Do Minimum Wages Increase Rents?

Evidence from US ZIP Codes Using High-Frequency Data

Diego Gentile Passaro Santiago Hermo Gabriele Borg

Brown University Brown University AWS

November 2, 2021

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

$\Rightarrow$ Housing market.

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

$\Rightarrow$ 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 (Brueckner et al. 1987).

$\Rightarrow$ 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 the elasticity of median market rents to workplace and residence MWs.
- Estimate the share on the extra dollar generated by MW increases accruing to landlords.

This paper

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

- Accounting for spatial spillovers, we estimate the elasticity of median market rents to workplace and residence MWs.
- Estimate the share on the extra dollar generated by MW increases accruing to landlords.

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.

An initial 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.

An initial intuition

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

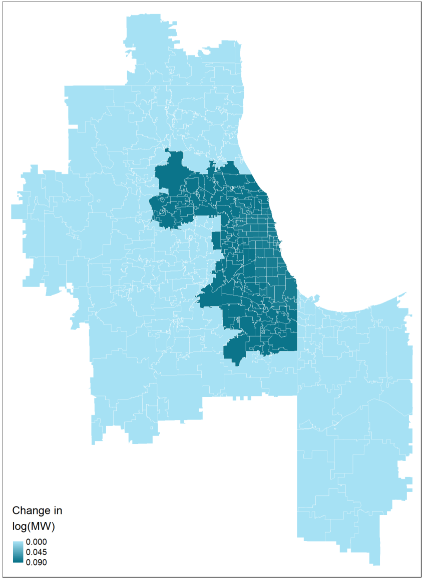
Partial equilibrium: short term

- 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.

General equilibrium: long term (Not this paper!)

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

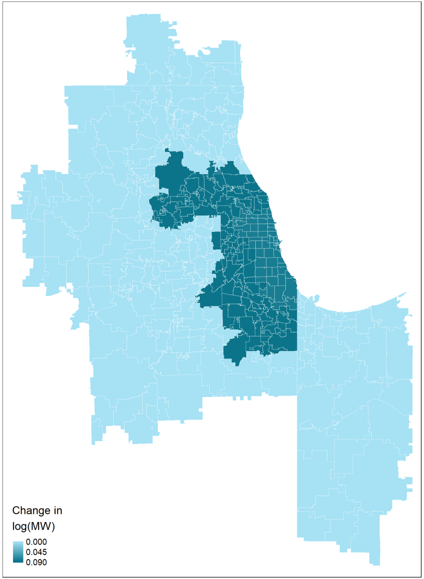
A motivating example



Cook County, IL

- Raised local MW from $12 to $13 in July 2019.
- State MW is $8.25 since 2010, and federal MW is $7.25 since 2009.

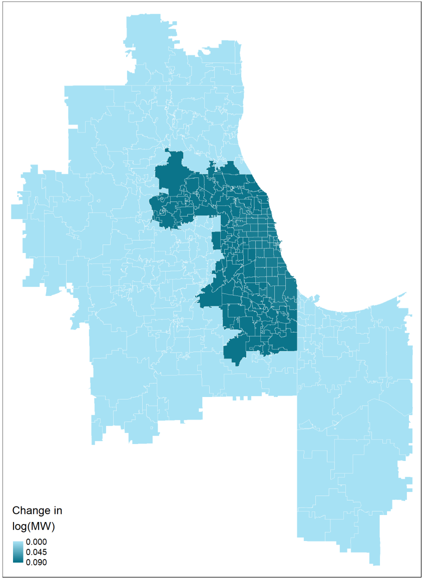
A motivating example



Cook County, IL

- Raised local MW from \$12 to \$13 in July 2019.
- 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.

A motivating example



Cook County, IL

- Raised local MW from \$12 to \$13 in July 2019.
- 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

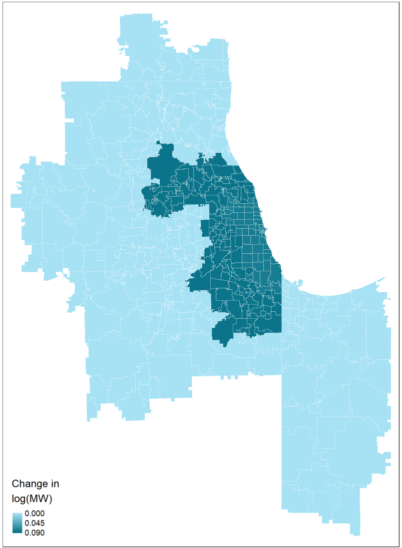
For ZIP code i and month t we define it as:

