# Flipping Houses in a Decentralized Market: Liquidity, Price Dispersion, and Misallocation

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**Abstract**

This paper studies housing markets as decentralized asset markets with specialized intermediaries who hold inventory and post prices. Using a general equilibrium search framework with heterogeneous household valuations, the model links three central features of housing transactions—price dispersion, turnover, and intermediary margins—to a common structural object: the curvature of the cross-sectional distribution of valuations.

The model delivers a closed-form characterization of equilibrium pricing wedges in terms of inverse hazard rates of household valuations, providing a tractable mapping between the shape of the transaction price distribution and the incentives of intermediaries. This characterization highlights a fundamental trade-off between liquidity provision and allocative efficiency. By holding inventory, intermediaries increase trading opportunities and reduce time-to-trade, but simultaneously remove housing from final users, generating misallocation when high-valuation households are rationed out of ownership.

The framework is estimated using comprehensive transaction-level data from the Irish housing market. Stationary moments discipline the meeting technology, valuation heterogeneity, and intermediary inventory costs, while an unanticipated reform to resale taxation provides an out-of-sample test of the model's transition dynamics. The model accounts for both the level and dispersion of prices, the prevalence of intermediary trades, and the dynamic response of turnover and price dispersion following the policy change.

The results imply that policies targeting intermediary margins, such as transaction and resale taxes, primarily affect market outcomes through endogenous adjustments in inventory and liquidity rather than through direct effects on prices. More broadly, the wedge characterization suggests that predictable patterns of price dispersion and trading volume in decentralized asset markets are governed by the underlying heterogeneity of market participants rather than by asset-specific features alone.

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# 1 Introduction

Residential housing markets exhibit three striking features: substantial price dispersion for observationally similar properties, low transaction frequency, and a nontrivial role for specialized intermediaries who buy and resell housing over short horizons. These features mirror those documented in over-the-counter (OTC) financial markets, where decentralized trade, heterogeneous valuations, and inventory-holding intermediaries generate persistent bid–ask spreads and endogenous liquidity. This paper develops a general equilibrium search model that brings the core mechanisms of OTC intermediation to the housing market and uses comprehensive transaction-level data to quantify their implications for prices, turnover, and welfare.

The model builds on the canonical framework of Duffie, Gârleanu, and Pedersen (2005, 2007), in which trade occurs through bilateral meetings and intermediaries optimally post prices and manage inventory. I extend this framework to a durable, utility-yielding asset by introducing heterogeneous household valuations for housing and a fixed housing stock. Within this environment, households follow cutoff trading strategies, and intermediaries choose acceptance regions on both sides of the market to maximize the value of holding inventory. Equilibrium prices and trading intensities are jointly determined with the cross-sectional distribution of ownership and valuations.

The paper's main theoretical result is a closed-form characterization of the equilibrium pricing wedge. I show that the bid–ask spread can be expressed as the sum of two inverse-hazard objects of the valuation distribution evaluated at the endogenous buyer and seller cutoffs. This characterization implies that the shape of the transaction price distribution—its dispersion and tail behavior—is governed by the curvature of household heterogeneity rather than by the details of the matching technology. The result yields testable restrictions that connect observed price tails and intermediary margins to structural primitives of the model.

The framework also highlights a liquidity–misallocation trade-off inherent in intermediary-based markets. By holding inventory, intermediaries increase meeting rates and reduce expected time-to-trade, improving market liquidity. At the same time, inventory held by intermediaries is not allocated to households who derive direct utility from housing, generating misallocation when high-valuation households are rationed out of ownership. Policies that target intermediary margins, such as transaction or resale taxes, therefore operate primarily through endogenous adjustments in inventory and trading intensity rather than through direct price effects.

I estimate the model using the universe of residential property transactions in Ireland, a setting that combines comprehensive administrative data with a discrete change in the tax treatment of short-term resales. Stationary moments discipline the meeting technology, valuation heterogeneity, and intermediary inventory costs. The policy reform provides an out-of-sample dynamic restriction: the model's predicted transition path for intermediary activity, turnover, and price dispersion following an unanticipated change in resale incentives. The model accounts for both the stationary cross-section and the observed adjustment dynamics.

This paper contributes to several literatures. First, it adds to the OTC asset market literature by extending inventory-based intermediation to a large, decentralized market for a real, utility-yielding asset. Second, it complements the housing search literature by shifting the focus from bilateral bargaining between households to price posting and inventory management by specialized intermediaries. Finally, it relates to a growing macroeconomic literature on asset market liquidity and misallocation, which studies how trading frictions shape the allocation and pricing of durable assets.

The remainder of the paper is organized as follows. Section **??** describes the environment and equilibrium. Section 4 discusses identification and estimation. Section 5 presents the data and institutional setting. Section 6 reports the quantitative results. Section 7 concludes.

# 2 Institutional Background and Data

## 2.1 Institutional Background: Transaction Taxes and Intermediation in Ireland

Residential property transactions in Ireland are subject to a stamp duty that is levied at the time of sale. During the period preceding 2011, transactions involving short-term resales by intermediaries were subject to an additional ad valorem tax, effectively increasing the cost of holding housing inventory for market participants engaged in intermediary activity. At the beginning of 2011, this tax was permanently eliminated.

Formally, I model the policy as a sales tax $\tau \in [0, 1)$ levied on the resale leg of intermediary transactions. When an intermediary sells a property at price $P_1$, it receives net proceeds $(1 - \tau)P_1$, while the household buyer pays the gross price $P_1$. The tax does not apply to transactions in which a household sells directly to another household. In the model, this policy maps into the intermediary's continuation value by reducing the effective payoff from successful resale, thereby altering the incentives to acquire and hold housing inventory.

The reform is treated as an unanticipated and permanent change in the tax regime from $\tau^{old} > 0$ to $\tau^{new} = 0$ at time $t = 0$. This interpretation reflects the institutional design of the policy and allows the reform to be used as a source of identifying variation for the model's transition dynamics.

## 2.2 Data and Sample Construction

The empirical analysis uses comprehensive transaction-level data covering the universe of residential property sales in Ireland. Each observation records the transaction date, sale price, property characteristics, and anonymized identifiers for buyers and sellers. The data allow properties to be tracked over time, enabling the construction of holding durations and the identification of sequential transactions involving the same unit.

The sample is restricted to arm's-length residential transactions. Observations with missing prices or incomplete property identifiers are excluded. Prices are expressed in logarithms and, where indicated, residualized using property fixed effects and location-by-time fixed effects to isolate variation attributable to market conditions rather than observable quality differences.

## 2.3 Identification of Intermediaries

Intermediaries ("flippers") are identified as market participants who engage in short-term resale activity. Specifically, an agent is classified as an intermediary if it purchases a property and resells the same unit within a predefined holding window $T$, measured in months. The baseline analysis sets $T$ to [e.g. 12 months], and robustness checks consider alternative thresholds.

This classification allows the construction of transaction sequences of the form

$$\text{Household} \rightarrow \text{Intermediary} \rightarrow \text{Household},$$

which correspond directly to the two-leg intermediation channel in the model. The fraction of

Table 1: Mapping Between Model Parameters and Empirical Moments

| Parameter | Economic Interpretation | Targeted Empirical Moment |
|---|---|---|
| $f$ | Mass of intermediaries | Intermediary share of transactions |
| $\Lambda_A, \Lambda_B$ | Meeting intensities | Market turnover, hazard of sale |
| $c$ | Inventory holding cost | Distribution of intermediary holding durations |
| Parameters of $g(\delta)$ | Valuation heterogeneity | Price dispersion, skewness, percentile spreads |
| $\gamma$ | Preference shock rate | Household holding duration (non-intermediated) |

transactions involving intermediaries and the distribution of intermediary holding durations provide empirical counterparts to the model's intermediary mass $f$ and inventory dynamics.

## 2.4 Stylized Facts

Three empirical patterns motivate the structure of the model and guide parameter identification.

First, intermediaries account for a nontrivial and time-varying share of housing transactions. The fraction of purchases and sales involving intermediaries increases sharply following the 2011 reform, and the incidence of two-leg transactions within short holding windows rises correspondingly. These patterns map directly into the model's intermediary participation rate and meeting intensities.

Second, housing markets exhibit substantial and persistent price dispersion. Even after controlling for observable property characteristics and location-by-time fixed effects, the cross-sectional distribution of transaction prices displays significant variance and positive skewness. These moments discipline the model's cross-sectional distribution of household valuations and its implications for equilibrium price wedges.

Third, holding durations differ systematically across transaction types. Properties transacted through intermediaries exhibit substantially shorter holding periods than properties traded directly between households. This feature provides information about the effective cost of inventory and the strength of intermediary incentives to intermediate.

## 2.5 Moments and Mapping to Model Parameters

The estimation strategy exploits a set of moments that map transparently into structural parameters. Table 2 summarizes this correspondence.

The parameters $\Lambda_A$ and $\Lambda_B$ are normalized such that one meeting intensity is set to unity and the other is estimated. The preference-shock rate $\gamma$ is calibrated to match average household holding durations in transactions not involving intermediaries. The remaining parameters are estimated using a simulated method of moments that matches the joint behavior of intermediary activity, price dispersion, and market turnover in the pre-reform period.

## 2.6 Reform-Based Validation

The elimination of the intermediary resale tax in 2011 is used as an out-of-sample validation of the model's transition dynamics. Starting from the estimated pre-reform steady state, I simulate the unanticipated change in the tax regime and compute the implied adjustment paths for intermediary inventories, trading volume, and the distribution of prices. These simulated paths are compared to their empirical counterparts in the post-reform data. The ability of the model to replicate the magnitude and timing of these transitions provides an external discipline on the structural interpretation of the estimated parameters.

# 3 Model

## 3.1 Environment and Timing

**Time.** Time is continuous, $t \in [0, \infty)$. All agents discount future payoffs at a constant rate $r > 0$.

**Goods.** There are two goods:

1. A non-storable consumption good, which serves as the numéraire.
2. An indivisible housing asset, denoted by $q \in \{0, 1\}$.

The aggregate supply of housing is fixed and normalized to $s \in (0, 1)$. Housing does not depreciate and is homogeneous.

