Do Minimum Wages Increase Rents?

Evidence from US ZIP Codes Using High-Frequency Data

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Motivation

Research on minimum wage (MW) has mostly focused on employment.

However, as MW policies are *place-based*, so one should expect broader effects in the local economy:

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⇒ Housing market.

Prediction from theory
A canonical version of the (Muth-Mills) monocentric city model suggests that income increases will pass-through 1:1 to rents (**Brueckner1987**).

⇒ We are not aware of empirical estimates of that pass-through!

This paper

We investigate the short term effects of MW policies on rents in the US:

- Accounting for spatial spillovers, we estimate elasticity of median rents to workplace and residence MWs.
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- Estimate pass-through of MW increases to rents.

To do so, we:

- Exploit high-frequency (monthly) high-resolution (ZIP Code) rents data from Zillow.
- Leverage timing and spatial variation in MW changes *within* metropolitan areas.
- Propose a novel model-based measure of exposure to MW changes based on commuting shares.

Comparative statics intuition

Think of a metropolitan area, and a MW increase in the business district (CBD).

Partial equilibrium: short term

- Firms producing in the CBD will pay a higher wage. Income redistribution from firms to low income workers.
- Income changes are heterogeneous across space because people work and reside in different locations.
- Housing is a normal good. Housing demand in some areas increases and landlords charge a higher rent.

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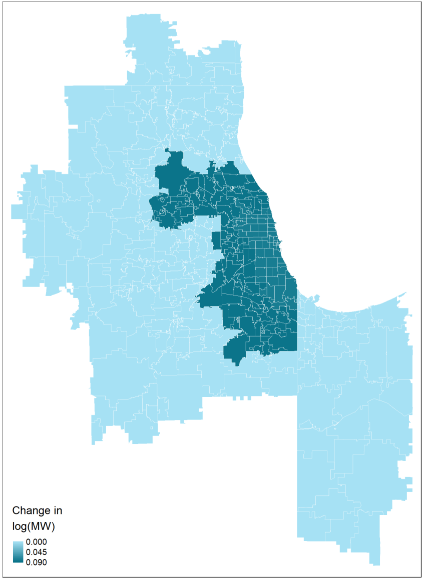
General equilibrium: long term (Not this paper!)

- People change residence and workplace locations (sorting).
- Developers build more houses (supply response).

A motivating example



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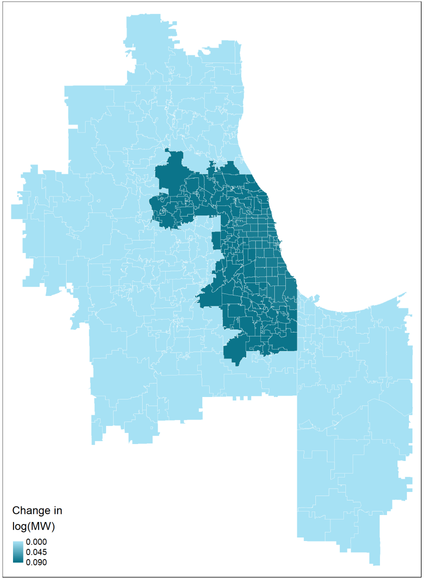

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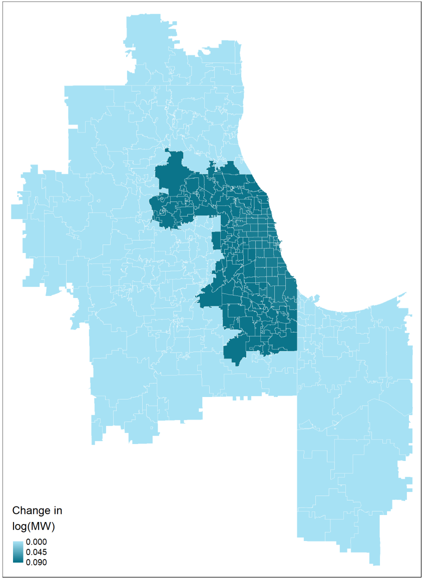

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- A (naive) regression model of changes in rents on changes in MW's will imply that rents can only be affected in Cook County.
- However, MW workers in Cook County may also live elsewhere in the Chicago metropolitan area. → We need to take the commuting structure into account!

A novel model-based measure of access to MW's

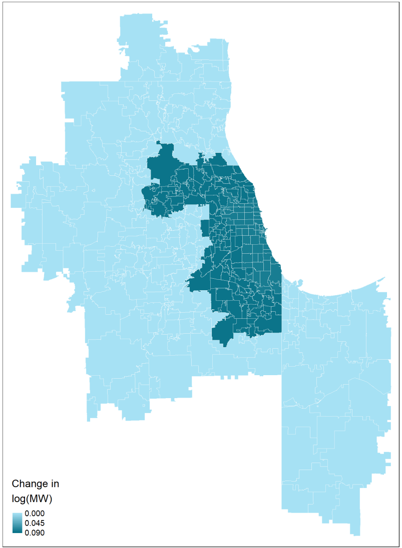
For ZIP code i, and month t we define it as:

