Housing Market Frictions and Affordability: A Search-and-Matching Perspective

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Housing affordability have emerged as a central policy challenge

High housing cost has coincided with

- **Persistent Vacancies.**
  - US/Canada: 10.8%; Japan: 13%; France: 18%; China, Portugal, Spain: $\geq 20\%$
- **Slow and costly**.
  - Conditional on transaction, median 10 weeks for buyers, 55 days for sellers (NAR; Redfin)
  - About 1/3 listings never sold, 18-25% in hotter markets, $>$ 50% during downturns
  - Brokers on both sides with high commissions (88% sellers and 89% buyers)
- **Substantial residual price dispersion**.
  - Median 18% even among homes with similar characteristics and locations (Jiang,*et al* 24)
- **Price-liquidity trade-off**.
  - Prices and volumes tend to move together
  - Time-to-sell generally moves in the opposite direction

Housing Paradox: Scarce to Households, Yet Some Sits Underused

Housing markets are decentralized and frictional

Analogy to Labor Markets

Labor Market	Housing Market
Workers	Buyers
Firms	Sellers
Vacancies (postings)	Vacancies (listings)
Matches	Transactions

Matching as the Allocation Mechanism

$$\mathcal{M}(b, s)$$

- **Vacancies:** needed to facilitate matching (not inefficiency)
- **Time-on-market:** meetings and suitable matches are probabilistic
- **Price dispersion:** outcomes depend on match quality and competition
- **Price–liquidity trade-off:** tighter markets $\Rightarrow$ faster sales and higher prices

Matching Function for the Housing Market

$$\mathcal{M}(b,s) = \phi \cdot \frac{bs}{(b^\alpha + s^\alpha)^{1/\alpha}}, \quad \theta \equiv \frac{b}{s}$$

- **Matching probabilities:**

$$\lambda(\theta) = \frac{\mathcal{M}(b,s)}{b}, \quad \theta\lambda(\theta) = \frac{\mathcal{M}(b,s)}{s}$$

- **Frictions:**
  - α: congestion / search efficiency
  - ϕ: *ex ante* uncertainty about idiosyncratic matching quality

- **Frictionless limit:**

$$\alpha \to \infty,\ \phi \to 1 \ \Rightarrow\ \mathcal{M}(b,s) = b = s$$

Matching Function Estimates

- Cobb-Douglas matching function: $M(b, s) = \phi b^{\alpha} s^{1-\alpha}$
- Genesove-Han (2012):
  - A seller contact hazard elasticity of about 0.84 (α)
- Head–Lloyd-Ellis–Sun (2014):
  - Calibrate matching elasticity to time-to-sell and turnover
  - Meeting elasticity: 0.7-0.8
- Corbae-Golver-Nattinger (2024):
  - Calibrate a directed search equilibrium in rental market
  - Meeting elasticity: 0.7-0.8
- Badarinza-Balasubramaniam-Ramadorai (2024)
  - Richer micro-level data to estimate elasticities at multiple stages of the matching process.
  - 0.77 for search; 0.35 for meetings, and 0.27 for transactions.

Understand matching is central to policy design

- Housing affordability is often framed as a problem of insufficient supply.
- But how housing markets function is just as important as how much housing exists.
- Housing supply operates on multiple margins:
  - Listing behavior
  - Market liquidity
  - Tenure allocation
  - New construction
- How housing markets function is equally important as new construction.
  - Even with fixed housing stock,

    effective supply $= f(\text{listings, tightness, tenure}) \neq \text{constant}$

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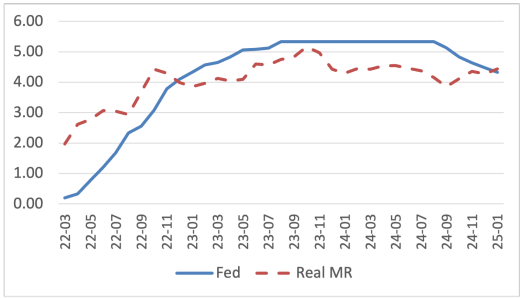
- How housing markets function is equally important as new construction.
  - Even with fixed housing stock,

    effective supply $= f(\text{listings, tightness, tenure}) \neq \text{constant}$
- Policies affect affordability by reshaping these margins, often in ways that generate unintended equilibrium responses that offset of amplify their intended effects.

Application 1: Fed Fund Rate and Housing Costs



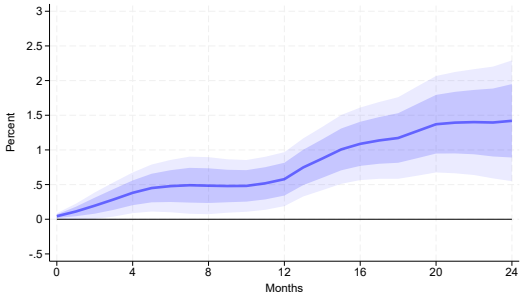
Source: FRED Economic Data

Left panel: solid line is the Fed Fund Rate, dash line is the 30-year mortgage rate minus 30-year inflation expectation.
Right panel: solid line is the Case-Shiller price, dash line is the rent, both deflated by CPI, in logs and normalized.

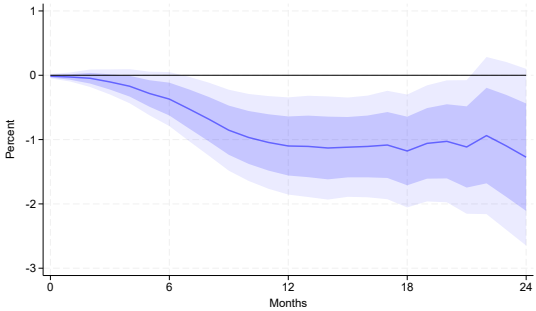
Nominal

Local Projection Estimates, Instrumented by Bauer-Swanson Shock

Rent Indices

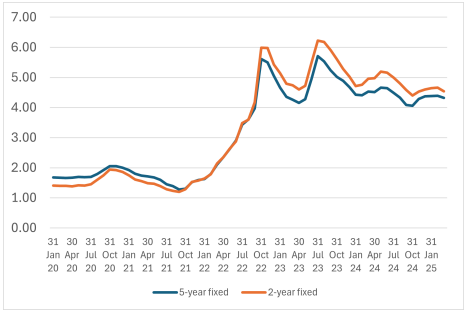


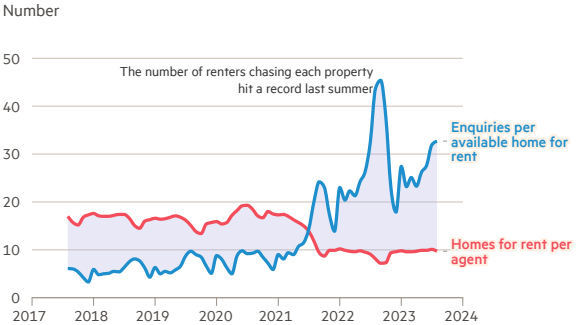
Price Indices



Contractionary MP increases rents: 25bps ↑ in 30-year FRM ⇒ 1.7% ↑ in real rent & 1.27% ↓ real price

Mortgage Rates and Rental Market Tightness, UK





Left Panel: Bank of England, mortgage rate for 75% LTV
Right Panel: Financial Times (November 2023), proxy for rental market tightness using data from Zoopla

Housing Cost Channel through Search Frictions (Han, Ngai & Sheedy, 2026)

- Search frictions in rental market:
  - Search frictions create *bilateral monopoly rent* when two parties meet
    $\rightarrow$ equilibrium *housing rent* is increasing in rental market tightness
  - $\uparrow r$ shifts households from owning towards renting (due to credit frictions)
    $\rightarrow$ $\uparrow$ rental market tightness $\rightarrow\uparrow$ rent
  - GE effect: Higher housing rent attract entry of buy-to-rent investors
    $\rightarrow\uparrow$ house prices, offsetting the direct effect of r on house price
- With search frictions, $\uparrow r$ implies a larger $\uparrow$ in rent, a smaller $\downarrow$ in house prices.

