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

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Abstract

In this paper, we study the implications of a vacant home tax for housing availability and affordability. We develop a model with owner-occupied homes, tenanted rental units, and empty houses. Housing units are constructed by competitive developers and supplied to local households, but can also be sold to investors as a store of wealth. Empty homes held by investors are classified as *speculative* vacancies. *Frictional* vacancies, on the other hand, are the equilibrium result of search-and-matching frictions in the owner-occupied market. A tax on empty homes can improve housing availability and affordability in the rental market by reducing speculative vacancies, but can distort the incentives to supply vacant homes for sale in the owner-occupied market (i.e., frictional vacancies), thereby increasing house prices and lowering home-ownership. Empirical predictions derived from the calibrated model are consistent with the patterns we observe for listings and sales in Vancouver following the recent implementation of an empty homes tax.

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1 Introduction

Vacant home taxes are becoming popular in Canada in abroad. Vancouver implemented an empty homes tax in 2017 that currently amounts to 3 percent of the property's assessed taxable value annually. Toronto approved a 1 percent vacant home tax in 2021 that comes into effect next year. In the US, a vacant home tax has been part of Washington D.C.'s property tax system since 2003, and Oakland introduced a $6000 per year tax on vacant homes in 2018.

The stated policy objective is to reduce the prevalence of empty homes, thereby increasing both housing availability and affordability. The policy analysis is complicated, however, for a variety of reasons: the rental market and the market for owner-occupied homes are interdependent; the stock of housing is not fixed, so one needs to take into account new housing development; etc. In this paper, we develop a theoretical framework to help understand the housing market effects and welfare implications of an empty homes tax. The theoretical insights are then explored empirically with an application to the Vancouver empty homes tax (EHT).

In Vancouver, properties that are deemed or declared empty in a reference year are subject to a tax. The status of *empty* means unoccupied by a principal resident or tenant for at least six months of the reference year. There is a list of reasons for exemption from the tax, including death of owner, owner in care, and redevelopment or major renovations. An important exemption for our analysis is the transfer of property exemption: the EHT does not apply if the legal ownership of a home was transferred in the reference year.

Vancouver's EHT was designed and approved in the Fall of 2016. It was initially set to 1 percent, but since 2021 has been 3 percent of the property's assessed taxable value. The tax was implemented around the same time as other housing market policies (see Figure 1), including the foreign buyer tax (FBT) and the speculative vacancy tax (SVT). Our identification strategy exploits the different geographic areas of the various policies. The EHT applies to the city of Vancouver, whereas the FBT and the SVT apply to the Greater Vancouver Regional District and the province of British Columbia, respectively.

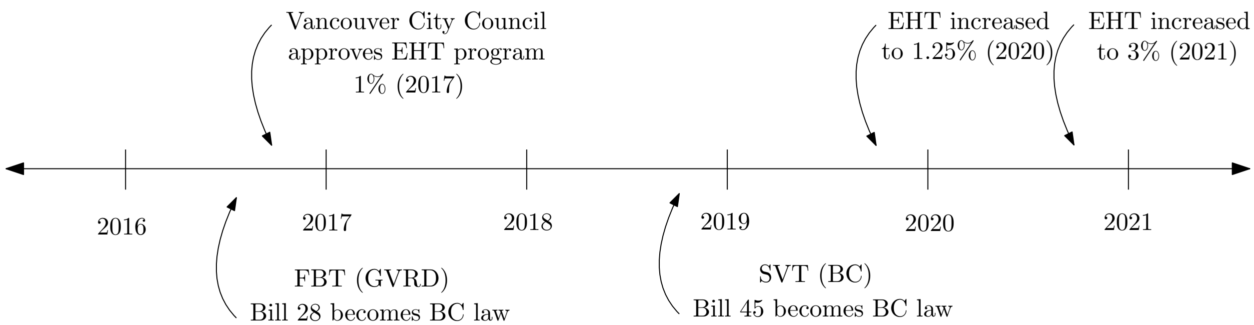


Figure 1: The Timing of Vancouver's EHT.

More generally, we study the housing market effects of a generic vacant home tax like the EHT in Vancouver by developing a city-level search-theoretic model of housing with the following features: (i) a growing population of households that consume goods and housing services; (ii) houses, constructed by competitive developers, that may be owned or rented; (iii) a competitive rental market and a frictional owner-occupied market; and, finally, (iv) non-resident investors that desire home-ownership for exogenous financial reasons, and not for the consumption of housing services. Empty homes owned by investors are termed *speculative vacancies*. *Frictional vacancies*, on the other hand, are the equilibrium result of search-and-matching frictions in the owner-occupied market.

We characterize the dynamic equilibrium, as well as the equilibrium balanced growth path (BGP) of the model. We then undertake a calibration exercise that parameterizes the equilibrium BGP using city-level observations in the absence of an EHT. We then compute the equilibrium transition path following the introduction of an EHT.

By comparing equilibrium BGPs before and after the tax, we find that an empty homes tax causes a decline in vacancies, and this can apply to both frictional and speculative vacancies. The decline in vacancies induces an increase in the relative supply of rental units, but a decline in home ownership. Finally, an EHT can simultaneously put downward pressure on rents and upward pressure on house prices. In the short-run immediately following the introduction of the tax, however, some of these can be exactly the opposite of what was just described. The rental and owner-occupied markets first need to absorb some of the speculative vacancies that are supplied to both markets in response to the EHT.

In a market with search frictions, a certain amount of frictional vacancies are needed for the constrained efficient level of turnover in the owner-occupied market. Speculative vacancies, in contrast, are welfare-reducing because they increase the cost of supplying homes to the households that want to occupy them. The EHT can reduce both types of vacancies, meaning that there are offsetting welfare effects.

We test the model's predictions using 2014 to 2018 transaction-level data for residential homes in and around Vancouver. We compare Vancouver listings, sales and prices before and after the introduction of the EHT. Because this comparison would capture other confounding macro forces and accompanying policy interventions, such as the foreign buyer tax, we study neighbourhoods just inside the Vancouver border relative to neighbourhoods just outside the border to identify the housing market effects of the EHT.

Our results reveal that listings and sales increase initially with the introduction of the EHT, and decrease thereafter. These results are consistent with the dynamic empirical implications of the simulated model. The relative price effects are inconclusive. From the perspective of the theoretical model, the absence of an economically and statistically significant effect on prices is potentially because of the offsetting channels through which the tax affects prices.

A brief review of the related literature is in order. There are other housing models that feature a choice between owning and renting (Halket and di Custoza, 2015; Garriga and Hedlund, 2020; Head et al., 2023). Some of our modelling features, including the choice between a frictional owner-occupied market and a frictionless rental market, are similar to those in

Head et al. (2014). Other recent papers have studied the role of speculators/investors in the housing market, include Buchak et al. (2020) and Favilukis and Van Nieuwerburgh (2021). Finally, there is a long-standing interest among housing economists in vacancies dating back to Arnott (1989). A recent paper by Abramson, Landvoigt, Piazzesi, and Schneider (Abramson et al.) distinguishes between *frictional* and *structural* vacancies, whereas the distinction in our analysis is between *frictional* and *speculative* vacancies. Structural vacancies in the aforementioned paper are defined as vacancies in excess of the number of searchers, whereas speculative vacancies in our framework are empty homes owned by investors for exogenous financial reasons.

The rest of the paper is organized as follows. The model environment and equilibrium are described in Sections 2 and 3. Comparative statics are also derived and discussed in Section 3. Section 5 presents our calibration and simulation of the model. Sections 6 and 7 discuss the data and empirical results. Section 8 concludes.

2 Model Environment

Time is discrete and indexed by t. There are L_t households residing in the city at time t. The population growth rate is ν, so that $L_{t+1} = (1+\nu)L_t$. An assumption of the model is that households require housing in every period.

Households. Households are infinitely-lived with discount factor $\beta \in (0,1)$. They earn a constant exogenous income y each period.[1] Preferences are given by

$$u(c_t, z_t) = c_t + z_t, \tag{1}$$

[1]Section 4 contains a discussion of a model extension involving income heterogeneity.

where c_t denotes non-housing consumption at time t, and

$$z_t = \begin{cases} z > 0 & \text{if homeowner and } \textit{well-matched} \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

denotes the utility premium associated with home ownership. The utility flow from the housing services of a rental unit is normalized to zero. Parameter z is an additional utility benefit designed to capture the enjoyment experienced by homeowners that have found the *right* house and customized it to their idiosyncratic preferences. With probability δ per period, an owner-occupier is hit by a preference shock that results in them losing the utility premium from living in that house. That is, the shock causes z_t to fall to zero as long as continue to live in their current house. This preference shock captures a household's evolving preferences arising from changes in age and family status over the life cycle, and generates churning in the owner-occupied market.

