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Brother can you Spare a Ride? Carpooling in Immigrant Neighbourhoods

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Abstract

Immigrants are more likely to travel by carpool than the US-born. Strong ethnic ties within immigrant communities may contribute to immigrants' propensity to carpool, enabling residents to find carpool partners more easily and increasing the likelihood that residents will travel to and from common destinations. Drawing on data from the 2000 US census and a 2001 regional travel survey, this paper examines whether residents of ethnic neighbourhoods in Southern California are more likely to carpool than other residents. A strong positive relationship is found between the percentage foreign-born in a census tract and carpooling rates. Analysis of individual data shows that this relationship is strongest for immigrants who live in immigrant neighbourhoods; immigrants living in non-immigrant neighbourhoods are less likely to carpool. These findings suggest an important role for social networks in travel behaviour and the potential benefits of linking land use to the specific needs of local residents.

Keywords: carpooling, immigrants, immigrant neighbourhoods, social networks, travel behaviour

1. Introduction

Many urban planners promote compact, mixed-use neighbourhoods—communities where homes, workplaces, shopping and other destinations are located within walking distance of each other—as one component of a broader sustainable development strategy. Among other benefits, some scholars and advocates argue that these neighbourhoods have the potential to reduce congestion by promoting fewer and shorter trips and alternative modes of travel (Cervero and Gorham, 1995). With their

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mix of ethnic residents, businesses, services and community institutions, ethnic enclaves share many of the characteristics of these mixed-use neighbourhoods. In these neighbourhoods, ethnic ties connect residents to adjacent jobs, services and retail opportunities (Choldin, 1973; Portes and Manning, 1986). Consequently, residents of ethnic neighbourhoods should exhibit different travel patterns than would residents of other neighbourhoods.

Indeed, previous research has repeatedly found that immigrants do travel differently from non-immigrants; they are less likely to use cars and, conversely, more likely to use alternative modes of transport. A growing number of scholars have explored various explanations for these disparities in travel behaviour and, in particular, mode choice (Myers, 1997; Pisarski, 2006; Cline *et al.*, 2009; Kim, 2009; Blumenberg and Smart, 2010; Tal and Handy, 2010; Smart, 2010). The statistical models in these studies *only* uncover that there is a difference between the US-born and the foreign-born after controlling for a number of common covariates such as income and residential density. In this study, we explore this 'immigrant effect' further by examining whether some of this unexplained variation might be associated with immigrants' residential location in immigrant neighbourhoods where, we hypothesise, they might be more likely to rely on ethnic social networks both to form and use carpools.

Specifically, we model the commute travel of immigrants in Southern California, which we define as the Los Angeles Consolidated Metropolitan Area (CMSA), composed of Los Angeles, Orange, San Bernardino, Riverside and Ventura counties. First, we use census-tract-level data to examine whether residents of ethnic neighbourhoods are more likely to carpool than other workers, controlling for a set of factors predicted to influence commute mode choice. We find a strong positive relationship between the percentage foreign-born in the tract and carpooling rates. We then use regional travel survey data—data on the travel of individuals—to test whether immigrants living in immigrant neighbourhoods are more likely to carpool than immigrants living in non-immigrant neighbourhoods. Analysis of the microdata shows that this relationship is strongest for immigrants who live in immigrant neighbourhoods; immigrants living in non-immigrant neighbourhoods are *less* likely to carpool than the US-born. These findings suggest an important role for social networks in understanding travel behaviour.

2. Immigrants, Carpooling and Social Networks

Carpooling is significantly higher among immigrants than the US-born (Myers, 1997; Cutler *et al.*, 2008; Chatman and Klein, 2009; Cline *et al.*, 2009; Kim, 2009; Blumenberg and Smart, 2010). In general, carpooling rates among immigrants decline with length of residence in the US (Cline *et al.*, 2009; Kim, 2009; Blumenberg and Smart, 2010). However, they remain higher than among US-born adults even after many years of residence in the US Despite the prevalence of immigrant carpooling, little is known about *why* immigrants are more likely to carpool than the US-born. The carpooling literature focuses on three groups of explanatory factors—individual and household characteristics, trip characteristics and residential location. A small body of literature has developed around a fourth factor, the presence and strength of social networks.

In addition to years in the U.S, the carpooling literature suggests that other characteristics of immigrants such as their country of origin, sex, economic status and household structure to contribute to their

higher rates of carpooling (Teal, 1987; Ferguson, 1997; Charles and Kline, 2006). For example, we know that income is positively related to the likelihood of solo driving; therefore, if immigrants, on average, have lower incomes than US-born workers, they would be, all else equal, more likely to carpool as well as rely on other low-cost transport modes such as public transit and walking. Certainly, income plays an important role in mode-choice decisions; yet statistical models predicting the probability of carpooling among immigrants show that immigrants remain more likely to carpool even controlling for income as well as other personal characteristics such as household size (Cline *et al.*, 2009; Blumenberg and Smart, 2010). Similarly, immigrant households tend to be larger, on average, than other households (Grieco *et al.*, 2012). Studies of carpooling find that carpooling is positively associated with marriage (Teal, 1987; Charles and Kline, 2006), women with small children (Ferguson, 1997) and workers in households with older children (Ferguson, 1997).

With respect to trip types and residential location, carpoolers tend to make longer trips than solo drivers (Teal, 1987; Ferguson, 1997). Carpooling is also negatively related to residential density and metropolitan area size (Teal, 1987; Ferguson, 1997; Charles and Kline, 2006) since in many large and dense urban areas public transit serves as a reasonable substitute for travel by automobile. Although they are dispersing over time, immigrants still concentrate in large urban areas (Wilson and Singer, 2011). They also remain more likely to live in dense, central-city neighbourhoods (49 per cent) than are the US-born (36 per cent) (US Census Bureau, 2010).

