Zoning Regulations: Have We Confused the Cure with the Disease?

Nathaniel Harris* and Chuanhao Lin†

April 1, 2022

Abstract

Previous empirical research has demonstrated that indexes of urban planning restrictions are associated with higher housing prices. Many economists argue that this relation is caused by a decrease in the supply of housing compared to a laissez-faire city. City planners and some detailed testing argue that this relation is caused by an increase in the attractiveness of a city. This paper demonstrates theoretically that, in the presence of building density externalities, both are correct, and that the optimality of planning regulations cannot be determined by the relation between housing prices and regulation. Theory implies that the welfare effects of urban planning can be tested using aggregate land value, which can be shown to provide a dispositive measure of the welfare effects of urban planning. Empirical tests indicate that the relation between past patterns of planning regulation and current aggregate land rent is positive, implying that planning is a remedy for problems of overbuilding under laissez-faire land development.

*Department of Economics, George Washington University, nharris58@gwu.edu
†Department of Economics, George Washington University, linch@gwu.edu

1. Introduction

How do building restrictions affect aggregate welfare in a city? To answer this question, previous economic research has relied on the relation between indexes of urban planning restrictions and housing prices. A variety of tests involving levels, rates of change, and supply elasticity has demonstrated empirically that indexes of urban planning restrictions increase housing prices (Segal and Srinivasan (1985), Malpezzi (1996), Mayer and Somerville (2000), Green et al. (2005), Glaeser et al. (2005), Quigley and Raphael (2004), Saiz (2010), Turner et al. (2014)). This established empirical relation has been used to argue that urban planning restrictions decrease the supply of housing compared to a laissez-faire city. City planners, on the other hand, use this fact to argue in favor of planning, contending that this relation is caused by an increase in the attractiveness of a city. There is also empirical evidence that density makes housing less attractive. This paper demonstrates theoretically that, in the presence of building density externalities, both are correct, and that the optimality of planning regulations cannot be determined by the relation between housing prices and regulation. Consequently, this research explores the optimality of urban planning using aggregate land value rather than housing prices. As opposed to housing prices, aggregate land value provides a dispositive measure of the welfare effects of urban planning, because they internalize externalities associated with laissez-faire development and gains or losses due to regulatory restrictions on that development.

The rest of this paper is organized as follows. The next section presents a theoretical model of urban land use that considers possible effects of density externalities and effects of urban planning on housing prices, aggregate land value, and aggregate welfare. Section 3 then discusses the specification strategy used to test the optimality of urban planning. The data, which is due to recently developed estimates of aggregate land value in cities, is described in Section 4. Section 5 reports main results and interprets them using theory, and the final section concludes.

2. Literature

The effect of urban planning on cities has been studied using empirics and economic theory. Substantial attention has been given to the effect of land use and transportation policies on the supply of labor in large cities. These policies have both costs and benefits, affecting housing affordability, access to employment, and urban amenities. Recently, substantial research, Herkenhoff et al. (2018), Glaeser and Gyourko (2018), and Hsieh and Moretti (2019), among others, have argued that a regulation-induced increase in housing costs in highly productive cities could induce costly failure in the national allocation of labor and capital, with consequential effects on U.S. output and economic growth. Hsieh and Moretti (2019) famously claim that land-use regulations have reduced the growth rate of aggregate output by 36 percent between 1964 and 2009, reducing GDP by 3.7 percent and reducing average annual earnings per worker by 3,685 dollars by limiting growth of cities due to elevated housing prices. Our results suggest that the long-run effects of land-use regulations on the cost of labor cannot be based on housing prices because higher housing prices may be the result of greater urban amenity produced by planning restrictions on laissez-faire housing markets. The results presented here are consistent with Monte et al. (2018) and Larson et al. (2018) who find using very different approaches, that the elasticity of labor supply is primarily a function of transportation systems rather than land use planning.

The effect of regulations on the cost of labor has two main channels. First, there is the housing cost channel, which has been exhaustively studied in seminal papers by Segal and Srinivasan (1985), Malpezzi (1996), Mayer and Somerville (2000), Green et al. (2005), Glaeser et al. (2005), Quigley and Raphael (2004), Saiz (2010), Turner et al. (2014). These papers estimate models of the relation between indexes of land use planning regulations and the price of housing, construction of new units, and/or the price elasticity of housing supply. The empirical results all indicate a significant negative (positive) relation between the strength of regulation and housing supply (housing price).

Second, regulations affect the cost of labor by potentially offsetting negative population density externalities. Density externalities make housing less attractive. To few a couple of empirical studies on density externalities, Shoag and Veuger (2019) develop a measure of restaurant quality and show that more restrictions on land use are associated with access to higher-quality and more-diverse restaurants. Kuang (2017) shows that the quality of surrounding restaurants is capitalized in the value of nearby housing. Flemming et al. (2018) show that each extra daily hour of sunlight exposure is associated with a 2.6 percent increase in house sale price. Borck and Schrauth (2021) show that higher population density worsens local air quality, which presumably lowers housing prices. Likewise, theoretical papers have explored urban policy, such as height restrictions (Bertaud and Brueckner (2005), Larson et al. (2018)) and greeenbelts (Larson et al. (2012)). A recent study, Lin (2021), combines theory and empirics to study building height externalities. Lin (2021) finds a statistically significant negative effect of adjacent building height on rent.

3. Theory

The theoretical analysis of urban planning applies the standard urban model (SUM).[1] While much of the application of the model is standard, it differs in focusing explicitly on building heights and on the possibility that there is an externality associated with height, which can be addressed by planning restrictions. By formulating the problem as an open city model with costless migration and either fixing wages or population, the welfare effects of laissez faire versus a planned city can be evaluated explicitly in terms of changing aggregate land value. Consequences for housing prices, the object of previous empirical testing, are also be developed.

As noted above, the open city models developed here consider cases where population is fixed and wages vary and another where wages are fixed and population varies. Then, for each type of city, it is necessary to consider the cases where building height externalities do and do not exist. Finally, for each type of open city with building height externalities, the possibilities that planning addresses or does not address the building height externality are considered. It is necessary to address all these possibilities so that the implications of testing the relation between planning regulations and both housing prices and land prices can be determined.

[1] Mills (1967) , Muth (1969)

3.1 A city without height externalities

Begin with the basic setup of the SUM. Households consume a composite good, c, and housing space, q. Households maximize $U = v(c, q)$ subject to budget a constraint, namely, $y - tx = c + pq$, where y is income, p is housing price per square foot, t is travel cost, and distance to city center is indexed by x. The first order condition of the household's problem and the iso-utility condition, $v(c, q) = u, \forall x$, determine housing prices and housing demand.

$$p(x, y), \quad q(x, y), \quad p_x < 0, p_y > 0, q_x > 0, q_y < 0 \tag{1}$$

In contrast with the standard SUM, developers choose building height to maximize profits. Housing output measured in square feet of floor space is the product of the number of stories (h) and land (l). Competitive housing builders maximize profit by choosing h and l. Construction cost is a function of building height $S(h)$. It is assumed that $S' > 0, S'' > 0$. r is the land rent per unit land paid to absentee landlords. Because the amount of land use is indeterminate, builders maximize profit per unit land in a laissez-faire city. Formally, developers maximize $p(x, y)h - S(h) - r$. The first order condition $p(x, y) = S'(h)$ determines building height, and the zero profit condition, $r = p(x, y)h - S(h)$, determines land rents.

$$h(x, y), \quad r(x, y), \quad h_x < 0, h_y > 0, r_x < 0, r_y > 0 \tag{2}$$

To close the model, the following two equations must be satisfied:

$$r(\bar{x}, y) = r_a \tag{3}$$

$$\int_0^{\bar{x}} 2\pi\theta \frac{h(x, y)}{q(x, y)} dx = N \tag{4}$$

In the case of an open city with a constant population, the city radius, $\bar{x}$, and wage, y, are determined simultaneously by equation 3 and 4. In the case of an open city with a constant wage, city radius $\bar{x}$, and population N, are solved by the two equations.

Proposition 1. *In the absence of a local height externality, imposing binding height restriction at some location (1) In a city with flexible wage and fixed population, regulation raises house prices at all locations; it raises the land rent at unrestricted locations, but the effects on land rent at the restricted locations and on aggregate land rent are ambiguous. It reduces total welfare, measured as the aggregate land rent minus the sum of wage. (2) In a city with flexible population and fixed wage, regulation has no effect on house price, but reduce land rent and population.*

(Proof) (1) In a wage-varying city, height restriction makes the city sprawl and raises wage. To show this, let $\bar{x}_1$ and y_1 be the solutions for the restricted city and $\bar{x}_0$ and y_0 for the laissez-faire city. There are four possible cases here: (1) $\bar{x}_1 > \bar{x}_0, y_1 > y_0$ (2) $\bar{x}_1 > \bar{x}_0, y_1 < y_0$ (3) $\bar{x}_1 < \bar{x}_0, y_1 > y_0$ (4) $\bar{x}_1 < \bar{x}_0, y_1 < y_0$. But only the first case $\bar{x}_1 > \bar{x}_0, y_1 > y_0$ is true.[2]

Higher wage in the restrictive city will then affect house price and land rent throughout the city. Given that $y_1 > y_0$, and $p_y(x, y) > 0$, it is apparent that $p(x, y_1) > p(x, y_0)$ for all x. It indicates that at every location, the restricted city has a higher level of house price. For locations that non-restricted, land rent, $r(x, y_1) > r(x, y_0)$. For restricted location, effect on land rents are ambiguous. Land rent is $\tilde{r}(x, y, h) = p(x, y)h - S(h)$. Suppose at some location the restricted height is $\bar{h}$ and land rent is $p(x, y)\bar{h} - S(\bar{h})$ On one hand, restriction raises wage in the restricted city and raise land rent as $\tilde{r}_y = p_y(x, y)h > 0$. On the other hand, the height restriction reduces land rent. The derivative with respect to height is $\tilde{r}_h = p(x, y) - S'(h)$ and the second derivative is $\tilde{r}_{hh} = -S''(h) < 0$. Laissez-faire developer's first order condition requires $p(x, y) - S'(\hat{h}) = 0$ hold. These conditions implies that at the restricted height $p(x, y) - S'(\bar{h}) > 0$, which means that relaxing height restriction increases land rent.

In the absence of externality, the laissez-faire city is socially optimal. Note that in the literature for an open city with varying wage, the total welfare is measured by aggregate land rent minus the sum of wages (Larson and Yezer, 2015). The planner's problem is maximization of aggregate

[2] To rule out case 2 and 3, noted that $r_x < 0$, $r_y > 0$, and at the edge of both cities land rent must equate agriculture land rent. To rule out case (4), suppose it is true that $y_1 < y_0$, then it must be $h(x, y_1) < h(x, y_0), q(x, y_1) > q(x, y_0)$. That is at unrestricted areas, population density must be lower in the restricted city. For restricted areas, because $\bar{h}(x) < h(x, y_1) < h(x, y_0)$, the restricted city must also have lower population density than the laissze-faire city. This contradict with the premise that $\bar{x}_1 < \bar{x}_0$, since restricted city can't have lower population density everywhere and a small city radius to host the same amount of people.

land rents minus total compensated wage:

$$\int_0^{\bar{x}} 2\pi\theta x[p(x)h(x) - S(h(x)) - r_a]dx - Ny$$
$$+ \int_0^{\bar{x}} \lambda(x)[v(c(x), q(x)) - u]dx + \int_0^b \delta(x)[y - c(x) - tx - p(x)q(x)]dx \quad (5)$$

The first-order conditions that characterize the city are:

$$c(x) : \lambda(x)v_c - \delta(x) = 0 \quad (6)$$

$$q(x) : \lambda(x)v_q - \delta(x)p(x) = 0 \quad (7)$$

$$h(x) : 2\pi x[p(x) - S'(h)] = 0 \quad (8)$$

$$p(x) : 2\pi xh(x) - \delta(x)q(x) = 0 \quad (9)$$

$$\bar{x} : 2\pi\bar{x}[p(\bar{x})h(\bar{x}) - S(\bar{x}) - r_a = 0 \quad (10)$$

$$y : -N + \int_0^b \delta(x)dx = 0 \quad (11)$$

These conditions can be rewritten as:

$$\frac{v_q}{v_c} = p(x) \quad (12)$$

$$p(x) = S'(h) \quad (13)$$

$$p(\bar{x})h(\bar{x}) - S(\bar{x}) = r_a \quad (14)$$

$$N = \int_0^b 2\pi x \frac{h(x)}{q(x)} dx \quad (15)$$

Along with two constraints:

$$v(c(x), q(x)) = u, 0 \leq x \leq b \quad (16)$$

$$y = c(x) + t(x) + p(x)q(x), 0 \leq x \leq b \quad (17)$$

Note that these are the same sets of the equations that characterizes the laissez-faire city. Thus, the laissez-faire city maximizes the total welfare measured by aggregate land rent net of sum of household wage. Any restriction on height would distort this optimum and lower total welfare.

(2) In an open city with varying population, while land rent function depends on y or u, but since these two parameters are already predetermined. Unless height restriction is imposed at the edge of the city, there is no change in city radius. Because income and utility are fixed, house price are determined only household's problem and are not affected by height/density restriction. While height restriction has no effect on house price, it reduce land rent at the restricted location. To see this, noting that land rent can be rewritten as: $\tilde{r}(x, y, h) = p(x, y)h - S(h)$. The first partial with respect to h is $\tilde{r}_h = p - S'(h)$. The second partial with respect to h is $\tilde{r}_{hh} = S''(h) > 0$. Profit maximizing implies: $p = S'(= \hat{h})$. So any other height $\bar{h}$ that is different from $\hat{h}$ will result is a lower land rent at the restricted location. At locations that do not have height restrictions, land rent functions are unaffected.

Planner's problem is to maximize aggregate land value.

$$\max_{h(x),\bar{x}} \int_0^{\bar{x}} 2\pi x\theta[p(x))h(x) - S(h(x))]dx + \int_{\bar{x}}^{\bar{m}} 2\pi x r_a dx \tag{18}$$

Where $\bar{m}$ is the geographic boundary of city. The first part of Eq. 41 is residential land value, and the second part is agricultural land value. The planner's first-order necessary conditions are:

$$h(x) : p(x, h(x)) = S'(h(x)), \forall x \tag{19}$$

$$\bar{x} : p(\bar{x}, h(\bar{x}))h(\bar{x}) - S(h(\bar{x})) = r_a \tag{20}$$

Equation 19 shows that planner's solution for building height is identical to that of the laissez-faire city.

3.2 The city with height externalities

In this section height externalities are added to the SUM, following Lin (2021). Suppose that households are adversely affected by neighboring height(H), ($v_H < 0$). They maximize utility

$$U = v(c, q, H) \tag{21}$$

Subject to budget constraint $c + pq = y - tx$

The first-order condition for utility maximization is:

$$\frac{v_q(y - tx - pq, q, H)}{v_c(y - tx - pq, q, H)} = p \tag{22}$$

Since households are identical, in equilibrium, households must have the same level of utility: $v(y - tx - pq, q, H) = \bar{u}$. FOC and iso-utility condition simultaneously determine household's bid rent curve for housing space p and housing demand q in terms of location x, wage y, and local density H:

$$p(x, y, H), q(x, y, H) \tag{23}$$

Rewrite iso-utility condition as $v(y - tx - p(x, y, H)q(x, y, H), q(x, y, H), H) = \bar{u}$. Differentiate against x and makes use of the FOC yields the following similar results as in the city without height externality.

$$p_x = \frac{-t}{q} < 0, \quad p_y = \frac{1}{q} > 0, \quad p_H = \frac{v_H}{v_c q} < 0 \tag{24}$$

As house price varies with x and H, housing demand would also adjust so that households maintain the same level of utility[3].

$$q_x = q_p^h p_x > 0, \quad q_y = q_p^h p_y < 0, \quad q_H = q_p^h p_H + q_H^h > 0 \tag{25}$$

[3] Solve for household's expenditure minimization problem gives the compensated Hicksian demand for housing $q^h(p, u; H)$. An increase in H would require greater consumption to compensate for utility lost, or $q_H^h > 0$. Substitute the house price function result in the following identity: $q(x, y, H; u) \equiv q^h(p(x, y, H; u), u, H)$. Then differentiate the identity.

