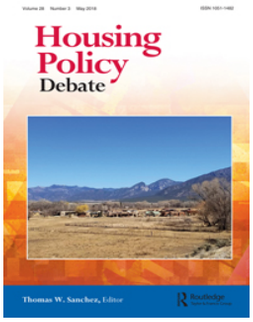

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Complicating the Story of Location Affordability

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ABSTRACT

In recent years, researchers and advocates have turned their attention to the trade-offs between housing affordability and transportation expenses. They argue that were families to move to more compact, transit-accessible, and walkable neighborhoods, they would reduce their driving and, possibly, forego the need for one or more cars, thus saving them money. We use the Panel Study of Income Dynamics to test this assumption with descriptive statistics and panel regression models, and we find little evidence to support it. We conclude that the location affordability literature may significantly overstate the promise of cost savings in transit-rich neighborhoods.

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Location affordability; residential mobility; transportation; expenditures; PSID

The location affordability literature argues that housing and transportation expenses are inextricably linked. Housing that seems affordable in the far-flung suburbs may be unaffordable if families' transportation expenses outweigh potential savings from less-expensive housing. And, conversely, housing that seems expensive in urban areas may be affordable since transportation expenses may be lower. The concept of trade-offs between housing and transportation expenses is not new—classical models of urban spatial structure have relied on the concept for many years—but today's scholars seek to reanimate the research within the context of contemporary patterns of auto-oriented suburbs and concerns about housing affordability.

In this article, we examine one half of the location affordability hypothesis—that living in transit-accessible, compact, walkable neighborhoods means spending less on transportation. We improve on prior studies by using a nationally representative panel study of U.S. families' sources of income and their expenditures, the Panel Study of Income Dynamics (PSID), to examine how expenses change when families move to more accessible neighborhoods. The data set contains detailed information on transportation expenses for the same families over time. We use six biennial waves (2003 through 2013) from a confidential, geocoded version of the PSID that enables us to analyze nearly 11,000 families' transportation expenditures across different neighborhoods (at the level of the census tract) and over time.

We find that the relationship between transportation expenditures and transit access is not as clear-cut as the location affordability hypothesis proposes. When families move from transit deserts to transit-rich neighborhoods, their transportation expenses do not change systematically, as the existing literature would suggest. The same holds true for moves to more walkable or more compact neighborhoods. Transportation expenditures are primarily driven by income and household characteristics, not whether one lives near high-quality transit service. In sum, we find that the existing research on housing and transportation expenditures may significantly overstate its case.

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We first explore how transportation expenses and expenditure burdens vary across different neighborhoods. Next, we examine how transportation expenses change when families move to more or less transit-friendly locations, asking: Do transportation expenses decline when families move to transit-rich neighborhoods? We also test the relationship between transportation expenses and other variables from the location efficiency literature, including walkability and compact urban form. We then model changes in transportation expenditures as a function of changes in the family's economic status, family composition, transit access to jobs, and other factors. Finally, we conclude with a discussion of implications for policy.

Transportation and Housing Costs

Housing and transportation are the largest and second-largest expense categories for American families (Bureau of Labor Statistics, 2016). Spending on these essential needs varies throughout society. Poor families spend fewer dollars on housing and transportation, but these dollars represent a much larger share of their incomes (Blumenberg, 2003; Rice, 2004; Sanchez, Makarewicz, Hasa, & Dawkins, 2007). Spending also varies by geography; transportation expenses are, on average, higher in regions that are more spread out (McCann, 2000). And researchers claim that transportation costs are lower in neighborhoods where residents can use public transit and nonmotorized modes and get by without a car (Haas, Makarewicz, Benedict, Sanchez, & Dawkins, 2006; Sanchez et al., 2007).

From these observations, scholars, advocates, and nonprofit organizations have argued that analyses of housing affordability and mortgage lending should account for the associated transport costs for that specific location. *Location-efficient mortgages* or *smart-commute mortgages*, which gained traction in the 1990s and early 2000s as pilot programs, allowed households to borrow more if the neighborhood's transportation and land use enabled households to own fewer cars and drive less (Blackman & Krupnick, 2001; Chatman & Voorhoeve, 2010; Krizek, 2003). These mortgage programs were first proposed by Holtzclaw (1994) in a report for the Natural Resources Defense Council and subsequently the Center for Neighborhood Technology (CNT), Sierra Club, and the Surface Transportation Policy Project (e.g., Holtzclaw, Clear, Dittmar, Goldstein, & Haas, 2002). A report from the CNT suggests:

> Compact, walkable, mixed-use communities with convenient access to public transit and employment centers may initially appear expensive because of higher housing costs. But after [accounting for transportation expenses by] applying the H+T Index, these places can often make for more affordable living than less dense exurban communities because households can own fewer cars—the single biggest expense in a household transportation budget—and still maintain a high quality of life. (Center for Neighborhood Technology, 2010, p. 2)

Existing research on location affordability largely relies on models that *estimate* transportation expenditures, not direct measurement of these expenses. This is because most transportation surveys do not ask questions about household- or family-level transportation expenses, and expenditure surveys, like the Consumer Expenditure Survey (CES), report data at geographic scales too large to make observations about variation in transportation spending at the neighborhood level (disaggregate CES data are publicly available at the census-division level, a set of geographically contiguous states).

The most well-known location affordability indexes are the CNT's Housing + Transportation (H+T) Affordability Index and the federal government's Location Affordability Index (LAI). These estimate the average housing and transportation expenses for a variety of *typical* households for every census block group in the United States using widely available data (Haas, Makarewicz, Benedict, & Bernstein, 2008). These indices assume that the built environment is a primary driver of travel behavior, which in turn shapes transportation expenses—although they do not neglect other factors, such as household income. Holtzclaw (1994) laid out the basic approach to estimating transportation costs, although others have amended the process in the years since. For each neighborhood, LAI and similar metrics estimate transportation costs as the sum of the fixed costs of car ownership and the variable costs of car use. Fixed costs are derived from census data on car ownership for the area multiplied by an average car ownership cost. In some studies, this approach is modified by using estimates of the costs of specific cars popular in certain regions (e.g., Hamidi, Ewing, & Renne, 2016). Variable costs, on the other hand,

are derived in the original study from estimates of vehicle miles traveled (VMT). Although the specifics in subsequent studies vary, the approach assumes that VMT is a function of built environment and household characteristics, including income, household size, the number of commuters, and household tenure. Recent studies add data on local travel patterns, gasoline prices, transit usage, and local transit fares (Hamidi et al., 2016). The CNT approach uses a structural equation model, producing estimates of transportation expenses at the census block-group level as a function of the estimated number of cars households own, estimates of VMT, and estimates of transit use (Haas, Newmark, & Morrison, 2016; Haas et al., 2008).