Additionally, ethnic neighbourhoods may represent a beneficial environment for the creation of racially, culturally and linguistically based social capital necessary for the formation and use of carpools. Successive waves of immigration have engendered the formation of ethnic-specific migrant networks, relationships cemented by kinship, friendship, community of origin and shared language and cultural traditions (Tilly and Brown, 1967). These networks offset the costs associated with migration by providing prospective migrants with information on opportunities and, upon arrival, assistance with accommodation, employment and other services (Choldin, 1973; Portes and Bach, 1985; Boyd, 1989; Massey, 1990).

Ethnic networks are also a source of transport assistance. In a study of immigrants to Chicago, Choldin (1973) finds that 18 per cent of immigrants received transport assistance when they arrived: 69 per cent of these from family members (either immediate family or other relatives) and 25 per cent from friends, co-workers or neighbours. In her examination of the receipt of private transport assistance, Hao (2003) finds that three immigrant groups—Mexicans, Filipinos and Vietnamese—are significantly more likely to receive private transport assistance than non-Hispanic Whites. Further, she finds that contact with co-ethnics increases the likelihood of receiving private transport support. Blumenberg and Smart (2010) show that, among recent immigrants (those in the US less than 5 years) who travelled by carpool, 72 per cent of trips included only family members who lived in their household, while 28 per cent of trips included at least one non-family member. Overall, immigrants were more likely to engage in both types of carpooling—within and across households—than US-born adults.

Some ethnic networks are spatially bounded and operate through specific communities or neighbourhoods, in theory further facilitating the use of carpools for both work and non-work related travel. Immigrants—particularly recent immigrants—often co-locate in ethnic neighbourhoods to share social networks and resources more

easily. In statistical models of the determinants of residential location choice among immigrants, the presence of other foreign-born residents consistently is the primary determinant of initial location choice (Zavodny, 1999; Chiswick and Miller, 2004; Åslund, 2005). Historically, many ethnic neighbourhoods emerged in central cities—ports of entry for migrants to the US. Although the countries of origin of residents of these neighbourhoods have shifted over time, some continue to serve as residential gateways to life in the US. Consequently, immigrant groups continue to experience substantial segregation and isolation from US-born residents (Chiswick and Miller, 2004; Cutler *et al.*, 2008; Iceland and Scopilliti, 2008).

It is in neighbourhoods with high concentrations of immigrants where

> socially, such clusters may form the institutional core of the immigrant culture and the nexus of its communal intercourse (Galster *et al.*, 1999, p. 409).

Many ethnic neighbourhoods are principally residential. Others include a mix of residents and ethnic-specific businesses and services. Ethnic enclaves form as ethnic firms agglomerate around consumers of ethnic goods and services, as well as around preferred ethnic labour. For immigrants, businesses in these enclaves offer ethnic-specific specialty goods and services, as well as opportunities for nearby employment with co-ethnics (Light *et al.*, 1994; Li, 1998; Zhou, 2004). The agglomeration of ethnic firms and residents provides a nexus in the city-region for the production and maintenance of social networks to facilitate the ethnic economy. These enclaves can offer one-stop shopping experiences similar to those found at shopping malls and centres, while providing ethnic goods and services not readily available outside the enclave.

Just as new immigrants co-locate in ethnic neighbourhoods to share social networks, they also may be more likely to use these social networks in meeting their transport needs and, in particular, in forming carpools. The spatial clustering of family members in particular neighbourhoods might enable adults more easily to find carpooling partners and also to avoid one of the principal barriers to carpooling: the increased travel time associated with picking up and dropping off carpool members. Charles and Kline (2006) find that spatial clustering along ethnic and racial lines contributes to higher carpooling rates. Focusing specifically on race, they show that individuals are more likely to engage in carpooling when their neighbours are similar to themselves, hypothesising that carpooling represents a complex form of social capital production, the capacity both to build and to use neighbourhood social networks. Similarly, in their study of low- and semi-skilled Latino immigrants in six immigrant gateway metropolitan areas, Liu and Painter (2012) find that residence in areas with higher ethnic concentrations is associated with an increased likelihood of commuting by carpool.

Further, residents of ethnic neighbourhoods may be more likely to travel to common destinations, easing yet another challenge associated with carpooling—dispersed destinations. The research in this area is only suggestive. For example, many immigrants find employment—particularly their first jobs—through friends and relatives, and are highly likely to find employment in jobs at work sites that consist mainly of co-ethnics (Catanzarite and Aguilera, 2002; Wilson, 2003). For Latino immigrants, Liu and Painter (2012) find a positive association between ethnic niche employment and commuting by carpool. Further, studies of immigrant consumption behaviour shows that immigrants tend to

patronise ethnic-specific stores, again facilitating the ease of shared travel (Wang and Lo, 2007). Finally, for undocumented immigrants, the motivation to carpool may be amplified by federal and state laws that restrict them from obtaining driver's licences.

3. Methodology

For the reasons already suggested, we contend that ethnic neighbourhoods represent a beneficial environment for the creation of racially, culturally and linguistically based social capital necessary for the formation of carpools. Liu and Painter (2012) examine this issue among low- and semi-skilled Latino immigrants. However, given the limitations of the available data, the authors define 'ethnic concentrations' using large geographical units of analysis—Public Use Microdata Areas (PUMAs). PUMAs are census-designated areas with populations greater than 100,000 residents, a population size much larger than a typical neighbourhood. Further, their analysis is restricted to commute travel, yet immigrants may be more likely than the US-born to carpool to other ethnic-specific destinations.

