Distributing Wealth to the Wealthy: A Parking Story

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Abstract

In recent years, attempts to mitigate losses associated with open access inefficiencies have moved away from relying primarily on centralized regulation, towards the assignment of private property rights. While property right assignment has generally been more politically acceptable than limiting access to public resources through higher costs, we suggest that rights assignment creates a significant transfer of wealth. We examine this phenomenon with a simple example, parking. On-street parking has often been cited as being susceptible to the Tragedy of the Commons, leading to increased congestion, accidents, and emissions. Policy makers have often addressed this issue by assigning property rights to public spaces through residential or other permits. While such regulations may improve congestion and productivity, they also reallocate public goods to private individuals, without proper consideration of the associated wealth transfer. This study quantifies the effect of residential parking policies on home sale prices using spatially explicit difference-in-difference and triple difference hedonic price models. We find strong evidence that homes within walking distance of the destination location experience a significant increase in sale price (approximately $31,000).

Keywords

Parking; Wealth distribution; Land-use planning; Transportation policy

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1. Introduction

Recent attempts to mitigate the losses associated with open access externalities in a common pool resource setting have moved away from primary reliance upon centralized regulation, towards the assignment of private property rights (Libecap, 2007). Such solutions are suggested as a way to improve incentives, productivity, and the provision of capital investment (Kim and Mahoney, 2005; Gilmour *et al.,* 2012; Joseph, 2008). While researchers generally agree that open access resources—without proper regulation—will be over-consumed and lead to inefficient outcomes (Hardin, 1968; Maas *et al.,* 2017), the proposed solutions to open access dilemmas are highly divergent (Wade, 1987; Libecap, 2007; Pires and Moreto, 2011). The natural solution to prevent overconsumption is to limit access, but there are many ways to accomplish this goal. Because increasing explicit costs to access public resources is politically unpopular (Citrin, 1979; Harrington *et al.*, 2001)[1], the common mechanisms for limiting access often transfers rights to particular groups or individuals through quotas, permits, or other means. Limiting access in this way—through the assignment of property right—avoids imposing explicit costs on individuals, but may result in large implicit costs for all those who do not receive access.

Economist agree that distributional effects arise whenever there is a change in property rights, such that an unintended consequence of assigning property rights with the intention of solving open access market failures is the transfer of wealth from one group to another (Libecap, 1989; Matulich *et al.* 1996). The redistributive properties of such polices are particularly acerbic when the transfer is seen as benefiting a relatively wealthy group at the expense of a relatively disadvantaged group. The purpose of this paper is to offer insight into the distribution of wealth that occurs during such property rights transfers through an empirical example, parking. Specifically, we investigate how a city's decision to reassign public parking spaces to private residences near a destination location disproportionately increases the value of nearby homes. To the extent that homes near destination locations are owned by wealthy individuals, such policies are likely regressive.

[1] This phenomenon is easily observed in the current backlash over recent increases to entrance fees of National Parks (Clarke 2017)

While parking regulations may be thought of as a minor contributor to overall wealth consolidation trends (see Saez and Zucman, 2016), our results show a significant value transfer and are instructive for policy makers and researchers interested in how basic land-use planning decisions may affect wealth and welfare. This research is particularly timely given the recent trends of privatizing infrastructure and private spaces (WBUR 2017). Parking is an important example of this trend since spaces in highly urbanized areas sell for tens of thousands of dollars, cruising for parking spaces results in increased accidents, higher levels of pollution, and considerable wasted productivity (Shoup, 2006; Chatman and Manville, 2014; Inci 2015; Inci, Ommeren, and Kobus 2017). As such, parking regulations are a serious driver of welfare and wealth that deserves scientific inquiry.

Research into the economics of parking has covered a wide range of topics, including, "cruising for parking" (Shoup, 2006; Arnott and Inci, 2006), spatial competition (Arnott *et al.,* 1991; Arnott 2006), minimum and maximum parking requirements, on-street and garage parking price elasticities (Kobus *et al.,* 2013), and congestion pricing (Lindsney and Verhoef, 2001; Arnott and Inci, 2006). A common theme among past analyses is that on-street parking suffers from the Tragedy of the Commons because it is provided too cheaply (Epstein, 2002; Glazer, 2013).