As the location affordability literature has gained traction in academic, policy, and advocacy arenas, scholars have raised questions about the approach, particularly in the pages of this Journal. Ganning (2017) provides a notable critique by attempting to recreate the LAI estimates at the census-tract level, revealing a number of shortcomings with the LAI data and methodology. First, Ganning questions the reliability of many of the variables, arguing that the "reliability metrics for the Journey to Work (JTW) data on transit use [at the block-group level] warrant jettisoning these data altogether" (2017, p. 7). Second, the index may suffer from aggregation biases despite efforts to provide estimates for various subgroups by income, housing tenure, or other variables, as others have also pointed out (e.g., Guerra & Kirschen, 2016; Hamidi et al., 2016). Average transportation expenditures for the block group may be a poor measure of what individual families spend, and inferences made based on these averages may not reflect the changes in expenses when families move to more or less accessible areas. Others have critiqued the location affordability approach for other reasons. Renne, Tolford, Hamidi, and Ewing (2016) examine affordability in transit-oriented developments and critique the LAI housing cost estimates for being out of date in rapidly changing housing markets. Tremoulet, Dann, and Adkins (2016) conducted a series of focus groups with low-income movers and find that location efficiency was rarely a primary concern in their decisions about where to move. Blackman and Krupnick (2001) find that rates of default on Chicago-area location-efficient mortgages provide no support to the location-efficiency hypothesis (see also Chatman & Voorhoeve, 2010).

Although the existing studies offer some insight into the nuanced relationship between housing and transportation costs, they do not answer the critical question of whether individuals who move into *location-efficient* neighborhoods actually reduce their transportation expenses. Our approach is to use a large, nationally representative panel survey to overcome these limitations, analyzing transportation expenses as a function of residential location and relocation.

Approach

We use data from a confidential version of the PSID to examine transportation expenses as a function of residential location (Panel Study of Income Dynamics, Restricted Use Data, 2015). The PSID has been surveying the same families annually or biennially since 1968 (McGonagle, Schoeni, Sastry, & Freedman, 2012). The survey began with roughly 5,000 families and has since grown to include over 9,000 families and 22,000 individuals. The sample has increased through natural growth (children leaving the nest and starting their own *PSID families*, divorce, etc.) and new participants have been added to improve the representativeness of the sample. We limit our analysis to the six biennial waves covering 2003 through 2013 when the questionnaire included consistent questions about transportation expenditures. Scholars in other fields have found that the PSID's accounting of these expenses closely matches those of the CES, and we follow their approach to calculating these costs (Andreski, Li, Samancioglu, & Schoeni, 2014).

To estimate transportation expenditures using the PSID data, we include expenses from car ownership and operation, transit fares, taxi expenses and other transportation expenses. Car ownership costs include regular loan and lease payments as well as loan down payments. The operating costs include gasoline, insurance, repairs, and parking expenses. Some survey questions ask about expenses "in the past month" (e.g., auto repairs), whereas others ask about both the outlay amount and the frequency of the payment (e.g., auto insurance). This likely leads to some error in our data, although with a sufficient

sample size we expect that these errors are randomly distributed across neighborhood types. We separately analyze spending on gasoline alone, which does not suffer from the problems associated with infrequent, *lumpy* expenses such as down payments and costly repairs.

To examine the relationship between transportation expenses and neighborhood contexts, we augment the PSID with data on respondents' neighborhoods. The confidential version of the PSID that we use identifies the census tract where each individual resides, which we use to characterize the residential neighborhood. We present our findings as they relate to transit accessibility, although we also evaluated a number of other measures of the built environment that may influence how much families spend on transportation. We discuss these other analyses in the appendix. These other measures include alternative measures of transit accessibility, transit density, population density, Walk Score, a measure of the compactness of the neighborhood (from CNT), and test for possible biases because our analysis was conducted at the tract level rather than the block group used by location affordability indexes. Our findings are consistent across these different measures.

Our measure of transit accessibility is based on the number of jobs accessible by public transit within 30 min, including access to and from the transit stop. We obtained these data from the University of Minnesota Accessibility Observatory (Owen, Levinson, & Murphy, 2017). These data have coverage for most of the nation. For each combined statistical area (CSA), we constructed a *z*-score of the transit accessibility for each census tract, defined as the number of standard deviations the family's tract is from the regional mean. Because transit accessibility is considerably right-skewed, roughly two thirds of the sample families live in tracts with negative *z*-scores (below the mean), and another third live in tracts with positive *z*-scores (above the mean). Our measures of transit accessibility are time invariant and likely introduce some error. However, transit environments change relatively slowly in the United States, and our measure of transit access correlates just as well with the share of workers in the tract commuting by transit for each of the four censuses between 1970–2000 (correlation coefficients of 0.53 to 0.56) as it does for the more recent American Community Survey (ACS) (correlation coefficient of 0.54). Thus, whereas the use of time-invariant data are imperfect, it appears robust over time.

Transportation Expenses and Neighborhood Accessibility

In this section, we use the PSID to test one of the assumptions of the location affordability literature: that moving to neighborhoods with better transit access leads to lower transportation expenditures. First, we begin with an overview of transportation expenditures. Second, we examine the cross-sectional relationship between expenses and neighborhoods. Third, we take advantage of the panel nature of the PSID data to look specifically at families that relocated to observe how their transportation expenses changed in response to a better or worse transit environment. Finally, we present the results of regression models of changes in transportation expenditures as a function of residential relocation and other variables.

Transportation Expenditures

Housing and transportation costs eat up a significant portion of PSID families' incomes. Between 2003 and 2013, housing expenses (in constant 2013 dollars) totaled $11,139 for the median family, and transportation expenses totaled $5,432 (see Table 1). Transportation expenses for families without cars were, unsurprisingly, much lower: the median expenses were $753 per family compared with $8,371 for families with cars. Car costs are roughly evenly split between ownership and operation costs. For car owners, 61% of the cost of operations went to gasoline and 34% went to insurance payments. Although car repair and maintenance account for a small fraction of the total operational costs, there is considerable variation among these expenses (no doubt in large part because of the PSID questionnaire asking about these expenses during the past month, rather than the past year).

Our estimates of transportation expenses are lower than those published by the American Automobile Association (AAA) but in line with those of previous expenditure studies. AAA reports that the average

Table 1. Annual housing and transportation expenses per family, Panel Study of Income Dynamics 2003–2013, pooled data in 2013 constant dollars.

