A Longitudinal Analysis of Cars, Transit, and Employment Outcomes

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REPORT 12-49

A LONGITUDINAL ANALYSIS OF CARS, TRANSIT, AND EMPLOYMENT OUTCOMES

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16. Abstract

Access to cars and transit can influence individuals' ability to reach opportunities such as jobs, health care, and other important activities. While access to cars and public transit varies considerably across time, space, and across populations, most research portrays car access as a snapshot in time; some people have a car and others do not. But does this snapshot approach mask variation in car ownership over time? And how does access to particular types of transportation resources influence individuals' economic outcomes?

The authors improve upon existing research by using panel data from 1999 to 2013 from the Panel Study of Income Dynamics (PSID) to examine levels of automobile access in groups that have variable access: poor families, immigrants, and people of color. They further employ two new national datasets of access to jobs using public transit. These datasets are used to examine the effect of transit and automobile access on income growth over time within families, controlling for a number of relevant variables.

The research found that for most families, being "carless" is a temporary condition. While 13% of families in the US are carless in any given year, only 5% of families are carless for all seven waves of data examined in the analysis. The research also found that poor families, immigrants, and people of color (particularly blacks) are considerably more likely to transition into and out car ownership frequently and are less likely to have a car in any survey year than are non-poor families, the US-born, and whites.

The research also found that improving automobile access is associated with a decreased probability of future unemployment and is associated with greater income gains. However, the analysis suggests that the costs of owning and maintaining a car may be greater than the income gains associated with increased car ownership. The relationship between public transit and improved economic outcomes is less clear. The research found that living in areas with access to high-quality public transportation has no relationship with future earnings. However, transit serves an important purpose in providing mobility for those who cannot or choose not to own a car.

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EXECUTIVE SUMMARY

Access to transportation resources varies considerably across time, space, and populations. The quality of these transportation resources influences individuals' ability to access opportunities such as jobs, health care, and other important activities. However, in most transportation research, automobile access is seen as a snapshot in time; some people have a car and others do not. But does this snapshot approach mask variation in car ownership over time? And how does access to particular types of transportation resources influence individuals' economic outcomes? These questions are not just of academic interest; policies designed to enable access to opportunities such as jobs are an important part of ongoing economic development strategies. Yet just how transportation influences economic outcomes remains a murky question.

The authors improve upon existing research by using panel data from 1999 to 2013 from the Panel Study of Income Dynamics (PSID) to examine levels of automobile access in groups that have particularly variable automobile access: poor families, immigrants, and people of color ("Panel Study of Income Dynamics, public use dataset," 2014). They further employ two new national datasets of access to jobs using public transit. They use these datasets to examine the effect of transit and automobile access on income growth over time within families, controlling for a number of relevant variables.

First, the research measured the level of car ownership within a family as a ratio of the number of cars in the family to the number of adults, and it found large differences across population groups. It further found that car access varies considerably across time within a household, with many families transitioning into and out of car ownership. This longitudinal perspective can potentially reframe scholars' and practitioners' understanding of zero-car households by highlighting that very few families in the US remain carless for very long; even long-term poor families are likely to own a car for at least some portion of the survey.

The research found that for most families, being "carless" is a temporary condition. While 13% of families in the US are carless in any given year, only 5% of families are carless for all seven waves of data examined in the analysis. The research also found that poor families, immigrants, and people of color (particularly blacks) are considerably more likely to transition into and out car ownership frequently and are less likely to have a car in any survey year than are non-poor families, the US-born, and whites.

Second, the research examined the relationship between economic outcomes and transportation access over a fourteen-year period. It compared two forms of transportation access: public transit accessibility and car ownership. Eight waves of panel data were used from the Panel Study of Income Dynamics to assess how transit accessibility and car ownership shape future employment outcomes and earnings. Further, the same panel dataset was used to estimate the costs of car ownership to examine if the increased earnings from access to cars outweigh the financial burdens of car ownership.

The research found that improving automobile access is associated with a decreased probability of future unemployment and is associated with greater income gains. However, the analysis suggests that the costs of owning and maintaining a car may be greater

than the income gains associated with increased car ownership. The relationship between public transit and improved economic outcomes is less clear. The research found that living in areas with access to high-quality public transportation has no relationship with future earnings but, unexpectedly, is associated with increased chances of being unemployed in the next survey wave. The authors suspect that transit accessibility is a proxy for other aspects of the neighborhood or residents that were unable to be included in the model.

Although the research finds no clear income effect of living near high-quality transit (and a negative effect on future employment), transit service will continue to play an important role. Others have found that moving to neighborhoods with improved transit access is associated with increased likelihood of being employed (Blumenberg & Pierce, 2012), and transit serves an important purpose in providing mobility for those who cannot or choose not to own a car.

Of course, the costs and benefits of cars are neither entirely economic nor borne only by individual families. Increased car ownership has negative societal impacts in terms of pollution, congestion, and traffic injuries and fatalities. Similarly, the benefits are not only economic; access to transportation resources can enable improvements in quality of life by increasing access to food, recreation, and social opportunities as well as to jobs.

I. CAR TODAY, GONE TOMORROW

INTRODUCTION

In most transportation research, automobile access is seen as a snapshot in time; some people have a car and others do not. But does this snapshot approach mask variation in car ownership over time? The authors used seven waves of the Panel Study of Income Dynamics (PSID), spanning 1999 to 2011, to examine levels of automobile access in groups that have particularly low automobile access: poor families, immigrants, and people of color ("Panel Study of Income Dynamics, public use dataset," 2014).

The level of car ownership was measured within a family as a ratio of the number of cars in the family to the number of adults, and large differences were found across population groups. As others have found, the researchers observed large differences in car ownership across population groups. However, it was also found that families' access to cars varies considerably *across time*, with many families transitioning into and out of car ownership. This longitudinal perspective can potentially reframe scholars' and practitioners' understanding of zero-car households by highlighting that very few families in the US remain carless for very long; even long-term poor families are likely to own a car for at least some portion of the survey.

In the next section, a brief summary of research is provided on household auto ownership with a focus on longitudinal data, populations of special interest, and studies that elaborate on the standard model of auto ownership. Next, the PSID data employed in this analysis were described. Then the findings are described and synthesized. The report concludes with a discussion of the findings' implications for research and practice.

HOUSEHOLD AUTOMOBILE OWNERSHIP

There is a large body of research on household auto ownership using a variety of complex statistical models. Transportation researchers use these models to understand household consumption and travel behavior. Governments, transportation planners, and researchers use aggregate, disaggregate, cross-sectional, and panel analyses to estimate travel demand and environmental emissions, and car manufacturers and oil producers use them to predict demand for their products (de Jong, Fox, Daly, Pieters, & Smit, 2004; Train, 1993). Disaggregate cross-sectional studies have consistently found that income, automobile purchase costs, the number of workers, and "the availability and ease of travel on public transit are significantly related to the household level of auto ownership" (Train, 1993, p. 115).

Panel datasets provide a significant advantage by allowing researchers to examine changes within households over time. While aggregate studies of auto ownership have found (at least until recently) increasing levels of auto ownership in many contexts, these studies conceal the large numbers of households who actually decrease their car ownership (Axhausen, 1995; Goodwin, 1988, 1993). Over a ten-year period in the UK, 15% of surveyed households decreased and 21% increased the number of cars they owned (Goodwin, 1993). Others report that 7.6% of households decrease the number of

autos, while 8.2% increase between any two years (also using data from the UK though a decade later) (Dargay & Hanly, 2007; see Table 3). Together, panel research suggests that changes in auto ownership are associated with life-cycle changes, aging, and income and car ownership in the previous panel waves (Dargay & Hanly, 2007; Goodwin, 1997; Nolan, 2010; Oakil, Ettema, Arentze, & Timmermans, 2013; Woldeamanuel, Cyganski, Schulz, & Justen, 2009).

Research on auto ownership using panel data is largely absent in the US context. Existing studies of auto ownership have been conducted with data from Great Britain (Axhausen, 1995; Dargay & Hanly, 2007; Goodwin, 1993), Ireland (Nolan, 2010), the Netherlands (Goodwin, 1989; Kitamura, 2010), Germany (Woldeamanuel et al., 2009), and Australia (Hensher, 1986). Although transportation researchers have used panel data from the US (e.g., Krizek, 2003), to the authors' knowledge, none have examined auto ownership changes within households over time.

Additionally, researchers have examined how auto ownership varies among populations of particular social and policy interest. Low-income households have much lower access to autos than more affluent households, and they subsequently travel less (Blumenberg & Pierce, 2014). However, auto ownership is increasing among these families (Blumenberg & Thomas, 2014). For those low-income households who do own cars, the costs of auto ownership represent a higher share of their total household budget than for more affluent households (Rice, 2004). For low-income households, access to cars translates to jobs and higher earnings (Baum, 2009; Blumenberg & Manville, 2004; Gurley & Bruce, 2005; Ong, 2002). Similarly, African-American households have lower levels of car access, particularly when they live in more racially segregated metropolitan areas (Berube, Raphael, & Deakin, 2008). Immigrants to the US also own autos at lower rates than US-born persons, and because immigrants generally live in larger households, they often face greater competition for the use of these cars (Blumenberg & Smart, 2011; Tal & Handy, 2010). However, auto ownership is not the same as access to cars. Even in households with no cars, over one-third of all trips are made in cars, either as a passenger or driver (Pucher & Renne, 2003). A recent focus group of immigrants in California describes how access to cars varied across a number of dimensions, not just whether a household owns a car, but also regarding access to social networks, reliability of the vehicles, gender, and so forth (Lovejoy & Handy, 2008).

This research report adds to this body of research by using panel data from the US context. The study examined car ownership for three demographic groups: poor families, immigrant families, and families headed by a person of color. The panel nature of the data sheds light on the volatility of car ownership for many families in the US, particularly for low-income and black families. The study highlights that the "carless" families often found in cross-sectional studies miss an important point: the overwhelming majority of zero-car families are carless only for a short while.

RESEARCH APPROACH

The PSID was used to analyze the changes in automobile access within and across families over time. The PSID began as part of President Lyndon Johnson's War on Poverty

and is "the world's longest-running housing panel survey" (McGonagle, Schoeni, Sastry, & Freedman, 2012, p. 268). Since 1968, the Institute for Social Research (ISR) at the University of Michigan has been collecting economic and demographic data on the same families and their descendants who start their own families (Becketti, Gould, Lillard, & Welch, 1988). The ISR has surveyed these families annually from 1968 through 1997 and biennially since 1997. The first wave included approximately 18,000 individuals living in 5,000 families and just over one-third were part of an oversample of low-income families. ISR has periodically refreshed the PSID sample to ensure that the sample is representative of the changing demographics of the US population. In 1990, a new sample was added, including 2,043 Latino families. In 1997, 511 immigrant families—arriving in the US after 1968—were added (McGonagle et al., 2012). The most recent waves of the PSID include responses from roughly 22,000 individuals living in 9,000 families.

The PSID survey includes a number of transportation-related questions. From 1968–1986 and again from 1999–2013, the survey has included questions about family auto ownership, which this study used as a proxy for access to automobiles. (This is an admittedly imperfect measure because many people who do not have cars use them, and many people may own cars that are not operable, to name a few of the problems with this metric.) From 1968–1986, the PSID collected data on the commute trip (duration, distance, and mode). More recently, the transportation-related questions have shifted and become more limited, focusing on expenditures related to auto purchases and maintenance, parking, and public transportation as well as attributes about vehicles owned by the families. Yet only a handful of researchers have used the PSID to examine transportation-related research questions (Hill, 1981; Hunt, Abraham, & Weidner, 2004; Paleti, Copperman, & Bhat, 2011; Simonsohn, 2006).

The analysis uses seven waves of PSID data, from 1999 biennially through 2011. The unit of analysis is the family, the unit the PSID uses to collect transportation data. The family "head" was tracked across survey waves, and new families were added to the dataset when they broke off from an existing family (e.g., separations, divorces, and children moving out). Similarly, families were dropped when they left the survey due to nonparticipation, a move abroad, or death. Over the PSID's long tenure, there has been significant attrition of the original sample, particularly among low-income and minority respondents (Fitzgerald, 2011). However, other research on health outcomes using PSID data suggests that the survey is still representative if survey weights are used (Fitzgerald, 2011). Those survey weights were included in this analysis.