There are some households that are simply not inclined to enjoy the benefits of home-ownership (i.e., $z_t = 0$ regardless of housing tenure): an exogenous fraction $\psi \geq 0$ of all new households entering the city are assumed to be *permanent renters*. The remaining $1 - \psi$ of households rent only temporarily while searching for the right match to prompt a purchase in the owner-occupied market.

Housing. Let H_t denote the city's stock of housing at time t. Housing can either be owned (H_t^n), rented out to permanent renters (H_t^r), rented to prospective buyers (H_t^b), vacant and listed for sale[2] (H_t^f), or vacant and investor-owned (H_t^s):

$$H_t = H_t^n + H_t^r + H_t^b + H_t^f + H_t^s. \tag{3}$$

Empty homes held by investors are termed *speculative vacancies*. *Frictional vacancies*, on

[2] An assumption is that a home must remain vacant while listed for sale in the owner-occupied market.

the other hand, are the result of search-and-matching frictions in the owner-occupied market.

Housing construction is carried out by a large number of competitive developers. The construction of a new housing unit costs

$$q(H_t, L_t) = \zeta_0 + \zeta_1(H_t/L_t). \tag{4}$$

We interpret ζ_0 as the cost of building a house, and $\zeta_1(H_t/L_t)$ as the cost of land. The latter is proportional to the existing stock of housing relative to the population of households, which is consistent with balanced growth. Depreciation is exactly offset by maintenance: the owner of an occupied home incurs cost m per period.

Markets. Households and developers can borrow and lend in a competitive market at gross interest rate $1/\beta$. As for housing services, there are three relevant markets: a rental market, a wholesale market, and an owner-occupied market. The rental market is perfectly competitive, with the rental payment at time t denoted by x_t. For analytical convenience, we also assume that vacant homes can be traded in a competitive wholesale market, with V_t denoting the wholesale market value of a house at time t. If a household were to buy a house in the wholesale market, it would serve only as a financial asset.[3] In other words, it would not be the *right* house that delivers the utility premium, z. In order to buy a home from which to derive the additional utility benefit from the housing services enjoyed when living in a home that they own, they must engage in a time-consuming process of search-and-matching in order to find the *right* house in the owner-occupied market.

We model these frictions in the owner-occupied market with a matching function. In addition, search is *directed* by list prices. Within a *submarket* characterized by price, P, bilateral matches are formed between the measures of buyers and sellers participating in that submarket (i.e., the buyers searching for homes at a given price point and the sellers

[3]Because of the interest rate and the absence of financial market frictions, households will not have any incentive in equilibrium to buy a home as a financial asset.

listing vacant homes at that same price). The measure of bilateral matches is governed by a constant returns to scale matching function, so that matching probabilities can be expressed as functions of the buyer-seller ratio, $\theta_t(P)$, termed *submarket tightness*. The matching probability for a buyer participating in submarket P at time t is denoted $\lambda(\theta_t(P))$, and the matching probability for a seller is $\gamma(\theta_t(P))$. The matching probabilities satisfy $\lambda(\theta) \in [0, 1]$, $\gamma(\theta) \in [0, 1]$, $\lambda'(\theta) < 0$, $\gamma'(\theta) > 0$ and $\gamma(\theta) = \theta\lambda(\theta)$.

Following a preference shock, we assume for simplicity that households sell their house back to a developer in the wholesale market. The developer can then supply it to the competitive rental market or frictional sales market.

Empty-homes-tax. Owners of homes determined to be *vacant* are subject to an empty-homes-tax (EHT). If applicable, the tax is calculated as a percentage, τ, of the value of a vacant home, totaling τV_t for period t. The EHT does not apply to principal residences and tenanted rentals. Importantly, there may also be an EHT exemption when a house changes ownership.[4] Owners on the supply side of the frictional market (i.e., developers) can therefore mitigate their vacancy tax obligations or even avoid it altogether by making strategic listing and rent-or-sell decisions. Nevertheless, there may be some uncertainty about how long it will take to sell and therefore whether the tax will ultimately be avoided when listing a home for sale in a frictional market. Rather than explicitly modeling these strategies, we will assume that developers pay only a fraction, $1 - \omega$, of the EHT, with $\omega \in [0, 1]$. Setting $\omega = 0$ corresponds to an environment in which every vacant home is subject to the full EHT. With $\omega = 1$, on the other hand, frictional vacancies are exempt from the tax.

Investors. Investors, like households, are long-lived with discount factor β. The measure of potential investors at time t, denoted I_t, grows at the same rate ν as the city's population of households so that the ratio of investors to households, $\phi = I_t/L_t$, remains constant over time. Investors do not need to or want to live in a house, but may nonetheless receive an

[4] In Vancouver, for example, the EHT does not apply in the year that a house changes ownership.

exogenous flow value from home ownership, denoted π_t at time t. Each individual investor's π_t follows a Markov process with transition function

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

This heterogeneity is designed to capture the idea that *some* investors may want to own a house as part of their financial portfolio or as a temporary store of wealth. It could be that home ownership provides a hedge against other sources of financial risk and/or the threat of wealth appropriation.[5] Regardless of the interpretation, sufficient heterogeneity in π_t results in some investors having a higher willingness to pay for a house than households, developers, and other investors.

Since an investor that owns a home does not live in the house, they can either rent it out[6] or be subject to the EHT.[7] Given the stochastic nature of π_t, home-ownership duration can be short and investors may want their investment to be liquid. For that reason, they may want to avoid the illiquidity associated with a home that is rented out (e.g., the time and possible legal costs associated with evicting a tenant in order to sell). We model this additional cost of being a landlord as an additional cost of leasing, ε_t, which is also heterogeneous over time and across investors: each investor's ε_t is an *iid* draw from distribution F_ε.[8]

Note that an investor purchasing a house need not undergo the search-and-matching process in the owner-occupied market since they are not shopping for the *right* house to live

[5]It could also be that some investors value home ownership more than others because they derive utility from it as a vacation property.

[6]We maintain the assumption that ϕ is small in the sense that there are fewer investor-landlords than there are renters. A suitable condition is $\phi \leq \nu + \psi$.

[7]Importantly, there is no vacancy tax exemption for investors. This means, for example, that investors cannot simply transfer the ownership of their homes amongst themselves every year in order to to circumvent the EHT. We view this assumption as reasonable given the (unmodeled) transaction costs associated with the transfer of home ownership. In fact, tax exemption because of the legal transfer of ownership requires proof of payment of the property transfer tax.

[8]Additional property management costs that an investor incurs as a landlord is another possible interpretation of ε_t since some investors may be non-local.

in and derive utility from. Instead, they buy from a developer in the competitive wholesale market. When an investor decides they no longer want to own the house, they could sell it back to a developer (or to another investor) in the wholesale market, or try to sell to an owner-occupier in the frictional market. We assume for simplicity that investors supply to the wholesale market.

3 Equilibrium

3.1 Equilibrium Values and Prices

For a developer, the value of a house in the competitive wholesale market reflects the option of renting it out or supplying it to the owner-occupied market:

$$V_t = \max\{x_t - m + \beta V_{t+1}, -(1-\omega)\tau V_t + \beta \max_P \gamma(\theta_t(P))P + (1-\gamma(\theta_t(P)))V_{t+1}\}, \tag{5}$$

where the first expression in curly brackets is the value of renting the house, and the second expression is the value of holding it vacant and listed for sale in the frictional market. The maximization operator in the second expression again reflects the directed nature of search in the owner-occupied market, and the function θ_t captures the perceived trade-off between price and submarket tightness. As the supply side of the market can freely choose between participation in the rental market and any submarket of the owner-occupied market, we must have indifference in equilibrium:

$$V_t = x_t - m + \beta V_{t+1} \tag{6}$$

and

$$V_t = -(1-\omega)\tau V_t + \beta \max_P \left[\gamma(\theta_t(P))P + (1-\gamma(\theta_t(P)))V_{t+1}\right]. \tag{7}$$

Equations (6) and (7) equate the value of a vacant home across rental and all active sub-markets of the owner-occupied market.

The free entry of competitive developers into housing construction constrains the value of a vacant home since newly constructed homes can be supplied to rental and owner-occupied markets:

$$q(H_t, L_t) \geq V_t. \tag{8}$$

Let 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. These values satisfy the following system of Bellman equations:

$$V_t^r = y - x_t + \beta V_{t+1}^r \tag{9}$$

$$V_t^b = y - x_t + \beta \max_P \lambda(\theta_t(P)) \left[V_{t+1}^n - P\right] + (1 - \lambda(\theta_t(P)))V_{t+1}^b \tag{10}$$

$$V_t^n = y - m + z + \beta \left\{(1-\delta)V_{t+1}^n + \delta \left[V_{t+1}^b + V_{t+1}\right]\right\}, \tag{11}$$

where the maximization operator in (10) reflects the directed search problem of a prospective buyer, and the function θ_t again captures the perceived trade-off between price and tightness. The value of buying, V_t^b, is just the present discounted value of lifetime consumption (income minus rent). The value of owning, V_t^n, on the other hand, takes into account current consumption (income minus maintenance costs), the utility benefit of owning the right house, z, and the discounted expected continuation value. This expected continuation value reflects the possibility of maintaining home-ownership status next period, which occurs with probability $1 - \delta$, as well as the possibility of being hit with the preference shock, which occurs with probability δ. When hit by the preference shock, the household's status changes from *owner* to *buyer* because they no longer value the housing services provided by their current house and therefore search for a new house to purchase. When this happens, they also experience a capital gain because they sell their current house in period $t + 1$ to a developer for the competitive price of V_{t+1} in the wholesale market.

