Where is the Opportunity in Opportunity Zones?*

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Abstract

In December 2017, the U.S. Congress passed into law the Opportunity Zone (OZ) program. As an opportunity zone, designated low-income census tracts provide considerable tax benefits to investors who are willing to renovate / redevelop their properties in the OZ. Intended to spur economic growth, a success of the OZ program should result in higher property values, even for properties without redevelopments / renovations. In this study, we compare property prices in designated and eligible (but not designated) OZ census tracts in a difference-in-differences framework. We find that OZ designation did not impact properties prices in general but resulted in a 10% – 20% price increase for properties with high redevelopment / renovation requirements and vacant land. These findings suggest that tax benefits are priced in but investor anticipate limited future economic growth of OZ census tracts.

Keywords: Opportunity Zones, Real Estate, Tax Policy
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1. Introduction

In December 2017, the United States Congress passed the *Tax Cuts and Jobs Act of 2017*, including numerous widely publicized provisions to reduce corporate tax rates and modify income tax brackets for individuals. Many criticized the reform for increasing income inequality and deepening the US budget deficit.[1] However, at its heart comes a measure with unambiguous potential to stimulate low-income neighborhoods: Opportunity Zones (OZ). Meant as a development tool, the OZ program intends to spur local economic growth and job creation in distressed communities by offering location-based (census tract) tax breaks and deferrals to investors in commercial real estate.

Following a selection process with strict eligibility requirements, such as poverty rates above 20 percent and median family income below 80 percent of the metro or state average, approximately 8,800 census tracts across the US were officially designated as OZs between April and July 2018.[2] To qualify for the tax incentive, investors must acquire properties in OZ designated census tracts. Acquired properties must further undergo a capital improvement at least equal to the initial acquisition expense within 30 months of purchase. Therefore, the OZ program specifically targets economically obsolete, heavily depreciated properties, as well as development sides (vacant land).

In this paper, we analyze investors' response to the OZ program, examining the effect on commercial property markets and providing an early indication of its success. Due to the design of the OZ program, it ultimately targets commercial property investors. The program intends to spur positive economic spillover effects, such as job growth and land price appreciation, through commercial investments. Assuming that real estate markets are efficient, we use the heterogeneity in eligible properties to analyze if future expected spillover effects

[1] Retrieved Spring 2019: `https://wapo.st/2XG5DWl`.

[2] A US census tract covers a population of 1,200 to 8,000 people with an optimal size of 4,000. The spatial size varies based on density.

are priced today (Smith, 2009). Properties with development potential should increase in value as they allow for tax benefits. In contrast, properties with little improvement potential should only show price effects due to anticipated economic spillover effects (Lin et al., 2009).

To our knowledge, there are two studies examining the effects of OZ designation on property prices, focusing on housing and reaching different conclusions. Whereas a study by Zillow finds two-digit, positive price effect using a moving average of house prices in all OZs (Casey, 2019), a study by Chen et al. (2019) finds negligible price effects using repeat sales-indices at census tract and zip code level. In addition, Arefeva et al. (2020) find positive employment effects for OZs in metropolitan areas. Out study adds to the literature by focusing on the mechanisms to these economic outcomes, the response of commercial investors. Given the recency of the designation, we argue it is important to focus on commercial investments first and economic outcomes in due time.

We use a difference-in-differences (DiD) setup and individual property transactions, analyzing prices and market liquidity in eligible and designated OZs before and after designation. For better comparability we use propensity score matching (PSM) on income and poverty to select only the nearest eligible census tracts. We focus on commercial real estate transactions of existing properties and development sites (vacant land). We disentangle tax and anticipated economic effect by grouping properties based on requirements for heavy capital expenditures. The latter is proxied by effective property age (Bokhari and Geltner, 2018)

We find no general property price effect after OZ designation. However, redevelopment properties, old & depreciated properties likely to be redeveloped, increase by 7 – 20 percent in price compared to similar properties in eligible census tracts, on average. Vacant land increases by up to 40 percent in price compared to vacant land in eligible census tracts fulfilling the OZ criteria. For both existing properties (young and old) and vacant land we find initial drops in liquidity. However, afterwards liquidity restores or slightly increases. Our results suggest mixed evidence for the success of the OZ program. We find no general positive price effect, but an effect limited to properties benefiting directly from OZ tax benefits. This indicates that investors expect limited to no positive spillover effects, such as from land value appreciation. However, we further find that more vacant land is sold, which might lead to more developments in the future.

To our knowledge, this is among the first academic paper estimating the property price and liquidity effects of the OZ program. We are also among the first to show how place-based tax incentives translate into commercial real estate property prices, giving insights into the investor's believes. Prior research on similar place-based tax incentives has primarily discussed second-order effects on socioeconomic indicators and residential housing prices growth rather than on changes in commercial real estate values (see Section 2.1).

2. Background and Theory

2.1. The history of location-based tax incentives

Bernstein and Hassett (2015) first proposed the framework for the OZ program, since previous state and federal location-based tax incentives yielded mixed results. Prior and existing programs, such as *enterprise zones* (EZ), *Empowerment Zone / Enterprise Community* (EZ/EC) program and the federal *New Markets Tax Credit* (NMTC) program, have suffered from complex tax regulations and shallow subsidy levels, failing to sufficiently spur investments and employment in distressed communities. The state-level EZ and federal-level EZ/EC programs are the most relevant predecessors to the OZ program. While the exact form and magnitude of EZs incentives differ from state to state, they all include some combination of wage tax credits for employees, capital investment tax credits (ITCs), property tax credits, and sales tax exemptions within a specific designated geographic region.

Even though 75% of all states across the U.S. established some EZ program by 1990 (Peters and Fisher, 2002), their incentives were significantly smaller than those of the OZ program. Peters and Fisher (2004) note that the principal benefit of EZs, the wage tax credit, was often too small to matter, as a firm's wage expense is about 11 times the size of its tax expenses. Hebert et al. (2001) show that 65% of all businesses in EZs report no noticeable benefits associated with being located in an EZ. Studies on socioeconomic measures, such as employment, wages, and business starts, show mixed effects. Some find significant positive effects (see Busso et al., 2013; Hanson and Rohlin, 2011; Papke, 1993, 1994; Greenbaum and Engberg, 2004), whereas others show limited to no effects (see Elvery, 2009; Neumark and Kolko, 2010; Engberg and Greenbaum, 1999). Boarnet (2001) argue that findings diverge due to methodological inconsistency in addressing quasi-random designation from a pool of eligible zones.

Three studies look at the impact of incentive programs on real estate, but none on commercial real estate, potentially because of data limitations around commercial properties. Krupka and Noonan (2009) find that median home price appreciate 25% faster in federal EZs compared to what would have happened without the program. In contrast, Boarnet and Bogart (1996) find that New Jersey's state EZ program did not have a statistically significant impact on property values. Evaluating the *New Markets Tax Credit* (NMTC) program, Freedman (2012) find a 2% increase in median home values for every $1 million in NMTC investment in low-income neighborhoods.[3]

OZs were first formally introduced at the federal level within the Investing in Opportunity Act in February 2017.[4] After the bill passed as part of the larger Tax Cuts and Jobs Act in December 2017, census tracts were first required

[3]The *New Markets Tax Credit* (NMTC) program is also restricted to low-income communities. However it differs somewhat from OZs and EZs, providing a capped allocation of tax credits which are competitively awarded to individual projects or companies.

[4]See: `https://eig.org/opportunityzones/history`

to meet one of a number of eligibility requirements, specifically a poverty rate of greater than 20% or a tract median family income below 80% of that of the corresponding metro area or state. From the approximately 42,000 eligible census tracts, state governors nominated up to 25% in their respective states to be designated. Tracts were then designated in state-level cohorts between April and July of 2018.

The designation process was not unified across the country. While some states explicitly scored different census tracts for designation using socioeconomic factors, others also considered recommendations from relevant stakeholders. For example, New Jersey did not only account for socioeconomic indicators such as poverty rate and unemployment, but also transit access and existing investments.[5] In contrast, New York designated tracts based on recommendations from the state economic development and housing agencies, along with regional councils.[6] Frank et al. (2020) further find a higher probability of designation if the census tract representative and state governor shared the same political party.

2.2. Benefits of the OZ program

To qualify for the three main incentives, investors have to deploy capital through an Opportunity Fund (OF), an investment vehicle set up for making qualified investments in OZ census tracts. As a first benefit, investors are permitted to defer taxes on previous capital gains invested in the OF. Capital gains have to be invested in the OF within 180 days and can be deferred until the earlier of 2026 or the date on which the property is sold. This benefit is broader than, but in many ways similar to, the benefit provided through Section 1031 of the Internal Revenue Code, allowing for a deferral of capital gains taxes upon selling real property and subsequently reinvesting proceeds within the same tax year in

[5] `https://www.state.nj.us/dca/`
[6] `https://esd.ny.gov/opportunity-zones`

other real property. In contrast, OZ investors may defer any prior capital gains, such as from the sale of public equities, as opposed to only capital gains from the sale of real property.[7]

Second, in addition to deferred capital gains OZ investors receive a reduction of 15% on the amount of prior capital gains tax when it finally comes due, provided the investment in the OF is held for more than 7 years and the investment was made before the end of 2019 (there is a 10% discount if the investment is held for more than 5 years and made before the end of 2021). Third, if the investment is held for at least 10 years, the investor also receives an increase in tax basis equal to the investment's fair market value upon sale, effectively eliminating the exit tax due from any new capital gains generated by the OF's investment activities.

Investors may avail themselves of the aforementioned tax benefits only to the extent an OF successfully makes qualified investments in OZs. Most importantly for OF investments in real estate, properties must undergo a capital improvement at least equal to the OF's initial acquisition expense within 30 months of purchase, thereby privileging development and significant rehab over acquisition. The program allows for a wide range of asset classes without any blanket restrictions, and so can be used to finance industrial facilities, hotels, commercial space, and residential properties, to name a few.