Roadmap

Search-Based Framework

- **Search paradigms**
  - Random search
  - Directed search
- **Price formation**
  - Bargaining
  - Auctions
  - Price posting
- **Tenure interaction**
  - Rental $\leftrightarrow$ ownership

Policy Applications

- **Credit constraints**
  - Target specific price segments
  - Affect listing and bidding behavior
- **Transaction taxes**
  - Reduce ownership demand
  - Shift housing toward rental markets
- **Vacancy taxes**
  - Release unused housing (short run)
  - Reduce listing incentives (long run)

Han, L. and D. Stacey (2026), *Housing Market Frictions and Affordability: A Search-and-Matching Perspective*
https://ssrn.com/abstract=6703338

Search and Matching Models

- Initially developed by Diamond (1982), Mortensen (1982), Pissarides (1985) to study frictional unemployment.
- Capture frictions and delays inherent in buying, selling and renting.
- Formalize indivisibility, decentralized trading, idiosyncratic match
- Flexibly accommodates housing market features, such as MLS platform, role of real estate agents, credit frictions, segmentation, and co-existence of rental and owner-occupied markets.
- Highlight the ways search frictions shape housing market outcomes, such as price, rents, time on the market, vacancies, allocation, tenure choice, and ultimately, affordability, within a GE framework.
- Provide a structural framework for policy evaluations.

Variations of Search Models

- Search Paradigms
  - Random matching: Wheaton (90), Albrecht et al. (07), Anenberg & Bayer (20)
  - Directed search: Diaz & Jerez (13), Head, Lloyd-Ellis & Sun (14),, Albrecht et al. (16)
  - Stock-flow matching: Coles and Smith (98); Gilbukh (24)
- Price determination
  - Bargaining: Pissarides (84), Wheaton (90), Han, Ngai & Sheedy (25)
  - Auction: Peters & Severinov (97), Han, Stacey et al (21); Arefeva (25)
  - Price posting: Moen (97), Albrecht et al. (16); Stacey (16; 19)
- Turnover
  - Exogenous moving: Wheaton (90)
  - Endogenous moving: Ngai & Tenreyro (14), Han, Ngai & Sheedy (25)
- Tenure choice
  - More segmented markets: Greenwald and Guren (25); Piazzesi et al (20)
  - Frictional owner-occupied market + competitive rental market: Head et al. (2014)
  - Frictions in both markets: Badarinza *et al* (24); Han, Ngai & Sheedy (25)

Extensions

- Endogenous construction: Head & Lloyd-Ellis, 12; Head, Lloyd-Ellis & Sun, 14, Head, Lloyd-Ellis & Stacey, 23; Gabrovski & Ortego-Marti, 25; Han et al., 25, etc. .
- Credit frictions: Hedlund 16, Head *et al.* 16, Garriga & Hedlund 20, Guren & McQuade 20, Han *et al.* 21, 26, etc.
- Heterogeneity and sorting: Albrecht et al. 07, Hedlund 16, Piazzesi et al. 20, Head, Lloyd-Ellis, & Stacey, 23, etc.
- Intermediaries: Anglin & Arnott, 91; Han & Hong, 16, Gilbukh 25, etc.
- Investors: Buchak, Matvos, Piskorski, & Seru, 24; Badarinza & Ramadorai, 25; Han, Ngai & Sheedy, 25, Han, Stacey & Chen, 26; etc.
- Search in mortgage and housing markets: Gabrovski & Ortego-Marti 21; Agarwal, *et al*, 24; Allen *et al*, 2025, etc.

Connecting Model to the Data

- Integrate structural modeling with credible empirical identification to uncover underlying mechanisms.
- The advantage of a housing search-and-matching framework is that many of its key objects correspond naturally to observable housing market statistics.
  - Discount factor: risk-free interest rate
  - Average income: unity
  - Flow value associated with residing outside the city: rent-to-income
  - Utility premium associated with homeownership: price-to-income
  - Moving shock rate: Household mobility rates
  - Matching efficiency: time on market or vacancies
- Continued advances in the advances in data, particularly linking search, listing, transactions, and tenure transitions, offer new opportunities to discipline and test these models.
  - Provide information about housing market microstructure and household preferences.

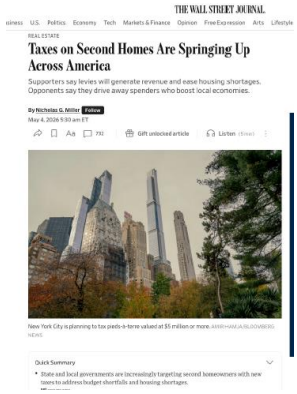
REAL ESTATE

Taxes on Second Homes Are Springing Up Across America

Supporters say levies will generate revenue and ease housing shortages. Opponents say they drive away spenders who boost local economies.

By Nicholas G. Miller Follow

May 4, 2026 5:30 am ET



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New York City is planning to tax pieds-à-terre valued at $5 million or more. AMIR HAMJA/BLOOMBERG NEWS

Quick Summary

- State and local governments are increasingly targeting second homeowners with new taxes to address budget shortfalls and housing shortages.

study of the Vancouver tax led by Lu Han, a professor of real esta
Wisconsin School of Business, found that as a result of this shift
perties to the rental market, rental prices in the city saw a lasting
line.

said in many cities where land is scarce and construction is expe
empty-housing tax can be a cost-effective way to increase housing
ilability and ease pressure on rental prices.

l, housing analysts say these taxes are unlikely to make a significa
he housing shortages in most cities. Such a tax isn't sizable enoug
ivate many owners to rent out their homes, which can be costly.
n if they do, second or vacant homes typically comprise only a sm
centage of the overall housing stock.

Frictional and Speculative Vacancies: The Effects of an Empty Home Tax

(with Derek Stacey, Hong Chen and Giselle Labrador Badia)

Empty/Vacant Homes Taxes: when and where?

