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The Endogenous Housing Liquidity Premium

Search Frictions, Seller Urgency, and Price Discovery

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Abstract

This paper studies how search frictions, heterogeneous seller urgency, financing frictions and bargaining jointly determine the liquidity discount, transaction prices, sale hazards and price dispersion in a local housing market. In a continuous-time matching model with free entry of buyers, sellers differ in a permanent carrying cost, buyers draw match-specific valuations, and prices are set by Nash bargaining. The urgency discount, defined relative to the most patient seller, is nonnegative and increasing in the carrying cost, and the expected price falls by less than the reservation price. A fall in buyer arrivals or in mortgage qualification lowers prices, lengthens time on market and widens the discount when the valuation distribution has an increasing failure rate; with heavy-tailed valuations a more liquid market can lengthen time on market, under an explicit condition on the carrying cost. Liquidity shocks move prices, volume, inventory and durations with no change in housing-service values, and buyer entry amplifies them. The gap between mortgage and cash prices decomposes into a delay-bargaining term that rises with urgency, an outside-option term, and a selection term that can be negative. The composition of transactions shifts after a liquidity shock in a direction governed by the shape of the valuation distribution, and its effect on a transaction-price index is an order of magnitude smaller than the within-type liquidity effect, which no quality adjustment removes. The Walrasian free-entry price is shown not to be a liquidity premium benchmark, since search prices exceed it in thick markets. Results are illustrated numerically with a documented parameterisation and reproducible code; no data are used.

Keywords: housing liquidity, search and matching, seller urgency, time on market, price dispersion, sale selection, financing contingencies

JEL Classification: R31, R21, D83, C63, G51

1. Introduction

Houses do not trade at a single price. Two identical houses listed in the same street in the same month can sell weeks apart at prices several percent apart, and the difference is systematically related to the circumstances of the sellers: those who have already moved, who carry two mortgages, or who face a deadline sell faster and for less (Glomer et al., 1998; Springer, 1996; Campbell et al., 2011; Andersen and Nielsen, 2017). The size of this concession varies with the state of the market, larger when buyers are scarce (Mayer, 1998), and it varies with the way the sale is financed, since cash buyers pay less than mortgage buyers for the same house (Han and Hong, 2024; Reher and Valkanov, 2024). At the aggregate level, transaction-price indices and sales volumes move together over the cycle and inventories move against them (Clayton et al., 2010; Leamer, 2007), and the houses that transact in a downturn are not the houses that transact in a boom (Gatzlaff and Haurin, 1997; Goetzmann and Peng, 2006). These facts are usually discussed separately, as a liquidity discount, a cash discount, a volume–price correlation and a selection bias. This paper argues that they are four faces of one object: the price of urgency in a market where buyers arrive slowly, sellers differ in what waiting costs them, and the two sides bargain.

The paper asks how market tightness, heterogeneous seller reservation values, financing frictions, time-on-market costs and bargaining power jointly determine an endogenous liquidity discount, transaction prices, sale hazards and price dispersion, and under which conditions a liquidity shock propagates through prices and quantities when the value of housing services has not changed. It answers with a continuous-time search model of a local housing market that is deliberately simple. New listings arrive at a constant rate and their owners pay a permanent, heterogeneous carrying cost while the house is listed; buyers enter freely at a sunk cost, meet listings through a constant-returns matching technology, and draw a match-specific valuation at each meeting; a meeting is with a qualified buyer with some probability; the surplus is split by Nash bargaining; listings are withdrawn at an exogenous rate. Free entry pins the buyer’s value at the entry cost, which isolates the seller side of the market and makes tightness the only general-equilibrium channel. Two controlled extensions add a financing contingency, in which a mortgage agreement spends time in a pending state and fails with some probability while cash agreements close at once, and a posted-price protocol. A dynamic version tracks the economy after an unanticipated change in matching efficiency or qualification.