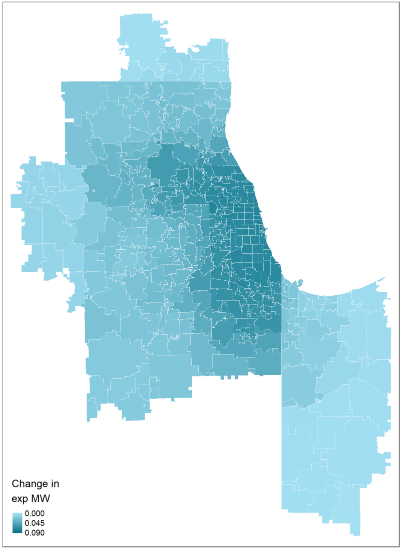
$$\underline{w}_{it}^{\text{wrk}} = \sum_{z \in \mathcal{Z}(i)} \pi_{iz} \ln \underline{w}_{zt} \ ,$$

where

- $\mathcal{Z}(i)$ are workplace locations of i's residents, and
- $\pi_{iz} = \frac{L_{iz}}{L_i}$ is the share of i's residents who work in z.

A motivating example (Continuation)





Example NYC | Example Seattle | Example Bay Area | Example San Diego | Example Kansas City

Outline for Today

A Partial Equilibrium Model of the Local Rental Markets

Overview

Goals of the model:

- Stylized answer to: what is the short-term effect of MW changes in rent prices?
- Motivate and derive a new access to MW measure.
- Emphasize why one may expect residence and worker MWs to have different effects on the housing market.
- Motivate our empirical strategy: use commuting patterns to account for spatial spillovers of MW policies.

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The model is *not* intended to:

- Describe within-city residential sorting.
- Describe the local labor markets.
- Describe the local goods markets.
- Perform general equilibrium welfare analysis of MW policies.

Setup

Static rental market of some residence ZIP code i embedded in a larger geography $\mathcal{Z}$ with finite number of ZIP codes.

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- Exogenous and fixed L_{iz} that denotes the measure of i's residents who work in z.
  - Measure of residents in i: $L_i = \sum_{z \in \mathcal{Z}(i)} L_{iz}$.
  - Measure of workers in z: $L_z = \sum_{i \in \mathcal{Z}(i)} L_{iz}$.

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- $h_{iz}(R_i, \underline{w}_i, \underline{w}_z)$: housing demand of i's residents that work in z, where R_i represents housing rents per square foot.

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- $h_{iz}(R_i, \underline{w}_i, \underline{w}_z)$: housing demand of i's residents that work in z, where R_i represents housing rents per square foot.
- $D_i\left(r_i\right)$: supply of square feet in i, which is increasing in R_i.

Housing Demands

Assumption (Housing demand)

For all residence-workplace pairs, the housing demand functions $h_{iz}(R_i, \underline{w}_i, \underline{w}_z)$ *is:*

1. *continuously differentiable in its three arguments;*
2. *decreasing in rental prices* R_i*;*
3. *non-decreasing in workplace minimum wage* $\underline{w}_z$*.*
4. *non-increasing in residence minimum wage* $\underline{w}_i$*;*

Furthermore, for at least one $z \in \mathcal{Z}(i)$*, the inequalities in points (iii) and (iv) are strict.*

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We think that the interpretation underlying point 4. is plausible:

- Recent evidence by **MiyauchiEtAl2021** shows that individuals tend to consume close to home. Households respond and are aware of price differentials in local consumption across neighborhoods.
- MWs have been shown to increase prices of local consumption (**AllegrettoReich2018**; **LeungForthcoming**).

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Potential microfoundation:

- If firms in i that produce non-tradable local goods, use MW workers as an input, then a MW increase will increase prices. Higher cost of non-tradables will translate into a lower demand for housing if the substitution effect on local demand of housing is smaller than the corresponding income effect.
- A sufficient condition for that is that housing and local consumption are complements.

Equilibrium

Define the housing demand in Zip Code i as:

$$H_i(R_i, \{\underline{w}_z\}_{z \in \mathcal{Z}(i)}) = \sum_{z \in \mathcal{Z}(i)} L_{iz} h_{iz}(R_i, \underline{w}_i, \underline{w}_z)$$

The rental market of ZIP code i is in equilibrium if

$$H_i(R_i, \{\underline{w}_z\}_{z \in \mathcal{Z}(i)}) = D_i(R_i)$$

As housing demand functions are continuous and decreasing in rents, under suitable regularity conditions there is a unique equilibrium in this market.

We denote equilibrium rents as $R_i^* = f(\{\underline{w}_i\}_{i \in \mathcal{Z}(i)})$.

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We are interested in the effects of MW policies on rents.

- What is the effect of a change in the vector of MWs $(\{d\underline{w}_i\}_{i\in\mathcal{Z}(i)})'$ on equilibrium rents?
- Under what conditions can we represent those effects in a simple way?

Comparative Statics

Proposition (Comparative Statics)

Under the assumptions of:

1. *Fixed of workers across workplace and residence pairs.*
2. *housing demand equation satisfying Assumption* **??**,
3. *continuously differentiable and increasing housing supply.*

We have that:

- *workplace-MW hikes increase rents.*
- *holding constant workplace-MW hikes, residence-MW hikes decrease rents.*

Proof of Proposition (Comparative Statics)

Proof.