Formally, builders $\max_h p(x, y, H)h - S(h) - r$. The first-order condition is:

$$p(x, y, H) = S'(h) \tag{26}$$

The second-order sufficient condition for Laissez-Faire developers is satisfied given that construction cost is strictly convex $S'' > 0$. The FOC implicitly defines the builder's solution at a given location and for a particular level of neighborhood density: $h(x, y, H)$. As in the standard model, competition among builders implies each builder earn zero profit. So that land rent is: $r(x, y, H) = p(x, y, H)h(x, y, H) - S(h(x, y, H))$

Differentiation and making use of FOC yields the following:

$$r_x = p_x h(x, d) + [p(x, H) - S'(h)]h_x = p_x h(x, y, H) < 0 \tag{27}$$

$$r_y = p_y h(x, y, H) + [p(x, H) - S'(h)]h_y = p_y h(x, y, H) > 0 \tag{28}$$

$$r_H = p_H h(x, d) + [p(x, H) - S'(h)]h_H = p_H h(x, y, H) < 0 \tag{29}$$

So far, H is treated as given by household and builders. But at the equilibrium, at any location, any household's decision must be consistent with his neighbors' decisions, or $H(x) = h(x)$:

$$p(x, y, h) = S'(h) \tag{30}$$

This solves for $\hat{h}(x, y)$. Implicitly differentiate yields the following:

$$\hat{h}_x = \frac{p_x}{(S'' - p_H)} < 0, \quad \hat{h}_y = \frac{p_y}{(S'' - p_H)} > 0 \tag{31}$$

The laissez-faire city's key variables can be written in term of important parameters x and y:

$$\hat{r}(x, y) = r(x, y, \hat{h}(x, y)), \quad \hat{p}(x, y) = p(x, y, \hat{h}(x, y)), \quad \hat{q}(x, y) = q(x, y, \hat{h}(x, y)) \tag{32}$$

To discuss the effect of density regulations on land rent and house price, it is important to know how p, q, r respond to a change in wage. First, for house price, it can be shown that house price falls with distance and increases with city wage.

$$\hat{p}_x = p_x + p_H \hat{h}_x = \frac{p_x S''}{S'' - p_H} < 0 \tag{33}$$

$$\hat{p}_y = p_y + p_H \hat{h}_y = \frac{p_y S''}{S'' - p_H} > 0 \tag{34}$$

The above results can be signed without ambiguity and says that house price falls with distance, higher income raises house price. Both are similar to the city without height externality. Now consider the comparative result for floor space:

$$\hat{q}_x = q_x + q_H \hat{h}_x = \frac{q_x(S'' - p_H) + q_H p_x}{S'' - p_H} = \frac{p_x(q_p^h S'' + q_H^h)}{S'' - p_H} >< 0 \tag{35}$$

$$\hat{q}_y = q_y + q_H \hat{h}_y = \frac{q_y(S'' - p_H) + q_H p_y}{S'' - p_H} = \frac{p_y(q_p^h S'' + q_H^h)}{S'' - p_H} >< 0 \tag{36}$$

The ambiguity arises due to $q_p^h S'' + q_H^h$ can be positive or negative. While the sign $\hat{q}_x$ and $\hat{q}_y$ is not known, usual observation suggests that $\hat{q}_x > 0$. Suppose the conventional observation of consumption of floor space increases with distance from CBD does hold, so that $\hat{q}_x > 0$. Then $\hat{q}_y < 0$ must be true.

For land rent:

$$\hat{r}_x = r_x + r_H \hat{h}_x = r_x + \frac{r_H p_x}{S'' - p_H} = \frac{r_x S''}{S'' - p_H} < 0 \tag{37}$$

$$\hat{r}_y = r_y + r_y \hat{h}_x = r_y + \frac{r_H p_y}{S'' - p_H} = \frac{r_x S''}{S'' - p_H} < 0 \tag{38}$$

Finally, the model is closed by setting land rent at the edge of the city must equal agricultural land rent:

$$\hat{r}(\bar{x}, y) = r_a \tag{39}$$

$$\int_0^{\bar{x}} 2\pi\theta \frac{\hat{h}(x, y)}{\hat{q}(x, y)} dx = N \tag{40}$$

Similarly, two possibilities for height externalities are considered here.

The following summarize the effect of regulation on a city with height externality.

Proposition 2. *In the presence of a local height externality, optimal planning requires a regulatory restriction or a tax on density (1) In wage varying city, optimal planning raises house prices, and total welfare measured as the aggregate land rent minus the sum of wage differences. (2) In population varying city, regulation raises house price and aggregate land rent.*

Proof. (1) For wage varying city, any restriction on maximum height will make the city sprawl and raises household wage. Similar to the case without height externality, the other three cases can be ruled out given that the city with height externality also satisfy: $\hat{r}_x < 0, \hat{r}_y > 0, \hat{h}_y > 0, \hat{q}_y < 0$.

Planner's objective is to maximize total welfare, which equals to aggregated land rent minus the sum of compensated wage. Since planner maximize total welfare, and sum of wage increases, aggregated land rent must be higher in the planned city.

(2) In the population varying city, optimal building height is always below laissez-faire city height. Lower building height raises house price as $p_h < 0$.

The planner's optimal solution requires a regulatory tax on building height. In an open city with constant wage and varying population, planner maximized aggregate land rent:

$$\max_{h(x),\bar{x}} \int_0^{\bar{x}} 2\pi x\theta[p(x,h(x))h(x) - S(h(x))]dx + \int_{\bar{x}}^{\bar{m}} 2\pi x r_a dx \quad (41)$$

The solution to height is:

$$h(x) : p_H(x,h(x))h(x) + p(x,h(x)) = S'(h(x)), \forall x \quad (42)$$

Comparing Eq. 30 and Eq. 42, while the laissez-faire builder builds up to the point where the house price equals marginal construction cost; but the planner chooses a height where housing price exceeds marginal construction cost. The extra term, $p_H(x,h)h$, is the external social cost of an additional floor. Thus, imposing a cost on developers equal to this externality is land rent maximizing.

The laissez-faire equilibrium has a higher level of housing price, lower level of housing consumption, and a higher level of land rent at all locations where the height externality exists than the social optimum.

3.3 Summary of theoretical results

A summary of the theoretical results can be found in the first table of Appendix A, labelled as Table of Theoretical Results. As seen in the table, if there is uncertainty about the type of city, uncertainty about the existence of a negative building density externality, and uncertainty about the ability of planners to properly internalize negative building density externalities, then neither the relation between housing price and land-use regulation nor the relation between aggregate land rent and land-use regulation is a sufficient condition for determining the optimality of land-use regulation.

On the other hand, since aggregate land rent is part of the total welfare calculation in both types of cities (Sullivan (1985), Wheaton (1998), Larson and Yezer (2015)), the relation between aggregate land rent and land-use regulation is a necessary condition for determining the optimality of land-use regulation, while the relation between house price and land-use regulation is neither a necessary nor a sufficient condition. In the traditional open city with a varying population, aggregate land rent is a direct measure of aggregate welfare, while in an open city with a varying wage, aggregate welfare is measured by aggregate land rent minus the sum of wage differences. Thus, when there is uncertainty about the type of city, uncertainty about the existence of a negative building density externality, and uncertainty about the ability of planners to properly internalize negative building density externalities, then the optimality of land-use regulation can be sufficiently determined by comparing the effect of land-use regulation on aggregate land rent with the effect of land-use regulation on wages.

The Table of Theoretical Results also shows that the results vary across city type. In a population-varying city, a positive relation between house price and land-use regulation is a necessary and sufficient condition for determining that land-use regulation is aggregate welfare enhancing; the same is true about a positive relation between aggregate land value and land-use regulation in a population-varying city. In a wage-varying city, a positive relation between house price and land-use regulation is neither necessary nor sufficient for determining the welfare effects of land-use regulation; the same is true for a positive relation between aggregate land rent and land-use regulation. However, in a wage-varying city, a necessary and sufficient condition for determining that land-use regulation is aggregate welfare enhancing is that the effect of land-use regulation on aggregate land rent is greater than the effect of land-use regulation on total compensating wages. For example, if land-use regulation has a positive effect on aggregate land rent and a negative effect on wages, then land-use regulation is aggregate welfare enhancing. Because the data used in this paper are generated by open cities, population and earnings measures are both included in the stochastic specification.

4. Stochastic specification

In the previous section, economic theory was used to explore the possible effects of urban planning on housing prices, aggregate land value, and aggregate welfare in models with and without density externalities. This section discusses the stochastic specification used to test the effects of planning regulation on housing price and land values. Consider the following equation, where urban planning regulation, P, and a set of covariates, X, determines aggregate land value, R.

$$R = \beta_0 + \beta_1 P + \mathbf{X}\beta + \epsilon_1 \tag{43}$$

In order to test the central hypothesis regarding the welfare effects of planning regulation reflected in available measures, estimates of β_1 are required.

$$R = \hat{\beta}_0 + \hat{\beta}_1 P + \mathbf{X}\hat{\beta} + \epsilon_2 \tag{44}$$

Because the data are generated by open cities, population and earnings measures are included in equation (43) in order to apply the theoretical results for open cities discussed in the theory section.

In estimating β_1, three potential sources of bias need to be considered: attenuation bias, omitted variable bias, and simultaneity bias. Attenuation bias, due to measurement error in the indexes of planning regulation, biases $\hat{\beta}_1$ towards zero, regardless of the true sign of β_1. Thus, attenuation bias reduces the likelihood of obtaining statistical significance. Concerning omitted variable bias, there is the possibility that the effects of and need for planning depend on amenity of the city due to natural features. As a result, standard amenity and topography variables are added to determine if omitted variable bias is a problem.

Lastly, in estimating β_1, the possibility that regulations are caused by current land values is not a significant concern because the Harris (2021) land values are based on underlying data from 2012 to 2018 transactions and the Albouy measures come from 2005 to 2010 transactions. The indexes of planning regulation are from regulations observed in 2006 and 2018 and are the result of planning decisions implemented decades earlier. Simply put, most planning regulations predate the property transactions used to create the land value estimates by decades. The regulation measures in 2006 and in 2018 reflect legislation that has been in place for decades (McDonald and Mcmillen (2012)). For example, Washington, D.C. height limits were imposed in 1910. Similarly, there was a wave of regulation that began in the 1920s. Lastly, park and open space dedication reflects planning decisions made in the mid-20th century. Based on the timing and political nature of past regulation, it is unlikely that current land values caused past regulation.

The theoretical results also establish an expected relation between urban planning and housing prices, p.

$$p = \hat{\alpha_0} + \hat{\alpha_1} P + \mathbf{X}\hat{\alpha} + \nu_1 \tag{45}$$

This paper also tests for concavity by including the square of indexes of urban planning in the estimations.

$$R = \bar{\beta_0} + \bar{\beta_1} P + \bar{\beta_2} P^2 + \mathbf{X}\bar{\beta} + \epsilon_4 \tag{46}$$

$$p = \bar{\alpha_0} + \bar{\alpha_1} P + \bar{\alpha_2} P^2 + \mathbf{X}\bar{\alpha} + \nu_2 \tag{47}$$

These subsequent analyses are subject to the same biases discussed above.

5. Data

The two outcome variables in this paper include aggregate land values and median housing rents. Median housing rents are obtained from the 2019 American Community Survey (ACS). Aggregate land values are estimated by Albouy et al. (2018) and Harris (2021). These studies are used because they are the only two papers to estimate cross-sectionally comparable aggregate land values. Likely, lack of data explains why the tests reported here were not performed earlier. Albouy et al. (2018) construct aggregate land values for every U.S. metropolitan area using observed land sales from the CoStar COMPS database. To estimate aggregate land value, the paper integrates land rent gradients over the land area of each city. The city hall is used to determine the central business district (CBD) and the 1999 OMB definitions of Metropolitan Statistical Areas (MSAs) is used to determine the city edge. Due to insufficient sample sizes for each city, the study estimates a meta-city land value gradient and uses this single land value gradient to estimate aggregate land values across all 331 U.S. metropolitan areas.

Rather than relying on vacant or near-vacant land sales, Harris (2021) estimates the aggregate land value for 30 major U.S. cities using economic theory and indirect measures. Land values, estimated by Davis et al. (2019), are based on home values and used to estimate land value gradients. As noted by Harris (2021), this avoids the problems with using vacant land sales, which are selected, nonstandard, and influenced by regulation and site buildability in ways that are difficult to observe. Aggregate land values are estimated by integrating city-specific land value gradients over aggregate, buildable land area. The central business district is determined by the 1982 U.S. Census after Holian (2019) and metropolitan boundaries are determined by estimating population density gradients.

Following the literature, the strength of land use planning restrictions in each city is measured by the 2006 and 2018 Wharton Residential Land Use Regulatory Index (WRLURI) (Gyourko et al. (2008), Gyourko et al. (2019)). The WRLURI is based on a nationwide survey of residential land-use regulations in around 2,500 communities in the US. The 2006 WRLURI includes 293 metropolitan statistical areas and the 2018 WRLURI includes 543 core-based statistical areas. Consistent with both papers, the degree of planning restriction is based on using two measurements: the average WRLURI and the fraction of highly regulated communities, defined by WRLURI> 0.64.

For estimations that use aggregate land values from Albouy et al. (2018), control variables include aggregate land area, population, skill intensity ratios (SIR), fraction of employment in the information industry, and median earnings. For estimations that use aggregate land values from Harris (2021), the same controls are included as well as the crime rate, the number of days below 32°F in 2018, the number of days above 90°F in 2018, and a dummy variable indicating whether the center of the city is 15 miles from the coast. Skill intensity ratios (SIRs), the fraction of employment in the information industry, and median earnings come from the 2019 American Community Survey (ACS). 2017 crime rate comes from the Federal Bureau of Investigation (FBI). Temperature statistics come from the National Oceanic and Atmospheric Administration (NOAA). Aggregate land areas come from Albouy et al. (2018) and Harris (2021). Estimations using aggregate land values from Albouy et al. (2018) obtain population from the 2019 ACS and estimations using aggregate land values from Harris (2021) obtain population directly from his paper.

After merging data sets, 266 observations remain estimations using aggregate land values from Albouy et al. (2018) and the 2006 WRLURI, 181 observations remain for estimations using aggregate land values from Albouy et al. (2018) and the 2018 WRLURI, 30 observations remain for estimations using aggregate land values from Harris (2021) and the 2006 WRLURI, and 29 observations remain for estimations using aggregate land values from Harris (2021) and the 2018 WRLURI.

6. Results

Estimated effects of urban planning on housing prices are discussed first and can be found in Tables 1-4 (Appendix A). Tables 1-2 use cities found in Albouy et al. (2018) and Tables 3-4 use cities found in Harris (2021). Tables 1 and 3 use the average WRLURI as the index of urban planning and Tables 2 and 4 use the fraction of highly regulated communities (WRLURI>.64) as the index of urban planning. Each table progressively adds control variables.

Tables 1-2 indicate that urban planning has a positive effect on housing prices, with statistical significance at the one-percent level. Table 3-4 indicate that urban planning has a statistically significant positive effect on housing prices for all estimation using the 2018 WRLURI. For estimations using the 2006 WRLURI, urban planning has a statistically significant positive effect on housing prices up until adding the entire list of control variables. These results provide additional evidence that urban planning raises housing prices in cities. These results are consistent with both the theory of this paper and with the rest of the empirical literature.

Estimated effects of urban planning on aggregate land values are found in Tables 5-8 (Appendix A). Tables 5-6 use aggregate land values from Albouy et al. (2018) and Tables 7-8 use aggregate land values from Harris (2021). Tables 5 and 7 use the average WRLURI as the index of urban planning and Tables 6 and 8 use the fraction of highly regulated communities (WRLURI>.64) as the index of urban planning. As before, each table progressively adds control variables.

Estimations that use aggregate land values from Albouy et al. (2018) indicate that urban planning has a positive effect on aggregate land values, with statistical significance at the one-percent level (Tables 5-6). The aggregate area, the population, the SIR, the fraction of employment in the information industry, and median earnings also have a statistically significant positive effect on aggregate land values (Tables 5-6). Estimations that use aggregate land values from Harris (2021) indicate that urban planning has a statistically significant positive effect on aggregate land values up until adding the entire list of control variables. These empirical results provide suggestive evidence that urban planning increases aggregate land value and aggregate welfare in cities.[4]

Tables 1-8 (Appendix B) add the square of indexes of urban planning to the estimations above and repeat the same analyses. Estimations using the 2006 WRLURI provide some evidence that the relation between urban planning and housing prices is concave (Tables 1-4, Appendix B). Estimations using the 2018 WRLURI provide little evidence that the relation between urban planning and housing prices is concave (Tables 1-4, Appendix B). Similar results are obtained using aggregate land values. Estimations using the 2006 WRLURI provide some evidence that the relation between urban planning and aggregate land values is concave (Tables 5-8, Appendix B). Estimations using the 2018 WRLURI provide little evidence that the relation between urban

[4]Estimated effects of land-use regulation on wages is forthcoming.

planning and aggregate land values is concave, as effects are mostly insignificant (Tables 5-8, Appendix B).

7. Conclusion

There is an on-going contention between economists and urban planners as to whether urban planning helps or hurts cities. Arguments from both sides often rely on the empirical fact that urban planning restrictions increase housing prices. Economists maintain that urban planning increases housing prices in a city because it decreases the supply of housing compared to a laissez-faire city. City planners, on the other hand, argue that urban planning increases housing prices in a city because it makes the city more attractive. This paper demonstrated theoretically that, in the presence of building density externalities, both are correct, and that the optimality of planning regulations cannot be determined by the relation between housing prices and regulation. Rather than relying on housing prices, this research explored the optimality of urban planning using aggregate land value. It was demonstrated theoretically that, under certain conditions, aggregate land value provides a dispositive measure of the welfare effects of urban planning. Furthermore, interpreting the empirical results through the lens of theory suggests that urban planning may be beneficial for cities. These results go against the mainstream narrative in economics, which contends that urban planning hurts aggregate welfare in cities.

References

Albouy, D., Erlich, G., and Shin, M. (2018). Metropolitan land values. *Review of Economics and Statistics*, 100:454–466.