As discussed above, both buyers and developers perceive a trade-off between the price and the matching probability (i.e., tightness) in the owner-occupied market. In equilibrium, this trade-off is pinned down by a version of the supply side indifference condition (7), even for out-of-equilibrium prices:

$$V_t = -(1-\omega)\tau V_t + \beta\left[\gamma(\theta_t(P))P + (1-\gamma(\theta_t(P)))V_{t+1}\right]. \tag{12}$$

When buyers direct their search to the set of homes listed at price P, they anticipate that the relative supply of houses is consistent with a buyer-seller ratio, $\theta_t(P)$, satisfying (12).

The directed search problem of a prospective home buyer is therefore the maximization problem in (10) subject to the supply side equation (12) to constrain the price-tightness pairs to those that would deliver exactly payoff V_t to participating developers:

$$\max_{\theta,P} \lambda(\theta)\left[V^n_{t+1} - V^b_{t+1} - P\right] \quad \text{s.t.} \quad V_t = -(1-\omega)\tau V_t + \beta V_{t+1} + \gamma(\theta)\beta\left[P - V_{t+1}\right].$$

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

$$\gamma(\theta_t) = \frac{[1+(1-\omega)\tau]V_t - \beta V_{t+1}}{\beta\left[P_{t+1} - V_{t+1}\right]} \tag{13}$$

$$P_{t+1} = \eta(\theta_t)V_{t+1} + (1-\eta(\theta_t))\left[V^n_{t+1} - V^b_{t+1}\right], \tag{14}$$

where $\eta(\theta) = \theta\gamma'(\theta)/\gamma(\theta) = 1 + \theta\lambda'(\theta)/\lambda(\theta)$. This solution is depicted in Figure 2 by the point of tangency between the buyer's indifference curve and the constraint set (i.e., the turquoise set of pairs, $\{\theta, P\}$, satisfying the seller's indifference curve).

Each investor, characterized by the current flow value of home ownership, π_t, and the additional cost of being a landlord, ε_t, decides first whether to buy a house. If they do buy a house, they then decide whether to rent it out or keep it empty. The present discounted

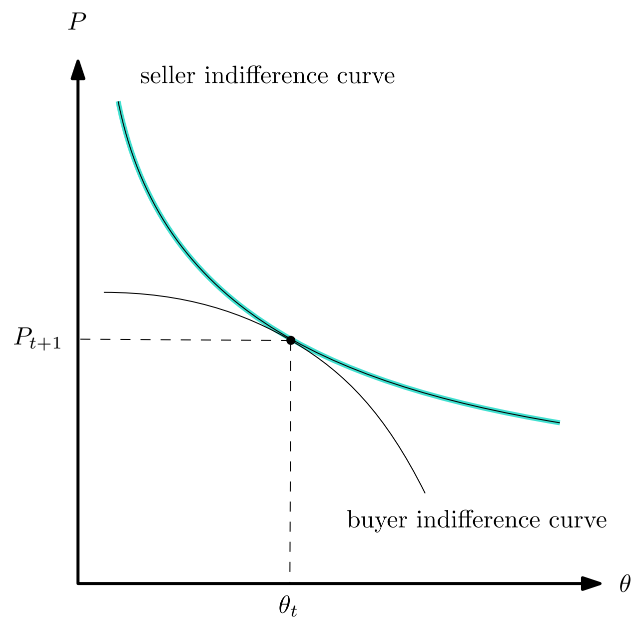


Figure 2: The Solution to the Directed Search Problem.

expected value of an investor satisfies

$$V_t^i(\pi_t, \varepsilon_t) = \max \big\{ \beta \mathbb{E}[V_{t+1}^i(\pi_{t+1}, \varepsilon_{t+1})], \\ \pi_t - V_t + \max\{x_t - m - \varepsilon_t, -\tau V_t\} + \beta \mathbb{E}[V_{t+1}^i(\pi_{t+1}, \varepsilon_{t+1}) + V_{t+1}] \big\} .$$

The first maximization operator reflects the decision of whether or not to buy a house in the wholesale market at a price of V_t from a developer. Conditional on owning a house in period t, the second maximization operator is the investor's choice of whether to rent out the house or keep it vacant. Because the market for vacant homes is competitive, the investor's decision problems are static. Buying/selling vacant homes and renting them out are choices that the investor makes period-by-period as π_t and ε_t evolve stochastically. To see this more clearly, we can rewrite Bellman equation (15) as follows:

$$V_t^i(\pi_t, \varepsilon_t) = \max \{0, \pi_t - V_t + \max\{x_t - m - \varepsilon_t, -\tau V_t\} + \beta V_{t+1}\} + \beta \mathbb{E}[V_{t+1}^i(\pi_{t+1}, \varepsilon_{t+1})].$$

Simplifying further using (6) yields

$$V_t^i(\pi_t, \varepsilon_t) = \max\{0, \pi_t - \min\{\varepsilon_t, (1+\tau)V_t - \beta V_{t+1}\}\} + \beta \mathbb{E}[V_{t+1}^i(\pi_{t+1}, \varepsilon_{t+1})]. \qquad (15)$$

The investor chooses home-ownership if the benefit, π_t, is sufficiently high:

$$\pi_t \geq \min\{\varepsilon_t, (1+\tau)V_t - \beta V_{t+1}\}.$$

Their house is rented out if the additional cost of being a landlord is sufficiently low:

$$x_t - m - \varepsilon_t \geq -\tau V_t \quad \Rightarrow \quad \varepsilon_t \leq -m + \tau V_t + x_t = (1+\tau)V_t - \beta V_{t+1}.$$

Figure 3 plots the optimal decisions of investors for different regions of the parameter space. The kinked orange line represents the locus of marginal investors that achieve the same surplus from owning a house as would any developer. Investors to the right of the orange line find it worthwhile to buy a house. Those in the top right-hand corner own vacant homes because they would find it too costly to rent them out.

3.2 Equilibrium Distributions of Households and Houses

When characterizing the equilibrium distributions of households and houses in period t, we exploit the fact that one household occupies one house. The measure of permanent renters or, equivalently, the measure of houses occupied by permanent renters evolves according to

$$H_{t+1}^r = H_t^r + \nu\psi L_t.$$

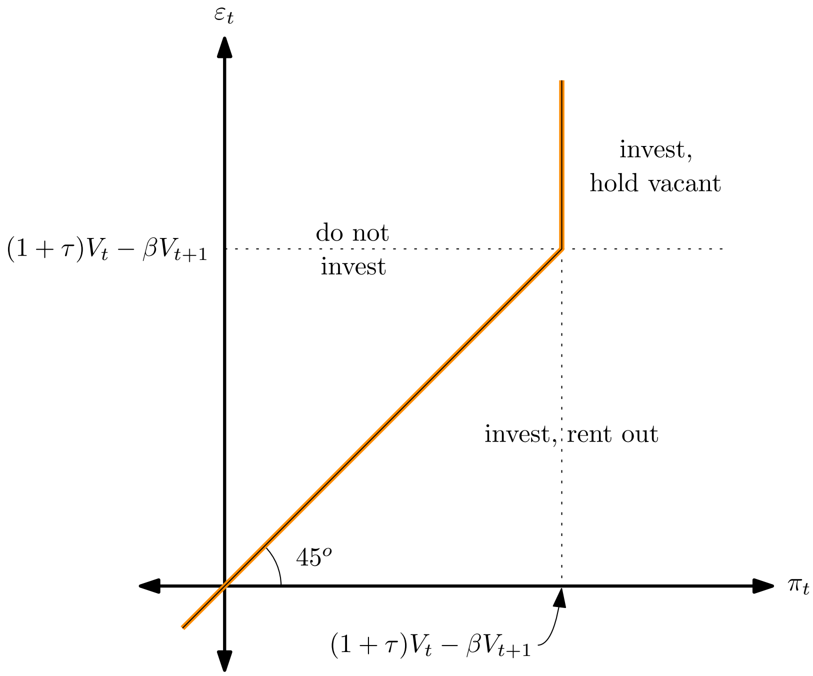


Figure 3: The Equilibrium Decisions of Investors.