Fully differentiate the market clearing condition with respect to $\ln R_i$ and $\ln \underline{w}_i$ for all $i \in \mathcal{Z}(i)$ and re-arrange terms to get:

$$\left(\eta_i - \sum_z \pi_{iz}\xi_{iz}\right) d\ln R_i = \sum_z \pi_{iz}\left(\epsilon^i_{iz} d\ln \underline{w}_i + \epsilon^z_{iz} d\ln \underline{w}_z\right), \tag{1}$$

where:

- $\eta_i = \frac{1}{L_i}\frac{dD_i}{dR_i}\frac{R_i}{D_i}$ is the per resident elasticity of housing supply in ZIP code i
- Commuter shares: $\pi_{iz} = \frac{L_{iz}}{L_i}$
- $\xi_{iz} = \frac{dh_{iz}}{dR_i}\frac{R_i}{\sum_z \pi_{iz} h_{iz}}$ is the elasticity of housing demand at the average per-capita demand of ZIP code i
- $\epsilon^i_{iz} = \frac{dh_{iz}}{d\underline{w}_i}\frac{\underline{w}_i}{\sum_z \pi_{iz} h_{iz}}$ and $\epsilon^z_{iz} = \frac{dh_{iz}}{d\underline{w}_z}\frac{\underline{w}_z}{\sum_z \pi_{iz} h_{iz}}$ are the elasticities of housing demand to workplace and residence MWs also at the average per-capita demand of ZIP code i

□

Proof of Proposition (Comparative Statics) (Continuation)

Using that:

- $\xi_{iz} < 0$ for at least some workplace
- $\epsilon_{iz}^{i} < 0$
- $\epsilon_{iz}^{z} > 0$

It follows from (**??**) that:

1. an increase in workplace MW unambiguously increases rents
2. an increase in residence MW on rents is generally ambiguous (as long as some residents of i also work in i) as it is composed of a direct negative effect and an indirect positive effect through changing the experienced MW. [1]
3. Holding constant workplace MWs, the effect of the residence MW is negative.

[1] The sign of the overall partial effect depends on the sign of $\pi_{ii}\epsilon_{ii}^{z} + \sum_z \pi_{iz}\epsilon_{iz}^{i}$.

Representation

Proposition (Representation)

Under the assumption of constant elasticity of housing demand (across workplace locations) to workplace minimum wages we have that:

- *We can write the change in log rents as a function of the change in two MW-based measures: the* **experienced log MW** *and the* **statutory log MW***.*

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Proof.

Set $\epsilon_{iz}^{z} = \epsilon_{i}^{z}$ for all $z \in \mathcal{Z}(i)$ we can manipulate (**??**) to write:

$$d \ln R_i = \beta_i \underbrace{\sum_i \pi_{iz} d \ln \underline{w}_z}_{d\underline{w}_i^{\text{wrk}}} + \gamma_i \underbrace{d \ln \underline{w}_i}_{d\underline{w}_i^{\text{res}}} \tag{2}$$

where $\beta_i = \frac{\epsilon_i^z}{\eta_i - \sum_z \pi_{iz}\xi_{iz}}$ and $\gamma_i = \frac{\sum_z \pi_{iz}\epsilon_{iz}^i}{\eta_i - \sum_z \pi_{iz}\xi_{iz}}$. $\square$

Motivating our empirical Strategy

We have that the theoretical partial equilibrium effect of a change in elements of a vector of MW on rents is given by:

$$d \ln R_i = \beta_i d \underline{w}_i^{\text{wrk}} + \gamma_i d \ln \underline{w}_i^{\text{res}} \tag{3}$$

Where, because of Proposition (Comparative Statics), we have that:

- The partial equilibrium effect of workplace MW, $\beta_i = \frac{\epsilon_i^z}{\eta_i - \sum_z \pi_{iz} \xi_{iz}} > 0$
- The partial equilibrium effect of residence MW, $\gamma_i = \frac{\sum_z \pi_{iz} \epsilon_{iz}^i}{\eta_i - \sum_z \pi_{iz} \xi_{iz}} < 0$.

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Today, we will estimate an empirical analog assuming homogenous effects across residence locations.

Data

Zillow Data

- Leader online real estate and rental platform in the U.S. (more than 110 million homes and 170 million unique monthly users in 2019).
- Provides *median* rents data at ZIP code, county, and state levels at a monthly frequency for several housing categories.

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  Comparison with Small Area Fair Market Rents
- Limitation: Zillow sample is not random.

  Zillow Zip Codes and Population Density

The Statutory MW

- Collect MW data at state, county and city levels between Jan 2010 and Dec 2019.
  - Up to 2016 we relied on data from **CegnizEtAl2019** and **VaghulZipperer2016**
- For each US Postal ZIP Code we assigned place, ZCTA, city, county, and state codes.
- Define statutory MW in ZIP code as maximum between state and local levels.

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- Define statutory MW in ZIP code as maximum between state and local levels.
- ZIP codes available in Zillow contain 18,689 changes at the ZIP code-month level.
  - 151 state-level changes.
  - 182 county and city-level changes.

Distribution of MW changes

Using LODES to construct the experienced log MW

Construct **origin-destination matrix** at ZIP code level from LODES 2009 to 2018.

We observe:

- Number of workers residing in a ZIP code and working in every other ZIP code.
- Analogous, matrix for number of workers younger than 29 and earning less than $1,251.

In our baseline specification we use constant commuter shares using year 2017. We will show robustness with other fixed years and with time varying shares using the closest year.