- London (1993)
- France (1998)
- Washington DC (2003)
- Barcelona (2014)
- Jerusalem (2016)
- Vancouver (2017)
- Oakland (2016)
- Ireland (2022)
- Taiwan (2022)
- Sacramento (2022)
- Toronto (2023)
- San Francisco (2024)

This paper

Examines the EHT effects on both housing availability and affordability

- New facts:
  - Sales/listings increase initially then fall
  - Prices drop initially and then climb back up
  - Rents decline
  - Time-on-the-market increases initially and then declines.
- A novel search model consistent with the dynamic EHT effects
  - A competitive rental market vs. a frictional owner-occupied market
  - households who rent or own vs. investors who own for financial reasons
  - Free entry of competitive developers
  - Speculative vacancies vs. frictional vacancies
- The model aligns well with the empirical evidence.

Literature

- Housing vacancies:
  - Titman (1985); Arnott (1989); Wheaton (1990); Glaeser & Gyourko (2005), Cunningham (2006)
- Policy responses to vacancies:
  - Eviction bans: Abramson (2024); Collinson *et al* (2022); Corbae, *et al* (2022)
  - Empty home tax: Desgranges & Wasmer (2000); Segu (2020); Menard (2012)
- Search models in housing:
  - Albrecht, Anderson, Smith & Vroman (2007); Albrecht, Gautier & Vroman (2016); He, Wright & Zhu (2015); Rekkas, Wright & Zhu (2020), Han & Genesove (2012); Han, Lutz, Sand & Stacey (2021)etc.
- Search models that feature own and rent:
  - Head and Lloyd-Ellis (2012); Kashiwagi (2014); Halket & di Custoza (2015); Garriga & Helund (2021); Head, Lloyd-Ellis & Stacey (2023); Han, Ngai & Sheedy (2022); etc.
- Storage demand:
  - Commodity markets: Hart & Kreps (1986); Stein (1987)
  - Financial assets: Tirole (1985); Shiller (2014)
  - Investors in housing: Buchak *et al* (2020); Glaeser *et al* (2017), Gorback & Keys (2023); Favilukis & Van Nieuwerburgh (2021); etc.

Part 1: New Facts

Vancouver's Empty Homes Tax (EHT)

- Properties deemed or declared *empty* in a reference year will be subject to a tax
- *empty*: unoccupied by principal resident or tenant for at least six months of the reference year
- *exemptions*: death of owner, owner in care, court order, redevelopment or major renovations, transfer of property, etc.

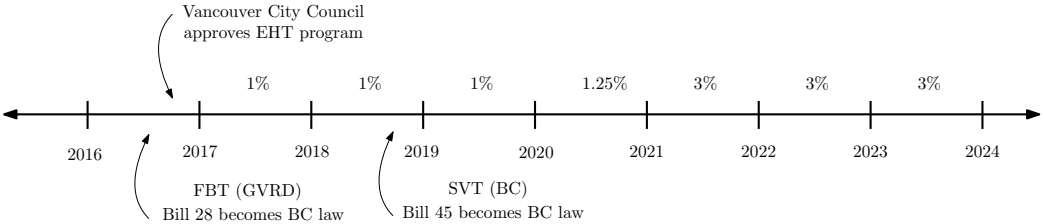
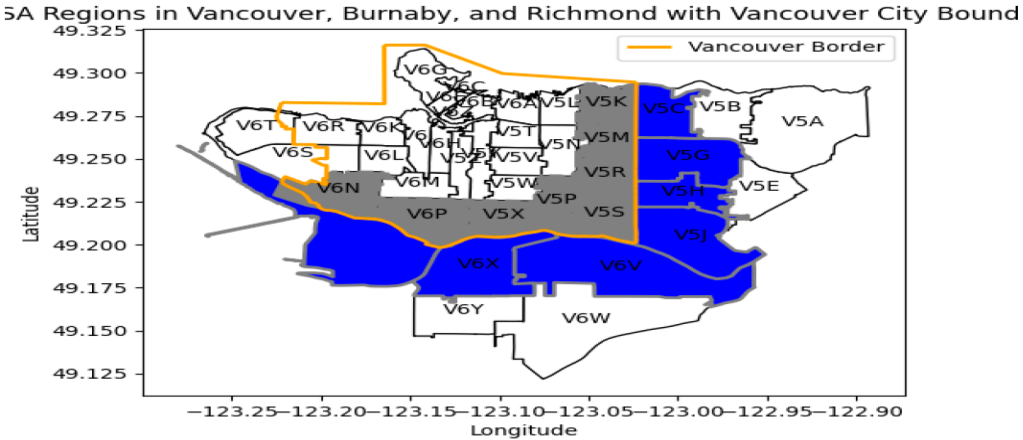


Figure: The Timing of Vancouver's EHT.

Vancouver

Figure: Bordering Neighborhoods



Data

- MLS transaction records in the Greater Vancouver (2014-2022)
  - Sales: listing and sales price, listing and transaction date, address, time-on-the-market, address, house characteristics
- Canada Mortgage and Housing Corporation Data (2014-2022)
  - Neigborhood level vacancies, rents, constructions
- Canadian Census Data (2014-2020)
  - Neigborhood level social demographics

Local Projection Specification I

$$\Delta Y_{j,t-1,t+h} = \alpha_{j,h} + \beta_h \Delta \tau^{EHT}_{j,t} + \sum_{2 \geq i \geq p} \gamma_i Y_{j,t-i} + \Gamma'_h X_{j,t-1} + \epsilon_{j,t-1,t+h}$$

$\Delta Y_{j,t-1,t+h} \equiv Y_{j,t+h} - Y_{j,t-1}$: change in *sales*, *listings*, *price*, *time-on-the-market*, and *rents* in neighborhood j between $t-1$ and $t+h$;

$\Delta \tau^{EHT}_{j,t}$: change in the EHT policy in neighborhoold j between $t-1$ and t;

$\{\beta_h\}_{h=0}^{h=18}$: effect of EHT on $\Delta Y_{j,t-1,t+h}$ after h periods.

p: lag-length chosen using AIC and BIC;

$X_{j,t-1}$: observed time-varying neighborhood-level characteristics;

We estimate it for separate horizons by local projection (Jorda, 2005), with additional controls of local seasonality and city-specific trend.

Identification Assumption: conditional on rich controls, adjacent neighborhoods across the city border do not experience significantly different market trends between $t-1$ and t in the absence of the EHT policy.

Local Projection Specification II

$$\Delta Y_{j,t-1,t+h} = \alpha_{j,h} + \beta_h \kappa_j \Delta \tau^{EHT}_{j,t} + \sum_{2 \geq i \geq p} \{\gamma_i Y_{j,t-i} + \delta_i \kappa_j \Delta \tau^{EHT}_{j,t+1-i}\}$$
$$+ \Gamma'_h X_{j,t-1} + \epsilon_{j,t-1,t+h}$$

κ_j: shock exposure of local housing market i, measured by one of the following neighborhood-level variables in 2016.

- vacancy rate
- fraction of immigrants
- fraction of China, Hong Kong, and Taiwan-born immigrants
- fraction of non-permanent-residents

Identification Assumption: conditional on rich controls, adjacent neighborhoods across the city border do not experience significantly different market trends between $t-1$ and t in the absence of the EHT policy in a way that depends on κ_j.