In order to qualify for the benefits mechanically, a partnership or other investing vehicle needs only to self-certify to the U.S. Treasury and Internal Revenue Service (IRS) its status as an eligible OF concurrently with filing its federal tax return. As of December 2018, 53 legal entities across the country had certified as OFs, with a total capitalization of approximately $15 billion.[8] To set this in context, the total commercial real estate transaction volume across the U.S. in

[7] `https://www.irs.gov/pub/irs-news/fs-08-18.pdf`

[8] *Opportunity Zone Fund Directory*, retrieved 2019 from `https://bit.ly/2VSLAGW`

2018 was \$394 billion.[9]

2.3. Theoretical effects of OZ investing

Due to the required capital expenses on top of the transaction value (> 100% of property price), the OZ program is preliminary targeted at (re)development structures and land and effectively excludes properties with low capital requirements, since the additional costs for investors would outweigh all potential tax benefits. However, qualifying properties, such as (re)development structures, should appreciate in value equal to potential tax gains, assuming that real estate markets are efficient.

To understand the magnitude of direct tax benefits, we illustrate the OZ designation effects for a simple investment example. We assume an unlevered redevelopment investment in 2018 with a 10 year investment horizon. Following the income approach, we show the difference in investment value with and without OZ designation status. As shown in equation (1), the market value (MV) of a property in period $t = 0$ equals the sum of discounted future free cash flows (CF), plus its after-tax and discounted terminal value (TV). Since we assume that the efficient market hypothesis holds, Net Present Value equals 0 and the total investment I_0 (transaction price plus capital expenses) equals the market value MV_0.

$$I_{t=0} = MV_{t=0} = \sum_{t=1}^{T} \frac{CF_t}{(1+c)^t} + \frac{TV}{(1+c)^T} \tag{1}$$

Equation (2) shows the investment from an after-tax perspective without OZ designation status, where $PATCF$ is the property after-tax free cash flow, x the capital gains and income tax rate (assumed to be equal for simplicity), and c the after-tax discount rate.[10] We assume the initial investment $I_{t=0}$ constitutes of

[9] Retrieved 2019 from statistica.

[10] With "property" cash flow we mean we ignore debt payments. If debt is included we call it an "equity" cash flow, see Geltner et al. (2013)

prior, taxable capital gains.[11] In addition to equation (1), investors have to pay capital gains tax on the initial investment $I_0 x$, assuming it results from prior capital gains, and the gain from sale of the OZ investment at the end of the investment horizon.

$$\textbf{no OZ: } I_0 = -I_0 x + \sum_{t=1}^{T} \frac{CF_t}{(1+c)^t} + \frac{TV}{(1+c)^T} - \frac{(TV - I_0)x}{(1+c)^T} \tag{2}$$

Equation (3) shows the same investment with OZ designation status, where t_i is the maximum deferral period of prior capital gains. We assume the maximum capital gains tax discount of 15 percent. As we can see, the exist capital gains tax on the sale of the OZ investment is eliminated, while the tax on prior capital gains is reduced and discounted.

$$\textbf{OZ: } I_0 = \sum_{t=1}^{T} \frac{CF_t}{(1+c)^t} + \frac{TV}{(1+c)^T} - \frac{(1-0.15)I_0 x}{(1+c)^{t_i}} \tag{3}$$

Ceteris paribus, the investment difference for opportunity zones ($I_{\text{OZ}} - I_{\text{no OZ}}$) can therefore be reduced to:

$$\Delta OZ = \underbrace{I_0 x \left(1 - \frac{0.85}{(1+c)^{t_i}}\right)}_{\text{Term 1}} + \underbrace{\frac{(TV - I_0)x}{(1+c)^T}}_{\text{Term 2}} \tag{4}$$

where ΔOZ is the post-tax difference of an investment and can be explained by the reduction and deferral of prior capital gains tax (Term 1), and the effective elimination of the exit tax on new capital gains (Term 2). Considering ΔOZ as a percentage of the initial investment I_0, the difference for investors can be

[11] This is a crucial assumption but also a main argument to invest in OZ, making up a major part of the direct tax benefits. We acknowledge that this condition might cause a barrier to entry for investors, resulting in a potential selection effect. However, our data do not allow to determine the tax status of initial investments. We therefore assume that investors generally structure their investments efficiently, making use of the maximum in potential OZ benefits.

defined as:

$$pOZ = \frac{\Delta OZ}{I_0} = x\left(1 - \frac{0.85}{(1+c)^{t_i}} - \frac{1}{(1+c)^T} + \frac{TV}{I_0(1+c)^T}\right) \tag{5}$$

Assuming constant annual capital appreciation, the terminal value (TV) can be expressed as a function of the initial investment and the average annual growth rate g, shown in equation (6).[12] Substituting equation(6) into equation (5) shows that the expected percentage tax benefit of OZ investments can be expressed independently of the initial investment I_0, solely defined by the tax rate, assumed growth, discount rate, and deferral and investment horizon.

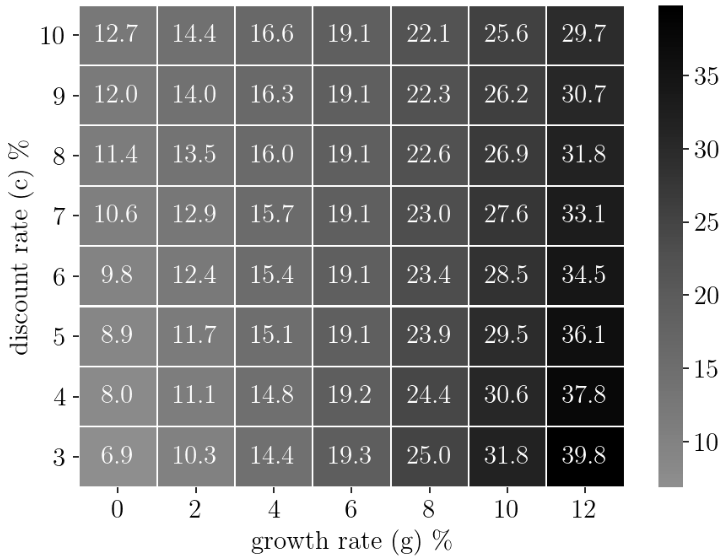
$$TV = I_0 \times (1+g)^T. \tag{6}$$

$$pOZ = x\left(1 - \frac{0.85}{(1+c)^{t_i}} + \frac{(1+g)^T - 1}{(1+c)^T}\right) \tag{7}$$

Figure 1 shows a range of theoretical OZ tax benefits pOZ, fixing all parameters, except growth and discount rate. We assume a tax rate, x of 21 percent, investment period T of 10 years, and a deferral of capital gains tax until 2026 ($t_i = 8$). Testing a discount rate between 3 to 10 percent and a growth rate between 0 to 12 percent, we find theoretical tax benefits between 6.9 and 39.8 percent. The potential benefits are more sensitive to growth rate assumptions than to discount rates. Figure 1 demonstrates that OZ tax benefits do not outweigh additional, potentially unnecessary, capital expenditures to qualify for the OZ status. Therefore, the program preliminary benefits investments with high capital requirements, such as (re)development sites.

[12] Alternatively, TV can be estimated by a perpetuity formula using the last cash flow, an exit discount rate and a growth factor: $\frac{CF_T}{(c_{\text{exit}} - g)}$. However, for simplicity we use the definition of equation (6) as the difference is a numbers game and we only need to introduce one additional parameter.

Figure 1.
Theoretical tax benefits of OZs (in percent)



Notes: The values are the theoretical difference in investment value of similar properties in OZs compared to non-OZs as a percent of the initial investment (pOZ) as described in Section 2.3. We use a tax rate x at 21 percent, investment period T of 10 years, and an deferral of capital gains tax until 2026 ($t_i = 8$). The simulated benefits do not take into account possible rent incresaes due to gentrification effects of OZ designation.

2.4. Qualified OZ properties

As Titman (1985) show, potential future land price appreciation increases the option value of properties and should therefore result in present price increases. If we assume that investors believe in the success of the OZ program, properties in OZ census tracts should consequently sell at a higher price after designation. Properties qualified for the OZ program should show an additional price increase due to opportunities of tax benefits. In contrast, if investors don't anticipate future land price appreciation, only qualified properties should show price effects due to tax benefits. We therefore distinguish qualified and non-qualified transactions and examine the OZ designation effects for the two groups.

The two extreme definitions for qualified and non-qualified transactions are: vacant land and newly built properties. Development sites or vacant land has the highest option value and capital requirements as there is no structure (e.g. see Cunningham, 2006; Titman, 1985). The land value fraction ($\frac{\text{land value}}{\text{total property value}}$) is close to 100% by definition. In contrast, newly built properties are very likely built according to the Highest-and-Best-Use (HBU) and therefore have the highest structure value and lowest capital requirements. Several studies find that the average land value fraction for newly constructed commercial properties in the US is approximately 20% (Bokhari and Geltner, 2018; Geltner et al., 2020; Albouy et al., 2018).

To define qualified, redevelopment properties between the two extreme cases, we are interested in properties with a high land value fraction. Since the land value fraction is complemented by the structure value fraction it can also be expressed as $1 - \frac{\text{structure value}}{\text{total property value}}$. As the structure value decreases through depreciation over time, we determine qualified properties by a high *effective age* (Lusht, 2001). Francke and van de Minne (2017) explore the link between depreciation and capital expenditures. They define three forms of depreciation, causing heavy capital expenditures and being correlated with age: (1) physical deterioration, (2) functional obsolescence and (3) economic obsolescence.

Physical deterioration is the decay of structure over time. Even though it is typically deferred by regular maintenance activities, regular maintenance cost increase as a function of property age, up to a point where the cost of a renovation are below future cumulative maintenance cost (Bokhari and Geltner, 2019). Functional obsolescence, occurs if properties no longer correspond with current tastes and preferences. This could be anything from an antiquated heating, ventilation, and air conditioning (HVAC) system, lack of electrical plugs, to the architectural style of the property. Functional obsolescence makes it difficult to attract prospective tenants or charge higher rents, up to the point that an investment in large scale *renovations* or redevelopment becomes a positive NPV project. Newly constructed buildings are usually built according to current tastes and preferences, thus functional obsolescence is arguably a function of property age.