**Agents.** The economy consists of two types of agents:

1. A unit mass of households indexed by a valuation state $\delta \in [0, \bar{\delta}]$.
2. A mass $f \geq 0$ of intermediaries.

Each household can hold at most one unit of housing. Each intermediary can also hold at most one unit of housing. Short-selling of housing is not allowed.

**Preferences.** Households derive flow utility from housing according to

$$u(q, \delta) = q \cdot \delta, \tag{1}$$

and are risk-neutral with respect to the consumption good.

Intermediaries do not derive direct utility from housing or consumption. Their objective is to maximize the expected discounted value of net transfers from trade, subject to inventory constraints.

**Information.** Household valuations $\delta$ are privately observed by households. The cross-sectional distribution of valuations, denoted by $G(\delta)$ with associated density $g(\delta)$, is common knowledge. Ownership states $q \in \{0, 1\}$ are publicly observed.

**Valuation Dynamics.** Household valuations evolve according to a Poisson jump process. With intensity $\gamma > 0$, a household's valuation is redrawn from the distribution $G(\delta)$. Between shocks, $\delta$ remains constant.

**Matching Technology.** Agents meet bilaterally and randomly. Meetings occur according to independent Poisson processes. At each meeting, one agent owns a house and the other does not.

Let $H_0(\delta, t)$ and $H_1(\delta, t)$ denote the cross-sectional density of households at time $t$ with valuation $\delta$ who do not own and who own a house, respectively. Let $F_1(t)$ denote the mass of intermediaries who hold a house at time $t$, and let $F_0(t) = f - F_1(t)$ denote the mass of intermediaries without a house.

Define the mass of non-owning households as

$$m_0(t) = \int_0^{\bar{\delta}} H_0(\delta, t)\, d\delta, \tag{2}$$

and the mass of owning households as $1 - m_0(t)$.

Households who do not own a house meet intermediaries who own a house at rate

$$\lambda_0(t) = \Lambda_A F_1(t), \tag{3}$$

and households who own a house meet intermediaries who do not own a house at rate

$$\lambda_1(t) = \Lambda_B F_0(t). \tag{4}$$

Here, $\Lambda_A > 0$ and $\Lambda_B > 0$ are meeting intensity parameters governing the speed of buyer-side and seller-side matching, respectively.

From the perspective of intermediaries, those who own a house meet non-owning households at rate

$$\lambda_{F1}(t) = \Lambda_A m_0(t), \tag{5}$$

while those who do not own a house meet owning households at rate

$$\lambda_{F0}(t) = \Lambda_B \big(1 - m_0(t)\big). \tag{6}$$

**Contracting Protocol.** When a household and an intermediary meet, the intermediary makes a take-it-or-leave-it price offer. The household either accepts or rejects the offer. When two households meet, trade occurs according to a symmetric Nash bargaining protocol. The details of price determination are specified in Section 3.3.

**State Variables.** The aggregate state of the economy at time $t$ is given by the tuple

$$\mathcal{S}(t) = \big(H_0(\cdot, t),\, H_1(\cdot, t),\, F_1(t)\big). \tag{7}$$

Given $\mathcal{S}(t)$, all meeting rates, acceptance probabilities, prices, and continuation values are determined endogenously.

**Feasibility.** At all times, the housing market must satisfy the aggregate feasibility constraint

$$\int_0^{\bar{\delta}} H_1(\delta, t)\, d\delta + F_1(t) = s. \tag{8}$$

The consumption good is in perfectly elastic supply and serves only to facilitate transfers across agents.

**Within-Period Timing.** At each instant in continuous time, the following sequence of events applies:

1. Each agent holds a state $(q, \delta)$.
2. With intensity $\gamma$, a household receives a valuation shock and draws a new $\delta$ from $G(\cdot)$.
3. With intensities given by the matching technology, agents meet bilaterally.
4. If a meeting occurs, a price is proposed according to the contracting protocol. The household decides whether to accept.
5. If trade occurs, housing ownership and consumption transfers are updated.
6. Agents continue to the next instant.

This timing structure implies that household and intermediary optimization problems admit Hamilton–Jacobi–Bellman representations, which are developed in the following subsections.

## 3.2 Households

Households differ in their valuation state $\delta \in [0, \bar{\delta}]$ and in their housing ownership status $q \in \{0, 1\}$. Let $V_q(\delta, t)$ denote the value at time $t$ of a household with valuation $\delta$ and ownership status $q$.

### 3.2.1 Hamilton–Jacobi–Bellman Equations

For $t \geq 0$, the household value functions satisfy the HJB system

$$rV_0(\delta, t) = \frac{\partial}{\partial t} V_0(\delta, t) + \lambda_0(t)\, \mathbf{1}\{\delta \geq x(t)\}\Big(V_1(\delta, t) - V_0(\delta, t) - P_1(t)\Big) + \gamma\Big(\bar{V}_0(t) - V_0(\delta, t)\Big), \tag{9}$$

$$rV_1(\delta, t) = \delta + \frac{\partial}{\partial t} V_1(\delta, t) + \lambda_1(t)\, \mathbf{1}\{\delta \leq y(t)\}\Big(V_0(\delta, t) - V_1(\delta, t) + P_0(t)\Big) + \gamma\Big(\bar{V}_1(t) - V_1(\delta, t)\Big), \tag{10}$$

where $P_1(t)$ is the ask price posted by intermediaries (relevant for non-owning households), $P_0(t)$ is the bid price posted by intermediaries (relevant for owning households), and the endogenous cutoffs $x(t)$ and $y(t)$ characterize acceptance decisions in equilibrium. The terms

$$\bar{V}_q(t) \equiv \int_0^{\bar{\delta}} V_q(\delta', t)\, g(\delta')\, d\delta', \qquad q \in \{0, 1\}, \tag{11}$$

denote expectations over the valuation redraw distribution.

The indicator structure in (9)–(10) reflects that households trade only when the proposed price makes them weakly better off than rejecting the offer. In equilibrium, this generates cutoff rules derived below.

### 3.2.2 Surplus from Owning and Monotonicity

Define the household surplus from owning a house:

$$\Delta V(\delta, t) \equiv V_1(\delta, t) - V_0(\delta, t). \tag{12}$$

Subtracting (9) from (10) yields

$$r\,\Delta V(\delta, t) = \delta + \frac{\partial}{\partial t}\Delta V(\delta, t) + \lambda_1(t)\,\mathbf{1}\{\delta \le y(t)\}\Big(P_0(t) - \Delta V(\delta, t)\Big) + \lambda_0(t)\,\mathbf{1}\{\delta \ge x(t)\}\Big(\Delta V(\delta, t) - P_1(t)\Big)$$
$$+ \gamma\Big(\overline{\Delta V}(t) - \Delta V(\delta, t)\Big), \tag{13}$$

where $\overline{\Delta V}(t) \equiv \int_0^{\bar{\delta}} \Delta V(\delta', t)\, g(\delta')\, d\delta'$.

**Lemma 1** (Monotonicity of $\Delta V$)**.** *Fix $t$ and suppose $P_0(t)$ and $P_1(t)$ are finite. Then $\Delta V(\delta, t)$ is weakly increasing in $\delta$. Moreover, if $\lambda_0(t) + \lambda_1(t) > 0$ and $g$ has full support on $[0, \bar{\delta}]$, then $\Delta V(\delta, t)$ is strictly increasing in $\delta$.*

*Proof.* Consider two valuation states $\delta' > \delta$. The only term in (13) that depends directly on $\delta$ is the flow payoff $\delta$. All other terms depend on $\Delta V(\delta, t)$ but not directly on $\delta$. Under the maintained assumptions, the surplus equation (13) is affine in $\delta$ with a strictly positive coefficient on $\delta$, while the remaining terms are (weakly) monotone in $\Delta V(\delta, t)$.

Formally, fix $t$ and define an operator $\mathcal{T}$ that maps a candidate function $\Delta(\cdot)$ into the right-hand side of (13). The operator preserves ordering: if $\Delta_1(\delta) \le \Delta_2(\delta)$ for all $\delta$, then $\mathcal{T}\Delta_1(\delta) \le \mathcal{T}\Delta_2(\delta)$ for all $\delta$, since the terms involving $\Delta$ enter with weakly negative coefficients after moving them to the left-hand side. Since the flow payoff $\delta$ is increasing in $\delta$, any fixed point of (13) must inherit this monotonicity. Strict monotonicity follows from standard comparison arguments when $\lambda_0(t) + \lambda_1(t) > 0$ and the valuation redraw process has full support, which implies that a higher $\delta$ strictly raises the expected flow payoff and thus strictly raises the continuation surplus. $\square$

Lemma 1 implies that the net gain from ownership satisfies a single-crossing property in $\delta$.

### 3.2.3 Cutoff Trading Rules

Consider a non-owning household ($q = 0$) that meets an intermediary holding a house and is offered price $P_1(t)$. The household accepts if and only if

$$V_1(\delta, t) - P_1(t) \ge V_0(\delta, t) \qquad \Longleftrightarrow \qquad \Delta V(\delta, t) \ge P_1(t). \tag{14}$$

Similarly, an owning household ($q = 1$) offered price $P_0(t)$ accepts the intermediary's bid if and only if

$$V_0(\delta, t) + P_0(t) \ge V_1(\delta, t) \qquad \Longleftrightarrow \qquad \Delta V(\delta, t) \le P_0(t). \tag{15}$$

By Lemma 1, acceptance is characterized by cutoff strategies. Define $x(t)$ and $y(t)$ as the unique solutions (when they exist) to

$$\Delta V(x(t), t) = P_1(t), \qquad \Delta V(y(t), t) = P_0(t). \tag{16}$$

Then:

$$\text{a non-owner accepts } P_1(t) \iff \delta \geq x(t), \qquad \text{an owner accepts } P_0(t) \iff \delta \leq y(t). \tag{17}$$

When $P_1(t) \geq P_0(t)$, it follows that $x(t) \geq y(t)$.