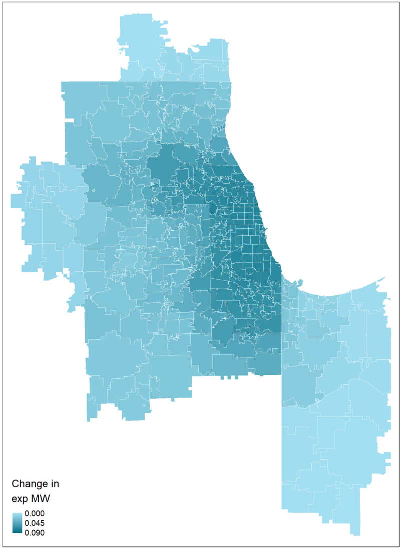
$$\underline{w}_{it}^{\text{wrk}} = \sum_{z \in \mathcal{Z}(i)} \pi_{iz} \ln \underline{w}_{zt} \ ,$$

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 measure of exposure to MW.
- Emphasize why residence and workerplace MWs may have different effects on the housing market.
- Motivate empirical strategy: use commuting patterns to account for spatial spillovers of MW policies.

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 measure of exposure to MW.
- Emphasize why residence and workerplace MWs may have different effects on the housing market.
- Motivate 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 local labor or goods markets.
- Perform general equilibrium welfare analysis of MW policies.

Setup

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

- Workers with residence i may work in some other ZIP code $z \in \mathcal{Z}(i) \subseteq \mathcal{Z}$.

Setup

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

- Workers with residence i may work in some other ZIP code $z \in \mathcal{Z}(i) \subseteq \mathcal{Z}$.
- Exogenous and fixed measure of i's residents who work in z, L_{iz}.
  - Residents in i: $L_i = \sum_{z \in \mathcal{Z}(i)} L_{iz}$.
  - Workers in z: $L_z = \sum_{i \in \mathcal{Z}(i)} L_{iz}$.

Setup

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

- Workers with residence i may work in some other ZIP code $z \in \mathcal{Z}(i) \subseteq \mathcal{Z}$.
- Exogenous and fixed measure of i's residents who work in z, L_{iz}.
  - Residents in i: $L_i = \sum_{z \in \mathcal{Z}(i)} L_{iz}$.
  - Workers in z: $L_z = \sum_{i \in \mathcal{Z}(i)} L_{iz}$.
- Binding minimum wages: $\{\underline{w}_i\}_{i \in \mathcal{Z}}$.

Setup

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

- Workers with residence i may work in some other ZIP code $z \in \mathcal{Z}(i) \subseteq \mathcal{Z}$.
- Exogenous and fixed measure of i's residents who work in z, L_{iz}.
    - Residents in i: $L_i = \sum_{z \in \mathcal{Z}(i)} L_{iz}$.
    - Workers in z: $L_z = \sum_{i \in \mathcal{Z}(i)} L_{iz}$.
- Binding minimum wages: $\{\underline{w}_i\}_{i \in \mathcal{Z}}$.
- $h_{iz}(R_i, \underline{w}_i, \underline{w}_z)$: housing demand of i's residents that work in z, where R_i represents housing rents per square foot.

Setup

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

- Workers with residence i may work in some other ZIP code $z \in \mathcal{Z}(i) \subseteq \mathcal{Z}$.
- Exogenous and fixed measure of i's residents who work in z, L_{iz}.
  - Residents in i: $L_i = \sum_{z \in \mathcal{Z}(i)} L_{iz}$.
  - Workers in z: $L_z = \sum_{i \in \mathcal{Z}(i)} L_{iz}$.
- Binding minimum wages: $\{\underline{w}_i\}_{i \in \mathcal{Z}}$.
- $h_{iz}(R_i, \underline{w}_i, \underline{w}_z)$: housing demand of i's residents that work in z, where R_i represents housing rents per square foot.
- $S_i\left(R_i\right)$: supply of square feet in i, which is increasing in R_i.

Housing demand functions

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 (3) and (4) are strict.*

Housing demand functions

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 (3) and (4) are strict.*

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

Discussion on assumption 4

Evidence suggests that MW changes affect prices of local consumption

- Miyauchi, Nakajima, and Redding (2021) 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 (e.g., Allegretto and Reich 2018; Leung forthcoming).

Discussion on assumption 4

Evidence suggests that MW changes affect prices of local consumption

- Miyauchi, Nakajima, and Redding (2021) 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 (e.g., Allegretto and Reich 2018; Leung forthcoming).

Will MW changes also affect housing demand? Consider an increase in residence MW:

- If non-tradable goods use low-wage work as input, then local prices will increase.
- Housing demand will fall if substitution effect is smaller than income effect.
    - Sufficient condition: housing and local consumption are complements.