Dividing all quantities by L_t and using lower-case letters to represent per capita values yields

$$h^r_{t+1} = \frac{1}{1+\nu} h^r_t + \frac{\nu\psi}{1+\nu}. \tag{16}$$

The measures of buyers/renters and owners evolve according to

$$\begin{aligned} H^b_{t+1} &= (1-\lambda(\theta_t))H^b_t + \delta H^n_t + \nu(1-\psi)L_t \\ H^n_{t+1} &= (1-\delta)H^n_t + \lambda(\theta_t)H^b_t, \end{aligned}$$

and the per-capita versions are

$$h^b_{t+1} = \frac{1-\lambda(\theta_t)}{1+\nu} h^b_t + \frac{\delta}{1+\nu} h^n_t + \frac{\nu(1-\psi)}{1+\nu} \tag{17}$$

$$h^n_{t+1} = \frac{1-\delta}{1+\nu} h^n_t + \frac{\lambda(\theta_t)}{1+\nu} h^b_t. \tag{18}$$

The per capita measure of homes vacant and for sale in the owner-occupied market is characterized by the directed search equilibrium level of market tightness:

$$h_t^f = \frac{h_t^b}{\theta_t}. \tag{19}$$

Finally, it follows from the analysis surrounding Figure 3 that the per-capita measure of homes held vacant by investors is

$$h_t^s = \phi[1 - F_\pi((1+\tau)V_t - \beta V_{t+1})][1 - F_\varepsilon((1+\tau)V_t - \beta V_{t+1})]. \tag{20}$$

The vacancies in (19) are *frictional* vacancies, whereas those in (20) are *speculative* vacancies.

Since houses can be constructed but not destroyed in the model, we have $H_t \geq H_{t-1}$ or, equivalently, $h_t(1+\nu) \geq h_{t-1}$, where

$$h_t = h_t^n + h_t^r + h_t^b + h_t^f + h_t^s \tag{21}$$

is the per capita measure of homes at time t. There is either a growing supply of housing in the economy with a binding free entry condition, or the supply of housing is constant and the free entry condition is slack. More formally, the free entry condition for developers along with housing market clearing can be expressed as[9]

$$q(h_t) \geq V_t \quad \text{and} \quad h_t(1+\nu) \geq h_{t-1} \tag{22}$$

with complementary slackness.

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

3.3 Equilibrium Definition

Definition 1 *Given an initial distribution* $\{h_0^r, h_0^b, h_0^n, h_0^f\}$*, an equilibrium is a sequence of values,* $\{V_t^r, V_t^b, V_t^n\}$*; a sequence of value functions,* $\{V_t^i(\pi, \varepsilon)\}$*; a sequence of house values and rents,* $\{V_t, x_t\}$*; a sequence of prices and functions for market tightness,* $\{P_t, \theta_t(P)\}$*; a sequence of housing stocks,* $\{h_t\}$*; and a sequence of distributions of houses/households,* $\{h_t^r, h_t^b, h_t^n, h_t^f, h_t^s\}$*; such that*

(i) household and investor values: $\{V_t^r, V_t^b, V_t^n\}$ *and* $\{V^i(\pi, \varepsilon)\}$ *satisfy* (9), (10), (11) *and* (15)*, taking house values* $\{V_t\}$*, rents* $\{x_t\}$*, and market tightness* $\{\theta_t(P)\}$ *as given;*

(ii) free entry in the rental market: $\{x_t\}$ *satisfies* (6)*;*

(iii) directed search in the sales market: $\{\theta_t(P)\}$ *satisfies* (12)*, and* $\{P_t\}$ *satisfies* (14) *given* $\{\theta_t = \theta_t(P_{t+1})\}$*;*

(iv) aggregation: $\{h_t, h_t^r, h_t^b, h_t^n, h_t^f, h_t^s\}$ *satisfy* (16), (17), (18), (19), *and* (20)*;*

(vi) free entry into housing development: $\{V_t, h_t\}$ *satisfy the inequalities in* (22) *with complementary slackness, given aggregation conditions* (21).

3.4 Equilibrium Balanced Growth Path

Along a balanced growth path (BGP) with population growth and hence new housing construction, house values and rental costs are constant. Conditions (8), (6) and (12) become

$$V = q(h) \tag{23}$$

$$x = (1 - \beta)V + m. \tag{24}$$

$$\gamma(\theta(P)) = \frac{(1 + (1 - \omega)\tau - \beta)V}{\beta(P - V)} \tag{25}$$

Equation (23) ties the value of a vacant house to the cost of construction. Equation (24) then pins down the rental cost of a housing unit. The equilibrium relationship between the price and submarket tightness in the owner-occupied market is established in (25) using the indifference condition for sellers/developers.

We can write stationary versions of Bellman equations (9), (10), and (11), and of the price equation (14):

$$(1-\beta)V^r = y - x \tag{26}$$

$$(1-\beta)V^b = y - x + \beta \max_P \lambda(\theta(P)) \left[V^n - V^b - P\right] \tag{27}$$

$$(1-\beta)V^n = y - m + z - \beta\delta \left[V^n - V^b - V\right], \tag{28}$$

$$P = \eta(\theta)V + (1-\eta(\theta))[V^n - V^b]. \tag{29}$$

Solving this system yields the following price equation for the owner-occupied market:

$$P = V + \frac{1-\eta(\theta)}{1-\beta(1-\delta-\eta(\theta)\lambda(\theta))} z. \tag{30}$$

The stationary version of (15) is

$$V^i(\pi,\varepsilon) = \max\{0, \pi - \min\{\varepsilon, (1+\tau-\beta)V\}\} + \beta\mathbb{E}[V^i(\pi',\varepsilon')]. \tag{31}$$

Imposing stationarity in (16), (17), (18), (19), (20) and yields

$$h^r = \psi \tag{32}$$

$$h^b = \frac{(\nu+\delta)(1-\psi)}{\nu+\delta+\lambda(\theta)} \tag{33}$$

$$h^n = \frac{\lambda(\theta)(1-\psi)}{\nu+\delta+\lambda(\theta)} \tag{34}$$

$$h^f = \frac{h^b}{\theta} \tag{35}$$

$$h^s = \phi[1-F_\pi((1+\tau-\beta)V)][1-F_\varepsilon((1+\tau-\beta)V))]. \tag{36}$$

Finally, the stationary version of the aggregation condition (21) is

$$h = h^r + h^b + h^n + h^f + h^s. \tag{37}$$

Definition 2 *An equilibrium balanced growth path 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,* $\{h^r, h^b, h^n, h^f, h^s\}$*; such that*

(i) V^r, V^b, V^n *and* V^i *satisfy* (26), (27), (28) *and* (31)*;*

(ii) free entry in the rental market: x *satisfies* (24)*;*

(iii) directed search: θ *satisfies* (25)*, and* P *satisfies* (30) *with* $\theta = \theta(P)$*;*

(iv) stationary distribution of houses/households: h^r, h^b, h^n, h^f *and* h^s *satisfy* (32), (33), (34), (35), *and* (36)*;*

(v) free entry into housing development: V *and* h *satisfy* (23) *and* (37)*.*

3.5 Analytical Results

We are interested in the implications of the empty-homes-tax, τV_t. To that end, we consider the implications of an increase in the EHT rate, τ, using the equilibrium BGP equations from Section 3.4.

There are two offsetting effects: First, an increase in the EHT rate, τ, reduces *speculative* vacancies, h^s. Using (36), this effect is most straightforward to show under the assumptions that $\xi_1 = 0$ (i.e, construction costs do not depend on the relative supply of housing) and $\omega = 1$ (i.e., frictional vacancies are fully exempt from the EHT):

$$\frac{dh^s}{d\tau} = -\phi V \left\{ \begin{array}{l} [1 - F_\pi((1+\tau-\beta)V)]\, f_\varepsilon((1+\tau-\beta)V) \\ \quad + [1 - F_\varepsilon((1+\tau-\beta)V)]\, f_\pi((1+\tau-\beta)V) \end{array} \right\} < 0. \tag{38}$$

Figure 4 depicts how an increase in τ reduces the set of investors that own empty homes. By discouraging the ownership of speculative vacancies, an increase in τ causes some investors to instead rent them out, while others abstain from acquiring them altogether.

