Amy Johnson

From: Eunice Kim
Sent: Tuesday, February 04, 2020 4:00 PM
To: Amy Johnson
Subject: FW: parking mandates mean a less walkable Salem: new data
Attachments: BundledParkingandTravelManvilleWalking.pdf

Hi Amy,

Here is testimony (email and attachment) for the Multifamily Housing Design code amendment, which will have its continued public hearing on Monday.

Thanks!

-Eunice | 503-540-2308

From: Evan Manvel <evanmanvel@gmail.com>
Sent: Tuesday, February 4, 2020 3:54 PM
To: Chuck Bennett <CBennett@cityofsalem.net>; Brad Nanke <BNanke@cityofsalem.net>; Vanessa Nordyke <VNordyke@cityofsalem.net>; Chris Hoy <CHoy@cityofsalem.net>; Tom Andersen <TAndersen@cityofsalem.net>; Cara Kaser <CKASER@cityofsalem.net>; Jackie Leung <JLeung@cityofsalem.net>; Jim Lewis <JLewis@cityofsalem.net>; Matthew Ausec <MAUSEC@cityofsalem.net>
Cc: Eunice Kim <EKim@cityofsalem.net>
Subject: parking mandates mean a less walkable Salem: new data

Dear Mayor Bennett and City Councilors -

Thank you again for listening to my testimony on parking mandates last week.

Just after that meeting, a new study "Parking Behavior: Bundled Parking and Travel Behavior in American Cities" (Land Use Policy 91, 2020) came out. It found bundled parking (i.e. included with rent) means people drive significantly more, and take transit significantly less, than if they have unbundled parking. It is attached.

A few highlights:

"Households with bundled parking use transit less, spend more on gasoline, and—when they do take transit—are more likely to drive from their homes to the transit stop."

"It is not uncommon for urban governments—in the name of sustainability, congestion relief, or public health—to recommend that residents drive less and walk or ride transit instead. Yet these same governments often have strict minimum parking requirements, meaning that governments may be urging residents to pursue one course of action while arranging the landscape in a manner that encourages another one entirely."

"**A landscape dominated by parking is often hostile to other ways of moving around. Surface parking pushes buildings away from each other, making walking difficult and (by reducing density) making transit less effective."**

"**Off-street parking puts curb-cuts in sidewalks, creating more potential collision points for pedestrians and cyclists, and increasing the stress involved in walking or biking."**

"controlling for everything else (including, we should emphasize, car ownership), the odds that a household with bundled parking will use transit of any sort are about 56 percent lower than the odds for a household without it."

"**households with bundled parking drive 328 more miles per month**, and 3936 more miles per year, than households without. They also suggest bundled parking households emit 119,480 more grams of vehicle-related carbon dioxide each month, and over 1.4 million more grams annually."
"Much of the travel behavior associated with Transit Oriented Development—such as less driving and more walking—arise not from the presence of rapid transit but the relative absence of parking."

"Bundled parking makes vehicle ownership artificially inexpensive; households that own fewer cars do not save money, because their parking costs are no longer a function of how many vehicles they own."

I hope you will:

(1) Remove parking mandates (at least within a mile of downtown and frequent transit corridors); and
(2) Require parking to be leased separately from units.

Thank you again for your consideration, and your service to the City of Salem.

Warm regards,

Evan

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Parking behaviour: Bundled parking and travel behavior in American cities

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ABSTRACT

We investigate the relationship between bundled residential parking and travel behavior, with a particular focus on use of public transportation, and controlling for vehicle ownership. When the cost of parking is bundled into the price of housing, the time and stress of finding parking near home falls. These lower costs may lead households with bundled parking to drive more and use transit less than households without parking, even if both households own vehicles. To date this idea has been difficult to examine empirically. In this article we test this prediction using the public transportation module of the 2013 American Housing Survey. We confirm the association between bundled parking and travel. Households with bundled parking use transit less, spend more on gasoline, and—when they do take transit—are more likely to drive from their homes to the transit stop.

1. Introduction

Imagine two women who work the same job in the same office, and also lease apartments across the hall from each other in the same building. The building is in an urban neighborhood with good bus and train connections, and the apartments are identical in every way but one: the first comes with a parking space, and the other does not. Both women own cars. The first woman, who has parking, keeps her car in a reserved space in the basement garage. The second keeps her car on the street. If she drives, she must search for parking when she comes home.

How much more likely is the second woman to take the subway?

That question, which this article considers, is essentially a question about the relationship between bundled parking and travel behavior. Parking is "bundled" when its cost is included in the cost of housing —the rent or purchase price of a home—rather than paid for separately by vehicle owners. For scholars of land use, bundling matters, because it is often an artifact of land use regulation. For scholars of transportation, bundling matters, because it shifts what should be a cost of driving (the terminal cost of storing a vehicle) into the property market, which could lead people to drive more, and use transit less, than they otherwise would. Bundling could thus represent an important link between land use and transportation.

Bundling is more common in cities that require more off-street parking with development (Manville et al., 2013). Especially in dense areas, minimum parking requirements in zoning codes can force developers to provide parking spaces whose construction cost exceeds their market value (Shoup 2011). In these cases, bundling might be the easiest, or only, way for the developer to recover costs. While bundling is a rational reaction by the developer, it can subtly change a resident's perception of the costs and benefits of driving. Residents' residential parking expenses are now independent of how much they drive, because they pay for parking in their housing purchase. Householders with bundled parking get, at no additional travel-related expense, ease and certainty of vehicle storage. This ease and storage could in turn affect how they travel.

The simple prediction that flows from this logic is that households with bundled parking will drive more, and use other forms of mobility less, than households without it. The most obvious form this travel difference would take is the decision to own a vehicle. People without bundled parking might own fewer cars, and drive less as a result. This relationship has already been demonstrated in the literature (Manville, 2017b).

Our contribution in this article is to examine the idea that bundled parking can alter travel behavior even *after* vehicle ownership is controlled for. Take the example above. Both tenants own cars. The difference lies in how easy it is to use them. The tenant with bundled parking could drive to work or dinner and know that a parking space will be waiting on her return. For her neighbor, the same trip carries more risk: coming home might involve circling the block to find a nearby space, and if no spaces are available she may have to park a block or more from her building. If this occurs, it will make not just her current vehicle trip but also her *next* trip less convenient, since her car will be farther away (in extreme cases, she might forget where it is). Over time, the average price of driving, in potential time and stress, becomes higher for the person without bundled parking. As this price rises, she might become more likely to use transit.

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To be clear, we are *not* saying that people without bundled parking will not drive, or even that they will drive very little. It is possible, and perhaps even likely, that both women in the example above would drive for most trips. (Indeed, if they like each other, they might even carpool to work). The woman without bundled parking might prefer driving because the destinations she frequents are poorly-served by transit, or because street parking in the neighborhood is not hard to find, which reduces the inconvenience of relying on it. Or perhaps she is sufficiently committed to driving that she leases an off-street space in a nearby garage. None of these scenarios is outlandish. Our contention is only that all else equal, households without bundled parking will use transit more, and drive less.

In this article we test this prediction, by examining whether people without bundled parking use transit more than people with it. Our test uses the 2013 version of the American Housing Survey (AHS). The 2013 AHS is notable for including both a measure of bundled parking, and for having a topical module (not present in other years of the AHS), with data on household travel. The survey thus offers a rare opportunity to link nationally representative parking data with relatively detailed information about travel habits.