Traditionally, this market failure has been corrected by assigning property rights to these public spaces, either in the form of metered parking (which we think of as renting) or through permits which entitle certain individuals to park in certain locations (which we can think of as a permanent transfer). Reducing parking congestion through increased metering costs may improve efficiency—since only individuals with the highest willingness-to-pay will attempt to park in expensively metered locations—but this solution requires increasing explicit costs for transportation or parking (via tolls and meters), which is politically unpopular (Marsden, 2006; Russo, 2013). In reality, local governments' often use the second option, addressing parking shortages by discriminating between residents and non-residents, and assigning rights to parking based on this determination (van Ommeren *et al.*, 2011). Such property assignment policies may be politically acceptable, as they do not explicitly increase costs, but in many cases they may be more regressive than their fee-based counterparts, since they reallocate public goods (which have real value) to private individuals, often without proper distributional considerations.

There is no doubt that restricting on-street parking access in destination locations through permitting may improve congestion (among other benefits). However, we suggest that special attention must be paid to the distribution of wealth associated with such policies and suggest that these policies may be regressive when wealthier individuals live closer to destinations of interest (parks, downtown, college campuses, etc.). This issue is of particular relevance, given the recent trends of “urbanizing money,” in which affluent, educated individuals are returning to urban centers (Couture and Handburry, 2016; Kolko, 2016). To our knowledge, no study has quantified the distribution of wealth associated with the introduction of such parking regulations, and only a few studies have investigated the capitalization of parking rights into home values for any reason (van Ommeren *et al*., 2011).

This paper quantifies the value of capitalized parking rights into home values associated with transferring public parking rights around a destination location (Colorado State University) using spatially explicit difference-in-difference and triple difference hedonic price models. In addition to the two primary models used, we conduct a host of robustness and ancillary tests to ensure the proper effect is being identified. By analyzing home values before and after residential parking regulations were implemented in neighborhoods close to a destination location, we can identify the wealth distribution effects of such policies. If we also assume that the value of total housing stock is constant in the area, this value changes are necessarily a redistribution of wealth from one group to another.

This paper is broken into 5 sections. Section 2 describes the institutional setting of our analysis, Section 3 presents the data and methodology, Section 4 presents our results, and Section 5 concludes the a discussion about limitations and needs for further research.

2. Institutional Setting

While understanding the wealth implications for changes in property rights is broadly important, we use the specific case of Fort Collins, Colorado and its high parking demand destination location, Colorado State University (CSU). After decades of high population growth, the City of Fort Collins began to roll out neighborhood parking permits in November of 2013. By the middle of 2016, the majority of neighborhoods near CSU had permit parking in place, which restrict street parking to two hours once daily for all drivers except residents to the neighborhood. CSU has roughly 33,200 students and 6,000 employees, which makes it the largest single destination for daily commuters in the Fort Collins area. Thus, parking in and around the university became a major problem for individuals looking for parking and for homeowners dealing with increased congestion caused by increased "cruising". This problem is not unique to CSU; in fact, universities have a long history of parking and transportation problems (Shoup, 2008). Like other universities, parking spaces around CSU were a valuable commodity, which were historically overcrowded with drivers "cruising for parking" in excess of 15 minutes.[2] The new parking regulation led to a steep decline in the number of cars around campus, and available spots grew to outnumber the drivers looking for them. While this policy may benefit residents, the ability of individuals to commute and park in public spaces was severely limited.[3]

Concurrent to the introduction of parking permits by the city, CSU expanded its own parking facilities and the number of permits and metered spots open to students and staff. Unlike the public parking, permits from the university cost upwards of $536 per year. Thus, students and employees of CSU who traditionally used public street parking, were forced to buy costly permits, walk greater distance, or use public transit. Not surprisingly CSU's revenue from parking services increased from $3.28 million in 2013 to $4.97 million in 2017. Because some of this difference can be attributed to increased enrollment at the university, a better metric may be dollar of parking revenue per student, which also increased from $104 to $148 during this time.