To test this hypothesis and address these methodological issues, we examine the travel behaviour of the foreign-born in Southern California at the census-tract level. The Census Bureau defines the foreign-born as anyone who is not a US citizen at birth, a category that includes naturalised citizens, lawful permanent residents, temporary migrants, refugees and undocumented migrants (Grieco *et al.*, 2012). We apply two different analytical approaches. Models 1 and 2 rely on aggregate, census-tract-level data from the 2000 US census and focus on commute mode, the only mode data included in the US census. In a third statistical model, we use the 2001 regional travel survey from the Southern California Association of Governments (SCAG) to examine the mode choice behaviour of individuals for all trip purposes. These data include a census-tract identifier, enabling us to link the characteristics of individuals to the characteristics of the neighbourhoods in which they live. We use these two datasets since they overlap in year and offer relatively large samples of the foreign-born for the Los Angeles region. While immigration to Los Angeles has slowed in recent years, the number and composition of new entrants to the Los Angeles area are similar to those of the early 2000s (US Department of Homeland Security, various years). Each modelling approach has its own strengths and weaknesses, and we use the two distinct analyses to gain a more robust understanding of immigrants' use of carpools. We discuss both modelling approaches in detail.

In our census-tract-level analysis, we use a Poisson regression to predict geographical variation in the rate of carpooling by workers across Southern California census tracts. These data are best suited to a Poisson distribution since the distribution of carpooling rates is right-skewed and ranges from zero to one. The model takes the following specification

$$\log_e(\text{carpool rate}) = \beta_0 + \beta_1\,(\text{resident characteristics}) + \beta_2\,(\text{neighbourhood characteristics}) + \beta_3\,(\text{immigrant neighbourhood})$$

or

$$\log_e(p/1-p) = \beta_0 + \beta_1 X_1 + \beta_2 X_2, \ldots, \beta_n X_n$$

where, the carpool rate is the percentage of workers (16+ years) who commute by carpool; resident characteristics is a set of characteristics describing residents and their households (median income, household size and race/ethnicity); neighbourhood characteristics includes a set of characteristics that define the urban structure of the neighbourhood (distance from city hall as a measure

of centrality, employment density and accessibility, and residential density); and levels of transit service is defined as the number of bus stops per square mile. Immigrant neighbourhood is defined as the percentage of the population that is foreign-born.

In model 2, we test the effect of country of origin on carpooling rates by including the percentage of immigrants from the top 10 countries of origin—Armenia, China, the Philippines, Guatemala, India, Iran, Korea, Mexico, El Salvador and Vietnam. To adjust for variation in the size of census tracts, we weight the models by the number of workers in the tract, and the descriptive statistics by the population, number of workers, or number of households, as appropriate for each variable.

The independent variables used in this first analysis are summarised in column 2 of Table 1. Most of the variable descriptions are self-explanatory with one exception—levels of job access. The job accessibility variable measures respondents' access to employment (and thus, likely to activity sites), supporting the hypothesis that greater access to these activity sites might be related to the use of alternative modes of travel. We use employment data by census tract obtained from the private firm American Business Information to develop an accessibility measure using an empirically derived exponential distance decay function. To obtain the accessibility measure for each census tract (similar to Shen, 1998), we divide the distance-weighted number of jobs available within 15 miles of that tract by the number of distance-weighted number of workers within 15 miles. Thus, the measure accounts not only for job density within a commute distance, but also accounts for individuals' would-be competition for these jobs. We expect that job accessibility will be negatively related to carpool use, as job-seekers would be more likely to find a nearby jobsite rather than a more distant one, all else equal. This, in turn, reduces the impetus to save on fuel and other variable costs associated with the use of the automobile. Further, nearby origins and destinations should minimise the time costs associated with modes such as public transit, walking and bicycling, particularly for low-wage workers for whom multiple potential jobsites are essentially interchangeable.

The strength of our approach is our use of relatively small geographical units (census tracts) to test the relationship between ethnic neighbourhoods and carpooling rates and, more specifically, to determine whether this relationship increases with the concentration of immigrants in a neighbourhood. However, aggregate analyses have limitations. For one, the census data only include information on travel as part of the journey to work, yet travel to and from work comprises less than 16 per cent of all trips in the US (Santos *et al.*, 2011). Carpooling rates are substantially lower for work travel than for non-work trips such as shopping, socialising and recreational trips (Santos *et al.*, 2011). If residents of ethnic neighbourhoods have strong ties to friends and relatives in the neighbourhood *and* tend to travel to common ethnic-specific locations (stores, services, etc.), they might be even more likely to carpool to non-work destinations than work destinations.

A second limitation of the aggregate analysis relates to the diversity of ethnic neighbourhoods. As discussed previously, ethnic neighbourhoods are racially and ethnically diverse (Galster *et al.*, 1999); with a few exceptions, they tend to include significant numbers of non-immigrants and, oftentimes, several immigrant groups living side-by-side. Therefore, we might expect immigrants living in ethnic neighbourhoods to be more likely to carpool than non-immigrants living in the same neighbourhoods; this suggests that an undifferentiated, aggregate-level analysis may bias the findings downward. Further, we might expect immigrants who share the ethnic