Bertaud, A. and Brueckner, J. K. (2005). Analyzing building-height restrictions: predicted impacts and welfare costs. *Regional Science and Urban Economics*, 35(2):109–125.

Borck, R. and Schrauth, P. (2021). Population density and urban air quality. *Regional Science and Urban Economics*, 86.

Davis, M. A., Larson, W. D., D, O. S., and Shui, J. (2019). The price of residential land for counties, zip codes, and census tracts in the united states.

Flemming, D., Grimes, A., Lebreton, L., Mare, D., and Nunns, P. (2018). Valuing sunshine. *Regional Science and Urban Economics*, 68:268–276.

Glaeser, E. and Gyourko, J. (2018). The economic implications of housing supply. *Journal of Economic Perspectives*, 32(1):3–30.

Glaeser, E. L., Gyourko, J., and Saks, R. (2005). Why is manhattan so expensive? regulation and the rise in housing prices. *The Journal of Law and Economics*, 48(2):331–369.

Green, R. K., Malpezzi, S., and Mayo, S. K. (2005). Metropolitan-specific estimates of the price elasticity of supply of housing, and their sources. *American Economic Review*, 95(2):334–339.

Gyourko, J., A., S., and A., S. (2008). A new measure of the local regulatory environment for housing markets: The wharton residential land use regulatory index. *Urban Studies.*, 45(3):693–729.

Gyourko, J., Hartley, J., and Krimmel, J. (2019). The local residential land use regulatory environment across u.s. housing markets: Evidence from a new wharton index. *National Bureau of Economic Research.*, (w26573).

Harris, N. (2021). Using theory and indirection to measure aggregate land value in cities.

Herkenhoff, K. F., Ohanian, L. E., and Prescott, E. C. (2018). Tarnishing the golden and empire states: Land-use restrictions and the u.s. economic slowdown. *Journal of Monetary Economics*, 93(6):89–109.

Hsieh, C.-T. and Moretti, E. (2019). Housing constraints and spatial misallocation. *American Economic Journal: Macroeconomics*, 11(2):1–39.

Kuang, C. (2017). Does quality matter in local consumption amenity? an empirical investigation with yelp. *Journal of Urban Economics*, 100:1–18.

Larson, W., Liu, F., and Yezer, A. (2012). Energy footprint of the city: Effects of urban land use and transportation policies. *Journal of Urban Economics*, 72(2-3):147–159.

Larson, W. and Yezer, A. (2015). The energy implications of city size and density. 90:35–49.

Larson, W., Yezer, A., and Zhao, W. (2018). An examination of the link between urban planning policies and the high cost of housing and labor. institute for international economic policy working paper series, p. 2018 - 2024. posted: 2018.

Lin, C. (2021). Do planning regulations raise the cost or quality of housing?

Malpezzi, S. (1996). Housing prices, externalities, and regulation in us metropolitan areas. *Journal of Housing Research*, pages 209–241.

Mayer, C. J. and Somerville, C. T. (2000). Land use regulation and new construction. *Regional Science and Urban Economics*, 30(6):639–662.

McDonald, J. F. and Mcmillen, D. P. (2012). The economics of zoning. *The Oxford Handbook of Urban Economics and Planning*.

Mills, E. S. (1967). An aggregative model of resource allocation in a metropolitan area. *The American Economic Review*, 57(2):197–210.

Monte, F., Redding, S. J., and Rossi-Hansberg, E. (2018). Commuting, migration, and local employment elasticities. *American Economic Review*, 108(12):3855–90.

Muth, R. F. (1969). Cities and housing; the spatial pattern of urban residential land use.

Quigley, J. M. and Raphael, S. (2004). Is housing unaffordable? why isn't it more affordable? *Journal of Economic Perspectives*, 18(1):191–214.

Saiz, A. (2010). The geographic determinants of housing supply. *The Quarterly Journal of Economics*, 125(3):1253–1296.

Segal, D. and Srinivasan, P. (1985). The impact of suburban growth restrictions on us housing price inflation, 1975–1978. *Urban Geography*, 6(1):14–26.

Shoag, D. and Veuger, S. (2019). Do land use restrictions increase restaurant quality and diversity? *Journal of Regional Science*, 59(3):435–451.

Turner, M. A., Haughwout, A., and van der Klaauw W. (2014). Land use regulation and welfare. *Econometrica*, 82(4):307–326.

Table of Theoretical Results

<table>
<tr><td></td><td colspan="3">With Externality</td><td colspan="2">No externality</td></tr>
<tr><td></td><td>Optimal planning restriction (1)</td><td>Ineffective planning restriction (2)</td><td>No planning (3)</td><td>Any planning restriction (4)</td><td>No Planning (5)</td></tr>
<tr><td colspan="6">A: Effect on House price(p)</td></tr>
<tr><td>Wage varying open city</td><td colspan="3">$p_1 > p_2 > p_3$
Any planning regulation, optimal or ineffective, raises city's wage and therefore houses price; Optimal planning raises house price more due to the direct amenity effect.</td><td colspan="2">$p_4 > p_5$
Planning raises income which raises house price</td></tr>
<tr><td>Population varying Open city</td><td colspan="3">$p_1 > p_2 = p_3$
Optimal planning lower density has a positive amenity effect on house price.</td><td colspan="2">$p_4 = p_5$
Planning has no effect on house price, but lower population</td></tr>
<tr><td colspan="6">B: Effect on Aggregate Land Rent (R)</td></tr>
<tr><td>Wage varying open city</td><td colspan="3">$R_1 <> R_3 <> R_2$
Optimal planning raises land rents close to the center of the city, but lowers land rents beyond a particular distance ($R_1 <> R_3$).</td><td colspan="2">$R_4 <> R_5$
Ambiguous effect. Planning has a negative partial equilibrium effect on land rents but a positive general equilibrium effect on land rent by raising income.</td></tr>
<tr><td>Population varying open city</td><td colspan="3">$R_1 > R_3 > R_2$
Ineffective regulation reduces land rent ($R_3 > R_2$). Optimal planning increase land rent ($R_1 > R_3$)</td><td colspan="2">$R_4 < R_5$
Only negative partial equilibrium effect, restriction prevent land from best use.</td></tr>
</table>

Table 1: median housing rent and average WRI (Albouy et. al cities)

	(1)	(2)	(3)	(4)	(9)	(10)	(11)	(12)
Dependent variable: log(median housing rent)								
	2006 WRI data (metropolitan)				2018 WRI data (suburban communities)			
average WRI + 10	0.329***	0.308***	0.294***	0.211***	0.277***	0.253***	0.238***	0.169***
	(0.0272)	(0.0271)	(0.0257)	(0.0221)	(0.0384)	(0.0378)	(0.0367)	(0.0315)
log(aggregate area) sq miles		0.0847***	-0.112***	-0.153***		0.0993***	-0.0759	-0.181***
		(0.0232)	(0.0402)	(0.0339)		(0.0276)	(0.0535)	(0.0462)
log(population)			0.176***	0.139***			0.158***	0.161***
			(0.0302)	(0.0256)			(0.0419)	(0.0351)
SIR				0.536***				0.519***
				(0.0723)				(0.0912)
Industry (% Information)				5.878				4.590
				(3.606)				(4.687)
log (median earnings)				0.705***				0.828***
				(0.135)				(0.158)
crime rate								
number of days below 32 degrees f (2018)								
number of days above 90 degrees f (2018)								
CBD 15 miles from coastline								
Constant	8.885***	8.666***	7.575***	1.377	9.330***	9.086***	8.114***	0.350
	(0.270)	(0.271)	(0.317)	(1.317)	(0.385)	(0.379)	(0.447)	(1.628)
Observations	266	266	266	266	181	181	181	181
R-squared	0.356	0.387	0.458	0.649	0.226	0.278	0.332	0.573

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 2: median housing rent and fraction of highly regulated communities (WRI>.64) (Albouy et. al cities)

	(1)	(2)	(3)	(4)	(9)	(10)	(11)	(12)
Dependent variable: log(median housing rent)								
	2006 WRI data (metropolitan)				2018 WRI data (suburban communities)			
(fraction of highly regulated communities)*10	0.0796***	0.0736***	0.0701***	0.0480***	0.0629***	0.0567***	0.0551***	0.0379***
	(0.00827)	(0.00818)	(0.00774)	(0.00651)	(0.00972)	(0.00957)	(0.00916)	(0.00779)
log(aggregate area) sq miles		0.0986***	-0.110**	-0.156***		0.102***	-0.0952*	-0.194***
		(0.0246)	(0.0429)	(0.0358)		(0.0282)	(0.0544)	(0.0469)
log(population)			0.186***	0.147***			0.176***	0.176***
			(0.0323)	(0.0270)			(0.0422)	(0.0353)
SIR				0.605***				0.550***
				(0.0754)				(0.0912)
Industry (% Information)				4.097				3.889
				(3.803)				(4.749)
log (median earnings)				0.772***				0.816***
				(0.143)				(0.160)
crime rate								
number of days below 32 degrees f (2018)								
number of days above 90 degrees f (2018)								
CBD 15 miles from coastline								
Constant	11.98***	11.50***	10.21***	2.588*	11.95***	11.47***	10.23***	1.948
	(0.0297)	(0.123)	(0.252)	(1.428)	(0.0373)	(0.139)	(0.325)	(1.609)
Observations	266	266	266	266	181	181	181	181
R-squared	0.260	0.302	0.381	0.608	0.190	0.245	0.313	0.561

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3: median housing rent and average WRI (Harris cities)

	(1)	(2)	(3)	(4)	(9)	(10)	(11)	(12)
Dependent variable: log(median housing rent)								
	2006 WRI data (metropolitan)				2018 WRI data (suburban communities)			
average WRI + 10	0.385***	0.234**	0.242**	0.0738	0.526***	0.392***	0.392***	0.207**
	(0.119)	(0.109)	(0.115)	(0.0780)	(0.128)	(0.109)	(0.111)	(0.0844)
log(aggregate area) sq miles		0.241***	0.161	-0.215		0.233***	0.320	0.0656
		(0.0686)	(0.288)	(0.223)		(0.0598)	(0.255)	(0.194)
log(population)			0.0751	0.222			-0.0822	0.000726
			(0.260)	(0.194)			(0.235)	(0.168)
SIR				0.231				0.921*
				(0.536)				(0.496)
Industry (% Information)				10.40				8.618
				(9.298)				(7.700)
log (median earnings)				1.405*				0.152
				(0.809)				(0.761)
crime rate				-1.305				-1.682
				(3.095)				(2.615)
number of days below 32 degrees f (2018)				-0.0103**				-0.00900**
				(0.00467)				(0.00399)
number of days above 90 degrees f (2018)				-0.000849				-0.00321**
				(0.00143)				(0.00137)
CBD 15 miles from coastline				0.199				0.0371
				(0.148)				(0.136)
Constant	8.487***	8.479***	7.840***	-5.271	6.999***	6.877***	7.503***	7.837
	(1.223)	(1.031)	(2.446)	(8.659)	(1.321)	(1.070)	(2.097)	(8.025)
Observations	30	30	30	30	29	29	29	29
R-squared	0.271	0.500	0.502	0.869	0.385	0.612	0.614	0.917

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4: median housing rent and fraction of highly regulated communities (WRI>.64) (Harris cities)

	(1)	(2)	(3)	(4)	(9)	(10)	(11)	(12)
Dependent variable: log(median housing rent)								
	2006 WRI data (metropolitan)				2018 WRI data (suburban communities)			
(fraction of highly regulated communities)*10	0.0761**	0.0488*	0.0494*	0.0121	0.145***	0.116***	0.116***	0.0690**
	(0.0280)	(0.0239)	(0.0247)	(0.0161)	(0.0369)	(0.0291)	(0.0297)	(0.0244)
log(aggregate area) sq miles		0.259***	0.219	-0.193		0.250***	0.301	0.0785
		(0.0664)	(0.283)	(0.222)		(0.0562)	(0.247)	(0.186)
log(population)			0.0374	0.212			-0.0486	0.00880
			(0.258)	(0.195)			(0.227)	(0.160)
SIR				0.327				1.098**
				(0.530)				(0.481)
Industry (% Information)				9.752				6.674
				(9.386)				(7.400)
log (median earnings)				1.279				-0.0877
				(0.807)				(0.746)
crime rate				-0.957				-1.983
				(3.069)				(2.522)
number of days below 32 degrees f (2018)				-0.0104**				-0.00773*
				(0.00472)				(0.00394)
number of days above 90 degrees f (2018)				-0.000938				-0.00345**
				(0.00144)				(0.00133)
CBD 15 miles from coastline				0.218				0.00583
				(0.146)				(0.133)
Constant	12.17***	10.59***	10.31***	-3.269	11.88***	10.38***	10.75***	12.01
	(0.123)	(0.416)	(1.999)	(8.478)	(0.156)	(0.358)	(1.757)	(7.952)
Observations	30	30	30	30	29	29	29	29
R-squared	0.209	0.494	0.494	0.867	0.365	0.640	0.640	0.923

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5: aggregate land value (Albouy et. al) and average WRI

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: log (aggregate land value)								
	2006 WRI data (metropolitan)				2018 WRI data (suburban communities)			
average WRI + 10	0.665***	0.365***	0.334***	0.269***	0.604***	0.293***	0.259***	0.197***
	(0.0993)	(0.0471)	(0.0431)	(0.0432)	(0.142)	(0.0616)	(0.0571)	(0.0557)
log(aggregate area) sq miles		1.249***	0.831***	0.814***		1.273***	0.863***	0.781***
		(0.0402)	(0.0674)	(0.0662)		(0.0449)	(0.0835)	(0.0816)
log(population)			0.374***	0.309***			0.369***	0.337***
			(0.0507)	(0.0499)			(0.0653)	(0.0620)
SIR				0.296**				0.325**
				(0.141)				(0.161)
Industry (% Information)				21.79***				22.22***
				(7.039)				(8.279)
log (median earnings)				0.467*				0.697**
				(0.264)				(0.278)
crime rate								
number of days below 32 degrees f (2018)								
number of days above 90 degrees f (2018)								
CBD 15 miles from coastline								
Constant	17.16***	13.94***	11.62***	7.786***	17.59***	14.46***	12.19***	5.836**
	(0.987)	(0.470)	(0.531)	(2.571)	(1.421)	(0.617)	(0.697)	(2.876)
Observations	266	266	266	266	181	181	181	181
R-squared	0.145	0.817	0.848	0.867	0.092	0.835	0.860	0.885

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6: aggregate land value (Albouy et. al) and fraction of highly regulated communities (WRI>.64)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: log (aggregate land value)								
	2006 WRI data (metropolitan)				2018 WRI data (suburban communities)			
(fraction of highly regulated communities)*10	0.169***	0.0930***	0.0857***	0.0668***	0.149***	0.0710***	0.0676***	0.0520***
	(0.0286)	(0.0136)	(0.0124)	(0.0122)	(0.0351)	(0.0153)	(0.0140)	(0.0135)
log(aggregate area) sq miles		1.262***	0.832***	0.811***		1.273***	0.839***	0.762***
		(0.0409)	(0.0687)	(0.0672)		(0.0451)	(0.0830)	(0.0812)
log(population)			0.384***	0.319***			0.388***	0.353***
			(0.0516)	(0.0506)			(0.0645)	(0.0612)
SIR				0.375***				0.335**
				(0.141)				(0.158)
Industry (% Information)				19.58***				21.33**
				(7.131)				(8.229)
log (median earnings)				0.523*				0.693**
				(0.268)				(0.276)
crime rate								
number of days below 32 degrees f (2018)								
number of days above 90 degrees f (2018)								
CBD 15 miles from coastline								
Constant	23.41***	17.30***	14.63***	9.637***	23.28***	17.22***	14.49***	7.618***
	(0.103)	(0.204)	(0.404)	(2.677)	(0.135)	(0.222)	(0.496)	(2.788)
Observations	266	266	266	266	181	181	181	181
R-squared	0.117	0.809	0.842	0.863	0.092	0.834	0.862	0.887

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7: aggregate land value (Harris) and average WRI

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: log (aggregate land value)								
	2006 WRI data (metropolitan)				2018 WRI data (suburban communities)			
average WRI + 10	1.294***	0.415**	0.456**	0.156	1.399***	0.595***	0.596***	0.266*
	(0.418)	(0.170)	(0.175)	(0.112)	(0.494)	(0.175)	(0.177)	(0.147)
log(aggregate area) sq miles		1.405***	0.988**	0.688**		1.399***	1.119**	0.909**
		(0.107)	(0.440)	(0.321)		(0.0961)	(0.407)	(0.336)
log(population)			0.388	0.437			0.266	0.258
			(0.397)	(0.279)			(0.375)	(0.292)
SIR				1.484*				1.751*
				(0.771)				(0.862)
Industry (% Information)				12.54				12.82
				(13.38)				(13.38)
log (median earnings)				-0.114				-0.773
				(1.164)				(1.322)
crime rate				-2.343				-3.296
				(4.455)				(4.544)
number of days below 32 degrees f (2018)				-0.0190**				-0.0168**
				(0.00673)				(0.00692)
number of days above 90 degrees f (2018)				-0.00425*				-0.00553**
				(0.00206)				(0.00238)
CBD 15 miles from coastline				0.344				0.211
				(0.213)				(0.236)
Constant	12.20***	12.16***	8.856**	13.68	11.07**	10.34***	8.315**	20.64
	(4.290)	(1.602)	(3.740)	(12.46)	(5.100)	(1.719)	(3.345)	(13.94)
Observations	30	30	30	30	29	29	29	29
R-squared	0.255	0.900	0.903	0.978	0.229	0.916	0.917	0.979