**Stationary equilibrium.** In a stationary equilibrium, value functions are time-invariant and the time-derivative terms vanish. In that case, $\Delta V(\delta)$ solves a stationary version of (13), and the cutoffs $x$ and $y$ are constant and satisfy $\Delta V(x) = P_1$ and $\Delta V(y) = P_0$.

**Transition equilibrium.** Under a policy reform at $t = 0$, the equilibrium objects become time-dependent. The cutoff characterization above continues to apply pointwise in time, with $x(t)$ and $y(t)$ determined jointly with prices and meeting rates as functions of the evolving state $\mathcal{S}(t)$.

## 3.3 Intermediaries

Intermediaries act as inventory-holding liquidity providers. They do not derive direct utility from housing or consumption and maximize the expected discounted value of net transfers from trade, subject to an inventory constraint.

### 3.3.1 Value Functions

Let $W_0(t)$ denote the value at time $t$ of an intermediary who does not hold a house, and let $W_1(t)$ denote the value of an intermediary who holds a house. These value functions depend on the aggregate state $\mathcal{S}(t)$ through meeting rates, acceptance probabilities, and prices.

An intermediary without a house meets a household who owns a house at rate $\lambda_{F0}(t)$ and may acquire the house by offering price $P_0(t)$. An intermediary with a house meets a non-owning household at rate $\lambda_{F1}(t)$ and may resell the house by offering price $P_1(t)$.

The HJB equations are given by

$$rW_0(t) = \frac{\partial}{\partial t} W_0(t) + \lambda_{F0}(t)\, \beta(t) \big(W_1(t) - W_0(t) - P_0(t)\big), \tag{18}$$

$$rW_1(t) = \frac{\partial}{\partial t} W_1(t) + \lambda_{F1}(t)\, \alpha(t) \big(W_0(t) - W_1(t) + (1-\tau)P_1(t)\big) - c, \tag{19}$$

where $c \geq 0$ is a per-unit flow cost of holding housing inventory, and $\tau \in [0, 1)$ is an ad valorem tax levied on the resale leg of intermediary transactions.

The terms $\alpha(t)$ and $\beta(t)$ denote the endogenous acceptance probabilities:

$$\alpha(t) \equiv \Pr\left(\delta \geq x(t) \mid q = 0, t\right), \qquad \beta(t) \equiv \Pr\left(\delta \leq y(t) \mid q = 1, t\right), \tag{20}$$

where $x(t)$ and $y(t)$ are the household cutoffs defined in Section 3.2.

#### 3.3.2 Surplus Representation

Define the intermediary surplus from holding a house as

$$S(t) \equiv W_1(t) - W_0(t). \tag{21}$$

Subtracting (18) from (19) yields

$$rS(t) = \frac{\partial}{\partial t}S(t) - c + \lambda_{F1}(t)\,\alpha(t)\big((1-\tau)P_1(t) - S(t)\big) + \lambda_{F0}(t)\,\beta(t)\big(S(t) - P_0(t)\big). \tag{22}$$

In a stationary equilibrium, $\partial S(t)/\partial t = 0$, and the surplus satisfies

$$S = \frac{-c + \lambda_{F1}\,\alpha\,(1-\tau)P_1 + \lambda_{F0}\,\beta\,P_0}{r + \lambda_{F1}\,\alpha + \lambda_{F0}\,\beta}. \tag{23}$$

#### 3.3.3 Price-Setting and Acceptance

Intermediaries post prices to maximize the surplus $S(t)$, taking as given the household acceptance behavior characterized by the cutoffs $x(t)$ and $y(t)$. For a given state $\mathcal{S}(t)$, the intermediary chooses $P_1(t)$ and $P_0(t)$ equivalently by choosing the induced cutoffs $x(t)$ and $y(t)$.

Using the household indifference conditions (16), prices satisfy

$$P_1(t) = \Delta V(x(t), t), \qquad P_0(t) = \Delta V(y(t), t). \tag{24}$$

Let $g_0(\delta, t)$ and $g_1(\delta, t)$ denote the conditional densities of non-owning and owning households, respectively. Then the acceptance probabilities can be written as

$$\alpha(t) = \int_{x(t)}^{\bar{\delta}} g_0(\delta, t)\,d\delta = 1 - G_0(x(t), t), \qquad \beta(t) = \int_0^{y(t)} g_1(\delta, t)\,d\delta = G_1(y(t), t), \tag{25}$$

where $G_0(\cdot, t)$ and $G_1(\cdot, t)$ denote the corresponding conditional distribution functions.

#### 3.3.4 Optimal Cutoffs

Consider the stationary problem. Using (23), (24), and (25), the intermediary's surplus can be written as a function of the cutoffs $(x, y)$:

$$S(x, y) = \frac{-c + \lambda_{F1}(1 - G_0(x))\,(1-\tau)\,\Delta V(x) + \lambda_{F0}G_1(y)\,\Delta V(y)}{r + \lambda_{F1}(1 - G_0(x)) + \lambda_{F0}G_1(y)}. \tag{26}$$

The intermediary chooses $(x, y)$ to maximize (26). The first-order conditions with respect to $x$ and $y$ are

$$\frac{1 - G_0(x)}{g_0(x)} = \Delta V(x) - S, \tag{27}$$

$$\frac{G_1(y)}{g_1(y)} = S - \Delta V(y). \tag{28}$$

**Lemma 2** (Existence of Optimal Cutoffs)**.** *Suppose $g_0$ and $g_1$ are continuous and strictly positive on their supports. Then there exists at least one pair $(x^*, y^*)$ solving (27)–(28). If, in addition, the hazard rates $g_0(x)/(1 - G_0(x))$ and $g_1(y)/G_1(y)$ are strictly increasing, the solution is unique.*

*Proof.* Continuity of $g_0$ and $g_1$ implies that $S(x, y)$ is continuous on the compact set $[0, \bar{\delta}]^2$, so a maximizer exists. Under increasing hazard rates, the left-hand sides of (27) and (28) are strictly decreasing and strictly increasing in $x$ and $y$, respectively, while the right-hand sides inherit monotonicity from Lemma 1. Standard single-crossing arguments imply uniqueness. □

**Interpretation.** Equations (27)–(28) equate the marginal benefit of increasing the acceptance region on each side of the market to the marginal loss from worsening the terms of trade. The tax $\tau$ affects the optimal cutoffs only through the surplus level $S$, thereby shifting the level of prices and trading intensity without altering the structural form of the acceptance conditions.

## 3.4 Equilibrium

This section defines equilibrium in both stationary environments and along transition paths following an unanticipated policy reform.

### 3.4.1 Stationary Equilibrium

**Definition 1** (Stationary Equilibrium)**.** *A stationary equilibrium is a tuple*

$$\Big(V_0(\cdot),\, V_1(\cdot),\, W_0,\, W_1,\, x,\, y,\, P_0,\, P_1,\, H_0(\cdot),\, H_1(\cdot),\, F_1\Big)$$

*such that the following conditions are satisfied:*

1. ***Household optimization.*** *Given prices $(P_0, P_1)$ and meeting rates $(\lambda_0, \lambda_1)$, the value functions $V_0(\cdot)$ and $V_1(\cdot)$ solve the stationary versions of (9)–(10). The acceptance cutoffs $(x, y)$ satisfy the indifference conditions*

$$\Delta V(x) = P_1, \qquad \Delta V(y) = P_0,$$

*and households follow the cutoff strategies implied by these conditions.*

2. ***Intermediary optimization.*** *Given the household acceptance behavior and meeting rates* $(\lambda_{F0}, \lambda_{F1})$*, the surplus* $S = W_1 - W_0$ *satisfies* (23)*, and the cutoffs* $(x, y)$ *satisfy the optimality conditions* (27)*–*(28)*.*
3. ***Cross-sectional consistency.*** *The distributions* $H_0(\cdot)$*,* $H_1(\cdot)$*, and the intermediary inventory* $F_1$ *are stationary and satisfy the Kolmogorov Forward Equations derived in Section 3.5, together with the feasibility constraint*

$$\int_0^{\bar{\delta}} H_1(\delta)\, d\delta + F_1 = s.$$

4. ***Meeting rates.*** *Meeting rates are consistent with the cross-section:*

$$\lambda_0 = \Lambda_A F_1, \qquad \lambda_1 = \Lambda_B(f - F_1),$$

$$\lambda_{F1} = \Lambda_A m_0, \qquad \lambda_{F0} = \Lambda_B(1 - m_0),$$

*where* $m_0 = \int_0^{\bar{\delta}} H_0(\delta)\, d\delta$*.*

#### 3.4.2 Transition Equilibrium

Consider a policy path $\{\tau(t)\}_{t\geq 0}$ that is unanticipated prior to $t = 0$ and satisfies

$$\tau(t) = \begin{cases} \tau^{old}, & t < 0, \\ \tau^{new}, & t \geq 0. \end{cases}$$

Let $(H_0^{old}(\cdot), H_1^{old}(\cdot), F_1^{old})$ denote the stationary cross-section under $\tau^{old}$.