Our analysis suggests that households without bundled parking, even controlling for vehicle ownership and a wide array of other factors, are more than twice as likely to use transit as households with bundled parking. This association is larger in central cities, which makes sense given that street parking is likely more scarce in cities. Further, while the association holds for most forms of transit it does *not* hold for commuter rail—which makes sense given that commuter rail often serves suburban households where parking, on- or off-street, is easy to find. We also find evidence suggesting that people with bundled parking drive more, although our metrics for driving are more limited than our metrics of transit use.

As we will discuss, our findings may generalize to all forms of reserved parking, not just parking that is bundled. But bundled parking is probably the most common form of reserved parking, and particularly in central cities it is usually the product of local zoning. As such, if bundled parking does in fact nudge people away from transit and toward driving, then many cities may have land use regulations that quietly undermine their transportation objectives. It is not uncommon for urban governments—in the name of sustainability, congestion relief, or public health—to recommend that residents drive less and walk or ride transit instead. Yet these same governments often have strict minimum parking requirements, meaning that governments may be urging residents to pursue one course of action while arranging the landscape in a manner that encourages another one entirely.

2. Parking, travel and the built environment

Although the study of parking has grown dramatically in the last 15 years (Shoup, 2018), parking in many ways remains a missing link in the literature on land use and transportation. The literature on how the built environment affects travel is now voluminous (e.g., Kain, 1967; Boarnet and Crane, 2001; Ewing and Cervero, 2001; Boarnet, 2011), but parking makes only occasional appearances within it (Manville, 2017a,b). The reason for parking's absence is understandable—parking data are hard to find—but omitting parking nevertheless leaves a void in how our understanding of how transportation and land use interact.

It would be an overstatement to say that researchers are in agreement about the mechanisms and magnitude of the built environment's influence on travel (e.g., Stevens, 2017; Ewing and Cervero, 2017). But there is a rough consensus about the broad mechanism by which land use can shape travel decisions. The logic, in essence, is that different built environments can raise or lower the price (in time or stress) of travelling in different ways (Boarnet, 2011). Researchers measure the built environment through the so-called "Five Ds" – density, diversity of land uses, destination accessibility, distance to transit, and design of streets. Dense places with narrow streets and a mix of uses, for example, might make walking or transit use easier but driving more difficult. In contrast, sprawling neighborhoods with detached homes along broad curved streets could make driving easier (because congestion is lower and speeds are higher), but make walking or transit use more difficult (because destinations are fewer and further between).

Parking, by this reasoning, could powerfully sway people's personal transportation decisions. Spatially and temporally, parking is a dominant fact of automobility. The benefits of using a private car hinge on being able to store the car between trips, and most cars spend most of their time at rest. As a result, parking is a large component of the built environment, and certainly it is the largest land use devoted explicitly to a single transportation mode. In many lower-density places surface parking accounts for a large share of land area, and even in denser American neighborhoods buildings that lack parking are often close to parking structures or subterranean garages.

But parking is only sometimes reflected in the Five Ds. Certainly an area with many surface lots will be less dense than one without, so the Five Ds can capture the most sprawling parking landscapes. In central cities, however, standard metrics of the built environment can overlook parking's role. Two buildings of equal density, on adjacent sites, might look identical in terms of the Five Ds. But if one sits atop an underground parking garage and the other has no parking at all, they could have very different prices for driving (Manville, 2017b). And if zoning has forced much of this parking into existence, and thereby caused its price to be shifted into the property market, that can create an inducement to driving that the Five D's will miss entirely.

The supply of parking influences travel in two ways. First and most directly, abundant parking makes driving easier. Most driving trips end in parking spaces, and if parking is cheap and easy to pay for, the overall price of driving falls. Second, parking can also make *not* driving *harder.* A landscape dominated by parking is often hostile to other ways of moving around. Surface parking pushes buildings away from each other, making walking difficult and (by reducing density) making transit less effective. Structured or underground parking can consume less land, but reduces density nevertheless, by siphoning development capital away from housing or commercial space and into parking space. And all off-street parking puts curb-cuts in sidewalks, creating more potential collision points for pedestrians and cyclists, and increasing the stress involved in walking or biking.

Parking data for the United States, unfortunately, are hard to find. Other travel and built environment variables, like Vehicles Miles Traveled (VMT) or density, are tracked in a variety of government surveys. It is not hard for researchers to gather data for the entire United States and correlate density and VMT. The National Household Travel Survey, as well as many smaller travel diaries, like the California Household Travel Survey, contain detailed data on vehicle trips, transit trips, and miles travelled by different modes. These surveys also offer direct links, through geographic identifiers, to US Census data, allowing researchers to match travel data to the built environment data tracked by the Census (density, employment, and so on). But neither the travel diaries nor the Census track parking. Parking is a crucial link between transportation and land use, but neither transportation surveys nor land use surveys track it.

As a result, assembling parking data often requires original survey work. The labor and expense of such work means that studies of parking often focus on smaller geographies (e.g., Manville et al., 2013; Chatman, 2013). Despite these obstacles, when researchers are able to gather parking data and include it in studies of travel, its role appears to be large. Rowe et al. (2011) showed that places with higher transit service had lower parking demand. Chatman (2013), in a study of New Jersey, shows that much of the travel behavior associated with Transit Oriented Development—such as less driving and more walking—arise not from the presence of rapid transit but the relative absence of parking. Policies that make storing a vehicle harder, in other words, reduce driving more than policies that make riding transit easier.

Our focus in this article is on bundled parking in particular, not parking overall. As we discussed in the introduction, bundled parking could influence travel decisions in two ways. The first, which we will control for but not dwell on, is through vehicle ownership. Bundled parking makes vehicle ownership artificially inexpensive; households that own fewer cars do not save money, because their parking costs are no longer a function of how many vehicles they own. Manville (2017b) uses the 2003 AHS to show that bundled parking is associated with increased vehicle ownership—households without bundled parking are 60–80 percent more likely to be vehicle-free than households with bundled parking—and further shows that this increased vehicle ownership is in turn associated with more driving to work. So households with bundled parking are more likely to own cars, and by virtue of that car ownership are more likely to drive and less likely to use other modes.

The second way bundled parking could alter travel behavior is by reducing the search costs and uncertainty associated with residential parking. If the bundled spot is near the housing unit, it also makes driving more convenient. It is this mechanism that we emphasize here. Our primary research question is whether bundled parking can influence travel behavior *over and above* its impact on vehicle ownership.

Some existing evidence suggests that convenient parking makes people more likely to drive. Weinberger (2012), for instance, in a study of New York City, shows that having parking adjacent to the home, such as in a driveway or garage, generates more driving trips to work than parking in a commercial off-site lot, which requires more walking and also may require valet notification. She also shows that people with bundled parking are more likely to drive to work.

The obvious implication of our hypothesis is that people in households with bundled parking will drive more and use transit less. This the implication we will primarily test, but note that our logic has other implications as well. Bundled parking offers some certainty about residential parking availability, and this certainty will be more valuable in places where other forms of parking are less available. A person who lives on a street where curb parking is abundant sees less advantage from bundled parking than does someone who lives on a street where curb space is scarce. As such, we expect the association between bundled parking and travel behavior to be stronger in central cities, where competition for the curb is greater.

Further, while we expect bundled parking to be associated with less transit use, we also expect the size of that association to vary by the extent to which a given transit mode reduces the need to drive. A person who walks to the bus or subway completely eschews a vehicle trip. A person who rides commuter rail, in contrast, will often drive to the train station, and not be saved a vehicle trip. Commuter rail's appeal, for riders, usually stems from the absence of parking at the *destination* (usually a CBD) not at the residential point of origin. The ease of residential parking might still be important to a commuter rail rider in a way that it is not to a bus rider.

