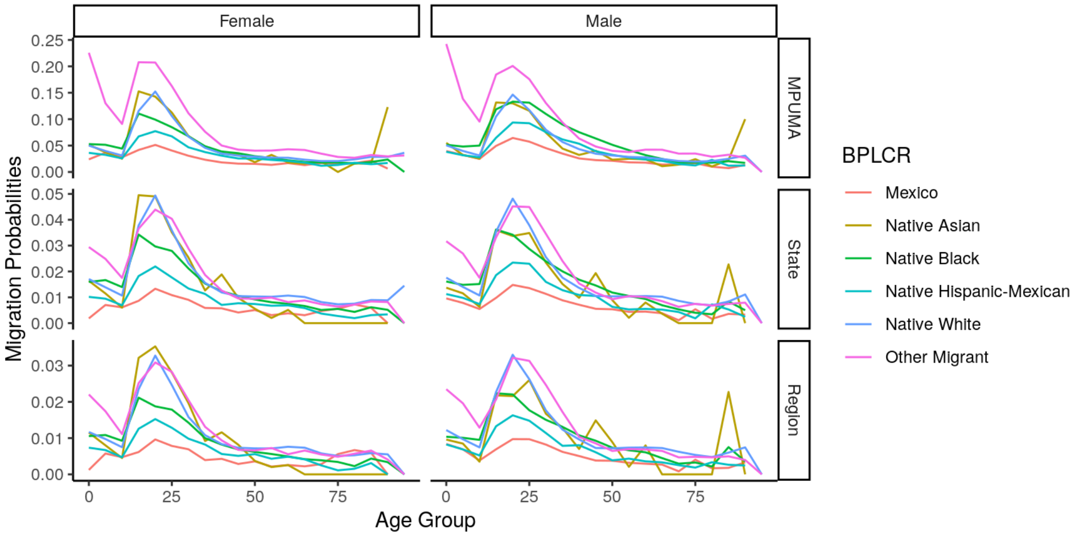

Figure A.12: Age specific rate of county migration by region of destination, birthplace, race, and ethnicity for years 2000-2018. Migration rates have less variance across ages for the Mexican population across all geographic levels.

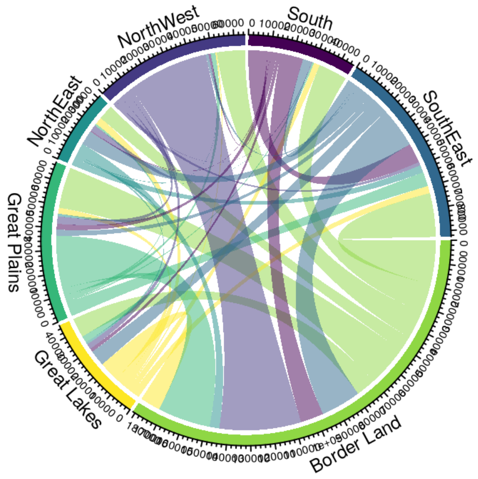

Figure A.13: Circle diagram of migration flows from 2000-2018 of Mexican-born population in the US between regions. Each stream represents a move from one US state to another with colors representing region of origin.