While increased traffic congestion and limited parking is often cited as a problem (Shoup, 2006), there are no empirical estimates of the total net costs of cruising or other externalities. Moreover, there are economic indirect benefits which are created from free parking. Hasker and Inci suggest that other than money and credit cards, parking is probably the most important intermediate good in the modern economy (2014). Shopping malls have capitalized on this phenomenon for decades and often feature large swaths of paved free parking (Urban Land Institute, 1999). While the negative externalities associated with on-street parking have been identified here and elsewhere, research weighing the total value of on-street parking, including both negative and positive, and direct and indirect benefits, is limited. Thus, the default solution, to fix over-crowded parking areas

[2] This estimate was the most common response given during informal and anecdotal conversations.
[3] Although, the city has acknowledged a small ring effect, in which some commuters simply park further away and walk longer distances.

by increasing price or limiting access, may also be inefficient. While quantifying the total economic effect of parking policies is near impossible due to data limitations and identification issues, Fort Collins provides a natural experiment in which on-street parking rights are "curbed" for some hosueholds and given to others. We find strong evidence that residential parking permits near destination locations are capitalized in home values, such that these homes experience a significant value increase compared to comparable homes in the area. The methods of this analysis are presented in the next section.

3. Data and Methodology

While economic externalities around parking have become a popular topic in urban and transportation economics, few studies have quantified the relative wealth transfers associated with increased resident-based permit parking regulations. The lack of research papers in this area may reflect the difficulty in creating the proper identification strategy, and while such limitations are problematic, our use of difference models controls for many of the potential confounding factors which may bias the analysis. We also conform to past literature and use a hedonic price model which allows for spatial correlation in sale price and error (Anselin, 2013; Irwin *et al.*, 2014). While fixed-effects models have also been used to control for spatial aspects of hedonic price models (van Ommeren *et al.*, 2011), there is little theoretical impetus for determining the areas which constitute the "fixed effect." Accordingly, we suggest that modeling spatial correlation directly is more defensible and captures similar spatial effects as fixed-effects models.

This paper uses hedonic difference-in-difference (DID) and difference-in-difference-in-differences approaches (DDD) to estimate the additional value added to homes that are within walking distance of campus, many of which received parking permits, before and after the introduction of residential parking restrictions. A DID approach[4] allows us to isolate the effect of parking policy while accounting for differences across housing groups before and after the policy was introduced and has a history of successful application to spatially-explicit hedonic models (Diao *et al.*, 2017). While the DID model controls for many confounding factors, it may be insufficient in controlling for certain macro-level conditions. Similar to the example Woolridge

[4] See Cameron and Trivedi 2005 for a discussion of this methodology

(1992) provides about healthcare, forces outside the specific parking policy may affect the value of living closer to a destination location relative to living farther away. Thus, a triple-difference model is included to control for any changes which may affect the value of living close to destination locations in Northern Colorado. In particular, this control may be necessary because of the increased congestion in the region due to sharp population growth, which may have additional implications for the value of walking or driving to destination locations regardless of parking policy.

We use walking distance as the variable of interest over specific permit assignment for three reasons. First, the city does not provide house-specific permit purchasing data due to privacy concerns. Second, many residences near the university have driveways such that access to permits has little or no value for many of these households. Third, logic dictates that the introduction of residential parking permits *excludes* individuals who live outside the permit zone from using the resource more than it *includes* individuals within the permit zone, since they were generally not the individuals using these parking resource in the first place. In other words, when parking regulations were implemented, individuals living within walking distance to CSU *did not* gain the ability to drive to CSU—they already walked—but individuals who live farther away *did* lose the ability to drive and park.

Our empirical approach is to use hedonic valuation to quantify the relative gains associated with assigning on-street parking rights to houses near the destination location. Hedonic valuation decomposes the value of a good (a house in this case) into its comprising attributes, and enables researchers to assign monetary value to each attribute as determined by the sale price. This method assumes that goods are heterogeneous in there attribute make-up and that buyers and sellers consider the total price of a good as a summation of the values of all attributes (Morancho, 2003). While this assumption may not hold for all goods, there is a long history of its successful application to housing markets (Smith and Huang, 1995; Brander and Koetse, 2011; Nelson, 2004).

We compare home sale prices before permits were introduced (January, 2013 to November 2013) to home sale prices after permits were in place (January, 2016 to August, 2017), using both DID and DDD models. Sale price information and household attributes used in this study were provided by the Larimer and Weld County Assessors' offices. In the DID model, one binary variable indicates before or after parking restrictions, the second binary variable indicates whether the home is within walking distance (fewer than 0.5 miles), and the DID estimator is the interaction term of both. The DDD model adds an additional binary variable—and corresponding interaction terms—indicating if the sale occurred in Fort Collins, the city with the change in parking regulations. Greeley, Colorado was used as the comparison city for the DDD model because it is within 30 miles of Fort Collins, experienced similar state-level macro conditions, and is home to the University of Northern Colorado (UNC), such that the walking distance variable can be created and evaluated for each city.