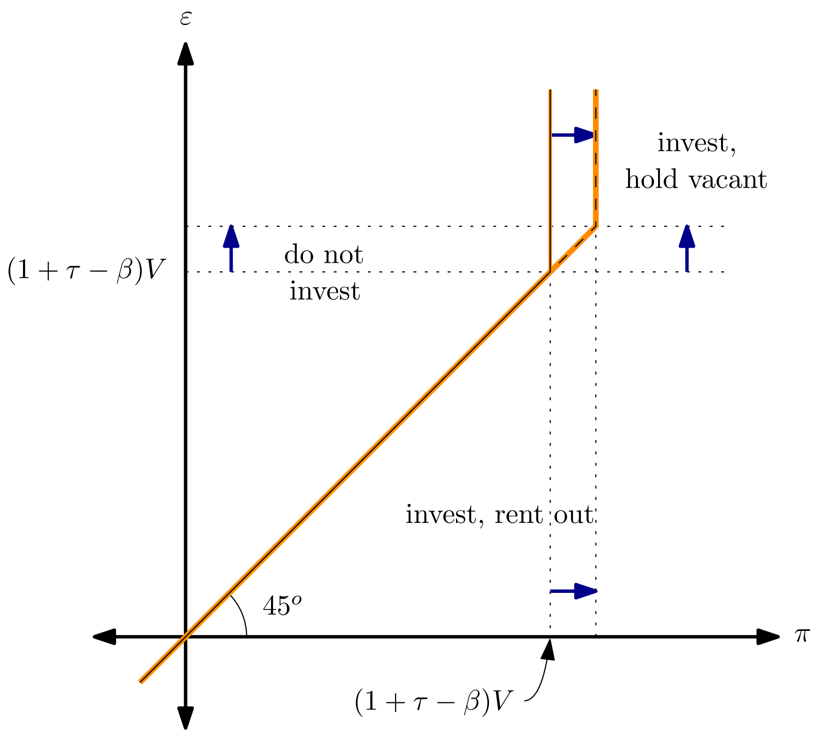


Figure 4: The Effect of τ on the Equilibrium BGP Decisions of Investors.

The second effect is a reduction in *frictional* vacancies when $\omega < 1$. This effect is again relatively straightforward to establish if we maintain the assumption that $\xi_1 = 0$. From (25) and (30), we have

$$\frac{d\theta}{d\tau} = \frac{(1-\omega)V}{\beta z} \frac{[1-\beta(1-\delta-\eta(\theta)\lambda(\theta))]^2}{\alpha(\theta)\eta(\theta)\lambda(\theta)\,[1-\beta(1-\delta-\lambda(\theta)]} > 0, \tag{39}$$

where

$$\alpha(\theta) \equiv 1 - \eta(\theta) - \frac{\theta\eta'(\theta)}{\eta(\theta)} = -\frac{\theta\gamma''(\theta)}{\gamma'(\theta)} > 0.$$

Equations (33) (36) then yield

$$\frac{dh^b}{d\tau} = -\frac{\lambda'(\theta)h^b}{\nu + \delta + \lambda(\theta)} \frac{d\theta}{d\tau} > 0 \tag{40}$$

and

$$\frac{dh^f}{d\tau} = -\frac{h^f}{\theta} \frac{\nu + \delta + \eta(\theta)\lambda(\theta)}{\mu + \delta + \lambda(\theta)} \frac{d\theta}{d\tau} < 0. \tag{41}$$

Given imperfect tax exemption for vacant homes listed for sale and the simplifying assumption that $\xi_1 = 0$, an increase in τ causes a reduction in frictional vacancies. More generally, the reduction in both speculative and frictional vacancies lowers the relative supply of housing, h. When $\xi_1 > 0$, this lowers the cost of housing development, since $q'(h) \geq 0$. In the absence of an empty homes tax, developers build more homes in equilibrium, some of which are sold to investors and left vacant, which raises construction costs. Increasing the EHT therefore makes it cheaper to build houses that can then be supplied to the rental market, making rental units more affordable.

The reduction in construction costs also affects housing affordability in the owner-occupied market for the same reason. An increase in τ, however, can also increase the price of owner-occupied homes, and reduce their relative availability in the owner-occupied market. Since developers can freely choose between supplying a home to the rental market and the owner-occupied market, an increase in the EHT applied to frictional vacancies means that vacant homes listed for sale command a higher price premium and a shorter expected time-to-sell, *ceteris paribus*. Given the matching technology, a shorter time-to-sell implies a longer time-to-buy. By distorting the incentives to supply homes to the owner-occupied market, the EHT shifts the equilibrium BGP composition of housing from owner-occupied to rental:

$$\frac{dh^n}{d\tau} = -\frac{dh^b}{d\tau} < 0. \tag{42}$$

In other words, the EHT can worsen both the affordability and availability of owner-occupied homes, despite lowering rents and increasing the supply of rental units.

These effects on owner-occupied homes are depicted in Figure 5 under the assumption once again that $\xi_1 = 0$ so as to isolate the distortionary effects of the EHT when $\omega < 1$. As can be seen in the Figure, an increase in τ shifts and stretches a developer's indifference cure upward. Because a house can always be supplied to the rental market which circumvents the EHT, the tax on vacant homes means that the owners of frictional vacancies need to be appropriately compensated. In the directed search framework, this compensation comes in two forms: a higher price and a higher tightness (i.e., shorter expected time-to-sell).

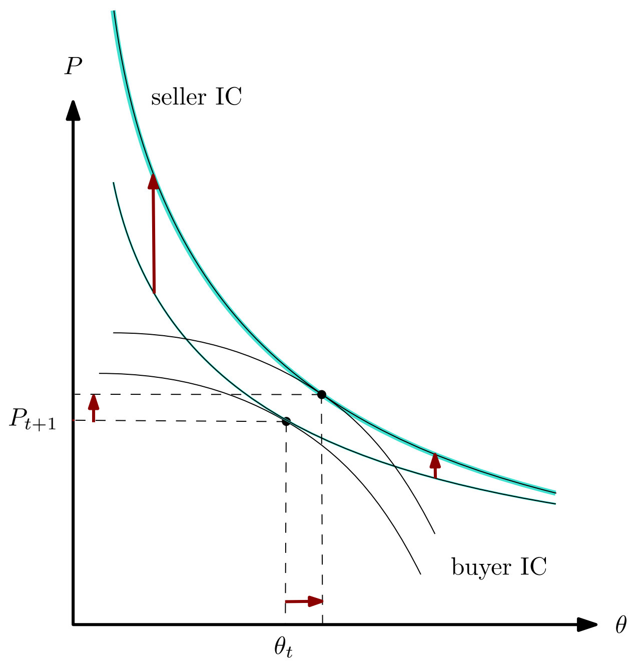


Figure 5: The Effect of τ on the Equilibrium BGP Decisions of Investors.

The overall effect on the equilibrium BGP price of owner-occupied housing is ambiguous. The lower construction cost that results from an increase in τ when $\xi_1 > 0$ means that the equilibrium wholesale market value of a house is lower, which brings down the price in the owner-occupied market, P. As discussed above and illustrated in Figure 5, an increase in τ can also put upward pressure on price P because it distorts the incentive to supply frictional vacancies when $\omega < 1$. These two effects thus have opposing forces on the affordability of owner-occupancy.

4 Discussion of the Modeling Assumptions

Model predictions about the effects of the empty-home-tax. In terms of the effects of the EHT rate, τ, the model yields predictions about prices, rents, price-rent ratio, listings, sales, rental transactions, vacancies, time-on-the-market, home-ownership, and new construction. Section 3.4 characterizes and defines the model's equilibrium BGP, and Section 3.5 discusses the comparative statics with respect to the EHT rate, τ. These provide theoretical insights about the *long-run* effects of the EHT. Earlier Sections 3.1, 3.2 and 3.3, on the other hand, characterize and define the dynamic equilibrium more generally. The off-BGP implications of τ are important here because the equilibrium outcomes like prices, sales, and listings may respond differently to the EHT in the short term than in the long term. Below, in Section 5, we parameterize the model and compute the transitional dynamics to a long-run BGP following the introduction of the empty-homes-tax, starting from an initial BGP with $\tau = 0$.

Income and wealth. The assumption that income is constant over time and across households is admittedly simplistic. With linear preferences and the assumption that the interest rate is $1/\beta$, households face no incentive to shift consumption intertemporally or accumulate wealth. This is a convenient feature of the model for tractability because households face risk in the frictional owner-occupied market (because of matching risk and preference shocks) which would complicate the consumption/savings problem of a household with curvature in their utility function. Extending the model to include income heterogeneity, non-linear utility and an endogenous wealth distribution could potentially be accomplished by assuming financial markets are complete (as in Head et al., 2023) or by exploiting block recursivity (as in Garriga and Hedlund, 2021). Income/wealth heterogeneity we think is an important extension: income has been widely cited as an important factor in home-ownership. Insights on whether an EHT would benefit lower income households would be important in a discussion of social welfare.

Selling while occupying. An assumption of the model is that a house must be vacant in order to be listed for sale in the owner-occupied market. Consequently, the value that an *unhappy* (or *mismatched*) homeowner assigns to home-ownership is just V_t, which is the financial value of a vacant house that could either be rented out or listed for sale in the owner-occupied market. This is the the amount that developers are willing to pay for a house. We could instead consider the possibility that mismatched owners could continue to live in their house and thus avoid rental costs while also trying to sell it in the owner-occupied market. In that case, the value of the house to its mismatched owner would exceed its financial value. By the same reasoning, perhaps mismatched homeowners as well as developers could rent out their house while it is listed for sale in the owner-occupied market. These modifications, however, would eliminate most vacancies in the model – all but those owned by investors with high maintenance costs. In other words, it would eliminate *frictional* vacancies, leaving only *structural* vacancies. The assumption that a house listed for sale must be vacant thus ensures that the search-and-matching frictions generate frictional vacancies in equilibrium.