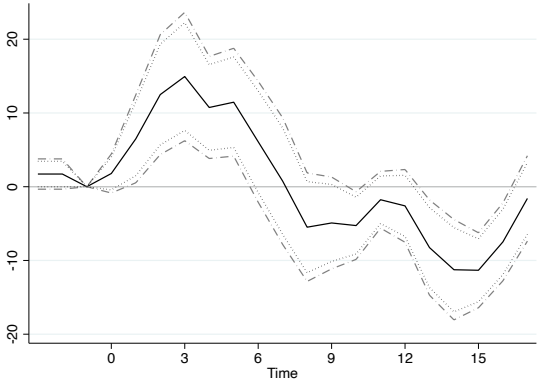
Local Projection Specification III

$$\begin{aligned}\Delta Y_{j,t-1,t+h} \quad = \quad & \alpha_{j,h} + \beta_h \kappa_j \Delta \tau^{EHT}_{j,t} + \beta'_h \Delta \tau^{FBT}_{j,t} + \sum_{2 \geq i \geq p} \{\gamma_i Y_{j,t-i} \\ & + \delta_i \kappa_j \Delta \tau^{EHT}_{j,t+1-i} + \phi_i \Delta \tau^{FBT}_{j,t+1-i}\} + \Gamma'_h X_{j,t-1} + \epsilon_{j,t-1,t+h}\end{aligned}$$

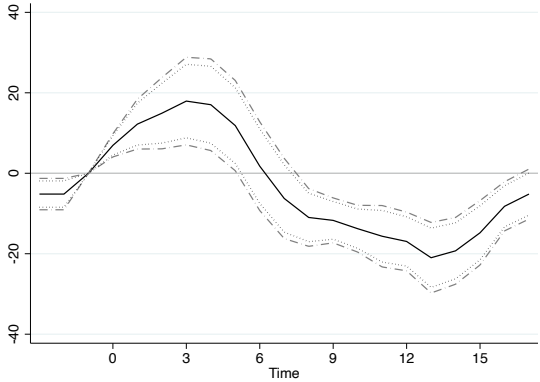
$\Delta \tau^{FBT}_{j,t}$: change in the FBT policy in neighborhood j between month $t-1$ and t;

Identification Assumption: conditional on rich controls and the FBT's differential dynamic impacts, adjacent neighborhoods across the city border do not experience significantly different market trends between $t-1$ and t in the absence of the EHT policy in a way that depends on κ_j.

Dynamic EHT Effects on Sales and Listings

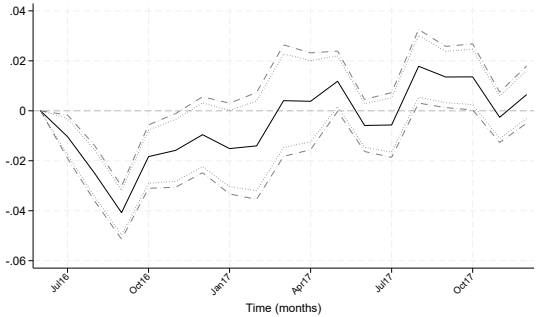


(a) Sales

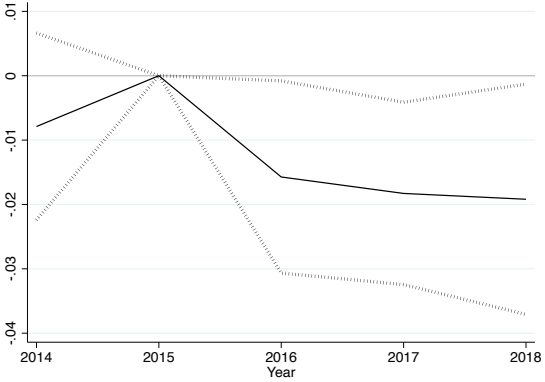


(b) Listings

Dynamic EHT Effects on Price and Rents

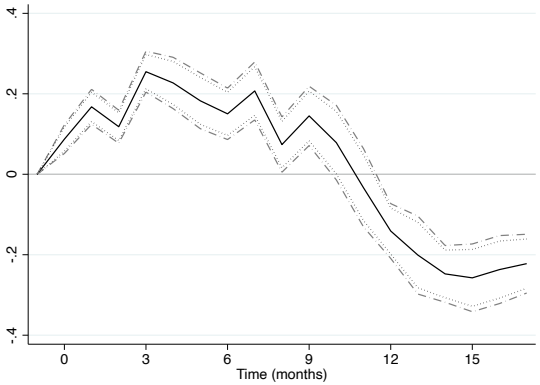


(a) Monthly Quality-Adjusted Price



(b) Annual Average Rents

Dynamic EHT Effects on Time-on-the-Market



(a) Monthly Time-on-the-Market

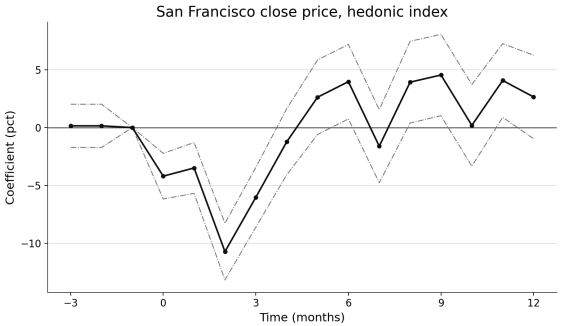
Robustness Checks

- Expand sample from border areas to entire metro details
- Dynamic differences-in-differences approach details
- Spillover and anticipation detail
- Alternative vacancy exposure κ_i detail
- Alternative border samples detail
- Alternative definition of listings detail

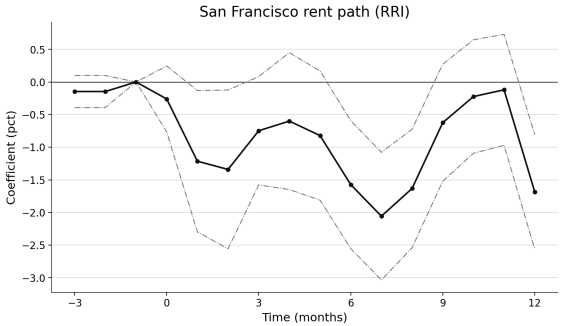
External Validity: Empty Home Tax in San Francisco

- Adopted Proposition M in the November 8, 2022 election.
- Created an Empty Homes Tax on vacant residential units in buildings with three or more units when the unit is vacant for more than 182 days in a calendar year.
- No exemption applies.