Other Data Sources

- Economic controls from the Quarterly Census of Employment and Wages (QCEW).
- IRS Statistics of income - ZIP Code Aggregates (New)
- American Community Survey
- US Census
- Shapefile of US Postal ZIP Codes

Empirical Strategy

Empirical (Naive) model

One may estimate the following first differences model:

$$\Delta r_{it} = \tilde{\delta}_t + \tilde{\beta}\Delta \underline{w}_{it}^{\text{res}} + \Delta \mathbf{X}'_{c(i)t}\tilde{\eta} + \Delta\tilde{\varepsilon}_{it},$$

where

- ZIP code i, county $c(i)$, month t.
- $r_{it} = \ln R_{it}$: log of rents per square foot.
- $\underline{w}_{it}^{res} = \ln \underline{w}_{it}$: log of the residence MW.
- $\tilde{\delta}_t$: month fixed effects (ZIP code FE $\tilde{\alpha}_i$ is implicit).
- $\mathbf{X}_{c(i)t}$: time-varying controls at the county level.

Empirical model

Now add experienced MW:

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is our measure of access to MW in workplace locations derived from the model.

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For causal effect of β we need:

$$E\left[\Delta \varepsilon_{ict} \Delta \underline{w}_{i\tau}^{\text{wrk}} \middle| \Delta \underline{w}_{it}^{\text{res}}, \delta_t, \Delta \mathbf{X}_{c(i)t}\right] = 0 \qquad \forall \tau \in [\underline{T}, \overline{T}]$$

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In words: conditional on FEs, controls, and MW in same ZIP code, unobserved innovations to rent shocks are uncorrelated with past and future values of log MW changes in nearby ZIP codes.

Discussion Identification Assumption

Thus, for causal effect of β we need:

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Analogously, for causal effect of γ we need:

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Is this plausible?

- MW policies are rarely set by considering differential dynamics of the rental housing market within metropolitan areas.
- Furthermore, there is substantial heterogeneity in the housing market across ZIP codes.
- Indirectly test assumption through pre-trends, assuming no anticipatory effects in housing market.
- Use only MW changes that are not pre-announced (pending).

Intuition for Identification (Homogeneous Case)

Potential Outcomes with Continuous Treatment and Spatial Spillovers

Consider the potential outcomes model for log rents given by:

$$r_{it} = r_{it}\left(\{\underline{w}_{zt}\}_{z\in\mathcal{Z}(i)}\right)$$

We impose some structure by assuming that:

$$r_{it}(\underline{w}_{1t},...,\underline{w}_{it},...,\underline{w}_{Z_{\mathcal{Z}(i)}}) = \alpha_i + \delta_t + \beta \underbrace{\sum_{z\in\mathcal{Z}(i)} \pi_{iz} \ln \underline{w}_{zt}}_{\underline{w}_{it}^{\text{wrk}}} + \gamma \underbrace{\ln \underline{w}_{it}}_{\underline{w}_{it}^{\text{res}}} + u_{it}$$

where the econometrician has knowledge of the commuting shares, and u_{it} is an unobserved shock.

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Questions:

- Are β and γ identified?
- Through which comparisons?

A simple example with 3 ZIP Codes and 2 time periods

Consider a hypothetical metropolitan area with 3 ZIP Codes and 2 consecutive periods (period 0 and 1), and suppose that in period 0 the MW is \$0 everywhere, but in period 1 the MW in unit 2 increases to \$1.

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We have have 6 observations for rents, and the potential outcomes model implies:

- $r_{10}(0,0,0) = \alpha_1 + \delta_0 + u_{10}$
- $r_{11}(0,1,0) = \alpha_1 + \delta_1 + \beta\pi_{12} + u_{11}$
- $r_{20}(0,0,0) = \alpha_2 + \delta_0 + u_{20}$
- $r_{21}(0,1,0) = \alpha_2 + \delta_1 + \gamma + \beta\pi_{22} + u_{21}$
- $r_{30}(0,0,0) = \alpha_3 + \delta_0 + u_{30}$
- $r_{31}(0,1,0) = \alpha_3 + \delta_1 + \beta\pi_{32} + u_{31}$

Solving for β

Taking time differences, and denoting $\Delta x_i = x_{i1} - r_{i0}$ and $\delta = \delta_1 - \delta_0$ we have that:

- $\Delta r_1 = \delta + \beta\pi_{12} + \Delta u_1$
- $\Delta r_2 = \delta + \gamma + \beta\pi_{22} + \Delta u_2$
- $\Delta r_3 = \delta + \beta\pi_{32} + \Delta u_3$

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- $\Delta r_3 = \delta + \beta \pi_{32} + \Delta u_3$

Now differentiate the indirectly treated units and rearrange to obtain:

$$\beta = \frac{(\Delta r_3 - \Delta r_1) + (\Delta u_3 - \Delta u_1)}{\pi_{32} - \pi_{12}}$$

To identify β we need:

- parallel trends across indirectly treated units: $\Delta u_3 - \Delta u_1 = 0$
- variation in the "spillover" levels across indirectly treated units: $\pi_{32} - \pi_{12} \neq 0$