Finally, economic obsolescence is not related to a change of the building itself, but of its surroundings. If a property is newly constructed, it will be built according to its HBU. It will have the optimal density (measured by its floor-area-ratio), and "best" property type to maximize its NPV (see Geltner et al., 2020; Büchler et al., 2020, among others). However, the HBU might change over time, leading to building types that are "better" suited for the buildings' location. Economic obsolescence can only be cured by very extreme renovations or by a complete redevelopment. Therefore, economic obsolescence is a function of the effective age of the property.

As result, we identify OZ qualified properties by comparing older properties to newer properties. The starting point for effective age is either the development time or - if applicable - the time of last large renovation, but not necessarily the original building time (Lusht, 2001).

3. Methodology

We explore the effect of OZ designation on two market outcomes: price and liquidity. If OZ designation increases the expected future growth of rents in the census tract and real estate markets are efficient, we expect to measure an effect in property prices. We further examine market liquidity, measured by the probability to sell, since it is possible that liquidity improves without price changes, especially for older properties and vacant land. Tax benefits might turn negative NPV to zero or positive NPV properties. The literature shows that in real estate, liquidity typically moves ahead of prices after positive shocks, due to long search and match processes (van Dijk et al., 2020). In this case liquidity moves first, until the market reaches a new price-equilibrium, at which point liquidity reverts back to its long-run average.[13]

[13]This process of "Tatonnement" was first discussed by Walras.(e.g. see Uzawa, 1960)

We use a difference-in-difference (DID) setup to identify designation effects, comparing outcome variables between eligible, but not designated census tracts ("runner-ups"), with those of designated OZs. Since designation might have not been completely random but influenced by census tract characteristics, we use propensity score matching (PSM) to find a representative control group within the "runner-ups" (see Section 4.1 for details). We only focus on transactions within one year around the treatment moment, reducing concerns of non-parallel trends between OZ and non-OZ areas, before and after treatment. OZ designations occurred early 2018 and we consequently limit our data to include only transaction between 2017 and 2019.

3.1. Main models

Equation 8 shows the model to estimate the effects on price. The model follows a hedonic regression model with a log-linear specification (log dependent variable) (Rosen, 1974). The model is estimated by OLS with county location and time fixed-effects. This reduced form model allows for the inclusion of various unobserved heterogeneous characteristics in the form of fixed effects.

$$\ln Y_{jtz} = \beta_{jt} + \gamma X_t + \theta_z + \mu_{t \geq t_d, z} + \varepsilon_{jtz} \tag{8}$$

In the model, Y is a vector of dependent variables - prices - for individual transactions at time of sale t, in county j.[14] Subscript z indicates that a property is located in an opportunity zone census tract, before or after designation, and β_{jt} is an interaction between county and year of sale dummies. Location dummy θ_z indicates if a transaction took place in an opportunity zone census tract (before *or* after designation). Our variable of interest is the interaction dummy $\mu_{t \geq t_d, z}$, indicating that a property is transacted in an opportunity zone, *after*

[14]Since this equation and all following equations are vectorized, we drop the subscript i for individual properties.

OZ designation t_d. X controls for other building characteristics, such as size, age and property type. The residual is designated ε and assumed to be normally distributed with zero mean.

Since prices might not capture the full success of the program, we further explore market liquidity. If prices stay flat after OZ designation but more capital expenditures are incurred, such as from renovations and developments, it could mean that previously negative NPV projects became positive NPV projects. However, this would effect most likely vacant land and properties up for (re)development. The literature shows that liquidity tends to move before prices and that reservation prices from potential buyers typically move earlier compared to reservation prices of owners (van Dijk et al., 2020).[15]

We follow van Dijk et al. (2020) and define liquidity as the probability of a property to sell in any specific time period. We interpolate our data into a full panel, resulting in a full, quarterly time-series for every property, allowing us to observe every property in every quarter, even if the property never got transacted in our analyzed time period (2017 – 2019).[16] The dependent variable is a binary (1/0) indicator, measuring whether or not a property is sold in a certain time period. For transactions the indicator is 1 and for interpolated quarters it is 0. Consequently, the number of observations increases through this process.

The logit model for the estimation is shown in equation (9), where $p = P(Y = 1)$ indicates that property i is sold in period t and l is the log-odds. All

[15]This classical perspective on the dynamics of market equilibrium was put forth by Walras, with the concept of "tatonnement". Essentially, at any given price, the observable difference in the quantity of supply offered and the quantity of demand bid determines how the price must change in order to balance those two quantities. The Walrasian auctioneer calls out a price, and if there are more buyers than sellers she adjusts the price upward, and vice versa. It is the empirical observation of quantities that moves the price toward equilibrium over time. Fundamentally, quantity changes are observed first, followed by price adjustments. Prices respond to imbalances in quantity.

[16]The full data set provided to us, contains close to the full population of commercial property transactions between 2000 and 2020. This allows us to identify close to the full population properties in the US, assuming all properties would have been sold at least once during the years 2000 – 2020.

explanatory variables and subscripts are similar to the previous linear models. We estimate the model by Generalized Least Squares (GLM) using a logit-link function. The coefficients can be interpreted as follows: a positive (negative) and significant parameter increases (decreases) the probability of a property to get sold. If properties become more attractive to investors (e.g. positive NPV) after OZ designation, we would expect the coefficient for $\mu_{t \geq t_d, z}$ to be positive and significant, increasing market liquidity.

$$l = \ln\left(\frac{p}{1-p}\right) = \beta_{jt} + \gamma X_t + \theta_z + \mu_{t \geq t_d, z} \tag{9}$$

We apply both models to different sub-samples, sorted by property age. Additionally, we use a rolling window estimation. To identify proper age brackets and window size, we estimate a survival function using a Kaplan-Meier estimator similar to Hulten and Wykoff (1981, 1996); Bokhari and Geltner (2018); Büchler et al. (2020). Since our data contain information if a property is bought with the intend to do heavy capital expenditures (CAPEX), we use this information to estimate the probability that properties receive no CAPEX at certain effective ages.

3.2. Heterogeneity analysis & robustness tests

Due to three reasons, it might be that designation effects vary over time: (1) Some details of the OZ program were not ironed out immediately after designation, (2) to take full advantage of the program, investors would need to perform capital expenditures as soon as possible, and (3) buying and selling (commercial) real estate can take a long time, potentially delaying the effect of OZ designation. We therefore explore trend differences after OZ designations by extending our models. We add a time-designation interaction term, as shown in equations (10) and (11). Using semi-annual time periods, $\mu_{t \geq t_d, z}, d^t$ measures the interaction of $\mu_{t \geq t_d, z}$ with the four half-years after designation (2018-1, 2018-2, 2019-1 and

2019-2).[17]

$$\ln Y_{jtz} = \beta_{jt} + \gamma X_t + \theta_z + f(\mu_{t\geq t_d,z}, t \geq t_d) + \varepsilon_{jtz}, \quad (10)$$

$$l = \ln\left(\frac{p}{1-p}\right) = \beta_{jt} + \gamma X_t + \theta_z + f(\mu_{t\geq t_d,z}, t \geq t_d) \quad (11)$$

Examining potential investor preferences, we further group the data based on other property characteristics than age. We distinguish for different property types, such as apartments and office properties, since different property type investments lead arguably to different spill-over effects, such as job creation. We further examine spatial heterogeneity, distinguishing for urban and rural census tracts by estimating distance to the seven biggest US metropolitan regions. Due to the proximity to US metropolitan regions, urban OZ cenus tracts might be preferred by investors. Lastly, we sort properties by transaction price, examining if investors with different capital constraints or investment target volumes act differently.

Assuming that OZ designation increases future land values due to economic growth, it is hard to believe that the effects stop at the census tract border. Instead, spillover effects might also affect neighboring, eligible census tracts. Since we compare OZ to eligible census tracts, this would potentially understate our designation effect estimates or make them insignificant. We therefore run a robustness test, using only properties in eligible census tracts. For every property, we measure the distance to the closest property transactions in an OZ census tract. The model is shown in equation (12), where ϕ_t is the distance to the nearest OZ transaction in log(meters), $\omega_{t\geq t_d}$ indicates if a property is transacted after designation in the nearest OZ census tract took place ($D = 1$), and $\phi_t * \omega_{t\geq t_d}$ measures the interaction of the two. We are interested to compare the effect of ϕ_t, the location effect, to $\phi_t * \omega_{t\geq t_d}$, the change in location effect after designa-

[17]We use semi-annual dummies for the OZ area interaction term, since we found that quarterly dummies are affected by too much noise, resulting in volatile estimates.

tion.[18] If OZ designation lead to positive spillover effects, we expect $\phi_t * \omega_{t \geq t_d}$ to be negative.[19]

$$\ln Y_{jt} = \beta_{jt} + \gamma X_t + \phi_t + \omega_{t \geq t_d} + \phi_t * \omega_{t \geq t_d} + \varepsilon_{jt} \tag{12}$$

4. Data and Descriptive Statistics

4.1. Opportunity Zones

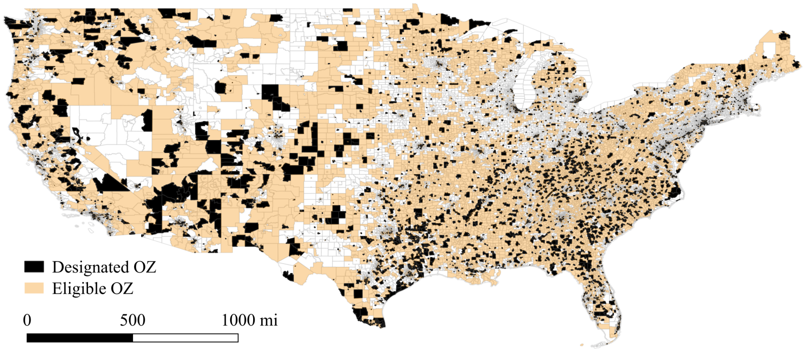
Opportunity zone data are provided by the Community Development Financial Institutions (CDFI) Fund of the U.S. Treasury. Figure 2 shows the locations of all eligible and designated census tracts across the U.S. (excluding Alaska, Hawaii and territories for illustrative purposes). There are approximately 42,000 eligible census tracts, of which approximately 8,800 tracts (21%) were designated by the U.S Treasury and Internal Revenue Service (IRS) between April and July 2018. We focus on census tracts with observed commercial property transactions, resulting in 10,994 eligible census tracts, of which 21% were designated as OZs.