Dynamic EHT Effects on Price and Rents

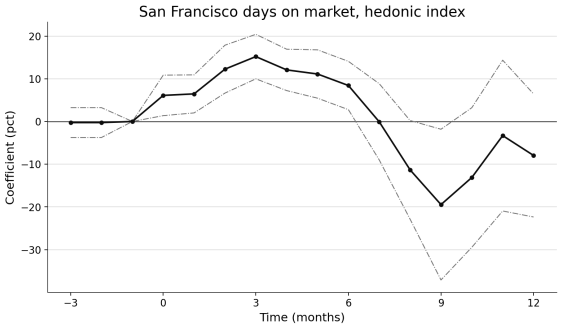


(a) Monthly Quality-Adjusted Price

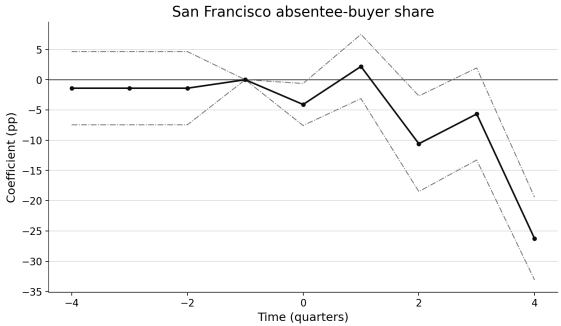


(b) Annual Average Rents

Dynamic EHT Effects on Time-on-Market and Absentee-Investor Share



(a) Monthly Quality-Adjusted Time-on-Market



(b) Quarterly Absentee Investor Share

Summary of Findings

- Sales and listings increase initially then fall
- Price drops initially then climbs back up
- Time-on-the-market increases initially then declines
- Rents decline

Part 2: Search Model

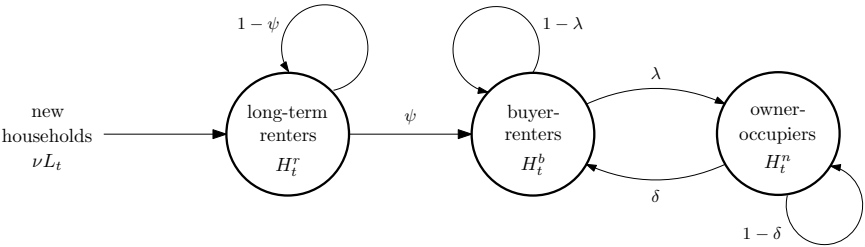
A dual ownership and rental markets model of housing

- A city with growing population of hhlds that consume housing
- Competitive rental market, frictional owner-occupied market
- Investors that desire homeownership for financial reasons
- Owned or rented houses, constructed by developers

Model Environment

- time is discrete $t = 0, 1, 2, \ldots$
- *households* residing in the city details
  - population, L_t, growing at rate ν
  - home ownership utility premium $z_t > 0$
  - exogenous mobility shock δ
- *investors* details
  - idiosyncratic Markov-flow financial value from owning π
  - idiosyncratic cost of leasing, ε
- *housing* stock, H_t details
  - constructed by competitive developers
  - unit cost of construction: $q(H_t, L_t) = \zeta_0 + \zeta_1(H_t/L_t)$

Households Stocks and Flows



Households

- Infinitely-lived with discount factor $\beta \in (0, 1)$
- Constant exogenous income y each period
- Preferences: $u(c_t, z_t) = c_t + z_t$
  - c_t: non-housing consumption
  - z_t: home ownership utility premium, $z_t \in \{0, z\}$
- Mobility shock:
  - with probability δ per period
  - z_t falls to zero permanently for current house
- Permanent renters:
  - $z_t = 0$ regardless of housing tenure
  - fraction ψ of all new households

return

Investors

- Infinitely-lived, risk-neutral, with discount factor $\beta \in (0, 1)$
- Constant ratio, ϕ, of potential investors to households
- Exogenous idiosyncratic flow value from home-ownership, π_t, follows a Markov process with transition function

$$F_\pi(\pi', \pi) = \text{Prob}\{\pi_{t+1} \leq \pi' | \pi_t = \pi\}$$

- An investor that owns a home does not live in the house
  - An investor's vacant home is subject to the EHT
  - An investor's rented out home is subject to an additional cost of leasing, $\varepsilon \sim F_\varepsilon$

return

Construction

- Free entry given a large number of competitive developers
- Unit cost of construction:

$$q(H_t, L_t) = \zeta_0 + \zeta_1(H_t/L_t)$$

  - ζ_0: construction cost
  - $\zeta_1(H_t/L_t)$: cost of land (proportional to the existing stock of housing relative to the population)

- Depreciation of occupied homes offset by per-period maintenance cost m

return

Housing

City's stock of housing at time t:

$$H_t = H_t^n + H_t^r + H_t^b + H_t^f + H_t^s$$

H_t^n: owner-occupied

H_t^r: rented to permanent renters

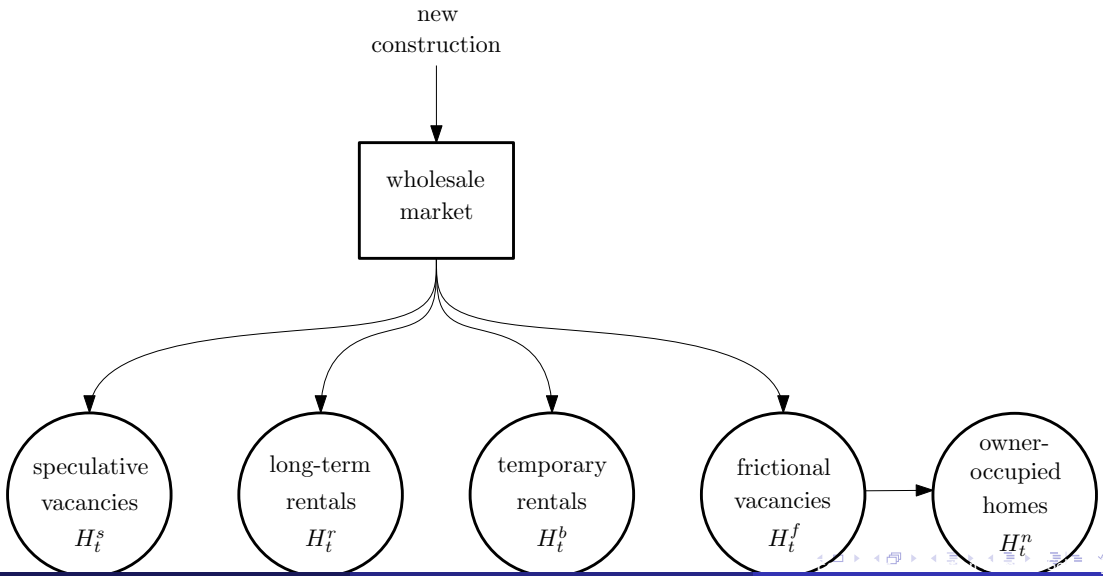
H_t^b: rented to prospective buyers

H_t^f: vacant and for sale (i.e., *frictional* vacancies)

H_t^s: vacant and investor-owned (i.e., *speculative* vacancies)

Housing Stocks and Flows

return



Housing Markets

rental market:

- perfectly competitive

x_t: the cost of renting a house at time t

wholesale market:

- perfectly competitive

V_t: wholesale market value at time t

owner-occupied market

- time-consuming process of SaM to find the *right* house
- market frictions modelled using *competitive search*
- trade-off between *price*, P, and *market tightness*, θ

Competitive Search in the Owner-Occupied Market

- vacant homes offered for sale in a continuum of potential *submarkets*, characterized by price, P
- within each submarket, buyers and sellers match via a CRS matching function
- the buyer-seller ratio is denoted $\theta_t(P)$ and termed *submarket tightness*
- matching probabilities:

$$\text{buyers: } \lambda(\theta_t(P)) \quad \text{and} \quad \text{sellers: } \gamma(\theta_t(P))$$