Put another way, when transit is only a short distance from home and parking is unavailable at the station or stop, bundled parking represents a competing mode (the decision to drive rather than ride). For transit modes that typically require people to drive to stations, however, bundled parking *can* represent a competing mode (driving for the whole trip) but can also represent a complement to, and component of, using transit (driving to the station and then riding). As a result, we expect the relationship between bundled parking and subway or bus use to be much stronger (in both size and statistical significance), than the relationship between bundled parking and commuter rail.[1]

Finally, we emphasize that the mechanism we describe for less transit use is not unique to bundled parking: it describes any sort of reserved off-street space, and in particular any sort of reserved space that is convenient and nearby. Bundled parking makes driving more convenient than does searching for parking on the street, but there is no obvious way that it makes driving more convenient than using an off-street parking space purchased separately. Some people without bundled parking are sufficiently committed to driving that they will purchase unbundled off-street parking, either on-site or elsewhere. Driving will be convenient for these people as well. Thus any association we find between bundled parking and travel behavior (above and beyond vehicle ownership) may apply to reserved parking more generally. We discuss this issue further below.

3. Data and method

The vignette introducing this article described what was essentially a controlled experiment in bundled parking: a situation that let us observe the travel behavior of two people alike in every way except their parking access. In this experimental condition, we could learn bundled parking's influence on travel by simply measuring the travel differences between the two people. Because the two women differ along no other relevant axes, we could confidently attribute any travel differences between them to the presence or absence of the parking "treatment."

The real world, of course, does not give us experimental travel conditions. No central planner usefully places people in undifferentiated residential and work environments and then randomly assigns them bundled parking. Some people have bundled parking and some do not, but these people also differ in many other ways, and many of those ways—from income to race to housing tenure to a variety of intrinsic beliefs and motivations—also influence decisions about how to move around. As a result, observed differences in travel behavior between people with and without bundled parking will be only partly explained by the parking itself, while differences along the other dimensions will explain the rest. In these conditions, we must use regressions to statistically control for other factors, and isolate the association between bundled parking and travel. Following this approach requires a data set with reasonably detailed information on bundled parking, travel, and other socioeconomic indicators. To our knowledge, the only nationally-representative data set that meets these criteria is the 2013 AHS.

The AHS is a US Census Bureau panel survey of American housing units, first conducted in 1973 and then every two years subsequently. The AHS stands out for including questions about residential parking. In almost all its iterations, the survey has recorded the presence or absence of bundled off-street parking, making it the only US government survey, and the only nationally-representative survey of the United States, to regularly include parking data. In most years, however, the utility of these data to travel researchers has been limited, because the AHS usually has few or no questions about travel. In some years the survey asked household workers about commute modes, but these questions were few, and discontinued after 2003 (they returned in 2017). The 2013 AHS is an exception, however, because it includes a topical module (a special subsection of the survey) on the use of public transportation.

The module allows us to link nationally-representative parking data with detailed travel data. But the module does have some disadvantages. First, it was administered to fewer than half of AHS respondents, so using it deprives us of one of the usual benefits of the AHS, which is a large sample size that permits robust use of city and metropolitan area fixed effects. [2] Further, the module is focused on transit, rather than travel overall, so it has no questions that are directly about driving, which is the largest travel mode in the United States. Nevertheless, the module makes the 2013 AHS unique, and gives us the

[1] Were we able to control for the price and availability of parking at the workplace, the statistical association between parking and commuter rail use might be stronger. We do not have access to such data, however.

[2] The appendix shows summary statistics from the AHS public transportation module and from the core AHS sample, to establish that the public transportation module is a representative sample of the survey as a whole.

opportunity to statistically associate measures of bundled parking with measures of travel.

We build our primary independent variable of interest—whether a housing unit has bundled parking—from the AHS's "Garage" question. This question has up to two parts. It first asks: "Is a garage or carport included with this unit?" If the answer is yes, the surveyor records the unit as having bundled parking and moves on. If the answer is no, the surveyor follows up by asking if some other form of off-street parking is included in the rent or purchase price. For our purposes all forms of bundled parking are equivalent, so we roll these answers into one variable. If a household answers "yes" to either question, we code the unit as having bundled parking. Doing so gives us a dichotomous variable coded 1 if a housing unit has bundled parking, and zero otherwise.

This variable has limitations. It records only the presence or absence of bundled parking, and offers no information about how many bundled spaces a housing unit has. It also does not indicate the location of the bundled parking—whether it is on- or off-site. And it casts no light on whether *unbundled* parking is available on the property—that is, if households can access parking for an additional price.

These limitations are unavoidable, given the wording of the "Garage" question. But they are worth reiterating and exploring, given the relationship between bundled parking specifically and reserved off street parking generally that we alluded to above. A person who answers "no" to the AHS parking questions might have no off-street parking at all, or might have off street parking they pay for separately. As a result, our independent variable likely contains a mix of people who do and do not have reserved parking with their residence, and this may bias our results.

The extent of the bias would depend on the extent of the mix. If many people without bundled parking purchase parking separately, then reserved parking might dominate both sides of our independent variable. We consider this scenario unlikely. Developers bundle parking in part because parking requirements make residential parking so abundant, and this abundance makes a robust market in unbundled parking unlikely.

When zoning forces a developer to build parking at a cost that exceeds its market price, the developer could unbundle spaces and sell them at a loss. But this course of action carries risks. It is worthwhile if all the residents buy parking spaces, but it also burdens the building's management with a second layer of transactions: keeping not just the housing units leased but also the parking spaces.

If a parking space becomes vacant and no one in the building wants it, it may be hard to a) find a buyer (almost every building is subject to parking requirements, so most nearby residents will have parking in their own building) and b) negotiate the various legal, insurance and other transactional hurdles that come with renting on-site parking to a non-resident. This combination of a small customer base, large supply, and high transactions costs probably means that in most places the market for off-site residential parking is small. Certainly there will be exceptions: in older parts of dense central cities, the market for off street residential spaces may be more robust. A number of our control variables, however (described below) at least partially account for these circumstances.

A larger point is that if we are wrong, and many of the zero values in our independent variable represent bundled off street parking rather than curb parking, the resulting bias will be a conservative one. Much of our comparison group will have reserved parking, and our coefficient will underestimate the travel behavior differences between reserved off street parking and street parking. For this reason we are not overly concerned about the ambiguity in the zero value, although we want readers to be aware of it.

We relate our bundled parking variable to a variety of dependent variables, most of which are measures of transit use. The AHS module tracks transit use through a series of questions. The survey first asks if anyone in the household uses transit at all. If the answer is yes, the survey asks what type of transit is used, how far that transit is from the housing unit, and how often the household uses it (with round trips counting as a single use). The survey asks about subway and light rail, buses, taxis, commuter rail, and some smaller transit modes like commuter shuttles. The survey then categorizes the response data into the following brackets: daily use, 4–6 times per week, 1–3 times per week, 3 or more times per month, 1–2 times per month, and less than once per month (but more than never). We are interested in whether people use a given mode at all, and whether they use it "frequently"—which we define as using at least four times per week. We build dichotomous variables (1 = yes, zero = no) indicating both "use" and "frequent use".

Our hypothesis is that people with bundled parking will use transit less (although, as mentioned earlier, we expect this relationship to be much weaker for transit that is built around driving, like commuter rail). Implicit in this hypothesis is that they will also drive more. Unfortunately, the transit focus of the AHS topical module means it lacks any standard measures of driving. Where traditional travel diary surveys record vehicle trips, trip times, and trip distances, the AHS does none of this, and in fact does not even ask respondents how often they drive. We rely instead on a question that asks respondents to estimate their monthly household gas expenditure. We treat this question as a rough proxy for how much the household drives, and use it as a dependent variable. We emphasize that the proxy is rough: gas expenditures are influenced by the total amount of household driving, but also by the type of vehicles driven, by local gas prices, the type of fuel used, the driving and braking behavior of household members, and so on.