Table 1. Determinants of carpooling

Characteristics	*Model 1 Census tract analysis*	*Model 2 Individual analysis*
Resident characteristics		
Nativity status		Speaks no English English non-primary language Speaks no English by immigrant percentage in neighbourhood English is non-primary language by immigrant percentage in neighbourhood
Sex		Male/female
Race/ethnicity	Percentage African American Percentage Asian	African American[a]
Age		Age Age (squared)
Household size	Mean household size	Household size
Educational attainment		Four-year college degree
Household income	ln(median income)	ln(median income)
Automobile ownership		Ratio of vehicles to adults in household
Trip characteristics		
Trip purpose		Work, family/personal, school/ church and social
Neighbourhood characteristics		
Foreign-born	Percentage foreign-born	Percentage foreign-born in census tract
County of origin	Percentage from Armenia, China, the Philippines, Guatemala, India, Iran, Korea, Mexico, El Salvador and Vietnam	
Residential density	Residential density (1000/ square mile)	Residential density (1000/ square mile) in census tract
Employment access	Employment access (distance decay function)	Employment access (distance decay function) in census tract
Centrality	Distance to city hall	Distance to city hall
Level of transit service	Bus stops/square mile in census tract	Bus stops/ square mile in census tract

[a]We include only a dummy variable for the Black racial category in the disaggregate model, as the Hispanic variable is highly correlated with language variables and the other non-Hispanic non-White categories are very small.

background of the ethnic cluster—thus, for example, Mexicans living in Mexican neighbourhoods—to have even higher rates of carpooling since they, at least in theory, would live in close proximity to members of their own ethnic group *and* be more likely to have shared preferences for stores and services that match their ethnic tastes.

To address these weaknesses, we developed a multinomial logistic regression model using the individual-level SCAG travel survey data. We examine whether residence in ethnic neighbourhoods is positively related to an individual's likelihood of carpooling for all trip purposes, not just the commute. A traditional multinomial logistic model assumes that the likelihood of selecting one choice over another remains unchanged regardless of the availability of other choice options. This property, known as the irrelevance of independent alternatives (IIA), is violated in the case where choices act as substitutes for one another. We tested our multinomial logistic regression model for violations of the IIA principle using the Small–Hsiao test and found that the assumption held.

We model the likelihood of traveling by modes of transport other than the single-occupant vehicle, although we present only the results for carpooling, our outcome of interest. We control for a set of independent variables and also include a set of immigrant-proxy variables. Ideally, we would include data on the immigrant status of respondents as well as the number of years in which immigrants have lived in the US, a proxy for acculturation and other forms of adjustment. However, the SCAG travel survey data do not include these variables. They do include variables on English language usage. We assume that respondents who do not speak English are likely to be recent immigrants to the US and that those who use English as their non-primary language are likely to be immigrants who have lived in the US for a longer period, as well as their children. These assumptions are supported by research on assimilation and language ability (Carliner, 2000). Using the census-tract identifier, we link the data with census-tract-level information from the 2000 US census such as the percentage of immigrants in the neighbourhood in which the respondent lives. Finally, to examine whether the 'ethnic neighbourhood effect' is stronger for immigrants who live in immigrant neighbourhoods, we estimate a further model in which we include additional interaction terms that relate English language ability and the neighbourhood immigrant concentration.

This modelling approach also has limitations. For instance, because of collinearity between some variables in the SCAG dataset, we cannot test for the 'matching effect' of immigrant individuals living in a co-ethnic neighbourhood (for example, a Chinese immigrant living in a Chinese immigrant neighbourhood rather than a Mexican immigrant neighbourhood), although the strong co-ethnic clustering of (particularly new) immigrants (Iceland and Scopilliti, 2008) suggests that this problem may be minimal. However, through the comparison of results from both modelling approaches for the same metropolitan area during the same timeframe, we hope to enhance the robustness of our findings.

4. Immigrant Neighbourhoods in Southern California

In 2000, almost one-third of all residents in the five-county Southern California region were immigrants (31 per cent) (US Census Bureau, 2000). However, the foreign-born population is not evenly dispersed across the Los Angeles region. In order to classify immigrant concentration for descriptive statistics, we use a location quotient (LQ)

which, in this case, is the calculated ratio of the percentage foreign-born in each census tract to the percentage foreign-born in the Southern California region as a whole (just over 30 per cent). The specific formula is the following

$$LQ_i = (e_i/e)/(E_i/E)$$

where, LQ_i = location quotient (immigrant concentration) for foreign-born i (in the census tract); e_i = foreign-born i in the census tract; e = total population in the census tract; E_i = foreign-born i in Southern California; and E = total population in Southern California.

We define neighbourhoods with a LQ of less than 1.5 (<45 per cent foreign-born) as having low immigrant concentrations, neighbourhoods with location quotients of between 1.5 and 2.0 (45–60 per cent foreign-born) to have medium immigrant concentrations and then those neighbourhoods with location quotients of greater than 2.0 (>60 per cent foreign-born) to have high concentrations.

Approximately 20 per cent of all census tracts in Southern California have immigrant concentrations of note—17 per cent medium concentrations (location quotients between 1.5 and 2.0) and four per cent high concentrations (location quotients greater than 2.0). The immigrant population in the Los Angeles region is clustered in several distinct areas. While the population of much of central and south Los Angeles is over 45 per cent foreign-born, the central city is by no means the only location with pronounced clusters of foreign-born individuals. Non-coastal Orange County and the San Gabriel Valley contain large concentrations of (mostly Asian) immigrant populations, while the outlying cities of Oxnard and Palmdale contain significant concentrations of Mexican immigrants.

Table 2 describes Southern California neighbourhoods grouped by immigrant concentration. Foreign-born residents comprise a majority of the population in medium and high immigrant neighbourhoods. Yet these neighbourhoods, even those with the highest concentrations of immigrants, are racially and ethnically diverse. Indeed, the average high-immigrant-concentration tract is composed of only 48 per cent individuals of one dominant racial category and 52 per cent all other races; low-immigrant tracts are, on average, composed of 62 per cent individuals of one race and 38 per cent all other races.