EHT exemption when there is a change in ownership. The model environment assumes that every vacant home is subject to the EHT, but that developers only pay a fraction, $1-\omega$, of the tax. In Vancouver, the EHT does not apply in the year that a house changes ownership. Developers and households on the supply side of the market can therefore avoid or mitigate their vacancy tax obligations by making strategic listing and rent-vs-sell decisions. If developers in the model were completely exempt from the vacancy tax (i.e., if $\omega = 1$), parameter τ can still affect owner-occupied and rental markets because construction costs depend on the existing housing stock, which includes empty investor-owned homes.[10]

5 Model Simulation

The equilibrium BGP implications of the EHT derived in Section 3.5 may seem surprising because they are long-run effects that do not take into account the initial effect of turning speculative vacancies into tenanted and owner-occupied homes. We therefore numerically simulate the equilibrium transitional dynamics following an exogenous introduction of an EHT.

With a quarterly interpretation of the model's time periods, we parameterize the model to match several characteristics of a city's housing markets in the absence of an EHT. We then consider the implications of an exogenous increase in the empty-homes-tax rate by computing the equilibrium transition from an initial equilibrium BGP with $\tau = 0$ to a new equilibrium BGP with $\tau > 0$.

5.1 Distributional and Functional Form Assumptions

Suppose the matching function takes the following form:

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

Suppose the flow value of home ownership to an investor remains the same from one period to the next with probability $(1 - \rho)$, but otherwise is drawn anew from stationary distribution

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

[10]When construction costs are constant (i.e., $\zeta_1 = 0$) and developers are tax-exempt (i.e., $\omega = 1$), parameter τ does not affect the BGP at all except for the set of homes owned by investors. Of course, other equilibrium outcomes like prices, listings, and sales could be affected by τ off the BGP.

5.2 Parameterization of the Initial Equilibrium BGP

The parameter values and target values for the initial equilibrium BGP are reported in Table 1.

Table 1: Parameters

statistic	target value	parameter	parameter value
annual population growth rate (%)	1	ν	0.0025
annual household income (normalization)	1	y	0.2500
annual interest rate (%)	4	β	0.9902
five-year mobility rate of homeowners (%)	33	δ	0.0198
ownership rate (%)	63.6	ψ	0.3181
construction cost relative to house price (%)	21	ζ_0	2.2432
average rent to median income (ratio)	0.137	ζ_1	0.8722
average price to average rent (ratio)	23.36	m	0.0035
housing flow value implied by optimal m[11]		z	0.0081
share of homes owned by non-residents (%)	10	ϕ	0.1802
vacancy rate (%)	4.8	σ	0.1314
five-year turnover rate for non-residents (%)	67	ρ	0.1352

5.3 Equilibrium Transition Path with EHT

The initial equilibrium BGP does not feature an EHT (i.e., $\tau = 0$). We now consider the equilibrium transition path to a final equilibrium BGP following the unexpected introduction of an EHT. More specifically, we exogenously increase the EHT rate to a level that matches the current tax rate of 3 percent annually in Vancouver; that is, we set $\tau = 0.0075$ so that the EHT amounts to 3 percent of V_t annually. We present the results under the extreme assumption that there is no tax exemption for frictional vacancies (i.e., $\omega = 0$). Owners of homes that remain vacant while listed for sale in the frictional owner-occupied market bear

[11] See Head, Lloyd-Ellis and Sun (2014) page 1189 for details.

the full brunt of the EHT. For comparison purposes, we also show results under the opposite assumption: full EHT exemption for frictional vacancies (i.e. $\omega = 1$).

Computing the equilibrium transition path is complicated by the fact that the free entry condition for developers may not always bind (recall equation (22)). We therefore start with an initial guess, $\{h_t\}$ and hence $\{V_t\} = \{q(h_t)\}$, and solve backwards in time for rents, prices, tightness, values, and structural vacancies, $\{x_t, P_t, \theta_t, V_t^n, V_t^b, h_t^s\}$, using the first-order difference equations from Sections 3.1 and 3.2. The distribution of households and houses, $\{h_t^r, h_t^b, h_t^n, h_t^f\}$, are solved forwards in time. We then check market clearing period-by-period. If $h_{t+1}(1+\nu) < h_t$, we calculate what the value of a house in the wholesale market needs to be in order for the ownership decisions of investors to restore market clearing, $h_{t+1}(1+\nu) = h_t$. This generates a new series, $\{V_t\}$. These steps are repeated until the series of values converge.

5.4 Simulation Results

The implementation of the EHT induces some investors with vacant homes to sell them back to the wholesale market. This creates an excess supply of homes, which temporarily halts the construction of new housing and causes the value of a home in the wholesale market to fall below the cost of construction. The immediate fall in V_t coinciding with the introduction of the EHT is depicted in Figure 6b. Figure 6a displays how new construction falls to zero, but resumes four or five periods after the new tax.

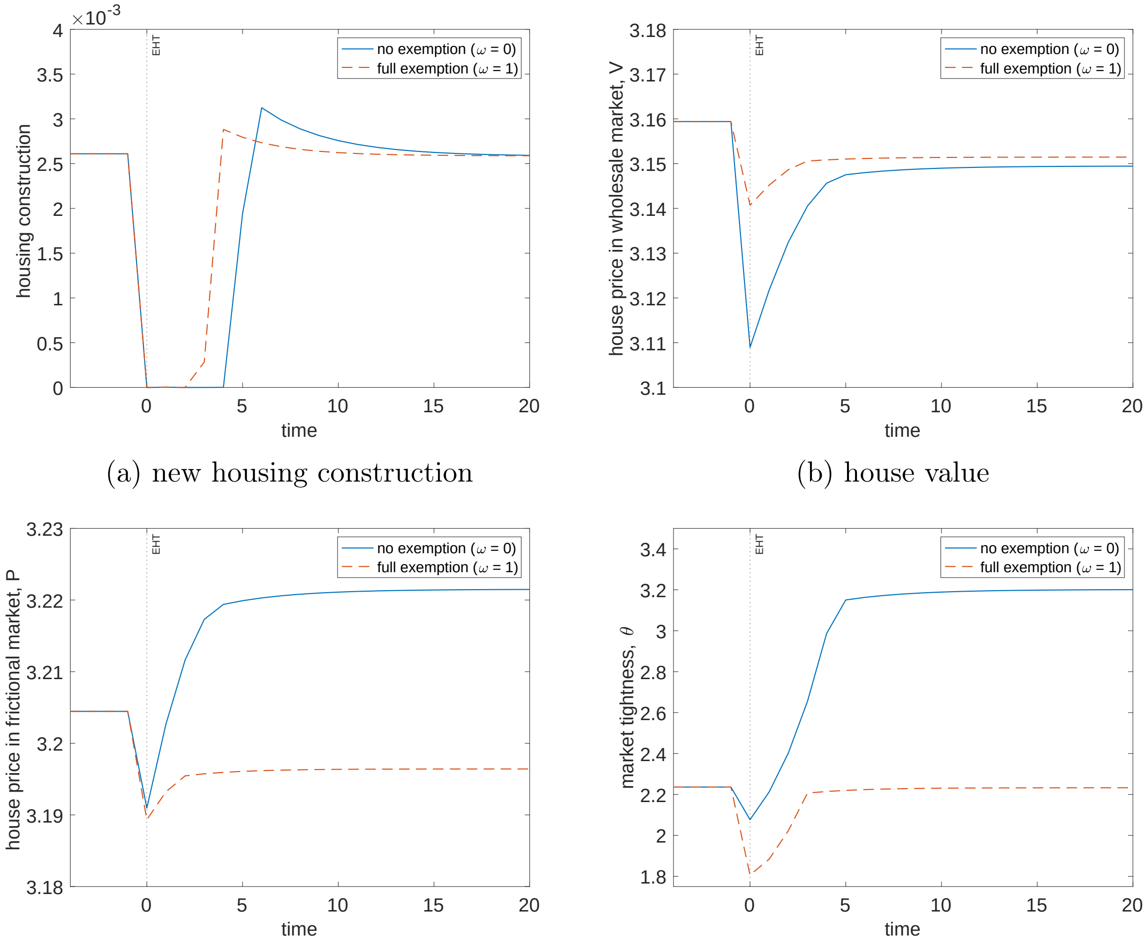
In the frictional owner-occupied market, the abundance of homes causes an immediate price decline (Figure 6c) and a fall in market tightness (Figure 6d). When frictional vacancies are not exempt from the policy (i.e., $\omega = 0$, both price and tightness ultimately converge to values above those in the initial BGP. The higher final price indicates that the distortionary effect of the EHT more than offsets the cost reduction. The distortionary effect is absent when frictional vacancies are fully exempt (i.e., $\omega = 1$), which is way the dashed red line converges to a final price that is lower than the initial price. A scenario in which frictional vacancies are not fully exempt from the tax is important for generating the result that price and tightness end up higher than before the introduction of the EHT. In such environments, a price premium and shorter expected time-to-sell compensate supply side participants for creating frictional vacancies. Consequently, owner-occupied homes become more scarce and expensive.