While there is little consensus on what constitutes a walking distance, we use 0.5 miles as the upper bound, since research generally suggests a walking distance is defined as between 0.25 and 0.62 miles (Buehler *et al*., 2011; Yang and Diez-Roux 2012). As a robustness check, ancillary regressions were run with different thresholds constituting walking distance; qualitative results are robust to reasonable specifications. We also limit home sale observations to those that occurred within the Fort Collins Utilities service area as to eliminate any confounding price effects caused by utilities service provision and pricing. For the years in our study, we observe 2,710 single family home sales at a mean price of approximately $312,000 in Fort Collins. In Greeley we observe 3,821 single family home sales with an average price $250,000. Summary statistics for all homes sold are reported in Table 1.[5]

Table 1. Summary Statistics of Homes Sold

Control variables included in our model are consistent with previous hedonic valuation research and include: number of bedrooms, number of bathrooms, age of the home, size of home, size of lot, and if the sale occurred in the summer season (Sander and Polasky, 2009; Sirmans *et al.,* 2005). Some of these terms were also included as squared term to add flexibility. Beyond individual characteristics, home prices also depend on other sales in the area, which the model estimates through spatial correlation terms.

[5] Note that home sale data was cleaned based on a number of logical rules. Homes were omitted from the sample if,

1) The difference between assessed value and sale price was greater than $100,000
2) Sale price was greater than $800,000
3) Complete information was not provided for the home

Given the spatial nature of our data there is a strong likelihood that the observations are not independent from one another. This spatial dependency may arise from a variety of causes, including political boundaries that split or aggregate areas without regard to economic explanatory variables, as well as more fundamental problems including knowledge and social spillovers between even carefully constructed economically functional geographic areas (Watson and Deller, 2017). Because home sales are likely to suffer from high levels of spatial correlation (Basu and Thibodeau, 1998), we use an inverse distance weighting matrix to adjust for correlations in sale prices and errors across observations. Depending on the specific nature of the problem, spatial dependency may not only render OLS standard errors inefficient, but may also introduce omitted variable bias if the explicit nature of the spatial dependency is not accounted for. To address this concern, we employ a spatial autoregressive combined model which incorporates both spatial lag (Wy) and spatial error ($W\epsilon$) dependence corrections.[6,7]

Thus, the DID model for a given household is specified as:

$$y_i = \beta_0 + \beta_1 wd_i + \beta_2 pp_i + \beta_3 (wd_i * pp_i) + \sum_{h=1}^{8} \delta_{hi} X_{hi} + \gamma W y_i + (I - \rho W)^{-1} \epsilon_i \quad (1)$$

Where *y* represents sale price, *wd* is a dummy variable for walking distance, *pp* is a dummy variable indicating if the home sale was before or after parking regulations, X_h represents eight household characteristics, W is a spatially weighted matrix, and the last term represents autoregressive error. $\beta's$, $\delta's$, ρ, and γ are parameters to be estimated. β_3 represents the primary DID coefficient of interest for this study.

It is important to note that, unlike the standard DID estimator, which can be thought of as a pure treatment effect, the above DID estimator may be an aggregate of multiple effects. First, home values within walking distance of campus may increase due to less traffic and greater parking availability. Second, and more importantly, homes away from campus may decrease in value since occupants of those properties have ostensibly lost their ability to drive to campus without buying

[6] Strong spatial dependence is present as tested by a Moran's I test (χ^2=10,667 ; p-value=0.000)
[7] Note, there is a current an active debate over the inclusion of both the dependent and error terms in regression estimation. In recognition of this debate, we include an additional model that only accounts for spatially correlated error in supplemental material (Table S1.1).

expensive permits. Thus, the introduction of permits may decrease the value of faraway homes and increase the value on walking distance homes. While we can't separate these effects, we can evaluate the relative price increase across homes in Fort Collins and gain some additional insight by including Greeley in the triple difference model. However, explicitly isolating these effects is not necessary for the primary purpose of our research, which is to empirically estimate the relative wealth change experienced by households due to the privatization of public parking.