Empty Homes Tax

- *Vacant* homes subject to an empty homes tax (EHT)
- calculated as a percentage, τ, of the value of a vacant home, totalling τV_t for period t
- exemptions:
  - owner-occupied homes
  - tenanted rental units
- partial exemption: $(1-\omega)\tau V_t$ for vacant homes listed for sale in the owner occupied market

Equilibrium Values and Prices (1 of 4)

developers:

- the value of a house at time t in the wholesale market:

$$V_t = \max \left\{ \begin{array}{l} x_t - m + \beta V_{t+1}, \\ -(1-\omega)\tau V_t + \beta \max\limits_{P} \gamma(\theta_t(P))P + (1-\gamma(\theta_t(P)))V_{t+1} \end{array} \right\}$$

- supply side indifference in eqm. between renting out and listing for sale at price P:

$$V_t = x_t - m + \beta V_{t+1}, \text{ and} \tag{1}$$

$$V_t = -(1-\omega)\tau V_t + \beta \left[\gamma(\theta_t(P))P + (1-\gamma(\theta_t(P)))V_{t+1}\right] \tag{2}$$

- free entry: $q(H_t, L_t) \geq V_t$

Equilibrium Values and Prices (2 of 4)

households:

- V_t^r, V_t^b and V_t^n denote the present discount expected values associated with *renting* permanently, renting while *buying*, and *owning*
- Bellman equations:

$$V_t^r = y - x_t + \beta \left[(1-\psi) V_{t+1}^r + \psi V_{t+1}^b \right] \tag{3}$$

$$V_t^b = y - x_t + \beta \max_P \lambda(\theta_t(P)) \left[V_{t+1}^n - P \right] + (1 - \lambda(\theta_t(P))) V_{t+1}^b \tag{4}$$

$$V_t^n = y - m + z + \beta \left\{ (1-\delta) V_{t+1}^n + \delta \left[V_{t+1}^b + V_{t+1} \right] \right\} \tag{5}$$

Equilibrium Values and Prices (3 of 4)

buyers' directed search problem:

$$\max_{\theta,P} \lambda(\theta)\left[V_{t+1}^n - V_{t+1}^b - P\right]$$

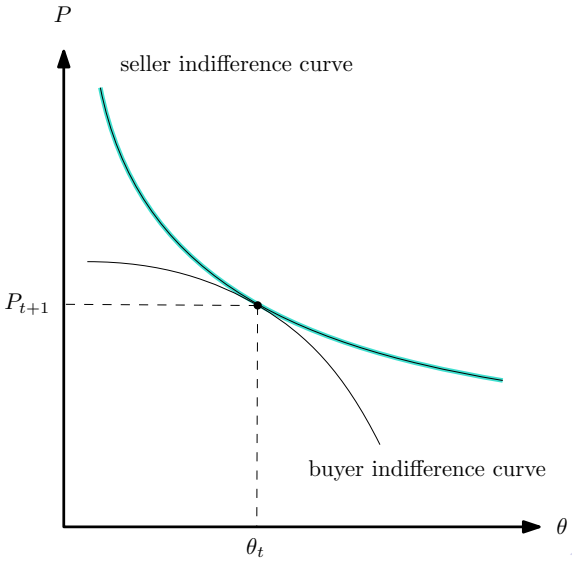
subject to $V_t = -(1-\omega)\tau V_t + \beta V_{t+1} + \gamma(\theta)\beta\left[P - V_{t+1}\right]$.

- solution is a pair $\{\theta_t, P_{t+1}\}$ that solves the constraint and the FOC:

$$P_{t+1} = \eta(\theta_t)V_{t+1} + (1-\eta(\theta_t))\left[V_{t+1}^n - V_{t+1}^b\right], \tag{6}$$

where $\eta(\theta) = \theta\gamma'(\theta)/\gamma(\theta) = 1 + \theta\lambda'(\theta)/\lambda(\theta)$.

Competitive Search Equilibrium



EHT and Frictional Vacancies

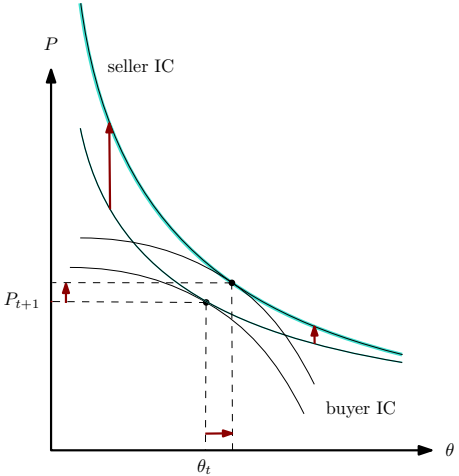


Figure: The Effect of τ on the Decisions of Developers.

Equilibrium Values and Prices (4 of 4)

investors:

- present discounted expected value of an investor satisfies

$$V_t^i(\pi_t, \varepsilon_t) = \max \left\{ \begin{array}{l} \beta \mathbb{E}[V_{t+1}^i(\pi_{t+1}, \varepsilon_{t+1})], \\ \pi_t - V_t + \max\{x_t - m - \varepsilon_t, -\tau V_t\} \\ \qquad\qquad + \beta \mathbb{E}[V_{t+1}^i(\pi_{t+1}, \varepsilon_{t+1}) + V_{t+1}] \end{array} \right\}.$$

or

$$V_t^i(\pi_t, \varepsilon_t) = \max \left\{ \begin{array}{l} 0, \\ \pi_t - \min\{\varepsilon_t, (1+\tau)V_t - \beta V_{t+1}\} \end{array} \right\} \\ + \beta \mathbb{E}[V_{t+1}^i(\pi_{t+1}, \varepsilon_{t+1})].$$

Optimal Decisions of Investors

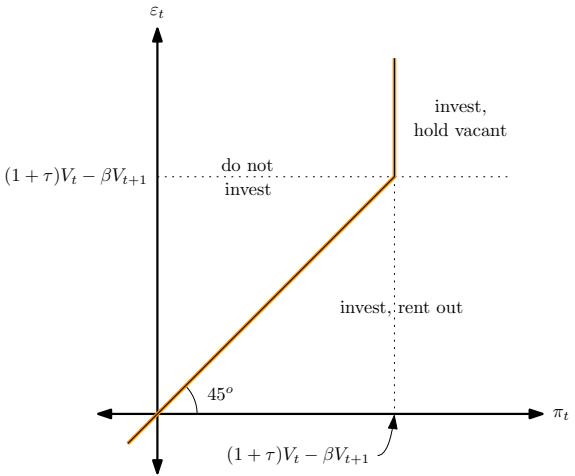


Figure: The Equilibrium Decisions of Investors.