Both listings and sales increase immediately in response to the EHT (Figures 7a and 7c) as speculative vacancies are supplied to the owner-occupied market, but decline thereafter. Both frictional and speculative vacancies, as well as the overall stock of housing, ultimately decline in response to the EHT (Figures 7a, 7b and 7d), as predicted by the theory.

The stock of buyers falls slightly in the period following the implementation of the EHT (Figure **??**) because it becomes easier to buy a house when they are in abundance. After this initial decline, however, the relative measure of buyers increases and the measure of homeowners (Figure 8a) declines to the new stationary levels because frictional vacancies become scarce and it takes longer to find the right home to purchase. This transpires gradually because it takes time for homeowners to experience a preference shock and transition to buyer status. The stock of buyers continues to accumulate even after new housing construction resumes a few periods after the introduction of the EHT. This also explains why listings and hence sales start to increase along with the stock of buyers after period four or five in Figures 7a and 7c.

6 Data

Since the EHT in Vancouver requires an annual declaration of the status of each house, the City of Vancouver has information since 2017 about the share of homes that are vacant, exempt, tenanted, and occupied as a principal residence. The Empty Homes Tax Annual



(a) new housing construction

(b) house value

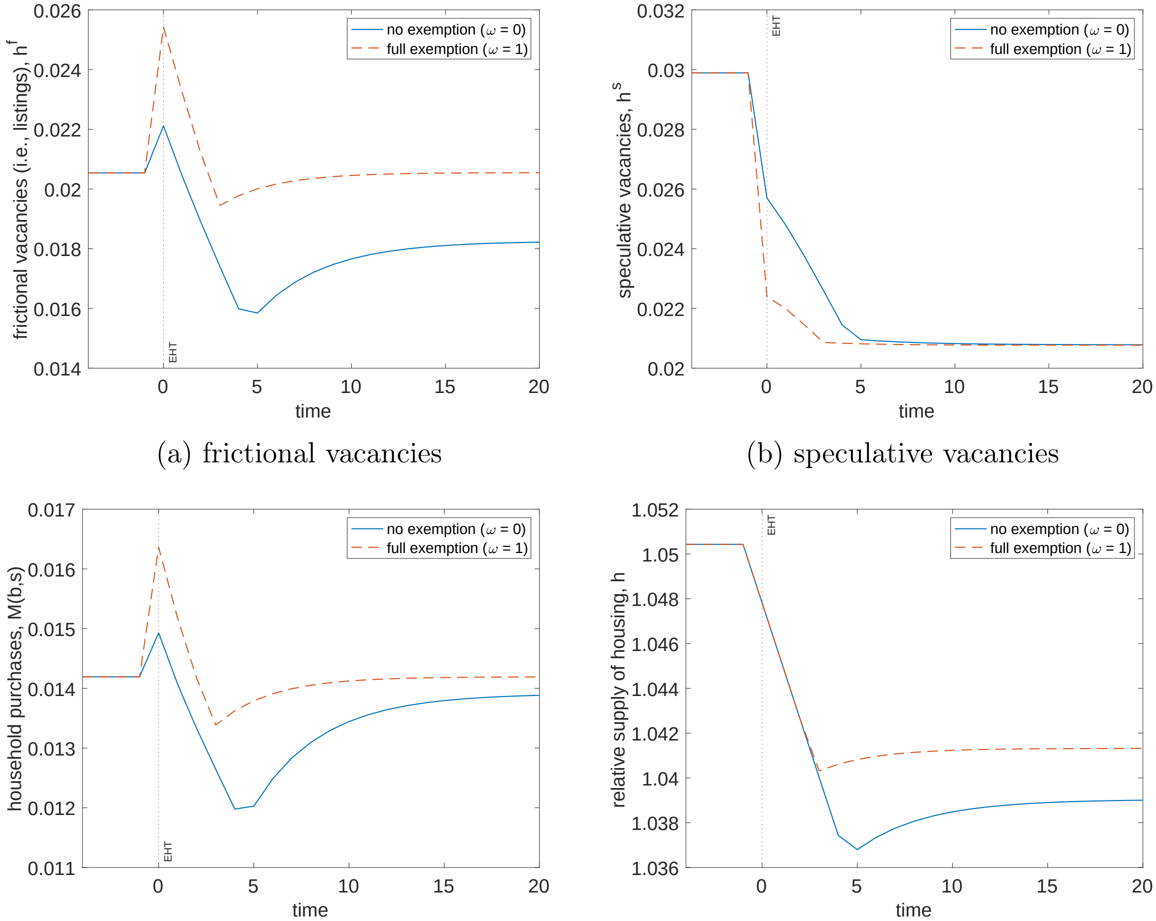
(c) house price

(d) market tightness

Figure 6: Equilibrium construction, house values, prices, and tightness in response to EHT.

Report (City of Vancouver, 2020) provides some summary statistics for the four years following the introduction of the EHT. Consistent with the empirical predictions of the model with less-than-full exemption, the City reported a decline in home-ownership from 70.6 percent in 2017 to 68.2 percent in 2020, and an increase in rentership from 25.2 percent in 2017 to 28.8 percent in 2020.

For our own empirical analysis, our transaction-level data include all residential home sales in the Greater Vancouver Regional District (GVRD) from 2014 to 2018. For each trans-



(a) frictional vacancies

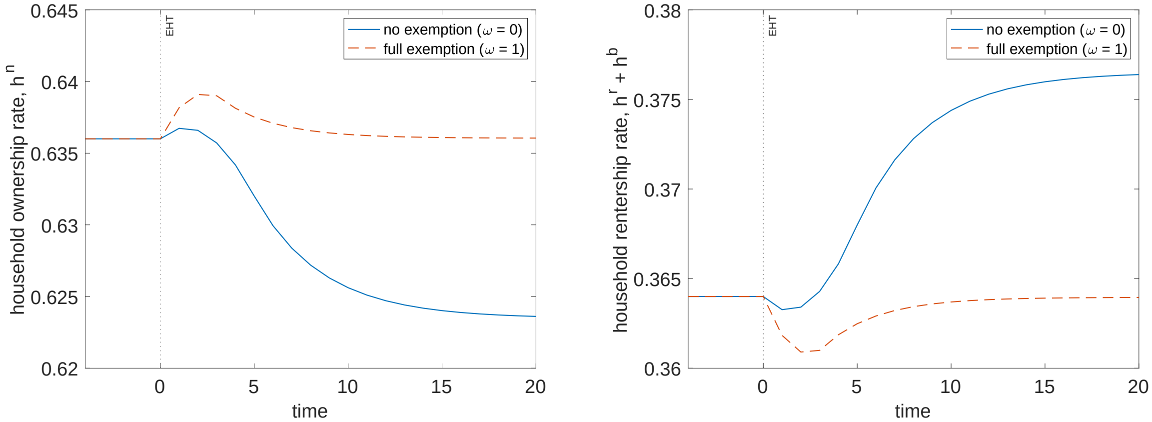
(b) speculative vacancies

(c) sales in frictional market

(d) housing supply

Figure 7: Equilibrium vacancies, sales, and housing supply in response to EHT.

action, we observe the sales price, listing date, transaction date, location (at the FSA level), and detailed housing characteristics. We can compare pre- and post-EHT housing market outcomes (e.g., listings, sales, prices) based on the announcement of Bill 28 in July, 2016, and the enactment of the EHT in November, 2016. We can further compare neighbouring FSAs across the Vancouver border to disentangle the EHT effects form other contemporaneous macro forces and accompanying government interventions, such as the Foreign Buyer Tax which came into effect around the same time, but affected the GVRD and not just the



(a) home-ownership rate

(b) rentership rate

Figure 8: Equilibrium ownership and rentership rates in response to EHT.

City of Vancouver.

7 Empirical Results

Figure 9 is a scatterplot of the FSAs within 5 kilometres of the Vancouver border. Each dot represents an FSA in the treated (i.e., within the Vancouver border) and non-treated (i.e., outside the Vancouver border)tregions by month, controlling for FSA-level fixed effects. The leftmost vertical dashed line represents the July 2016 announcement of Bill 28, and the rightmost dashed line represents the November 2016 enactment of the EHT. The pre-EHT period features intricate patterns, but no notable difference between the two regions. During the intervening period, there are more new listings in Vancouver than just outside Vancouver, and the difference is statistically significant. This reverses for the longer-term trend. From the perspective of the model, there are most listings in Vancouver as speculative vacancies are supplied to the market to avoid the tax, but fewer listings thereafter because the EHT distorts the incentive to supply frictional vacancies.