This complication, as well as potential state-level policies and economics that influence the value of living close to campus regardless of parking permits, necessitate the use of a DDD model. For example, gas prices or increased traffic congestion may increase the value of walking distance homes even without parking policy shifts. As such, Greeley is used to control for any changes in value created by changing macro conditions. When parameterizing the DDD model we assume that spatial correlation in independent variables and error exists within a city, but not across cities. As such the spatially explicit DDD model is written as:

$$y_i = \beta_0 + \beta_1 wd_i + \beta_2 pp_i + \beta_3 fc_i + \beta_4 (wd_i * pp_i) + \beta_5 (wd_i * fc_i) + \beta_6 (fc_i * pp_i) + \beta_7 (wd_i * pp_i * fc_i) + \sum_{h=1}^{8} \delta_{hi} X_{hi} + \gamma W y_i + (I - \rho W)^{-1} \epsilon_i \quad (2)$$

Where each variable is the same as above and fc is included as a dummy variable for city location. Elements populating the spatial weighting matrix, $w_{i,j} = 0$ when $c_i \neq fc_j$.

To determine the value change experienced by homes within walking distance of campus experienced as a result of parking policy, the DID approach estimates the effect as:

$$\beta_{DID} = [Y_{WD=1,PP=1} - Y_{WD=1,PP=0}] - [Y_{WD=0,PP=1} - Y_{WD=0,PP=1}] \quad (3)$$

Similar in nature, the DDD model also controls for exogenous, macro-level changes that may bias the results of the DID model. To determine the same value, the DDD approach estimates the effect as:

$$\beta_{DDD} = \left[\left[Y_{WD=1,PP=1,FC=1} - Y_{WD=1,PP=0,FC=1}\right] - \left[Y_{WD=0,PP=1,FC=1} - Y_{WD=0,PP=0,FC=1}\right]\right] - \left[\left[Y_{WD=1,PP=1,FC=0} - Y_{WD=1,PP=0,FC=0}\right] - \left[Y_{WD=0,PP=1,FC=0} - Y_{WD=0,PP=0,FC=0}\right]\right] \quad (4)$$

The results of these estimates are reported in the next section.

4. Results

Results are reported for the DID model (Table 2) and the DDD model (Table 3), which are largely in line with expectations and consistent across models. Results reported in Column 1 of Tables 2 and 3 present the direct effects of covariates, which estimate the mean of the direct impacts of independent variables on the reduced-form mean of the dependent variable (standard coefficient estimates from this model are presented in Column 2). Direct effects are reported in an effort to highlight the specific effect of the treatment on a home, as opposed to the total effect, which includes the effect of the treatment on other homes. A standard OLS model was also included in Column 3 of both tables as a robustness check. Results presented in this section will focus on the results from Column 1 of both tables, which represent the most relevant information to the question at hand: "To what extent is the privatization of public, on-street parking rights a redistribution of wealth through increased home values?"

As expected, even without parking restrictions, homes within walking distance of CSU, conditional on other home attributes, are more valuable than homes outside this distance. In Fort Collins (the city of interest) the pre-regulation walking-distance premium is estimated at $39,746 in the DID model, and $28,288 in the DDD model. This higher value likely stems from the increased commuter convenience and ability to rent these properties as investments. The price differential is muted if we compare unconditional mean sale price, since many of the farther away homes are considerably larger, with more bedrooms and bathrooms.

Table 2. Regression Results

Table 3. DDD Regression Results

Comparing the pre- and post- parking regulation home sales in the Fort Collins area, we observe an average price increase of $74,554 (or $74,908 in the DDD model) from 2012-13 to 2016-17, for homes outside the designated walking distance to CSU. This large increase in value is not surprising, since home values along the Front Range of Colorado (where Fort Collins and Greeley are located) were cited as some of the fastest growing in the nation. Indeed, this sharp growth is partially what necessitates the use of difference models, since they allow us to separately identify the value of the walking distance attribute (before and after parking permits) independent of the overall housing trend. To estimate the wealth transfer due to parking-restrictions, we compare this overall trend to the specific price increase experienced by homes within walking distance of the destination location.