People might also just misremember their monthly gasoline expenditures. As is always the case with self-reported travel data, the answers to the questions in the AHS topical module almost certainly contain some errors. People regularly report behavior that differs from their actual travel, usually due to incomplete recall (Clarke et al., 1981; Stopher et al., 2005; Oliveria et al., 2011; Wolf et al., 2003). The AHS questions, however, do avoid some of the biggest problems with travel diaries. Diaries become more error-prone when they ask for more specifics—such as exact locations traveled to, specific routes used, or even the total number of trips taken in a day. The more general questions asked in the AHS (e.g., do you use the bus, and how often?) have answers that deliver less precision, but may be also be more accurate.

Our last dependent variable is whether the household has members who regularly walk or bike around the neighborhood. We use this variable primarily to refine our understanding of how bundled parking affects different kinds of travel. We suspect that trips around a neighborhood are more strongly associated with the conventional "Five Ds" than with the availability of parking at home.

We round out our regressions with an array of control variables that are standard in the travel and built environment literature: we account for household income, race, nativity, and educational attainment, as well as vehicle ownership, housing tenure, and central city location. Because our primary interest is transit use, we control for income in two ways. We use the AHS's household income variable, but because transit ridership in much of the United States is associated with very low-incomes, we also control for poverty status. Our income coefficients should therefore be interpreted as the association between mode choice and each additional dollar of income above the poverty line.

Transit use also varies by geographic area. Ideally we could control for this geographic variation by using fixed effects for every metropolitan area, but the size of the topical module makes it difficult to do this and still have models converge. We include dummy variables that control for location in New York, San Francisco, Philadelphia, Los Angeles and Boston (these MSAs alone account for well over half of US transit ridership, and close to two-thirds of all rail ridership. They are also areas—Los Angeles excepted—where bundled parking tends to be less common.

We control as best we can for other aspects of the built environment.

The standard AHS includes a battery of questions about the nearby neighborhood, but the responses to these questions are unfortunately only available in the restricted version of the survey, so we cannot access them. We do have, however, a series of questions from the topical module that measure neighborhood accessibility. These questions ask about distance to transit, access to bike lanes, the condition of sidewalks, and whether some common destinations (banks, grocery, retail) are within walking distance. We use these questions to build variables that act as rough measures of the density and diversity of the nearby built environment. As a result, our control variables cover most of the "five Ds" along with household demographics and economics.

A final issue we confront is residential self-selection. The self-selection problem in transportation and land use is essentially a problem of reverse causality. It is possible that people who move into housing without bundled parking will find driving less convenient as a result, and therefore drive less and use transit more. But people are not randomly assigned to their housing units; they get to choose them. So we cannot rule out the possibility that people who start off wanting to drive less and use transit more will choose housing without bundled parking. In this case, their choice in travel behavior would cause their housing choice, not the other way around. A regression that did not control for this endogeneity would overestimate bundled parking's influence on travel.

Self-selection is a legitimate issue in transportation research. In this article, however, we are not overly concerned that it will bias our results, and we do not explicitly control for it. We base our optimism in part on the now-considerable evidence suggesting that fears about self-selection in travel research are often overblown (e.g., Naess, 2014). Research that controls for self-selection usually finds its impact to be small. Residential self-selection *can* yield overestimates of the built environment's influence on travel, but the conditions under which it will do so are actually quite stringent, and often unrealistic. In many circumstances, in fact, it is equally plausible that self-selection will lead to *underestimates* of the built environment's impact (Chatman, 2009; Manville, 2017b).[3] Our second reason for optimism, which is more specific to our question and data set, is that Manville (2017b) extensively tested for self-selection in the relationship between bundled parking and vehicle ownership using the 2003 and 2009 AHS, and found that self-selection was if anything underestimating parking's influence. So while we are careful in this article not to claim causality in our regression results, we also remain fairly sanguine about self-selection.

4. Analysis: descriptive statistics

Table 1 shows summary statistics for the independent variables we use. Of particular relevance to us is the sheer abundance of bundled residential parking. Ninety percent of US housing units have some form of bundled parking. This is perhaps not surprising, since the typical US housing unit is a detached single-family home with a driveway and often a garage. Parking is more common in owned units than rented, and (though not shown) more common outside central cities and in housing that was built after 1920.

Table 2 shows that, on average, households with bundled parking travel in starkly different ways than households without it. Households with bundled parking spend more than twice as much per month on gasoline as households without ($237 to $105), while households without bundled parking spend over six times as much on transit ($59 to $9). Households without bundled parking also spend more each month on parking itself ($20 to $7), probably in part because some of them pay for parking at home, and in part because they are more likely to live in urban environments where parking at destinations away from home is less likely to be free. Such areas are more likely to discourage vehicle ownership and encourage transit use, and the data suggest as much. Households without bundled parking are over three times as likely as households with bundled parking to have no vehicles (48 percent to 16 percent), and at least twice as likely as households with bundled parking to use every kind of transit. They are almost five times as likely to use the bus, and over six times as likely to ride subways or light rail. (Though not shown, households without bundled parking are also more than five times as likely to be *frequent* bus users, and six times as likely to be frequent transit users). At least descriptively, bundled parking is strongly associated with less driving and more transit use.

Table 3 shows, furthermore, that even among households who do take transit, bundled parking is associated with more driving—people from these households are much more likely to drive to the transit station. Across all modes of transit, the likelihood of driving to the transit stop is much higher for households with bundled parking. Households with bundled parking who use the bus are more than ten times as likely to drive to the bus stop as bus-using households without bundled parking. Similarly, households with bundled parking who use subways or light rail are almost nine times as likely to drive to the station as subway-using households without bundled parking. The differences are not as stark for commuter rail. As we suggested above, commuter rail riders are in general much more likely to drive (57 percent of riders drive to the station, compared to 4 percent of bus riders), but rail riders with bundled parking are nevertheless more than twice as likely to drive. Across modes, transit users from households with bundled parking are more likely to access stations by driving alone or carpooling, and less likely to do so by walking, biking or other transit.

Together, Tables 2 and 3 suggest a strong correlation between

Table 1
Summary Statistics, 2013 AHS Topical Module.

		N
Owned Units	66%	14,286
With Bundled Parking	97%	9,083
Rented Units	34%	14,286
With Bundled Parking	87%	5,184
In Central City	31%	14,489
Household in Poverty	14%	14,489
Units Built Pre-1920	7 %	14,489
Unit Rent-Controlled	1%	14,489
Median Household Income	$40,800	14,130
Median Year Structure Built	1970	14,489
Average Number of		
People in Household	2.5	14,489
Vehicles in Household	1.2	14,489
Units per housing development	9	14,489
Average Proportion of:		
HH Female	52%	14,489
HH Children	12%	14,489
HH Age 65 or Older	21%	14,489
HH Native Born	87%	14,489
HH Black	13%	14,489
HH Adults College-Educated	25%	14,489
Share of Households with:		
Access to Grocery Store by Biking or Walking	54%	13,873
Bike Lanes in Neighborhood	15%	14,143
Usable, Well-Lit Sidewalks in Neighborhood	46%	14,114
Access to Retail by Biking or Walking	22%	14,417
Access to Bank by Public Transit	52%	13,816

[3] For residential self-selection to over-estimate the role of the built environment, three conditions must be satisfied. People must search for housing based on their travel preferences, they must be able to find housing that meets their criteria, and—most crucially—if they *not* find such housing, they must *not* travel in their preferred way. These assumptions are strong. They imply, rather heroically, that people most devoted to a particular mode are also most likely to be deterred from that mode by the built environment (Chatman, 2009). If that isn't true—if a determined cyclist will be more likely than his neighbors to cycle even if he settles for a big home in a low-density suburb—then correcting for self-selection will make the association between travel and the built environment stronger.