Category	Mean	Median
Total housing expenses	$18,516	$11,139
Mortgage payments	$10,065	$0
Rent	$3,686	$0
Home insurance	$452	$0
Property tax	$1,223	$0
Utilities	$2,777	$2,504
Telephone and internet	$2,221	$2,054
Furnishings	$1,132	$232
Household repairs	$1,465	$0
Total transportation expenses	$7,250	$5,432
Car expenses (total)	$7,015	$5,273
Loan	$2,835	$0
Lease	$272	$0
Car operations	$3,800	$3,410
Gasoline	$2,314	$1,872
Auto insurance	$1,310	$1,142
Car repair	$131	$0
Parking	$45	$0
Additional car payments	$108	$0
Taxi	$37	$0
Public transit	$104	$0
Other transportation	$95	$0
Observations (person-years)	32,976	

Note. Sum of means for housing expenses do not equal grand total for housing expenditures due to item nonresponse; these cases were retained as housing is not the focus of our article's analysis.

cost to own and operate a single car in the United States in 2013 was $9,122 based on 15,000 miles of travel per vehicle (American Automobile Association, 2013). We estimate that the average cost per car for a family is only $4,678 (not shown in Table 1). Thakuriah and Liao (2005) previously estimated that the average cost per car was $2,888 in 1999 dollars ($4,038 in 2013 dollars) using data from the Consumer Expenditure Survey (CES).

Do Families in More Accessible Neighborhoods Spend Less on Transportation?

Do families in transit-rich neighborhoods spend less on transportation than families in neighborhoods with worse transit service? Figure 1 shows there is a negative relationship, although it is very weak. The figure uses hexagonal binning, rather than a standard scatter plot, to show the concentration of observations indicated by darker colors. The line represents a fitted regression model for the relationship between neighborhood-level transit accessibility and transportation expenses. The R^2 is less than 0.02, suggesting a very weak relationship. Beyond this, the figure suggests something else: that the aggregate analyses that others have used (correlating neighborhoods, not people, with estimated expenditures) overlook the remarkable amount of expenditure variation within neighborhood types.

Despite the heterogeneity within transit-rich and transit-poor neighborhoods, there are differences between the two in the aggregate. We suspect that many of these differences in transportation expenses are driven by attributes about the household rather than proximity to transit (a point acknowledged in the literature; see Haas et al., 2016). Table 2 shows that families living in transit-friendlier places have considerably lower incomes, are more likely to have zero or negative wealth, and live in somewhat smaller families with fewer workers and fewer children. They also have fewer cars and spend less on transportation overall.

Expenses are closely tied to total family income. As incomes increase, expenses for housing and transportation increase whereas the burden declines. Figure 2 compares housing and transportation expenses as well as burdens for several subpopulations across neighborhood types. Each plot is divided into two halves: families living above the poverty line and those under the poverty line. Costs and

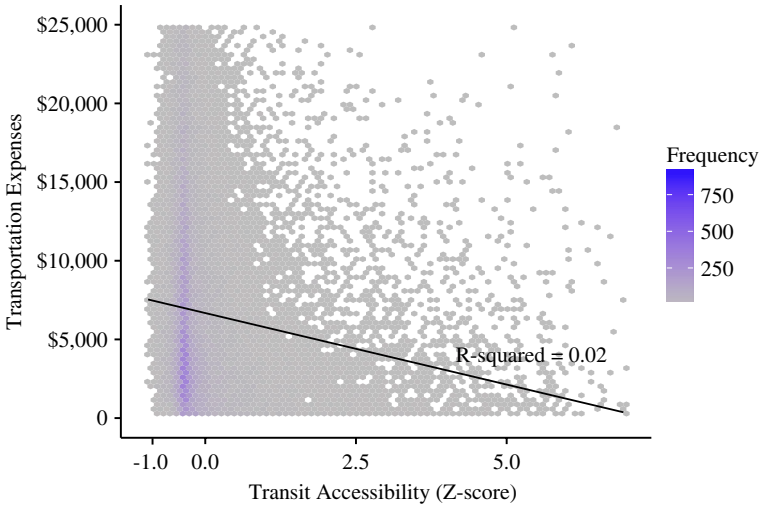

Figure 1. Transportation expenses across neighborhoods, Panel Study of Income Dynamics 2003–2013.

Table 2. Characteristics of families living in low- and high-transit census tracts, Panel Study of Income Dynamics 2003–2013.

	Low-Transit (z≤0)	High-Transit (z>0)	Sig.
Mean family income	$79,537	$59,608	***
Median family income	$56,200	$38,520	***
Mean family wealth	$162,836	$120,758	*
Median family wealth	$9,265	$2,616	***
Family has zero or negative wealth	29%	39%	***
Number of employed family members	1.3	1.2	***
Number of adults in family	1.8	1.6	***
Number of children in family	0.7	0.6	***
Number of cars in family	1.74	1.31	***
Ratio of cars to adults in family	1.00	0.83	***
Annual transportation expenditures	$8,021	$5,741	***
Age	44	42	***
N(person-years)	23,513	9,462	

Note. Sig. = significance:
*$p < 0.10$; **$p < 0.05$; ***p < 0.01.

burdens are shown using letter markers indicating the median value for each population subgroup, and a dash below and another above the marker indicate the 25th and 75th percentile values. The letter markers indicate each population subgroup: *A* indicates all families, *L* indicates families living in low-transit-accessible environments (below the regional mean transit accessibility), and so forth, as indicated in the figure legend.

Poor families spend considerably less on housing and transportation than nonpoor families do, as expected. This difference is much greater than differences between transit-poor and transit-rich neighborhoods (markers *L* and *H*). As a percentage of their income, poor families' burdens for both housing and transportation are considerably higher than those of nonpoor families; again, these differences are much greater than the differences by level of transit access. Although the burdens are certainly significant, Blumenberg (2003) notes that these ratios may be particularly high because of, among other reasons, underreporting of income, including transfer payments and subsidies, among lower income groups.

Transportation expenditures are lowest for families with no car (marker *N*). The differences in expenditures between carless and car-owning families are larger than the differences across different neighborhood types or between poor and nonpoor families. Most American households own cars and even most poor families own cars, although the poor are much more likely to experience bouts of carlessness from