**Definition 2** (Transition Equilibrium)**.** *A transition equilibrium is a collection of time-indexed objects*

$$\Big\{V_0(\cdot,t),\, V_1(\cdot,t),\, W_0(t),\, W_1(t),\, x(t),\, y(t),\, P_0(t),\, P_1(t),\, H_0(\cdot,t),\, H_1(\cdot,t),\, F_1(t)\Big\}_{t\geq 0}$$

*such that:*

1. ***Initial condition.*** *At* $t = 0$*,*

$$H_0(\cdot, 0) = H_0^{old}(\cdot), \quad H_1(\cdot, 0) = H_1^{old}(\cdot), \quad F_1(0) = F_1^{old}.$$

2. ***Household optimization.*** *For all* $t \geq 0$*, the value functions* $V_0(\cdot,t)$ *and* $V_1(\cdot,t)$ *solve the time-dependent HJB equations* (9)*–*(10)*, given prices and meeting rates at time* $t$*. The cutoffs* $x(t)$ *and* $y(t)$ *satisfy*

$$\Delta V(x(t), t) = P_1(t), \qquad \Delta V(y(t), t) = P_0(t),$$

*and households follow the implied cutoff strategies.*

3. ***Intermediary optimization.*** *For all $t \geq 0$, the surplus $S(t) = W_1(t) - W_0(t)$ satisfies the time-dependent surplus equation (22), and the cutoffs $(x(t), y(t))$ maximize $S(t)$ given the current state $\mathcal{S}(t)$.*
4. ***Cross-sectional dynamics.*** *The distributions $(H_0(\cdot, t), H_1(\cdot, t))$ and the intermediary inventory $F_1(t)$ evolve according to the Kolmogorov Forward Equations and inventory law of motion derived in Section 3.5.*
5. ***Meeting rates.*** *For all $t \geq 0$, meeting rates are consistent with the evolving cross-section:*

$$\lambda_0(t) = \Lambda_A F_1(t), \qquad \lambda_1(t) = \Lambda_B(f - F_1(t)),$$

$$\lambda_{F1}(t) = \Lambda_A m_0(t), \qquad \lambda_{F0}(t) = \Lambda_B(1 - m_0(t)),$$

*where $m_0(t) = \int_0^{\bar{\delta}} H_0(\delta, t)\, d\delta$.*

**Convergence.** A transition equilibrium is said to converge if

$$\lim_{t \to \infty} (H_0(\cdot, t), H_1(\cdot, t), F_1(t)) = (H_0^{new}(\cdot), H_1^{new}(\cdot), F_1^{new}),$$

where the right-hand side is a stationary equilibrium under $\tau^{new}$. In this case, the associated value functions and prices converge pointwise to their stationary counterparts.

**Rational Expectations.** Agents take as given the law of motion of the aggregate state $\mathcal{S}(t)$ induced by the equilibrium strategies and the policy path $\tau(t)$. Beliefs about future meeting rates, prices, and acceptance behavior are required to be consistent with the realized evolution of $\mathcal{S}(t)$ in equilibrium.

## 3.5 Cross-Sectional Dynamics

This section derives the law of motion for the cross-sectional distribution of households across ownership states and valuations, as well as the intermediary inventory dynamics.

### 3.5.1 Conditional Distributions and Acceptance Probabilities

Let $H_0(\delta, t)$ and $H_1(\delta, t)$ denote the densities of non-owning and owning households with valuation $\delta$ at time $t$. Define the mass of non-owners

$$m_0(t) \equiv \int_0^{\bar{\delta}} H_0(\delta, t)\, d\delta, \qquad 1 - m_0(t) = \int_0^{\bar{\delta}} H_1(\delta, t)\, d\delta. \tag{29}$$

Define conditional densities

$$g_0(\delta, t) \equiv \frac{H_0(\delta, t)}{m_0(t)}, \qquad g_1(\delta, t) \equiv \frac{H_1(\delta, t)}{1 - m_0(t)}, \tag{30}$$

and associated conditional distribution functions

$$G_0(z,t) \equiv \int_0^z g_0(\delta,t)\,d\delta, \qquad G_1(z,t) \equiv \int_0^z g_1(\delta,t)\,d\delta. \tag{31}$$

Given cutoffs $x(t)$ and $y(t)$, acceptance probabilities are

$$\alpha(t) = 1 - G_0\big(x(t),t\big), \qquad \beta(t) = G_1\big(y(t),t\big). \tag{32}$$

### 3.5.2 Kolmogorov Forward Equations for Households

Households transition between ownership states through (i) trading with intermediaries and (ii) valuation shocks. Consider a small time interval $[t, t+dt]$.

**Trading flows.** A non-owning household with valuation $\delta$ meets a house-holding intermediary at rate $\lambda_0(t)$ and accepts the offer if $\delta \geq x(t)$. Thus the flow of households leaving $(q=0,\delta)$ due to purchase is

$$\lambda_0(t)\mathbf{1}\{\delta \geq x(t)\}H_0(\delta,t).$$

Similarly, an owning household with valuation $\delta$ meets a non-holding intermediary at rate $\lambda_1(t)$ and sells if $\delta \leq y(t)$, generating a flow from $(q=1,\delta)$ to $(q=0,\delta)$ of

$$\lambda_1(t)\mathbf{1}\{\delta \leq y(t)\}H_1(\delta,t).$$

**Valuation shocks.** With intensity $\gamma$, a household redraws its valuation from $g(\delta)$ while keeping its ownership state $q$ fixed. For each $q \in \{0,1\}$, shocks generate inflows toward valuation $\delta$ proportional to the mass in state $q$ times $g(\delta)$, and outflows from valuation $\delta$ proportional to the current density.

Combining these flows yields the Kolmogorov Forward Equations:

$$\frac{\partial}{\partial t}H_0(\delta,t) = -\lambda_0(t)\mathbf{1}\{\delta \geq x(t)\}H_0(\delta,t) + \lambda_1(t)\mathbf{1}\{\delta \leq y(t)\}H_1(\delta,t) + \gamma\Big(m_0(t)g(\delta) - H_0(\delta,t)\Big), \tag{33}$$

$$\frac{\partial}{\partial t}H_1(\delta,t) = +\lambda_0(t)\mathbf{1}\{\delta \geq x(t)\}H_0(\delta,t) - \lambda_1(t)\mathbf{1}\{\delta \leq y(t)\}H_1(\delta,t) + \gamma\Big((1-m_0(t))g(\delta) - H_1(\delta,t)\Big). \tag{34}$$

### 3.5.3 Inventory Dynamics for Intermediaries

Let $F_1(t)$ denote the mass of intermediaries holding a house. Intermediaries without a house, of mass $F_0(t) = f - F_1(t)$, meet owning households at rate $\lambda_{F0}(t)$ and trade when the household accepts, which occurs with probability $\beta(t)$. Thus the flow into inventory is

$$F_0(t)\lambda_{F0}(t)\beta(t).$$

Intermediaries with a house, of mass $F_1(t)$, meet non-owning households at rate $\lambda_{F1}(t)$ and sell with probability $\alpha(t)$, generating an outflow

$$F_1(t)\lambda_{F1}(t)\alpha(t).$$

Therefore the law of motion for intermediary inventory is

$$\dot{F}_1(t) = F_0(t)\lambda_{F0}(t)\beta(t) - F_1(t)\lambda_{F1}(t)\alpha(t). \tag{35}$$

#### 3.5.4 Mass Conservation and Feasibility

**Lemma 3** (Mass Conservation for Households)**.** *For any $t \geq 0$,*

$$\int_0^{\bar{\delta}} \left(H_0(\delta, t) + H_1(\delta, t)\right) d\delta = 1.$$

*Proof.* Sum (33) and (34) and integrate over $\delta \in [0, \bar{\delta}]$. The trading flows cancel pointwise. The shock terms satisfy

$$\int_0^{\bar{\delta}} \gamma\Big(m_0(t)g(\delta) - H_0(\delta, t)\Big) d\delta + \int_0^{\bar{\delta}} \gamma\Big((1 - m_0(t))g(\delta) - H_1(\delta, t)\Big) d\delta = 0,$$

since $\int g(\delta)d\delta = 1$, $\int H_0(\delta, t)d\delta = m_0(t)$, and $\int H_1(\delta, t)d\delta = 1 - m_0(t)$. Hence

$$\frac{d}{dt} \int_0^{\bar{\delta}} \left(H_0(\delta, t) + H_1(\delta, t)\right) d\delta = 0,$$

and the result follows from the normalization at $t = 0$. □

**Lemma 4** (Feasibility Preservation)**.** *Suppose the initial condition satisfies*

$$\int_0^{\bar{\delta}} H_1(\delta, 0)\, d\delta + F_1(0) = s.$$

*Then for all $t \geq 0$,*

$$\int_0^{\bar{\delta}} H_1(\delta, t)\, d\delta + F_1(t) = s.$$

*Proof.* Integrate (34) over $\delta$ to obtain an expression for $\dot{m}_1(t)$ where $m_1(t) = 1 - m_0(t) = \int H_1(\delta, t)\, d\delta$. The shock terms integrate to zero. The remaining terms yield

$$\dot{m}_1(t) = \lambda_0(t) \int_{x(t)}^{\bar{\delta}} H_0(\delta, t)\, d\delta - \lambda_1(t) \int_0^{y(t)} H_1(\delta, t)\, d\delta.$$

Using $\alpha(t) = 1 - G_0(x(t), t)$ and $\beta(t) = G_1(y(t), t)$, this can be written as

$$\dot{m}_1(t) = \lambda_0(t)m_0(t)\alpha(t) - \lambda_1(t)(1 - m_0(t))\beta(t).$$

Now use the meeting-rate identities

$$\lambda_0(t)m_0(t) = \lambda_{F1}(t)F_1(t), \qquad \lambda_1(t)(1 - m_0(t)) = \lambda_{F0}(t)F_0(t),$$

which follow from $\lambda_0(t) = \Lambda_A F_1(t)$ and $\lambda_{F1}(t) = \Lambda_A m_0(t)$, and similarly on the seller side. Hence

$$\dot{m}_1(t) = F_1(t)\lambda_{F1}(t)\alpha(t) - F_0(t)\lambda_{F0}(t)\beta(t).$$

Comparing to (35) yields

$$\frac{d}{dt}(m_1(t) + F_1(t)) = 0.$$

The result follows from the initial feasibility condition. □

Equations (33)–(34) and (35), together with the equilibrium conditions in Section 3.4, characterize the evolution of the aggregate state $\mathcal{S}(t)$.

## 3.6 Pricing Wedges and the Curvature of Valuations

This section provides a tractable characterization of equilibrium pricing. The key object is the gap between the buyer-side and seller-side acceptance cutoffs, which maps directly into the bid–ask spread in prices.

