

# 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 labor market outcomes.

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

⇒ Housing market.

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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.
- Estimate pass-through of MW increases to rents.

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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 CBD consumers to low income workers.
- Income changes are heterogeneous across space because people work and reside in different locations.
- Housing is a normal good, so 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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- State MW is \$8.25 since 2010, and federal MW is \$7.25 since 2009.
- A (naive) regression model of rents on same-location MW imposes that rents can only be affected in Cook County.
- However, workers in Cook County may live somewhere else. → We must account for commuting structure!

## A novel model-based measure of exposure to minimum wages

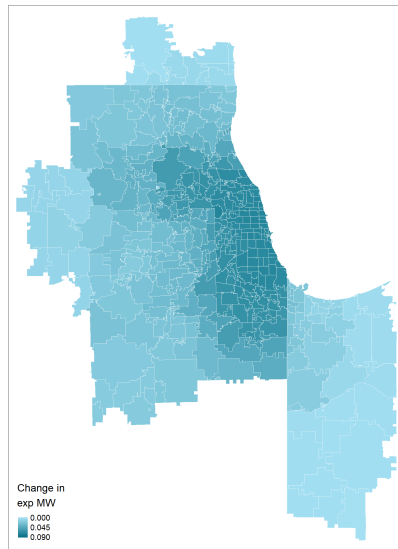
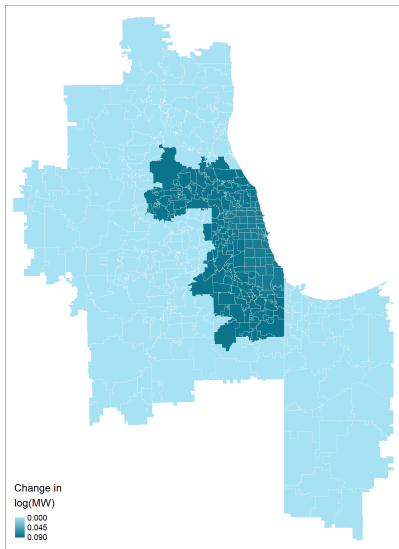
For ZIP code  $i$  and month  $t$  we define it as:

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

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 Local Rental Markets

Data

Empirical Strategy

Results

The incidence of a counterfactual federal MW change

Concluding remarks

## A Partial Equilibrium Model of 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 workplace 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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- Motivate our empirical strategy: use commuting patterns to account for spatial spillovers of MW policies.

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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  - Measure of residents in  $i$ :  $L_i = \sum_{z \in \mathcal{Z}(i)} L_{iz}$ .
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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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- $D_i(r_i)$ : 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.*

## Discussion on 4.

**In words:** conditional on workplace MWs, residence MW may negatively affect disposable income and thus demand for housing.

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Interpretation underlying point 4. is plausible:

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



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Potential microfoundation:

- If firms in  $i$  produce non-tradable local goods with MW workers as inputs, a MW increase will raise prices. This means lower demand for housing if the substitution effect on housing demand 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 1,*
- 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:

$$\left( \eta_i - \sum_z \pi_{iz} \xi_{iz} \right) d \ln R_i = \sum_z \pi_{iz} \left( \epsilon_{iz}^i d \ln \underline{w}_i + \epsilon_{iz}^z d \ln \underline{w}_z \right), \quad (1)$$

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  $i$
- $\epsilon_{iz}^i = \frac{dh_{iz}}{d\underline{w}_i} \frac{\underline{w}_i}{\sum_z \pi_{iz} h_{iz}}$  and  $\epsilon_{iz}^z = \frac{dh_{iz}}{d\underline{w}_z} \frac{\underline{w}_z}{\sum_z \pi_{iz} h_{iz}}$  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 (1) 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.<sup>1</sup>
3. Holding constant workplace MWs, the effect of the residence MW is negative.