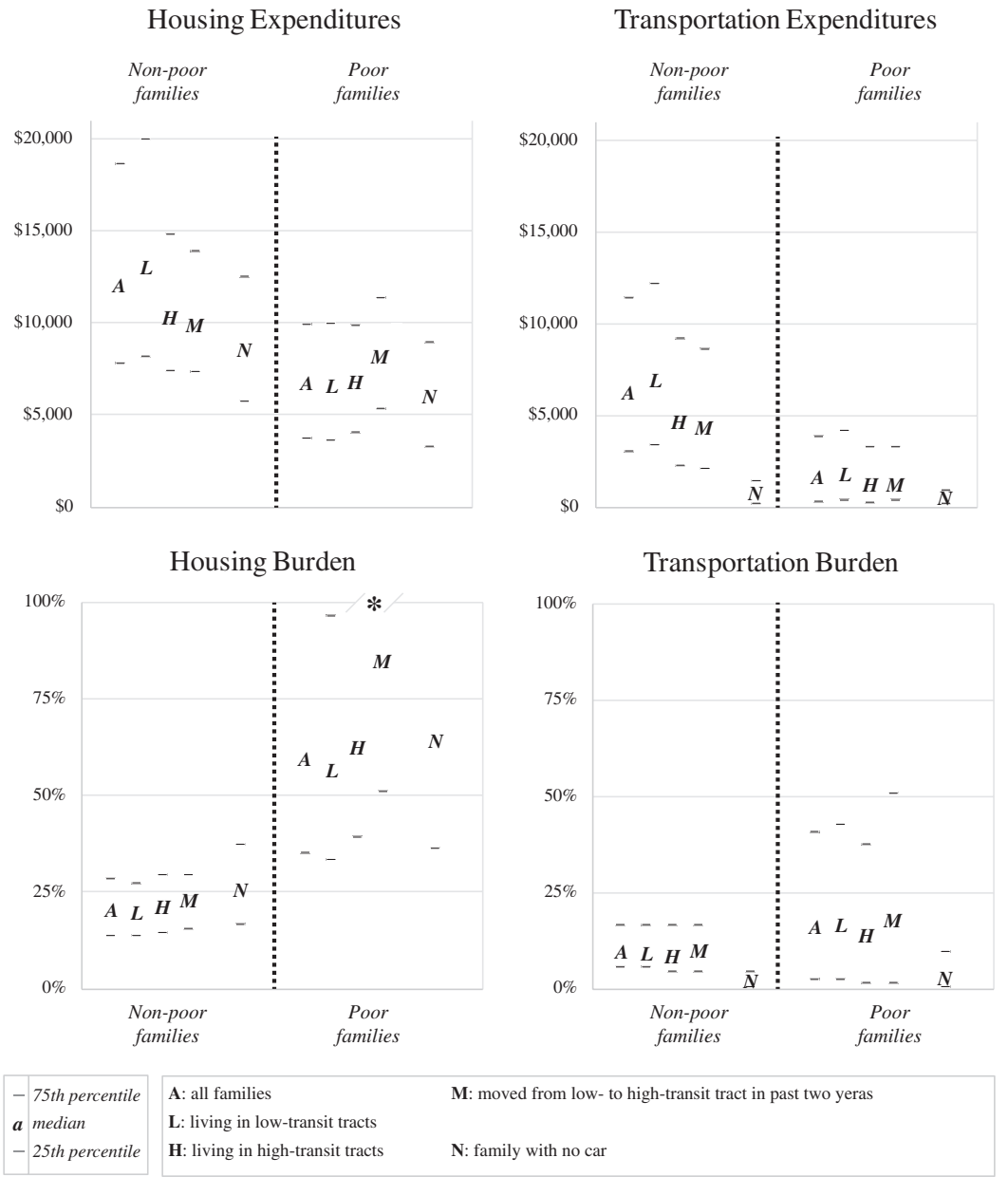

Figure 2. Housing and transportation expenses for nonpoor and poor families, by location and mover status, Panel Study of Income Dynamics 2003–2013.

Note. The 75th percentile for poor families' housing burdens exceeds 100%; this may be the result of housing subsidy not being reported as income, or income underreporting more generally. See Blumenberg (2003).

time to time (Klein & Smart, 2017). Nearly half of the poor families in the PSID data set have a car (Klein & Smart, 2017), leading to higher costs and expenditure burdens; as Figure 2 shows, the median poor family in the PSID—even those living in neighborhoods with good transit access—spends more (in both absolute and relative terms) on transportation than zero-car families do; the *N* values for transportation expenses and burdens are consistently lower than all other values in the graphic.

Neighborhood location does play a role in housing and transportation expenses, although the story is complex, and location appears to be less important than poverty status or car ownership. Housing and

transportation expenses are indeed lower in high-transit neighborhoods than in low-transit neighborhoods (*H* and *L* in Figure 2), as predicted by the location affordability literature. Further, housing burdens are somewhat higher in transit-rich neighborhoods, whereas transportation burdens are somewhat lower, as the literature suggests.

There are some cost savings for families who moved from low- to high-transit neighborhoods (*M* vs. *L* in Figure 2). We observe that movers have lower median housing and transportation expenses compared with other families who remain in low-transit neighborhoods, although the expenditure burden graphs tell another story; nonpoor families who move from low- to high-transit neighborhoods spend just as large a fraction of their income on transportation as do families who remain in low-transit neighborhoods. Those who make the move to transit-richer neighborhoods are actually *more* burdened by transportation expenses than their low-transit former neighbors are.

Figure 2 also shows that there is significant variation in housing and transportation costs across the different groups. Within the poor and nonpoor categories, the 25th and 75th percentile markers show that there is significant overlap in transportation expenditures for the low- and high-transit quality neighborhoods. In our models presented below, we explore some of the drivers of this variation, including household structure and wealth.

In sum, whereas descriptive statistics lend some support to the location affordability hypothesis, we note that residential location plays a considerably smaller role in explaining housing and transportation expenses and burdens than income does. Further, snapshot statistics may not tell the full story. In the following section, we make use of our panel data to examine family-level expenditures on housing and transportation before and after a residential move.

Do Families Spend Less on Transportation When They Move to More Accessible Neighborhoods?

The central assumption of the location affordability literature is that were families to move to more accessible neighborhoods, many would behave much like those who currently live in accessible neighborhoods: they would reduce their driving and, possibly, forgo ownership of one or more cars, saving them money. But our analysis suggests that changes in transit access appear to have no systematic effect on transportation expenditures. We present several analyses in this section and summarize dozens

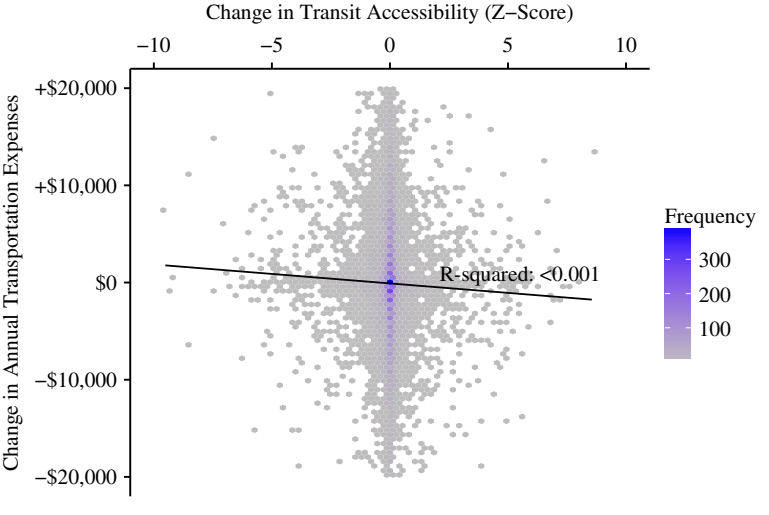

Figure 3. Change in transportation expenses for families that moved between panel waves, Panel Study of Income Dynamics 2003–2013.

of others, including changes in walkability, density, compact urban form, and others (these also found no relationship).