The analysis focused on changes in auto ownership within families over time, concentrating on three dimensions of socioeconomic difference. First, differences were examined in auto ownership between families in poverty and other families. Two poverty categories were included: families that were in poverty in any year and those who were in poverty during at least half of the survey waves analyzed. This latter group is named the "long-term poor." A family is defined as living in poverty if the total family income is less than the Census Needs Standard, which varies by family size, composition, and year.

Second, analysis was conducted on how auto ownership varies by nativity. Immigrant families were defined as those in which the family head and/or spouse or partner was born

abroad. In cases in which information was available on the year of arrival for the foreign-born, the family level year of arrival was assigned according to the person who arrived first in the US.

Third, auto ownership was examined across racial and ethnic groups. These included non-Hispanic white, non-Hispanic black, non-Hispanic Asian, and Hispanics of any race. Race and ethnicity information is available only for the family head and his or her married or unmarried partner. Each family was assigned the race and ethnicity of the family head, an admittedly imperfect measure of the family's racial and ethnic identity.

A straightforward research approach was employed, presenting descriptive statistics of car ownership for the poor, immigrants, and people of color. These groups were compared with their non-poor, US-born, and white counterparts, and the differences were highlighted. The goal was to explore both the total number of cars owned by a family and the ratio of cars to adults in the family, a measure of competition for car use. Additionally, the longitudinal nature of the dataset was used to explore the permanence—or ephemeral nature—of car ownership in these families. The focus was not to examine motivations and "trigger events" for gaining or losing access to a car, although the research did find that the differences between racial/ethnic groups and between immigrants and the US-born remain when the analysis was restricted to non-poor families.

Table 1 summarizes the number of families by poverty status, nativity, and race/ethnicity, and it includes basic information on auto ownership and income. It presents data on the first wave and the final wave of the dataset; data for all seven waves are provided in the Appendix. After excluding families without information on car ownership, the sample included 7,493 families in 1999 and 9,690 in 2011. Because ISR has not refreshed the PSID sample since the addition of an immigrant sample in 1997 and 1999, the growth in the number of families in the sample is due to family segmentation over time. As a result, the research cannot compare immigrant families in the sample with more recent arrivals. These immigrants can be followed only over time.

Table 1. Characteristics of Populations of Interest in the 1999-2011 Panel Study of Income Dynamics

	Sample Size		Mean number of cars in family		Mean car-to-adult ratio in family		Median family income (2011 $s)	
	1999	2011	1999	2011	1999	2011	1999	2011
All families	7,493	9,690	1.64	1.59	0.95	0.94	$55,614	$49,529
Poverty								
Families not in poverty	90%	88%	1.73	1.71	0.99	1.00	$62,100	$56,300
Families in poverty	10%	12%	0.80	0.72	0.57	0.52	$8,848	$8,500
Nativity								
US-born families	91%	90%	1.67	1.61	0.97	0.96	$57,205	$50,006
Foreign-born families	9%	10%	1.36	1.46	0.67	0.74	$41,896	$41,719
Race/ethnicity								
Non-Hispanic white	77%	72%	1.76	1.69	1.02	1.01	$62,238	$55,380
Non-Hispanic black	13%	15%	1.02	1.11	0.63	0.75	$37,260	$31,520

	Sample Size		Mean number of cars in family		Mean car-to-adult ratio in family		Median family income (2011 $s)	
	1999	2011	1999	2011	1999	2011	1999	2011
Non-Hispanic Asian	2%	2%	1.57	1.54	0.87	0.80	$65,357	$82,000
Hispanic, any race	5%	9%	1.34	1.58	0.68	0.81	$38,640	$39,000

Note: This includes only cases with information on auto ownership in the family.

Auto ownership decreased slightly between 1999 and 2011 in the full sample, and inflation-adjusted incomes have decreased for most groups over the 12 years. The number of families in poverty increased from 10% to 12%, and these families owned slightly fewer cars in 2011 compared with 1999. Auto ownership and family incomes increased among immigrants in the sample. Among non-Hispanic black families, incomes declined sharply while auto ownership rates nevertheless increased. This contrasts with non-Hispanic white families, whose auto ownership declined with declining incomes. Non-Hispanic Asian families had the largest income gains, although cars per adults decreased slightly in these households. Hispanic families increased both auto ownership and incomes from 1999–2011. These data are provided wave-by-wave in the Appendix.

Drawing on the full range of PSID data from 1968–2011, it was observed that the ratio of cars to adults steadily increased during the 1970s through 2000, and it leveled off during the mid-aughts, consistent with other research (see also Millard-Ball & Schipper, 2011). Figure 1 charts the mean ratio of cars to adults in each family in the PSID for the two eras when the survey collected information on the number of cars owned by each family. The PSID collected this information annually from 1968–1986 (excluding 1973 and 1974) and then again from 1999–2011 biennially. A dashed line indicates the years for which no data on car ownership were available.
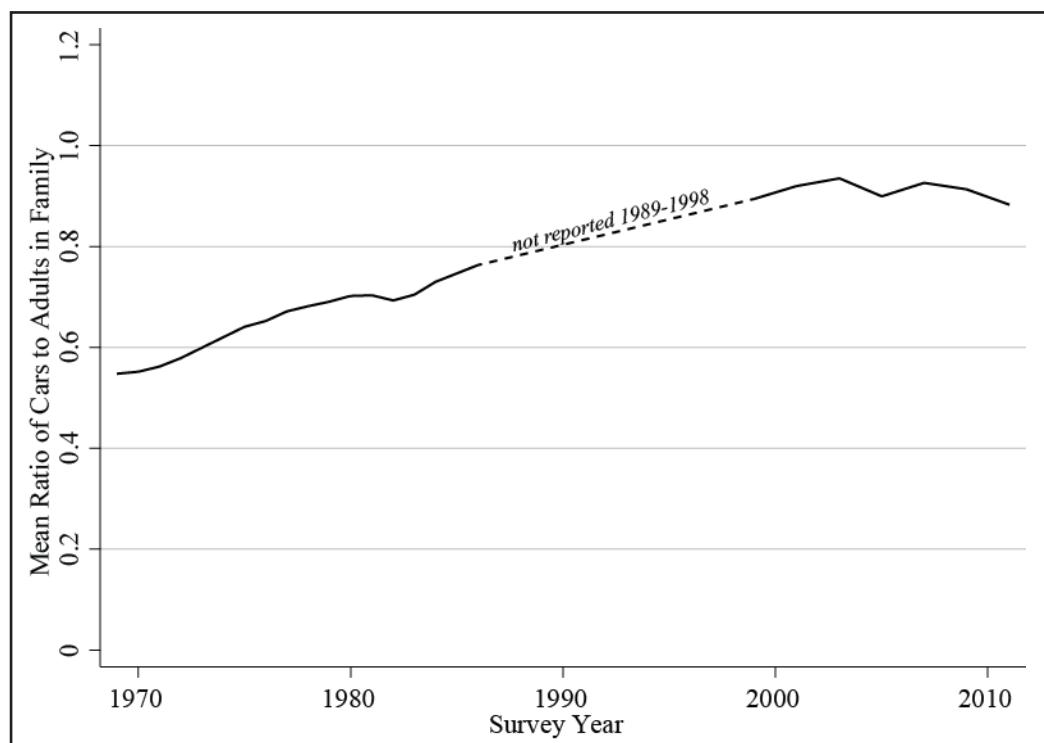
Figure 1.   Mean Number of Cars per Adult 1969-1986 and 1999-2011

In addition to charting the trend for the full sample, two other figures were created (Figures 2 and 3) comparing the same ratio for families by poverty status and for white- and black-headed families. The figures below show that poor and black families have significantly lower rates of car ownership compared with the families above poverty and white families. While the gap between black and white families may be closing, the gap in auto ownership between poor and non-poor families may be growing.
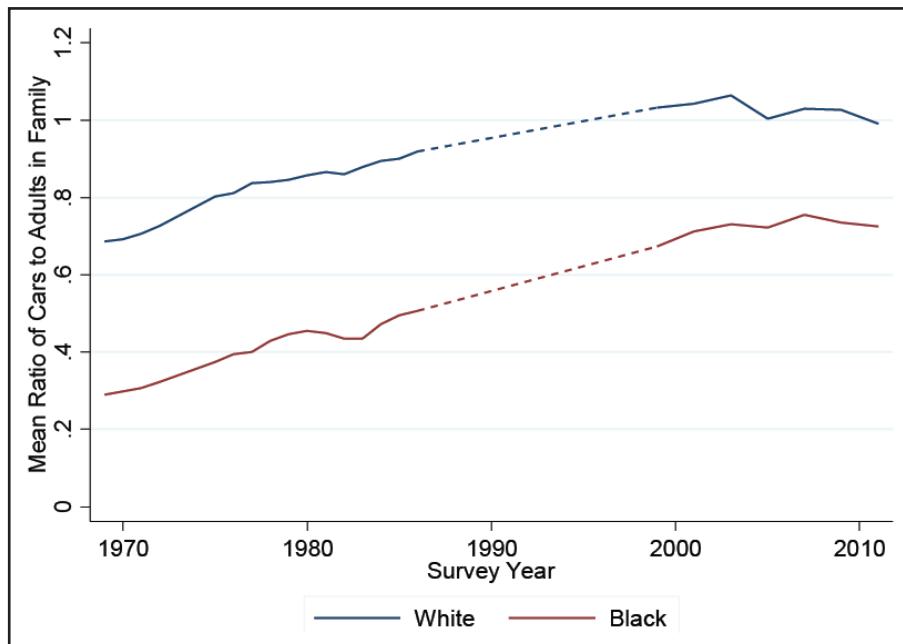
Figure 2.   Ratio of Cars per Adult for White- and Black-headed Families, 1969-1986 and 1999-2011
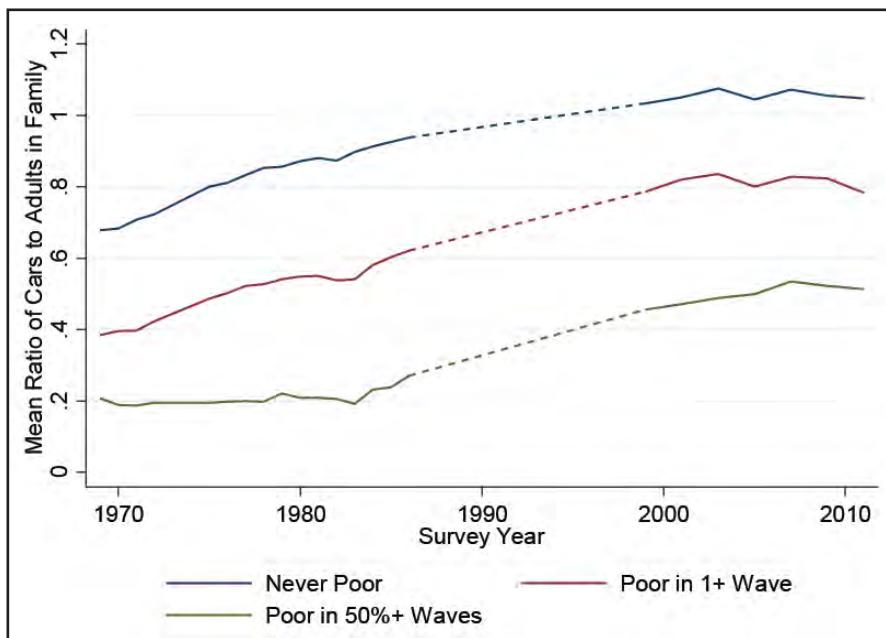
Figure 3.   Ratio of Cars per Adult for Families in Poverty and those not in Poverty, 1969-1986 and 1999-2011

AUTO OWNERSHIP OVER TIME

How stable is car ownership over time within families? The first task was to explore the changes in auto ownership that all families in the PSID make from year to year. Table 2 summarizes the relationship between the number of cars a family owns in one period and the number of cars owned in the next period. Across the seven waves of the survey, 62% of families retained the same number of cars from the previous period, while 21% decreased the number of cars they owned (indicated by the red cells in Table 2) and 17% increased that number (the green cells in Table 2). The most frequent transitions in car ownership are from two cars to one car (7% of all families) and from one car to two cars (6%). These findings suggest greater fluctuation in auto ownership levels compared with earlier research based in the UK (Dargay & Hanly, 2007).