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<sup>1</sup>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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- *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**.*

## Proof.

Set  $\epsilon_{iz}^z = \epsilon_i^z$  for all  $z \in \mathcal{Z}(i)$  we can manipulate (1) to write:

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

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





## 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:

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

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

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

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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
- 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.
- $\underline{w}_{it}^{\text{res}} = \ln \underline{w}_{it}$ : 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:

$$\Delta r_{it} = \delta_t + \beta \Delta \underline{w}_{it}^{\text{wrk}} + \gamma \Delta \underline{w}_{it}^{\text{res}} + \Delta \mathbf{X}'_{c(i)t} \eta + \Delta \varepsilon_{it},$$

where

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

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

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For causal effect of  $\beta$  we need:

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

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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  $\beta$  we need:

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Analogously, for causal effect of  $\gamma$  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.

# Potential Outcomes with Continuous Treatment and Spatial Spillovers

Consider the potential outcomes model for log rents given by:

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

We impose some structure by assuming that:

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

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

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

## Questions:

- Are  $\beta$  and  $\gamma$  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 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 $\beta$

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

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  $\beta$  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 $\gamma$

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  $\gamma$  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.
- $\beta$  can be thought of a difference-in-differences between indirectly treated units adjusted by their difference in exposure to the treated units.
- $\gamma$  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 Model

	Change wrk. MW	Change log rents		
	(1)	(2)	(3)	(4)
Change residence minimum wage	0.8683 (0.0298)	0.0257 (0.0137)		-0.0302 (0.0169)
Change workplace minimum wage			0.0321 (0.0150)	0.0645 (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
Observations	131,196	131,196	131,196	131,196

## Testing Identification with a Dynamic model

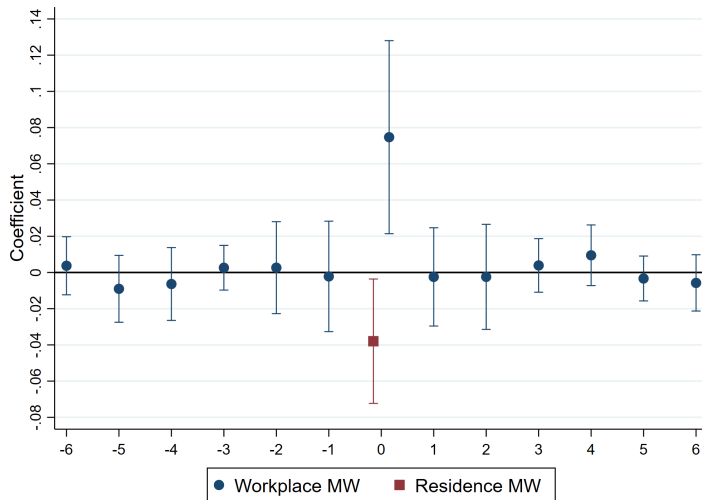
Adding leads and lags of the experienced log MW:

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

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  $\gamma$ .

## Including leads and lags of workplace MW



# Robustness checks and Sample Selection

Concerns about differential geographic trends across treated

- Inclusion of non-parametric geographical trends
- Inclusion of ZIP code-specific parametric trends
- Use only MW changes that are not pre-announced (work in progress)
- Stack events a lá **CegvizEtAl2019** (work in progress)

## Robustness results

Concerns that results are particular to our sample or not generalizable

- Estimate model on fully balanced and unbalanced panels
- Reweight observations to match characteristics of average urban ZIP code

## Sample-issues results

Concerns about residence MW definition:

- Estimate under different commuter shares.

## Sensitivity to alternative commuter shares

The incidence of a 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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Consider an increase of the federal MW to \$9 in January 2020.

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Consider an increase of the federal MW to \$9 in January 2020.

- Changes income  $\{\Delta Y_i\}_{i \in \mathcal{Z}}$  and housing expenditure  $\{\Delta H_i\}_{i \in \mathcal{Z}}$

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

## Pass-through coefficients

Define pass-through coefficients as

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

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  $\rho_i$  is a lower bound.