Table 2 also shows a negative relationship between immigrant concentration and household income. This relationship—combined with the positive association between immigrant concentration and both residential density and distance to City Hall—supports the widespread finding that immigrants tend to concentrate in ethnic enclaves located in high-density neighbourhoods close to the central business district. As the data in Table 2 show, these neighbourhoods also tend to have high employment access and good transit coverage.

5. Immigrants, Immigrant Neighbourhoods and Carpooling

Consistent with other studies, immigrants in Southern California are significantly more likely to carpool than US-born workers. Twenty-one per cent of all immigrants commute to work by carpool, almost twice the percentage of US-born workers (Ruggles *et al.*, 2010). A number of articles focus on immigrants' higher rates of transit use compared with US-born workers (Rosenbloom, 1998; Heisz and Schellenberg, 2004; Blumenberg and Evans, 2010), yet immigrants are almost three times as likely to commute by carpool as they are by public transit. Carpooling is highest among recent immigrants, those who have lived in the US less than six years (27 per cent), and declines

Table 2. Characteristics of Southern California neighbourhoods by immigrant concentration, US census (2000)

	Immigrant concentration[a]			*Whole region*
	Low LQ<1.5 <45 per cent FB	*Medium LQ 1.5-2.0 45–60 per cent FB*	*High LQ>2.0 >60 per cent FB*	
Tracts	2652	558	121	3331
Population	12,980,566	2,789,043	569,110	16,338,719
Percentage foreign-born	25	53	67	30
Race (Hispanic or non-Hispanic)				
Percentage White	60	38	34	55
Percentage Black	8	4	3	7
Percentage Asian	9	14	21	10
Percentage other	23	44	42	27
Percentage Hispanic	34	68	60	40
Mean concentration of largest race category	62	50	48	60
Mean household size	2.9	3.8	3.2	3.0
Median household income ($)	53,842	35,147	24,787	50,290
Residential density (1000s per square mile)	7.7	16.4	36.8	9.9
Employment access (distance decay)	0.96	1.04	1.08	0.97
Distance to city hall (miles)	31.1	15.4	6.1	28.1
Bus stops/square mile	42.8	88.3	196.2	54.2
Percentage carpooling to work	14	21	18	15

[a]The difference in characteristics between medium and high immigrant concentrated neighbourhoods and low immigrant concentrated neighbourhoods are both statistically significant at $p<0.001$.

with length of residence in the US. Yet, even after more than 20 years of living in the US, immigrants' rate of carpooling (17 per cent) remains higher than among US-born workers (12 per cent).

Carpooling rates are higher in medium and high immigrant neighbourhoods compared with low immigrant neighbourhoods—21 per cent, 18 per cent, 14 per cent; these differences are statistically significant at $p < 0.001$. However, as might be expected, carpooling rates are highest in medium immigrant neighbourhoods. Residents of high immigrant neighbourhoods live in dense urban neighbourhoods with extensive transit service. In these neighbourhoods, transit can serve as an effective substitute for travel by automobile.

In the analysis presented in Table 3, we test the association between immigrant concentration and carpooling rates, controlling for other determinants of mode choice. The table presents incidence-rate ratios for two Poisson regression models, or the change in the ratio of carpoolers to non-carpoolers for a one-unit change in the explanatory

Table 3. Share of census tract residents commuting to work by carpool (Poisson regression) ($N = 3331$)

Independent variables	*Model 1*			*Model 2*		
	Incidence-rate ratios	*Significance*	*Z-score*	*Incidence-rate ratios*	*Significance*	*Z-score*
Resident characteristics						
Average household size	1.173	***	82.24	1.175	***	79.75
ln(percentage African American)	1.042	***	37.76	1.048	***	41.55
ln(percentage Asian)	0.986	***	−10.43	0.974	***	−16.20
ln(percentage Hispanic)	1.230	***	78.91			
ln(percentage foreign-born)	1.159	***	42.25	1.149	***	36.99
ln(percentage from Armenia)				1.051	***	19.18
ln(percentage from China)				1.009	***	4.28
ln(percentage from the Philippines)				1.039	***	14.13
ln(percentage from Guatemala)				0.910	***	−14.00
ln(percentage from India)				0.956	***	−4.63
ln(percentage from Iran)				0.973	***	−5.49
ln(percentage from Korea)				1.035	***	12.70
ln(percentage from Mexico)				1.195	***	68.75
ln(percentage from El Salvador)				1.039	***	9.81
ln(percentage from Vietnam)				1.024	***	10.07
ln(median household income)	0.819	***	−50.28	0.794	***	−58.10
Neighbourhood characteristics						
ln(employment density)	0.991	***	−8.30	0.992	***	−7.82
Employment access (distance decay)	0.793	***	−27.08	0.791	***	−26.65
ln(distance to city hall)	1.092	***	53.98	1.082	***	45.83
ln(residential density)	0.983	***	−12.55	0.984	***	−11.71
ln(bus stops/square mile)	0.994	***	−6.44	0.994	***	−6.81
Constant	0.791	***	−5.20	0.479	***	−14.93
Pseudo R^2		0.642			0.643	
Log-Likelihood		−41,133			−40,998	
LR Test vs null		<0.001			<0.001	
LR Test vs model 1		—			1.000	

Notes: *** p <0.01; ** p <0.05; * p <0.10.
Source: 2000 US census (2000).

variable. Thus, numbers that are greater than one represent an increase in the likelihood of carpooling, while those between zero and one represent a decrease.

In general, the estimated effects of the control variables coincide with expectations. Carpooling rates are positively related to household size, being non-White, and distance from downtown. Household size is one of the strongest determinants of carpooling (Teal, 1987) since most carpooling occurs among members of the same household (Teal, 1987; Blumenberg and Smart, 2010). Non-White adults may have less access to automobiles than White adults and, therefore, be more likely to share

resources such as automobiles. Finally, we find that carpooling is slightly more prevalent in outlying neighbourhoods distant from downtown, where public transit is often a poor substitute for automobile travel.