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8: aggregate land value (Harris) and fraction of highly regulated communities (WRI>.64)

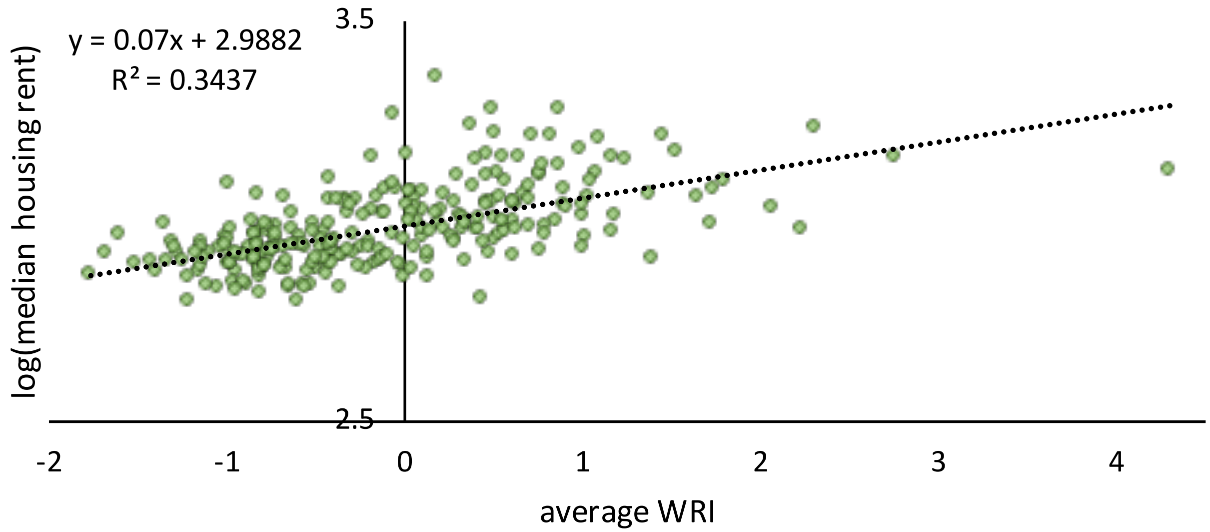
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: log (aggregate land value)								
	2006 WRI data (metropolitan)				2018 WRI data (suburban communities)			
(fraction of highly regulated communities)*10	0.222**	0.0687*	0.0736*	0.0114	0.332**	0.163***	0.166***	0.0650
	(0.101)	(0.0385)	(0.0396)	(0.0240)	(0.146)	(0.0486)	(0.0489)	(0.0455)
log(aggregate area) sq miles		1.451***	1.154**	0.756**		1.430***	1.100**	0.888**
		(0.107)	(0.453)	(0.331)		(0.0939)	(0.407)	(0.347)
log(population)			0.280	0.399			0.313	0.298
			(0.413)	(0.290)			(0.375)	(0.298)
SIR				1.690**				1.913**
				(0.789)				(0.898)
Industry (% Information)				11.62				10.72
				(13.98)				(13.80)
log (median earnings)				-0.365				-0.901
				(1.202)				(1.390)
crime rate				-1.234				-2.925
				(4.570)				(4.702)
number of days below 32 degrees f (2018)				-0.0198**				-0.0165**
				(0.00703)				(0.00734)
number of days above 90 degrees f (2018)				-0.00444*				-0.00549**
				(0.00214)				(0.00248)
CBD 15 miles from coastline				0.411*				0.241
				(0.217)				(0.248)
Constant	24.71***	15.88***	13.77***	17.87	24.25***	15.66***	13.29***	23.99
	(0.442)	(0.672)	(3.200)	(12.63)	(0.618)	(0.598)	(2.898)	(14.83)
Observations	30	30	30	30	29	29	29	29
R-squared	0.147	0.890	0.892	0.976	0.160	0.915	0.918	0.977

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Figure 1: median housing rent and 2006 WRI (Albouy et. al cities)

Panel A



Panel B

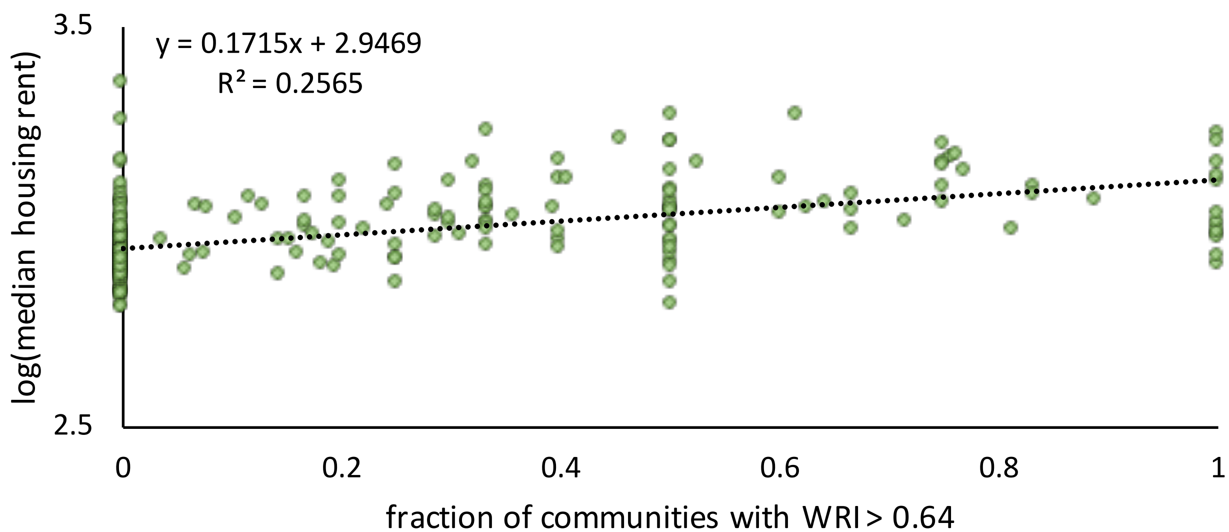
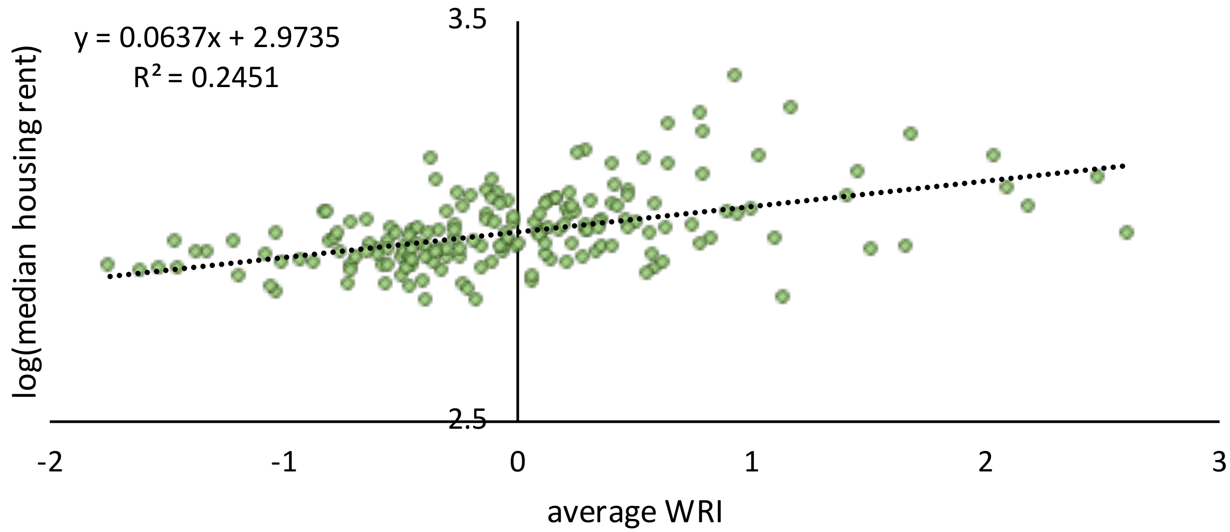


Figure 2: median housing rent and 2018 WRI (Albouy et. al cities)

Panel A



Panel B

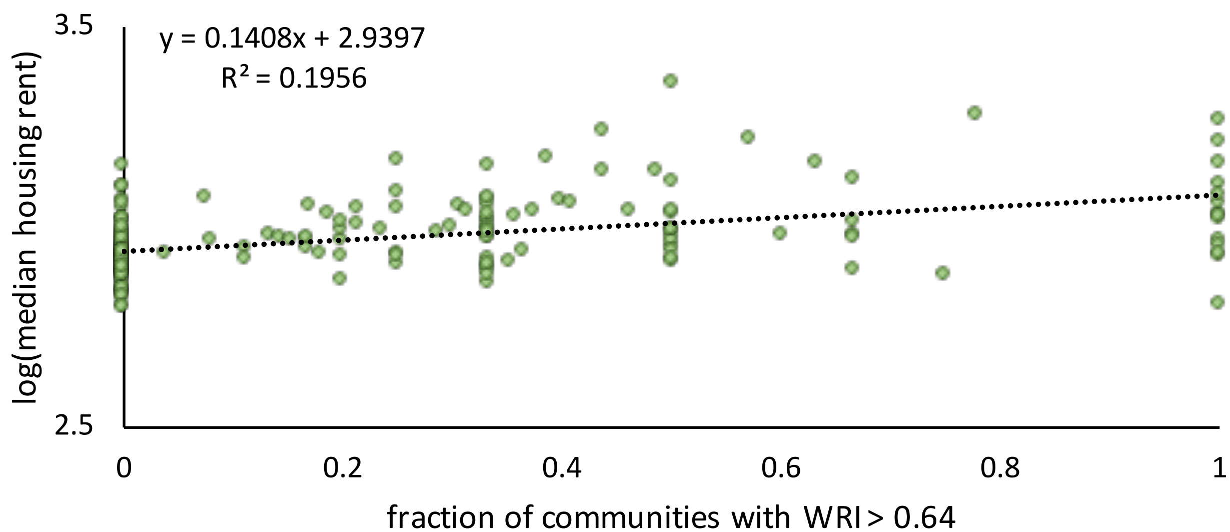
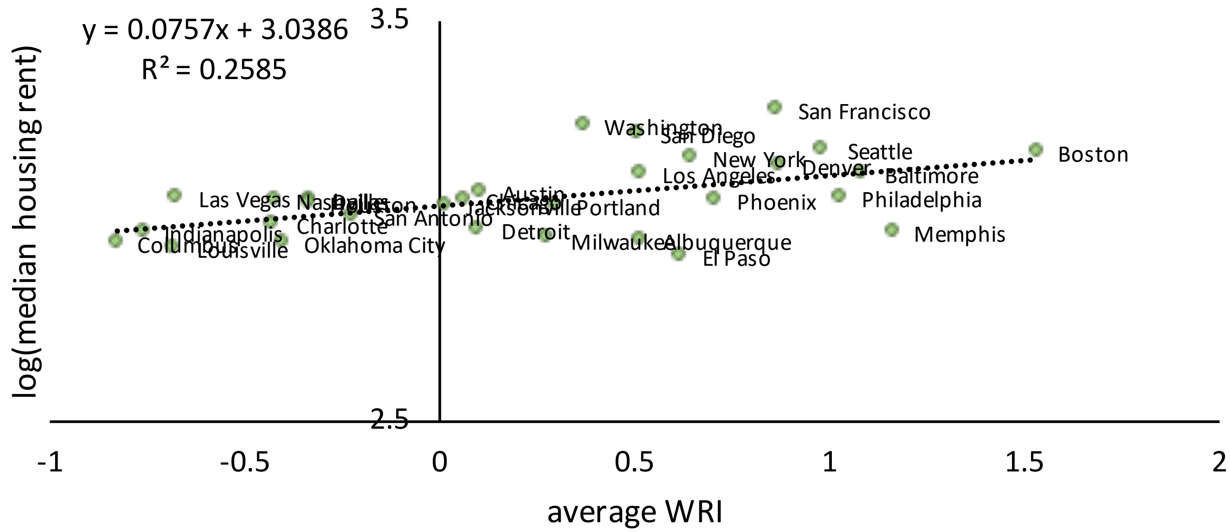


Figure 3: median housing rent and 2006 WRI (Harris cities)

Panel A



Panel B

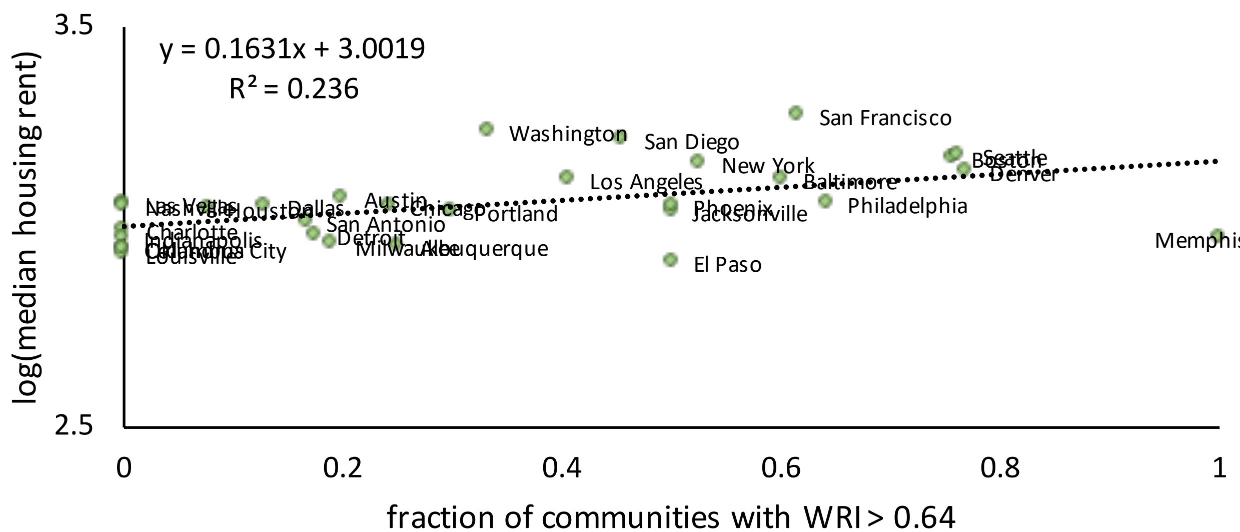
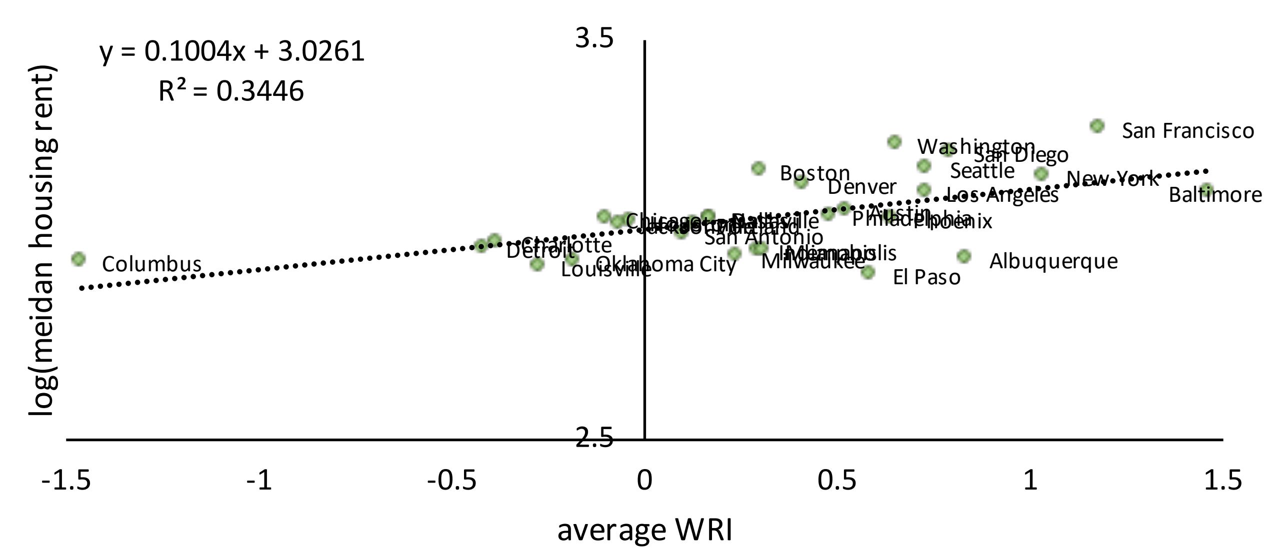


Figure 4: median housing rent and 2018 WRI (Harris cities)