We find that the sale prices of homes within walking distance of the destination location increase at a significantly faster rate than their farther away counterparts. This phenomenon is identified through the coefficient on the difference-in-difference term in the DID model and the triple difference interaction term on the DDD model; both are positive and significant. Homes within walking distance of CSU increased at an additional average rate of between $31,057 (DID model) and $31,816 (DDD model) after parking regulations were implemented. It is worth noting that the coefficient on *Post-Permit* Walking Distance* in the DDD model shows no price premium for homes, suggesting that the control city did not see the same increase in home sales near campus. Since the control did not experience parking permits, this result strengthens the hypothesis that home price increases observed for walking distance homes in Fort Collins are a direct effect of parking policy.

While the overall results are compelling, it is possible that unobserved factors are also driving the home values changes around CSU that do not exist at UNC. In this case, UNC would not be a good control to difference out the possible confounding factors. As such we hypothesize two other factors (beyond parking) that may affect homes values specifically around CSU. First, we posit that gentrification in the area could have begun such that the homes sold in the area have been more recently remodeled or redeveloped, compared to other homes in Fort Collins. We test for this possibility by observing the frequency of remodels in Fort Collins from 2012 through 2017. If we examine homes built before 1970 (homes near the area of interest were almost exclusively built before 1970), we find no significant evidence that homes near campus have been remodeled more frequently than homes elsewhere ($\chi^2 = 1.56$). The other possible explanation for home value increases specifically near our destination location is student enrollment, which increased faster in the location of interest than in the control city. To evaluate this possibility, we run an additional DID model using years before permitted parking began (2008-2012), and find no significant impacts of the difference interaction term ($\beta = 9489, p = .25$). The university experience higher student enrollment growth in these years, but the value of homes near campus did not increase significantly more than farther away homes, suggesting that it is parking policy—not student enrollment—that is driving the trend. An additional DDD regression model was also estimated to ensure robustness across cities; both these models are explained and estimated in supplemental material, but excluded from the main text for brevity.

In totality, our results support the underlying proposition that assigning residential parking rights to residents via permits in destination areas constitutes, at best, a consolidation of benefits to a select group, and at worst, a regressive form of taxation. While we confidently conclude that assigning parking permits significantly increases home values, determining the regressive or progressive nature of this redistribution is context specific. Assuming the total value of housing does not increase (the pie does not change size) with new parking policies, these policies necessarily create a redistribution wealth. In destination locations where wealthier individuals reside or own property (in the case of rentals where we expect parking benefits to be capitalized in rent), reassigning parking rights is likely to be regressive. While this redistribution is not a forgone conclusion, the increasing urbanization of money suggests that policy makers should be wary of land-use changes that simply reassign rights from one group to another.

5. Discussion and Conclusions

Parking policies have received considerable attention in transportation and urban economics literature, with particular focus on the negative externalities associated with "cruising for parking" and other open access issues (Arnott and Inci, 2006). Many of these papers implicitly advocate for restricting access or increasing costs for utilizing on-street parking. While such suggestions are clearly in-line with positive economics, they focus almost entirely on efficiency, without attention to the indirect and distributional effects of such policies. In reality, there may be significant distributional impacts from picking one form of limiting access over the other. While restricting on-street parking access through permits may increase efficiency, by decreasing cruising and the associated congestion and pollution, we find strong evidence that such policies capitalize the parking permit into home values, which substantially benefit individuals who live in the area. When wealthier individuals live closer to destinations of interest (parks, downtown, college campuses, etc.), residential parking permits may be a regressive policy, benefiting the affluent disproportionately. In fact, there is a historic record of such phenomenon; zoning for parking was first employed in the United States to address the high parking requirements of affluent neighborhoods in high density areas (Ferguson 2004).

Residential permits shift parking rights from one group to another. Given that wealthier individuals have greater means to influence local policies (such as instituting residential parking permits as is the case in Fort Collins) policies which assign rights in this way may not reflect the normative values of municipal citizens. In the case of increased costs (through long-term metering for example), the allocation of parking spaces may still go to those with a higher willingness- and ability- to-pay, but with a significant caveat. If parking space utilization is decreased through increased costs, the underlying rights would not be transferred, and the potential additional revenue to the city may be reallocated consistent with the city's normative views on wealth distribution. Such a program was instituted in Beijing, where policy makers charged "market prices" for parking and used the proceeds to improve public sanitation and security services (Shoup *et al.,* 2016). In the extreme case, the additional revenues could be given directly back to the same residents who would have received permits—indeed, such a system would be similar to that created by instituting residential parking permits in the first place.