Solving for γ

Differentiate the treated unit with an indirectly treated unit and rearrange to obtain:

$$
\begin{aligned}
\gamma &= \Delta r_2 - \Delta r_1 - \beta(\pi_{22} - \pi_{12}) + (\Delta u_2 - \Delta u_1) \\
&= \Delta r_2 - \Delta r_1 - \left[\frac{\Delta r_1 - \Delta r_3}{\pi_{32} - \pi_{12}}\right](\pi_{22} - \pi_{12}) + (\Delta u_2 - \Delta u_1) \\
&= \Delta r_2 - \left[\frac{\pi_{32} - \pi_{22}}{\pi_{32} - \pi_{12}}\Delta r_1 + \frac{\pi_{12} - \pi_{22}}{\pi_{32} - \pi_{12}}\Delta r_3\right] + (\Delta u_2 - \Delta u_1)
\end{aligned}
$$

To additionally identify γ we need:

- parallel trends across treated and indirectly treated units: $\Delta u_2 - \Delta u_1 = 0$

Interpretation

- We need parallel trends across treated and indirectly treated groups.
- Interestingly, with continuous treatment and an assumption of how spillovers are dosed, we don't need pure control control units, as we can make contrasts of units with different exposure levels.
- β can be thought of a difference-in-differences between indirectly treated units adjusted by their difference in exposure to the treated units.
- γ is identified by a difference-in-differences in which we difference the treated units with a linear combination of the difference in indirectly treated units, where the coefficients reflect the relative difference of exposure to treated units.

Results

Static

Table: Static model

	Change workplace MW	Change log rents		
	(1)	(2)	(3)	(4)
Change residence minimum wage	0.8683	0.0257		-0.0302
	(0.0298)	(0.0137)		(0.0169
Change workplace minimum wage			0.0321	0.0645
			(0.0150)	(0.0274
Sum of coefficients				0.0342
				(0.0151
County-quarter economic controls	Yes	Yes	Yes	Yes
P-value equality				0.0332
R-squared	0.9449	0.0209	0.0209	0.0209

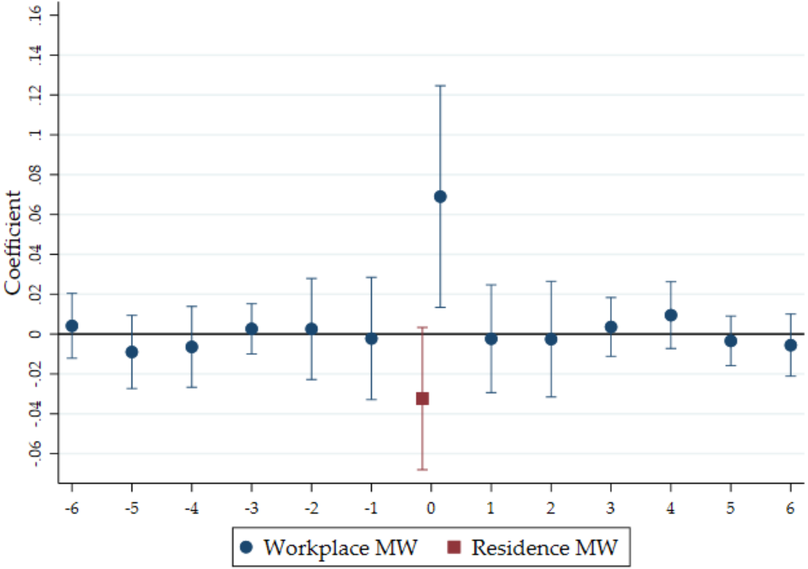
Testing Identification with a Dynamic model

Adding leads and lags of the experienced log MW:

$$\Delta r_{it} = \delta_t + \sum_{r=-s}^{s} \beta_r \Delta \underline{w}_{i,t+r}^{\text{exp}} + \gamma \Delta \underline{w}_{it}^{\text{res}} + \Delta \mathbf{X}_{c(i)t}^{'} \eta + \Delta \varepsilon_{it}$$

where $\{\beta_r\}_{r=-s}^{s}$ are the dynamic coefficients.

Analogously, one can add instead the leads and lags of the log residence MW to test the identification assumption of γ.


Coefficient
.16
.14
.12
.1
.08
.06
.04
.02
0
-.02
-.04
-.06
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
Workplace MW
Residence MW

Robustness and Heterogeneity

The incidence of counterfactual federal MW change

Overview

Entire commuting structure determines the incidence of MW policies.

- In some ZIP codes both residence and workplace MW increase
- Other nearby ZIP codes are affected only through workplace

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How much out of each extra dollar is captured by landlords?

Pass-through coefficients

Define pass-through coefficients

$$\rho_i := \frac{\Delta H_i}{\Delta Y_i} = \frac{h_i^{\text{Post}} r_i^{\text{Post}} - h_i^{\text{Pre}} r_i^{\text{Pre}}}{\Delta Y_i}$$

where

- h denotes rented space in i (square feet)
- Pre and Post indicate moments before and after the increase

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where

- h denotes rented space in i (square feet)
- Pre and Post indicate moments before and after the increase

Change in rented space are unobserved. We assume $h_i^{\text{Pre}} = h_i^{\text{Post}} = h_i$ so

$$\rho_i = \frac{h_i^{\text{Post}} r_i^{\text{Post}} - h_i^{\text{Pre}} r_i^{\text{Pre}}}{\Delta Y_i} = h_i \frac{\Delta R_i}{\Delta Y_i}$$

If $\Delta h_i > 0$ then our estimate of ρ_i is a lower bound.