Formalizing these ideas: Microfoundation

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

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

Under suitable regularity conditions, the unique equilibrium is

$$R_i^* = f(\{\underline{w}_i\}_{i \in \mathcal{Z}(i)})$$

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

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

Under suitable regularity conditions, the unique equilibrium is

$$R_i^* = f(\{\underline{w}_i\}_{i\in\mathcal{Z}(i)})$$

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 simpler way?

Comparative Statics

Proposition (Comparative Statics)

Under the assumptions of

1. *fixed number of workers across workplace and residence pairs;*
2. *housing demand equation satisfying conditions above;*
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)

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:

- $\eta_i = \frac{1}{L_i}\frac{dS_i}{dR_i}\frac{R_i}{S_i}$ is the per resident elasticity of housing supply in 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 to rents at average per-capita demand of 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 i

Proof of Proposition (Comparative Statics) (continuation)

Using assumption on housing demand we have that

$$\xi_{iz} < 0, \qquad \epsilon_{iz}^{i} < 0, \qquad \epsilon_{iz}^{z} > 0.$$

Therefore, 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 workplace 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 $\pi_{ii}\epsilon_{ii}^{z} + \sum_z \pi_{iz}\epsilon_{iz}^{i}$.

Simplifying the equilibrium rents function

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* **workplace log MW** *and the* **residence log MW***.*

Simplifying the equilibrium rents function

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* **workplace log MW** *and the* **residence log MW***.*

Proof.

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

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

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:

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

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

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

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:

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

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

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

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

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.
- We use category single-family, condominium, and cooperative houses (SFCC):
  - Most common housing type in the U.S.
  - Most populated series in Zillow.

Comparison with Small Area Fair Market Rents

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.
- We use category single-family, condominium, and cooperative houses (SFCC):
  - Most common housing type in the U.S.
  - Most populated series in Zillow.

  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 Cengiz et al. 2019 and Vaghul and Zipperer 2016
- 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.

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 Cengiz et al. 2019 and Vaghul and Zipperer 2016
- 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.
- 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.
- $\underline{w}_{it}^{res} = \ln \underline{w}_{it}$: 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.

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.

For causal effect of β we need:

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

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.

For causal effect of β we need:

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

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:

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

Analogously, for causal effect of γ we need:

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

Discussion Identification Assumption

Thus, for causal effect of β we need:

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

Analogously, for causal effect of γ we need:

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

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.

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.

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.

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:

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

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

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.

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.

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:

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

Solving for β

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

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

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 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.

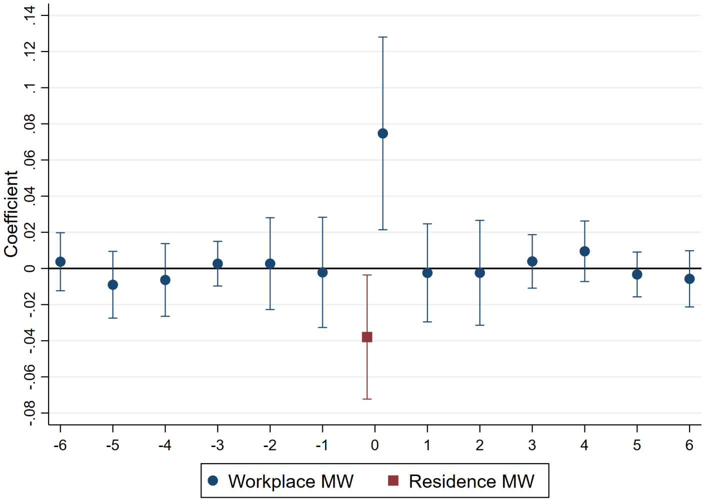
Results

Static Model

	Change wrk. 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
Observations	131,196	131,196	131,196	131,196

Example Predictions for Chicago July 2019

Including leads and lags of workplace MW



Leads and Lags of Residence MW
Leads and Lags of Both Residence and 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 Cengiz et al. 2019 (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 workplace 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

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

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

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

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

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

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

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.

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

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

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

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

Under these assumptions, we obtain

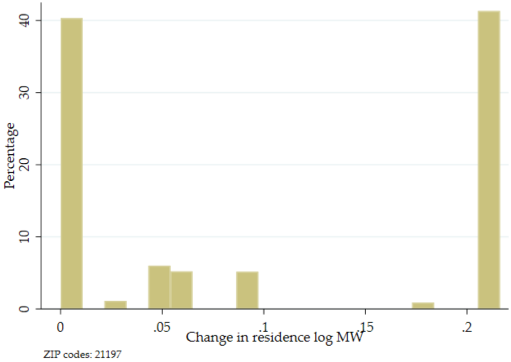
$$\rho_i = \alpha_i \left[\frac{\exp\left(\beta \underline{w}_i^{\text{wkr}} + \gamma \underline{w}_i^{\text{res}}\right) - 1}{\exp\left(\varepsilon \underline{w}_i^{\text{wkr}}\right) - 1} \right]$$