Table 2
Transportation Use, All Housing Units and Units with and without Bundled Parking, 2013.

		N
Average Monthly HH Gas Expenditures		
All Units	$228	13,126
Units with Bundled Parking	$237	11,885
Units w/out Bundled Parking	$105	1,241
Average Monthly Transit Expenditures		
All Units	$12	13,692
Units with Bundled Parking	$9	12,438
Units w/out Bundled Parking	$58	1,253
Average Monthly Parking Expenditures		
All Units	$7	13,668
Units with Bundled Parking	$7	12,397
Units w/out Bundled Parking	$20	1,270
Average Total HH Vehicles		
All Units	1.2	14,489
Units with Bundled Parking	1.3	13,123
Units w/out Bundled Parking	0.7	1,347
Proportion of Households with No Vehicles		
All Units	18%	14,489
Units with Bundled Parking	16%	13,123
Units w/out Bundled Parking	48%	1,347
Proportion of Households that Use:		
Transit of Any Kind		
All Units	19%	14,229
Units with Bundled Parking	16%	12,898
Units w/out Bundled Parking	59%	1,325
Transit to Commute to Work or School		
All Units	19%	14,489
Units with Bundled Parking	16%	13,123
Units w/out Bundled Parking	58%	1,347
Bus		
All Units	13%	14,485
Units with Bundled Parking	11%	13,119
Units w/out Bundled Parking	46%	1,347
Subway, Light Rail or Trolley		
All Units	7%	14,485
Units with Bundled Parking	5%	13,119
Units w/out Bundled Parking	38%	1,347
Commuter Rail		
All Units	2%	14,485
Units with Bundled Parking	2%	13,119
Units w/out Bundled Parking	4%	1,347
Taxis		
All Units	11%	14,197
Units with Bundled Parking	9%	12,873
Units w/out Bundled Parking	33%	1,320
Carpooling		
All Units	6%	14,197
Units with Bundled Parking	7%	12,873
Units w/out Bundled Parking	6%	1,320
Other Forms of Transit		
All Units	2%	14,485
Units with Bundled Parking	2%	13,119
Units w/out Bundled Parking	4%	1,347

*Other forms of transit includes commuter shuttle/bus

bundled parking, more driving, and less transit use. Some of these differences may owe, of course, to households with bundled parking simply having a higher socioeconomic status. Although not shown in any table, the median income for households with bundled parking is about $49,000, while the median income of households without bundled parking is just over $32,000. Vehicle ownership and use are obviously easier for households with more money. Yet households with and without bundled parking differ along more dimensions than just income. As Table 4 shows, the observed differences in travel behavior between these households may also owe to aspects of the built environment other than bundled parking. Housing units without bundled parking are more likely to be in neighborhoods that support walking, cycling and transit use. Households with unbundled parking are twice as likely to be able to reach a grocery store by walking or biking, and where three-quarters of respondents in unbundled units can reach a grocery store by transit, only 53 percent of households in bundled units can do the same. Similarly, almost three-quarters of households without bundled parking report living in places where the sidewalks are usable and well-lit, compared to less than half of households with bundled parking.

Table 3
Mode to Transit, All Transit-Using Households, and Households with and without Bundled Parking, 2013.

Mode to Bus	Overall	Bundled	Unbundled
Drive	3.9%	5.0%	0.3%
Walk	81.1%	79.3%	87.2%
Carpool	1.4%	1.8%	0.1%
Local Bus	11.3%	11.6%	10.6%
Other	2.3%	2.4%	1.9%
N	*2,301*	*1,597*	*703*
Mode to Commuter Rail	**Overall**	**Bundled**	**Unbundled**
Drive	56.6	60.4	25.1
Walk	21.2	19.2	38.0
Carpool	5.4	5.7	3.2
Local Bus	10.2	10.0	11.7
Other	6.6	4.7	22.1
N	*502*	*440*	*62*
Mode to Commuter Shuttle	**Overall**	**Bundled**	**Unbundled**
Drive	23.6	25.7	5.5
Walk	44.7	41.8	69.4
Carpool	1.8	2.0	0.0
Local Bus	4.6	4.8	3.4
Other	25.3	25.7	21.7
N	*206*	*174*	*32*
Mode to Subway/Light Rail[1]	**Overall**	**Bundled**	**Unbundled**
Drive	25.6	36.9	4.4
Walk	44.9	30.4	72.0
Carpool	2.1	3.1	0.3
Local Bus	20.9	22.7	17.6
Other	0.0	0.0	0.0
N	*1,417*	*825*	*592*

[1]Includes Trolley

Table 4
Neighborhood Accessibility, All Housing Units and Units with and without Bundled Parking, 2013.

Proportion of Units that are:		*N*
Within 1/2 Mile of Transit Stop		
All Units	15%	13,801
Units with Bundled Parking	36%	12,452
Units w/out Bundled Parking	27%	1,331
Accessible to Grocery Store by Walk or Bike		
All Units	26%	14,425
Units with Bundled Parking	25%	13,070
Units w/out Bundled Parking	50%	1,336
Accessible to Grocery Store by Transit		
All Units	54%	13,873
Units with Bundled Parking	53%	12,537
Units w/out Bundled Parking	75%	1,327
In Neighborhood w/Usable Well-Lit Sidewalks		
All Units	47%	14,114
Units with Bundled Parking	45%	12,784
Units w/out Bundled Parking	73%	1,324
Accessible to Bank by Transit		
All Units	52%	13,816
Units with Bundled Parking	51%	12,482
Units w/out Bundled Parking	75%	1,327
Accessible to Retail by Walk or Bike		
All Units	22%	14,417
Units with Bundled Parking	20%	13,062
Units w/out Bundled Parking	46%	1,336

Table 5
Associations with Use of Transit and Biking and Walking, 2013 (Logit Regressions).