The same patterns emerge for home sales in Figure 10. More specifically, there is no clear difference between the two regions for the EHT, but an immediate but temporary increase in sales in the intervening period. The subsequent relative decline in Vancouver home sales could again reflect the distortionary effects of the tax.

The pattern is less clear for home sales prices, plotted in Figure 11. A more rigorous difference-in-differences analysis could potentially help to identify the effects of the EHT. Recall from the model, however, that the tax can create two price effects that work in opposite directions, making it challenging to find and estimate the overall effect.

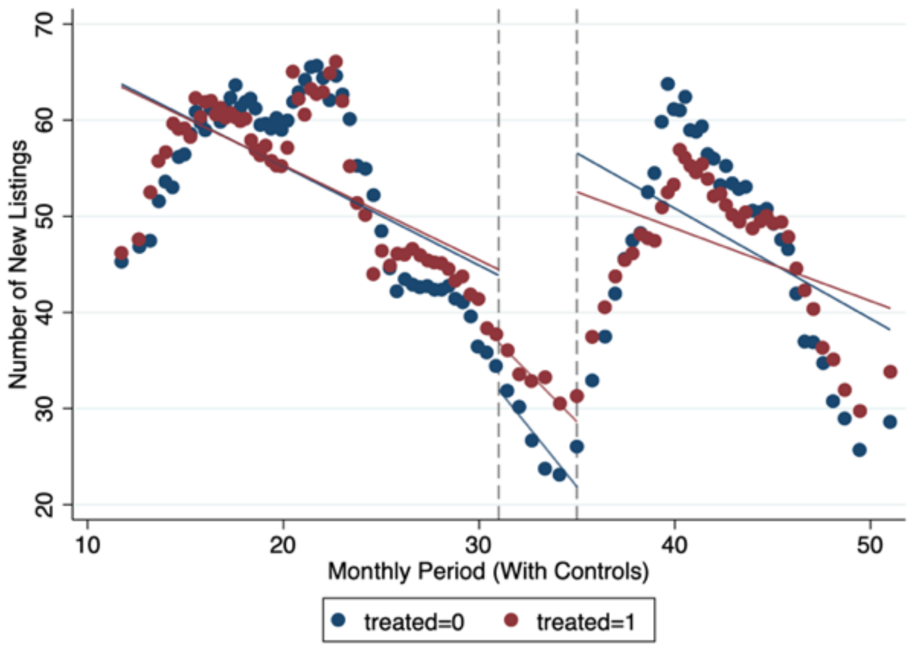


Figure 9: new listings

8 Conclusion

We develop a model that captures the effects of an empty homes tax on the rental market, the owner-occupied market, and new housing construction. Our model offers two key insights. First, an EHT turns speculative vacancies into more affordable tenanted rentals, which

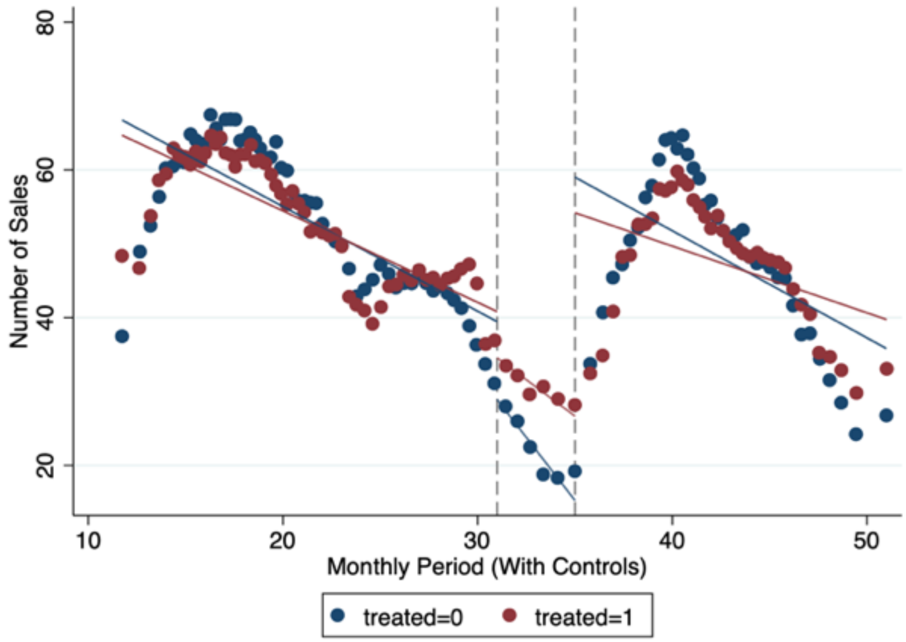


Figure 10: sales

represents an improvement in housing availability and affordability. Second, the vacancy tax can distort the incentives to supply homes to the owner-occupied market, which can worsen housing affordability and reduce home-ownership.

Our calibration and simulation reveals that the effects of the policy can differ initially from the longer-term effects because markets take time to absorb the initial increase in housing supply set off by investors' response to the EHT. Preliminary empirical analysis of the effects of Vancouver's empty homes tax on housing market outcomes suggests that the evidence aligns to some extent with the short- and long-term predictions of the theory.

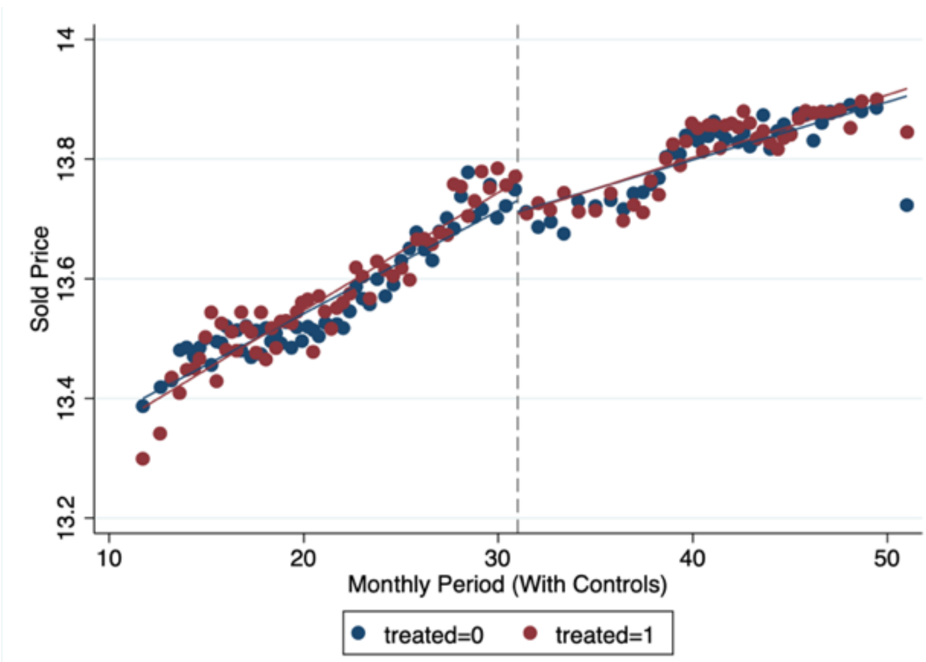


Figure 11: transaction prices

References

Abramson, B., T. Landvoigt, M. Piazzesi, and M. Schneider. Search to rent or search to own: Housing market churn in the cross section of cities. Technical report.

Arnott, R. (1989). Housing vacancies, thin markets, and idiosyncratic tastes. *The Journal of Real Estate Finance and Economics 2*(1), 5–30.

Buchak, G., G. Matvos, T. Piskorski, and A. Seru (2020). Why is intermediating houses so difficult? evidence from ibuyers. Technical report, National Bureau of Economic Research.

City of Vancouver (2020). Empty homes tax annual report. Technical report, Housing Vancouver.

Favilukis, J. and S. Van Nieuwerburgh (2021). Out-of-town home buyers and city welfare. *The Journal of Finance 76*(5), 2577–2638.

Garriga, C. and A. Hedlund (2020, June). Mortgage debt, consumption, and illiquid housing markets in the great recession. *American Economic Review 110*(6), 1603–34.

Garriga, C. and A. Hedlund (2021). Housing finance, boom-bust episodes, and macroeconomic fragility. Technical report.

Halket, J. and M. P. M. di Custoza (2015). Homeownership and the scarcity of rentals. *Journal of Monetary Economics 76*, 107–123.

Head, A., H. Lloyd-Ellis, and D. Stacey (2023). Heterogeneity, frictional assignment and home-ownership. *International Economic Review*.

Head, A., H. Lloyd-Ellis, and H. Sun (2014). Search, liquidity, and the dynamics of house prices and construction. *American Economic Review 104*(4), 1172–1210.