## Pass-through under the model

According to the model,

$$\Delta \ln R_i = \beta \underline{w}_i^{\text{wkr}} + \gamma \underline{w}_i^{\text{res}}$$

We also define

$$\Delta \ln Y_i = \varepsilon \underline{w}_i^{\text{wkr}}$$

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$$\Delta \ln R_i = \beta \underline{w}_i^{\text{wkr}} + \gamma \underline{w}_i^{\text{res}}$$

We also define

$$\Delta \ln Y_i = \varepsilon \underline{w}_i^{\text{wkr}}$$

Under these assumptions, we obtain

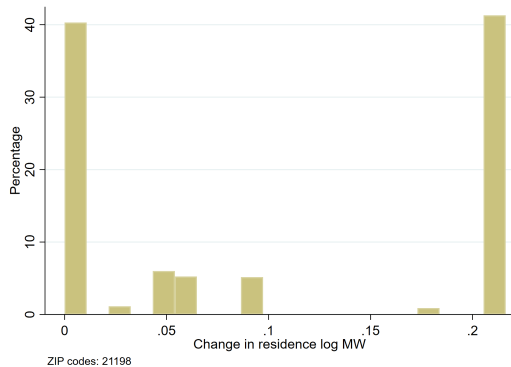
$$\rho_i = \alpha_i \left[ \frac{\exp(\beta \underline{w}_i^{\text{wkr}} + \gamma \underline{w}_i^{\text{res}}) - 1}{\exp(\varepsilon \underline{w}_i^{\text{wkr}}) - 1} \right]$$

where

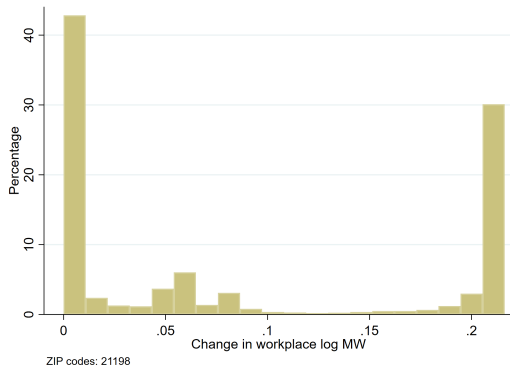
- $\alpha_i = \frac{h_i R_i}{Y_i}$  is the share of  $i$ 's expenditure in housing

We use our estimates to compute this share for urban ZIP codes.

## Increases in residence and workplace MWs

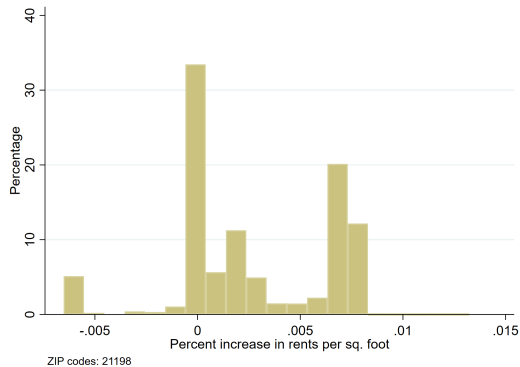


Residence MW

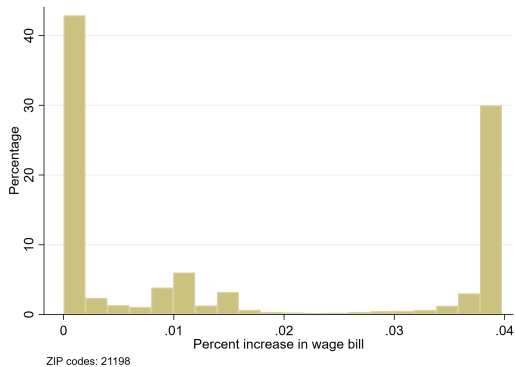


Workplace MW

# Predicted increases in rents and wages



Predicted changes in rents per sqft



Predicted changes in wage bill



## Increases in rents in the Chicago metro area

Map here

## The incidence of MW changes on average

		Change in log MW		Ratio perc. increases	Landlord share for $\alpha$		
	N	Res.	Wrk.		0.25	0.45	
Effect in ZIP codes...							
with previous res. $MW \leq \$9$	15,643	0.138	0.119	0.215	0.054	0.097	
with previous res. $MW > \$9$	5,555	0	0.004	0.357	0.089	0.161	

Notes: The table shows computations of the pass-through share for the following parameters:  $\beta = 0.064$ ,  $\gamma = -0.030$ ,  $\varepsilon = 0.180$ , and  $\alpha \in \{0.25, 0.45\}$ .