The model yields a set of analytical results and a program of numerical experiments. On the analytical side, the reservation price of a seller falls with her carrying cost by less than one-for-one, her sale hazard rises, and her expected transaction price falls by less than her reservation price, because urgent sellers accept lower valuations but capture a share of the larger surplus of the matches they accept; the urgency discount defined relative to the most patient seller is therefore a discount without qualification. A fall in buyer arrivals or in qualification lowers every seller’s

reservation price and expected price; it lengthens time on market and widens the dispersion of reservation prices when the distribution of buyer valuations has an increasing failure rate, and the paper gives an exact counterexample: with Pareto valuations, a more liquid market lengthens the time on market of every seller whose carrying cost exceeds a threshold that does not depend on the arrival rate. With free entry and homogeneous sellers, tightness is unique and amplifies qualification and matching shocks, which are observationally equivalent in the baseline. A liquidity shock moves prices, volume, inventory and durations together with no change in fundamentals, and the steady-state sales flow falls only if listings are withdrawn. Price dispersion among identical houses has a between-type component that is positive whenever sellers are heterogeneous, bounded by the dispersion of carrying costs scaled by the effective discount rate, and widening when liquidity falls. The composition of transactions shifts after a liquidity shock in proportion to the elasticity of each seller type's hazard, and the resulting bias in a transaction-price index has a sign that depends on whether the product of the hazard function and the mean residual valuation of the match-value distribution rises or falls: exponential and Pareto valuations make selection amplify measured price changes, light-tailed valuations make it dampen them. In the financing extension the gap between mortgage and cash prices for the same house decomposes exactly into a delay-bargaining term whose sign depends on which party bears the larger bargaining-weighted cost of waiting and which rises with the seller's urgency, an outside-option term, and a selection term that is positive only when the pending wedge exceeds the cash buyers' advantage in continuation value. Finally, the Walrasian free-entry price that would seem the natural benchmark for a liquidity premium is shown to lie *below* the search price in thick markets, because a seller with the option to wait for a high-valuation buyer captures match-specific rents that a uniform price does not; the paper therefore measures the liquidity discount among sellers in the same market and reports the gap to the Walrasian price only as a decomposition.

The numerical part solves the stationary equilibrium, the posted-price and financing variants, a steady-state planner's problem and transition paths for an illustrative parameterisation in which a listing sells in about two months, a buyer searches for about eleven months, and the most urgent seller concedes about six percent of the price of the most patient. Twelve pre-registered experiments trace the comparative statics of arrivals, qualification, approval delay, bargaining power, entry costs and seller heterogeneity, the transition after permanent and temporary shocks, the decomposition of the observed price index across four match-value distributions, the posted-price protocol, and the sensitivity of every result to the parameters. Three numerical findings stand out. Entry amplifies arrival shocks by about ten percent in the baseline. Prices adjust on impact while inventories and sales adjust over months, and a temporary shock is followed by a burst of sales. The composition term in the observed price index is at most a few basis points against a within-type liquidity effect of one to two percent, in every distribution and at every urgency dispersion considered, so that the

bias from sale selection is second order under the present mechanism while the liquidity effect that quality adjustment cannot remove is first order. In the financing extension mortgage buyers pay 1.7 percent more than cash buyers on average, between 1.1 and 3.0 percent depending on the seller’s urgency, with a negative selection term for patient sellers; tighter approval and longer delays widen the gap. All code, tests, results and the manuscript are reproducible from a single configuration file; no data are used and no empirical claim is made.

The paper is related to four literatures, reviewed in Section 2. It builds on the search-and-matching theory of housing markets (Wheaton, 1990; Krainer, 2001; Albrecht et al., 2007; Díaz and Jerez, 2013; Ngai and Tenreyro, 2014; Head et al., 2014; Han and Strange, 2015), from which it takes the acceptance margin, the matching technology and free entry, and to which it adds a continuous distribution of seller urgency as a state of the market. It is related to the theory of illiquid housing and credit (Hedlund, 2016b; Eerola and Määttänen, 2018; Gabrovski and Ortego-Marti, 2021; Guren and McQuade, 2020), to which it adds an explicit financing contingency and the decomposition of the cash–mortgage gap that the evidence of Han and Hong (2024) and Reher and Valkanov (2024) calls for. It is related to the measurement literature on constant-liquidity values and sale selection (Fisher et al., 2003; Lin and Vandell, 2007; Goetzmann and Peng, 2006), to which it adds the sign condition for the selection bias in a search equilibrium. And it rests on the foundations of Diamond (1982), Mortensen and Pissarides (1994), Hosios (1990), Lippman and McCall (1976) and Bagnoli and Bergstrom (2005). The first proposition restates a known comparative static in a new setting and is presented as a benchmark; the contributions that survive the novelty audit documented with the replication material are the joint treatment of continuous urgency, free entry and pending financing, the exact condition under which liquidity lengthens time on market, the sign condition for the index-selection bias, the three-term decomposition of the cash–mortgage gap, and the welfare analysis with heterogeneous sellers.