where

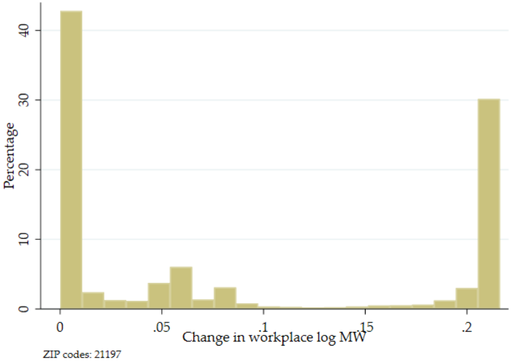
- $\alpha_i = \frac{h_i R_i}{Y_i}$ is the share of i's expenditure in housing

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

Increases in residence and workplace MWs

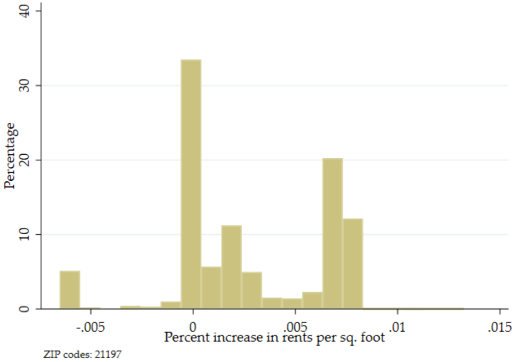


Residence MW

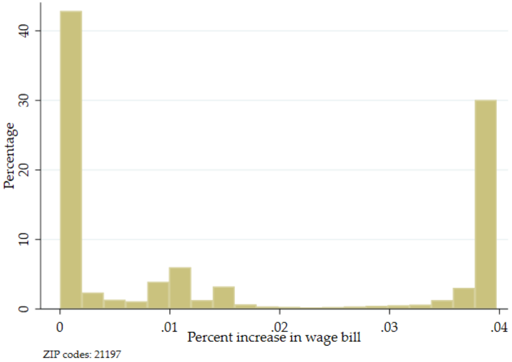


Workplace MW

Predicted increases in rents and wages

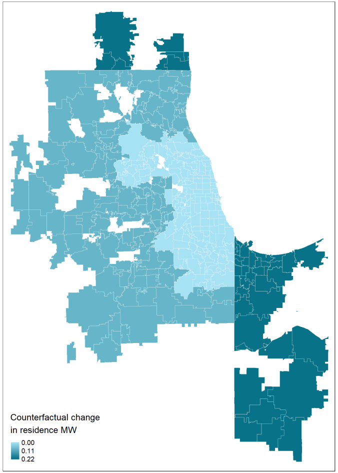


Predicted changes in rents per sqft

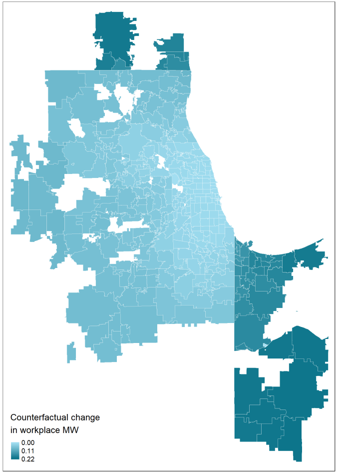


Predicted changes in wage bill

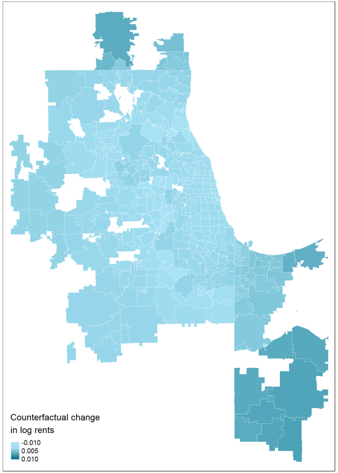
Predicted gradient of rent changes in the Chicago metro area



Counterfactual change in residence MW



Counterfactual change in workplace MW



Counterfactual change in log rents

The incidence of MW changes on average

	N	Change in log MW		Ratio perc. increases	Landlord share for α	
		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