## The incidence of MW changes on average

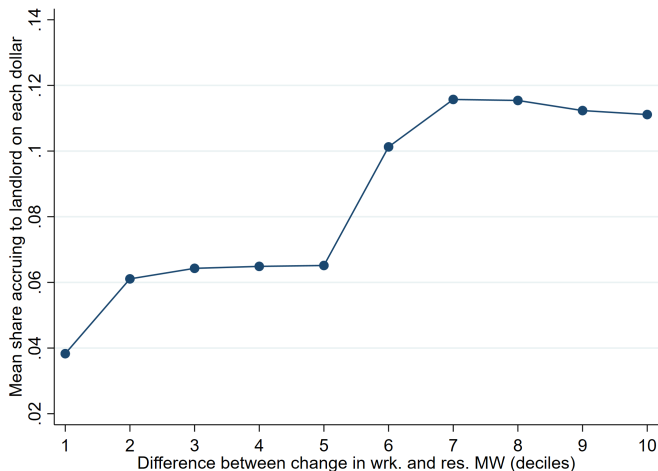
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Notes: The table shows computations of the pass-through share for the following parameters:  $\beta = 0.064$ ,  $\gamma = -0.030$ ,  $\varepsilon = 0.180$ , and  $\alpha \in \{0.25, 0.45\}$ .

More generally, one can think of the effect for different values of

$$\Delta \underline{w}_i^{wrk} - \Delta \underline{w}_i^{res}$$

## The incidence of MW changes according to intensity of treatment



Notes: The figure shows computations of the pass-through share for the following parameters:  
 $\beta = 0.064$ ,  $\gamma = -0.030$ ,  $\varepsilon = 0.180$ , and  $\alpha = 0.35$ .

## Concluding remarks

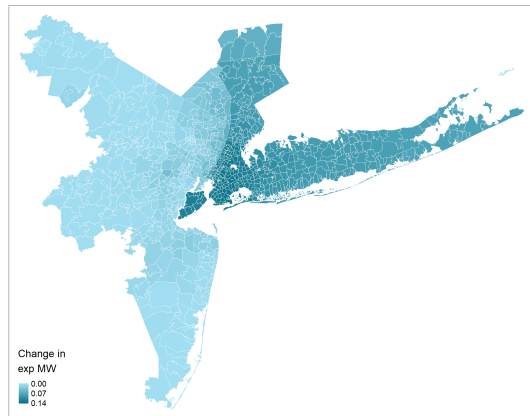
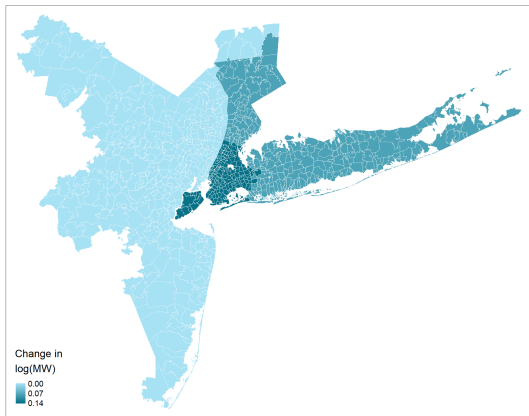
# Conclusion

Thank You!