	Transit	Bus	Subway	Rail	Bike/Walk
Bundled Parking	−0.842*	−0.655***	−1.406***	−0.250	−0.0519
	(0.370)	(0.0998)	(0.109)	(0.248)	(0.135)
Total Cars	−0.870***	−0.451***	−0.0817	−0.0176	0.0760*
	(0.209)	(0.0467)	(0.0557)	(0.0781)	(0.0343)
% HH Female	0.483	−0.0763	−0.149	−0.242	−0.0791
	(0.373)	(0.101)	(0.128)	(0.208)	(0.0846)
Household Income	−0.00422	−0.00106	0.00283***	0.00337***	0.00102*
	(0.00238)	(0.000562)	(0.000469)	(0.000537)	(0.000410)
Poor	−0.249	0.334***	−0.241*	0.120	−0.0429
	(0.321)	(0.0930)	(0.121)	(0.246)	(0.0861)
Rent Control	−0.0809	−0.0968***	−0.0304	−0.00958	−0.0198
	(0.0794)	(0.0283)	(0.0433)	(0.128)	(0.0395)
People in HH	0.103	0.328***	0.244***	0.104	0.0596*
	(0.172)	(0.0285)	(0.0347)	(0.0574)	(0.0260)
% HH Black	0.450	0.774***	0.880***	0.0198	−0.310***
	(0.289)	(0.0847)	(0.105)	(0.216)	(0.0840)
% HH Native Born	0.405	−0.510***	−0.432***	0.0981	−0.0270
	(0.471)	(0.0973)	(0.119)	(0.229)	(0.0980)
% Household 65 Years or Older	0.463	−0.243*	−0.407**	−0.217	−0.375***
	(0.289)	(0.104)	(0.147)	(0.209)	(0.0763)
% HH Under 18 Years	−0.270	−1.543***	−0.601**	0.157	0.578***
	(0.826)	(0.198)	(0.232)	(0.366)	(0.160)
% HH College Degree	0.466	0.0889	1.115***	1.097***	0.637***
	(0.361)	(0.0939)	(0.112)	(0.178)	(0.0746)
Central City	−0.264	0.583***	0.353***	−0.499**	−0.134*
	(0.282)	(0.0735)	(0.0940)	(0.169)	(0.0614)
Apartment	0.0348	−0.0351	0.250	−0.00518	0.0897
	(0.468)	(0.121)	(0.145)	(0.229)	(0.108)
Can walk/bike to grocery	−0.112	0.675***	0.874***	0.818***	
	(0.503)	(0.117)	(0.143)	(0.244)	
Can access grocery by transit	0.282	0.403**	−0.0360	0.0245	0.0360
	(0.476)	(0.152)	(0.169)	(0.267)	(0.110)
Bike lanes in neighborhood	0.477	0.202*	0.505***	−0.228	0.434***
	(0.272)	(0.0846)	(0.0978)	(0.176)	(0.0761)
Good sidewalks in neighborhood	−0.491	0.401***	0.646***	0.321*	0.323***
	(0.253)	(0.0757)	(0.101)	(0.142)	(0.0559)
Can walk/bike to retail	0.418	0.114	0.220	0.0833	
	(0.431)	(0.113)	(0.129)	(0.220)	
Can access bank by transit	−0.284	0.468**	0.198	0.154	0.0827
	(0.438)	(0.150)	(0.168)	(0.271)	(0.107)
Built pre-1920	−1.197	0.222	0.145	0.341	0.214*
	(0.707)	(0.120)	(0.137)	(0.206)	(0.102)
Units in Building	0.000340	0.000809	0.00368***	0.00230**	−0.00122
	(0.00135)	(0.000694)	(0.000724)	(0.000751)	(0.000771)
Tenure (Owned)	−0.655	−1.138***	−0.273	0.257	−0.304
	(0.492)	(0.178)	(0.270)	(0.783)	(0.238)
HH bikes or walks	0.256	0.138**	0.0211	0.126	
	(0.145)	(0.0421)	(0.0511)	(0.0687)	
Distance to nearest transit stop	−4.476*				−0.627*
	(1.751)				(0.265)
Transit stop < 0.5 miles from unit	−2.312				−0.0900
	(1.289)				(0.202)
N	9,758	13,231	13,231	13,231	9,788
Pseudo R-sq	0.134	0.269	0.322	0.127	0.057

Standard errors in parentheses. "Subway" = subway/light rail/trolley. "Rail" = Commuter rail.
* p < 0.05 ** p < 0.01*** p < .0.001″
*Additional control variables not shown in this table include dummies for the New York.
San Francisco, Boston, Los Angeles, and Philadelphia MSAs.
Walk/bike model does not include wak/bike access variables, due to the way the survey was collected.
HH = Household.

Ins um, the descriptive analysis suggests that unbundled parking is uncommon. It is correlated with more walking and transit use, but also correlated with other attributes that might predict walking and transit use—more accessible neighborhoods, lower incomes, etc. We now use regressions to sort out these different relationships, and isolate the association between bundled parking and travel.

5. Regression analysis

Our dependent variables are almost all binary (e.g., do people use transit or not, or use it frequently or not), so the bulk of our regressions are logit models (Long and Freese, 2014). Table 5 shows the output of five logit regressions measuring the relationship between bundled parking and transit use. The independent variable of interest in every equation is bundled parking. In the first equation the dependent variable is a dichotomous variable indicating if the household uses transit of any sort. The next three equations examine variables indicating if the household uses the bus, rail (light rail or subway) or commuter rail. (In regressions that are not shown, we also tested for other transit modes and found few differences in the results). The final equation analyzes the odds that a household has members that walk or bike around the neighborhood.

As we hypothesized, bundled parking has a negative and statistically significant association with overall transit use, bus use, and use of light rail/subway, even controlling for vehicle ownership. Also as we expected, bundled parking has a negative association with using commuter rail and walking/biking, but these relationships are not statistically significant and the coefficients are small.

The bundled parking coefficients in the overall transit, bus and subway models, in contrast, suggest that the decisions to use these modes are meaningfully associated with bundled parking. One way to interpret the coefficients is to exponentiate them. Exponentiating a coefficient yields the percent change in the odds of the dependent variable (in this case using a given mode) that is associated with a change in an independent variable (in this case having bundled parking). Performing this calculation suggests that, controlling for everything else in the model (including, we should emphasize, car ownership), the odds that a household with bundled parking will use transit of any sort are about 56 percent lower than the odds for a household without it. By way of comparison, this association is larger than the association between transit use and poverty (the odds of poor households using transit are 23 percent higher than for nonpoor households), and almost as large as the association between transit use and a household adding another car (each car is associated a 58 percent reduction in the odds of using transit). Similarly, households with bundled parking have odds of using the bus that are 47 percent lower than households without bundled parking, and have odds of using the subway or light rail that are 75 percent lower than those for households without bundled parking.

Our regressions control for central city location, but as a robustness check we re-estimate the regressions for only the central city units (N = 4,756). To conserve space we do not show these regressions, but they are available upon request, and the results are substantially similar. As we expected, the relationships are stronger, most likely because on-street parking in central cities is scarce, which raises the relative time or stress penalty for drivers who do not have bundled parking. In the central cities, the odds that households with bundled parking will use transit of any sort are 71 percent lower than households without bundled parking, and the odds of using the bus and the subway are 45 and 77 percent lower, respectively.

We next turn to models estimating the odds that a household has a frequent transit user (defined, again, as using a mode time four times a week or more). Table 6 shows the results of six logit regressions. We estimate two regressions for each of three modes: bus, subway/light rail, and commuter rail. We estimate two regressions for each mode because the AHS topical module, somewhat idiosyncratically, only asks a mode-specific "distance-to-transit" question *after* a respondent has confirmed that someone in the household uses the mode. As a result, no distance to the mode is recorded for non-users, which means that controlling for distance to the mode requires dropping every household that doesn't ride. These circumstances are not ideal, but since we already established, in Table 5, that bundled parking is associated with use of transit overall even in the presence of a distance control, we run the first set of "frequent use" models without a distance-to-transit variable. In the second model for each mode, we do include the distance variable. Note that in doing so we set a high bar for statistical significance. We have now not only dramatically reduced the sample size (to users only) but also reduced the sample variance, by analyzing only people who use the mode and. A statistically and substantially significant coefficient on bundled parking in these models would suggest that even among transit users, bundled parking is associated with less frequent transit use.

As it turns out, this result is precisely what we see. In models using the full sample (transit users and non-users), bundled parking is strongly and negatively associated with a household having a frequent bus or subway user. Specifically, the odds of a household with bundled parking having a frequent bus user are 45 percent lower than the odds of a household without bundled parking. Similarly, the odds that a household with bundled parking will have a frequent subway user are 76 percent lower. When we introduce distance to the bus stop as a control, and eliminate all non-riders, the bundled parking coefficient shrinks, but bundled parking nevertheless continues to predict a lower likelihood of frequent use. Among households that use transit, those with bundled parking have odds of frequent bus use that are 24 percent lower than those without bundled parking, and odds of frequent subway use that are 44 percent lower.