The primary goal of this work is to identify and estimate a subtle way in which a land-use policy influences wealth distribution, of which planners may not be aware during the creation of such policy. We acknowledge that the values of curb-rights are highly variable across cities such that the point estimate presented here should not be transferred beyond comparable communities. However, the underlying motivation for this research is applicable to urban planners everywhere. City planners must pay special attention to the indirect and distributional implications of land-use policies meant to improve life for their citizens. This fact may be particularly true when assigning access rights to public amenities. The solutions posed by previous work (Shoup, 2006; Inci, 2015; Glazer and Niskanen, 1992) to increase parking costs implicitly acknowledges that planners can price individuals with lower willingness or ability to pay out of the market. At first glance, policies that increase parking costs appear regressive and may be difficult to sell politically. However, our results suggest that instituting residential permits, a policy with higher political acceptability, could easily be more regressive than policies that increase costs. By reassigning public property rights to private citizens—the most typical policy—the planner may be unintentionally redistributing significant amounts of wealth. As such, results of this paper do not contradict the findings of past work, but they do suggest that limiting open access to parking through residential permitting may exacerbate inequalities within a city.

There is a considerable need for additional research to better understand the effect of parking policy—and land-use policy more generally—on wealth and welfare. For instance, introducing residential parking permits will likely create economic inefficiencies, particularly when these permits are assigned after individuals make home purchasing decisions. Individuals with different willingness-to-pay values for the ability to park or walk to given destinations is not considered when instituting such parking restrictions. In the long run, we may expect parking rights and walking distances to be capitalized in the value of the home, but such value shifts occur after many individuals have already purchased their homes. Introducing residential parking regulations in destination areas may also lead to an under-utilization of the resource such that many parking spaces remain empty, further reducing efficiency. [8] Lastly, we suggest that similar analysis be conducted in heterogeneous locations to create a robust understanding of the relationship between the privatization of public parking rights and wealth.

[8] Although it is not explored in this paper, the under-utilization of parking created by permitting has likely led to significant deadweight loss since many spots that were traditionally full, now sit empty.

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Supplemental Material

S1.1 spatially correlated error only

Table S1.1 Spatially Dependent Error Regression

S1.2 Additional Triple Difference Model

While Greeley is the closest comparable city, using it as the triple difference control has two drawbacks. First, the assessor's office for that city does not include a "quality" indicator for homes in the area. Quality is an obvious indicator of value such that our estimates using the triple difference model reported in the body of the paper may suffer from some amount of omitted variable bias. The second complication results in the nature of each city and destination area. The student body at CSU (the destination area of interest which experienced parking restrictions) grew at a slightly faster rate than the destination area in Greeley (UNC). Moreover, it is possible that despite similar locations and characteristics, Greeley is an insufficient control for some unobservable reasons. To add additional robustness to our findings, we include a second triple difference model which uses only the city of interest, but includes years prior to the parking permit introduction.

As such the second spatially explicit DDD model is written as:

$$y_i = \beta_0 + \beta_1 wd_i + \beta_2 pp_i + \beta_3 tc_i + \beta_4(wd_i * pp_i) + \beta_5(wd_i * tc_i) + \beta_6(tc_i * pp_i) + \beta_7(wd_i * pp_i * tc_i) + \sum_{h=1}^{11} \delta_{hi} X_{hi} + \gamma W y_i + (I - \rho W)^{-1} \epsilon_i$$

Where each variable is the same as above and tc is included as a dummy variable for time consistent with the parking regulations. Like the previous model, pp_i equal 1 for the years 2016 and 2017 and 0 for 2013, to reflect the timing of parking permits. However, pp_i also equals 1 for years 2011 and 2012 and 0 for 2008. While parking permits did not exist in 2011 and 2012, the goal of this secondary regression is to control for other local characteristics that may affect values near the destination location. Table S1 (Column 1) displays our results, which are quantitatively similar for the coefficient of interest ($25,156), the triple difference interaction term.