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If $\Delta h_i > 0$ then our estimate of ρ_i is a lower bound.

We construct empirical analogous of h_i, ΔR_i and ΔY_i.

Estimates of total rented space

We haven't found data on $\{h_i\}$. Therefore we do the following

- From Zillow get median rental price R_i and median rental price per square foot r_i
- Estimate average square footage $q_i = \frac{R_i}{r_i}$
- Compute number of rented units N_i from ACS 2019

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Our estimates of total rented space in each ZIP code i are

$$\hat{h}_i = q_i N_i$$

Model-based estimates of rent changes

Increase in federal MW to \$9 generates $\{\Delta \ln \hat{\underline{w}}_i\}_{i \in \mathcal{Z}}$

- $\Delta \ln \hat{\underline{w}}_i = 0$ for ZIP codes with binding MWs above \$9

Model-based estimates of rent changes

Increase in federal MW to \$9 generates $\{\Delta \widehat{\ln \underline{w}_i}\}_{i \in \mathcal{Z}}$

- $\Delta \widehat{\ln \underline{w}_i} = 0$ for ZIP codes with binding MWs above \$9

We proceed as follows

- Estimate $\{\Delta \ln r_i\}$ using our baseline model

$$\Delta \widehat{\ln r_i} = \gamma \Delta \widehat{\ln \underline{w}_i} + \beta \sum_{z \in \mathcal{Z}_i} \pi_{iz} \Delta \widehat{\ln \underline{w}_z}$$

- Using r_i^{Pre} from Zillow as of December 2019, compute

$$\Delta \hat{r}_i = \left(\exp(\Delta \widehat{\ln r_i}) - 1 \right) r_i^{\text{Pre}}$$

Model-based estimates of income changes

Increase in federal MW to \$9 generates $\{\Delta \ln \hat{\underline{w}}_i\}_{i \in \mathcal{Z}}$

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Increase in federal MW to \$9 generates $\{\Delta \ln \hat{\underline{w}}_i\}_{i \in \mathcal{Z}}$

We need an elasticity of income to the MW ϵ

- Estimate new model using IRS data, obtains 0.14 [BUTTON TO RESULTS]
- Use estimates from the literature (**CegnizEtAl2019**)

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Increase in federal MW to \$9 generates $\{\Delta \widehat{\ln \underline{w}_i}\}_{i \in \mathcal{Z}}$

We need an elasticity of income to the MW ϵ

- Estimate new model using IRS data, obtains 0.14 [BUTTON TO RESULTS]
- Use estimates from the literature (**CegnizEtAl2019**)

We proceed as follows

- Use elasticity ϵ to get

$$\Delta \widehat{\ln Y_i} = \epsilon \sum_{z \in \mathcal{Z}_i} \pi_{iz} \Delta \widehat{\ln \underline{w}_i}$$

- Compute $\Delta \hat{Y}_i$ using Y_i^{Pre} as of 2018

$$\Delta \hat{Y}_i = \left(\exp(\Delta \widehat{\ln Y_i}) - 1 \right) Y_i^{\text{Pre}}$$

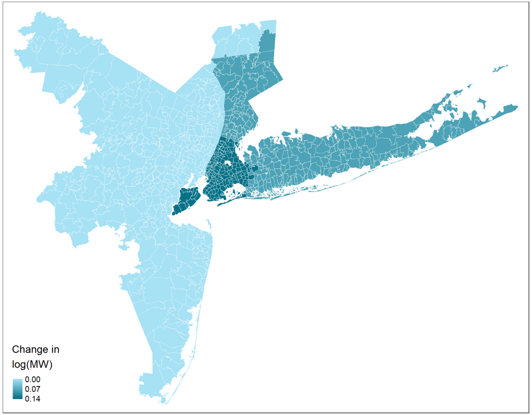
The incidence of MW changes across space

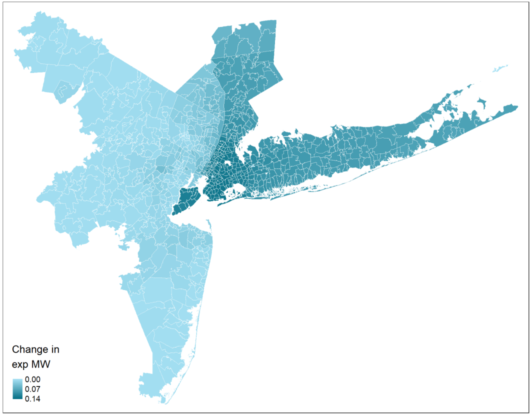
Figure distribution here

Thank You!