We match the data with census-level median household income and poverty rates from the American Community Survey data. Panel A in Table 1 shows descriptive statistics on household income and poverty rates for our sample at the timing of the Tax Cuts and Jobs Act of 2017. The average median household income in eligible, non-designated census tracts is \$44,604. In contrast, the median household income in designated census tracts is \$35,242. Similarly, the average poverty rate is higher in designated zones (28 percent) compared to eligible zones (20 percent). This indicates that the designation process was potentially not completely random, but favored census tracts with lower socio-economic status.

[18]Since we only compare among properties in eligible census tract, $\omega_{t \geq t_d}$ only captures the time effect but cannot be interpreted as a designation effect.

[19]We assume that spillover effects spread and decay over distance. If spillover effects are very high, affecting the entire eligible census tract equally, our analysis is limited.

Figure 2.
Geographic distribution of opportunity zones (OZs)



Notes: Illustrated are all eligible and designated opportunity zones in mainland U.S., excluding Hawaii, Alaska and territories. White census tracts were non-eligible.

We use propensity score matching to match runners-up 1:1 to designated census tracts. Ensuring geographic comparability, we only match within NCREIF[20] regions. Appendix A describes the process in more detail and Table Appendix A.1 shows the regional logit model results, indicating that lower (log) median household income and higher poverty rates have significant effects on the OZ designation outcome. Panel B in Table 1 provides summary statistics of the "matched" census tract data. After matching, both groups show a median household income close to $35,000 and a poverty rate close to 28 percent.

4.2. Commercial Property Transactions

We use commercial property transactions between 2017 and 2019 (including) provided by Real Capital Analytics (RCA), which cover over 90% of all U.S. commercial real estate transactions in the institutional investor space.[21] The data consists of existing property transactions and development site (vacant land) transactions. The data contain information on transaction price, land

[20] National Council of Real Estate Investment Fiduciaries, an industry group for pension and insurance funds that invest in real estate.

[21] Generally, RCA covers properties above $2 million in transaction value. For more information, see `https://www.rcanalytics.com`

Table 1.
Income & Poverty Statistics - Census Tracts

Panel A: Before Propensity Score Matching		
	Eligible	OZ
Avg. median income	$ 44,604	$ 35,252
Std.	$ 14,560	$ 13,405
Poverty rate	0.198	0.283
Std.	0.114	0.135
N.	10,994 (79%)	2,979 (21%)
Panel B: After Propensity Score Matching		
	Eligible	OZ
Avg. median income	$ 35,481	$ 35,252
Std.	$ 12,755	$ 13,405
Poverty rate	0.277	0.283
Std.	0.135	0.135
N.	2,979 (50%)	2,979 (50%)

Notes: Socioeconomic data for designated and eligible census tracts before and after PSM was conducted. Includes only tracts where repeat sale pairs were observed. Opportunity Zones (OZ) are designated census tracts, Eligible are non-designated tracts (control group).

size, structure, location and property type. For existing properties, we observe all commercial property types, but focus on apartments, industrial, office and retail. We filter out properties older than 120 years, as these might have special monumental status.

Panel A of Table 2 shows summary statistics for the sample of existing property transactions. The first column gives descriptive statistics of the entire sample, the second (third) column shows descriptive statistics for properties outside (within) OZ census tracts before and after designation. The fourth (fifth) column shows descriptive statistics for properties sold within OZ census tracts, before (after) designation. The number of observations show that 55% of the total sample are located in OZ census tracts (before and after designation) and 31% of transactions are in OZ census tracts *after* OZ designation (post-treatment).

Our variable of interest is the price per square foot of land, the dependent variable throughout most of our analysis. Controlling for the capital intensity of the property (measured by the Floor-to-Area Ratio, FAR), the price per square foot of land proxies the productive capacity of the land (Büchler et al., 2020; Geltner et al., 2020; Clapp et al., 2012). Using price per square foot of land further makes the results more comparable with the results from the vacant land analysis. The average sales price per square foot of land in the full sample is $326. For non-OZ and OZ properties it is $384 and $279, on average, resulting in significant average price difference of $105. For OZ properties, the average price per square foot of land increases by $10 after designation. A similar overview for redevelopment sites (vacant land) is shown in Appendix Table Appendix B.2. The price per square foot of land is approximately 10 percent higher after the designation.

Panel B of Table 2 shows descriptive statistics for the data on probability to sell. As described in Section 3, the data includes interpolated observations to reach a full panel, including non-transacted properties in some quarters and therefore increasing the number of observations considerably. Only 4% of observations are actual transactions during the sample period in any given quarter (*Dummy:* Sold). Through the interpolation, characteristics change slightly. For example, effective age increases by 4 years due to the fact that younger properties are sold more frequently. We do not observe a clear increase in liquidity in OZ census tracts after designation.

Figure 3 shows the distribution of effective age, indicating that most properties are younger than 40 years. The results for the Kaplan-Meier estimator are shown in Appendix Figure Appendix B.1. Based on the results and similar to Bokhari and Geltner (2018), we define three stages of a property's life; early (up to 30 years) when practically no CAPEX is received, medium (30 to 80 years) when more properties receive CAPEX, and old (after 80 years) when there is high probability of redevelopment / large renovations. We use the three age brackets to define sub-samples and a window size of 30 years in the rolling

Table 2.
Descriptive Statistics - Existing Properties

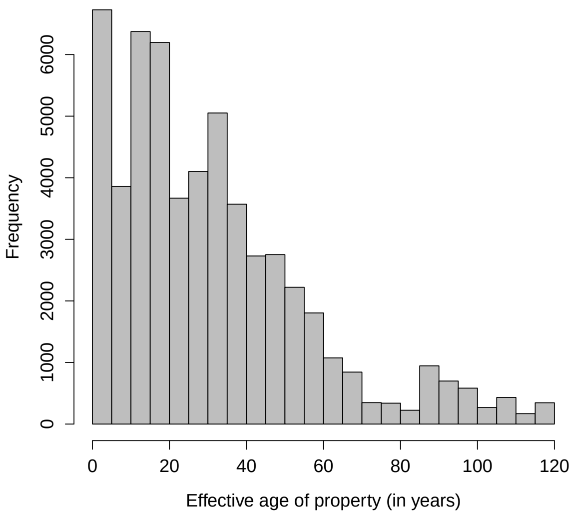
	(I)	(II)	(III)	(IV)	(V)
	Panel A: Transaction Price Dataset				
Variable	**Full**	**Non OZ**	**OZ ($\forall$t)**	**OZ (t<d)**	**OZ (t$\geq$d)**
Transaction price	\$ 12,601	\$ 12,979	\$ 12,288	\$ 11,961	\$ 12,533
($\times$ 1,000)	[\$ 25,279]	[\$ 27,037]	[\$ 23,718]	[\$ 25,045]	[\$ 22,673]
Land size (sqft)	209,050	209,992	208,269	203,623	211,751
	[439,003]	[422,977]	[451,899]	[410,104]	[480,879]
$Y = \frac{\text{Transaction price}}{\text{Land size}}$	\$ 326	\$ 384	\$ 279	\$ 273	\$ 283
	[\$ 649]	[\$ 753]	[\$ 544]	[\$ 544]	[\$ 543]
FAR	1.127	1.133	1.122	1.175	1.083
	[1.697]	[1.571]	[1.795]	[1.966]	[1.653]
Effective age	39	40	39	38	40
	[29]	[29]	[28]	[28]	[28]
Dummy: Apartment	0.351	0.421	0.293	0.305	0.284
Dummy: Industrial	0.290	0.226	0.343	0.340	0.345
Dummy: Office	0.178	0.161	0.192	0.182	0.199
Dummy: Retail	0.181	0.192	0.173	0.173	0.172
N. Observations	12,111	5,492	6,619	2,836	3,783
	Panel B: Probability to Sell Dataset				
Variable	**Full**	**Non OZ**	**OZ ($\forall$t)**	**OZ (t<d)**	**OZ (t$\geq$d)**
Y = *Dummy:* Sold	0.040	0.038	0.041	0.041	0.041
Land size (sqft)	207,195	211,762	203,049	203,705	202,560
	[456,755]	[493,223]	[420,883]	[424,987]	[417,796]
FAR	1.560	1.650	1.479	1.467	1.488
	[2.588]	[2.443]	[2.711]	[2.708]	[2.713]
Effective age	44	45	43	42	44
	[27]	[28]	[27]	[26]	[27]
Dummy: Apartment	0.416	0.471	0.367	0.365	0.368
Dummy: Industrial	0.241	0.182	0.294	0.295	0.293
Dummy: Office	0.184	0.177	0.191	0.191	0.192
Dummy: Retail	0.158	0.170	0.148	0.149	0.147
N. Observations	1,040,544	495,104	545,440	233,047	312,393

Notes: Opportunity Zone are designated OZ area, with t_d being the date of OZ designation. FAR = Floor Area Ratio, defined as the amount of square foot of structure over the square foot of land. Eff. age = effective age of a property, defined as the amount of years from last large renovation or construction year otherwise. Standard deviations of the variables are given in square brackets.

regression (1 year step size), providing sufficient observations per bracket.[22]

Lastly, we test if there is sufficient variation between OZ and control census tracts within counties, as we use county-level time year fixed effects (*D:* county $\times$ year). On average, a county consists of six census tracts. Appendix Figure Appendix B.2 shows the distribution of opportunity zones per county. A darker color highlights counties dominated by OZ transactions, whereas a light green color highlights counties dominated by transactions in the control group. There are 576 counties with (enough) commercial property transactions between 2017 and 2019. 218 counties have no variation in OZ designation, meaning transaction in these counties are not used to identify the treatment effect. For vacant land we have 181 counties with enough transactions during our analyzed period, of which 79 counties have no variation in OZ designation.