Table 2.   Change in Car Ownership Levels from Period T to Period T+1, 1999-2011 Panel Study of Income Dynamics

		Number of Cars This Year					
		0	1	2	3	4+	Total
Number of Cars Two Years Ago	0	8%	2%	1%	0%	0%	11%
	1	3%	24%	6%	1%	0%	34%
	2	1%	7%	22%	4%	1%	35%
	3	0%	2%	4%	5%	2%	13%
	4+	0%	1%	1%	2%	3%	6%
	Total	12%	36%	34%	12%	6%	100%

Total percentage of households not changing the number of cars = 62%

Total percentage of households changing the number of cars = 38%

Of which: *Decrease: 21%*

Increase:17%

However, changes in the number of cars in a family can represent two distinct cases: a change in the composition of the family (an adult child moves out and takes a car) or true "downsizing" of a family's fleet of cars. Figure 4 further displays changes in the ratio of cars to adults in the family between surveys. It was found that families in the PSID were more likely to gain cars relative to adults leading up to the 2001 and 2003 surveys. Leading up to the 2005 survey, the trend reversed, with more families giving up cars than gaining cars, relative to the number of adults in the family. These changes may be due to the rapid rise in gasoline prices in the United States during 2004 and 2005. Families were again more likely to gain cars relative to the number of adults leading up to the 2007 survey. In the final two waves, the trend again reversed itself, with more families shedding cars relative to the number of adults. In all survey waves, the majority of families remained at the same level of car access, ranging from 60% to 63% of families.
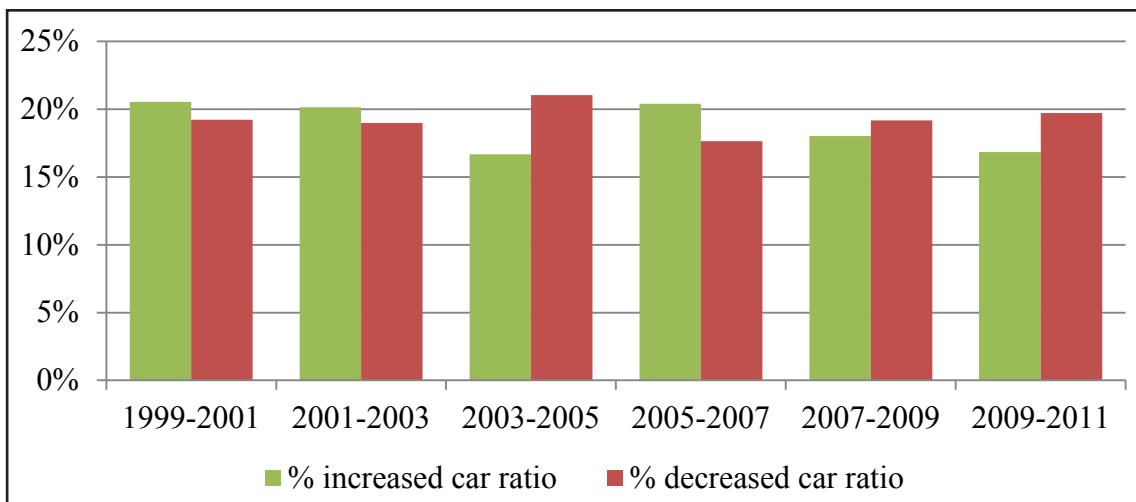
Figure 4. Percentage of Families Increasing or Decreasing the Ratio of Cars to Adults in the Family, 1999-2011 Panel Study of Income Dynamics

Car ownership levels vary by poverty status, nativity, and race/ethnicity. Figure 5 shows the ratio of cars to adults in the family unit, grouped into four categories: those with zero cars, those with less than one car per adult, those with an equal number of cars and adults, and those with more cars than adults. Here, the seven panel waves from 1999 to 2011 were used; thus, the figure shows a typical "snapshot" of auto ownership for any given year in this time span. Separately, these ratios were examined for each of the seven waves of data, and little variation was found across time, although all groups experienced a slight decline in auto ownership in recent waves.

In this cross-sectional analysis, the analysis found what prior research has shown: poor, foreign-born, and non-white families are all considerably less likely to have an automobile than non-poor, US-born, or white families. Even when these families do have cars, they are likely to have fewer cars than adults. Poor families are particularly likely to have no car (45% do not), as are families headed by a black individual (30%). Similarly, immigrants have considerably lower levels of car ownership than those who are US-born.
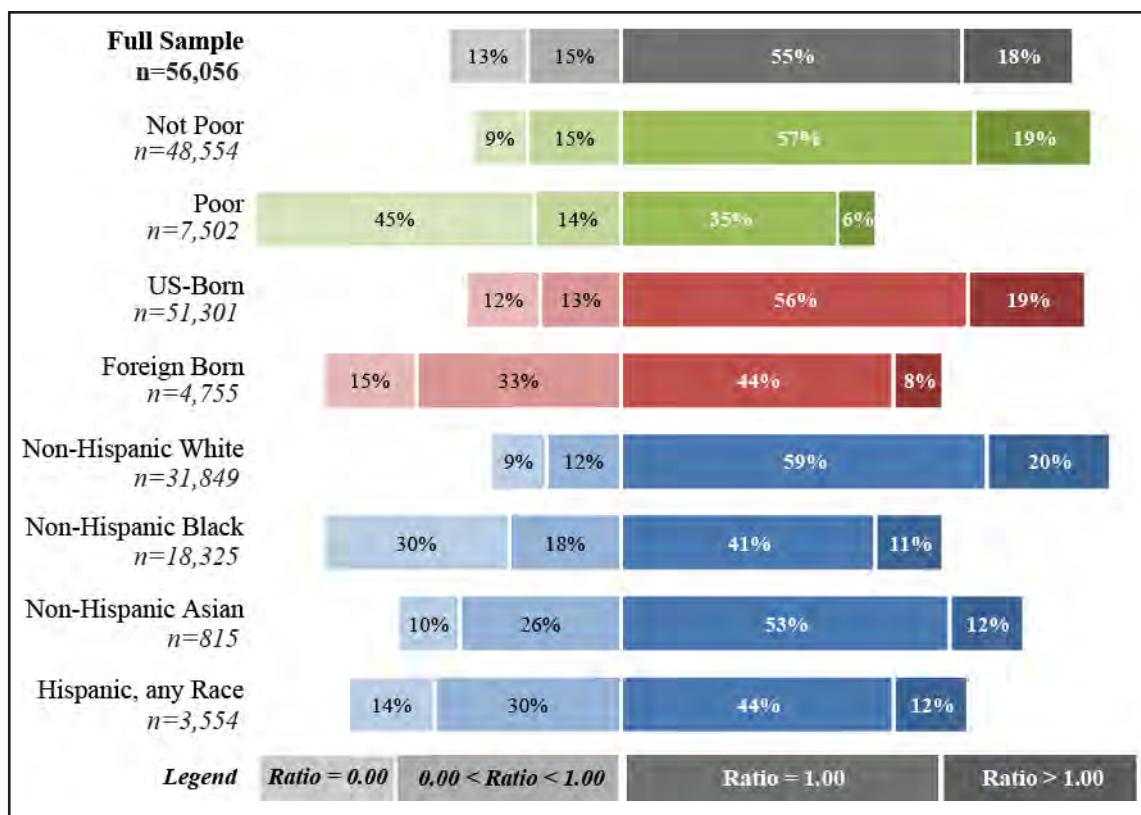
Figure 5.   Ratio of Cars to Adults in the Family in a Typical Year, 1999-2011 Panel Study of Income Dynamics

N = number of family-years.

The PSID estimates of zero-car families in the study years, from a low of 11.4% in 2003 to a high of 13.4% in 2011, are consistently higher than the estimate of zero-car households from the American Community Survey, at 8.8% of households in the 2005-2009 5-Year Estimates. The higher estimates of those without cars in the PSID are likely due to the differences in the unit of observation and the wording of the questions in the two surveys. The PSID is a survey of families, while the ACS surveys households. Further, the two surveys ask slightly different questions about access to automobiles. The PSID is more restrictive, asking whether the family "*own[s] or lease[s]* a car or other vehicle for *personal* use" [authors' italics] (Institute for Social Research, 2013, p. 49), while the ACS asks the number of vehicles "kept at home for use by members of this household" (United States Census Bureau, 2010, p. 5). Thus, borrowed cars (such as from a parent or roommate) present in the ACS but absent in the PSID could account for some of the gap.

Might such a snapshot picture of car ownership mask variation over time, particularly differences by poverty, nativity, and race/ethnicity? The panel nature of the PSID allows an examination of whether zero-car families are likely to remain car-free over time, or whether lacking a car is usually a temporary phenomenon. Looking across the 12 years, it was found that very few families in the PSID remain carless across all seven waves spanning these years. Only 5% of families never have a car during any of the seven waves, while 23% had a car for some (but not all) waves, and 72% had a car in all seven waves of the PSID. These numbers suggest a greater churn into and out of being without a car than

a cross-sectional look at the PSID or Census data would provide, in which 9% to 13% of families have no car in any given year. Figure 4 shows the stability of car ownership over time by these three patterns of car ownership by poverty status, nativity, and race/ethnicity.
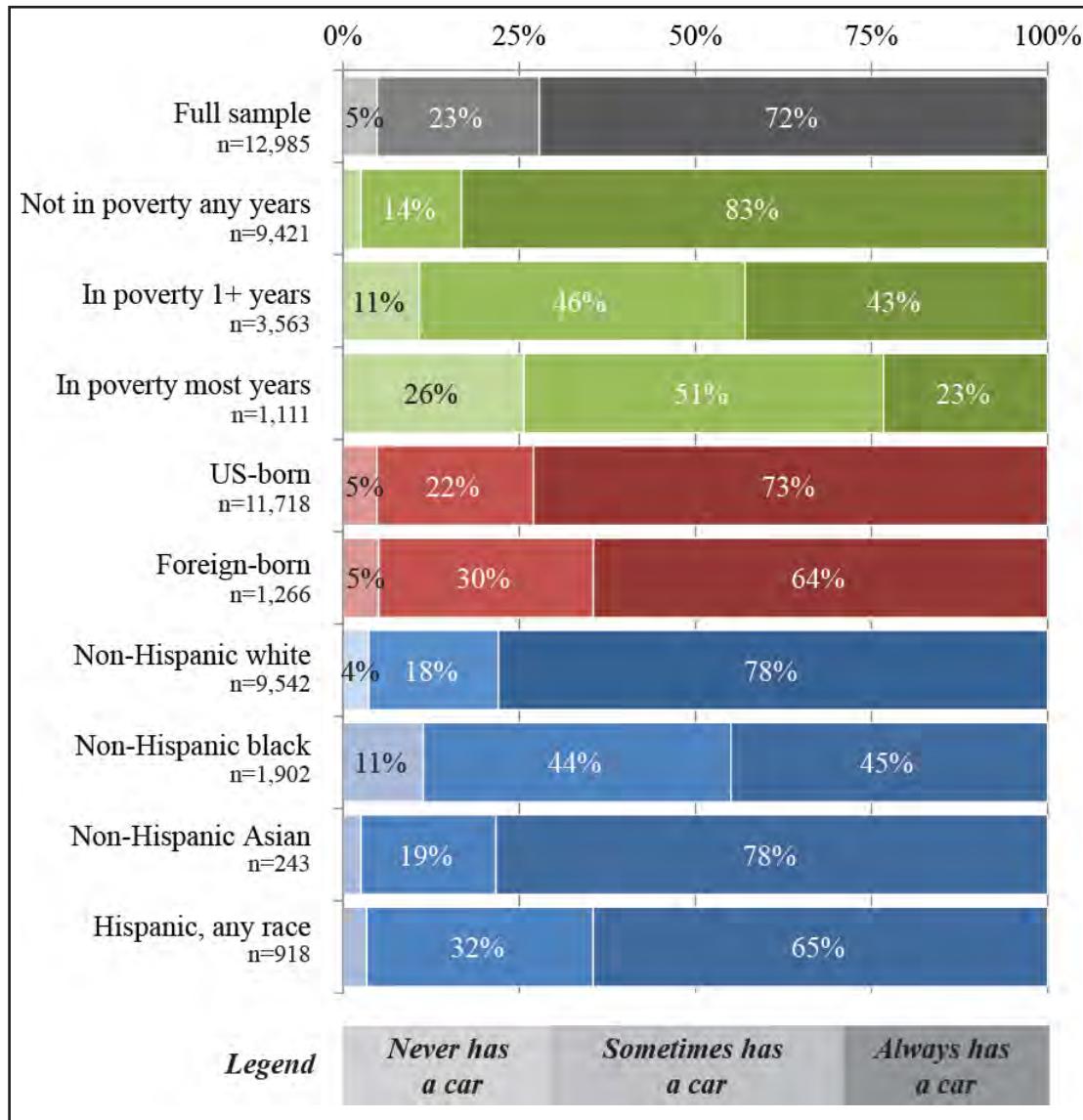

Figure 6.   Stability of Car Ownership within the Family over Seven Survey Waves,

N = number of families.