Section 2 reviews the literature. Section 3 sets out the institutional intuition and the two benchmarks. Section 4 presents the model, its dynamic version and the two extensions. Section 5 states the analytical results. Section 6 describes the numerical solution, the parameterisation and its validation. Section 7 presents the baseline equilibrium, Section 8 the counterfactual experiments, and Section 9 the welfare analysis. Section 10 states limitations, falsifiable predictions and conclusions. Proofs, computational details and additional tables are in the appendices.

2. Related literature

This paper belongs to the search-and-matching literature on housing markets and borrows its tools from the Diamond–Mortensen–Pissarides framework (Diamond, 1982; Mortensen and Pissarides, 1994; Pissarides, 2000; Rogerson et al., 2005). It is organised around four themes: the theory of

housing liquidity and seller urgency, the credit and financing channel, the measurement of prices and liquidity, and the foundations on which the formal results rest. The review draws on a verified bibliography of 132 references; the closest antecedents of each proposition are identified explicitly so that what is restated and what is new can be told apart.

2.1. Search, liquidity and seller urgency

The matching approach to housing begins with [Arnott \(1989\)](#), who shows that idiosyncratic tastes generate equilibrium vacancies in a thin market, and [Wheaton \(1990\)](#), in which a mismatched owner searches while carrying a vacant unit, so that the Nash-bargained price depends on the vacancy rate through the expected time to sell and the cost of holding two houses. [Yavas \(1992\)](#) adds two-sided search intensity, and [Williams \(1995\)](#) prices heterogeneous real assets as optimal-stopping values under Poisson buyer arrivals, which yields the first explicit search-induced price discount. [Krainer \(2001\)](#) is the reference theory of residential *liquidity*: buyers draw match-specific values, sellers set reservation prices that anticipate the aggregate state, and time on market lengthens in downturns because waiting is rational; [Krainer and LeRoy \(2002\)](#) value an illiquid asset relative to a liquid benchmark as a function of the arrival intensity. [Han and Strange \(2015\)](#) organise the field into one-sided search, random matching, directed search, bargaining and brokerage. The present model is a random-matching, Nash-bargaining model with a posted-price robustness check, and it inherits from this strand the two objects it formalises: the sale hazard and a discount measured against a benchmark price. A distinction that matters for what follows is that the “liquidity shock” of [Krainer \(2001\)](#) is a shock to the dividend from housing services, whereas the shocks studied here change matching efficiency or buyer qualification and leave the distribution of housing-service values unchanged. [Ngai and Tenreyro \(2014\)](#) provide the closest precedent for a non-fundamental driver: thick-market effects on match quality turn small seasonal shifts into large seasonal swings in prices and volume. [Novy-Marx \(2009\)](#) shows that the feedback between the buyer–seller ratio and bargaining positions amplifies demand shocks; [Díaz and Jerez \(2013\)](#) and [Head et al. \(2014\)](#) reproduce the comovement of prices, sales and time on market with random matching, bargaining and entry; [Ngai and Sheedy \(2020\)](#), [Ngai and Sheedy \(2024\)](#), [Moen et al. \(2021\)](#), [Gabrovski and Ortego-Marti \(2019\)](#), [Caplin and Leahy \(2011\)](#), [Guren \(2018\)](#), [Anenberg \(2016\)](#), [Leung and Tse \(2017\)](#) and [Piazzesi et al. \(2020\)](#) develop the aggregate-dynamics branch. The model below is stationary and local in scope: it asks what a fall in matching efficiency or qualification does to the cross-section of hazards and prices and to the composition of transactions, not what drives the cycle.