Figure 3.
Effective Age of Sample Properties



Notes: Effective age is the age of a property (in years) since it was last (considerably) renovated. If we do not observe any renovations, we use the age since construction.

[22]We use effective age as a proxy in our analysis instead of the CAPEX variable directly. As shown by Büchler et al. (2020); Clapp et al. (2012), CAPEX and prices are endogenous, since CAPEX is mostly done if there is a positive outlook in future price. Furthermore, our variable doesn't allow to observe the CAPEX size in dollars, creating a lot of noise.

5. Results

5.1. Main Results

Table 3 shows the results for price per square foot of land as the explanatory variable. Column (I) shows the estimates for the full sample, while columns (II) – (IV) show estimates for different age sub-samples. Column (V) shows the estimates for vacant land. The model shows a good general fit, with an adjusted R-squared between 0.87 and 0.79. All control variables are significant and in line with expected results. A density increase of 1 percent, measured by ln FAR, leads to a 0.876 percent increase in transaction price, on average. Property age has a negative effect on price, showing a -0.115 percent discount on price for every 1 percent increase in age. However, the effect is not stable among all age groups but reverts for very old properties, suggesting a U-turn pattern in line with the literature (Coulson and McMillen, 2008), caused by survival bias and vintage effects (Francke and van de Minne, 2017). Compared to apartments, industrial properties show a discount (-43.3 percent), while office (19.8 percent) and retail (36 percent) properties show a premium, on average. In line with the literature, we document that lot size has a negative effect on price per square foot of land (bulk discount).

Properties located in OZ census tracts show an average location discount of 6.3 percent compared to properties in eligible but not designated census tracts. Similarly, vacant land in OZ census tracts trades at a discount of 15.4 percent (significant within the 10% probability). For designation, we document no statistically significant effect on property prices for the full sample. However, looking at different age groups, we document a price increase of 6.8 percent for old properties, on average (significant within the 10% probability). For vacant land, we estimate a land price increase of 37.7 percent after designation.

Figure 4a plots the estimates for the rolling window model on property price, using a time window of 30 years for effective age and moving in one year steps.

The black line shows the point estimate of the designation effect $\mu_{t \geq t_d, z}$, including 95% confidence bounds. We document a positive trend in designation effects over property age. Even though the estimates are noisier for older properties, we see significant positive designation effects for properties of 60 years and older (at a 95% confidence level).

Table 3.
Effect of OZ designation on price

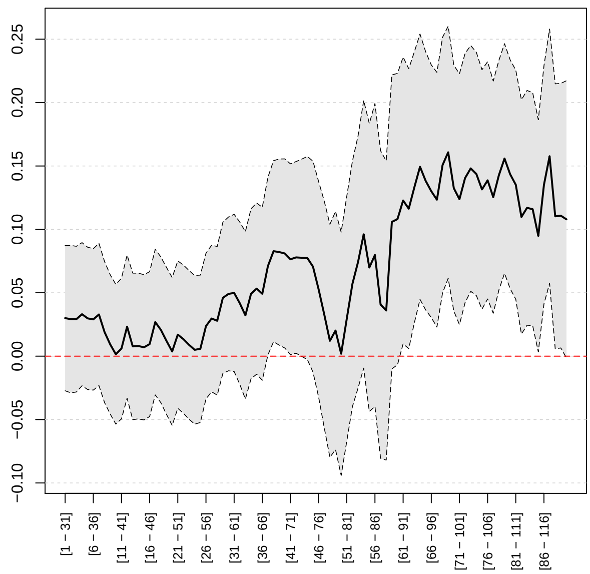
Age group / Land:	**(I)** **[1 – 120]**	**(II)** **[1 – 30]**	**(III)** **[31 – 80]**	**(IV)** **[81 – 120]**	**(V)** **Land**
Intercept	5.010***	5.133***	3.609***	2.052**	9.866***
	[14.19]	[15.05]	[15.04]	[2.43]	[16.96]
OZ area (θ_z)	-0.061***	-0.043	-0.081***	-0.075*	-0.143*
(1=yes)	[-3.51]	[-1.63]	[-2.91]	[-1.83]	[-1.75]
OZ designation ($\mu_{t \geq t_d, z}$)	0.001	-0.014	-0.014	0.066*	0.320***
(1=yes)	[0.07]	[-0.61]	[-0.57]	[1.75]	[3.19]
Property type:					
Industrial	-0.362***	-0.293***	-0.402***	-0.361***	
(1=yes)	[-22.32]	[-10.89]	[-16.60]	[-8.35]	
Office	0.181***	0.253***	0.138***	0.181***	
(1=yes)	[10.04]	[9.61]	[4.68]	[3.43]	
Retail	0.308***	0.390***	0.179***	0.415***	
(1=yes)	[16.60]	[13.48]	[5.77]	[10.48]	
ln Eff. age	-0.114***	-0.158***	0.150***	0.622***	
(years)	[-19.81]	[-16.79]	[3.64]	[4.12]	
ln FAR	0.876***	0.944***	0.803***	0.713***	
	[116.94]	[86.01]	[61.28]	[32.21]	
ln Land size					-0.529***
					[-22.47]
County × Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.847	0.870	0.804	0.821	0.790
RMSE	0.373	0.346	0.383	0.279	0.530
N. Observations	12,111	5,251	5,217	1,643	922

Notes: Dependent variable = log of sales prices per square foot of land. *Eff. age* = the effective age of properties, meaning the amount of years since last large renovation, or construction year if no heavy renovations were reported in the data. *OZ* = Opportunity zone, with OZ *designation* indicating the transaction took place after designation. *FAR* = floor area ratio, a density measure. *Apartments* are the reference group for the property types. T-stats are given in parenthesis. *** = significant within 99% probability, ** = significant within 95% probability and * = significant within 90% probability. The control group consists of transactions or development sites in eligible census tracts with similar median income and poverty levels.

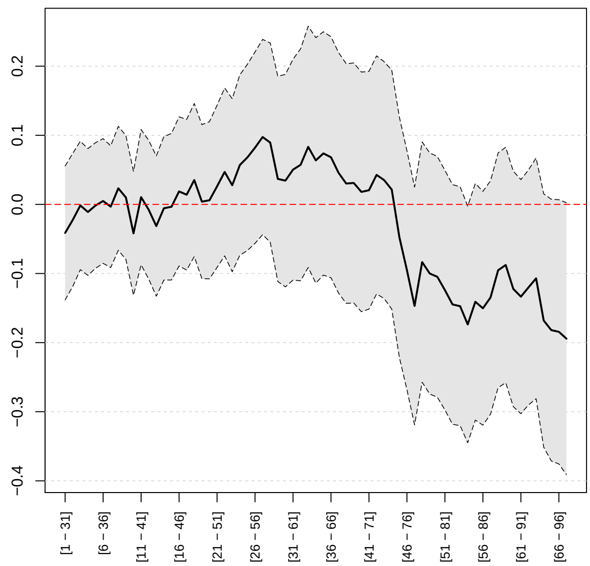
Table 4 shows the results for the probability to sell, measuring the effect of

Figure 4.
Rolling window estimate

(a) Designation effect on price



(b) Designation effect on probability to sell



Notes: The horizontal axis shows the windows of effective ages (length 30 years), which is moved in one-year steps. Effective age is the age of a property (in years) since the last (major) renovation. In the absence of renovations, we use age since construction. The vertical axis shows the designation of the respective model $\mu_{t \geq t_d, z}$ and the 95% confidence intervals (grey).

OZ designation on liquidity. We use the same hedonic controls as in Table 3 but report only estimates related to OZ designation due to space constraints.[23] In general, we do not find a significant location difference for OZ census tract (θ_z). However, for young properties (up to 30 years), we find an increased liquidity of 14.6 percent. In contrast, for middle aged properties, we document a lower probability to sell (-5%) compared to the control group. OZ designation does not show significant effect on liquidity of existing properties. Figure 4b shows the estimates for the rolling window model, including 95% confidence bounds. Even though we observe a drop in probability to sell for older properties, it is not significant at a 95% significance level. However, designation shows a positive effect on vacant land, increasing the probability to sell by 28.5 percent, on average.

Table 4.
Effect of OZ designation on probability to sell

	(I)	**(II)**	**(III)**	**(IV)**	**(V)**
Age group / Land:	**[1 – 120]**	**[1 – 30]**	**[31 – 80]**	**[81 – 120]**	**Land**
Intercept	-1.999***	-2.185***	-2.497***	-3.180***	-2.432***
	[-23.46]	[-18.55]	[-13.00]	[-8.24]	[-5.25]
OZ area (θ_z)	-0.013	0.146***	-0.058***	-0.011	-0.049
(1=yes)	[-0.82]	[1.82]	[-2.61]	[1.38]	[-0.46]
OZ designation ($\mu_{t \geq t_d, z}$)	0.020	-0.048	0.092	0.054	0.285**
(1=yes)	[1.04]	[-1.50]	[3.49]	[1.38]	[2.22]
AIC	267,543	121,627	168,059	79,972	8,708
Hedonic controls	Yes	Yes	Yes	Yes	Yes
County × Year FE	Yes	Yes	Yes	Yes	Yes
N. Observations	398,712	150,632	183,104	64,976	33,948

Notes: Dependent variable is a (1/0) dummy indicating that a property is sold in a specific quarter. This panel also includes properties that were not sold between 2017 – 2019. The model is estimated using a Logit regression. *OZ* = Opportunity zone. Z-stats are given in parenthesis. *** = significant within 99% probability, ** = significant within 95% probability and * = significant within 90% probability. We use the same hedonic controls and control group as in Table 3.