Poor families and families with a non-Hispanic black head-of-family were the most likely to transition into and out of car ownership. Among families living below the poverty line in more than one-half of the survey waves, 26% remained carless in all seven waves. A slightly smaller share (23%) had a car during all seven waves. Poor families' car ownership fluctuated, with 46% of poor families—and 51% of long-term poor families—transitioning to or from not having a car at least once during the seven waves. These differences are statistically significant using a Kruskal-Wallis rank test. Families headed by black individuals also show a high propensity to have a car for some, but not all, years of the survey. (The differences by race and ethnicity are also statistically significant.) As

expected, foreign-born families also transition in and out of auto ownership at higher rates than US-born families, although these differences are not statistically significant.

The higher prevalence of poverty among immigrants and black-headed families may explain part of these differences. To address this, the share of families were separately analyzed transitioning into and out of car ownership for families that are never in poverty in any of the survey waves. It was found that the differences remain statistically significant, although they are somewhat muted (results not shown here). Among families never in poverty, it was found that black families are twice as likely as white families (27% vs. 13%) to transition into and out of car ownership over the survey waves. Immigrant families not in poverty are also more likely than non-poor US-born families (22% vs. 13%) to experience fluctuation in car ownership. A more detailed analysis of the motivations for transitions into and out of car ownership is needed, and it is a goal worthy of further study.

Figure 7 further illustrates the variability in car availability across time. It shows the estimated probability of a family transitioning to or from not having a car between two waves of the PSID survey. Again, it was shown that poor families, immigrant families, and Hispanic and non-Hispanic black families are more likely to move into and out of not having a car than are non-poor, US-born, or white families. Compared with families who are never in poverty, those who are in poverty in one or more wave are more than three times more likely to transition into or out of car ownership between two waves of the survey. And families who are in poverty in more than half of the panel waves are more than four times as likely to make this transition compared with families who are never in poverty. Further, these differences are statistically significant, based on a test of the equality of proportions. Non-Hispanic black and Hispanic families are also statistically significantly more likely to switch into or out of car ownership compared with non-Hispanic white families. The differences between non-Hispanic white and non-Hispanic Asian families are not statistically significant.
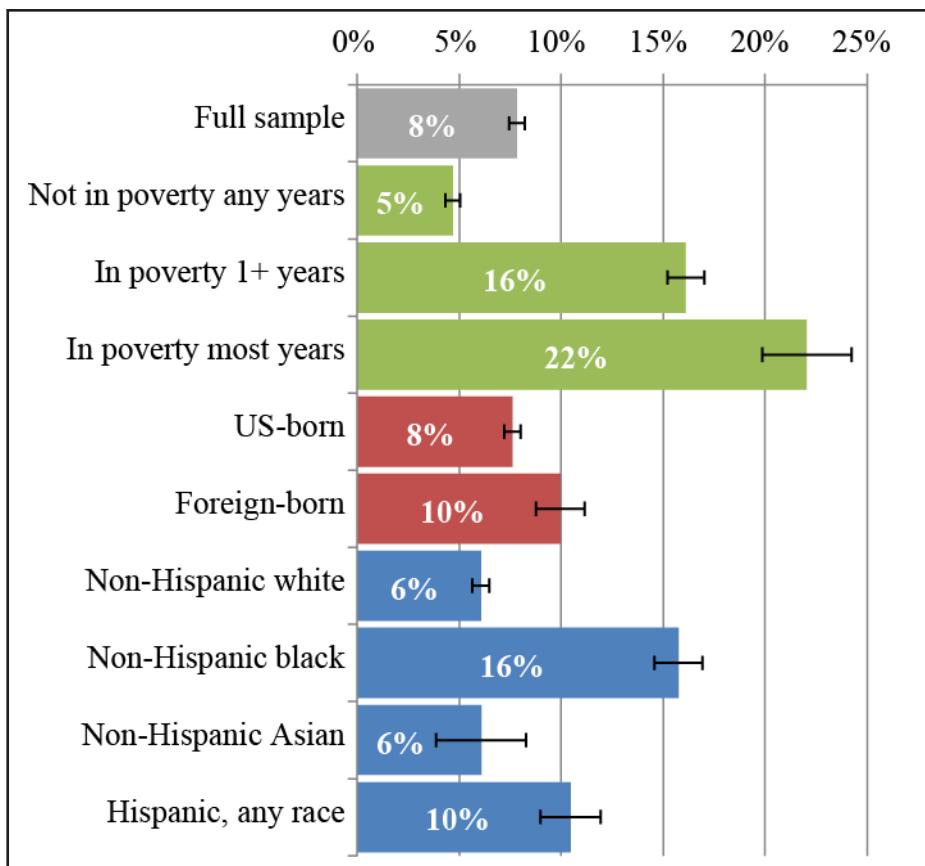
Figure 7. Probability of Family Switching Into or Out of Car Ownership, 1999-2011 Panel Study of Income Dynamics

Note: Error bars indicate 95% confidence interval.

As above, the study separately examined the differences by immigration status and race for households who were never poor in any of the seven waves of the survey. Again, it found statistically significant differences, although somewhat muted. Among the families never in poverty, immigrants are more likely (7%) to transition into and out of car ownership than are the US-born (4%), and black families (9%) are considerably more likely than white families (4%) to gain or lose access to a car between two successive waves.

Given one's car ownership status in 1999, how likely are families to have a car in later waves of the PSID? Figure 8 shows the probability that carless and car-owning families in 1999 will have a car in subsequent waves, disaggregated by poverty status in 1999. Overwhelmingly, car-owning families that were above the poverty line in 1999 were car owners in subsequent waves, with a 93% chance of having one or more cars in 2011. Poor families with a car in 1999 were somewhat more likely to become carless, although the majority (79%) owned a car in subsequent waves. Of those without a car in 1999, nearly half had a car in 2011, though poor families' rates of car ownership grew more slowly than did non-poor families'. These figures mask some further "churn"; of the nearly 40% of 1999's non-poor carless households who had gained a car by 2001, some later reverted to being car-free.
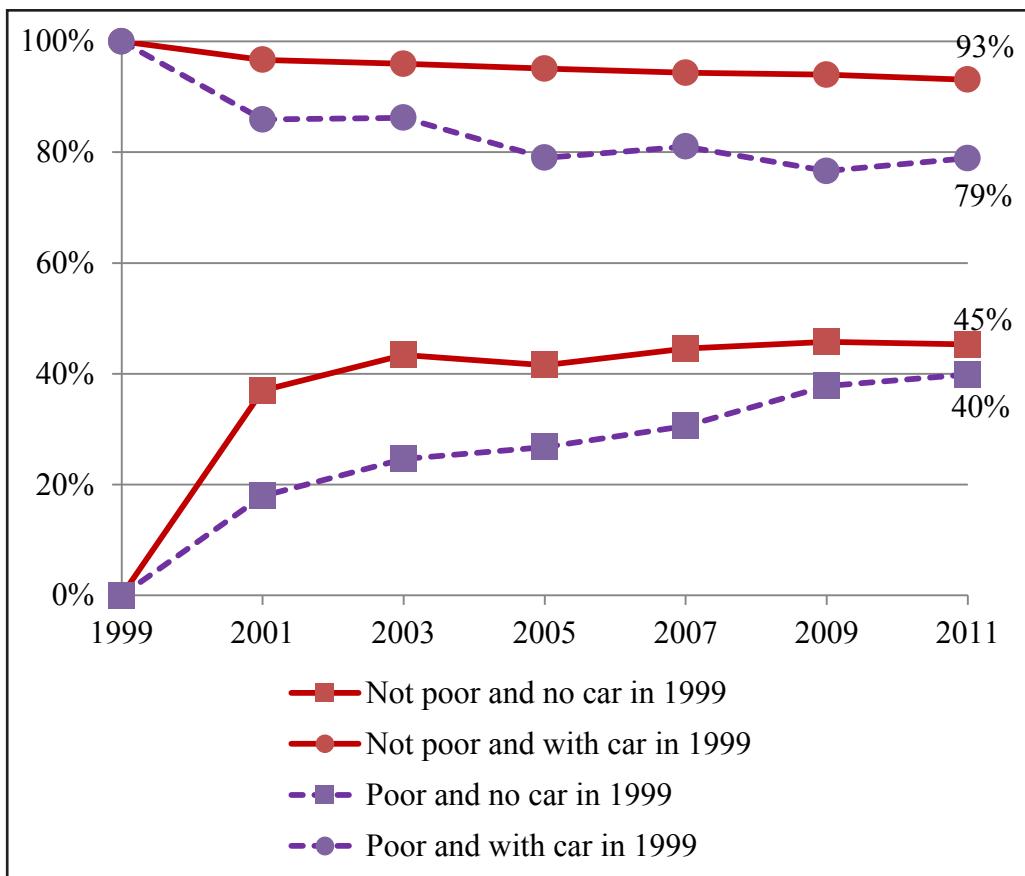
Figure 8.   Probability of Family having One or More Cars, by Poverty Status in 1999 and Car Ownership in 1999, 1999-2011 Panel Study of Income Dynamics

When these trends were examined by race (not presented here), it was found that Hispanic families that were carless in 1999 showed the most rapid increase in car ownership over time (to nearly 60% car ownership in 2011), while black carless families showed the slowest increase (to 45%). All racial/ethnic groups with a car in 1999 retained car ownership at roughly the same rates, with approximately 90% retention over the 12 years included in the study. Nativity played less of a role; rates of retention and gains in cars were nearly indistinguishable from those of the US-born.

Finally, the PSID was used to examine immigrants' acquisition of cars as they settled in the US. Previous research using cross-sectional data found that recent arrivals to the US have lower rates of car ownership, but immigrants who have been in the US five or more years are about as likely as US-born families to own at least one car (Blumenberg & Smart, 2011). However, immigrants' larger families often mean more competition for cars, and the ratio of cars to adults remains lower than that of the US-born even after many years in the US (Tal & Handy, 2010).
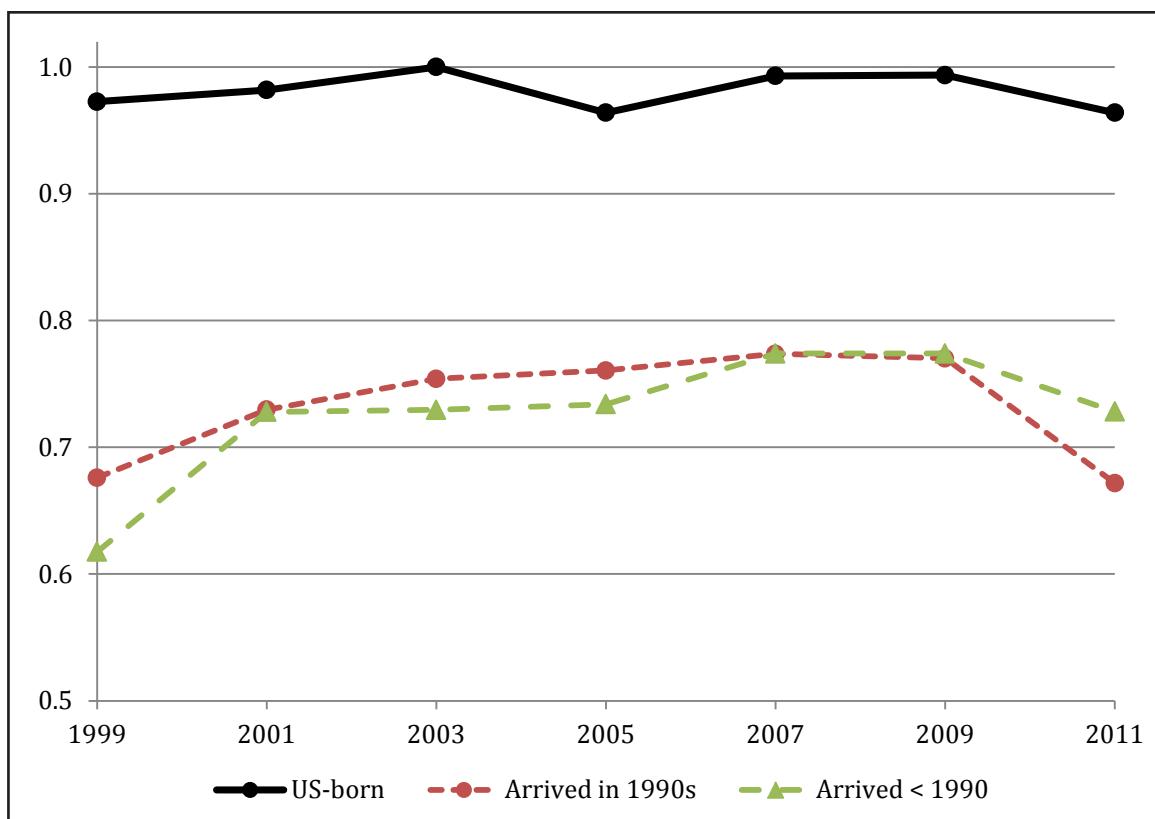
Figure 9.   Foreign-born Car Ratio as a Percentage of US-born Car Ratio, 1999-2011 Panel Study of Income Dynamics