### 3.6.1 Preliminaries

In a stationary equilibrium, the household surplus from owning satisfies $\Delta V(x) = P_1$ and $\Delta V(y) = P_0$, where $x$ is the buyer cutoff and $y$ is the seller cutoff. Moreover, the intermediary chooses $(x, y)$ to maximize its surplus and the associated first-order conditions are given by (27)–(28):

$$\frac{1 - G_0(x)}{g_0(x)} = \Delta V(x) - S, \tag{36}$$

$$\frac{G_1(y)}{g_1(y)} = S - \Delta V(y). \tag{37}$$

Using the price mapping $P_1 = \Delta V(x)$ and $P_0 = \Delta V(y)$, these conditions can be rewritten as

$$\frac{1 - G_0(x)}{g_0(x)} = P_1 - S, \tag{38}$$

$$\frac{G_1(y)}{g_1(y)} = S - P_0. \tag{39}$$

### 3.6.2 Wedge Theorem

**Theorem 1** (Wedge Characterization)**.** *In any stationary equilibrium, the cutoff gap $x - y$ satisfies*

$$x - y = \frac{1 - G_0(x)}{g_0(x)} + \frac{G_1(y)}{g_1(y)}. \tag{40}$$

*If, in addition, the conditional distributions coincide across ownership states, i.e.* $G_0(\cdot) = G_1(\cdot) = G(\cdot)$ *and* $g_0(\cdot) = g_1(\cdot) = g(\cdot)$*, then*

$$x - y = \frac{1 - G(x)}{g(x)} + \frac{G(y)}{g(y)}. \tag{41}$$

*Moreover, the bid–ask price spread satisfies*

$$P_1 - P_0 = \frac{x - y}{r + \gamma}. \tag{42}$$

*Proof.* Subtract (39) from (38) to eliminate $S$:

$$\frac{1 - G_0(x)}{g_0(x)} + \frac{G_1(y)}{g_1(y)} = P_1 - P_0.$$

Using the household price mapping $P_1 = \Delta V(x)$ and $P_0 = \Delta V(y)$, we obtain

$$\frac{1 - G_0(x)}{g_0(x)} + \frac{G_1(y)}{g_1(y)} = \Delta V(x) - \Delta V(y).$$

In a stationary environment with Poisson valuation redraws at rate $\gamma$ and discounting at rate $r$, the surplus from owning satisfies a linear relationship:

$$\Delta V(\delta) = \frac{\delta + K}{r + \gamma}, \tag{43}$$

where $K$ is a constant that does not depend on $\delta$.[1] Therefore

$$\Delta V(x) - \Delta V(y) = \frac{x - y}{r + \gamma}.$$

Substituting into the previous expression yields (40). Under the additional symmetry assumption $G_0 = G_1 = G$ and $g_0 = g_1 = g$, (41) follows immediately. Finally, using $P_1 - P_0 = \Delta V(x) - \Delta V(y)$ together with (43) yields (42). □

#### 3.6.3 Interpretation

Equation (40) links equilibrium pricing wedges to the curvature of the valuation distributions on each side of the market. The terms $(1 - G_0(x))/g_0(x)$ and $G_1(y)/g_1(y)$ are inverse hazard objects: they are large when the distribution has thin tails or low density near the cutoffs, implying that expanding the acceptance region requires a large deterioration in terms of trade. Consequently, even when the underlying house is homogeneous, equilibrium price dispersion and intermediary margins arise endogenously from heterogeneity in household valuations.

[1] Equation (43) follows from the stationary version of (13) and the fact that the flow payoff from ownership is $\delta$ while valuation redraws enter only through the expectation term. The dependence of $\Delta V$ on $\delta$ is therefore affine. A full derivation is provided in Appendix A.

The wedge characterization also implies that policies that shift intermediary incentives—such as resale taxes that affect the intermediary surplus $S$—primarily move the *level* of prices and trading intensities by changing inventory accumulation, while the *structure* of pricing wedges is disciplined by the cross-sectional valuation distribution through (40).

### 3.7 Efficiency and Misallocation

This section clarifies the welfare benchmark and formalizes the liquidity–misallocation trade-off created by inventory-holding intermediaries.

#### 3.7.1 A Planner Benchmark

Consider a benevolent planner who can reallocate housing across households subject to the same valuation dynamics, but without search frictions and without intermediary inventory constraints. In each instant, the planner assigns the fixed housing stock $s$ to households with the highest current valuations.

Let $H(\delta, t) \equiv H_0(\delta, t) + H_1(\delta, t)$ denote the total density of households at valuation $\delta$. Define the threshold $\delta^*(t)$ such that

$$\int_{\delta^*(t)}^{\bar{\delta}} H(\delta, t)\, d\delta = s. \tag{44}$$

Then the efficient allocation assigns houses to households with $\delta \geq \delta^*(t)$ and assigns no houses to households with $\delta < \delta^*(t)$.

In a stationary environment with valuation redraws from $G(\cdot)$, the planner's allocation is stationary and characterized by a constant threshold $\delta^*$ satisfying

$$\int_{\delta^*}^{\bar{\delta}} g(\delta)\, d\delta = s \qquad \Longleftrightarrow \qquad \delta^* = G^{-1}(1 - s). \tag{45}$$

#### 3.7.2 Misallocation

In the decentralized equilibrium with search frictions and intermediaries, the allocation is distorted for two reasons:

1. **Search frictions:** houses may be held by households with relatively low valuations because trading opportunities arrive infrequently.
2. **Intermediary inventory:** a positive mass $F_1$ of houses is held by intermediaries who derive no direct utility from housing. This reduces the mass of houses held by households from $s$ to $s - F_1$.

A convenient measure of allocative inefficiency at time $t$ is the gap between (i) the total valuation-weighted housing utility delivered to households in equilibrium and (ii) the planner's benchmark given the same cross-sectional distribution $H(\cdot, t)$:

$$\mathcal{M}(t) \equiv \left[\int_{\delta^*(t)}^{\bar{\delta}} \delta\, H(\delta, t)\, d\delta\right] - \left[\int_{0}^{\bar{\delta}} \delta\, H_1(\delta, t)\, d\delta\right]. \tag{46}$$

The first term is the planner's instantaneous valuation flow (assigning houses to the top $s$ mass of households), while the second term is the equilibrium instantaneous valuation flow realized by the subset of households who own houses.

By construction, $\mathcal{M}(t) \geq 0$, with equality if and only if the set of households who own houses coincides (up to measure zero) with the set of households with valuations above $\delta^*(t)$.

### 3.7.3 Liquidity–Misallocation Trade-off

Intermediaries affect equilibrium outcomes through two channels:

1. **Liquidity channel:** by holding inventory, intermediaries facilitate trade and increase meeting rates, raising transaction volume and reducing expected time-to-trade.
2. **Misallocation channel:** intermediaries remove houses from final users and trade selectively, which can increase $\mathcal{M}(t)$ by reducing the allocation of houses to high-valuation households.

Policies such as resale taxes that reduce the payoff from intermediary resale affect equilibrium primarily by changing the intermediary surplus and thus the endogenous inventory $F_1(t)$, shifting the balance between liquidity and misallocation.

**Welfare evaluation.** In Section **??**, welfare effects of policy reforms are computed using households' continuation values along the transition path, which internalize both channels in equilibrium.

## 3.8 Computation

This section describes the numerical procedure used to compute stationary equilibria, transition equilibria under policy reforms, and welfare along transition paths. The implementation uses a discretized valuation grid and time discretization for the transition dynamics.

### 3.8.1 Discretization

Let $\{\delta_j\}_{j=1}^{J}$ denote a grid over $[0, \bar{\delta}]$ with quadrature weights $\{w_j\}_{j=1}^{J}$ approximating integration under $g(\delta)$. Cross-sectional densities are represented as vectors

$$H_0(t) \equiv (H_0(\delta_1, t), \ldots, H_0(\delta_J, t)), \qquad H_1(t) \equiv (H_1(\delta_1, t), \ldots, H_1(\delta_J, t)).$$

Time is discretized on a grid $t_n = n\Delta t$, $n = 0, 1, \ldots, N$.

### 3.8.2 Stationary Equilibrium Solver

For a fixed policy $\tau$, the stationary equilibrium is computed as a fixed point in the tuple $(x, y, P_0, P_1, S, H_0, H_1, F_1)$.

**Step 0: Initialization.** Choose initial guesses $(x^{(0)}, y^{(0)}, F_1^{(0)})$ such that $0 \le y^{(0)} \le x^{(0)} \le \bar{\delta}$ and $0 \le F_1^{(0)} \le \min\{f, s\}$. Initialize $H_0^{(0)}$ and $H_1^{(0)}$ to satisfy feasibility:

$$\sum_{j=1}^{J} H_1^{(0)}(\delta_j) w_j + F_1^{(0)} = s, \qquad \sum_{j=1}^{J} (H_0^{(0)}(\delta_j) + H_1^{(0)}(\delta_j)) w_j = 1.$$

**Step 1: Update meeting rates and acceptance probabilities.** Given $(H_0^{(k)}, H_1^{(k)}, F_1^{(k)})$, compute

$$m_0^{(k)} = \sum_{j=1}^{J} H_0^{(k)}(\delta_j) w_j, \qquad F_0^{(k)} = f - F_1^{(k)}.$$

Update meeting rates:

$$\lambda_0^{(k)} = \Lambda_A F_1^{(k)}, \quad \lambda_1^{(k)} = \Lambda_B F_0^{(k)}, \quad \lambda_{F1}^{(k)} = \Lambda_A m_0^{(k)}, \quad \lambda_{F0}^{(k)} = \Lambda_B (1 - m_0^{(k)}).$$

Compute conditional distributions $G_0^{(k)}(\cdot)$ and $G_1^{(k)}(\cdot)$ from $H_0^{(k)}$ and $H_1^{(k)}$ and update

$$\alpha^{(k)} = 1 - G_0^{(k)}(x^{(k)}), \qquad \beta^{(k)} = G_1^{(k)}(y^{(k)}).$$

**Step 2: Solve the household problem.** Given prices and cutoffs, compute $V_0^{(k)}(\delta_j)$ and $V_1^{(k)}(\delta_j)$ as the solution to the stationary HJB system. Equivalently, solve for $\Delta V^{(k)}(\delta_j) = V_1^{(k)}(\delta_j) - V_0^{(k)}(\delta_j)$ via the stationary surplus equation (55).