[23] Full results for this Table and following Tables are available upon request.

5.2. Heterogeneity analysis

Examining the timeliness of the OZ designation effects, Panel A and B of Table 5 show the results for interacting the designation dummy ($\mu_{t \geq t_d, z}$) with semi-annual dummies, providing a more nuanced picture. We use the same controls as those reported in the baseline model of Table 3. Even though the Root Mean Squared Error (RMSE) is similar between all models, on an adjusted R^2 basis the baseline model in Table 3 fits best.

As shown in Panel A of Table 5, we do not find an immediate designation effect on prices, i.e. within the first half of 2018, except for vacant land. Vacant land prices in OZ census tracts increase by 39 percent in the first months after designation, on average (significant at 10% probability). For the second half of 2018, we document significant price effects for nearly all properties, except young properties (<30 years). For middle aged properties we find a 8.2 percent increase, on average (significant at 10% probability). As shown in Figure Appendix B.1 around 15 percent of these properties experience heavy capital expenditures, which could explain some effects. For old properties and vacant land, the estimates are 15.1 and 45.5 percent price increase, on average. The effect for old properties and vacant land remains in the first half of 2019, but becomes insignificant in the second half of 2019.

As shown in Panel B of Table 5, the results for probability to sell are more heterogeneous. We find a 19.9 percent reduction in probability to sell for the first half of 2018 for old properties or 9 percent reduction for the full sample. However, the effect does not persist for the second half of 2018. For the first half of 2019, we find an increase in probability to sell for old properties (17.1 percent) and vacant land (68.3 percent), but a decrease for young properties (-13.6 percent). For the second half of 2019, we only find an increased probability to sell for young properties (12.4 percent) but not for other properties. Assuming that liquidity tends to move before prices, our findings could be an indication for future price increases in OZ areas.

In line with previous findings, our results show that OZ designation does not affect young properties but primarily older properties. The estimated designation effects are not persistent over time, which fits more to temporary tax gains rather than long-term future land price appreciations. The initial absence of effects could be explained by little initial information about achievable benefits of the OZ program. Our results indicate investors where either careful, conservative or needed time at first but did not increase demand immediately.

In Table 6, we examine the OZ designation effect by property type instead of age.[24] We estimate our models by sub-samples of different property types, comparing only properties of the same type in eligible and OZ census tracts. Examining price in Panel A, we document a general OZ location discount (θ_z) for all property types except industrial, which shows a premium of 8.5 percent. OZ designation does not significantly affect property prices except for apartments, increasing 5.9 percent on average. For probability to sell we only find a general OZ location effect for industrial, showing a 12 percent higher probability to sell compared to industrial properties in eligible census tracts. For OZ designation, we document positive effects on probability to sell for retail properties (14.4 percent) and office (18.3 percent), and a negative effects on industrial (11.8 percent).

As shown in Table 2, we the share of apartments is generally lower in OZ census tracts compared to eligible census tracts. Vice versa, the share of industrial properties is generally higher in OZ census tracts. Our findings suggest that this relationship might shift through the OZ designation. Apartments increase in price, while industrial properties decrease in the probability to sell (but not necessarily in price).

Since Arefeva et al. (2020) find different effects for urban and rural OZ census

[24] Our number of observations does not allow for double sorting by type and age. Vacant land is excluded from the analysis.

Table 5.
OZ price effects with post-designation trend

Age group / Land:	(I) [1 – 120]	(II) [1 – 30]	(III) [31 – 80]	(IV) [81 – 120]	(V) Land
Panel A: Dependent variable = price					
OZ area (θ_z)	-0.061***	-0.045*	-0.081***	-0.073*	-0.134
(1=yes)	[-3.49]	[-1.67]	[-2.86]	[-1.77]	[-1.61]
OZ designation-time interaction:					
$\mu_{t=2018.I\&t\geq t_d,z}$	-0.004	-0.054	-0.008	0.125	0.330*
(1=yes)	[-0.11]	[-0.92]	[-0.13]	[1.27]	[1.73]
$\mu_{t=2018.II,z}$	0.068**	0.035	0.079*	0.141**	0.375***
(1=yes)	[2.53]	[0.85]	[1.86]	[2.29]	[3.04]
$\mu_{t=2019.I,z}$	0.048	0.017	0.022	0.182**	0.271*
(1=yes)	[1.58]	[0.35]	[0.47]	[2.43]	[1.91]
$\mu_{t=2019.II,z}$	0.064**	0.048	0.082*	0.028	0.223
(1=yes)	[2.12]	[1.04]	[1.76]	[0.36]	[1.45]
County × Year FE	Yes	Yes	Yes	Yes	Yes
Hedonic controls	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.836	0.849	0.778	0.798	0.739
RMSE	0.372	0.346	0.382	0.278	0.531
N. Observations	12,111	5,251	5,217	1,643	922

Age group / Land:	(I) [1 – 120]	(II) [1 – 30]	(III) [31 – 80]	(IV) [81 – 120]	(V) Land
Panel B: Dependent variable = probability to sell					
OZ area (θ_z)	0.014	0.102***	0.009	0.069	-0.086
(1=yes)	[0.47]	[3.37]	[0.30]	[1.29]	[-0.79]
OZ designation-time interaction:					
$\mu_{t=2018.I\&t\geq t_d,z}$	-0.090**	-0.063	-0.049	-0.199**	-0.053
(1=yes)	[-2.23]	[-1.00]	[-0.85]	[-1.96]	[-0.23]
$\mu_{t=2018.II,z}$	-0.059*	-0.075	-0.024	-0.069	0.192
(1=yes)	[-1.92]	[-1.58]	[-0.55]	[-0.88]	[1.21]
$\mu_{t=2019.I,z}$	-0.058	-0.136**	-0.039	0.171*	0.683***
(1=yes)	[-1.63]	[-2.44]	[-0.77]	[1.80]	[3.75]
$\mu_{t=2019.II,z}$	0.078**	0.124**	0.078	-0.109	0.314
(1=yes)	[2.24]	[2.34]	[1.59]	[-1.08]	[1.63]
County × Year FE	Yes	Yes	Yes	Yes	Yes
Hedonic controls	Yes	Yes	Yes	Yes	Yes
AIC	82,756	42,803	50,808	16,241	8,697
N. Observations	398,712	150,632	183,104	64,976	33,948

Notes: Dependent variable Panel A: log of sales prices per square foot of land. Panel B: (1/0) dummy indicating that a property is sold in a specific quarter. Panel B also includes properties that were not sold between 2017 – 2019. *OZ* = Opportunity zone, with OZ *designation* indicating the transaction took place after designation. Z-stats are given in parenthesis. *** = significant within 99% probability, ** = significant within 95% probability and * = significant within 90% probability. We use the same hedonic controls and control group as in Table 3.

Table 6.
OZ designation effect by property type

Property type:	**(I) Retail**	**(II) Industrial**	**(III) Office**	**(IV) Apartment**
Panel A: Dependent variable = price				
OZ area (θ_z)	-0.156***	0.082**	-0.199***	-0.064**
(1=yes)	[-2.720]	[2.527]	[-4.076]	[-3.025]
OZ designation ($\mu_{t \geq t_d, z}$)	0.06	0.019	0.076	0.057**
(1=yes)	[0.858]	[0.522]	[1.337]	[2.153]
County × Year FE	Yes	Yes	Yes	Yes
Hedonic controls	Yes	Yes	Yes	Yes
Adj. R^2	0.754	0.769	0.832	0.913
RMSE	0.595	0.320	0.379	0.188
N. Observations	2,195	3,510	2,153	4,253
Panel B: Dependent variable = probability to sell				
OZ area (θ_z)	0.019	0.120***	0.025	0.020
(1=yes)	[0.420]	[3.505]	[0.593]	[0.825]
OZ designation ($\mu_{t \geq t_d, z}$)	0.144***	-0.118***	0.183***	-0.027
(1=yes)	[2.629]	[-2.966]	[3.843]	[-0.913]
County × Year FE	Yes	Yes	Yes	Yes
Hedonic controls	Yes	Yes	Yes	Yes
AIC	45,386	77,037	59,082	136,005
N. Observations	162,616	247,952	189,200	428,280

Notes: Dependent variable Panel A: log of sales prices per square foot of land. Panel B: (1/0) dummy indicating that a property is sold in a specific quarter. Panel B also includes properties that were not sold between 2017 – 2019. T-stats and Z-stats are given in parenthesis. *** = significant within 99% probability, ** = significant within 95% probability and * = significant within 90% probability. We use the same hedonic controls and control group as in Table 3.

tracts, we explore the grouping by population density. We adapt the definition of our data provider RCA, grouping transactions in seven major metro areas: New York, Los Angeles, San Francisco, Boston, Chicago, Washington DC and Seattle. Focusing on general designation effects, we group all properties and vacant land into metro areas and non-metro areas (all other), as shown in Table 7. Since we estimate different sub-samples, all effects are relative to control properties within the same group (metro or non-metro).

We note that the seven metro areas account for around 42 percent of our sample. For property prices (Panel A), we find a OZ location discount (θ_z) for existing properties across all OZ census tracts. For vacant land, we only find a location discount in non-metro areas (-44 percent), showing that land values in metro areas are not statistically different across groups. OZ designation shows a positive price effect for existing properties in metro areas (9.5 percent) but not for non-metro areas. For vacant land, we find a significant OZ designation effect across both groups. For probability to sell (Panel B), we find an OZ location premium (θ_z) for existing properties in metro areas (17.1 percent). However, OZ designation lowers the probability to sell for existing properties in metro areas by -14.9 percent. In contrast we find an increase in non-metro areas (3.6 percent). For vacant land, we do not find a significant designation effect in metro areas but an higher probability to sell in non-metro areas (48.3 percent). Overall, our results suggest heterogeneity between metro and non-metro census tracts. OZ designation shows limited effects on existing properties in non-metro areas and vacant land in metro areas.