The analysis using the PSID suggests that immigrants on the whole have considerably lower access to cars compared with the US-born, with ratios of cars to adults ranging from roughly 0.6 to 0.8 cars per adult compared with almost one car for every adult among the US-born. Figure 9 compares immigrants who arrived in the US during the 1990s with immigrants who arrived earlier. (Because the PSID sample has not been refreshed since 1999, and it asked only about year of arrival in 1997 and 1999, there is no information on immigrant families who arrived after 1997.) Unlike other studies, this study found that the duration of stay in the US makes little difference. Some caution is urged when interpreting these results because they may be a manifestation of other differences between immigrants and US-born families in the survey, such as their socio-economic background, residential location, employment status, and so forth.

While this paper provides new analysis on family level changes in auto ownership, there are several limitations. First, the immigrant sample includes only a small number of recent arrivals to the US, precluding a detailed analysis of the changes in auto ownership during these crucial settlement years (Blumenberg & Smart, 2011). Additionally, panel surveys are a series of snapshots in time, and they can miss changes that occur between panel waves (Kitamura, Yamamoto, & Fujii, 2003). Hence, there is no information on families that change their level of car ownership multiple times in the period between the biennial surveys; some likely lose and subsequently gain a car during the two-year window, and they would show as having made "no change." Thus, the share of families who experience "car today, gone tomorrow" is likely even greater than the estimates in this study.

DISCUSSION

Snapshot pictures of car ownership tell only one part of the story. While 13% of families in the PSID have no car at any given moment, the panel analysis presents new evidence that, for most of these families, living without a car is a fleeting experience. Only 5% of families in the PSID had no car in all seven waves of the study from 1999 to 2011.

Auto ownership is more ephemeral for some groups more than for others. About one-half of black and poor families (both short-term and long-term poor) transitioned into or out of car ownership during the survey period. This is more than twice the rate of non-Hispanic white families. Of course, the observed differences may be due to a number of interrelated factors. Some of these differences may be due to variations in income, location, life cycle, employment status, and so forth. This report documents that car ownership is ephemeral for many, and that this ephemerality is greater within specific demographic groups. Future research can uncover the relationships that exist among a number of possible correlated variables and to test hypotheses that might explain these differences.

Transportation planners, researchers, and politicians should be cautious when crafting policies for carless households and transit-dependent populations. Previous research has shown that carless households use cars for one-third of their trips (Pucher and Renne 2003). To this, it should be added that many of today's carless families are likely to acquire a car within a short time; almost one-third of the families without a car in 1999 had a car two years later. These findings suggest at least two options for policy interventions aimed at improving transportation access for these families.

In most places in the US, even the poorest families choose to own a car, although their access to those cars may be short-lived. Living without a car is burdensome for most Americans due to land-use configurations and inadequate transit service; gaining and subsequently losing access to a vehicle may add additional costs, imperil employment, and further burden poor and disadvantaged families. This fluid view of car ownership adds another dimension to the understanding of transportation's role in disadvantage and social exclusion of marginalized populations (Blumenberg & Thomas, 2014; Currie, Stanley, & Stanley, 2007; Lucas, 2004). Policy interventions aimed at helping poor families obtain a car might serve to strengthen the family's economic outlook, but simply providing assistance with car acquisition may not be enough; these families may need additional help to keep the car once they have it.

For transit agencies and policymakers interested in increasing transit usage, this report's findings suggest something important. Many transit debates focus on "captive riders" (those without a car) and "choice riders" who have a car. To this, a third group could be added: families for whom the grasp on car ownership is tenuous. Focusing on ways to improve service for these riders—disproportionately the poor, people of color, and immigrants— could make transit a more feasible option for these families. This could increase transit ridership and alleviate the financial burdens of car ownership, both worthy goals.

II. TRANSPORTATION ACCESS AND EARNINGS

INTRODUCTION

For many transportation planners, improving access to jobs is a central goal, along with addressing congestion and the environmental impacts of automobiles. This is even more important for low-income and low-skill households, many of whom struggle to find and maintain a job. However, the question of how best to improve transportation linkages to jobs is not clear. Should policy-makers invest in public transit or help low-income and low-skill residents access cars?

This study analyzed the relationship between transportation and economic outcomes for a sample of families over a span of fourteen years. To do this, eight waves of data were used, from 1999–2013, from a large nationally representative panel data set, the Panel Study of Income Dynamics (PSID), to assess how transit access and car ownership relate to employment outcomes and earnings. Further, the PSID was used to estimate the costs of car ownership to examine if the increased earnings from access to cars outweigh the monetary costs of car ownership.

The research found that greater access to cars is associated with improved economic outcomes, but the effect of increased access to public transit is mixed. However, the average costs associated with owning and maintaining a car outstrip the average income gains associated with having a car. For researchers and policy-makers, the implications are not cut and dried. In some contexts, it is suspected that cars confer significant advantages; in others, transit offers advantages, while cars may be a financial burden. Future research should explore these costs and burdens in different contexts to shed more light on these trade-offs.

This chapter is organized as follows: First is a description of the existing research on the relationship between transportation and economic outcomes. Next, the research approach is described. Then the data is summarized, and two analyses are presented separately. The report concludes with a discussion of the results and policy implications.

CARS, TRANSIT ACCESS AND ECONOMIC OUTCOMES

At the core of much of the research on improving transportation access to jobs are theories of spatial mismatch and welfare reform policies of the 1990s. The spatial mismatch theory argues that part of the reason for the economic hardships facing minorities in cities is the lack of transportation access to suburban jobs (Kain, 1968). Policies to address spatial mismatch fall into two camps: those that aim to improve transit access to suburban jobs, and those that present policies to improve access to car ownership for poor households.

Evaluations of transit access programs are mixed. The most well-known of these programs is the Job Access and Reverse Commute (JARC) grant program, established in 1999 under the Transportation Equity Act for the 21st Century (TEA-21). It provided funds for state and regional planning organizations to improve low-income workers' access to jobs. JARC recipients typically used the funds to operate, enhance or establish transit services for

low-income populations (Government Accountability Office, 2009; Sanchez & Schweitzer, 2008). Evaluations of JARC have found mixed results, in keeping with the diverse range of transportation services that have been funded under this program (Blumenberg & Schweitzer, 2006; Cervero & Tsai, 2003; Government Accountability Office, 2009; Sanchez & Schweitzer, 2008). Most relevant to this study, cost-benefit analysis of programs found net positive returns on investments in the programs for transit riders on JARC programs, in terms of increased incomes, and for society, from decreased welfare payments and increased income taxes (Thakuriah, Persky, Soot, & Sriraj, 2013).

The second set of policies to overcome spatial mismatch are those aimed at improving automobile access for low-income populations. In the US, there are at least 120 car ownership programs for low-income families, usually in the form of small loans with little to no interest charged (Alst, McLaughlin, & Levy, 2014; Joblinks, n.d.) or matched savings programs that can be used for automobiles, among other things (Office of Refugee Resettlement, 2009). Research suggests that improved car access increases the likelihood of being employed (Baum, 2009; Blumenberg & Pierce, 2014; Cervero, Sandoval, & Landis, 2002; Clark & Wang, 2010; Gurley & Bruce, 2005; K. Lucas, Blumenberg, & Weinberger, 2011; M. T. Lucas & Nicholson, 2003; Ong, 2002; Raphael & Rice, 2002; Sandoval, Cervero, & Landis, 2011). Similarly, individuals with cars report higher earnings than those without (Gurley & Bruce, 2005; K. Lucas et al., 2011; M. T. Lucas & Nicholson, 2003; Raphael & Rice, 2002). Welfare beneficiaries with cars are more likely to transition away from welfare than those without cars (Baum, 2009; Cervero et al., 2002; Gurley & Bruce, 2005; M. T. Lucas & Nicholson, 2003; Ong, 2002; Sandoval et al., 2011). Persons with access to cars also had greater job stability compared with those who rely on public transit (Blumenberg & Pierce, 2014; Gurley & Bruce, 2005; Richards & Bruce, 2004; Sandoval et al., 2011). Beyond the direct economic outcomes, car access offers the promise of increased flexibility of work hours (Baum, 2009; Gurley & Bruce, 2005; Raphael & Rice, 2002), a particularly important consideration for single mothers (Blumenberg, 2004), who frequently bear all the time and labor burden of household-serving activities and the associated travel, and for families with more children (Baum, 2009; Fletcher, Garasky, & Nielsen, 2005; Lichtenwalter, Koeske, & Sales, 2006). To the best of the authors' knowledge, no scholars have examined whether the income and employment benefits of car ownership outstrip the monetary costs of cars, as this report does.

Compared with car access, researchers have found mixed evidence of transit's effect on economic outcomes, and where scholars have found effects, they have been relatively small. Low-income households dependent upon public transportation experience employment and earning gains, although less than those with cars (Blumenberg & Pierce, 2014; Lichtenwalter et al., 2006; Sandoval et al., 2011; Taylor & Ong, 1995). Others have found that only transit dependent households living in dense and transit accessible locations experience significant economic gains (Cervero et al., 2002; Gardenhire & Sermons, 2001; K. Lucas et al., 2011; Sandoval et al., 2011; Taylor & Ong, 1995). The increased frequency, reliability, and span (including nighttime service) of public transportation services also contribute to households' economic outcomes, demonstrating the importance of convenient services among transit-dependent households (Clark & Wang, 2010; Hart & Lownes, 2013).

The authors' approach to analyzing the relationship between access to transportation and economic outcomes improves on the existing research in a number of ways. First, the analysis looks at this relationship across a representative sample, not just impoverished persons. Similarly, the report draws from persons living throughout the US, not just in one state or region, as many have done. (An exception is Baum, 2009.) This report also uses a long-term panel data set rather than focusing on one or two years of data. (Again, an exception in this regard is Baum, 2009.) The analysis also improves on others by including information on the public transit accessibility at the home, not just on automobile ownership. Finally, because the PSID includes information on expenditures on automobiles, the authors are able to assess whether the income benefits derived from increased auto access are greater than the costs of owning and maintaining these vehicles.

RESEARCH APPROACH

It was hypothesized that increased access to automobiles and transit improves families' success in the labor market. By increasing the spatial extent of their job searches and improving their ability to arrive at work on time, family members are better able to obtain and maintain employment and improve their families' earnings over time. To test these two separate hypotheses, a restricted geo-coded version of the Panel Study of Income Dynamics (PSID) was used to examine changes over time in labor market outcomes as a function of automobile ownership and transit accessibility ("Panel Study of Income Dynamics, restricted use data," 2014). The units of analysis in this report's models are families, which is the unit of analysis that the PSID follows over time.