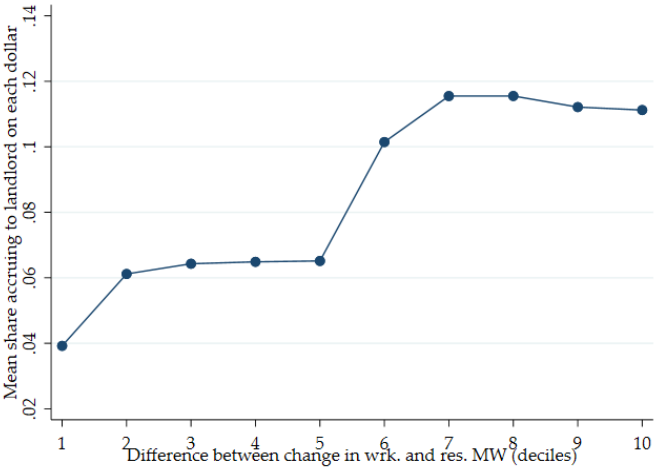
	N	Change in log MW		Ratio perc. increases	Landlord share for α	
		Res.	Wrk.		0.25	0.45
Effect in ZIP codes...						
with previous res. MW $\leq$ \$9	15,643	0.138	0.119	0.215	0.054	0.097
with previous res. MW $>$ \$9	5,555	0	0.004	0.357	0.089	0.161

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

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

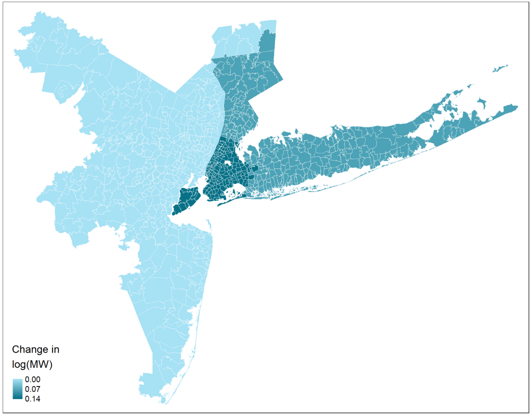
Conclusion

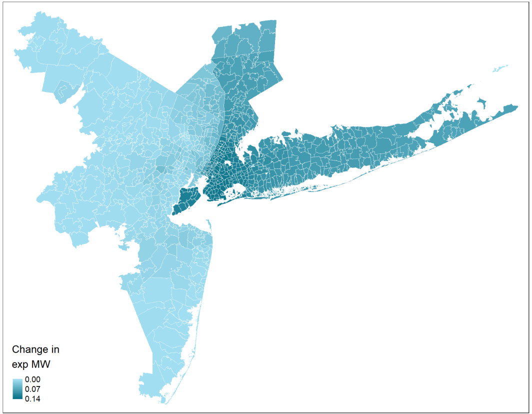
- When studying effects of place-based policies on the housing market it is of first order importance to account for the fact that agents live and work in different locations.
- We estimate an elasticity of workplace MW to rents of about 0.065, and of residence MW of -0.03.
- Our estimates imply that landlords pocket between 5 and 15 cents cents on the dollar of the extra income that MW policies put on the table.
- Landlords in areas right outside of where the MW policies are implemented are those that are set to extract the most rents.
- Even with a two parameter model, we are able to describe and predict rich patterns in the rental markets.

Thank You!

Appendix

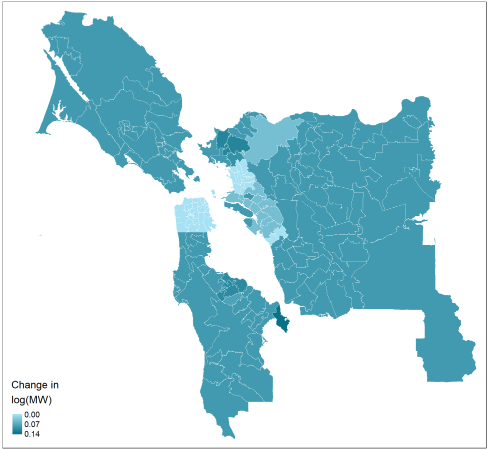
New York (MW changes in January 2019)

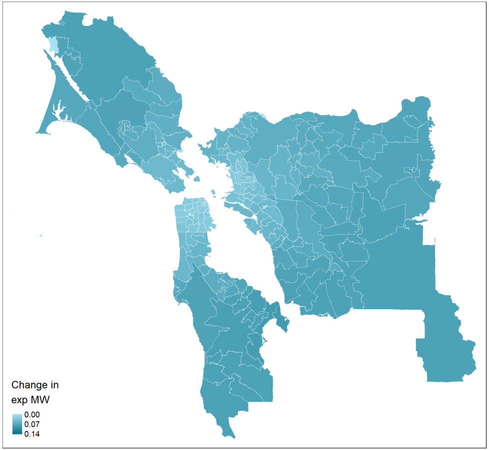




Go back

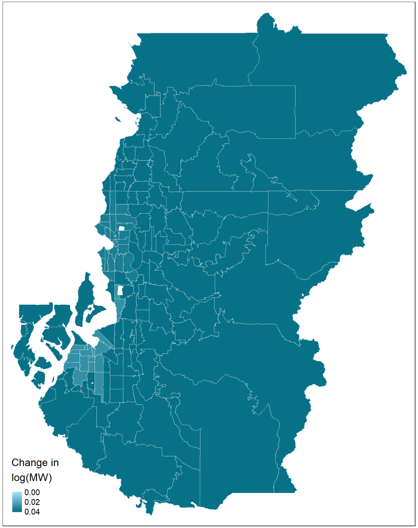
Bay area (MW changes in January 2019)