Panel A



Panel B

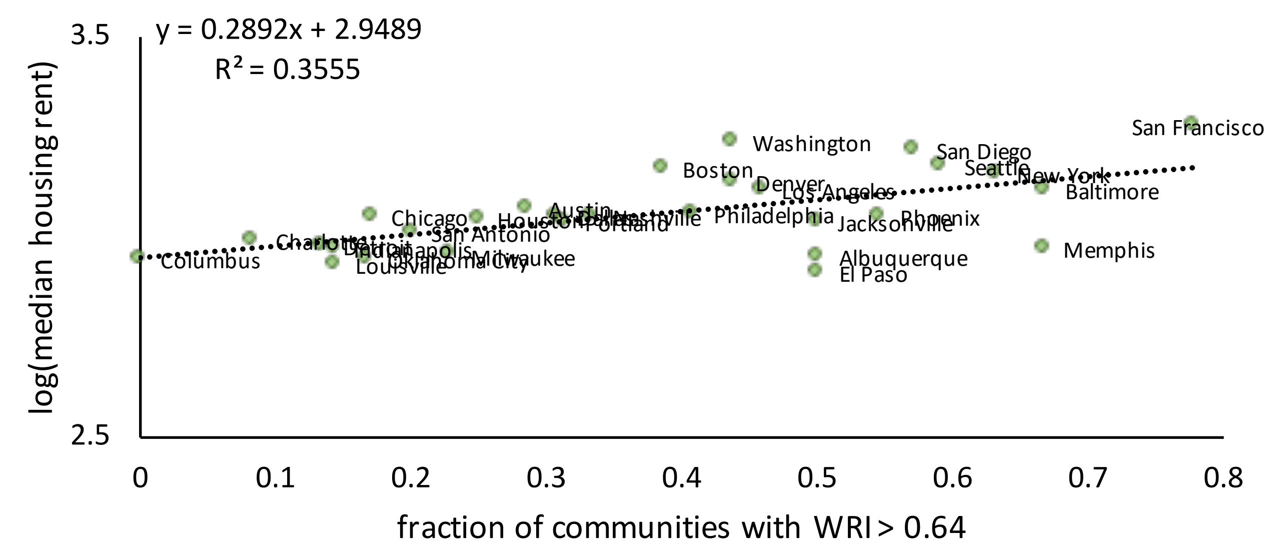
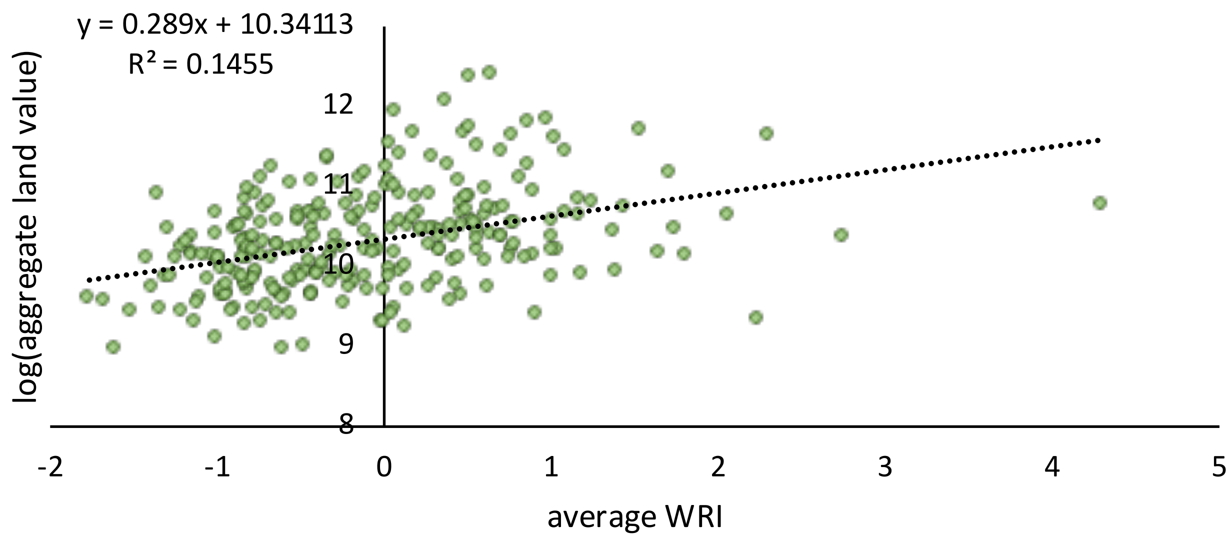


Figure 5: Aggregate Land Value (Albouy et. al) and 2006 WRI

Panel A



Panel B

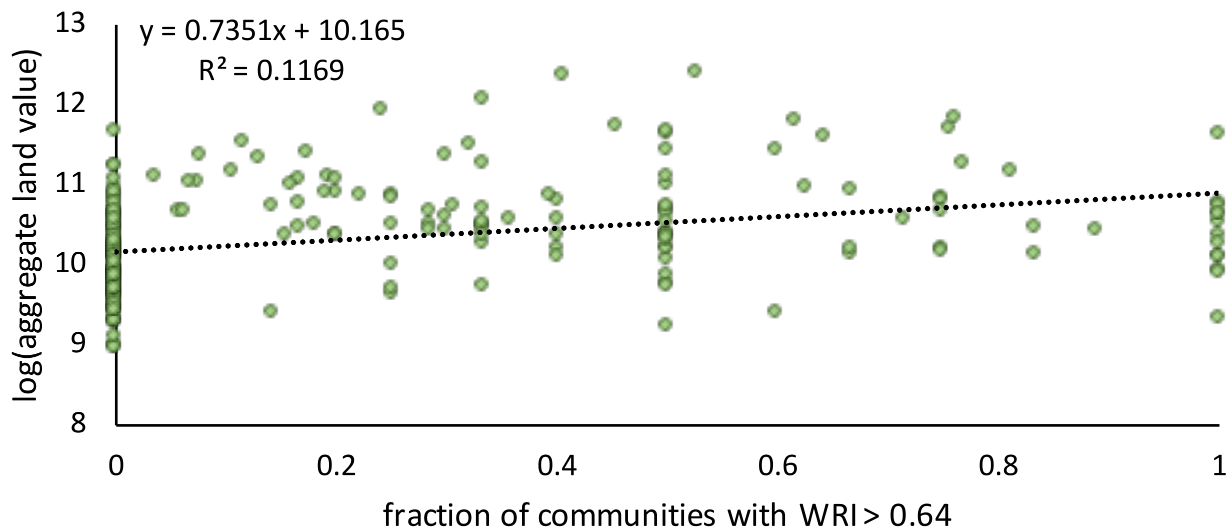
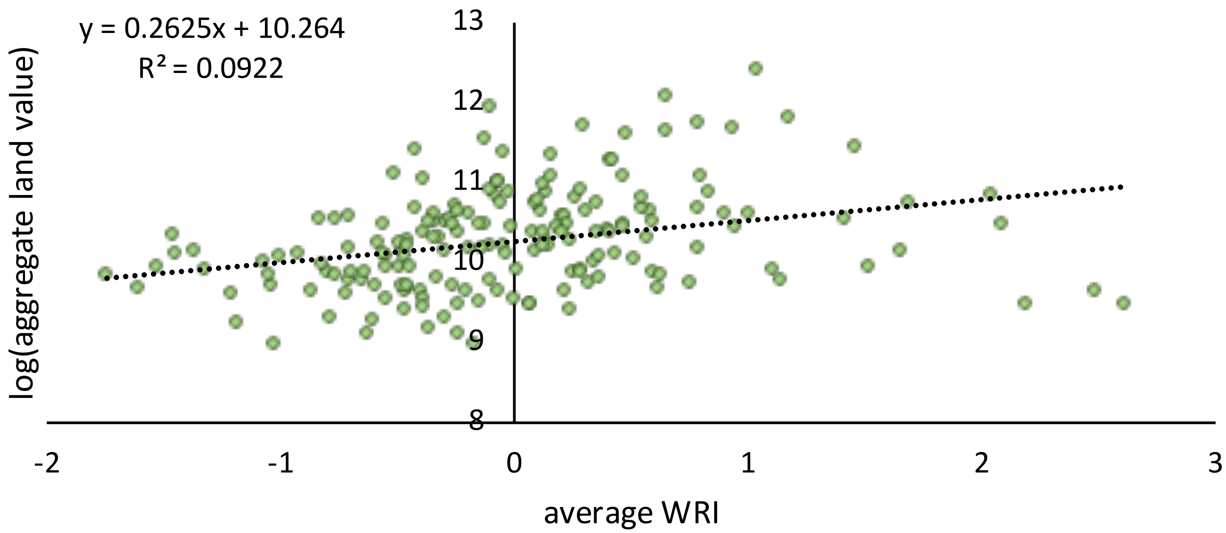


Figure 6: Aggregate Land Value (Albouy) and 2018 WRI

Panel A



Panel B

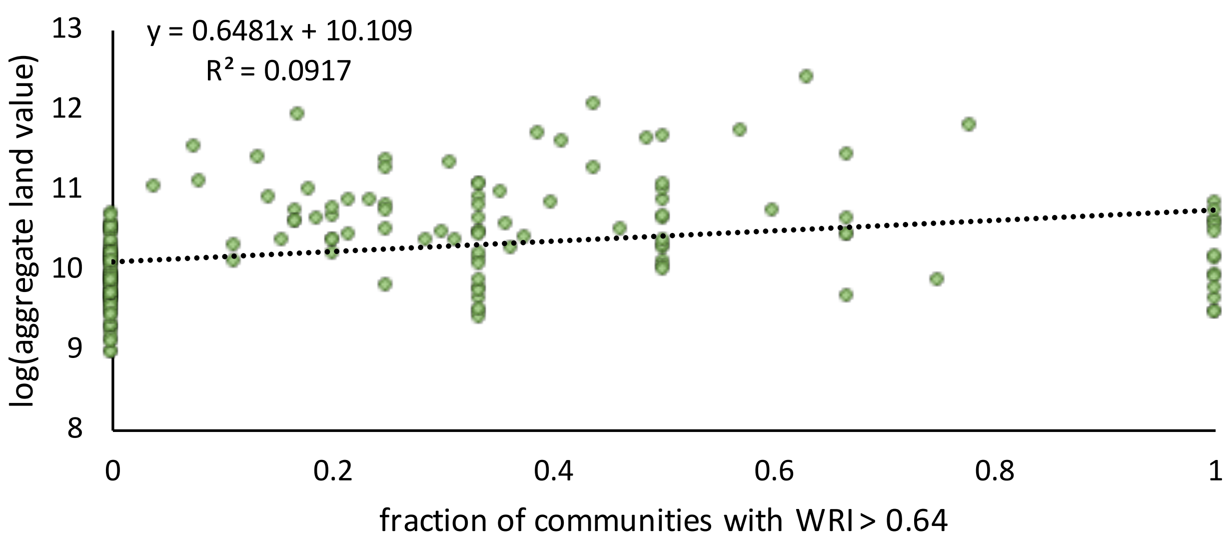
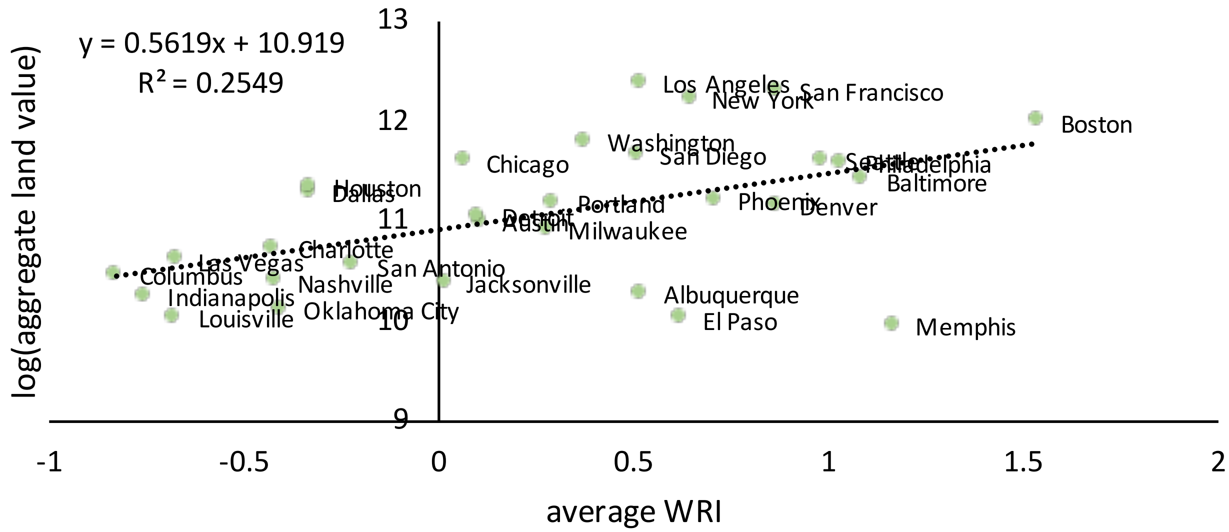


Figure 7: Aggregate Land Value (Harris) and 2006 WRI

Panel A



Panel B

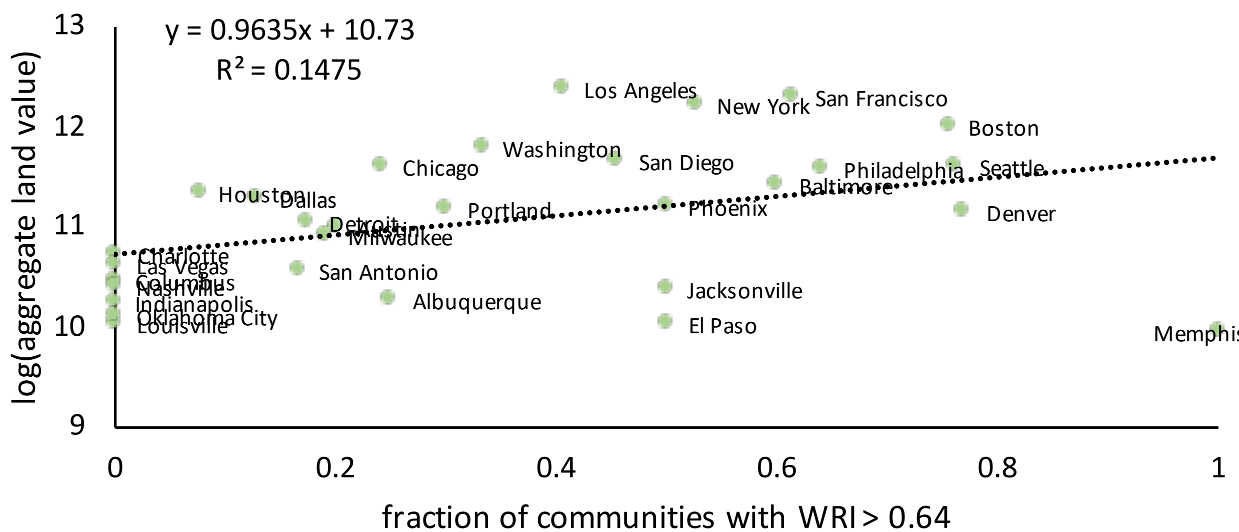
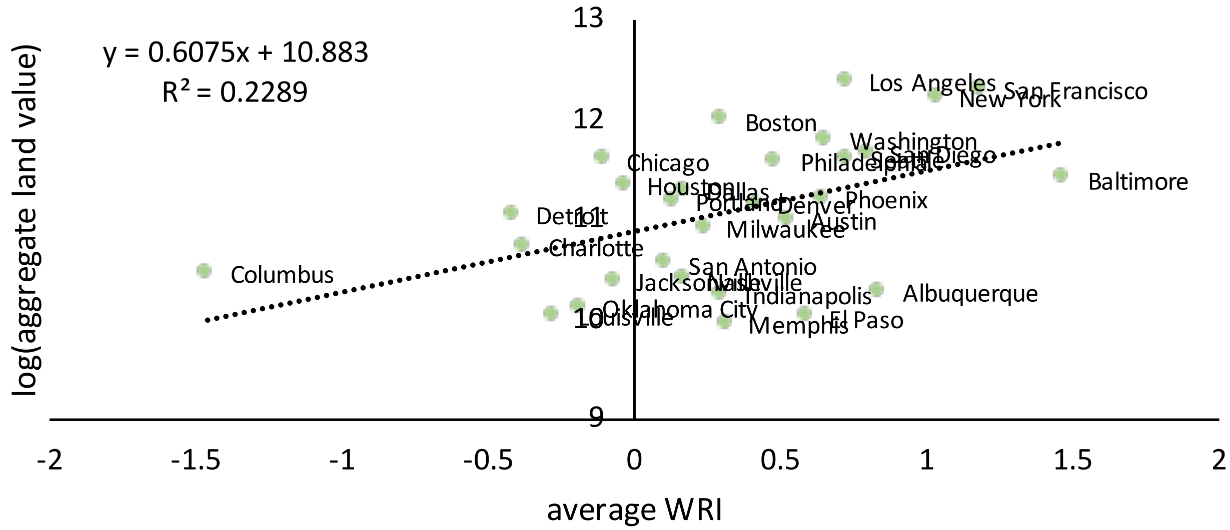
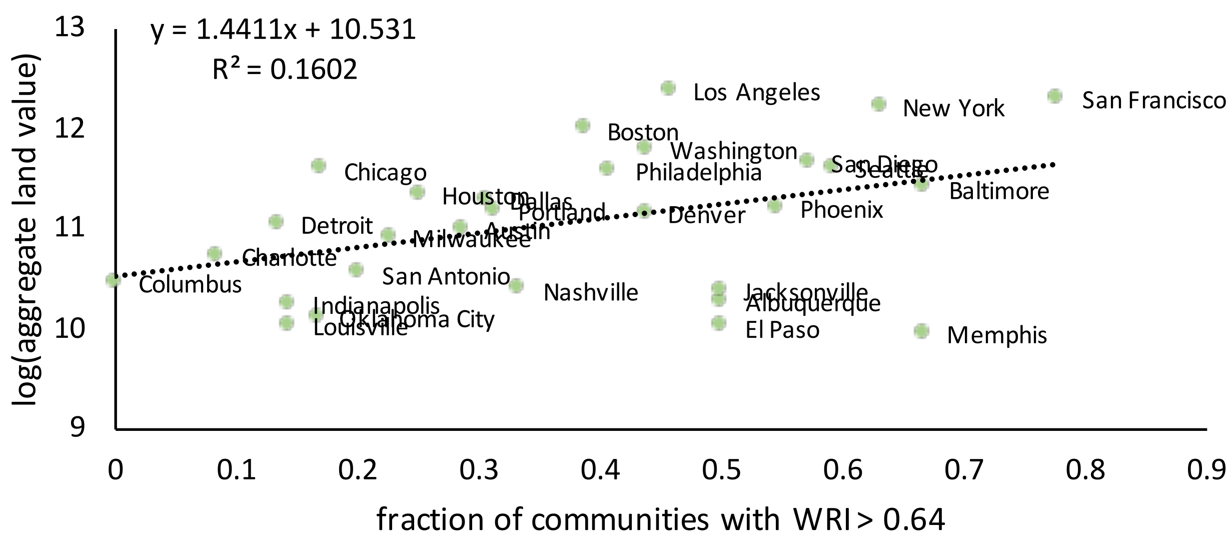