PSID movers are, in several important ways, different from nonmovers. Smart and Klein (2017) find that PSID families who moved between panel waves are somewhat younger, have approximately 30% lower incomes, live in marginally transit-richer places (their transit *z*-score is 0.13 standard deviations higher), and use transit more (11% spend any money on transit fares in a given month) than those who do not move (7%). They are also more likely to be students (3% vs. 1%) and people of color (30% vs. 22%). This suggests that movers are, overall, in somewhat less-secure financial positions than are nonmovers, and that they therefore might be more likely to take advantage of lower cost transportation options such as transit and walking. If anything, this may bias our findings toward a *stronger* cost savings associated with moving to a more accessible neighborhood.

We first analyze family-level changes in transportation expenditures before and after a residential move. We graph these changes as a function of changes in the built environment, as shown by transit access to jobs (shown in Figure 3). If moving to a more accessible location lowered transportation expenses, we would expect a negative trend line and greater concentration in the lower right quadrant. If moving to a less accessible location increased transportation expenses, we would expect a greater concentration in the upper left quadrant. Our results do not lend much support to the expected relationship. The figure shows a great degree of variation in spending at all levels of transit accessibility, and no clear pattern. Although there is a slight negative relationship between transit access and transportation expenditures, the relationship is not of a meaningful magnitude. The R^2 for the fitted line is less than 0.001, suggesting no relationship. (In the appendix, we discuss the same analysis for changes in other measures of the residential neighborhood).

Most movers relocate to neighborhoods with similar transportation access (we separately analyze more-drastic movers below). Changes in transportation expenditures are more likely dependent on changes in car ownership that stem from changes in household structure or life-course events, such as coupling up, separation, going to college, starting a new job, or retirement, rather than changes in location. We examine this more closely using regression analysis below.

When we looked at just the subset of families who move to neighborhoods with better access to transit, we observe that some families increase their costs, whereas others decrease them. The median family making such a move does not change their costs appreciably (a 1% decrease in transportation costs).

Because some rare and costly automobile expenses (such as car repairs) may add *noise* to our data, we ran the same analyses excluding expenses related to car repair and maintenance, and the results remained the same (the R^2 was less than 0.001).

To account for the fact that families may take several years to adjust their travel (and transportation spending) after moving to a new neighborhood, we evaluated the relationship between changes in expenses and transit access over a longer time horizon. Figure 4 shows the changes in transportation expenses and transit accessibility for families who moved and then stayed in their new location, for 2, 4, 6, 8, and 10 years. The R^2 values were consistently under 0.01. We take this all as evidence of no meaningful relationship.

We also conducted a separate analysis of families living below the poverty line. These families have the most to gain from reducing their transportation spending and have, accordingly, been a primary interest of much of the location affordability literature. We expect families with tight budgets to be particularly likely to economize on transportation expenditures when they move to a transit-friendly location. As Figure 5 shows, we find no evidence that poor families who move to transit-richer locations spend less on transportation ($R^2 < 0.001$).

The location affordability hypothesis assumes that, on average, families that move to more accessible locations will have lower expenses by some combination of driving fewer miles and reducing the number of cars they own. Using the PSID data, we evaluated whether families that move to more accessible neighborhoods purchase less gasoline and decrease the number of cars they own. The PSID asks families about their gasoline expenditures during the previous month. We combined these responses with data

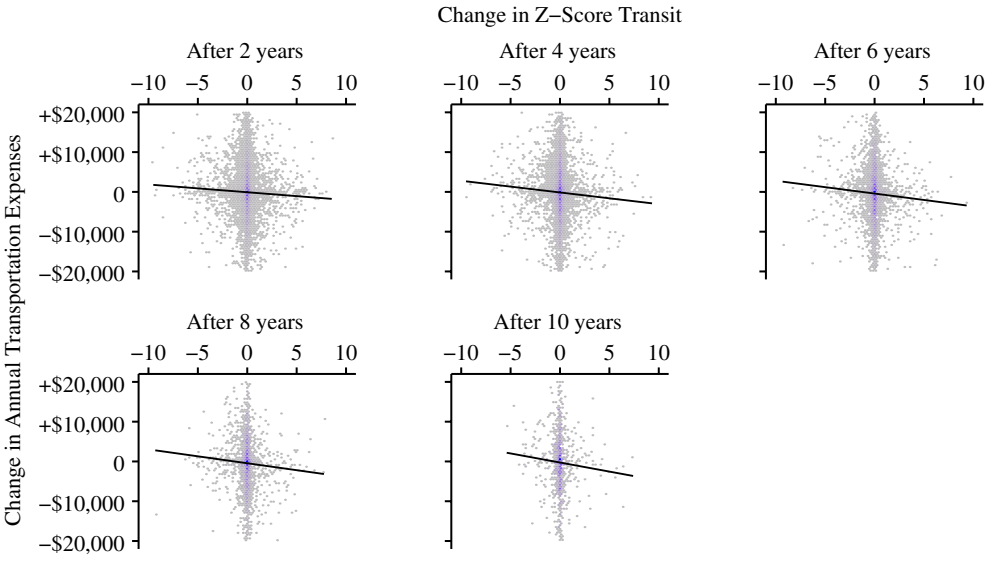

Figure 4. Change in transportation expenses 2, 4, 6, 8, and 10 years after moving, Panel Study of Income Dynamics 2003–2013.