EHT and Speculative Vacancies

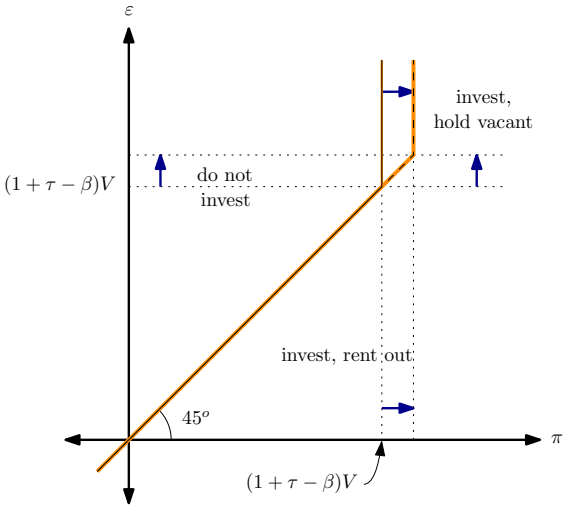


Figure: The Effect of τ on the Decisions of Investors.

Eqm. Distributions of Households and Houses (1 of 2)

the measures of renters, buyers, and owners evolve according to

$$H^r_{t+1} = H^r_t + \nu\psi L_t$$
$$H^b_{t+1} = (1-\lambda(\theta_t))H^b_t + \delta H^n_t + \nu(1-\psi)L_t$$
$$H^n_{t+1} = (1-\delta)H^n_t + \lambda(\theta_t)H^b_t$$

normalizing by the population (e.g., $h^r_t \equiv H^r_t/L_t$),

$$h^r_{t+1} = \frac{1}{1+\nu}h^r_t + \frac{\nu\psi}{1+\nu} \tag{7}$$
$$h^b_{t+1} = \frac{1-\lambda(\theta_t)}{1+\nu}h^b_t + \frac{\delta}{1+\nu}h^n_t + \frac{\nu(1-\psi)}{1+\nu} \tag{8}$$
$$h^n_{t+1} = \frac{1-\delta}{1+\nu}h^n_t + \frac{\lambda(\theta_t)}{1+\nu}h^b_t \tag{9}$$

Eqm. Distributions of Households and Houses (2 of 2)

(normalized) measure of vacant homes listed for sale:

$$h_t^f = \frac{h_t^b}{\theta_t} \tag{10}$$

(normalized) measure of homes held vacant by investors:

$$h_t^s = \phi[1 - F_\pi((1+\tau)V_t - \beta V_{t+1}][1 - F_\varepsilon((1+\tau)V_t - \beta V_{t+1})] \tag{11}$$

vacancies in (10) are *frictional* vacancies, those in (11) are *speculative* vacancies

New Construction

Construction of new housing is non-negative:

- $H_t \geq H_{t-1}$ or, equivalently, $h_t(1+\nu) \geq h_{t-1}$, where

$$h_t = h_t^n + h_t^r + h_t^b + h_t^f + h_t^s \tag{12}$$

- free entry into new housing development:[1]

$$q(h_t) \geq V_t \quad \text{and} \quad h_t(1+\nu) \geq h_{t-1} \tag{13}$$

(with complementary slackness)

[1] $q(h_t) \equiv q(H_t/L_t, 1) = q(H_t, L_t)$

Equilibrium Balanced Growth Path

An *equilibrium balanced growth path* (*BGP*) is a list of values, $\{V^r, V^b, V^n\}$, and a value function, $V^i(\pi, \varepsilon)$; a house value, V, and rent, x; a price P and a function for market tightness, $\theta(P)$; a housing stock, h; and a distribution of houses/households, $\{h^r, h^b, h^n, h^s, h^e\}$; such that:

(i) V^r, V^b, V^n and V^i satisfy the stationary BEs;

(ii) stationary distribution of houses/households: h^r, h^b, h^n, h^f and h^s satisfy stationary versions of (7), (8), (9), (10), and (11);

(iii) free entry into housing development: $q(h) = V$, where $h = h^r + h^b + h^n + h^f + h^s$;

(iv) competitive rental market: $x = (1 - \beta)V + m$; and

(v) directed search: θ and P solve the directed search problem.

The Housing Market Effects of an EHT

in an eqm. BGP, an increase in the EHT rate, τ:

1. reduces *speculative vacancies*, h^s, and hence the city's stock of housing, h
   - $\Rightarrow$ lower cost of housing development (since $q'(h) \geq 0$)
   - $\Rightarrow$ *welfare-improving*
2. reduces *frictional vacancies*, h^f, and increases house price, P
   - $\Rightarrow$ vacant houses listed for sale command a higher price premium and shorter time-to-sell
   - $\Rightarrow$ shifts the composition of housing from owner-occupied to rental
   - $\Rightarrow$ *welfare-reducing*

Part 3: Calibration

Calibration Approach

1. calibration
   - parameterize the eqm. BGP of the model with $\tau = 0$ to match characteristics of a city's housing markets
2. simulation
   - compute the eqm. transition path from the initial BGP with $\tau = 0$ to a new BGP with $\tau > 0$

Calibration (1 of 2)

distributional and functional form assumptions:

- matching function:

$$\mathcal{M}(b,s) = \frac{bs}{b+s}$$

- investor's flow value of home ownership:
  - $\pi_{t+1} = \pi_t$ with prob. $(1-\rho)$
  - otherwise, with prob. ρ, π_{t+1} is drawn from

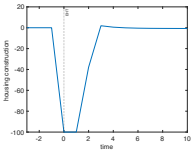
$$F_\pi = F_\varepsilon = \mathcal{N}(0,\sigma)$$

Calibration (2 of 2)

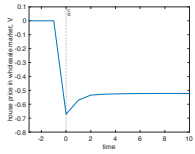
Table: Model Parameters

calibration target	target value	model parameter	parameter value
annual population growth rate (%)	1.27	ν	0.0032
annual household income (normalization)	1	y	0.2500
annual interest rate (%)	4	β	0.9902
five-year mobility rate of homeowners (%)	20.4	δ	0.0113
ownership rate (%)	63.7	ψ	0.3454
construction cost relative to house value (%)	55.1	ζ_0	1.2333
annual rent relative to median income (%)	25.6	ζ_1	2.9546
annual maintenance cost relative to house value (%)	2.0	m	0.0217
housing flow value implied by optimal maintenance		z	0.0562
vacancy rate (%)	4.8	ϕ	0.1287
share of homes owned by non-residents (%)	7.6	μ	0.0406
five-year turnover rate for non-resident owners (%)	40.8	ρ	0.0681
empty homes tax rate (%)	1.0	τ	0.0025
average price converges back to pre-EHT eqm. BGP level		ω	0.6949
vacancy rate (%)	4.1	σ	0.0679

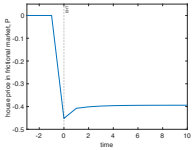
Simulation Results (1 of 4)



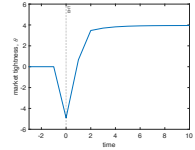
(a) housing construction



(b) house value



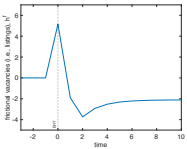
(c) house price



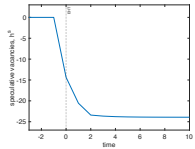
(d) market tightness

Figure: Percentage deviation from the pre-EHT equilibrium.