Figure 8: Aggregate Land Value (Harris) and 2018 WRI

Panel A



Panel B



Appendix B - squared term included

Table 1: median housing rent and average WRI (Albouy et. al cities)

	(1)	(2)	(3)	(4)	(5)	(11)	(12)	(13)	(14)	(15)
Dependent variable: log(median housing rent)										
	2006 WRI data (metropolitan)					2018 WRI data (suburban communities)				
average WRI + 10	0.161***	0.592***	0.427**	0.361**	0.385***	0.147***	0.512	0.00160	-0.0283	-0.197
	(0.0137)	(0.181)	(0.175)	(0.172)	(0.142)	(0.0192)	(0.313)	(0.302)	(0.300)	(0.248)
(average WRI + 10)^2		-0.0209**	-0.0136	-0.0106	-0.0138**		-0.0178	0.00613	0.00740	0.0140
		(0.00876)	(0.00842)	(0.00830)	(0.00683)		(0.0152)	(0.0147)	(0.0145)	(0.0120)
log(aggregate area) sq miles			0.0622***	0.00386	-0.0202			0.0778***	0.0324	-0.0190
			(0.0114)	(0.0203)	(0.0174)			(0.0137)	(0.0264)	(0.0226)
log(population)				0.0529***	0.0366***				0.0412**	0.0429**
				(0.0153)	(0.0132)				(0.0205)	(0.0173)
SIR					0.265***					0.242***
					(0.0371)					(0.0447)
Industry (% Information)					1.363					2.363
					(1.851)					(2.326)
log (median earnings)					0.393***					0.425***
					(0.0696)					(0.0787)
crime rate										
number of days below 32 degrees f (2018)										
number of days above 90 degrees f (2018)										
CBD 15 miles from coastline										
Constant	5.269***	3.061***	3.668***	3.657***	-0.173	5.381***	3.516**	5.832***	5.710***	2.396*
	(0.136)	(0.936)	(0.896)	(0.878)	(1.003)	(0.193)	(1.605)	(1.536)	(1.524)	(1.351)
Observations	266	266	266	266	266	181	181	181	181	181
R-squared	0.344	0.358	0.423	0.448	0.631	0.245	0.251	0.366	0.380	0.603

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 2: median housing rent and fraction of highly regulated communities (WRI>.64) (Albouy et. al cities)

	(1)	(2)	(3)	(4)	(5)	(11)	(12)	(13)	(14)	(15)
Dependent variable: log(median housing rent)										
	2006 WRI data (metropolitan)					2018 WRI data (suburban communities)				
(fraction of highly regulated communities)*10	0.0395***	0.0841***	0.0626***	0.0570***	0.0473***	0.0324***	0.0717***	0.0352**	0.0301**	0.0162
	(0.00414)	(0.0122)	(0.0124)	(0.0123)	(0.00998)	(0.00491)	(0.0137)	(0.0150)	(0.0150)	(0.0123)
[(fraction of highly regulated communities)*10]^2		-0.00555***	-0.00335**	-0.00280**	-0.00296**		-0.00461***	-0.000863	-0.000329	0.000296
		(0.00143)	(0.00144)	(0.00142)	(0.00115)		(0.00150)	(0.00162)	(0.00162)	(0.00133)
log(aggregate area) sq miles			0.0626***	0.00138	-0.0254			0.0741***	0.0205	-0.0262
			(0.0124)	(0.0214)	(0.0181)			(0.0155)	(0.0273)	(0.0235)
log(population)				0.0561***	0.0394***				0.0502**	0.0503***
				(0.0162)	(0.0137)				(0.0212)	(0.0179)
SIR					0.293***					0.263***
					(0.0381)					(0.0456)
Industry (% Information)					0.613					2.365
					(1.919)					(2.393)
log (median earnings)					0.422***					0.401***
					(0.0721)					(0.0805)
crime rate										
number of days below 32 degrees f (2018)										
number of days above 90 degrees f (2018)										
CBD 15 miles from coastline										
Constant	6.785***	6.766***	6.470***	6.076***	1.899***	6.769***	6.743***	6.411***	6.050***	1.972**
	(0.0148)	(0.0153)	(0.0603)	(0.128)	(0.720)	(0.0189)	(0.0203)	(0.0721)	(0.168)	(0.818)
Observations	266	266	266	266	266	181	181	181	181	181
R-squared	0.256	0.297	0.359	0.387	0.602	0.196	0.236	0.323	0.344	0.577

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3: median housing rent and average WRI (Harris cities)

	(1)	(2)	(3)	(4)	(5)	(11)	(12)	(13)	(14)	(15)
Dependent variable: log(median housing rent)										
	2006 WRI data (metropolitan)					2018 WRI data (suburban communities)				
average WRI + 10	0.174***	0.756	0.0944	0.224	1.077	0.231***	-0.930	-0.624	-0.706	0.799
	(0.0558)	(1.839)	(1.509)	(1.589)	(1.086)	(0.0614)	(1.249)	(0.983)	(0.986)	(0.800)
(average WRI + 10)^2		-0.0284	0.000200	-0.00632	-0.0512		0.0574	0.0390	0.0430	-0.0375
		(0.0897)	(0.0735)	(0.0776)	(0.0530)		(0.0617)	(0.0486)	(0.0488)	(0.0406)
log(aggregate area) sq miles			0.121***	0.163	-0.0561			0.116***	0.230*	-0.0236
			(0.0317)	(0.136)	(0.100)			(0.0280)	(0.117)	(0.110)
log(population)				-0.0392	0.0603				-0.108	0.0469
				(0.124)	(0.0898)				(0.108)	(0.0933)
SIR					0.0569					0.310
					(0.257)					(0.263)
Industry (% Information)					0.639					-0.235
					(4.163)					(4.027)
log (median earnings)					0.980**					0.597
					(0.394)					(0.422)
crime rate					-1.818					-1.218
					(1.420)					(1.419)
number of days below 32 degrees f (2018)					-0.00509**					-0.00537**
					(0.00219)					(0.00208)
number of days above 90 degrees f (2018)					0.000257					-0.000414
					(0.000661)					(0.000739)
CBD 15 miles from coastline					0.102					0.0840
					(0.0693)					(0.0863)
Constant	5.253***	2.287	5.270	4.921	-9.488	4.656***	10.51	8.568*	9.804*	-4.150
	(0.573)	(9.398)	(7.700)	(7.915)	(7.908)	(0.633)	(6.316)	(4.982)	(5.131)	(7.005)
Observations	30	30	30	30	30	29	29	29	29	29
R-squared	0.258	0.261	0.527	0.529	0.885	0.345	0.366	0.624	0.639	0.900

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

Table 4: median housing rent and fraction of highly regulated communities (WRI>.64) (Harris cities)

	(1)	(2)	(3)	(4)	(5)	(11)	(12)	(13)	(14)	(15)
Dependent variable: log(median housing rent)										
	2006 WRI data (metropolitan)					2018 WRI data (suburban communities)				
(fraction of highly regulated communities)*10	0.0376***	0.105***	0.0399	0.0430	0.0161	0.0666***	0.0703	0.0487	0.0517	0.0522
	(0.0128)	(0.0368)	(0.0358)	(0.0368)	(0.0265)	(0.0173)	(0.0684)	(0.0505)	(0.0509)	(0.0359)
[(fraction of highly regulated communities)*10]^2		-0.00847*	-0.00186	-0.00235	-0.000853		-0.000479	0.000442	-2.43e-05	-0.00341
		(0.00434)	(0.00406)	(0.00424)	(0.00303)		(0.00865)	(0.00635)	(0.00642)	(0.00484)
log(aggregate area) sq miles			0.119***	0.179	-0.0634			0.123***	0.214*	0.0259
			(0.0332)	(0.126)	(0.0987)			(0.0257)	(0.112)	(0.0948)
log(population)				-0.0586	0.0776				-0.0854	0.0112
				(0.118)	(0.0898)				(0.103)	(0.0810)
SIR					0.145					0.380
					(0.269)					(0.251)
Industry (% Information)					0.427					-0.342
					(4.376)					(3.800)
log (median earnings)					0.822*					0.403
					(0.394)					(0.390)
crime rate					-1.491					-1.611
					(1.359)					(1.349)
number of days below 32 degrees f (2018)					-0.00538**					-0.00434**
					(0.00221)					(0.00201)
number of days above 90 degrees f (2018)					0.000115					-0.000699
					(0.000664)					(0.000681)
CBD 15 miles from coastline					0.0797					0.0255
					(0.0645)					(0.0729)
Constant	6.912***	6.847***	6.175***	6.626***	-2.449	6.790***	6.785***	6.053***	6.694***	2.206
	(0.0560)	(0.0630)	(0.195)	(0.928)	(4.025)	(0.0730)	(0.119)	(0.175)	(0.792)	(4.164)
Observations	30	30	30	30	30	29	29	29	29	29
R-squared	0.236	0.330	0.551	0.556	0.886	0.356	0.356	0.666	0.675	0.914

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

Table 5: aggregate land value (Albouy et. al) and average WRI

	(1)	(2)	(3)	(4)	(5)	(11)	(12)	(13)	(14)	(15)
Dependent variable: log (aggregate land value)										
	2006 WRI data (metropolitan)					2018 WRI data (suburban communities)				
average WRI + 10	0.665***	4.660***	1.378**	0.913	0.964*	0.604***	8.514***	0.156	-0.113	-0.198
	(0.0993)	(1.305)	(0.622)	(0.573)	(0.539)	(0.142)	(2.238)	(1.037)	(0.958)	(0.896)
(average WRI + 10)^2		-0.193***	-0.0489	-0.0280	-0.0336		-0.385***	0.00665	0.0180	0.0192
		(0.0630)	(0.0300)	(0.0276)	(0.0260)		(0.109)	(0.0502)	(0.0464)	(0.0435)
log(aggregate area) sq miles			1.238***	0.831***	0.813***			1.274***	0.867***	0.782***
			(0.0406)	(0.0674)	(0.0661)			(0.0471)	(0.0842)	(0.0818)
log(population)				0.369***	0.302***				0.370***	0.339***
				(0.0510)	(0.0501)				(0.0655)	(0.0623)
SIR					0.298**					0.327**
					(0.141)					(0.161)
Industry (% Information)					21.79***					21.63**
					(7.030)					(8.406)
log (median earnings)					0.483*					0.722**
					(0.264)					(0.284)
crime rate										
number of days below 32 degrees f (2018)										
number of days above 90 degrees f (2018)										
CBD 15 miles from coastline										
Constant	17.16***	-3.300	8.788***	8.710***	4.149	17.59***	-22.77**	15.15***	14.06***	7.576
	(0.987)	(6.734)	(3.189)	(2.916)	(3.809)	(1.421)	(11.48)	(5.267)	(4.863)	(4.880)
Observations	266	266	266	266	266	181	181	181	181	181
R-squared	0.145	0.175	0.819	0.849	0.868	0.092	0.152	0.835	0.860	0.885

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6: aggregate land value (Albouy et. al) and fraction of highly regulated communities (WRI>.64)

	(1)	(2)	(3)	(4)	(5)	(11)	(12)	(13)	(14)	(15)
Dependent variable: log (aggregate land value)										
	2006 WRI data (metropolitan)					2018 WRI data (suburban communities)				
(fraction of highly regulated communities)*10	0.169***	0.617***	0.197***	0.160***	0.145***	0.149***	0.724***	0.106**	0.0663	0.0488
	(0.0286)	(0.0816)	(0.0425)	(0.0392)	(0.0368)	(0.0351)	(0.0891)	(0.0499)	(0.0461)	(0.0429)
[(fraction of highly regulated communities)*10]^2		-0.0558***	-0.0127**	-0.00902**	-0.00951**		-0.0674***	-0.00399	0.000144	0.000355
		(0.00959)	(0.00492)	(0.00453)	(0.00424)		(0.00978)	(0.00538)	(0.00498)	(0.00461)
log(aggregate area) sq miles			1.229***	0.822***	0.798***			1.254***	0.840***	0.763***
			(0.0424)	(0.0685)	(0.0669)			(0.0516)	(0.0842)	(0.0818)
log(population)				0.372***	0.306***				0.388***	0.353***
				(0.0517)	(0.0505)				(0.0653)	(0.0623)
SIR					0.366***					0.336**
					(0.140)					(0.159)
Industry (% Information)					19.85***					21.24**
					(7.077)					(8.323)
log (median earnings)					0.546**					0.696**
					(0.266)					(0.280)
crime rate										
number of days below 32 degrees f (2018)										
number of days above 90 degrees f (2018)										
CBD 15 miles from coastline										
Constant	23.41***	23.21***	17.41***	14.79***	9.581***	23.28***	22.89***	17.28***	14.49***	7.578***
	(0.103)	(0.103)	(0.206)	(0.410)	(2.656)	(0.135)	(0.132)	(0.239)	(0.519)	(2.845)
Observations	266	266	266	266	266	181	181	181	181	181
R-squared	0.117	0.218	0.814	0.845	0.866	0.092	0.283	0.835	0.862	0.887

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7: aggregate land value (Harris) and average WRI

	(1)	(2)	(3)	(4)	(5)	(11)	(12)	(13)	(14)	(15)
Dependent variable: log (aggregate land value)										
	2006 WRI data (metropolitan)					2018 WRI data (suburban communities)				
average WRI + 10	1.294***	13.65	6.059	5.093	7.917**	1.399***	-8.116	-4.457	-4.290	-0.292
	(0.418)	(13.59)	(5.073)	(5.302)	(3.092)	(0.494)	(10.05)	(3.304)	(3.358)	(2.734)
(average WRI + 10)^2		-0.603	-0.275	-0.226	-0.379**		0.470	0.250	0.242	0.0284
		(0.663)	(0.247)	(0.259)	(0.151)		(0.496)	(0.163)	(0.166)	(0.139)
log(aggregate area) sq miles			1.393***	1.082**	0.771**			1.386***	1.153***	0.940**
			(0.107)	(0.454)	(0.285)			(0.0941)	(0.399)	(0.376)
log(population)				0.292	0.267				0.222	0.236
				(0.414)	(0.256)				(0.368)	(0.319)
SIR					0.824					1.779*
					(0.730)					(0.897)
Industry (% Information)					14.12					12.94
					(11.85)					(13.76)
log (median earnings)					1.007					-0.872
					(1.122)					(1.443)
crime rate					-4.634					-3.563
					(4.043)					(4.848)
number of days below 32 degrees f (2018)					-0.0144**					-0.0168**
					(0.00623)					(0.00712)
number of days above 90 degrees f (2018)					-0.00303					-0.00565**
					(0.00188)					(0.00253)
CBD 15 miles from coastline					0.494**					0.176
					(0.197)					(0.295)
Constant	12.20***	-50.84	-16.61	-14.01	-35.61	11.07**	59.02	35.84**	33.32*	24.56
	(4.290)	(69.47)	(25.89)	(26.40)	(22.51)	(5.100)	(50.83)	(16.74)	(17.47)	(23.93)
Observations	30	30	30	30	30	29	29	29	29	29
R-squared	0.255	0.277	0.904	0.906	0.983	0.229	0.255	0.923	0.924	0.979