The model further suggests that carpooling is negatively related to income, employment density and access, residential density and access to public transit. For example, as the median income of tracts increases, we find that the propensity to carpool decreases. Households in higher-income neighbourhoods are likely to have greater access to automobiles and have less need to travel with others.[1] All else equal, greater employment access and higher employment density are associated with lower rates of carpooling perhaps because in dense urban neighbourhoods non-automobile modes of travel can serve as effective substitutes for the car. In other words, as the relative utility of transit, walking and biking increases, we would expect the use of carpools to decline.

With respect to our variable of interest, the results show a positive association between percentage foreign-born in the census tract and the likelihood of commuting by carpool, holding other factors constant. A one unit increase in the log-transformed percentage of the census tract that is foreign-born is associated with an increase in the propensity to carpool rather than drive alone by a factor of 1.14. Perhaps more intuitively, Figure 1 shows the estimated independent effect of immigrant concentration in a tract on carpooling rates, with all other variables in the model held constant at their means. While the descriptive statistics reveal that medium-immigrant tracts have the highest level of carpooling, separate analyses (not presented here) suggest that this can be explained by the high level of transit service (and usage) in these high-immigrant tracts. Independent of these covariates, greater densities of

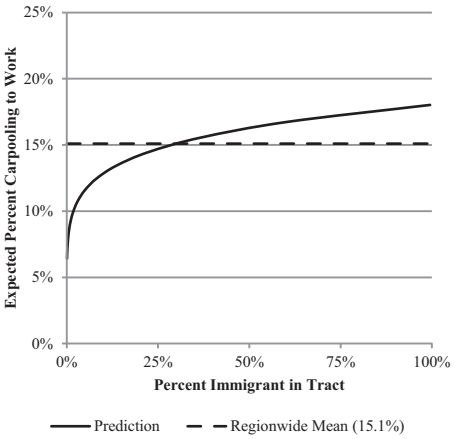

Figure 1. Expected carpooling rate by immigrant concentration of census tract, all other variables held at their means.

immigrant populations in a tract are associated with more carpooling. Finally, model 2 shows that, combined with percentage foreign-born, the positive association between carpooling and country of origin is robust across all 10 immigrant groups but strongest among Mexican immigrants.[2] However, the addition of immigrants by country of origin does not significantly strengthen the predictive power of the model.

Holding other factors constant, carpooling rates are higher in neighbourhoods where immigrants comprise a significant percentage of the population (roughly greater than 25 per cent) and lower in neighbourhoods with fewer immigrants. This finding suggests that there is something unique about immigrant neighbourhoods that makes carpooling a suitable travel option, at least for the commute. However, since neighbourhoods—even neighbourhoods in which immigrants comprise a substantial percentage of the population—house diverse residents, the analysis does not directly test whether immigrants themselves who live in these neighbourhoods are more likely to carpool than other residents.

To test this, we use regional travel survey data to predict the likelihood of traveling by carpool controlling for a number of factors, including residence in an ethnic neighbourhood. Table 4 presents the descriptive statistics by language proficiency, our proxy for nativity status.

The descriptive statistics presented in Table 4 are similar to those found in the census-tract summary data (Table 2). Recent immigrants—in this case, those who do not speak English—tend to live in dense neighbourhoods close to the central business district in census tracts with a high percentage of foreign-born residents. These neighbourhoods tend to have frequent transit service and good access to employment opportunities. Carpooling rates, however, are highest among more settled immigrants, those for whom English is a non-primary language. Again, these immigrants tend to live in neighbourhoods further from downtown and with less access to public transit than non-English speakers.

Table 5 presents the model results for two individual-level models (models 3 and 4). The variables of interest in the first model are the two indicators of immigrant status as well as the percentage of the tract that is foreign-born. In the second model, we interact the individual's immigrant status with the concentration of immigrants in the neighbourhood, thus testing whether the propensity to carpool is stronger for immigrants in immigrant neighbourhoods than for immigrants living in other (non-immigrant) neighbourhoods. As mentioned earlier, moderate collinearity between variables in the model prevents us from presenting our results using immigrant-group-specific or ethnicity-specific results, although additional models including these moderately collinear variables (not presented here) support our findings from the preferred models.[3]

As before, the control variables operate as predicted. Household income is strongly negatively associated with carpooling. Consistent with the broader literature, immigrants are more likely to carpool than non-immigrants. The relationship is statistically significantly stronger for those adults who speak no English, although the magnitude of difference is small. The variables 'female' and 'household size' are positively associated with the likelihood of carpooling. Age is negatively associated with carpooling and age squared is positively associated with carpooling, suggesting that younger and older individuals are more likely to carpool.

Two of the neighbourhood variables are statistically significant. Neighbourhoods with greater transit service tend to have fewer carpoolers, while residents of outlying neighbourhoods (distance from city hall) are *less* likely to carpool, all else equal. This finding contradicts our findings from the aggregate-level model, as well as the larger literature on carpooling.