Once again we re-estimate these regressions for the central city alone (again not shown, but available on request), and once again we see that the associations are stronger. In the central cities, across the whole sample the odds that a household with bundled parking will have a frequent bus or subway user are 41 percent and 76 percent lower, respectively, than the odds a household with bundled parking will have frequent users. If we restrict the sample to central city households that use these modes, the odds that a household with bundled parking will have a frequent bus user are 21 percent lower than the odds of a household without bundled parking, and the odds of a household having a frequent subway user are 41 percent lower if the household has bundled parking.

A disadvantage of calculating changes in odds is that these changes do not account for the baseline rate of use—they show a percent change, but relative to what? We can address this issue, and further clarify our results, by estimating the marginal effects of bundled parking on predicted transit use. We do so by fixing the values of all continuous variables at their means, all dichotomous variables at their modes, and predicting travel for households with and without bundled parking.

Table 7 shows the results. Controlling for all other variables in the model, a household without bundled parking has a roughly 1.6 percent probability of using transit, compared to a seven-tenths of percent probability for a household with bundled parking. Transit use is rare in the US, and bundled parking is just one determinant of it, so the absolute values associated with bundled parking are small. What matters is the difference; households without bundled parking are more than twice as likely to use transit of any kind.

When we examine the probability of being a frequent transit user without including distance-to-transit variables (and as a result include both transit riders and non-riders in the sample) we see large and economically significant differences between households with and without bundled parking. Households without bundled parking are five times as likely as households with bundled parking to be frequent rail users, and ten times as likely to be frequent bus users). Even when we include distance-to-transit variables, and thereby restrict the sample to transit riders, we still see a meaningful association between bundled parking and frequent transit use. Riders without bundled parking have a 25 and 50 percent probability of being frequent users of the bus and subway, respectively, while riders with bundled parking have probabilities of 20 and 36 percent.

Our final regression analyzes household gasoline expenditures, which we use as a rough proxy for the volume of household driving. Table 8 presents the results from an ordinary least squares regression where monthly gas expenditures are the dependent variable. The regression controls for a range of factors that can affect driving, including sociodemographic variables and built environment characteristics.

The bundled parking coefficient is both statistically and economically significant. The model suggests that, controlling for these other factors, a household without bundled parking spends about $48 less per month on gas than does a household with bundled parking. This difference makes bundled parking one of the model's largest determinants of gasoline expenditures. Bundled parking's association with spending on gasoline is larger than the *combined* association between gas spending and having good sidewalks, walkable grocery stores, and transit accessible banks.

Table 6
Associations with Frequency of Transit Use, 2013 (Logit Regressions).

	Frequent bus use		Frequent subway use		Frequent rail use	
	(1)	(2)	(3)	(4)	(5)	(6)
Bundled Parking	−0.614***	−0.276*	−1.421***	−0.571**	−0.257	−0.342
	(0.128)	(0.140)	(0.145)	(0.186)	(0.581)	(0.584)
Total Cars	−0.552***	−0.287***	−0.299***	−0.291**	−0.147	−0.197
	(0.0686)	(0.0801)	(0.0872)	(0.107)	(0.202)	(0.221)
% HH Female	0.0430	0.0175	0.0597	0.0988	−0.978*	−0.910
	(0.150)	(0.170)	(0.179)	(0.214)	(0.453)	(0.525)
Household Income	−0.00128	−0.000785	0.00310***	0.00148	0.00231*	−0.000765
	(0.000962)	(0.000978)	(0.000569)	(0.000854)	(0.00105)	(0.00127)
Poor	0.0887	−0.140	−0.654***	−0.694**	0.155	−0.00409
	(0.140)	(0.152)	(0.184)	(0.228)	(0.518)	(0.626)
Rent Control	−0.103**	−0.0419	−0.0168	0.0218	0.786	0.815
	(0.0362)	(0.0392)	(0.0515)	(0.0582)	(0.918)	(0.870)
Number of People in HH	0.384***	0.238***	0.384***	0.330***	0.0398	−0.0759
	(0.0351)	(0.0437)	(0.0477)	(0.0647)	(0.137)	(0.169)
% HH Black	0.820***	0.385**	0.866***	0.304	0.189	0.415
	(0.109)	(0.134)	(0.152)	(0.189)	(0.481)	(0.537)
% HH Native Born	−0.603***	−0.393**	−0.760***	−0.458*	0.0474	−0.102
	(0.127)	(0.151)	(0.162)	(0.202)	(0.459)	(0.517)
% Household 65 Years +	−0.647***	−0.585**	−1.546***	−1.414***	−0.498	−0.627
	(0.172)	(0.197)	(0.249)	(0.271)	(0.465)	(0.495)
% HH Under 18 Years	−1.277***	−0.104	−1.119***	−0.965*	0.220	−0.327
	(0.253)	(0.297)	(0.333)	(0.428)	(0.892)	(0.968)
% HH College Degree	−0.203	−0.288	0.848***	0.145	1.302***	0.183
	(0.145)	(0.179)	(0.167)	(0.205)	(0.359)	(0.441)
Central City	0.588***	0.191	0.724***	0.517**	−0.704	−0.402
	(0.105)	(0.126)	(0.149)	(0.193)	(0.442)	(0.492)
Apartment	−0.0123	−0.0329	0.329	0.130	0.123	−0.0940
	(0.152)	(0.190)	(0.197)	(0.239)	(0.500)	(0.518)
Can walk/bike to grocery	0.733***	0.235	0.995***	0.388	0.930	0.138
	(0.169)	(0.183)	(0.211)	(0.255)	(0.579)	(0.527)
Can access grocery by transit	−0.0660	−0.391*	−0.136	−0.150	−0.190	−0.232
	(0.204)	(0.185)	(0.251)	(0.254)	(0.317)	(0.351)
Bike lanes in neighborhood	0.302*	0.339*	0.161	−0.336	−0.193	0.0776
	(0.118)	(0.134)	(0.147)	(0.174)	(0.426)	(0.455)
Good sidewalks in neighborhood	0.507***	0.238	0.690***	0.0197	0.305	0.000344
	(0.111)	(0.132)	(0.162)	(0.204)	(0.341)	(0.324)
Can walk/bike to retail	0.0831	0.0121	0.0436	−0.321	0.292	0.181
	(0.159)	(0.176)	(0.178)	(0.232)	(0.538)	(0.501)
Can access bank by transit	0.794***	0.422*	0.198	0.0396	0.0611	−0.0441
	(0.208)	(0.185)	(0.254)	(0.263)	(0.318)	(0.352)
Built pre-1920	−0.0763	−0.161	0.215	0.169	0.159	−0.336
	(0.167)	(0.181)	(0.182)	(0.212)	(0.541)	(0.628)
Units in building	0.000475	0.000205	0.00260**	0.000726	0.00153	−0.00115
	(0.000613)	(0.000882)	(0.000907)	(0.000808)	(0.00155)	(0.00153)
Tenure (Owne)	−1.237***	−0.476	−0.325	−0.0652	5.227	5.242
	(0.233)	(0.261)	(0.332)	(0.384)	(5.549)	(5.281)
HH bikes or walks	0.00677	−0.0911	−0.0567	−0.0830	0.0529	−0.00628
	(0.0609)	(0.0696)	(0.0778)	(0.0882)	(0.188)	(0.206)
Station Within 1/2 Mile		−0.396		0.371*		−0.175
		(0.223)		(0.172)		(0.361)
Constant	−3.467***	−0.199	−4.295***	−0.514	−6.366***	−0.247
	(0.231)	(0.343)	(0.300)	(0.420)	(0.788)	(0.997)
N	13,231	2,170	13,231	1,354	13,160	469
Pseudo R-sq	0.265	0.075	0.372	0.158	0.108	0.044

Standard errors in parentheses. "Subway" = subway/light rail/trolley. "Rail" = Commuter rail. "HH" = Household.
Additional controls not shown: dummy variables for location in New York, Boston, Philadelphia, San Francisco, Los Angeles.
For bus, subway, or rail station to be close, must be less than 0.5 miles from unit.
Some models do not include variable measuring distance to nearest general transit stop, due to the way the survey was collected.