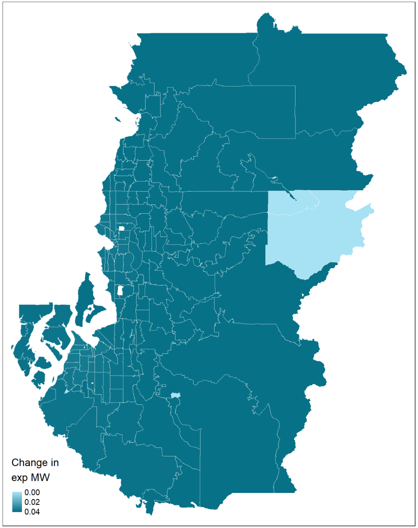




Go back

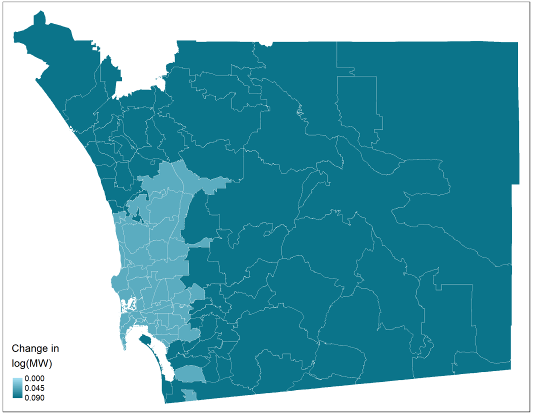
Seattle (MW changes in January 2018)

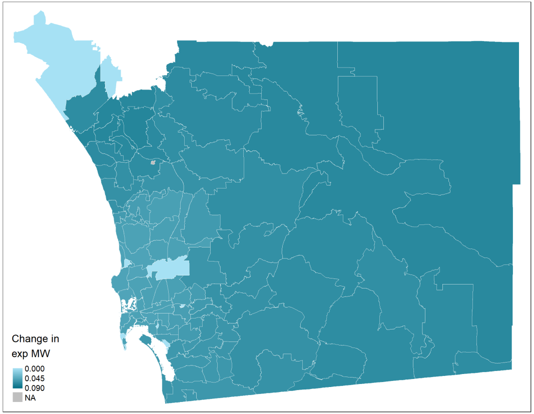




Go back

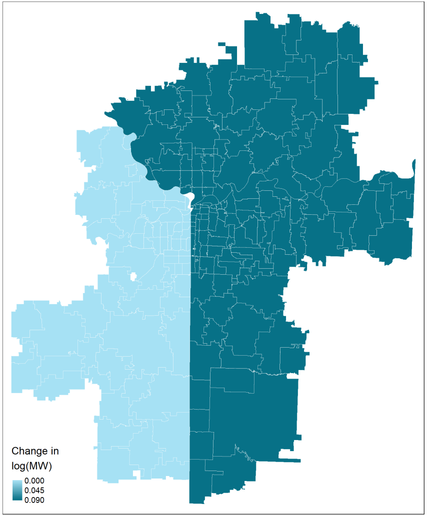
San Diego (MW changes in January 2019)

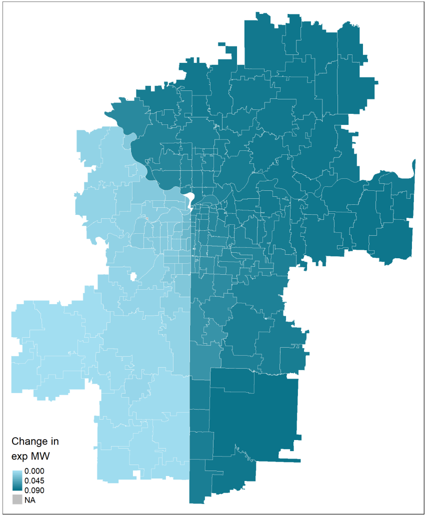




Go back

Kansas City (MW changes in January 2019)