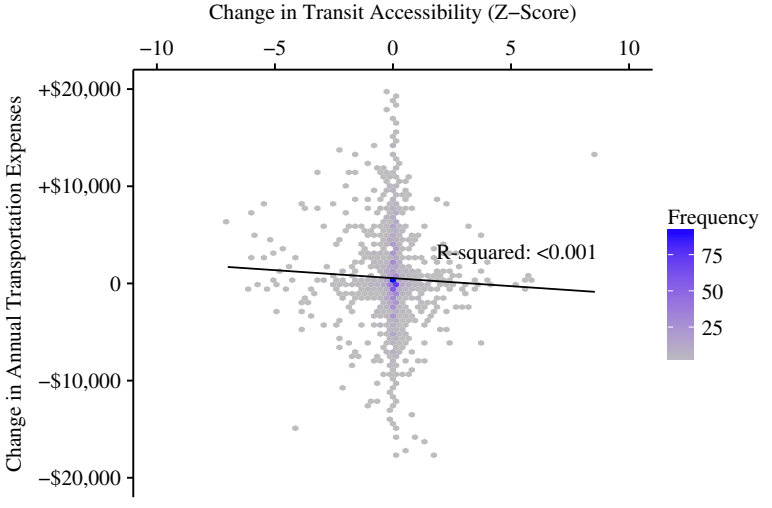

Figure 5. Change in transportation expenses for poor families that moved between panel waves, Panel Study of Income Dynamics 2003–2013.

on the average national gasoline price per gallon to estimate the gallons of gas each family purchased in the preceding month. Figure 6 shows the relationship between changes in gasoline consumption (left) and car ownership (right) and changes in transit access for movers. We would expect that families that move to more accessible locations reduce their driving, and thus their gasoline consumption, and decrease the number of cars they own, but our analysis shows little evidence that this happens. When we conducted the same analysis using changes in Walk Score, we also found no relationship. The results were consistent when we evaluated whether families reduce the number of cars they own per adult in the family (since changes in family structures may be related to moving).

To evaluate the robustness of our findings, we also analyzed numerous variations of the above analyses, included in the Appendix of this article. These alternative analyses all paint a very similar

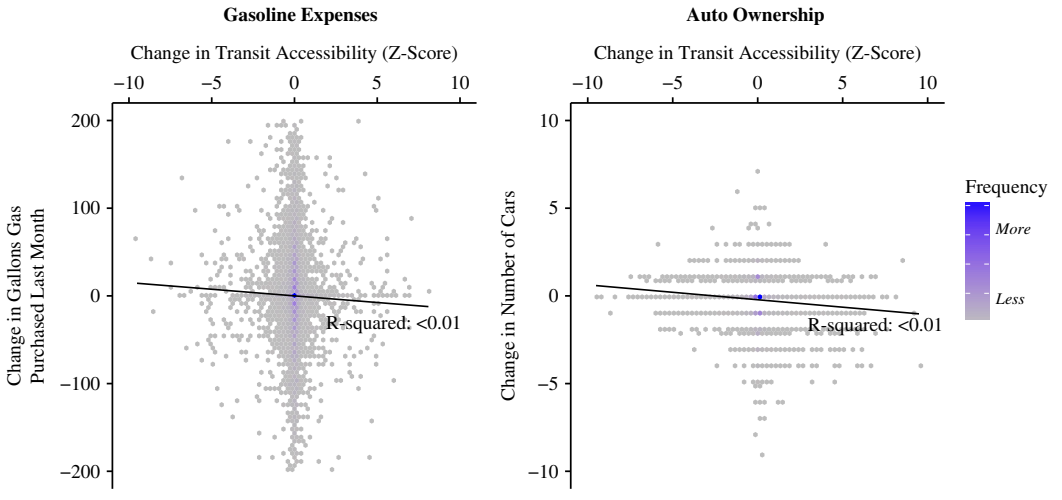

Figure 6. Change in gasoline consumption and number of cars for families that moved between panel waves, Panel Study of Income Dynamics 2003–2013.

story: although many families move, there is no clear relationship between the family's change in transit access, pedestrian access, or residential density and transportation expenditures or burdens.

Comparing CNT and the PSID

Finally, we use data from the CNT's H+T Index to compare estimated changes in transportation costs from CNT's Index for movers alongside the observed changes in transportation expenses from the PSID (Figure 7). We obtained the CNT's estimated transportation costs for movers in our PSID sample in the census tracts where they lived before and after their relocation. The transportation costs are CNT's estimates of the "Annual Transportation Cost for the Regional Typical Household (Center for Neighborhood Technology, 2017b)." The neighborhood built environment measure is one component of the H+T

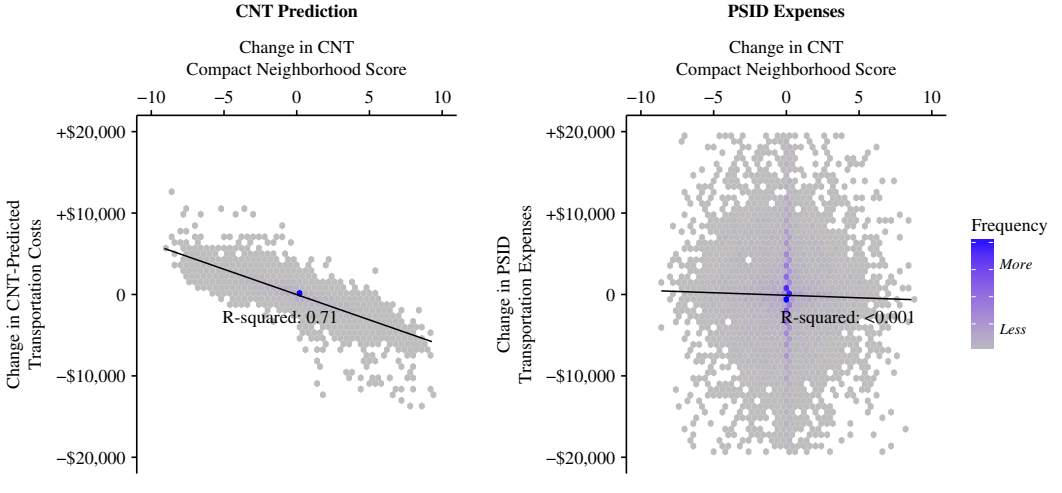

Figure 7. Comparison of Center for Neighborhood Technology (CNT) and Panel Study of Income Dynamics (PSID) changes in transportation expenses, CNT Housing + Transportation (H+T) Index 2017, PSID 2003–2013.

Index, namely the Compact Neighborhood Score, an index comprising neighborhood density and walkability (Center for Neighborhood Technology, 2017a). Here we present the findings for changes in CNT's neighborhood measures rather than our transit accessibility, although when we conducted that analysis, the results were the same.

The two charts (Figure 7), side by side, make clear the difference between the tidy predictions and the messiness of reality. We expected that the transportation expenditure data from the PSID, which is self-reported, would have more variation (noise) compared with an average household modeled in location affordability indices. Our analysis shows that the fitted line has no relation (R^2 is < 0.001) whereas the CNT data predict a clear relationship (R^2 is 0.71). Because the PSID sample contains families with widely varying incomes, whereas the CNT data presume a "regional typical household," we separately conducted this analysis controlling for PSID families' income; the results were the same, with an R^2 of less than 0.01 (Center for Neighborhood Technology, 2017b). CNT's transportation cost estimates are also moderately correlated with our own transit service metric (correlation coefficient $r = -0.5$), Walk Score ($r = -0.7$), and population density ($r = -0.6$), whereas PSID families' actual expenditures are not correlated with these.