The nearest antecedent of the central device of this paper is [Albrecht et al. \(2007\)](#), in which buyers and sellers switch from a “relaxed” to a “desperate” flow value at a Poisson rate and the bargained price depends on the urgency states of the pair; they derive that the expected price conditional on time on market falls with duration while its variance is hump-shaped. Other formal

treatments of urgency are deadlines ([Salant, 1991](#)), the seller's discount rate ([Arnold, 1999](#)), the endogenous cost of holding two homes ([Anenberg and Bayer, 2020](#)), debt overhang that *raises* asking prices ([Head et al., 2023](#)), and an estimated motivation parameter ([Carrillo, 2012](#)). The empirical call for heterogeneous-seller theory is explicit in [Glower et al. \(1998\)](#): sellers with a planned move sell faster and motivation lowers the sale price but not the list markup. [Springer \(1996\)](#) finds lower prices for eager, relocated, vacant and foreclosed sellers; [Harding et al. \(2003a\)](#) find weaker bargaining power for vacant sellers; [Levitt and Syverson \(2008\)](#) estimate that agents selling their own homes obtain about 3.7 percent more after about 9.5 more days on the market. Equity and reference dependence work in the opposite direction: high loan-to-value and loss-facing sellers set higher asking prices and sell more slowly ([Genesove and Mayer, 1997, 2001](#)), and patient sellers sort into for-sale-by-owner platforms ([Hendel et al., 2009](#)). In every theoretical treatment cited, urgency is a two-state process, a deadline, a debt position or a nuisance parameter. None models a continuous, permanent carrying-cost type whose cross-sectional distribution determines the stock of listings, the composition of transactions and, through free entry, market tightness. That is the modelling choice made here, and Proposition 1 should accordingly be read as the continuous-type version of a known comparative static ([Lippman and McCall, 1976](#)) rather than as a new result.

The size and state dependence of liquidity discounts are documented by [Campbell et al. \(2011\)](#) (foreclosure sales about 27 percent below comparable houses in Massachusetts, smaller discounts for death- and bankruptcy-related sales, and a spillover of about one percent per nearby foreclosure), [Clauret and Daneshvary \(2009\)](#) (naïve discounts above 20 percent overstated by about one third once condition, endogenous marketing time and spatial dependence are controlled), [Pennington-Cross \(2006\)](#), [Mayer \(1998\)](#) (a price of immediacy of 0–9 percent in a boom against 9–21 percent in a bust) and [Andersen and Nielsen \(2017\)](#) (forced sales after sudden death: discounts rising with urgency, poor market conditions and seller constraints, with demand held fixed). Spillovers from urgent sellers ([Harding et al., 2009](#); [Anenberg and Kung, 2014](#); [Mian et al., 2015](#)) show that a larger mass of urgent sellers lowers prices for all sellers without a change in fundamentals, which is the empirical content of Proposition 4. What these studies do not provide is a decomposition of the discount into bargaining under a high carrying cost and the selection of which houses transact.

2.2. Credit, qualification and the cash–mortgage gap

[Hedlund \(2016b\)](#), [Hedlund \(2016a\)](#) and [Garriga and Hedlund \(2020\)](#) make search-based illiquidity a state variable that interacts with long-term defaultable mortgages; [Guren and McQuade \(2020\)](#) show how foreclosures freeze the non-distressed market; [Eerola and Määttänen \(2018\)](#) find that a moderate tightening of borrowing constraints raises time on market and idiosyncratic price dispersion; [Gabrovski and Ortego-Marti \(2021\)](#) open a channel from credit to liquidity with multiplicity; [Díaz et al. \(2024\)](#) have wealthier buyers paying to transact faster under competitive

search; and [Stein \(1995\)](#) and [Ortalo-Magné and Rady \(2006\)](#) are the frictionless benchmarks with credit constraints. On the evidence side, qualification is elastic and delays are measurable ([Anenberg et al., 2019](#); [Bhutta and Ringo, 2021](#); [DeFusco et al., 2020](#); [Fuster et al., 2019](#)); [Allen et al. \(2019\)](#) show that the Canadian insured-mortgage market is itself a negotiated-price search market.