Appendix

Other examples: New York (MW Changes in January 2019)





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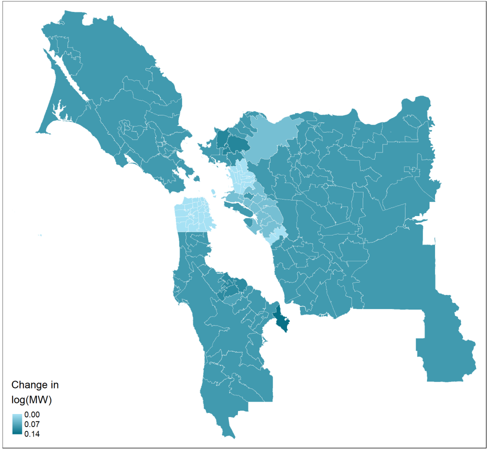
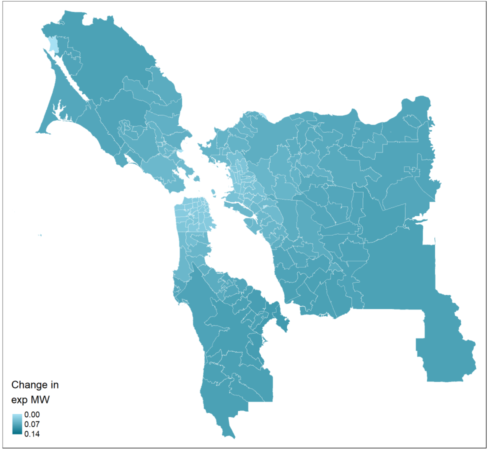
Other examples: Bay area (MW Changes in January 2019)





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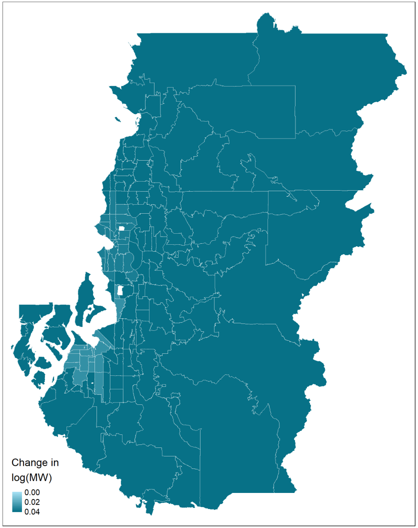
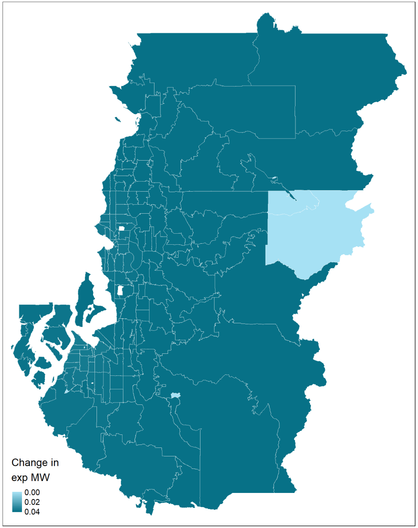
Other examples: Seattle (MW Changes in January 2018)





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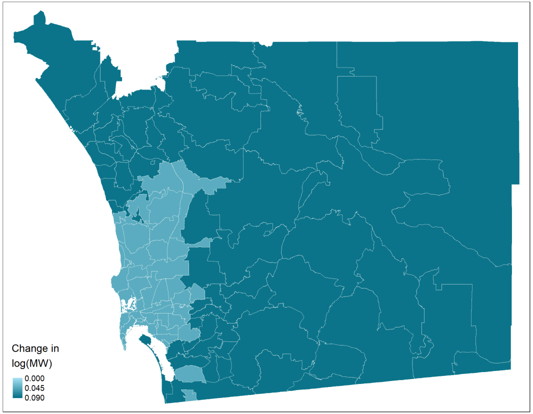
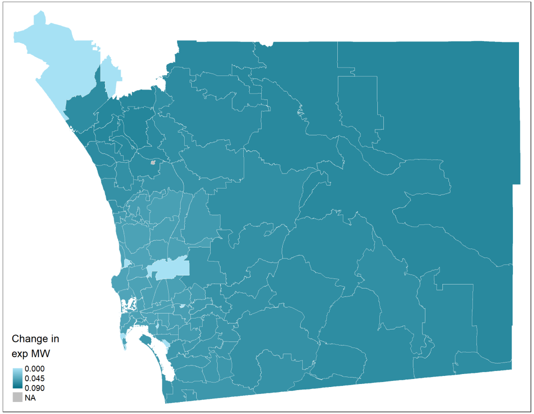
Other examples: San Diego (MW Changes in January 2019)





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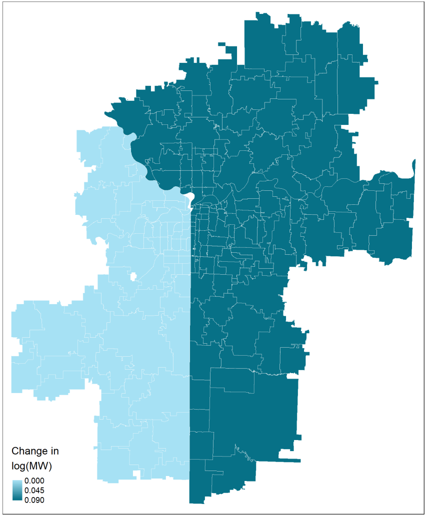
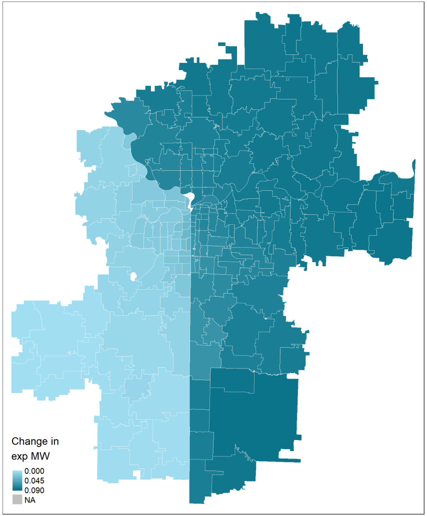
Other examples: Kansas City (MW Changes in January 2019)