In Table 8, we distinguish by transaction size, sorting transactions by price into two brackets: up to (and including) $10 million and above $10 million. For price (Panel A), general location effects do not differ for different size groups. Existing properties show a discount, whereas land shows not significant effect. OZ designation effects are limited to larger properties of more than $10 million (9.6 percent) and vacant land below $10 million (20 percent). For probability to sell (Panel B), we document negative OZ designation effects for properties above $10 million (-7.1 percent) and positive effects for land above $10 million (46.8 percent, significant at 10% probability). Due to spatial land value heterogeneity, we cannot rule out that the effects coincide with the estimates in Table 7.

Table 9 examines the spatial spillover effects of OZ designation on eligible (control) census tracts. We find that OZ distance ϕ_t has a negative effect on property prices. One percent increase in distance leads to a price discount of -3.8 percent for existing properties and 34.6 percent for vacant land. For probability to sell we do not find a significant effect. OZ designation shows no significant effect, except for probability sell of existing properties. Contradicting positive spillover effects, the probability to sell of existing properties increases with distance to the OZ census tract relative to other properties in the census tract.

Finally, we test the robustness of our findings with regard to the control census tract selection. Instead of using propensity score matching, we therefore match the OZ census tracts in our sample with random eligible census tract in the same area. Table Appendix B.1 shows the income and poverty statistics by census tract groups, indicating that the difference between OZ and eligible tracts is significantly higher. Table Appendix B.3 shows the results focusing on price. OZ designation effects are of a higher magnitude but generally in line with our previous findings, being predominantly visible for older, redevelopment properties and vacant land.

6. Discussion and Conclusion

Even though the success of the OZ program should ultimately be measured on economic growth, this study provides a first, early analysis on the success factors – institutional investments and property market reactions. Assuming efficient markets, the OZ program should increase property prices as investors price in future expected economic growth, through higher land values. In contrast, if the effects are limited to temporary tax benefits, only qualified properties should show an effect. We therefore examine the effects of OZ designation on commercial properties, comparing to similar properties in eligible, but not designated census tracts.

Our results show that the effect of OZ designation is limited to old properties and vacant land, both qualified for tax benefits. The significant positive price effects for old properties is 6.8 percent, on average. To put this effect in context, we estimated a theoretical tax benefit of approximately 10 to 25 percent in Table 1. However, our empirical estimates cannot be compared to the theoretical effects

Table 7.
OZ designation effect metro areas

	(I) Metro	(II) No-Metro	(III) Metro	(IV) No-Metro
	Existing properties		**Vacant Land**	
Panel A: Dependent variable = price				
OZ area (θ_z)	-0.073***	-0.049**	-0.001	-0.368***
(1=yes)	[-3.027]	[-1.987]	[-0.013]	[-2.967]
OZ designation ($\mu_{t \geq t_d, z}$)	0.091***	0.025	0.254*	0.416***
(1=yes)	[3.071]	[0.828]	[1.930]	[2.736]
County × Year FE	Yes	Yes	Yes	Yes
Hedonic controls	Yes	Yes	Yes	Yes
Adj. R^2	0.824	0.739	0.752	0.625
RMSE	0.322	0.409	0.537	0.492
N. Observations	5,140	6,971	497	425
Panel B: Dependent variable = probability to sell				
OZ area (θ_z)	0.171***	-0.009	-0.010	-0.083
(1=yes)	[11.363]	[-0.611]	[-0.073]	[-0.570]
OZ designation ($\mu_{t \geq t_d, z}$)	-0.149***	0.036**	0.055	0.483***
(1=yes)	[-7.995]	[2.026]	[0.340]	[2.740]
County × Year FE	Yes	Yes	Yes	Yes
Hedonic controls	Yes	Yes	Yes	Yes
AIC	343,526	326,209	5,225	4,633
N. Observations	1,137,372	548,292	20,796	16,932

Notes: Dependent variable Panel A: log of sales prices per square foot of land. Panel B: (1/0) dummy indicating that a property is sold in a specific quarter. Panel B also includes properties that were not sold between 2017 – 2019. T-stats and Z-stats are given in parenthesis. *** = significant within 99% probability, ** = significant within 95% probability and * = significant within 90% probability. We use the same hedonic controls and control group as in Table 3.

directly, as the required capital expenditures are not yet included and unknown to us. Assuming the minimum required capital expenditures are invested (at least equal to purchase price), the price effect of OZ designation on the property before refurbishments should be twice the estimated effect or between 13.6 to 40 percent.[25] Previous literature shows us that the average land value fraction for new buildings is approximately 20% (Bokhari and Geltner, 2018). This means

[25] This calculation is obviously back-of-the-envelope without knowing the actual capital expenditures. If investors would do more capital expenditures, tax benefits would decrease, on average.

Table 8.
OZ designation effect by property value

	(I) <\$10m	(II) >\$10m	(III) <\$10m	(IV) >\$10m
	Existing properties		**Vacant Land**	
Panel A: Dependent variable = price				
OZ area (θ_z)	-0.056***	-0.062*	-0.010	-0.038
(1=yes)	[-2.729]	[-1.876]	[-0.175]	[-0.251]
OZ designation ($\mu_{t\geq t_d,z}$)	0.034	0.092**	0.183**	0.108
(1=yes)	[1.340]	[2.301]	[2.347]	[0.648]
County × Year FE	Yes	Yes	Yes	Yes
Hedonic controls	Yes	Yes	Yes	Yes
Adj. R^2	0.818	0.879	0.913	0.842
RMSE	0.379	0.317	0.256	0.332
N. Observations	8,689	3,422	667	255
Panel B: Dependent variable = probability to sell				
OZ area (θ_z)	-0.008	0.044**	0.032	-0.402*
(1=yes)	[-0.561]	[2.269]	[0.279]	[-1.870]
OZ designation ($\mu_{t\geq t_d,z}$)	0.022	-0.071***	0.199	0.468*
(1=yes)	[1.241]	[-2.989]	[1.447]	[1.882]
County × Year FE	Yes	Yes	Yes	Yes
Hedonic controls	Yes	Yes	Yes	Yes
AIC	333,010	198,543	7,235	2,849
N. Observations	559,204	342,480	27,516	10,212

Notes: Dependent variable Panel A: log of sales prices per square foot of land. Panel B: (1/0) dummy indicating that a property is sold in a specific quarter. Panel B also includes properties that were not sold between 2017 – 2019. T-stats and Z-stats are given in parenthesis. *** = significant within 99% probability, ** = significant within 95% probability and * = significant within 90% probability. We use the same hedonic controls and control group as in Table 3.

that the initial 6.8 % has to be multiplied by 5 to find the possible land value increase is 34% after capital improvements. This effect is approximately in line with our estimated for vacant land price increases of 37.7 percent.

We further examine market liquidity for two reasons (measured by the probability to sell). First, even if designation price effects are insignificant, the program is still a success if more (re)developments would take place, suggesting that more (re)developments became positive NPV projects. This argument is especially important for vacant land and older "redevelopment" properties. Secondly, liquidity tends to move before prices. Given the recentness of the program

Table 9.
Spillover effect on eligible properties

Dependent variable:	**Price**		**Probability to sell**	
	Properties	**Land**	**Properties**	**Land**
Designation nearby ($\omega_{t\geq t_d}$)	0.262**	0.372	-0.343**	-1.069
(1=yes)	[0.049]	[0.544]	[0.011]	[0.209]
OZ distance (ϕ_t)	-0.037***	-0.297***	-0.026	-0.030
(log meters)	[0.007]	[0.000]	[0.120]	[0.710]
Distance*Designation ($\phi_t * \omega_{t\geq t_d}$)	-0.028	-0.035	0.051***	0.093
(log meters)	[0.105]	[0.637]	[0.004]	[0.376]
County × Year FE	Yes	Yes	Yes	Yes
Hedonic controls	Yes	Yes	Yes	Yes
Adj. R^2	0.864	0.816		
RMSE	0.332	0.569		
AIC			65,167	3,032
N. Observations	5,492	527	102,956	4,800

Notes: We focus on transactions in eligible census tracts only, measuring spillover effects. $\omega_{t\geq t_d}$, controls for OZ designation in the nearest OZ census tract and ϕ_t controls for the distance to the nearest OZ property in meters. Our variable of interest is: $\phi_t * \omega_{t\geq t_d}$. T-stats and Z-stats are given in parenthesis. *** = significant within 99% probability, ** = significant within 95% probability and * = significant within 90% probability. We use the same hedonic controls and control group as in Table 3.

and how slow information travels in real estate markets, perhaps we only observe an impact on liquidity at this point. We do not find general effects on liquidity, except for vacant land. However, examining the designation effect over time, we see positive effects in the last half-year of our sample, potentiality providing a silver lining.

Has the opportunity zone program worked? Even though we do not document general price increases, we do find a small increase in liquidity at the end of the sample period. Finding evidence of more vacant land sales, could mean negative NPV projects have turned into zero or positive NPV projects. However, we find a lot of heterogeneity in effects. We can therefore say that the OZ program did not yet show any general effects on land price appreciation. The estimated effects are temporarily and spatially limited, and do not affect all property of all type equally. These findings suggest that investors cherry-pick, which will consequently lead to partly failures of the OZ program.

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Appendix A. Propensity Score Matching

We perform propensity score matching (PSM) to match designated OZ census tracts 1:1 to eligible census tracts, using a simple logit model as shown in equation (A.1) (for details see: Ho et al., 2007). The dependent variable is the final OZ designation status ($OZ_i = 1$) of census tract i. As explanatory variables, we use log median income and poverty rate, as these characteristics were influential for the decision and differ between eligible and designated census tracts. We estimate the model for every NCREIF region separately.

$$OZ_i = \alpha + \tau \ln(\text{income})_i + \delta \text{poverty}_i + \varepsilon_i \tag{A.1}$$

Table Appendix A.1 shows that the explanatory variables are indeed significant for all regions, meaning that median income and poverty rates affected the OZ designation outcome. Based on the coefficients, we fit the model for every census tract and estimate the likelihood of every eligible census tract to be designated ($\bar{OZ_i}$). Finally, we use nearest neighbor matching to match every designated census tract to the runner-up tract in the same region with the highest propensity score.