The cash–mortgage gap is the empirical object to which the financing extension of Section 4 speaks. [Reher and Valkanov \(2024\)](#) estimate a mortgage premium of about 11 percent over 1980–2017, against about 3 percent from a representative-seller model, and find that heterogeneity in selling conditions closes half of the gap. [Han and Hong \(2024\)](#) estimate a cash discount of 2–3.9 percent with 29 percent faster closing in Los Angeles and show, with a calibrated search model, that closing risk alone is insufficient: the risk that a relisted property fails to sell is needed, which makes the discount smaller in booms and in larger markets. [Asabere et al. \(1992\)](#), [Jauregui et al. \(2019\)](#), [Aroul and Hansz \(2023\)](#), [Lin et al. \(2025\)](#) and [Buchak et al. \(2026\)](#) add magnitudes and selection caveats. The only formal bargaining theory with financing that could be verified is [Bian et al. \(2018\)](#). No paper decomposes the measured gap into a bargaining component that depends on seller urgency, an outside-option component, and a selection component arising from which matches are accepted; Proposition 7 does so.

2.3. Selection, indices and comovement

The measurement literature establishes that sold houses are not a random sample of the stock and that the resulting bias co-moves with the cycle ([Jud and Seaks, 1994](#); [Gatzlaff and Haurin, 1997, 1998](#); [Hwang and Quigley, 2004](#)). The closest antecedent of Proposition 6 is [Goetzmann and Peng \(2006\)](#): with heterogeneous reservation prices, falling volume biases index returns upward and rising volume biases them downward. In commercial real estate, [Fisher et al. \(2003\)](#), [Fisher et al. \(2007\)](#) and [Clayton et al. \(2008\)](#) build constant-liquidity indices that lead transaction indices and are more volatile; [Lin and Vandell \(2007\)](#), [Bond et al. \(2007\)](#), [Cheng et al. \(2010\)](#), [Lin and Liu \(2008\)](#) and [Cheng et al. \(2013\)](#) show that ignoring the uncertain marketing period biases returns upward and risk downward, and that the risk is seller-specific. The classical index tools ([Bailey et al., 1963](#); [Case and Shiller, 1989](#); [Clapp and Giaccotto, 1992](#)) assume random sampling. Bargaining and information confounders are documented by [Harding et al. \(2003b\)](#), [Kurlat and Stroebel \(2015\)](#) and [Garmaise and Moskowitz \(2004\)](#); volume leads prices in [Berkovec and Goodman \(1996\)](#), [Hort \(2000\)](#), [Clayton et al. \(2010\)](#), [Andrew and Meen \(2003\)](#) and [Leamer \(2007\)](#); [Dachis et al. \(2012\)](#) provide a Canadian transfer-tax experiment. The literature recognises the bias; no verified paper derives its sign from primitives in a search equilibrium, and the result below is that the sign is not a general law.

The duration literature ([Zuehlke, 1987](#); [Haurin, 1988](#); [Jud et al., 1996](#); [Anglin et al., 2003](#); [Knight, 2002](#); [Haurin et al., 2010](#); [Huang and Palmquist, 2001](#); [Benefield and Hardin, 2015](#); [Carrillo](#)

and Pope, 2012; Anglin, 2006) documents the price–time trade-off, positive duration dependence in parametric hazards without unobserved heterogeneity, and the sensitivity of results to withdrawals and relistings; Taylor (1999) (stigma) and Anenberg (2016) (learning) are competing explanations of duration effects. The observed hazard in the model is a mixture over urgency types with a competing withdrawal risk and predicts spurious negative duration dependence (Lemma 3); positive dependence in the data requires mechanisms that are outside the model.