# Appendix

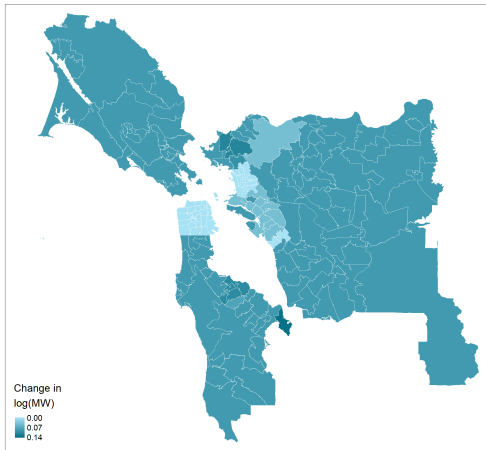


## Other examples: New York (MW Changes in January 2019)

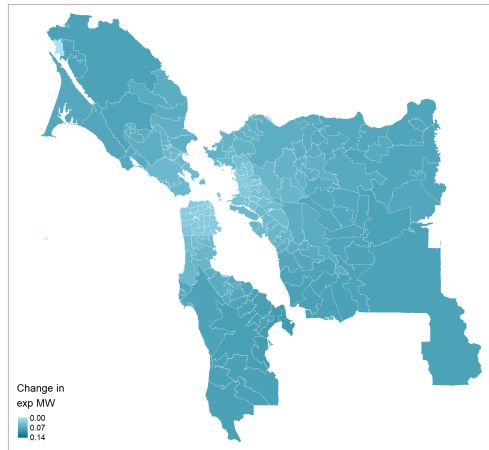


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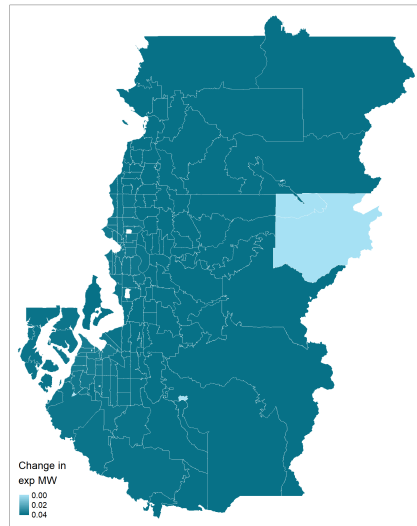
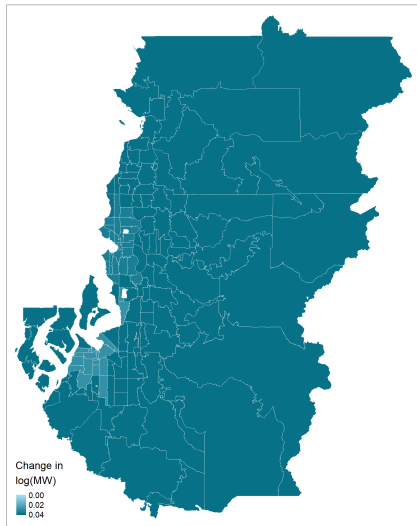
## Other examples: Bay area (MW Changes in January 2019)



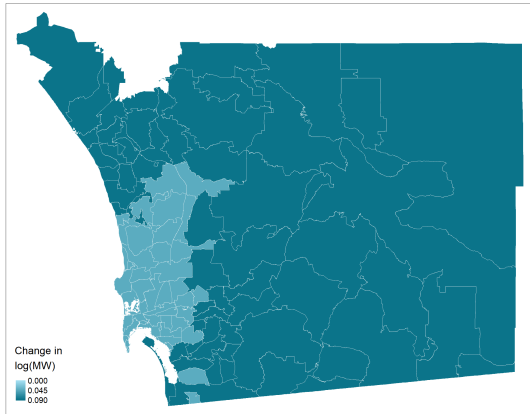
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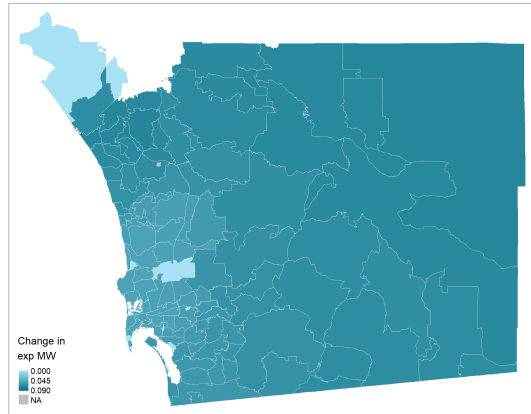
## Other examples: Seattle (MW Changes in January 2018)