Go back

Microfoundation

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

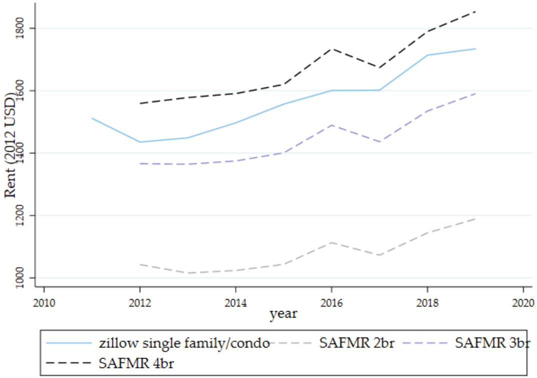
$$\frac{\partial h_{iz}^*}{\partial p_i} = \frac{\partial \tilde{h}_{iz}^*}{\partial p_i} - \frac{\partial h_{iz}^*}{\partial y_{iz}} c_{iz}^*$$

Then, we have that

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

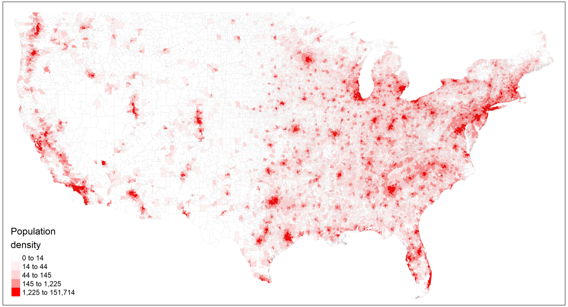
Go Back

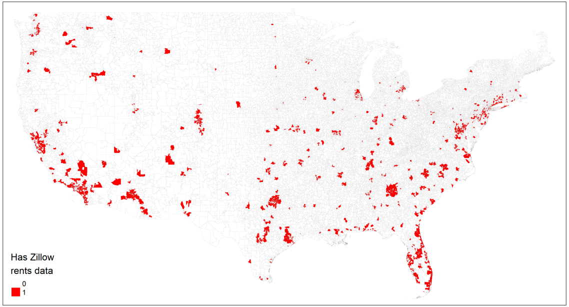
Comparison between Zillow and Small Area Fair Market Rents



Go Back

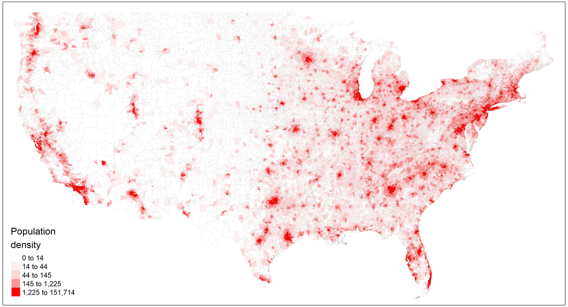
Comparison between Zillow Sample and Population Density