2.4. Foundations and tools

Efficiency is assessed against the Hosios condition (Hosios, 1990), with the caveat of Gabrovski and Ortego-Martí (2025) that two-sided entry breaks it in housing markets; the model keeps listing inflow exogenous so that heterogeneity is the only additional wedge. The reservation-value characterisation follows Lippman and McCall (1976); the monotone-hazard results use the log-concavity properties catalogued by Bagnoli and Bergstrom (2005); the matching function and the interpretation of its efficiency parameter follow Petrongolo and Pissarides (2001), with the contact-hazard elasticity of 0.84 estimated by Genesove and Han (2012) and the tightness measures of Carrillo (2013), Carrillo et al. (2015) and Han and Strange (2014) as empirical counterparts; Shimer (2005) and Mortensen and Pissarides (1999) provide the labour-market benchmarks. Bargaining follows Nash (1950), with Rubinstein (1982) as its strategic foundation; posted prices and directed search follow Moen (1997), Wright et al. (2021) and Albrecht et al. (2016), and the list-price literature (Horowitz, 1992; Yavas and Yang, 1995; Merlo and Ortalo-Magné, 2004; Merlo et al., 2015; Han and Strange, 2016) provides the empirical counterpart of the posted-price protocol. Price dispersion among homogeneous agents goes back to Burdett and Judd (1983), with Maury and Tripier (2014) and Sagi (2021) as housing and asset-market applications. The asset-market search literature (Duffie et al., 2005; Lagos and Rocheteau, 2009; Rocheteau and Weill, 2011) supplies the finance notion of an endogenous liquidity premium; the housing unit here is indivisible and match-specific, so the holdings margin that offsets frictions in those models is absent and the premium is driven by seller urgency and tightness instead. Head and Lloyd-Ellis (2012) first used “liquidity as how fast owners can sell” as a state variable linking housing and labour markets, and Piazzesi and Schneider (2009) note that the composition of marginal traders moves prices.

3. Institutional intuition and the frictionless benchmark

A house is sold through a sequence of costly events: a listing, visits and offers from buyers who arrive at random, a negotiation in which the seller’s willingness to wait and the buyer’s alternatives both matter, and, for most buyers, a financing step whose outcome is uncertain and takes time. During this sequence the seller pays a carrying cost that differs across sellers: mortgage interest

and maintenance for all, the cost of a second residence or a bridge loan for those who have already moved, and the psychological or financial cost of an unresolved sale for those under distress. The evidence reviewed in Section 2 shows that these costs translate into prices and durations in a systematic way: motivated, relocated and foreclosed sellers obtain lower prices and sell faster, and the discount they accept is larger when the market is thin. The purpose of the model is to make this logic explicit in a setting where the arrival of buyers, the acceptance decisions of sellers of different urgency, the price that results from bargaining, and the entry of buyers that determines how many of them there are per listing, are all determined jointly.

Two benchmarks are used throughout, and they answer different questions. The first is the most patient seller in the same market. Sellers who differ only in their carrying cost face the same buyers, the same matching technology and the same bargaining protocol, so the gap between their expected transaction prices isolates the price of urgency. The *urgency discount* of a seller with carrying cost c is defined relative to the most patient type,

$$D(c) \equiv \frac{\bar{p}(c_L) - \bar{p}(c)}{\bar{p}(c_L)}, \quad (1)$$

where $\bar{p}(c)$ is the expected transaction price conditional on a sale. This is the model counterpart of the forced-sale discount measured by [Campbell et al. \(2011\)](#) or [Andersen and Nielsen \(2017\)](#): a comparison among houses that are identical except for the circumstances of their owners. Proposition 1 shows that $D(c)$ is nonnegative and increasing in c under weak conditions, so that it can be called a discount without further qualification.

The second benchmark is a frictionless market. Consider the same buyers, with the same entry cost k , the same distribution G of match-specific valuations w and the same discount rate r , but suppose that buyers meet listings instantly and that each house trades at a uniform price p^* at which the buyer either buys or walks away. With free entry, buyers enter until the expected gain from an immediate purchase equals the entry cost:

$$\int (w - p^*)^+ dG(w) = rk \quad \Longleftrightarrow \quad H(p^*) = rk, \quad (2)$$

where $H(v) \equiv \int (w - v)^+ dG(w)$ is the expected surplus function that recurs throughout the paper.¹ Sellers in this benchmark trade immediately at p^* and pay no carrying cost, so p^* does not depend on c , on tightness, on bargaining power or on matching efficiency. The *market liquidity gap* is

¹The entry cost is a stock and the surplus flow is a present value; equating the flow equivalent rk to the expected surplus of a single immediate purchase is the Walrasian counterpart of the free-entry condition of the search economy, where the value of an active buyer equals k . Details are in Appendix A.