The analysis uses data from eight waves collected every other year from 1999 –2013. The overall modeling approach is diagrammed in Figure 10. The outcomes of interest (future employment outcomes and future income) are modeled using panel waves from 2001–2013. Responses to questions about employment status refer to the time of the survey, while incomes are reported for the previous calendar year. Independent variables are drawn from each of the panel waves preceding the dependent variables (waves 1999–2011). Thus, while eight waves of data were used for the analysis, the model includes only seven distinct time periods (1999/2001, 2001/2003, through 2011/2013).
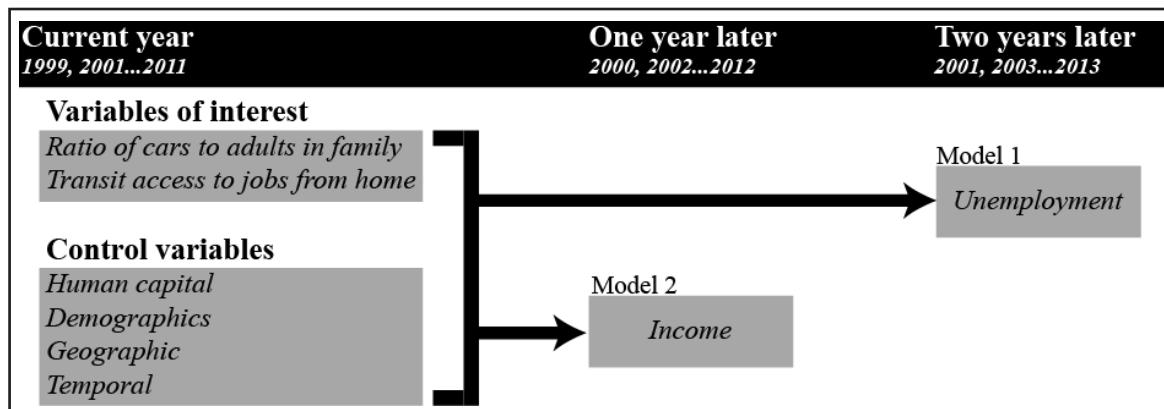

Figure 10. Modeling Approach

First, the relationship was tested between transportation access and future unemployment. The authors estimated a random-effects logit model of unemployment in the next panel wave (two years later) as a function of predictors about the family in the current panel wave. The dependent variable is 1 (unemployed) if the head or spouse (when present) is "looking for work, unemployed," and it is zero (not unemployed) if they are working, on temporary leave, retired, disabled, a homemaker, or a student. A random-effects (rather than fixed-effects) model was used because of the large share of families (roughly four-fifths) in that dataset that do not change employment status during the panel waves.

Second, the relationship was tested between transportation access and future earnings. In this model, a fixed-effects ordinary least squares (OLS) regression was used. The fixed-effects model at least partially accounts for unobserved factors associated with families, such as innate ability, drive to succeed, and so forth. Further, a Hausman test of the fixed versus random models was significant ($P < 0.01$) and thus the random-effects model was rejected. The dependent variable is total family income (log transformed) in the next year (obtained from the next panel wave reporting of "last year's" income), modeled as a function of predictors in the current panel wave. The total family income is a composite variable included in the PSID that includes the taxable income for the head, spouse, and other family members, transfer incomes, and Social Security income. Labor income (wages), admittedly a better measure of families' success in the labor market, is available only for the head and spouse of the family, not for all employed members of the family; thus, the variable measuring all family income was used.

In both models, the outcome variable was estimated as a function of access to transportation (cars and public transit accessibility), human capital measures, demographic attributes, and regional and temporal variables. The transportation variables are auto ownership and transit access to jobs. Auto ownership was measured as a ratio of the number of cars owned by the family relative to the number of adults (age 18 or older) in the family, which accounts for car ownership and competition for the use of those vehicles. The transit access data were obtained from two sources: the Transit and Jobs in Metropolitan America (Tomer, Kneebone, Puentes, & Berube, 2011) and Access Across America: Transit 2014 (Owen & Levinson, 2014). Because each provides only partial coverage for the US, a combined measure was created of the total number of jobs available within 30 minutes by transit. (When both measures were available, the average of the two was used. Otherwise, we used whichever was available; the two estimates are highly correlated for locations where they overlap). The combined transit accessibility dataset covers roughly 55% of the observations in the dataset. A limitation of transit access data is that it does not vary over time, only across geographies, and thus does not account for changes in the transit service or job availability.

In the models, a variety of different measures of access to jobs were tested. These measures included the raw number of jobs accessible by transit from one's home census tract in a 30-minute ride; these raw numbers converted into national and regional quintiles of job access via transit; and a regionally-standardized measure of job access by transit, with the most-accessible tract in the region scored as 1.0, and tracts with access to one-half as many jobs scored as 0.5, for instance. As discussed below, each of these measures produced different, and sometimes conflicting, results. This is discussed further in the Conclusion section.

Unlike previous studies of the relationship between transportation access and economic outcomes, this report's data source, the PSID, is not limited to low-income families. However, the authors were particularly interested in how the relationship between transportation and economic outcomes plays out among impoverished families. The report analyzed the full PSID sample along with several subsamples. The first subsample of "poor families" includes those families living in poverty in one or more of the survey waves. The second subsample of "low-skill" families includes families in which neither the head nor spouse/partner (if present) has a college degree in any of the survey waves. Although the full results are not presented here, models of subsamples are estimated for different racial and ethnic subgroups (non-Hispanic white, non-Hispanic black and Hispanic). In all cases, the analysis was restricted to families with heads of family that are of working age (at least 20 years old and no more than 65 years old) and families that have some (greater than zero dollars) income. Analyses also were conducted with a restricted sample of people aged 26–65 (families squarely in the post-college life stage), and the results did not vary meaningfully.

Finally, the costs of car ownership were estimated for families in the PSID. This analysis enabled a comparison of the economic gains from obtaining a car with the costs of car ownership. The PSID collects extensive information on the costs of car ownership, which was used to create an estimate of the total family car costs as a function of expenses for payments, leases, loans, and operation of these cars (gas, insurance, repairs, and parking). Depending on the particular attribute, the PSID collects some information about car expenditures during the previous month or year (e.g., they ask about repairs during the previous month, but purchase costs are for the previous year). As a result, there is significant variation among families, but the mean estimates for car costs are similar to those from the Consumer Expenditure Survey (Andreski, Li, Samancioglu, & Schoeni, 2014). Due to this variation among families, the data was used to estimate average annual costs of car ownership for new and used automobiles. (All costs were converted to inflation-adjusted 2013 dollars). However, these costs were separately modeled for the full sample and for the "poor" and "low-skill" subsamples.

DESCRIPTIVE STATISTICS

Table 3 summarizes the variables included in the models for three samples. Models were estimated for a number of other subsamples, described in a separate section (to follow) but not reported in the tables.

The dependent variables for the two models are unemployment in the following panel wave and total family income in the calendar year following the survey. As expected, families who are poor in at least one panel wave have the lowest incomes and the highest rates of unemployment. Families in the low-skill subsample lie between the poor families and the full sample on both measures. The mean and median income were reported in inflation-adjusted 2013 dollars across all survey waves.

The transportation variables vary considerably across the different subsamples. In the full sample, the typical family has just over one car per adult (1.01). In the subsample of poor families, the rate of car ownership is considerably lower (0.79) and somewhat lower for the low-skill sample (0.92). For just over one-half of the families, data are available on transit

accessibility. Among these families, transit access is marginally higher for poor families than in either the full sample or the low-skill sample.

As expected, poor families are worse off across all of the measures of human capital. Poor families are less likely to have a college degree, although they are somewhat more likely to be enrolled in college than the overall sample. For poor families, both the head and spouse (when present) have worked fewer years, on average, than families in the full sample and low-skill families. Poor families are also less likely to have members working for pay (0.9 compared with 1.4 in the full sample and 1.3 in the low-skill sample).

Family characteristics of the subsamples also show differences. Poor families are less likely to be headed by a non-Hispanic white or non-Hispanic Asian person, and more likely to be Hispanic or non-Hispanic black. Low-skill families show the same patterns, although the differences are less stark. Poor families are more likely to be headed by single men or women with no children, and single mothers are twice as common among poor families as in the overall population (13% versus 6% in the full sample).

Among the geographic variables, only the measure of local poverty rates varies meaningfully across the three subsamples. As expected, poor families tend to live in areas with higher rates of poverty, as measured by the mean poverty rate in the American Community Survey (ACS) 2005–2009 (5-Year Estimates). Prevailing wages (per capita income at the state level serve as a proxy) and living in a rural area are roughly similar in all three samples. These latter two geographic variables are coarse and it is expected that at the metropolitan or neighborhood scale, one would see considerably greater differences, as evidenced by the public transit service quality metric described above.

Table 3.   Descriptive Statistics, PSID 1999-2013

	Sample 1	Sample 2	Sample 3
	Full Sample	Poor Families	Low-Skill Families
Total family income, constant dollars (mean)	$91,097	$37,784	$58,274
Total family income, constant dollars (median)	$66,554	$25,466	$44,928
Unemployment Rate (head and spouse combined)	6.4%	13.5%	8.2%
Transportation variables			
Ratio of cars to adults in family	1.01	0.79	0.92
Mean number of jobs accessible by transit in 30 minutes (from home)	35,184	36,943	28,252
Mean transit accessiblity as a percent of the region's best tract	7%	10%	7%
No transit data available for home census tract	46%	49%	50%
Human capital variables			
Head of family has college degree	31%	13%	n/a
No spouse/partner present in family	41%	62%	49%
Spouse/partner of head (where present) has no college degree	37%	32%	51%
Spouse/partner of head (where present) has college degree	21%	6%	n/a
Head or spouse/partner in school	2%	4%	1%
Years worked (family head, if working)	12.1	10.8	12.7
Years worked (spouse/partner, if working)	10.7	9.8	10.8

	Sample 1	Sample 2	Sample 3
	Full Sample	**Poor Families**	**Low-Skill Families**
Number of workers in family next year	1.4	0.9	1.3
Wealth quintiles			
1st quintile	21%	41%	26%
2nd quintile	22%	30%	27%
3rd quintile	21%	16%	22%
4th quintile	19%	8%	16%
5th quintile	17%	6%	9%
Demographic variables			
Race/ethnicity of family head			
Non-Hispanic white	76%	57%	65%
Non-Hispanic black	14%	29%	21%
Non-Hispanic Asian	2%	1%	1%
Non-Hispanic other race	1%	1%	1%
Hispanic, any race	7%	12%	12%
Family type			
Couple with no children	25%	16%	23%
Couple with child(ren) at home	33%	29%	30%
Single man	15%	21%	17%
Single father with child(ren) at home	1%	1%	1%
Single woman	13%	17%	14%
Single woman with child(ren) at home	6%	13%	8%
Other family type	7%	3%	7%
Geographic variables			
Mean poverty rate for census tract (ACS 2005-2009)	10%	16%	13%
Average per capita income in home state (1999$)	$28,166	$27,426	$27,874
Family lives in rural area	3%	4%	4%
N(observations: family-years)	40,299	12,988	20,183
N(families)	10,113	3,619	5,104
Mean number of waves families present	4.0	3.6	4.0
N(observations: family-years)	38,002	11,823	18,899
N(families)	9,368	3,276	4,691
Mean number of waves families present	4.1	3.6	4.0

TRANSPORTATION AND EMPLOYMENT OUTCOMES

Greater access to automobiles appears to help families avoid periods of unemployment, as Table 2 shows. In the full sample, having one car per adult decreases the odds of a family member becoming unemployed by more than 18% ($e^{-0.20}=0.82$), compared with the case in which the family has zero cars; the effect is roughly one-half that for poor families, although it is greater for low-skill families. [Note: e = Euler's number]

Access to high-quality transit, however, has the opposite association. In the models, families living in the most transit-rich neighborhoods of their region are *far* more likely to become unemployed than are those living in less transit-rich neighborhoods, even after controlling for a host of other factors. In the model using the full sample, those living in the most transit-rich neighborhood are 60% ($e^{0.47}=1.60$) more likely to become unemployed than are those living in neighborhoods without any transit. It was speculated that this effect proxies for something else about the neighborhood or the families who live in it, although obvious factors were controlled for, such as education, wealth, neighborhood poverty rate, and so forth. Further research is needed to understand this association.