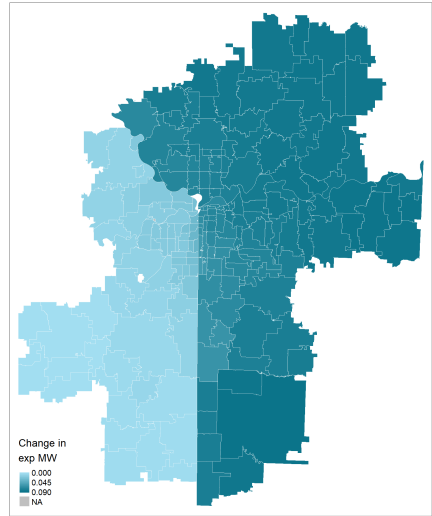
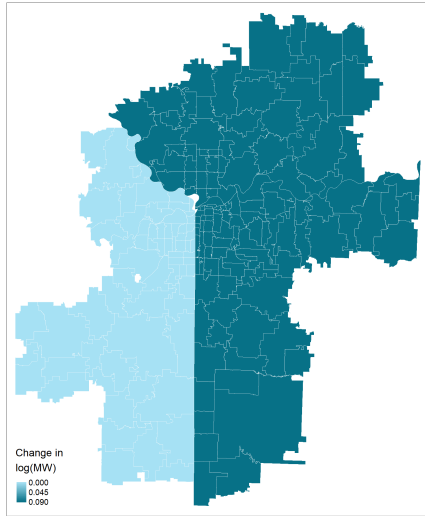
## Other examples: San Diego (MW Changes in January 2019)



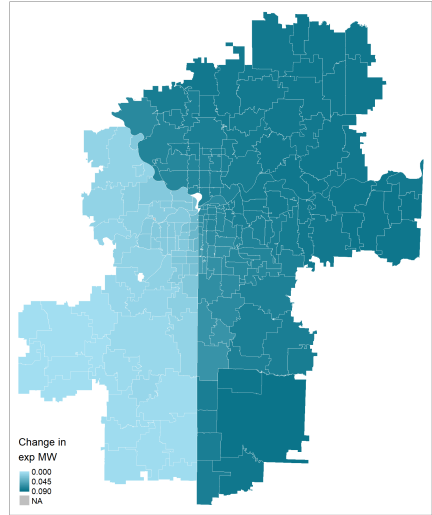
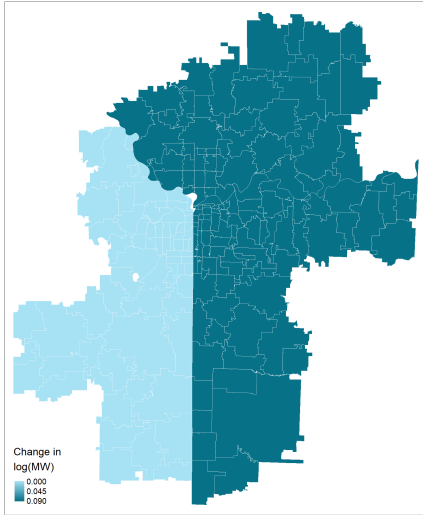
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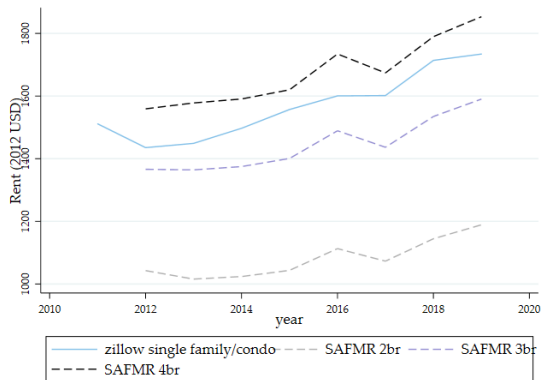
## Other examples: Kansas City (MW Changes in January 2019)



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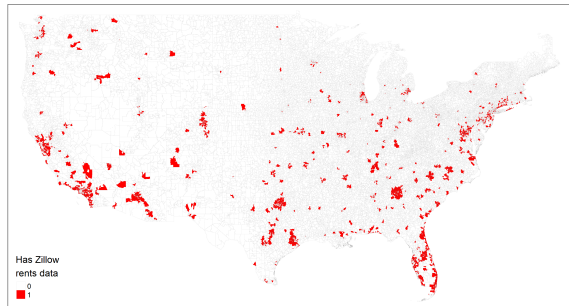
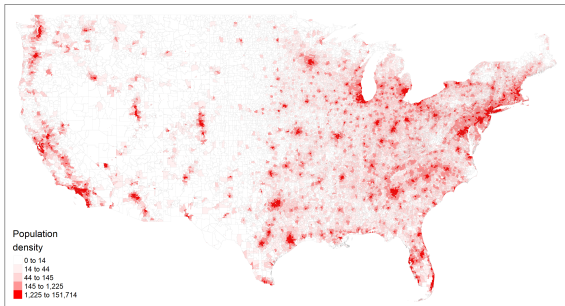