Just as we did with our transit regressions, we can predict gas expenditures for households with and without bundled parking. Once again we do this by holding all continuous independent variables at their means, and all dichotomous variables at their modes, and then estimating the marginal effect of bundled parking. The results suggest that a household with unbundled parking will spend $227 on gasoline per month, while the household with bundled parking will spend $274. For illustrative purposes, we can combine these figures with US Department of Energy (nd) data on average private vehicle fuel economy (23.4 miles per gallon) and the average fuel costs in 2013 ($3.49 per gallon (AAA 2013)), to estimate monthly household VMT for each household. These calculations suggest that households with bundled parking drive 328 more miles per month, and 3936 more miles per year, than households without. They also suggest, if we use the Environmental Protection Agency's estimate for carbon emitted per gallon of gasoline of fuel (8,872 g of CO_2), that bundled parking households emit 119,480 more grams of vehicle-related carbon dioxide each month, and over 1.4 million more grams annually

For reasons we have already discussed, all these estimates should be approached with caution. Because we cannot account for driving

Table 7
Predicted Probabilities of Transit Use, Households with and without Bundled and Parking.

Overall Transit Use	*Without Bundled Parking*	0.01568*** (0.0131)
	With Bundled Parking	0.007*** (0.0005)
Frequent Bus Use (no distance variables)	*With Bundled Parking*	0.00182***(0.0041)
	Without Bundled Parking	0.01004*** (0.0020)
Frequent Bus Use (distance variables included)	*With Bundled Parking*	0.2027*** (0.0493)
	Without Bundled Parking	0.2504*** (0.06191)
Frequent Subway Use (no distance variables)	*Without Bundled Parking*	0.0139**(0.0046)
	With Bundled Parking	0.0033** (0.001)
Frequent Subway Use (distance variables included)	*With Bundled Parking*	0.358** (0.1038)
	Without Bundled Parking	0.4981*** (0.1164)

Standard errors in parenthesis.
*** p < 0.001; p** < 0.01; *p < 0.05.

Table 8
Associations with Monthly Household Gas Expenditures, 2013.

Bundled Parking	48.41***
	(7.8644)
People in HH	35.33***
	(1.7394)
Total Cars	30.22***
	(2.3405)
Percent Native-Born	−2.05
	(6.3784)
Household Income	0.39***
	(0.02829)
Rent Control	1.51
	(1.7611)
Percent Black	−3.65
	(5.4789)
Percent College-Educated	−23.08***
	(5.2979)
Percent Women	−27.16***
	(5.684)
Percent Children	−39.38***
	(10.7912)
Poverty Status	−42.81***
	(5.6173)
Percent Older Adult	−96.03***
	(5.1911)
Unit Built Pre-1920	2.84
	(7.239)
Units in Building	−0.05
	(0.0443)
Tenure	−29.45*
	(9.947)
Bike Lanes Present	−0.26
	(5.292)
Well-lit, usable sidewalks	−18.37***
	(3.9847)
Central City Status	−17.92***
	(4.2844)
Can Walk/Bike to Grocery	−24.1***
	(6.7765)
Can Walk/Bike to Retail	6.24
	(7.2412)
Can Access Bank by Transit	−10.34**
	(3.956)
Unit is Apartment	−28.41***
	(5.6521)
N	12,541
Adj. R-Squared	0.24

*** p < 0.001; p** < 0.01; *p < 0.05.
HH = Household.

behavior or (especially) vehicle type, we cannot know that all differences in gas expenditures result from more miles driven. However, our regression probably does control, however indirectly, for many of the determinants of vehicle type. We control for income, race, and nativity, and we have controls for the nearby built environment. In previous work, Kim and Brownstone (2013) suggest that dense areas reduce gasoline consumption in two ways: mostly by influencing the choice of vehicle (in dense areas people buy smaller cars), and secondarily by influencing the amount of driving that people do (because congestion is worse, streets are narrow, and destinations tend to be closer together). Bundled parking is unlikely to influence vehicle size (unless the reserved space is small or tight) but it could plausibly influence the decision to drive, over and above the impact of density. We have reasonable proxies for density in our regressions, so probably at least some of the association with bundled parking that we find reflects the greater convenience of driving when one knows a parking space is waiting at home. Nevertheless, we do not want to overstate our confidence in this coefficient. Most likely the estimate has some bias. We can say that it is consistent with theory and existing evidence suggesting that bundled parking would be associated with more driving.

6. Conclusion

Most American housing units come with one or more parking spaces. In low-density suburban areas where land is inexpensive, most people want to drive, and driving is virtually the only mobility option, this prevalence of bundled parking probably has little influence on travel. In more urban places, however, where land is expensive and other modes are feasible, bundling may well nudge some people to drive more and use transit less. Given that urban governments frequently exhort their residents to do exactly the opposite—to drive less and use transit more—and that bundling in urban areas is often the result of minimum parking requirements, cities, through their parking policies, may be quietly undermining their attempts at sustainability.

In this article we have presented strong evidence that bundled parking is in fact associated with less transit use, and suggestive but sensible evidence that it is associated with more driving. These associations exist even when we control for vehicle ownership, as well as a broad array of built environment and demographic characteristics. Where previous work demonstrated a powerful relationship between bundled parking and the decision to own a car, we show that bundled parking influences the travel behavior of people *with* cars. Specifically, we show that households with bundled parking are less likely to use transit overall, and particularly less likely to use buses or subways and light rail, which are the most common forms of transit in the United States. Our conclusions are strengthened by the absence of an association between bundled parking and commuter rail (which often requires driving to the station) and between bundled parking and walking (which is mostly likely determined by other aspects of the built environment.) We also show that even among households that use transit, households with bundled parking are more likely to drive as part of their transit trip, and less likely to use transit frequently, than households without bundled parking.

We do not explicitly control for self-selection in our models, but the existing literature suggests that, at worst, self-selection controls would only modestly reduce the magnitude of our findings, and might even increase them. At a broad level, our results highlight parking's role as an important intermediary in the relationship between transportation and land use. More specifically, our results call attention, again, to cities' longstanding practice of requiring parking with new housing. If cities are hoping to increase driving and suppress transit riding, these policies are sensible. If cities have other goals, and their rhetoric suggests they do, then parking requirements may well be perverse, and should be removed.

Appendix A

Table A1

Table A1
Summary Data, 2013 AHS; Comparing the public transportation module to the core survey sample.

	All Units	*Units in Module*
Total Number of Units	40,710	14,490
% Rental Units	29%	34%
% Rental Units with Poor Tenants	24%	23%
% Rental Units with Off-Street Parking	48%	47%
% Rental Units with Garage	39%	39%
% Units with Bundled Parking	93%	93%
% Rental Units with Bundled Parking	87%	87%
% Mobile Home	7%	6%
% Single-Family Home	67%	69%
% Apartment	26%	25%
Median Rent	$787	$787
Rate of Car Ownership	81%	82%

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