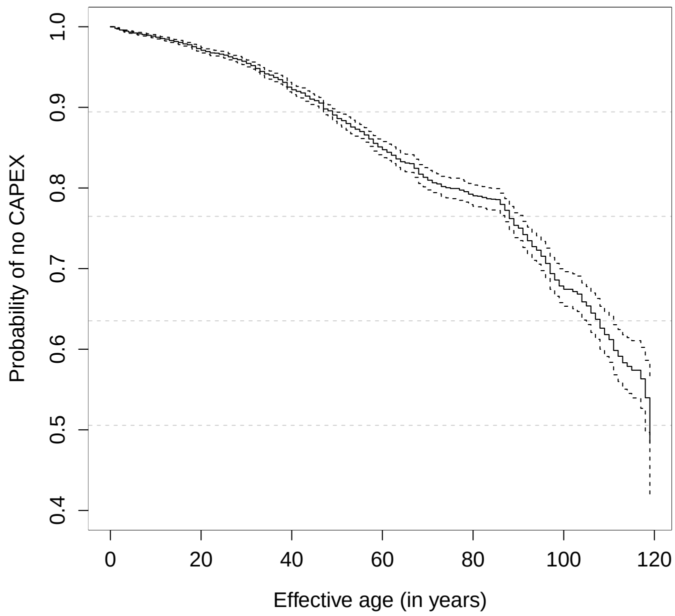
Table Appendix A.1.
Propensity Score Matching estimates

Region	Intercept	Ln median income	Poverty rate	AIC	N
Mid-Atlantic	10.843***	-1.123***	0.493***	1,207	1,110
Midwest	17.577***	-1.794***	0.032***	1,681	1,700
Northeast	7.489***	-0.856***	2.301***	2,103	1,934
Southeast	18.962***	-2.017***	2.375***	2,927	3,481
Southwest	9.032***	-1.057***	1.651***	1,643	1,951
West	15.380***	-1.647***	3.497***	3,498	3,797

Notes: AIC = Akaike Information Criterium. *** = significant at the 1% level. We use a logit model with opportunity zone designation (1/0) as explained variable, comparing eligible with designated census tracts. The scoring is done on a census tract level. Regions are defined by NCREIF (National Council for Real Estate Investment Fiduciaries).

Appendix B.

Figure Appendix B.1.
Kaplan-Meier Curve to CAPEX



Notes: Heavy capital expenditures (CAPEX) are modeled in a Hazard framework. The censoring variable are properties bought with the intent to be completely redeveloped or to undergo a large renovation. Displayed on the x-axis, the baseline is modelled as the effective age of the structure in years, using construction date or date of the last (considerably) renovation. The y-axis shows the percentage of properties left without any heavy CAPEX spending until the corresponding age on the x-axis. The 95% confidence intervals are given by the dotted line.

Table Appendix B.1.
Robustness sample: Income & Poverty Statistics

	Eligible	OZ
Avg. median income	\$44,935	\$35,206
Std.	\$14,730	\$13,256
Poverty rate	0.196	0.282
Std.	0.116	0.135
N.	3,157	3,157

Notes: Socioeconomic census tract characteristics for OZ and random control census tracts. Includes only tracts where repeat sale pairs were observed.

Table Appendix B.2.
Descriptive Statistics - Vacant Land

	Panel A: Transaction Price Dataset				
	(I)	**(II)**	**(III)**	**(IV)**	**(V)**
Variable	**Full**	**Non OZ**	**OZ ($\forall$t)**	**OZ (t<d)**	**OZ (t $\geq$ d)**
Transaction price ($)	$ 10,528	$ 10,292	$ 10,733	$ 9,972	$ 11,264
($\times$ 1,000)	[$ 18,318]	[$ 20,425]	[$ 16,266]	[$ 17,107]	[$ 15,657]
Land size (sqft)	476,183	335,444	599,388	702,691	527,513
	[1,265,128]	[1,054,580]	[1,413,541]	[1,728,601]	[1,141,566]
$\frac{\text{Transaction price}}{\text{Land size}}$	$ 237	$ 264	$ 213	$ 203	$ 221
	[$ 411]	[$ 431]	[$ 392]	[$ 411]	[$ 379]
N. observations	1,129	527	602	247	355
	Panel B: Probability to Sell Dataset				
Variable	**Full**	**Non OZ**	**OZ ($\forall$t)**	**OZ (t<d)**	**OZ (t $\geq$ d)**
Dummy: Sold	0.026	0.024	0.028	0.026	0.029
Land size (sqft)	633,185	485,453	779,042	772,446	784,084
	[3,587,906]	[3,304,049]	[3,842,181]	[3,795,442]	[3,877,672]
N. observations	43,236	21,480	21,756	9,425	12,331

Notes: Opportunity Zone are designated OZ area, with t_d being the date of OZ designation. Standard deviations of the variables are given in square brackets. Column (I) shows the full sample, columns (II) and (III) the sample divided by non OZ and OZ transactions, respectively. Columns (IV) and (V) show transactions within OZ census tracts before and after designation, respectability.

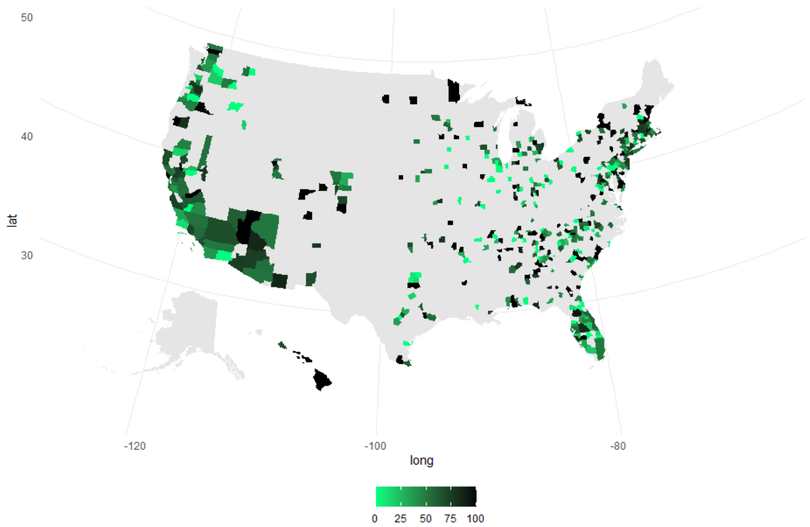
Table Appendix B.3.
Robustness check: alternative control census tracts

	(I)	**(II)**	**(III)**	**(IV)**	**(V)**
Age group / Land:	**[1 – 120]**	**[1 – 30]**	**[31 – 80]**	**[81 – 120]**	**Land**
OZ area (θ_z)	-0.054***	-0.064**	-0.048*	-0.125***	-0.031
(1=yes)	[-3.07]	[-2.41]	[-1.73]	[-2.61]	[-0.43]
OZ designation ($\mu_{t \geq t_d, z}$)	0.049**	-0.002	0.07**	0.171***	0.236***
(1=yes)	[2.32]	[-0.07]	[2.08]	[3.1]	[2.59]
Hedonic controls	Yes	Yes	Yes	Yes	Yes
County $\times$ Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.82	0.826	0.771	0.787	0.838
RMSE	0.37	0.352	0.365	0.293	0.535
N. Observations	12,004	5,394	5,060	1,326	1,178

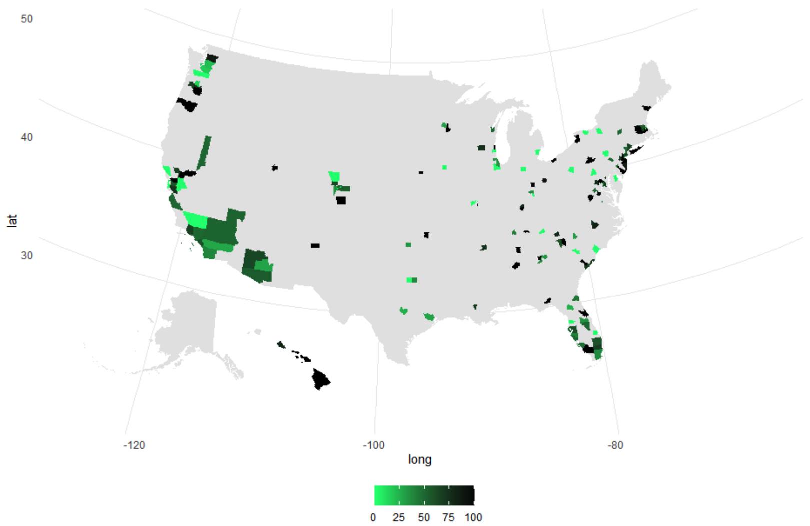
Notes: Dependent variable = log of sales prices per square foot of land. *OZ* = Opportunity zone, with OZ *designation* indicating the transaction took place after designation. T-stats are given in parenthesis. *** = significant within 99% probability, ** = significant within 95% probability and * = significant within 90% probability. We use the same hedonic controls and control group as in Table 3. The control group consists of transactions or development sites in eligible randomly selected eligible census tracts.

Figure Appendix B.2.
Sample: Opportunity Zones vs Control Groups

(a) Existing Properties



(b) Redevelopment Sites



Notes: Grey areas = no observations or excluded from the sample. Lighter color corresponds with more transactions in the control group in that county, dark (black) color represents counties dominated by opportunity zones. The control group consists of transactions in census tracts with similar median income and poverty levels and that were made eligible but did not get designated OZ.