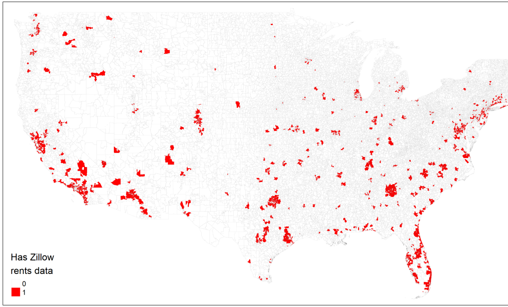




Go Back

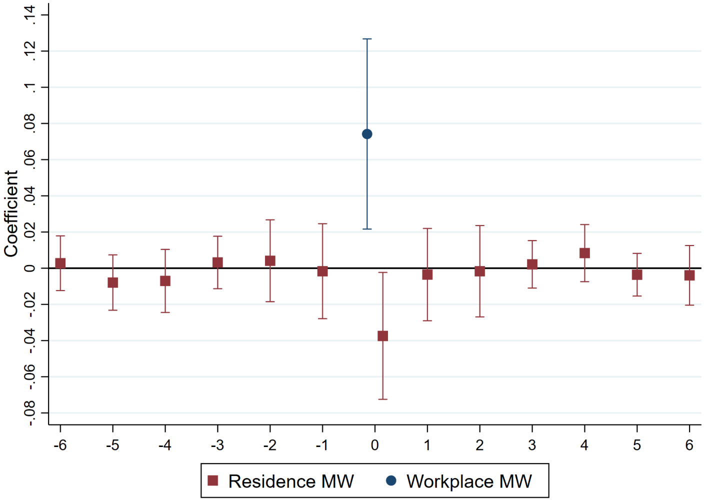
Distribution of (positive) MW changes





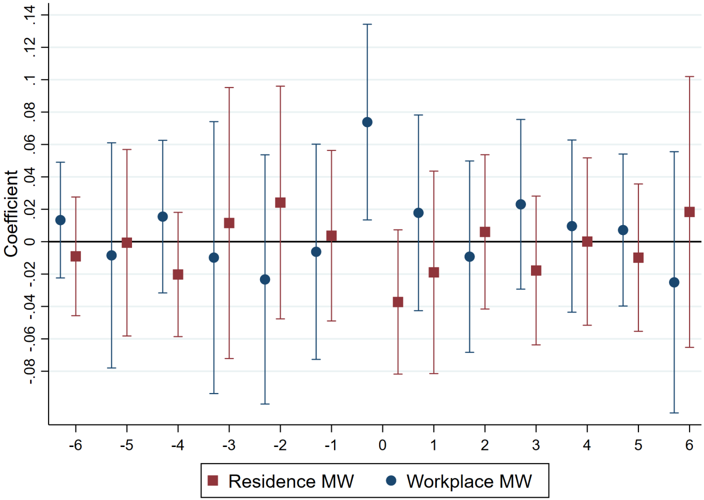
Go Back

Including leads and lags of residence MW



Go Back

Including leads and lags of workplace and residence MW



Go Back

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	-0.0289	-0.0300	-0.0521	-0.0596	-0.0052
	(0.0169)	(0.0171)	(0.0150)	(0.0346)	(0.0239)	(0.0147)
Change workplace minimum wage	0.0645	0.0632	0.0644	0.1231	0.1336	0.0046
	(0.0274)	(0.0279)	(0.0257)	(0.0561)	(0.0498)	(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

Go Back

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	-0.0273	-0.0418	-0.0319	-0.0295	-0.0199
	(0.0169)	(0.0207)	(0.0238)	(0.0195)	(0.0183)	(0.0172)
Change workplace minimum wage	0.0645	0.0697	0.0651	0.0515	0.0778	0.0795
	(0.0274)	(0.0296)	(0.0329)	(0.0258)	(0.0285)	(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

Go Back

Robustness to different samples

	Change log rents				
	(1)	(2)	(3)	(4)	(5)
Change residence minimum wage	-0.0278	-0.0290	-0.0314	-0.0391	-0.0359
	(0.0166)	(0.0170)	(0.0169)	(0.0195)	(0.0164)
Change workplace minimum wage	0.0613	0.0630	0.0658	0.0749	0.0716
	(0.0264)	(0.0274)	(0.0275)	(0.0314)	(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

Go Back

Microfoundation

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

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

subject to

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

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

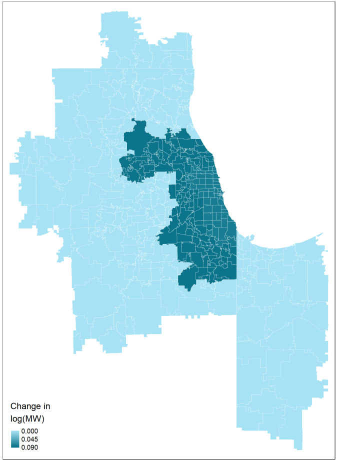
$$\frac{\partial h^*_{iz}}{\partial p_i} = \frac{\partial \tilde{h}^*_{iz}}{\partial p_i} - \frac{\partial h^*_{iz}}{\partial y_{iz}} c^*_{iz}$$

Then, we have that

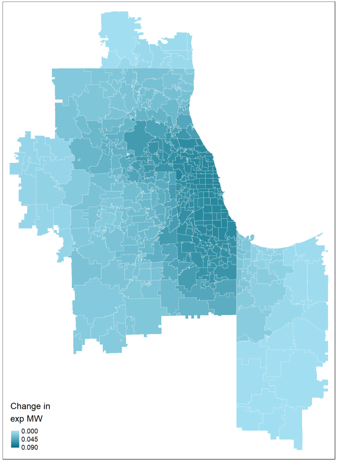
$$\frac{\partial h^*_{iz}}{\partial p_i} < 0 \iff \frac{\partial \tilde{h}^*_{iz}}{\partial p_i} < \frac{\partial h^*_{iz}}{\partial y_{iz}} c^*_{iz}$$

Go Back

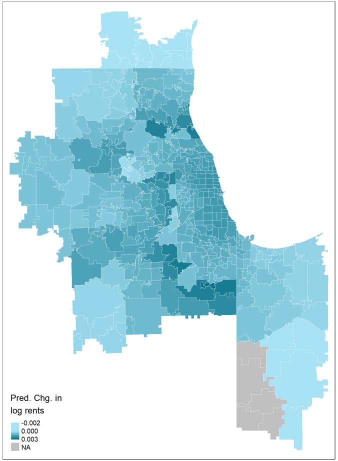
Example Predictions: MMW change in Chicago July 2019



Change in residence MW



Change in workplace MW



Predicted change in log rents

Go Back