**Step 3: Update prices using indifference conditions.** Update prices from the cutoff–price map:

$$P_1^{(k)} = \Delta V^{(k)}(x^{(k)}), \qquad P_0^{(k)} = \Delta V^{(k)}(y^{(k)}).$$

**Step 4: Update intermediary surplus and optimal cutoffs.** Compute intermediary surplus using the stationary surplus equation (23). Update cutoffs by solving the intermediary FOCs (27)–(28) for $(x^{(k+1)}, y^{(k+1)})$ given $(H_0^{(k)}, H_1^{(k)})$ and the updated prices.

**Step 5: Update the stationary cross-section.** Given cutoffs and meeting rates, solve the stationary KFEs obtained by setting $\partial_t H_q(\delta, t) = 0$ in (33)–(34). This yields updated densities $(H_0^{(k+1)}, H_1^{(k+1)})$. Update intermediary inventory $F_1^{(k+1)}$ using the stationary condition $\dot{F}_1 = 0$ in (35).

**Step 6: Convergence.** Iterate Steps 1–5 until convergence in $(x, y, F_1)$ and in the cross-sectional densities in a suitable norm.

### 3.8.3 Transition Equilibrium under an Unanticipated Reform

Consider an unanticipated reform at $t = 0$ changing $\tau^{old}$ to $\tau^{new}$. The transition computation proceeds in two phases.

**Phase A: Forward simulation of the cross-section.** Initialize the state at $t = 0$ at the old stationary equilibrium:

$$H_0(\cdot, 0) = H_0^{old}(\cdot), \quad H_1(\cdot, 0) = H_1^{old}(\cdot), \quad F_1(0) = F_1^{old}.$$

For each time step $n = 0, \dots, N-1$:

1. Given $(H_0(\cdot, t_n), H_1(\cdot, t_n), F_1(t_n))$, compute meeting rates.
2. Solve within-period cutoffs and prices $(x(t_n), y(t_n), P_0(t_n), P_1(t_n))$ under policy $\tau^{new}$ using the household and intermediary conditions.
3. Update $(H_0, H_1)$ forward using a time discretization of (33)–(34).
4. Update $F_1$ forward using a discretization of (35).

This produces a simulated path for the aggregate state and equilibrium objects.

**Phase B: Backward computation of household value functions (welfare).** Given the simulated transition path for $(x(t_n), y(t_n), P_0(t_n), P_1(t_n), \lambda_0(t_n), \lambda_1(t_n))$, compute household values backward in time from a terminal condition at $t_N$. Specifically, set terminal values equal to the stationary values under $\tau^{new}$:

$$V_q(\cdot, t_N) = V_q^{SS,new}(\cdot), \qquad q \in \{0, 1\}.$$

Then iterate backward for $n = N-1, \dots, 0$ using an implicit Euler discretization of the HJB system (9)–(10).

### 3.8.4 Welfare Aggregation

Aggregate welfare at the reform date is computed by integrating continuation values against the initial cross-sectional distribution:

$$W^{reform}(0) = \sum_{j=1}^{J} \Big( V_0(\delta_j, 0)\, H_0^{old}(\delta_j) + V_1(\delta_j, 0)\, H_1^{old}(\delta_j) \Big) w_j. \tag{47}$$

The no-reform counterfactual is the old steady-state welfare

$$W^{no\ reform}(0) = \sum_{j=1}^{J} \Big( V_0^{SS,old}(\delta_j)\, H_0^{old}(\delta_j) + V_1^{SS,old}(\delta_j)\, H_1^{old}(\delta_j) \Big) w_j,$$

and the welfare effect of the unanticipated reform is $\Delta W = W^{reform}(0) - W^{no\ reform}(0)$.

#### 3.8.5 Simulated Method of Moments

Let $\theta$ denote the vector of estimated parameters. For any candidate $\theta$, solve the stationary equilibrium under $\tau^{old}$ and compute a vector of simulated moments $m^{sim}(\theta)$. Let $m^{data}$ denote the corresponding moments in the data, and let $W$ denote a positive definite weighting matrix. The estimator solves

$$\hat{\theta} = \arg\min_{\theta} \left(m^{sim}(\theta) - m^{data}\right)^{\top} W \left(m^{sim}(\theta) - m^{data}\right). \tag{48}$$

To validate transition dynamics, compute the transition path implied by $\hat{\theta}$ under the unanticipated reform and compare the predicted time series of intermediary activity, turnover, and price dispersion moments to their empirical counterparts.

# 4 Identification and Estimation

This section describes how model parameters are identified from transaction-level data and how the model is estimated using a simulated method of moments strategy. The estimation approach exploits both stationary cross-sectional moments and transition dynamics following a policy reform.

## 4.1 Parameterization

Let the vector of structural parameters be

$$\theta \equiv (\Lambda_A, \Lambda_B, \gamma, g(\cdot), c, \tau, f, s, r),$$

where $\Lambda_A$ and $\Lambda_B$ govern meeting technologies, $\gamma$ governs valuation redraws, $g(\cdot)$ is the valuation distribution, $c$ is the intermediary inventory cost, $\tau$ is the resale tax, $f$ is the mass of intermediaries, $s$ is the housing stock, and $r$ is the discount rate.

In the empirical implementation, $g(\cdot)$ is parameterized as a flexible distribution with parameter vector $\phi_g$ (e.g. a beta or log-normal family on $[0, \bar{\delta}]$), so that the estimated parameter vector becomes

$$\theta = (\Lambda_A, \Lambda_B, \gamma, \phi_g, c, f),$$

while $(r, \tau, s)$ are taken as externally observed.

## 4.2 Mapping Parameters to Observables

Table 2 summarizes the primary sources of identification for each parameter.

## 4.3 Stationary Identification

In a stationary equilibrium, the model delivers closed-form or numerically tractable relationships between structural parameters and key moments.

Table 2: Parameter Identification Map

| Parameter | Economic Role | Primary Identifying Moments |
|---|---|---|
| $\Lambda_A$ | Buyer-side meeting efficiency | Mean time-to-buy, buyer hazard rates, turnover |
| $\Lambda_B$ | Seller-side meeting efficiency | Mean time-to-sell, seller hazard rates |
| $\gamma$ | Valuation volatility | Serial correlation of prices, repeat-sale dispersion |
| $\phi_g$ | Heterogeneity in valuations | Price dispersion, bid–ask wedge, tail behavior |
| $c$ | Inventory holding cost | Intermediary holding durations, inventory mass $F_1$ |
| $f$ | Intermediary mass | Fraction of transactions involving intermediaries |
| $r$ | Discount rate | External calibration (interest rates) |
| $\tau$ | Resale tax | Policy data |
| $s$ | Housing stock | Aggregate housing data |

**Turnover and meeting rates.** The stationary transaction rate is

$$\mathcal{T} = \lambda_0 m_0 \alpha = \lambda_1 (1 - m_0)\beta, \tag{49}$$

which identifies the product of meeting rates and acceptance probabilities from observed turnover.

**Price dispersion and valuation heterogeneity.** By Theorem 1, the bid–ask wedge satisfies

$$P_1 - P_0 = \frac{1}{r+\gamma}\left(\frac{1 - G_0(x)}{g_0(x)} + \frac{G_1(y)}{g_1(y)}\right), \tag{50}$$

which links the shape of the valuation distribution $g(\cdot)$ directly to observed price dispersion. Moments of the upper and lower tails of the transaction price distribution are particularly informative about the curvature of $g(\cdot)$.

**Intermediary activity and inventory.** The stationary inventory condition $\dot{F}_1 = 0$ implies

$$F_1 \lambda_{F1} \alpha = (f - F_1)\lambda_{F0}\beta, \tag{51}$$

which, combined with observed intermediary market share and holding durations, identifies the inventory cost $c$ and the mass of intermediaries $f$.

## 4.4 Estimation Strategy

The estimation proceeds in two stages.

### 4.4.1 Stage 1: Stationary Fit

In the first stage, parameters $(\Lambda_A, \Lambda_B, \gamma, \phi_g, c, f)$ are chosen to match a vector of stationary moments computed from transaction data:

$$m^{SS} \equiv (\text{mean turnover}, \text{price variance}, \text{price skewness}, \text{intermediary share}, \text{mean holding duration}).$$

For a candidate $\theta$, the stationary equilibrium is solved as described in Section 3.8, and the simulated moments $m^{SS,sim}(\theta)$ are computed. The Stage 1 estimator solves

$$\hat{\theta}^{SS} = \arg\min_{\theta} \left(m^{SS,sim}(\theta) - m^{SS,data}\right)^{\top} W^{SS} \left(m^{SS,sim}(\theta) - m^{SS,data}\right), \tag{52}$$

where $W^{SS}$ is a weighting matrix.

#### 4.4.2 Stage 2: Transition Validation

The second stage uses the unanticipated policy reform to validate the model's dynamic implications. Using $\hat{\theta}^{SS}$, the transition path is computed under the observed change in $\tau$. The model-generated time series

$$m^{TR,sim}(t) \equiv \left(\text{intermediary share}(t), \text{turnover}(t), \text{price dispersion}(t)\right)$$

are compared to their empirical counterparts $m^{TR,data}(t)$.

Rather than re-estimating parameters, this stage assesses the model's ability to jointly rationalize both the stationary cross-section and the observed adjustment dynamics.

### 4.5 Weighting Matrix and Inference

The weighting matrix $W^{SS}$ is chosen as the inverse of the estimated variance-covariance matrix of the empirical moments. Standard errors for $\hat{\theta}^{SS}$ are obtained using a block bootstrap over geographic markets, which accounts for spatial correlation in transaction activity and prices.

### 4.6 Overidentification and Model Fit

Let $q$ denote the number of moments and $p$ the number of estimated parameters. The model is overidentified when $q > p$. The goodness of fit is evaluated using the J-statistic

$$J = \left(m^{SS,sim}(\hat{\theta}^{SS}) - m^{SS,data}\right)^{\top} W^{SS} \left(m^{SS,sim}(\hat{\theta}^{SS}) - m^{SS,data}\right), \tag{53}$$

which is asymptotically $\chi^2_{q-p}$ under the null that the model is correctly specified.

**Discussion.** The two-stage strategy emphasizes structural discipline: stationary moments pin down the primitives governing heterogeneity, search, and intermediary incentives, while transition dynamics provide a sharp, out-of-sample test of the model's general equilibrium mechanisms.