The Hosmer-Lemeshow goodness of fit statistic suggests that the model is well-calibrated, and a variance inflation factor test finds that multi-collinearity is not a problem in the model. The control variables function as expected. Those people with more education, more work experience, and greater wealth are less likely to become unemployed, although a small effect associated with greater work experience for the spouse/partner is noted. Large differences were found between racial/ethnic categories, with blacks and Hispanics being much more likely to become unemployed, even after controlling for education, experience, and so forth.

The geographic and temporal variables also function as expected. Those living in higher-poverty neighborhoods are far more likely to become unemployed, and the model suggests that, compared with 1999, families were much more likely to experience unemployment in subsequent years, with the effect peaking in the 2007/2009 model.

An alternative model formulation was also tested, using a negative binomial model in which the dependent variable is the rate of unemployment among the head and other family members (if present). This models yielded results consistent with the logit model presented previously.

Table 4.   Random-effects Model of Unemployment, PSID 1999-2013

	Model 1		Model 2		Model 3	
	Full Sample		Poor Families		Low-Skill Families	
Transportation variables						
Ratio of cars to adults in family	-0.21	***	-0.11	***	-0.23	***
Mean transit accessibility as a percent of the region's best tract	0.48	***	0.22	***	0.30	***
No transit data available for home census tract	0.02		-0.13	***	-0.03	
Human capital variables						
Head of family has college degree	-0.37	***	-0.54	***	n/a	
Spouse/partner of head (where present) has no college degree	0.13	***	0.51	***	0.19	***
Spouse/partner of head (where present) has college degree	-0.23	***	0.25	***	n/a	
Years worked (family head, if working)	-0.03	***	-0.03	***	-0.03	***
Years worked (spouse/partner, if working)	<0.01		-0.01	***	-0.02	***
Demographic variables						
Race/ethnicity of family head (base: Non-Hispanic white)						
Non-Hispanic black	0.73	***	0.67	***	0.73	***

	Model 1		Model 2		Model 3	
	Full Sample		Poor Families		Low-Skill Families	
Non-Hispanic Asian	-0.32	***	-0.57	***	-0.79	***
Non-Hispanic other race	0.07		0.18	*	0.03	
Hispanic, any race	0.48	***	0.16	***	0.66	***
Family type (base: couple with no children)						
Couple with child(ren) at home	0.15	***	0.15	***	0.23	***
Single man	0.52	***	0.73	***	0.52	***
Single father with child(ren) at home	0.59	***	0.74	***	0.31	***
Single woman	-0.08	***	-0.14	***	-0.23	***
Single woman with child(ren) at home	0.52	***	0.44	***	0.45	***
Other family type	0.16	***	0.20	***	-0.01	
Family head or spouse (where present) born abroad						
Geographic and temporal variables						
Mean poverty rate for census tract (ACS 2005-2009)	-0.01		-0.13	**	0.17	***
Family lives in rural area	1.17	***	0.31	***	1.14	***
Year (base: 1999 (Ind. vars.) / 2001 (Dep. Var.))						
2001 / 2003	0.18	***	0.14	***	0.20	***
2003 / 2005	-0.11	***	-0.16	***	0.12	***
2005 / 2007	0.02		-0.27	***	0.10	***
2007 / 2009	0.75	***	0.37	***	0.85	***
2009 / 2011	0.68	***	0.37	***	0.80	***
2011 / 2013	0.49	***	0.21	***	0.50	***
Constant	-3.65	***	-2.66	***	-3.53	***
N(observations: family-years)	38,002		11,823		18,899	
N(families)	9,368		3,726		4,691	
Mean number of waves families present	4.1		3.6		4.0	
Log-likelihood at convergence	-169,501		-71,799		-91,647	
Hosmer-Lemeshow goodness of fit (deciles) chi-square	205.4		29.2		139.7	
Prob. > H-L chi-square	<0.001		<0.001		<0.001	
Rho (fraction of variance due to family-level random effect)	0.37		0.31		0.36	

Note: Stars denote significance: * $p<0.10$; ** $p<0.05$; *** $p<0.01$.

TRANSPORTATION AND EARNINGS

Having access to a car is a strong predictor of having a higher income the following year. The model (Table 3) suggests that a family's transition from zero cars per adult to one car for every adult is associated with a 5% gain ($e^{0.05}=1.05$) in future income in the full sample and a 9% gain in the subsample of poor families. For low-skill families, in which neither the family head nor spouse or partner (where present) has a college education, the effect of having a car for every adult is a 4% gain. Transitioning from sharing a car between two adults to having one car for each person (an increase of 0.5 cars per adult) would approximately halve the effect, controlling for other variables in the model. These effects are substantial; at the median income for each of these groups, the model suggests having one car per adult in the household would translate into next-year income gains of $3,552 for the full sample, $2,258 for families in poverty, and $1,851 for low-skill families.

And what of the effect of transit service on changes in families' incomes? Having access to public transportation has no statistically significant effect in any of the models presented here. But living somewhere in the US where there is no information on the transit supply has a negative association with future income gains; this variable may proxy for regions with poor or no transit service, although this cannot be confirmed. Alternative specifications were tested for transit access quality, such as the raw number of jobs that a transit rider can reach within thirty minutes, and regional and national quartiles of jobs access by transit. In the model using the raw number of jobs accessible by transit, a marginally significant and positive relationship with earnings was found, although not of a meaningful magnitude. (A doubling of transit access for the median family in the full sample would increase next year's income by $38, the model suggests.) In both of the alternative specifications using transit access quintiles, counterintuitive results were found: a negative effect associated with high-quality and middling transit service, compared with census tracts with the worst transit service. From these mixed results, it was concluded that transit service has little if any impact on families' future earnings.

Table 5.   Fixed-effects Model of Total Family Income in Next Year, PSID 1999-2013

	Model 1		Model 2		Model 3	
	Full Sample		**Poor Families**		**Low-Skill Families**	
Transportation variables						
Ratio of cars to adults in family	0.05	***	0.08	**	0.04	**
Mean transit accessibility as a percent of the region's best tract	0.08		-0.07		0.07	
No transit data available for home census tract	-0.08	***	-0.28	***	-0.14	***
Human capital variables						
Head of family has college degree	0.07	***	0.23	**	n/a	
Spouse/partner of head (where present) has no college degree	-0.03		-0.15		0.02	
Spouse/partner of head (where present) has college degree	0.02		-0.05		n/a	
Head or spouse/partner in school	-0.01		0.07		-0.11	
Years worked (family head, if working)	0.01	***	0.01	**	0.01	***
Years worked (spouse/partner, if working)	<0.01	**	0.01	*	<0.01	
Number of workers in family next year	0.11	***	0.20	***	0.14	***
Demographic variables						
Wealth quintiles (base: 1st Quintile)						
2nd quintile	0.04	**	0.03		0.06	**
3rd quintile	0.09	***	0.11		0.11	***
4th quintile	0.10	***	0.04		0.11	***
5th quintile	0.10	***	-0.14		0.18	***
Family type (base: couple with no children)						
Couple with child(ren) at home	0.06	***	-0.06		0.01	
Single man	-0.22	***	-0.40	***	-0.09	
Single father with child(ren) at home	-0.10		-0.28		0.03	
Single woman	-0.33	***	-0.50	***	-0.37	***
Single woman with child(ren) at home	-0.10	**	-0.28	***	-0.21	***
Other family type	0.11	***	0.18		0.08	*

	Model 1	Model 2	Model 3
	Full Sample	Poor Families	Low-Skill Families
Geographic and temporal variables			
Mean poverty rate for census tract (ACS 2005-2009)	-0.13	-0.06	-0.12
Average per capita income in home state (1999$)	<0.01	<0.01	<0.01
Family lives in rural area	-0.18 ***	-0.45 ***	-0.05
Year (base: 1999 (Ind. Vars.) / 2001 (Dep. Var.))			
2001 / 2003	-0.05 ***	-0.07	-0.06 **
2003 / 2005	-0.05 ***	-0.16 ***	-0.11 ***
2005 / 2007	-0.04 **	-0.24 ***	-0.14 ***
2007 / 2009	-0.06 ***	-0.28 ***	-0.12 ***
2009 / 2011	-0.08 ***	-0.30 ***	-0.20 ***
2011 / 2013	-0.07 ***	-0.30 ***	-0.22 ***
Constant	10.70 ***	10.50 ***	10.90 ***
N(observations: family-years)	40,299	12,988	20,183
N(families)	10,113	3,619	5,104
Mean number of waves families present	4.0	3.6	4.0
R-square (within families)	0.03	0.03	0.03
R-square (across families)	0.36	0.15	0.29
R-square (overall)	0.28	0.10	0.21
Rho (fraction of variance due to family-level random effect)	0.62	0.42	0.61

Note: Stars denote significance: * $p<0.10$; ** $p<0.05$; *** $p<0.01$.

In each of the models, the control variables performed as expected, and a variance inflation factor diagnostic shows that the inclusion of these variables does not threaten the findings through multi-collinearity. Families headed by a college graduate had greater income gains than those without college degrees in the full model and poor subsample. Wealthy families are more likely to see greater income gains in future years, likely reflecting return on investments. More work experience was also associated with greater income gains. Family type also appears to matter for income growth, even after controlling for the number of workers in the family. Couples with children saw greater income gains than did couples without children in the full model and poor subsample. Single men and women (with or without children) saw lower income gains relative to couples without children. As expected, the number of workers in the subsequent survey year adds significantly to the family's earnings. A limitation of the modeling approach is that this variable, the number of workers, is not temporarily synced with the measure of income next year. This may introduce some error, although it is unlikely biased in one direction or the other.

Finally, the variables controlling for geographic and temporal trends performed largely as expected. Families living in rural areas had lower incomes. The mean tract poverty rate and state-level prevailing wages were not significantly associated with family earnings. The temporal trends are also telling; compared with income in 1999, lower incomes were found in all subsequent years, with the temporal effects hitting low-income and low-skill families the hardest.

In addition to the above models, the robustness of the models was tested using alternative model specifications and additional subsamples of the PSID. For example, the PSID includes additional questions about individual income and earnings. The models were estimated using these (rather than total family income), and the results were largely consistent with the model presented previously.

In another series of models, non-Hispanic white, non-Hispanic black and Hispanic family subsamples of the PSID were evaluated separately. The model results for non-Hispanic white families were similar to the results for the full PSID population, although the effect size of the auto ownership variable is slightly smaller in magnitude (0.4 vs. 0.5). For non-Hispanic black families, gaining a car is associated with an 8% increase in income next year while transit access is not significant. In the Hispanic subsample, gaining a car is associated with a 13% increase in income next year and, notably, the transit accessibility variable is significant and positive.

ESTIMATES OF AUTOMOBILE EXPENDITURES

The analysis suggests that having access to a car is a strong predictor of income gains in the subsequent year. But owning and operating a vehicle is costly. In a separate analysis, the families' expenditures on automobiles were estimated to obtain an estimate of how much a typical family spends on owning and maintaining a car. Because the PSID does not report costs associated with each car individually, but rather as an series of aggregate expense categories for all cars (for example, dollars spent on gasoline for all cars), a linear regression model of total expenditures was estimated (including car purchase costs), with the number of new cars and used cars owned by the family as explanatory variables. (All costs were adjusted to 2013 dollars.) The constant term in the model is set to zero, as families with no cars should have no (or nearly no) automobile-related expenses.

Figure 11 presents the estimates of car-related expenditures for the same subsamples used in the analyses noted previously. The point estimate of all auto-related costs for new and used cars is presented separately, as well as a 95% confidence interval around the point estimate. Families spend roughly $7,000 on new cars per year in the full sample. Poor families spend $6,400, and low-skill families spend nearly $6,100 on new cars, although the confidence interval shows that these families' expenditures are more variable. Used cars cost families considerably less, or roughly $4,100 to $4,400 per year in all samples. Median operating costs (total costs excluding car purchases) were also estimated, and these range from $1,800 to $1,900 in the samples.