Table S1.2 Triple Difference Regression (Time Control)

Table 1. Summary Statistics of Homes Sold

		Fort Collins, CO		
n=2,710	Mean	Std. Dev.	Min.	Max
Sale Price	312,494	99,269	100,000	975,000
# Bathrooms	2.332	0.851	1	8
# Bedrooms	3.444	0.859	1	7
Age of Home	37.31	20.05	1	135
Size of Home (sq-f)	1,640	508.0	480	4,692
Area (acre)	0.263	0.241	0.0483	4.842
		Greeley, CO		
n=3,819	Mean	Std. Dev.	Min.	Max
Sale Price	250,267	97,451	100,000	775,000
# Bathrooms	2.54	0.872	1	6
# Bedrooms	3.591	0.910	1	7
Age of Home	32.93	27.69	1	146
Size of Home (sq-f)	1,535	532.6	496	5129
Area (acre)	0.207	0.163	0.0372	3.430

Table 2. Difference in Difference Regression Results

VARIABLES	(1) (dy/dx) Direct effect	(2) Spatial Corr. Sale Price	(3) OLS Sale Price
Walking Distance	39,746***	39,698***	60,660***
	(7,694)	(7,689)	(8,171)
Post-Permit	74,554***	74,463***	73,948***
	(2,364)	(2,358)	(2,603)
Walking Distance * Post-Permit (DID)	31,057***	31,019***	28,111***
	(9,390)	(9,379)	(10,489)
# Bathrooms	16,913***	16,893***	18,036***
	(2,033)	(2,033)	(2,213)
# Bedrooms	6,608***	6,600***	7,428***
	(1,625)	(1,624)	(1,789)
Age	-2,032***	-2,030***	-2,176***
	(199.5)	(199.5)	(187.2)
Age^2	12.51***	12.49***	19.28***
	(1.74)	(1.742)	(1.673)
House Size (sq-f)	-10.50***	-10.49	-28.51**
	(10.84)	(10.82)	(11.85)
House $Size^2$ (sq-f)	0.025***	0.0250***	0.0313***
	(0.00274)	(0.00274)	(0.00300)
Summer Season	17,205***	17,185***	16,292***
	(2,245.485)	(2,242)	(2,500)
Area (acres)	52,622***	52,559***	36,016***
	(5,050)	(5,031)	(5,399)
Constant	-	82,439***	181,842***
	-	(14,824)	(12,281)
Price corr.		1.204***	
		(0.0794)	
Error corr.		1.006***	
		(0.00339)	
R^2			0.59
Observations		2,710	2,710

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3. DDD Regression Results

VARIABLES	(1) (dy/dx) Direct effect	(2) Spatial Corr. Sale Price	(3) OLS Sale Price
Walking Distance	28,288***	28,266***	4,545
	(7683.7)	(7,676)	(6,434)
Post-Permit	65,744***	65,694***	60,465***
	(2093.1)	(2,091)	(2,474)
Fort Collins	37,381***	37,352***	64,250***
	(4,106.4)	(4,109)	(2,917)
Fort Collins* Walking Distance	-7,064	-7,058	69,004***
	(11,172)	(11,163)	(10,024)
Post-Permit * Walking Distance	-2,034	-2,033	7,424
	(6098.5)	(6,094)	(7,341)
Fort Collins* Post-Permit	9,164***	9,157***	15,482***
	(2964.578)	(2,962)	(3,507)
Fort Collins* Post-Permit * Walking Distance (DDD)	31,816***	31,792***	23,702*
	(10400.82)	(10,393)	(12,546)
# Bathrooms	13,873***	13,863***	18,321***
	(1234.9)	(1,234)	(1,403)
# Bedrooms	6,091***	6,086***	5,036***
	(897.24)	(896.5)	(1,052)
Age	-1,676***	-1,674***	-2,342***
	(139.39)	(139.5)	(94.87)
Age^2	7.15***	7.146***	15.51***
	(1.13)	(1.132)	(0.854)
House Size (sq-f)	7.75	7.743	20.14***
	(6.07)	(6.074)	(6.814)
House $Size^2$ (sq-f)	0.0154***	0.0154***	0.0150***
	(0.001)	(0.00148)	(0.00168)
Summer Season	15776***	15,764***	17,939***
	(1298.7)	(1,298)	(1,560)
Area (acres)	64210***	64,161***	63,682***
	(3660)	(3,659)	(4,190)
Constant	-	-23,405	96,308***
	-	(16,485)	(7,375)
Price corr.		0.538***	
		(0.0550)	
Error corr.		2.980***	
		(0.0178)	
R^2			0.64
Observations		6,529	6,529

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1