Turning now to model 4, we see that the immigrant effect on carpooling appears to be linked to the neighbourhood context. While the coefficient for non-English speakers is negative for carpooling, this is offset by the interaction term with the concentration of immigrants in one's home census tract. Figure 2 shows this relationship graphically and compares it with the results from model 3, which predicts similar effect curves for all three population groups, offset by a group-wise effect. Model 4 estimates that non-English speakers living in low-immigrant neighbourhoods are actually *less* likely to carpool than are the US-born and those who speak English as a non-primary language, both of whose carpooling behaviour appears insensitive to being in an immigrant neighbourhood. However, in high-immigrant concentration tracts, immigrants appear considerably more likely to

Table 4. Descriptive data, SCAG travel survey (2001)

	English primary language	*English not primary language*	*Significance*[a]	*Non-English speaker*	*Significance*[a]
Individual/household characteristics					
Female	52.3	50.8	**	49.9	**
Mean age (years)	45	39	***	35	***
Mean income ($ in bins)	73,737	63,104	***	35,647	***
Median income ($ in bins)	62,500	62,500		30,000	***
Household size	2.95	3.92	***	4.35	***
Race/ethnicity(percentages)					
Non-Hispanic White	69.9	26.7	***	6.0	***
Non-Hispanic Black	7.3	2.1	***	0.2	***
Non-Hispanic Asian	4.1	10.5	***	9.3	***
Non-Hispanic other	8.0	12.5	***	3.8	***
Hispanic	10.7	48.1	***	80.7	***
Four-year college degree (percentage)	46.8	39.3	***	19.0	***
Neighbourhood characteristics					
Percentage foreign-born	24.2%	33.8%	***	41.3%	***
Distance in miles to city hall	29.1	21.3	***	20.8	***
Residential density (persons/ square mile)	8,191	12,160	***	14,690	***
Employment density (1000s/ square mile)	2951	3193	***	4065	***
Employment access (distance decay)	0.97	1.00	***	0.99	***
Transit density (bus stops/ square mile	44.7	57.1	***	77.6	***
Trip characteristics(percentages)					
Mode					
SOV mode share	57.3	45.6	***	36.2	***
HOV mode share	36.5	43.8	***	40.7	***
Transit mode share	0.6	0.6		2.1	***
Non-motorised mode share	5.6	9.9	***	20.9	***
Trip purpose (percentages)					
Work	27.6	30.5	***	35.3	***
Family/personal	25.1	23.4	**	21.1	***
School/church	3.3	4.9	***	5.7	***
Shopping	33.3	29.9	***	27.0	***
Social	10.7	11.3		10.9	
N (persons)	8883	1388		802	
N (trips)	23,232	3291		1624	

[a]The significance levels for "English not Primary Language" and "Non-English Speaker" are both relative to "English as Primary Language".

Table 5. Likelihood of traveling by carpool vs driving alone (multinomial logistic regression) ($N = 28,147$)

	Carpool (HOV) vs drive alone (SOV)					
	Model 3: no interaction			*Model 4: interaction*		
	Coefficient	*Significance*	*Z*	*Coefficient*	*Significance*	*Z*
Individual and household characteristics						
ln (household Income/$1000)	−0.075	***	−3.53	−0.073	***	−3.44
Female	0.312	***	11.10	0.313	***	11.15
Age	−0.054	***	−9.70	−0.054	***	−9.74
Age squared	0.00056	***	9.49	0.00056	***	9.54
Household size	0.109	***	10.20	0.109	***	10.19
Race: Black	−0.032		−0.54	−0.026		−0.45
Four-year college degree	−0.126	***	−4.07	−0.125	***	−4.04
Speaks no English	0.291	***	5.33	−1.210	***	−3.41
English non-primary language	0.235	***	5.78	0.213		0.95
Ratio of vehicles to adults in household	−0.660	***	−15.02	−0.653	***	−14.85
Neighbourhood characteristics						
ln(percentage Foreign Born)	0.060	**	2.08	0.042		1.35
Speaks no English x ln(percentage foreign-born)				0.423	***	4.28
English Non-primary language x ln(percentage foreign-born)				0.010		0.15
ln(distance to city hall)	0.0028		0.47	0.0032		0.53
Residential density (1000s/ square mile)	−0.0013		−0.60	−0.0024		−1.06
Employment access (distance decay)	−0.102		−1.15	−0.106		−1.19
ln(transit density stops/square mile)	−0.043	***	−3.97	−0.042	***	−3.85
Trip characteristics						
Purpose: family/personal (work omitted)	1.695	***	40.10	1.699	***	40.15
Purpose: shopping	1.363	***	33.33	1.365	***	33.36
Purpose: school/church	1.154	***	15.56	1.154	***	15.55
Purpose: social	1.819	***	36.18	1.822	***	36.21
Constant	−0.204		−1.14	−0.156		−0.86
McFadden's R^2	0.151			0.152		
Log-likelihood at convergence	−21344			−21329		
Log-likelihood at constant only	−25153			−25153		
LR test vs. constant only	<0.001	***		<0.001	***	
LR Test vs. Model 1				<0.001	***	
Small-Hsiao test of IIA	1.000	***		1.000	***	

Notes: Other outcomes are not shown but are available from the authors. *** p <0.01; ** p <0.05; * p <0.10.
Source: 2001 SCAG travel survey.