# Comparison between Zillow and Small Area Fair Market Rents



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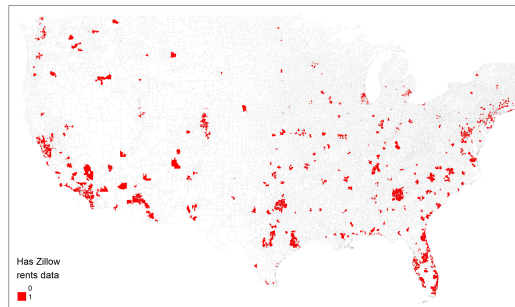
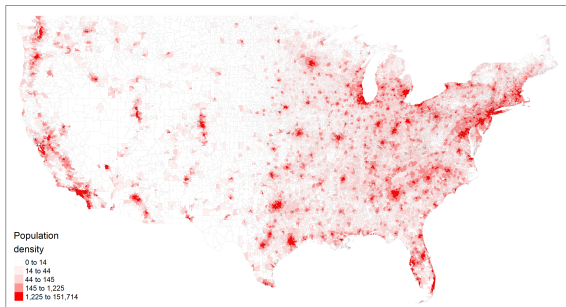
# Comparison between Zillow Sample and Population Density



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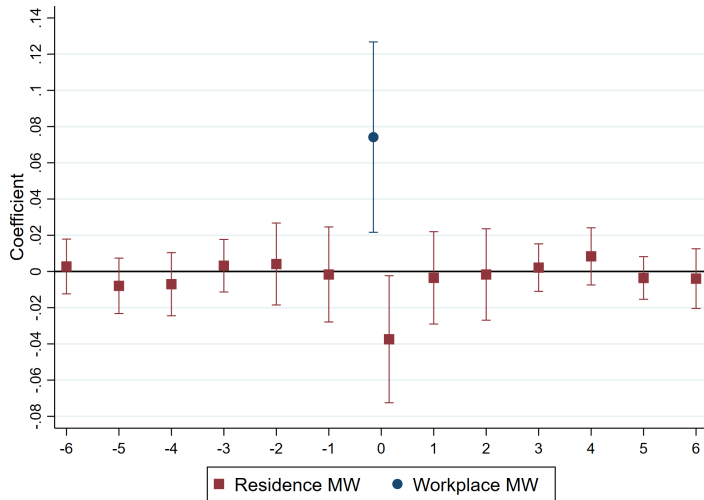


# Distribution of (positive) MW changes

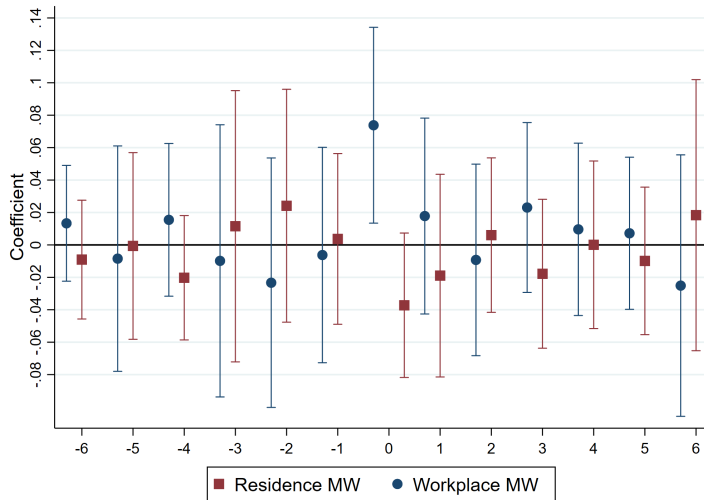


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## Including leads and lags of residence MW