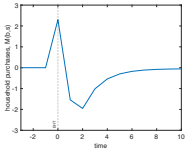
Simulation Results (2 of 4)



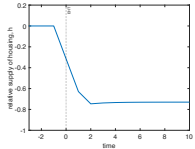
(a) frictional vacancies



(b) speculative vacancies



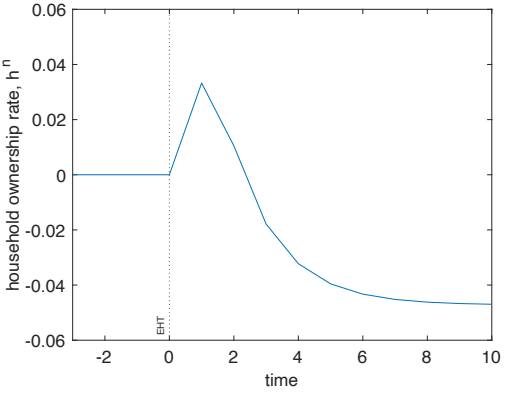
(c) sales



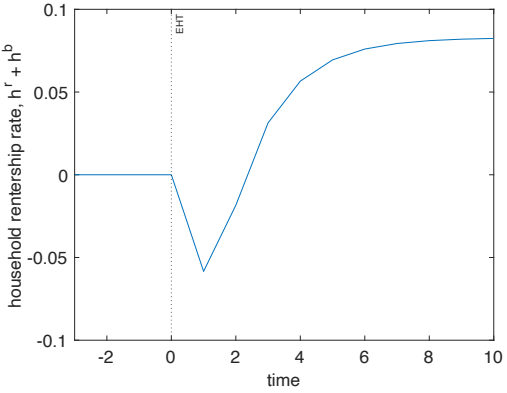
(d) housing supply

Figure: Percentage deviation from the pre-EHT equilibrium.

Simulation Results (3 of 4)



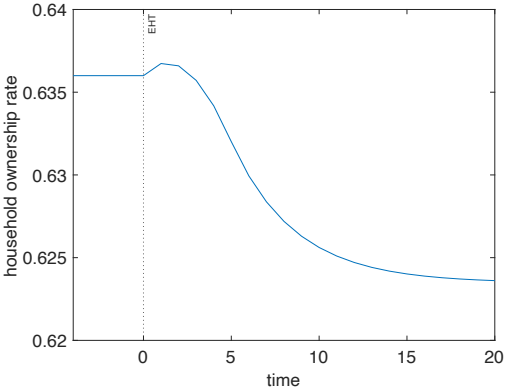
(a) home-ownership rate



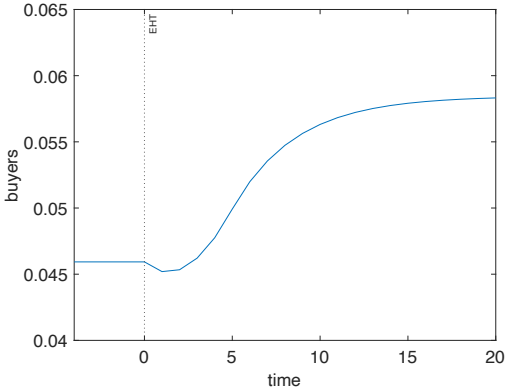
(b) rentership rate

Figure: Percentage deviation (from initial pre-EHT equilibrium BGP) of equilibrium ownership and rentership rates in response to EHT.

Simulation Results (4 of 4)



(a) homeowners



(b) buyers in frictional market

Welfare Analysis

- Household Welfare: weighted average of present value of lifetime housing consumption benefits averaged across all households (renters, buyers and owners):

$$W_t = h_t^r V_t^r + h_t^b V_t^b + h_t^n V_t^n$$

- Aggregate EHT revenues on a per-household basis:

$$R_t = \tau \left[(1-\omega) h_t^f + h_t^s \right] + \beta R_{t+1}$$

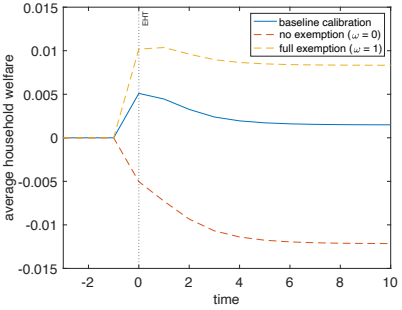
Welfare Analysis

- Present value of household welfare averaged across all households

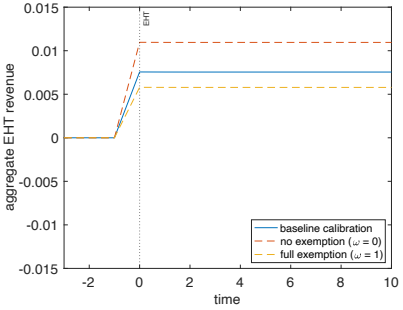
$$W_t = h_t^r V_t^r + h_t^b V_t^b + h_t^n V_t^n$$

- Aggregate EHT revenues on a per-household basis:

$$R_t = \tau \left[(1-\omega) h_t^f + h_t^s \right] + \beta R_{t+1}$$



(a) household welfare



(b) EHT revenue

Summary

- Empirically, we find that following an EHT
  - Sales and listings increase initially and then fall
  - Prices drop initially and then climb back up
  - Rents drop
  - Time-on-the-market drops initially and then climbs back up
  - Vacancies drop
- Theoretically, we build a search model that matches these patterns, with two key insights:
  1. EHT turns speculative vacancies into cheaper tenanted rentals, which represents a welfare-enhancing improvement in housing availability
  2. EHT distorts incentives to supply homes to the owner-occupied market, which can worsen housing affordability and reduce home-ownership

New Inventory Exemption Announced in 2023 (retroactive to 2022)

Residential properties that are unoccupied for more than six months during the vacancy reference period are no longer subject to Vancouver's EHT if the property was either listed for sale throughout the vacancy reference period or newly constructed.

Takeaway: Rethinking Housing Supply

- Housing markets are fundamentally **decentralized and frictional.**
- In a frictional world, physical stock is only one component of supply.
- Effective supply depends on
  - Willingness to list
  - Speed of matching
  - Allocation across uses
- Increasing construction alone may not resolve affordability

Takeaway: Housing Policy is a GE intervention

- Policy targets *one margin*:
  - Credit constraints
    - Macroprudential policy
    - Monetary policy
  - Transaction taxes
  - Vacancy taxes
- But with frictions, even small shocks can generate large equilibrium responses:
  - Listing withdrawal
  - Investor entry
  - Tenure reallocation
- Search frictions act as an *offsetting* or *amplification* mechanism.

Broad Implications

- Integrate structural modeling with credible empirical identification to uncover the underlying mechanisms
- Policy makers must account for frictions that govern how housing is allocated or traded.
- Extending search-based frameworks to incorporate richer forms of heterogeneity, dynamic investment and construction, and interactions with mortgage markets would further enhance their empirical relevance.
- Continued advances in data, particularly linking search, listing, transactions, and tenure transitions,offer new opportunities to discipline and test these models.
- Advancing along both fronts will be essential for developing a more complete and policy-relevant understanding of housing affordability in frictional markets.