The estimates of automobile costs represent pooled costs across the study period, including times of high fuel prices and times of lower fuel prices. However, a longitudinal analysis of auto-related expenditures reveals that total auto expenditures during the study period peaked in 2003, the second-lowest year for gasoline expenditures. Gasoline expenditures peaked in 2007, an average year for total car-related expenditures. Families appear to make trade-offs between gasoline prices and other car-related expenditures, such as the purchase of a car. In fact, when the regression analysis was restricted to the "cheaper fuel" years 1999 to 2006, it was found that an additional new car results in greater expenditures than in the full model (perhaps due to the purchase of more expensive cars), while the

cost estimate for owning and maintaining a used car is statistically indistinguishable from that of the full model.

Figure 11 includes the estimated gains in income associated with having an additional car available from the regression model presented earlier. In each of the three samples, it was found that the costs of owning and maintaining a car outstrip the estimated income benefits, although the 95% confidence intervals suggest some caution in this interpretation. The confidence interval for the coefficient estimate represents the most likely range of the true effect. Comparing the confidence intervals for the income gained from a car with the cost of a used car shows that, for both the full sample and the poor sample, these intervals overlap. This suggests that the income gains may be higher or lower than the costs of owning a used car. However, in the low-skill sample, the intervals do not overlap, suggesting that the costs of a used car are greater than the income gains in this sample.
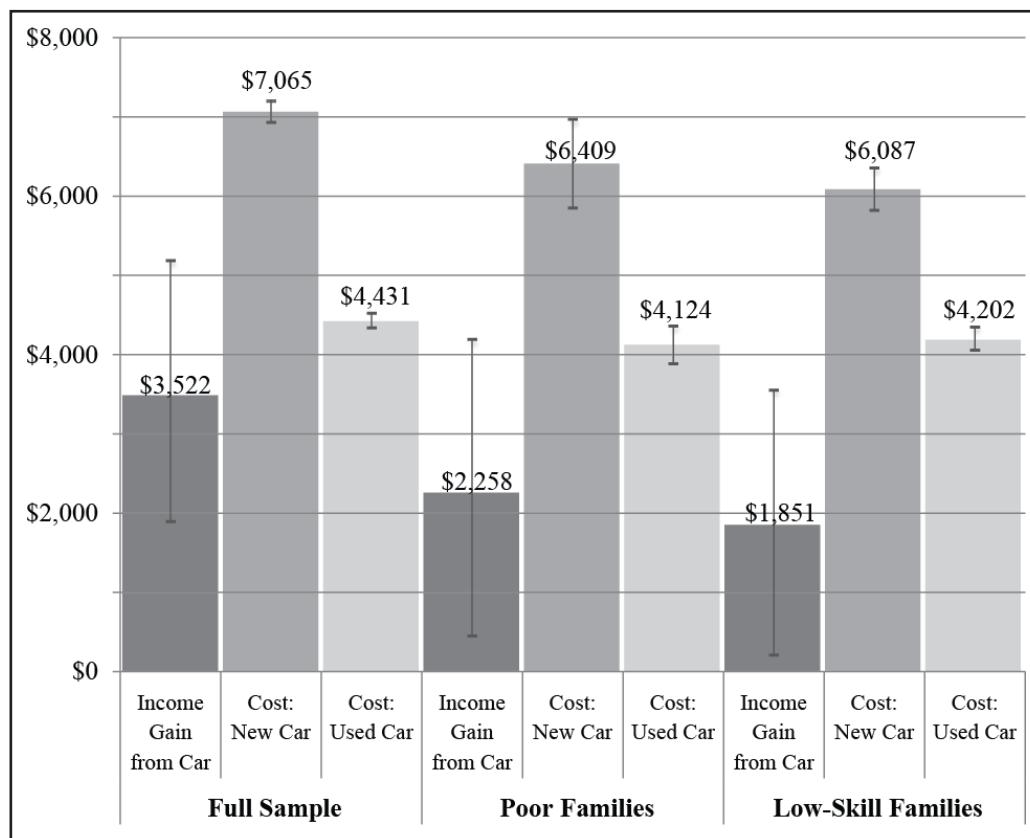
Figure 11. Estimates Annual Family Income Gains and Automobile Expenditures, PSID 1999-2013

DISCUSSION

While access to a car is nearly universal in the United States, some populations are considerably more likely to have either no car or to share cars within the family. As others have found, this report also found large differences across population groups, with the poor, immigrants, and people of color (particularly blacks) having lower levels of auto ownership than non-poor, US-born, and white families.

But car ownership and having no car are not static states. Using a panel dataset, it was found that families' access to cars varies considerably *across time*, with many families transitioning into and out of car ownership. This longitudinal perspective can potentially reframe scholars' and practitioners' understanding of zero-car households by highlighting that very few families in the US remain carless for very long; even long-term poor families are likely to own a car for at least some portion of the survey.

Those who lack access to an automobile may be at a disadvantage in the labor market in many places in the United States, where transit service may not provide a reliable connection to jobs, particularly in the suburbs. Improving job access continues to be one of the most important priorities for transportation planners, but policy-makers and researchers debate whether this goal is better served by investments in public transportation or increasing access to vehicles. In the analysis of a large-scale panel survey of families, it was found that improving automobile access decreases the likelihood of unemployment and increases earnings, but that—unsurprisingly—automobiles are also quite costly to own and maintain. For poor families, it was found that having one car per adult decreases the odds of a family member becoming unemployed by just over 10%, and it also increases earnings by 9%, for the median poor family, an income gain of roughly $2,300 the year after gaining their first car. While this is a substantial increase in income, owning a car is expensive. It was estimated that, for the typical poor family, a used car costs just over $4,100 annually to own and maintain. (New cars cost more, at $6,400.) Thus, for many families, the income gained from obtaining a car might be less than the costs of owning and maintaining that same car.

The role of public transit in improving economic outcomes is less clear. It was found that living in areas with access to quality public transportation has no effect on future earnings but, unexpectedly, it increases the likelihood of being unemployed in the next survey wave. The authors suspect that transit accessibility is a proxy for other aspects of the neighborhood or residents that are not included in the model. Transit service is typically best in inner-city, dense neighborhoods. With the history of public- and private-sector disinvestment in these areas, one possible explanation might be that residents of these neighborhoods are less upwardly mobile than are poor residents of less transit-rich neighborhoods due to the quality of education, employment discrimination, or other factors. Alternatively, the results may reflect something about the families that live in these neighborhoods. These families may be different from families living in less transit-accessible neighborhoods, even after controlling for other factors. Finally, the transit accessibility data are incomplete. The authors are missing information on transit accessibility for just under one-half (45%) of the sample. While it is suspected that most of these locations are not served by public transit, or the transit service is limited, it is possible that the missing data may be influencing the results.

What should researchers and transportation planners make of these results? One approach for policy-makers would be to provide assistance for low-income and low-skill families with the costs of car ownership. While the research suggests that, for many families, owning a car may not "pay for itself" in terms of income gains, the public benefits associated with stable employment may be substantial. Programs such as the US Office of Refugee Resettlement's Individual Development Account, which provides federally-funded matched savings accounts for large purchases "to maintain or upgrade employment," such as an

automobile, may be appropriate for low-income families and welfare recipients (Office of Refugee Resettlement, 2009). Because of the very high turnover rates in car ownership among poor families, policy-makers may want to expand these programs to allow spending on car maintenance, not just purchases.

Further, although this research finds no clear income effect of living near high-quality transit (and a negative effect on future employment), transit service will continue to play an important role. Others have found that moving to neighborhoods with improved transit access is associated with increased likelihood of being employed (Blumenberg & Pierce, 2014), and transit serves an important purpose in providing mobility for those who cannot, or choose not, to own a car.

Of course, the costs and benefits of cars are neither entirely economic nor borne only by individual families. Increased car ownership has negative societal impacts in terms of pollution, congestion, and traffic injuries and fatalities. Similarly, the benefits are not only economic; access to transportation resources can enable improvements in quality of life by increasing access to food, recreation, and social opportunities as well as to jobs.

APPENDIX

	Sample Size						
	1999	2001	2003	2005	2007	2009	2011
All families	7,493	7,887	8,346	8,718	8,941	9,308	9,690
Poverty							
Families not in poverty	90%	92%	90%	90%	90%	89%	88%
Families in poverty	10%	8%	10%	10%	10%	11%	12%
Nativity							
US-born families	91%	92%	90%	90%	90%	89%	90%
Foreign-born families	9%	8%	9%	9%	10%	10%	10%
Race/ethnicity							
Non-Hispanic white	77%	77%	77%	75%	74%	73%	72%
Non-Hispanic black	13%	13%	13%	14%	14%	15%	15%
Non-Hispanic Asian	2%	2%	2%	2%	2%	2%	2%
Hispanic, any race	5%	5%	5%	8%	8%	9%	9%

Note: This includes only cases with information on auto ownership in the family

Beginning in the 2005 survey, PSID changed the way they ask race and ethnicity questions, adding a new question about Hispanicity (Latino status). This likely resulted in the increase in Latino respondents between 2003 and 2005.

	Mean number of cars in family						
	1999	2001	2003	2005	2007	2009	2011
All families	1.64	1.67	1.69	1.63	1.68	1.65	1.59
Poverty							
Families not in poverty	1.73	1.76	1.79	1.74	1.78	1.76	1.71
Families in poverty	0.80	0.79	0.78	0.69	0.77	0.75	0.72
Nativity							
US-born families	1.67	1.69	1.71	1.64	1.69	1.66	1.61
Foreign-born families	1.36	1.52	1.54	1.52	1.58	1.57	1.46
Race/ethnicity							
Non-Hispanic white	1.76	1.77	1.79	1.73	1.77	1.76	1.69
Non-Hispanic black	1.02	1.15	1.16	1.11	1.15	1.13	1.11
Non-Hispanic Asian	1.57	1.71	1.66	1.63	1.72	1.61	1.54
Hispanic, any race	1.34	1.59	1.61	1.60	1.69	1.68	1.58

	Mean car-to-adult ratio in family						
	1999	2001	2003	2005	2007	2009	2011
All families	0.95	0.96	0.98	0.94	0.97	0.97	0.94
Poverty							
Families not in poverty	0.99	1.00	1.03	1.00	1.02	1.02	1.00
Families in poverty	0.57	0.57	0.56	0.48	0.55	0.55	0.52
Nativity							

US-born families	0.97	0.98	1.01	0.96	0.99	0.99	0.96
Foreign-born families	0.67	0.76	0.76	0.75	0.78	0.78	0.74
Race/ethnicity							
Non-Hispanic white	1.02	1.02	1.04	1.01	1.04	1.04	1.01
Non-Hispanic black	0.63	0.69	0.73	0.70	0.74	0.74	0.75
Non-Hispanic Asian	0.87	0.93	0.90	0.88	0.91	0.88	0.80
Hispanic, any race	0.68	0.81	0.81	0.82	0.84	0.84	0.81

	Median family income (2011 $s)						
	1999	2001	2003	2005	2007	2009	2011
All families	$55,614	$57,058	$54,250	$54,024	$55,149	$52,936	$49,529
Poverty							
Families not in poverty	$62,100	$61,701	$60,304	$60,690	$61,040	$59,280	$56,300
Families in poverty	$8,848	$8,646	$9,180	$8,925	$8,481	$9,023	$8,500
Nativity							
US-born families	$57,205	$58,410	$55,330	$54,740	$56,000	$53,285	$50,006
Foreign-born families	$41,896	$45,850	$45,360	$49,147	$48,020	$48,233	$41,719
Race/ethnicity							
Non-Hispanic white	$62,238	$62,225	$59,750	$59,582	$59,808	$58,240	$55,380
Non-Hispanic black	$37,260	$37,990	$35,000	$34,397	$33,600	$31,954	$31,520
Non-Hispanic Asian	$65,357	$94,975	$81,625	$86,394	$84,000	$71,812	$82,000
Hispanic, any race	$38,640	$38,016	$38,750	$44,037	$47,040	$45,760	$39,000

ENDNOTES

1. A restricted version of the PSID was obtained from the Institute for Social Research at the University of Michigan, Ann Arbor. This version was obtained so the authors could include geographic specific estimates of public transit accessibility. The restricted data, which was analyzed on a computer not connected to the Internet in a secure room, includes information on the census tract where respondents reside in each survey wave.

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