## Including leads and lags of workplace and residence MW



## Robustness to geographical trends

	Change log rents					
	Baseline (1)	No controls (2)	ZIP code trend (3)	County-time FE (4)	CBSA-time FE (5)	State-time FE (6)
Change residence minimum wage	-0.0302 (0.0169)	-0.0289 (0.0171)	-0.0300 (0.0150)	-0.0521 (0.0346)	-0.0596 (0.0239)	-0.0052 (0.0147)
Change workplace minimum wage	0.0645 (0.0274)	0.0632 (0.0279)	0.0644 (0.0257)	0.1231 (0.0561)	0.1336 (0.0498)	0.0046 (0.0288)
County-quarter economic controls	Yes	No	Yes	Yes	Yes	Yes
P-value equality	0.0332	0.0407	0.0218	0.0135	0.0117	0.8138
R-squared	0.0209	0.0208	0.0228	0.1760	0.1138	0.0605
Observations	131,196	132,255	131,196	121,928	127,079	130,656

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## Robustness to different samples

	Change log rents					
	Baseline (1)	Baseline Reweighted (2)	Unbalanced (3)	Unbalanced Reweighted (4)	Fully-balanced (5)	Fully-balanced Reweighted (6)
Change residence minimum wage	-0.0302 (0.0169)	-0.0273 (0.0207)	-0.0418 (0.0238)	-0.0319 (0.0195)	-0.0295 (0.0183)	-0.0199 (0.0172)
Change workplace minimum wage	0.0645 (0.0274)	0.0697 (0.0296)	0.0651 (0.0329)	0.0515 (0.0258)	0.0778 (0.0285)	0.0795 (0.0250)
P-value equality	0.0332	0.0525	0.0587	0.0599	0.0219	0.0189
R-squared	0.0209	0.0209	0.0161	0.0181	0.0215	0.0206
Observations	131,196	131,196	192,946	192,946	78,798	78,798

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## Robustness to different samples

	Change log rents				
	(1)	(2)	(3)	(4)	(5)
Change residence minimum wage	-0.0278 (0.0166)	-0.0290 (0.0170)	-0.0314 (0.0169)	-0.0391 (0.0195)	-0.0359 (0.0164)
Change workplace minimum wage	0.0613 (0.0264)	0.0630 (0.0274)	0.0658 (0.0275)	0.0749 (0.0314)	0.0716 (0.0278)
Commuting shares	2010	2014	2018	2014, low. Inc.	2014, young
P-value equality	0.0383	0.0387	0.0295	0.0280	0.0169
R-squared	0.0209	0.0209	0.0209	0.0209	0.0209
Observations	131,196	131,196	131,196	131,196	131,196

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## Microfoundation

Say a representative  $(i, z)$  worker chooses between housing demand  $h_{iz}$ , non-tradable consumption  $c_{iz}^{\text{NT}}$ , and tradable consumption  $c_{iz}^{\text{T}}$ , by maximizing

$$u_{iz} = u \left( h_{iz}, c_{iz}^{\text{NT}}, c_{iz}^{\text{T}} \right)$$

subject to

$$r_i h_{iz} + p_i(\underline{w}_i) c_{iz}^{\text{NT}} + c_{iz}^{\text{T}} \leq y_{iz}(\underline{w}_z)$$

where

- $p_i(\underline{w}_i)$  gives the price of local consumption, increasing in residence MW;
- the price of tradable consumption is normalized to one;
- $y_{iz}(\underline{w}_z)$  is an income function that depends positively on the workplace MW.

## Microfoundation (continuation)

Let  $h_{iz}^*$  and  $c_{iz}^*$  denote Marshallian demands, and  $\tilde{h}_{iz}^*$  denote the Hicksian housing demand.

By assumption, the price of the MW will increase prices of non-tradable consumption. Thus, consider the effect of an increase in  $p_i$  on housing demand. The Slutsky equation implies that

$$\frac{\partial h_{iz}^*}{\partial p_i} = \frac{\partial \tilde{h}_{iz}^*}{\partial p_i} - \frac{\partial h_{iz}^*}{\partial y_{iz}} c_{iz}^*$$

Then, we have that

$$\frac{\partial h_{iz}^*}{\partial p_i} < 0 \iff \frac{\partial \tilde{h}_{iz}^*}{\partial p_i} < \frac{\partial h_{iz}^*}{\partial y_{iz}} c_{iz}^*$$

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