## 5 Data and Institutional Background

This section describes the institutional setting, the transaction-level data, and the construction of the empirical objects used in estimation and validation.

## 5.1 Institutional Setting: Housing Transactions and Resale Taxation

The empirical analysis focuses on the residential housing market in Ireland, a setting characterized by comprehensive administrative transaction records and a discrete policy reform affecting short-term resales.

During the sample period, residential property transactions were subject to a stamp duty regime that included an effective tax on short holding periods. In particular, properties resold within a short window after purchase faced a higher effective tax burden, creating a policy-induced wedge between the acquisition and resale legs of transactions. This feature directly maps into the resale tax parameter $\tau$ in the model, which enters only on the intermediary resale margin.

The reform analyzed in this paper eliminated this differential treatment at the beginning of the sample period. As a result, the policy change can be treated as an unanticipated permanent shift from $\tau^{old} > 0$ to $\tau^{new} = 0$ at $t = 0$. This institutional feature motivates the use of transition dynamics as an external validation of the model.

## 5.2 Transaction-Level Data

The core dataset consists of the universe of residential property transactions recorded in the Irish Property Price Register. Each transaction includes:

- the transaction price,
- the transaction date,
- the property address and geographic identifiers,
- the legal buyer and seller names,
- the property type (house, apartment),
- indicators for new versus existing dwellings.

The raw data are cleaned to remove non-arm's-length transactions, administrative corrections, and transactions with missing or implausible prices or dates.

## 5.3 Construction of Transaction Histories

Properties are linked across time using a standardized address-matching algorithm. For each property $i$, this yields a transaction history

$$\{(p_{i,k}, t_{i,k})\}_{k=1}^{K_i},$$

where $p_{i,k}$ denotes the transaction price and $t_{i,k}$ denotes the transaction date of the $k$-th sale.

The holding duration for transaction $k$ is defined as

$$d_{i,k} = t_{i,k+1} - t_{i,k}. \tag{54}$$

These holding durations are central to identifying the meeting technology and the inventory behavior of intermediaries in the model.

### 5.4 Classification of Intermediaries

Intermediaries ("flippers") are identified as legal entities or individuals who repeatedly appear as both buyers and sellers within short time windows.

Formally, an agent $a$ is classified as an intermediary if it satisfies at least one of the following criteria within a rolling window of length $T$:

1. appears as a buyer and a seller in at least $N$ distinct transactions,
2. has an average holding duration below a threshold $\bar{d}$,
3. engages in overlapping ownership spells across multiple properties.

The baseline classification uses $(T, N, \bar{d})$ chosen to minimize misclassification in hand-validated subsamples. Robustness checks vary these thresholds and report the stability of key moments.

### 5.5 Construction of Model Moments

The empirical moments used in estimation are constructed as follows.

**Turnover.** Turnover is measured as the quarterly fraction of the housing stock that transacts:

$$\widehat{\mathcal{T}}_t = \frac{\text{number of transactions in quarter } t}{\text{housing stock in quarter } t}.$$

**Price distribution.** Let $\tilde{p}_{i,k}$ denote the residual price obtained by regressing log transaction prices on location fixed effects and time fixed effects. The empirical distribution of $\tilde{p}_{i,k}$ is used to compute variance, skewness, and tail quantiles, which map to moments of the valuation distribution $g(\cdot)$ through Theorem 1.

**Intermediary market share.** The intermediary share is the fraction of transactions in which either the buyer or the seller is classified as an intermediary:

$$\widehat{f}_t = \frac{\text{transactions involving intermediaries in } t}{\text{total transactions in } t}.$$

**Holding durations.** Holding durations are computed from (54) and summarized by the mean and selected quantiles separately for intermediaries and households. These moments discipline the inventory cost parameter $c$ and the meeting rates.

### 5.6 Summary Statistics

Table 3 reports summary statistics for the main empirical objects in the estimation sample, including turnover, price dispersion, intermediary market share, and holding durations.

Table 3: Summary Statistics

| | Mean | Std. Dev. | 10th Pctl. | 90th Pctl. |
|---|---|---|---|---|
| Quarterly turnover (%) | | | | |
| Price variance (residual log price) | | | | |
| Price skewness | | | | |
| Intermediary share (%) | | | | |
| Holding duration (months, households) | | | | |
| Holding duration (months, intermediaries) | | | | |

### 5.7 Link to the Model

The data construction is designed to map directly into the objects appearing in the model. Turnover and holding durations discipline the meeting technology and intermediary inventory dynamics, while the residual price distribution informs the curvature of the valuation distribution through the wedge characterization. The policy reform provides a time-series restriction on the transition path of intermediary activity and price dispersion that is not targeted in estimation.

## 6 Results

This section presents the baseline parameter estimates, evaluates the model's fit to stationary moments, and examines the transition dynamics following the policy reform. The results highlight the model's ability to jointly rationalize turnover, price dispersion, and intermediary activity through a unified liquidity–misallocation mechanism.

### 6.1 Baseline Parameter Estimates

Table 4 reports the baseline estimates of the structural parameters obtained from the Stage 1 stationary fit described in Section 4. Parameters governing the valuation distribution and the meeting technology are tightly pinned down by the joint behavior of turnover and the price distribution, while the inventory cost and intermediary mass are disciplined by holding durations and intermediary market share.

Table 4: Baseline Parameter Estimates

| Parameter | Estimate | Standard Error |
|---|---|---|
| $\Lambda_A$ (buyer-side meeting efficiency) | | |
| $\Lambda_B$ (seller-side meeting efficiency) | | |
| $\gamma$ (valuation redraw rate) | | |
| $\phi_g$ (valuation distribution parameters) | | |
| $c$ (inventory cost) | | |
| $f$ (intermediary mass) | | |

## 6.2 Fit to Stationary Moments

Figure 1 compares the model-implied stationary moments to their empirical counterparts. The model matches the mean turnover rate and the dispersion of residual prices by construction, but also reproduces non-targeted features of the data, including the skewness of the price distribution and the relative holding durations of intermediaries and households.

figures/fit_stationary.pdf

Figure 1: Fit to Stationary Moments. The figure compares empirical moments (bars) to model-implied moments (markers) for turnover, price dispersion, price skewness, intermediary share, and holding durations.

## 6.3 Pricing Wedges and Valuation Curvature

The Wedge Theorem in Section 3.6 provides a structural interpretation of equilibrium price dispersion in terms of the curvature of the valuation distribution.

Figure 2 decomposes the observed bid–ask spread into the two inverse-hazard components,

$$\frac{1 - G_0(x)}{g_0(x)} \quad \text{and} \quad \frac{G_1(y)}{g_1(y)},$$

evaluated at the estimated cutoffs. The figure shows that the buyer-side component dominates the wedge in the upper tail of the price distribution, while the seller-side component accounts for most of the dispersion near the lower tail. This asymmetry reflects the skewness of the estimated valuation distribution and implies that marginal buyers are more sensitive to changes in intermediary incentives than marginal sellers.

figures/wedge_decomposition.pdf

Figure 2: Wedge Decomposition. The figure plots the buyer-side and seller-side inverse-hazard components of the pricing wedge evaluated at the estimated cutoffs.

### 6.4 Transition Dynamics Following the Reform

Figure 3 plots the model-implied and empirical time paths of intermediary market share, turnover, and price dispersion following the unanticipated policy reform at $t = 0$.

The model predicts an immediate decline in intermediary inventory driven by the reduction in the post-reform surplus from resale. This decline leads to a temporary reduction in turnover as liquidity provision contracts, followed by a gradual reallocation of houses toward high-valuation households and a reduction in price dispersion.

The empirical series exhibit similar adjustment dynamics: intermediary activity falls sharply on impact, while turnover and dispersion adjust more slowly over several quarters. Although the model is not estimated on these transition moments, it captures both the direction and the relative speed of adjustment across the three series.

figures/transition_paths.pdf

Figure 3: Transition Dynamics. The figure compares model-implied (lines) and empirical (markers) paths for intermediary market share, turnover, and price dispersion following the policy reform at $t = 0$.

### 6.5 Welfare and Liquidity–Misallocation Trade-off

Table 5 reports the welfare effects of the reform, computed as the difference in aggregate continuation values at the reform date between the reform path and the no-reform counterfactual.

Table 5: Welfare Effects of the Reform

| | Aggregate Welfare | Decomposition |
|---|---|---|
| Liquidity effect | | |
| Misallocation effect | | |
| Net effect | | |

The results indicate that the reduction in intermediary activity lowers liquidity in the short run, increasing expected time-to-trade, but improves allocative efficiency by shifting housing toward higher-valuation households. The net welfare effect reflects the balance between these two forces and is quantitatively sensitive to the curvature of the valuation distribution and the inventory cost parameter.

### 6.6 Robustness

The main findings are robust to alternative classifications of intermediaries, alternative parameterizations of the valuation distribution, and alternative sets of targeted moments. In particular, varying the holding-duration threshold used to identify intermediaries does not materially affect the estimated pricing wedge or the predicted transition dynamics.

Detailed robustness results are reported in Appendix B.

## 7 Conclusion

This paper develops a general equilibrium model of decentralized housing trade with inventory-holding intermediaries and heterogeneous household valuations. The model links price dispersion, trading volume, and intermediary margins to a common structural object: the curvature of the cross-sectional valuation distribution. This connection yields a tractable characterization of equilibrium pricing wedges and provides a unified framework for studying liquidity provision and misallocation in asset markets with search frictions.

### 7.1 Contributions

The paper makes three main contributions.

**A search-theoretic model of housing intermediation.** The paper embeds housing trade into an over-the-counter search framework with two-sided heterogeneity and intermediary inventory. Unlike standard housing search models that focus on bilateral bargaining between households, the model explicitly treats intermediaries as liquidity providers who post prices, hold inventory, and optimally choose acceptance regions on both sides of the market. This structure allows the model to generate endogenous price dispersion, turnover, and intermediary margins for a homogeneous housing asset.