What Is Associated With Decreasing Transportation Expenditures?

If moving to neighborhoods with high-quality transit service does not lead to meaningfully lower transportation expenditures, what does? We use the same data as above to examine this question by estimating fixed-effects regression models of transportation expenditure. We also estimate a similar model of changes in the number of cars a family owns since this is the primary driver of transportation expenditures for families.

We model changes in transportation expenditures and auto ownership as a function of changes in the family's economic status, family composition, transit access to jobs, and other factors. We include two measures of their economic status: the change in total family income from the previous calendar year (log-transformed) and the change in total family wealth (also log-transformed, and excluding home equity). We also include changes in the numbers of adults, children and employed family members, as well as the current age of the head of the family and its squared term. In addition, we include changes in our measure of transit quality (logged), whether the family moved since the last panel wave, and whether the family moved into a large metro area with high-quality transit (New York City, Chicago, San Francisco, Boston, Washington DC, and Philadelphia). We also include dummy variables for each survey year to account for temporal trends in travel costs. We separately tested other variables related to the location efficiency of the neighborhood, which we discuss below.

Table 3 provides a summary of the mean and median values for these variables. The total family incomes over the six panel waves are slightly lower than the U.S. average from 1999 to 2013, when incomes fluctuated between roughly $65,000 and $90,000 (in 2013 inflation-adjusted dollars), with an average of roughly $75,000. For the same period, the inflation-adjusted values for median household income ranged from $52,000 to $57,000. Our PSID sample is slightly underrepresentative of the six major metro areas, with 11.4% of the sample in these metro areas compared with 15.5% of the total U.S. population.

Our results suggest that changes in access to transit have a weak influence on transportation expenditures, whereas changes in income and household composition have a strong influence. Furthermore, the variables in our model explain very little of the variation in transportation expenditures (our model of expenses has an R^2 of 0.04). The fact that our models are poor predictors of transportation expenses is not surprising given the variability we observed in the earlier analysis of the change in transportation expenses for movers (e.g., Figure 4). Table 4 presents two versions of the model of changes in transportation expenses, one that excludes the number of cars a family owns (Model E1) and one that includes this number as a control variable (Model E2). Model E1 shows that a log-unit change (nearly a tripling) of transit access to jobs is associated with a decrease in transit expenditures of $125 annually (about $10 per month). At the extreme, moving from a location with access to 1,000 jobs by public transit within

Table 3. Descriptive statistics, Panel Study of Income Dynamics 2003–2013.

	Mean	Median
Family income (2013 $)	$67,064	$50,022
Family wealth (2013 $)	$103,776	$6,664
Number of employed family members	1.3	1.0
Number of adults in family	1.8	2.0
Number of children in family	0.9	0.0
Transit access to jobs	22,494	2,526
Number of cars in family	1.6	1.0
Current age	41	40
Moved	42%	
Lives in…		
New York City metro	3.2%	
Chicago metro	2.5%	
San Francisco metro	0.9%	
Washington, DC metro	2.0%	
Boston metro	0.9%	
Philadelphia metro	1.9%	
N(person-years)	32,976	
N(families)	10,707	

Table 4. Fixed-effects panel model of changes in transportation expenses and number of cars, Panel Study of Income Dynamics 2003–2013.

	Change in Annual Transportation Expenses				Change in Number of Cars	
	Model E1		Model E2		Model C1	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Change from prior wave in…						
ln(Family income)	172	***	117	***	0.030	***
ln(Family wealth)	89	***	49	***	0.024	***
Number of employed family members	399	***	229	***	0.098	***
Number of adults in family	854	***	149	**	0.412	***
Number of children in family	255	***	87		0.099	***
ln(Transit access to jobs)	-125	***	-69	**	-0.031	***
Number of cars in family			1640	***		
Moved	-125		-36		-0.052	***
Moved to large metro area…						
to New York City metro	-1202	*	-652		-0.349	***
to Chicago metro	-948		-1083		0.076	
to San Francisco metro	1718	*	1554	*	0.096	
to Washington, DC metro	720		808		-0.058	
to Boston metro	-750		-929		0.102	
to Philadelphia metro	1114		1241		-0.058	
Current age	33		-12		0.023	***
Current age squared	-0.36		0.01		-0.0002	**
Year (base=2005)						
2007	-201	*	-314	***	0.063	***
2009	-753	***	-833	***	0.038	*
2011	14		47		-0.021	
2013	-107		-94		-0.008	
Constant	-524		707		-0.638	***
N(person-years)	32,976		32,959		32,959	
N(families)	10,707		10,707		10,707	
Rho	0.26		0.25		0.30	
R^2 (within)	0.03		0.09		0.17	
R^2(between)	0.07		0.16		0.28	
R^2 (overall)	0.04		0.12		0.19	

Note. Sig. = significance:
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

30 min to one with 268,000 jobs accessible by transit (the 99th percentile in our data set) is expected to result in transportation expense savings of just under $700 per year, or $58 per month. Model E2 illustrates that this effect is largely associated with those in high-quality transit areas having slightly fewer cars (the effect of transit access to jobs, controlling for car ownership levels, roughly halves). Model C1 explores the relationship between transit access and car ownership and finds that transit plays a modest role, whereas economic variables are quite important. A log-unit increase (roughly, a tripling) in transit accessibility is associated with an 8% decline in car ownership in the model.

In addition to the above model, we also tested a series of models that use alternative measures of the neighborhood built environment. We specified transit access to jobs as quintiles, and the results were much the same, with extreme movers (moving from the lowest to the highest quintile) expected to decrease their transportation expenditures by $55 per month. We also evaluated models using population density, employment density, Walk Score, and CNT's Compact Neighborhood Score. We tested these variables alone and in combination with each other. Our main findings hold regardless of what measure we use. The built environment plays a relatively minor role in transportation spending compared with the role of household income and composition.

Discussion and Conclusion

Our analysis provides little support for the location affordability hypothesis. Our panel microdata have detailed information on residential relocation and housing and transportation expenditures, and this allows us to examine how families' expenses change when they move to different neighborhoods. For some of these families, their transportation expenses *do* decrease when they move to transit-richer areas. But for just about as many movers, their costs increase. Even accounting for a *settling-in* period after a move, we find no evidence to support the location affordability hypothesis. Our models similarly provide little evidence that moving to a transit-richer neighborhood can lead to meaningful reductions in transportation expenditures; a tripling of a family's transit access to jobs is associated with a reduction of about $10 per month, or roughly a 2% cost savings. In our models, even moving from the least transit-accessible tracts (the bottom 1%) to the highest (the top 1%) in the United States is associated with only about $60 in savings per month. The poor fit of our models, with R^2 values consistently near zero, underscores that this is a weak trend, and certainly not the rule.