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

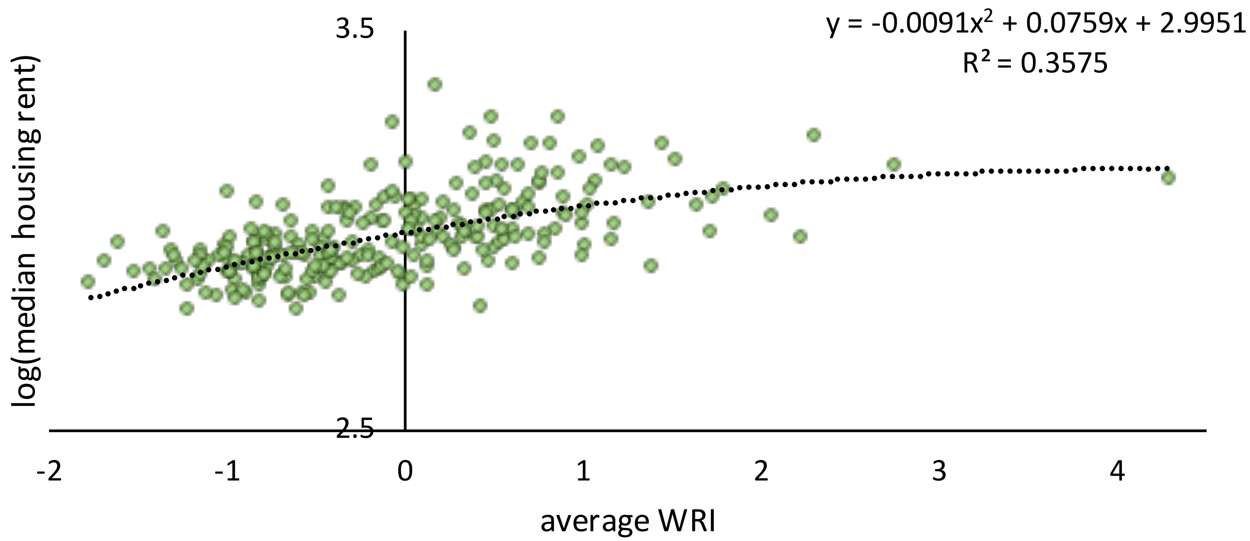
Table 8: aggregate land value (Harris) and fraction of highly regulated communities (WRI>.64)

	(1)	(2)	(3)	(4)	(5)	(11)	(12)	(13)	(14)	(15)
Dependent variable: log (aggregate land value)										
	2006 WRI data (metropolitan)					2018 WRI data (suburban communities)				
(fraction of highly regulated communities)*10	0.222**	1.038***	0.293**	0.286**	0.174**	0.332**	0.454	0.205	0.194	0.279**
	(0.101)	(0.262)	(0.124)	(0.128)	(0.0823)	(0.146)	(0.579)	(0.188)	(0.190)	(0.124)
[(fraction of highly regulated communities)*10]^2		-0.102***	-0.0266*	-0.0257*	-0.0194*		-0.0160	-0.00536	-0.00368	-0.0307*
		(0.0309)	(0.0141)	(0.0147)	(0.00943)		(0.0732)	(0.0237)	(0.0240)	(0.0167)
log(aggregate area) sq miles			1.352***	1.237***	0.812**			1.429***	1.105**	0.823**
			(0.115)	(0.438)	(0.307)			(0.0957)	(0.417)	(0.328)
log(population)				0.112	0.237				0.307	0.308
				(0.410)	(0.279)				(0.384)	(0.281)
SIR					0.852					1.531*
					(0.836)					(0.869)
Industry (% Information)					20.38					14.76
					(13.61)					(13.16)
log (median earnings)					0.697					-0.272
					(1.226)					(1.351)
crime rate					-1.312					-0.163
					(4.226)					(4.669)
number of days below 32 degrees f (2018)					-0.0152**					-0.0148**
					(0.00687)					(0.00696)
number of days above 90 degrees f (2018)					-0.00324					-0.00484*
					(0.00206)					(0.00236)
CBD 15 miles from coastline					0.393*					0.420
					(0.201)					(0.253)
Constant	24.71***	23.92***	16.28***	15.42***	8.591	24.25***	24.08***	15.60***	13.30***	17.25
	(0.442)	(0.449)	(0.675)	(3.224)	(12.52)	(0.618)	(1.004)	(0.654)	(2.957)	(14.42)
Observations	30	30	30	30	30	29	29	29	29	29
R-squared	0.147	0.392	0.904	0.904	0.980	0.160	0.162	0.916	0.918	0.981

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

Figure 1: median housing rent and 2006 WRI (Albouy et. al cities)

Panel A



Panel B

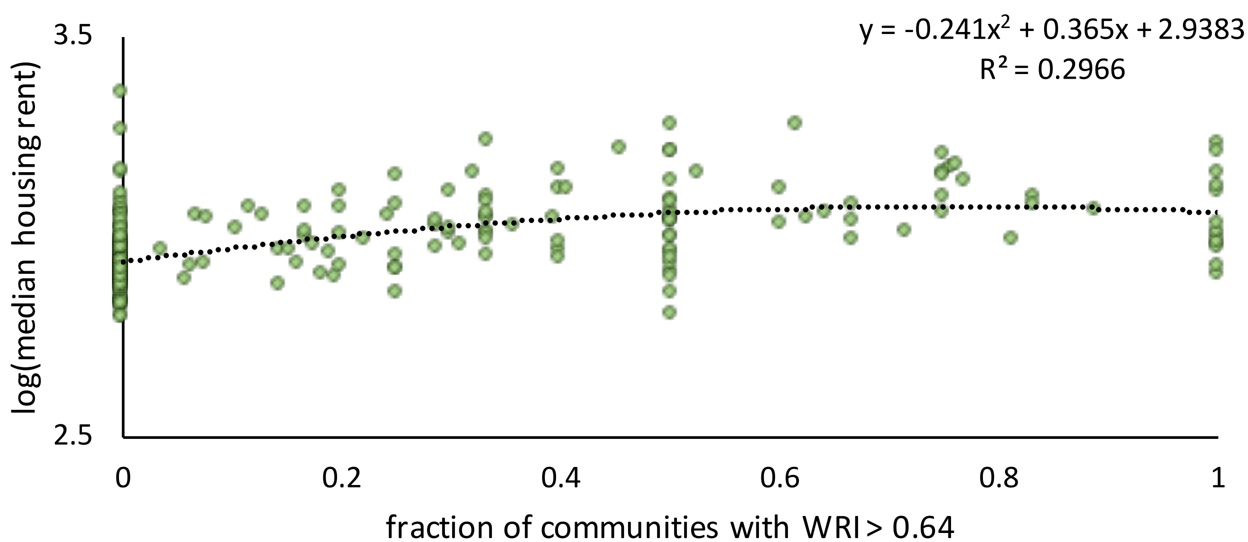
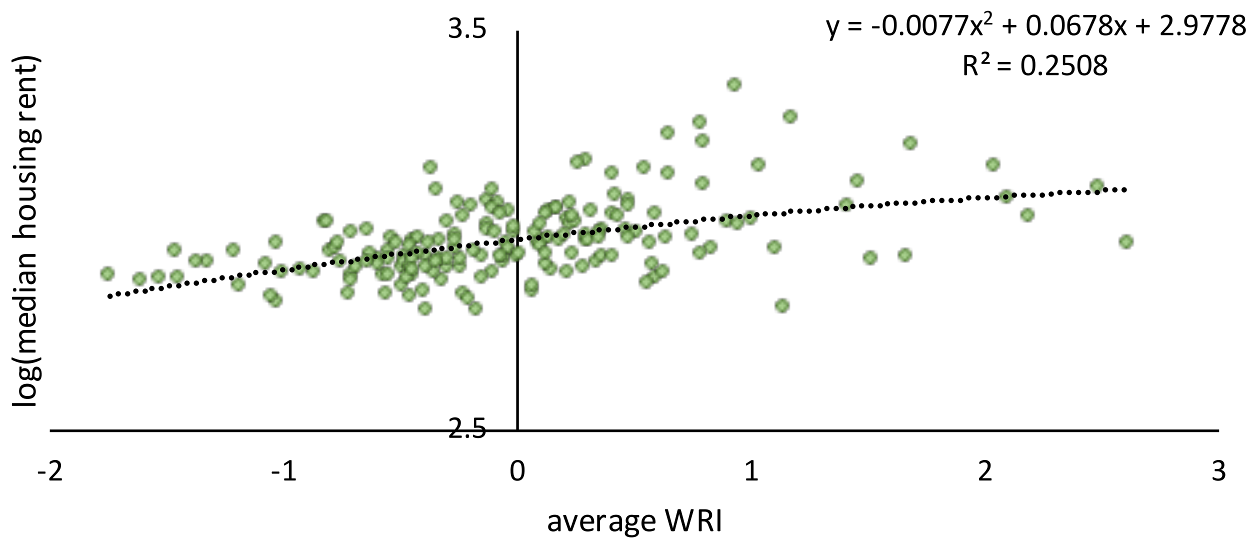


Figure 2: median housing rent and 2018 WRI (Albouy et. al cities)

Panel A



Panel B

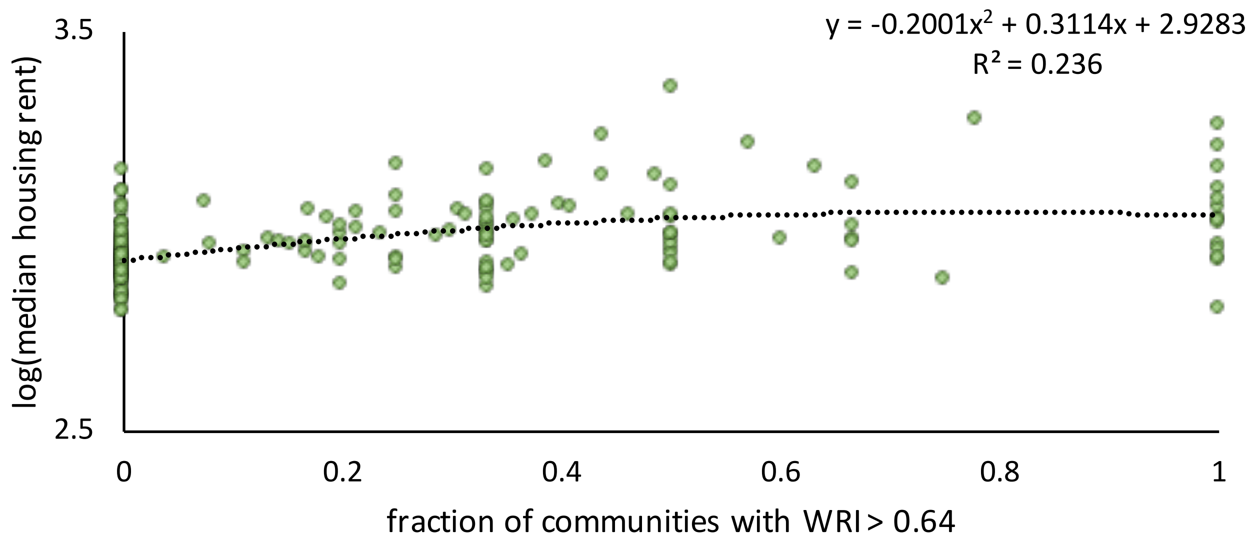


Figure 3: median housing rent and 2006 WRI (Harris cities)

Panel A

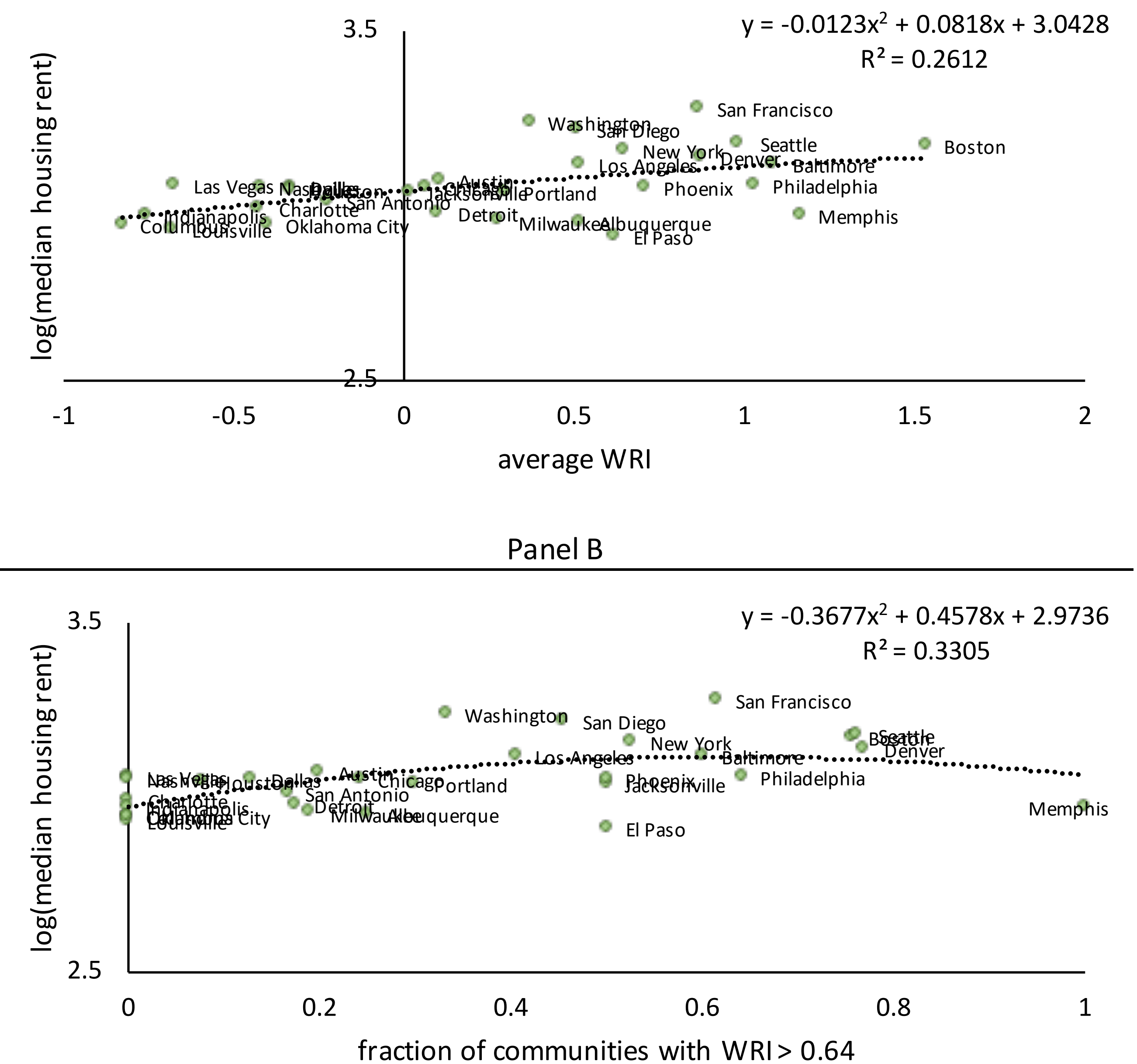


Figure 4: median housing rent and 2018 WRI (Harris cities)