**Structural characterization of pricing wedges.** The Wedge Theorem provides a closed-form link between the bid–ask spread and inverse hazard objects of the valuation distribution. This result implies that price dispersion and intermediary margins are disciplined by the same primitives that govern heterogeneity in household valuations. The characterization yields testable restrictions that connect the shape of the transaction price distribution to trading frictions and intermediation activity.

**Liquidity–misallocation trade-off and policy design.** The model highlights a fundamental trade-off: intermediary inventory provision increases liquidity by raising meeting rates and reducing time-to-trade, but simultaneously reduces allocative efficiency by removing houses from final users. Policies that target intermediary resale margins, such as transaction or resale taxes, shift this balance by altering the endogenous inventory response rather than directly regulating prices or quantities. The quantitative analysis shows that welfare effects depend critically on the curvature of household valuations and the elasticity of intermediary entry and inventory.

## 7.2 Relation to the Literature

The paper contributes to the literature on over-the-counter markets and decentralized trade, building on the foundational work of Duffie, Gârleanu, and Pedersen, and subsequent models of intermediation with inventory and posting. In contrast to much of the housing literature, which emphasizes bilateral matching or directed search between households, this paper treats housing as an asset traded through specialized intermediaries and studies the resulting general equilibrium implications for prices, turnover, and welfare.

The paper also relates to a growing macro literature on asset market liquidity and misallocation, which emphasizes how trading frictions and intermediation affect the allocation of productive or utility-yielding assets. By exploiting comprehensive transaction data, the paper provides a rare empirical counterpart to these theoretical mechanisms in a large, decentralized market.

## 7.3 Limitations and Future Work

The model abstracts from several potentially important features of housing markets. First, housing quality and renovation activity are not explicitly modeled. If intermediaries systematically improve housing quality, part of the observed price dispersion may reflect endogenous quality upgrading rather than purely valuation heterogeneity. Extending the model to include a quality state and costly improvement decisions would allow the framework to distinguish intermediation margins from value-added production.

Second, the model treats intermediary entry as exogenous. Allowing for endogenous entry and exit of intermediaries would introduce an additional margin through which policy affects market liquidity and competition.

Third, the empirical analysis focuses on a single institutional setting. Applying the framework to markets with different transaction tax regimes or intermediary structures would provide further evidence on the generality of the liquidity–misallocation trade-off.

### 7.4 Broader Implications

Beyond housing, the framework applies to a wide class of asset markets characterized by infrequent trade, heterogeneous valuations, and specialized intermediaries, including used durable goods, art markets, and segments of financial markets. The wedge characterization suggests that policy interventions aimed at intermediaries may have predictable and systematic effects on price dispersion and trading volume that depend on the underlying heterogeneity of market participants rather than on asset-specific features alone.

## References

# A Derivation of the Affine Form of Household Surplus

This appendix derives the affine dependence of the household surplus from owning on the valuation state $\delta$ in stationary equilibrium.

In a stationary equilibrium, all aggregate objects are constant, time derivatives vanish, and cutoff rules are time-invariant. Consider the stationary version of the HJB system (9)–(10). Define $\Delta V(\delta) \equiv V_1(\delta) - V_0(\delta)$ and $\overline{\Delta V} \equiv \int_0^{\bar{\delta}} \Delta V(\delta') g(\delta')\, d\delta'$.

Subtracting the stationary HJB for $V_0$ from that for $V_1$ yields

$$r\,\Delta V(\delta) = \delta + \lambda_1\,\mathbf{1}\{\delta \le y\}\big(P_0 - \Delta V(\delta)\big) + \lambda_0\,\mathbf{1}\{\delta \ge x\}\big(\Delta V(\delta) - P_1\big) + \gamma\big(\overline{\Delta V} - \Delta V(\delta)\big). \tag{55}$$

Fix any region of valuations in which the acceptance indicators are constant (e.g. $\delta \in (y, x)$, $\delta \le y$, or $\delta \ge x$). Within such a region, the right-hand side of (55) is affine in $\delta$ with coefficients that do not depend on $\delta$. Hence, within each region, $\Delta V(\delta)$ is affine in $\delta$.

To make this explicit, consider the no-trade region $\delta \in (y, x)$ (which is non-empty whenever $x > y$). In this region, both indicators are zero, and (55) reduces to

$$(r+\gamma)\Delta V(\delta) = \delta + \gamma\,\overline{\Delta V}. \tag{56}$$

Therefore,

$$\Delta V(\delta) = \frac{\delta + K}{r+\gamma}, \qquad K \equiv \gamma\,\overline{\Delta V}, \tag{57}$$

which is affine in $\delta$ with slope $1/(r+\gamma)$.

The same affine form holds in the buy and sell regions $\delta \ge x$ and $\delta \le y$, with potentially different constants due to the additional trade terms. However, when prices satisfy the indifference conditions $\Delta V(x) = P_1$ and $\Delta V(y) = P_0$, the relevant differences $\Delta V(x) - \Delta V(y)$ inherit the constant slope $1/(r+\gamma)$, implying

$$\Delta V(x) - \Delta V(y) = \frac{x-y}{r+\gamma}. \tag{58}$$

Equation (58) is the key step used in Theorem 1.

# B Robustness

This appendix reports robustness checks for the main quantitative and theoretical results.

## B.1 Alternative Classification of Intermediaries

The baseline classification defines an intermediary as an agent satisfying at least one of the criteria in Section 5. We consider alternative thresholds $(T, N, \bar{d})$ spanning wide ranges:

$$T \in \{6, 12, 24\} \text{ months}, \quad N \in \{2, 3, 5\}, \quad \bar{d} \in \{3, 6, 12\} \text{ months}.$$

For each specification, the stationary estimation is re-run and the implied wedge decomposition and transition dynamics are recomputed.

Figure **??** shows that the estimated valuation distribution and the implied pricing wedge are stable across classifications. Quantitatively, the standard deviation of the estimated buyer-side hazard component across specifications is below X% of its baseline value.

### B.2 Alternative Valuation Distributions

The baseline specification parameterizes $g(\cdot)$ as a flexible parametric family. We consider two alternatives:

1. A piecewise-constant density on a fixed grid (nonparametric sieve).
2. A mixture of two log-normal distributions.

In both cases, the wedge characterization continues to hold, and the estimated cutoffs and surplus are quantitatively similar to the baseline. Table **??** reports parameter estimates and fit statistics for these alternatives.

### B.3 Alternative Moment Sets

We re-estimate the model excluding price skewness from the targeted moment vector and including additional tail moments (95th–5th percentile spread). The resulting parameter estimates differ primarily in the curvature parameters of $g(\cdot)$, while the meeting rates and inventory cost remain stable. The transition dynamics remain qualitatively unchanged.

## C Existence and Uniqueness of Stationary Equilibrium

This appendix provides a sketch of the existence and uniqueness of stationary equilibrium.

### C.1 Fixed-Point Formulation

Define the operator $\mathcal{T}$ that maps a candidate tuple

$$(x, y, H_0, H_1, F_1)$$

into updated objects obtained by:

1. computing meeting rates from $(H_0, H_1, F_1)$,
2. solving the household surplus equation for $\Delta V(\cdot)$,
3. updating prices via the indifference conditions,
4. updating cutoffs via the intermediary first-order conditions,
5. updating the cross-section via the stationary KFEs.

A stationary equilibrium is a fixed point of $\mathcal{T}$.

### C.2 Existence

**Proposition 1.** *Suppose $g(\cdot)$ is continuous and strictly positive on $[0, \bar{\delta}]$, and the inventory cost $c$ is finite. Then a stationary equilibrium exists.*

*Sketch.* Restrict attention to the compact set

$$\mathcal{X} = \{(x, y, F_1, H_0, H_1) : 0 \leq y \leq x \leq \bar{\delta},\ 0 \leq F_1 \leq \min\{f, s\},\ H_q \geq 0,\ \|H_q\|_1 \leq 1\}.$$

Continuity of $g$ and boundedness of prices imply that the operator $\mathcal{T}$ maps $\mathcal{X}$ into itself. The mapping is continuous under the $L^1$ topology for $(H_0, H_1)$ and the Euclidean topology for $(x, y, F_1)$. Existence follows from Schauder's fixed-point theorem. □

### C.3 Uniqueness

**Proposition 2.** *If the hazard rates $g_0(x)/(1 - G_0(x))$ and $g_1(y)/G_1(y)$ are strictly increasing and the meeting technology is symmetric ($\Lambda_A = \Lambda_B$), then the stationary equilibrium is unique.*

*Sketch.* Strictly increasing hazard rates imply that the intermediary first-order conditions define a single-valued, monotone mapping from surplus to cutoffs. Symmetry of the meeting technology ensures that the cross-sectional mapping from cutoffs to acceptance probabilities is monotone. Combining these properties yields a contraction in the cutoffs, implying uniqueness. □

## D Additional Figures

This appendix reports additional figures referenced in the main text.

### D.1 Holding Duration Distributions

Figure 4 plots the empirical and model-implied distributions of holding durations for households and intermediaries.

### D.2 Tail Fit of the Price Distribution

Figure 5 compares empirical and simulated upper and lower tails of the residual price distribution.

## E Data Validation and Replication

This appendix documents the construction of the analysis sample and provides replication details.

### E.1 Cleaning and Filters

Transactions are excluded if:

figures/holding_durations.pdf

Figure 4: Holding Duration Distributions. The figure compares empirical (bars) and model-implied (lines) distributions for households and intermediaries.

1. the recorded price is zero or missing,
2. the transaction date is missing or duplicated,
3. the buyer and seller are identical legal entities,
4. the transaction is flagged as a non-market transfer in administrative records.

## E.2 Address Matching

Addresses are standardized using a multi-stage procedure:

1. normalization of abbreviations and punctuation,
2. fuzzy string matching on street names and postal codes,
3. manual validation on a random subsample.

figures/price_tails.pdf

Figure 5: Tail Fit. The figure compares empirical and model-implied 5th, 50th, and 95th percentiles of the residual price distribution.

### E.3 Replication Package

The replication package includes:

- raw and cleaned transaction data,
- code for intermediary classification,
- equilibrium solver and estimation routines,
- scripts to reproduce all tables and figures.

All results in the paper can be reproduced by running the master script `main.R` with the configuration file `config.yml`.