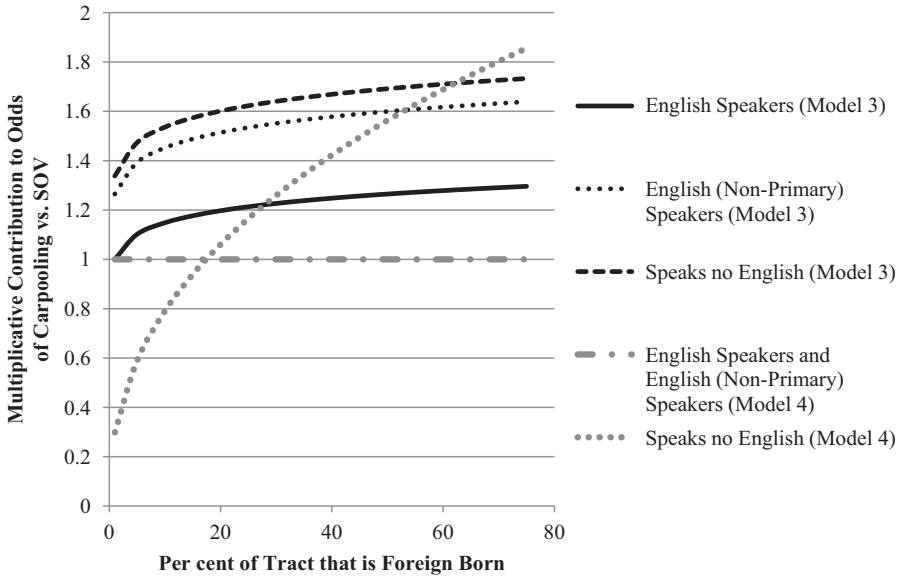

Figure 2. Expected change in the odds of carpooling rather than driving alone by percentage immigrant in one's home tract.

carpool than all others, holding other factors constant.

6. Conclusion

The aggregate census tract data show a strong positive relationship between ethnic neighbourhoods and carpooling rates. Carpooling rates increase with the immigrant concentration of a neighbourhood. In contrast, in our two statistical models using individual data, 'percentage immigrant' alone is not statistically significant, but only in conjunction with individual-level indicators of immigrant status. The first of these models shows that immigrants are more likely to carpool than non-immigrants, a finding consistent with the broader research on this topic. The second model suggests that this effect may only be true for immigrants themselves, and not for other residents of immigrant neighbourhoods, a relationship that we were unable to test in the aggregate-level model.

The positive relationship between immigrant status and ethnic neighbourhood is likely due—at least in part—to the match between the ethnicity of residents and the ethnic character of the neighbourhood in which they live. Ethnic neighbourhoods can create opportunities to travel by modes other than solo driving. Ethnic networks can also ease the process of carpool formation, providing easy access to carpool partners who share the same language and cultural traditions. Jobs in the ethnic economy and ethnic-specific services and retail may provide a set of common destinations that, once again, make travel by carpool feasible.

Analyses of the travel behaviour of immigrants are limited by available data. For confidentiality reasons, census microdata do not allow analysis of the relationship between individuals and the small-area neighbourhoods in which they live. Further, the census samples only include data on commute travel. The confidential version of the National Household Travel Survey

(NHTS)—a national survey of travel behaviour conducted under the sponsorship of the Federal Highway Administration—asks a broad set of transport questions and allows for the matching of individuals and the census tracts in which they live. However, this survey is nationally stratified and, therefore, is not intended for regional analyses. Finally, regional travel surveys—such as the SCAG data used in this study—can be quite useful; however, these surveys do not always include the necessary questions for this type of analysis, including—as was the case here—questions related to nativity. Finally, none of these data sources is longitudinal, data that follow individuals and their behaviour over time. Since immigrants now comprise 13 per cent of the US population and are more than 20 per cent of the population in states such as California (27 per cent), New York (22 per cent) and New Jersey (21 per cent), agencies ought to strengthen their data collection to address these weaknesses (Grieco *et al.*, 2012) and, therefore, enhance analyses of immigrant travel behaviour.

Nevertheless, the findings from this study suggest an important role for social networks—especially those embedded in particular places—in understanding travel behaviour. A handful of scholars have investigated the ways in which social networks influence activity and travel patterns (Axhausen, 2005, 2008; Arentze and Timmermans, 2008; Carrasco and Miller, 2009). In doing so, these studies—including our own—add an important dimension to the traditional rational choice framework, much as scholars in recent decades have enriched models by adding neighbourhood- and metropolitan-scale built environment characteristics. If increased carpooling is an important strategy for reducing vehicle travel and its negative externalities, then planners and policymakers must develop strategies to better link residents to each other as well as to the built environments in which they live.

By themselves, policies do not create ethnic neighbourhoods; however, they have played and can continue to play a role in shaping contemporary residential location patterns. Agglomerations of immigrant-serving institutions and services have emerged in response to the high concentrations of immigrants in particular neighbourhoods. At the same time, these agglomerations help to attract new immigrants to these neighbourhoods and, in so doing, contribute to the persistence of these ports-of-entry (Brown *et al.*, 2007). Therefore, efforts to strengthen the ethnic character of neighbourhoods—for example, by facilitating a strong match between local institutions and resident needs—may attract new immigrants and motivate current residents to remain in these neighbourhoods. Additionally, some ethnic neighbourhoods have experienced gentrification due to the high demand for prime central-city locations and, in some cases, as a result of ethnic packaging and promotion (Pamuk, 2004; Hackworth and Rekers, 2005). Therefore, anti-gentrification efforts also might help to preserve tight-knit immigrant communities where carpooling appears to be more likely.

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Notes

1. The aggregate model does not control for automobile ownership since it is collinear with household income (0.69). However, automobile ownership is the largest predictor of travel mode. We ran an additional model using mean number of cars available in the census tract in place of income. The model results are almost identical to the model reported here with a slightly lower R^2.

2. We remove the variable 'ln(percentage Hispanic)' in this model, as it is moderately collinear with the variable 'ln(percentage from Mexico)'. Multicollinearity tests suggest that there are no additional collinearity problems among the predictor variables.
3. The variable 'percentage Hispanic' is marginally collinear with 'percentage immigrant' since a large percentage of immigrants in the SCAG region are Hispanic. However, in a second model (available from the authors) we include the Hispanic variable. As expected, the Hispanic variable is positively related to carpooling; however, the addition of this variable does not change the effect associated with not speaking English and living in an immigrant neighbourhood.

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