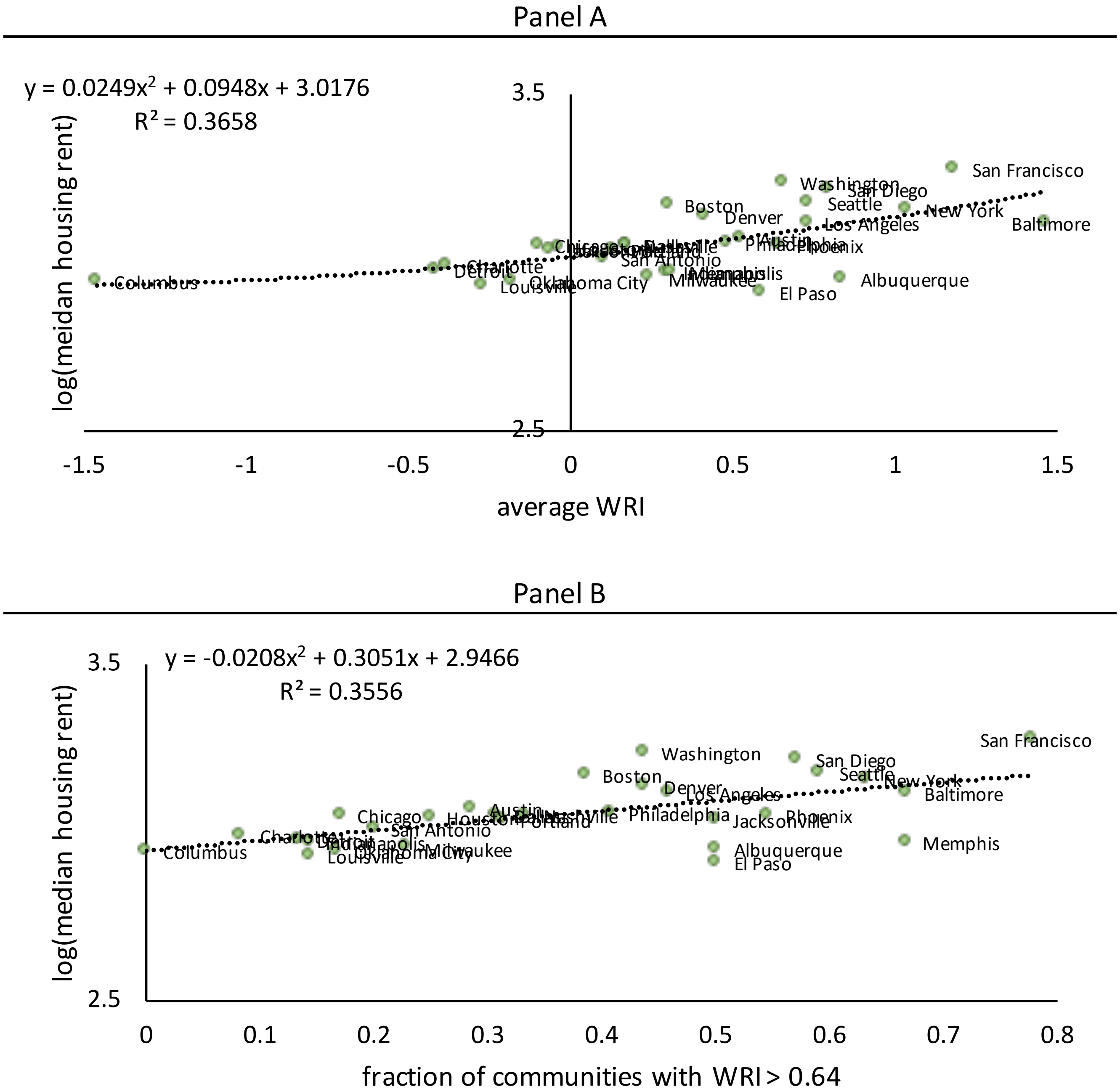
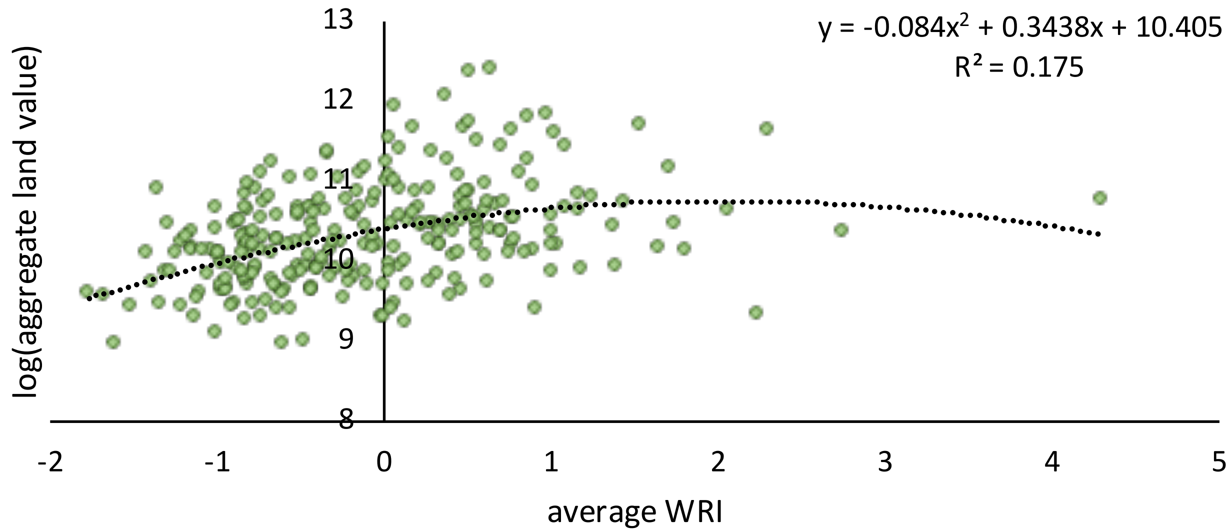


Figure 5: aggregate land value (Albouy et. al) and 2006 WRI

Panel A



Panel B

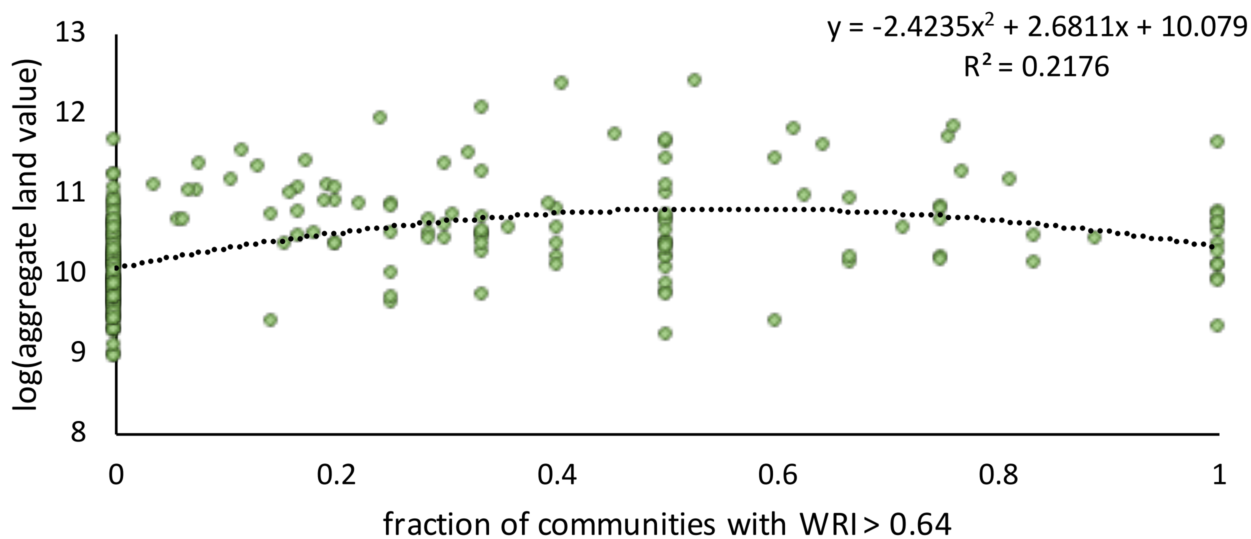
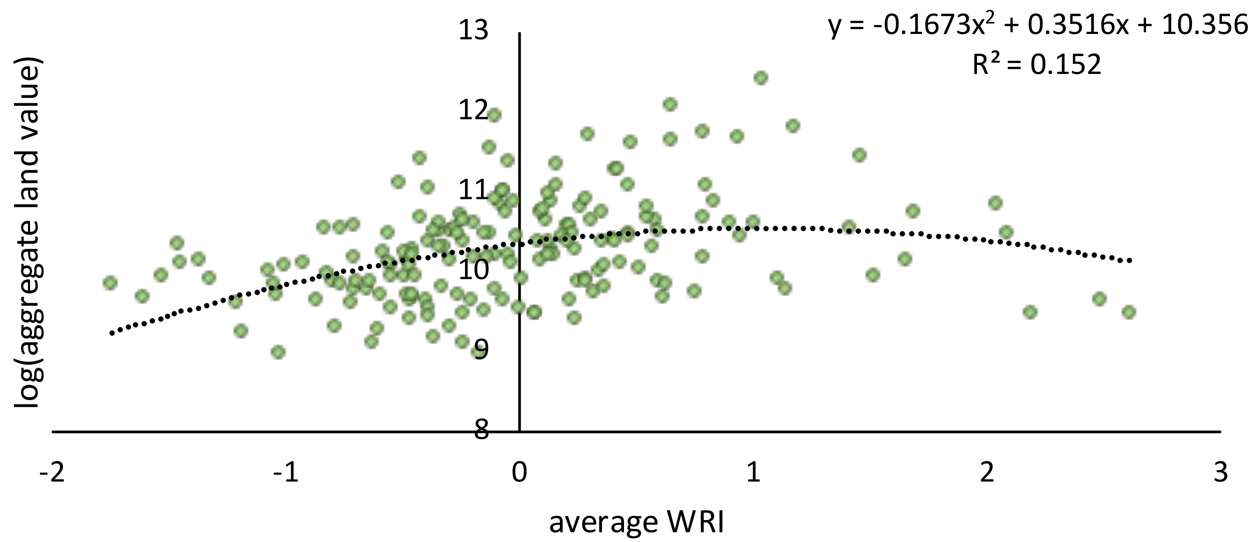


Figure 6: aggregate land value (Albouy) and 2018 WRI

Panel A



Panel B

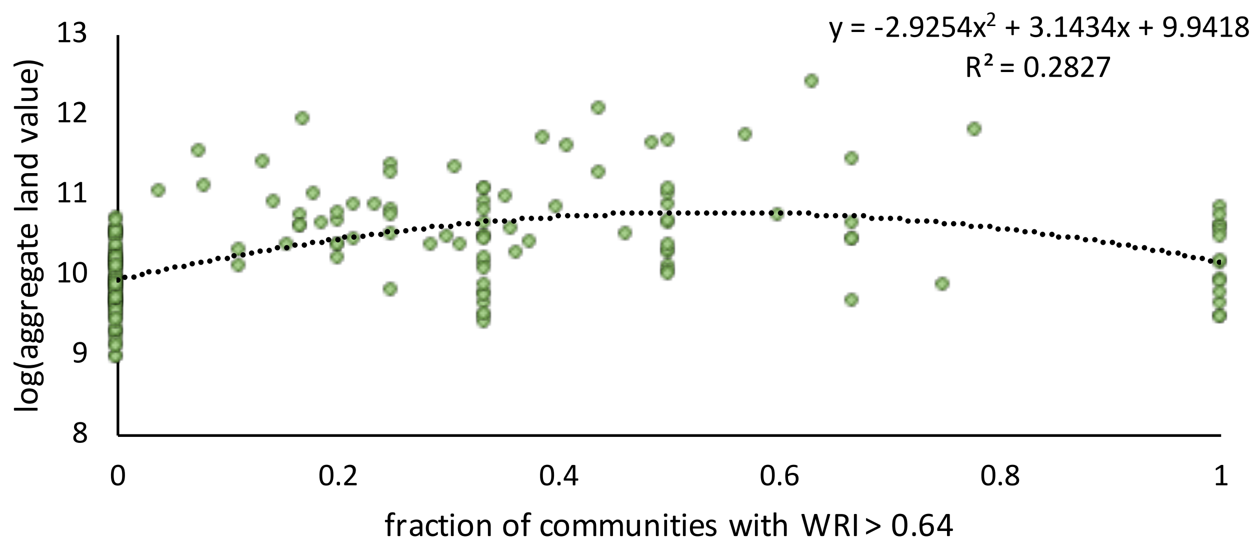
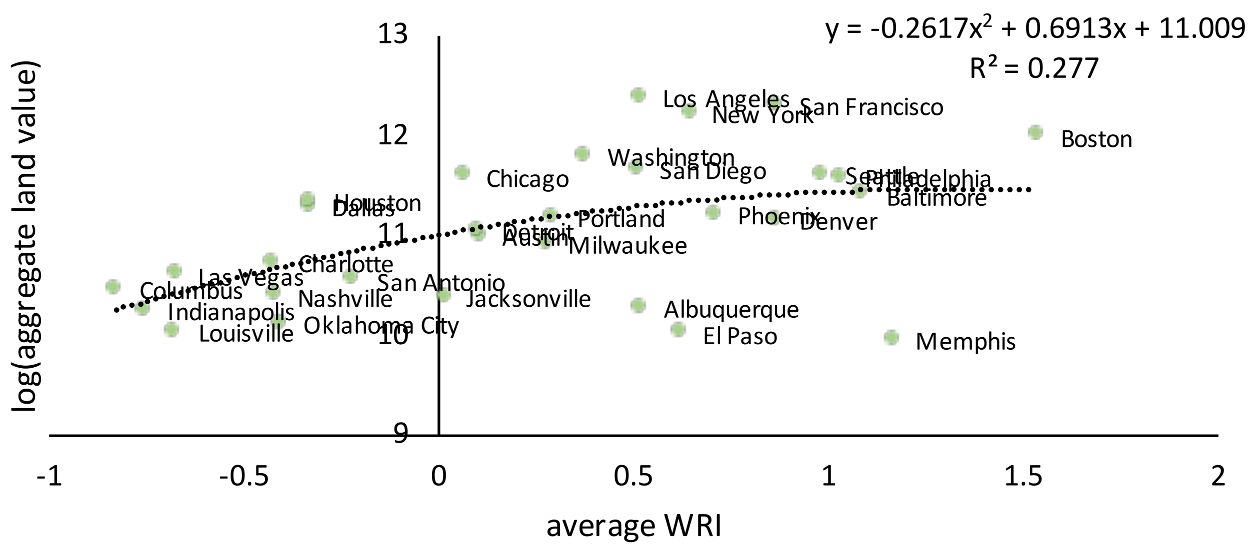


Figure 7: aggregate land value (Harris) and 2006 WRI

Panel A



Panel B

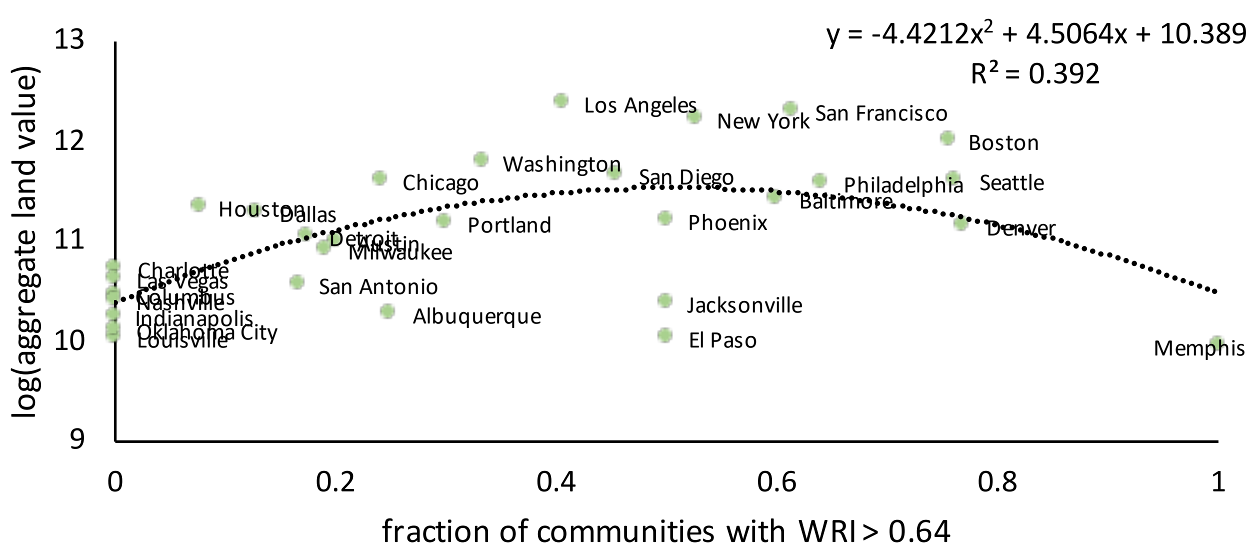
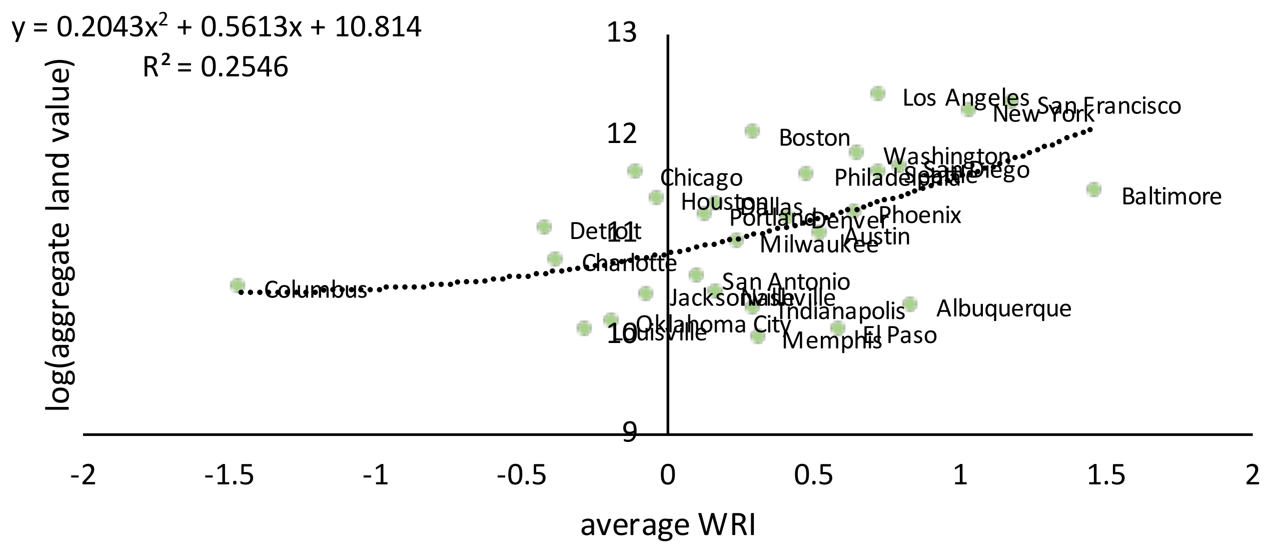


Figure 8: aggregate land value (Harris) and 2018 WRI

Panel A



Panel B