Why do our results differ so much from the existing location affordability literature? We speculate that the location affordability hypothesis places too much faith in families reducing car ownership and use when they move to compact neighborhoods with better transit service and more walkable destinations. People choose their residential neighborhood based on many factors, and transportation is just one of them. Many people may move to transit-rich neighborhoods not because they wish to spend less on transportation, but rather because of other amenities, social environments, safety concerns, and the like (e.g., Tremoulet et al., 2016).

Existing location-efficiency metrics are quite complex, but they calculate transportation expenses at arm's length. These models produce rough estimates of car ownership, VMT and transit use, and then estimate expenditures as a function of the types of cars residents are likely to own, gasoline prices, and so forth. Whereas urban form plays a role in this, for the vast majority of low-spending families in transit-rich neighborhoods, their constrained budgets likely contribute more. These problems are compounded by using unreliable data on commute mode and suffering from aggregation bias (Ganning, 2017).

This methodology overlooks something important: whereas transit access may allow *some* families to reduce their transportation spending, many other factors influence family-level transportation spending. Our models suggest that income and family composition matter considerably more than access to transit does. In their study of transportation-efficient mortgages, Chatman and Voorhoeve (2010) suggest that advocates may overestimate the transportation-related savings for movers who relocate to more accessible locations. Among other criticisms, the authors suggest that many of the users of location-efficient mortgages are more likely to be auto owners and that transit access is a likely an afterthought in their choice of where to move. Our findings, which include homeowners and renters

alike, support these authors' suggestions. Families may also choose to live in transit-rich environments even when locating there means *higher*, not lower, transportation expenditures, as in the case of individuals working in car-dominated suburban environments who move downtown and then continue to drive to work while paying for expensive parking downtown.

Living near transit does not necessarily entail using transit, and using transit does not necessarily mean giving up a car. Research has shown that in the case of transit-oriented development, restrictions on parking have a greater influence on transit use than access to rail does (Chatman, 2013). And, in most neighborhoods in the United States, parking is cheap and plentiful (Shoup, 2005). Families may move nearer to transit, but unless parking is expensive and or difficult, it seems unlikely that their transportation costs will decline.

Living in a transit-rich neighborhood has many benefits. We believe it is crucial that families have the opportunity to live in these communities to access jobs, education, shopping, and other services, without having to own a car. For many families, particularly poor families, this could be an excellent strategy to reduce costs. But as we have shown here, we should not assume that most families—even most poor families—who move to these areas will reduce their transportation expenditures.

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Disclosure Statement

No potential conflict of interest was reported by the authors.

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Appendix 1

To evaluate the robustness of our findings, we reconducted our analysis in numerous ways. We tested whether our results held up under different (a) neighborhood accessibility measures, (b) transportation expenditures, and (c) subsets of our sample. These alternative analyses all paint a very similar story: whereas many families move, there is no clear relationship between the family's change in neighborhood accessibility and transportation expenditures. Below, we summarize these tests.

Neighborhood Measures

In the main text, we examined the findings as they relate to transit accessibility, which we measured using regional *z*-scores for the number of jobs accessible via public transit within 30 minutes (including walk times). Additionally, we tested the following variations, and in each case, our finding of no relationship is robust with an R^2 value below 0.01:

1. We tested the changes in transportation expenses in relation to different measures of transit access: transit accessibility, distance to transit and transit frequency (from EPA Smart Location Database) and the share of workers who commute by transit (2000 Census and 2010 American Community Survey, whichever year is closer to the surveyed year). We found no relationship.
2. We also tested the same analysis using two measures of the pedestrian environment. We queried data from Walk Score, which Manaugh and El-Geneidy find perform well at explaining nonwork travel (2011) and tested measures of street intersection density (from the EPA Smart Location Database). Again, we found no relationship.
3. We also examined the relationship between transportation expenses and measures of density: population density (2000 Census and 2010 American Community Survey) and employment density (total employment density and retail employment density, from the EPA Smart Location Database). The results did not change.
4. Finally, we tested the relationship between transportation expenses and compactness using CNT's Compact Neighborhood Score. We found no relationship.
5. We evaluated whether standardizing transit access (z-scores) *dampened* the effect of changes in transit access by treating the mean value for small metropolitan areas the same as the mean value for transit-rich regions such as New York City. To correct for this potential error, we employed raw values for transit access to jobs. The results remained the same.

Expenditure Measures

We tested several different ways of estimating transportation expenditures. We found no pattern in any of these analyses, and the R^2 values remained at or below 0.01.

1. We examined changes in expense burdens (rather than costs) as they relate to changes in raw levels of transit access to jobs (as above). We found no relationship.
2. We separately evaluated transportation expenses per person, transportation expenses per adult, transportation burden, and transportation burden per adult. Again, we found no relationship.
3. As we describe in the text, we also excluded car repair and maintenance costs to test whether these highly variable costs were influencing our results. The results did not change.

Sample Subsets

In addition to evaluating alternative measures of the neighborhood and expenses, we also reran our analyses on several subsets of our data.

1. Because changes in transportation expenses may be sensitive to the magnitude of change in access to transit, we separately conducted three analyses on subsets of movers who changed their access to transit by more than one, two, and three standard deviations. For these families who made more drastic moves, the models similarly suggest no relationship.

2. When we separately examined families that move within or to the New York City metropolitan area (where one third of transit trips in the United States occur), we similarly found no pattern in the data; moving to a better transit environment, or a neighborhood with better pedestrian access, predicts neither transportation expenses nor burden.
3. To examine whether changes in family structures influenced our results, we conducted our analysis with a subset of PSID families that relocate but maintain the same number of adults and children. Again, the results remained unchanged.

Units of Analysis

We conducted our analysis at a different geographic unit of analysis than the location affordability indexes. We present our findings based on an analysis of the census tract where the PSID families reside, whereas the CNT and LAI predict transportation costs for block groups in the United States. We conducted an additional analysis to examine whether this biases our results. Although we know the tract in which PSID families live pre- and post-move, we do not know in which block groups they live. Thus, we tested the two extreme cases: that their move maximized the difference in transit accessibility, and that their move minimized the difference in transit accessibility. For the first example, families that move to more accessible areas would move from the least accessible block group in tract 1 to the most accessible block group in tract 2. For the second example, the opposite rule applies: families improving their transit accessibility are assumed to move from the most-accessible part of their old tract to the least-accessible part of their new, transit-friendlier tract. Because we only have access to the data from the University of Minnesota Accessibility Observatory at the block group level our sample was roughly half the size of the sample of movers used for the primary analysis. The findings were consistent with our other analysis (the R^2 was below 0.001).