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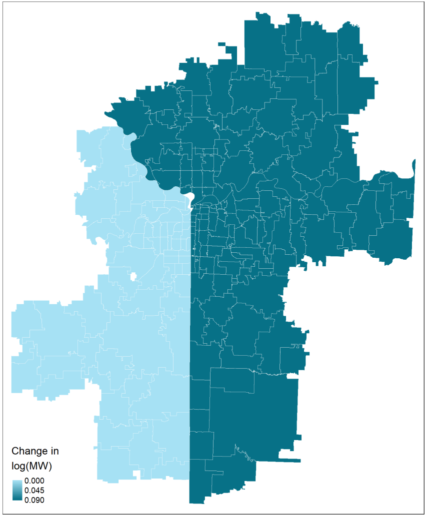
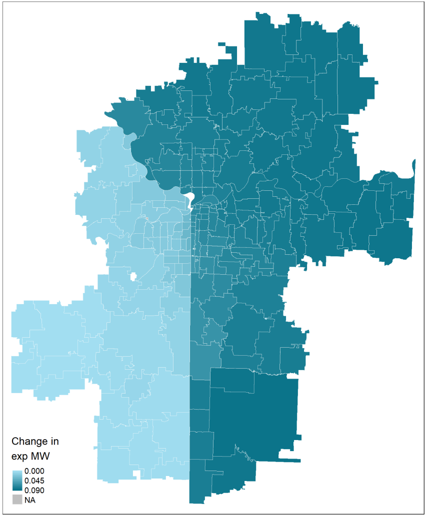
Other examples: Kansas City (MW Changes in January 2019)





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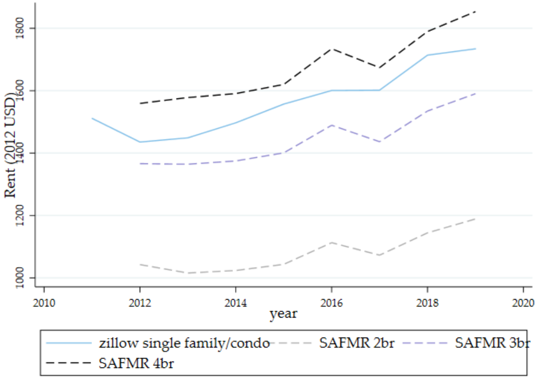
Comparison between Zillow and Small Area Fair Market Rents



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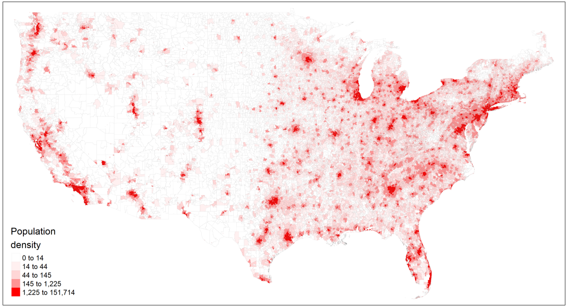
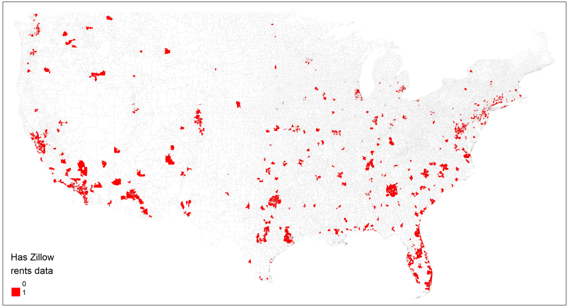
Comparison between Zillow Sample and Population Density





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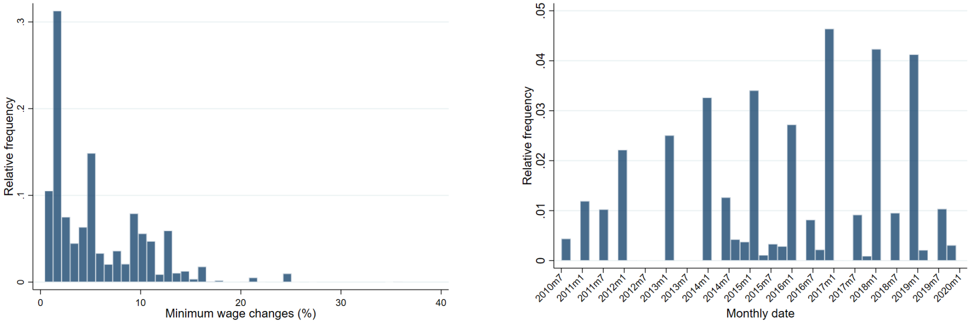
Distribution of (positive) MW changes

(a) Intensity (b) Timing



Notes: The histograms show the distribution of positive MW changes in the full sample of ZIP codes available in the Zillow data.

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