defined as

$$\Gamma \equiv \frac{p^* - \bar{p}_T}{p^*}, \quad (3)$$

where $\bar{p}_T$ is the transaction-weighted mean price of the search economy. It would be natural to call Γ the liquidity premium of the housing market, and the sign convention $D = (p^* - p)/p^*$ suggests that it should be positive. It is not: search delays and carrying costs push transaction prices below p^* , but in a search market with bargaining a seller also has the option to wait for a buyer with a high match-specific valuation and to capture part of that valuation, an option that the uniform-price benchmark rules out. Proposition 2(iv) shows that Γ is positive in thin markets and negative in sufficiently thick ones. The paper therefore reports Γ as a decomposition and reserves the term liquidity discount for $D(c)$ and its transaction-weighted average $\bar{D} = \int D(c) \omega(c) dc$, where ω is the composition of transactions across seller types. Two further objects are used: the *seller's liquidity cost* $L(c) = c/(r + \delta + \eta(c))$, the expected discounted carrying cost paid over a listing spell with sale hazard $\eta(c)$ and withdrawal hazard δ , and the *reservation-value gap* $V(c_L) - V(c)$ between the most patient and a type- c seller. A buyer's willingness to pay to avoid search is a distinct object, measured by the buyer's value U , and is not reported as a price discount.

The distinction between the two benchmarks matters for interpretation. Because the model has no quality heterogeneity within a market segment (quality is a scale factor, Lemma 1), every price gap it produces is a gap among identical houses. In data, the comparison of forced and unforced sales also requires conditioning on quality and condition, and [Clauret and Daneshvary \(2009\)](#) show that about a third of naive foreclosure discounts disappears once this is done. The urgency discount $D(c)$ is the part that survives such conditioning; the model is silent on the part that does not.

4. A search model of a local housing market

4.1. Environment

Time is continuous and the horizon infinite; all agents discount at the rate $r > 0$. The market is a quality segment of a local housing market with houses of quality $q > 0$; Lemma 1 shows that q scales values and prices, so the exposition sets $q = 1$ and measures prices, values and costs in units of the mean buyer valuation of the segment.

Sellers. New listings arrive at the exogenous flow $s > 0$ per unit time. The owner of a listing has a permanent *carrying cost* c , drawn at listing from a distribution F with support $[c_L, c_H]$, $0 \leq c_L < c_H < \infty$, and pays c per unit time while the house is listed. Listings are withdrawn at the exogenous rate $\delta \geq 0$; a seller who withdraws keeps the house and obtains its own-use value $w_0 \geq 0$.

The value of being listed, $V(c)$, is therefore measured relative to this outside option.

Buyers. A buyer enters the market at the sunk cost $k > 0$, pays the flow search cost $\kappa_b \geq 0$ while active, and exits upon purchase. Upon meeting a listing the buyer draws a match-specific valuation $w \sim G$, the present value of the housing-service flow to that buyer, with density g on $[w_L, w_H]$, $0 \leq w_L < w_H \leq \infty$. A purchase at price p yields $w - p$; resale is abstracted from.

Matching. With B active buyers and S listed sellers, meetings occur at the rate $m(B, S) = AB^\alpha S^{1-\alpha}$ with $\alpha \in (0, 1)$ and $A > 0$. Tightness is $\theta = B/S$; a seller meets buyers at the rate $\lambda_s(\theta) = A\theta^\alpha$ and a buyer meets listings at $\lambda_b(\theta) = A\theta^{\alpha-1}$. Meetings are random across the stock of listings, so a buyer meets a type- c seller with probability $N(c) = n(c)/S$, where n is the stock density of listed sellers. A meeting is with a qualified buyer with probability $\phi \in (0, 1]$ (a pre-approval screen); unqualified meetings are wasted. The effective contact rates are $\Lambda_s = \phi\lambda_s(\theta)$ and $\Lambda_b = \phi\lambda_b(\theta)$. Section 4.5 replaces the screen by a financing contingency with cash and mortgage buyers.

Bargaining. Within a match both parties observe (w, c) and split the surplus by generalised Nash bargaining with seller share $\beta \in (0, 1)$; trade occurs if and only if the match surplus is nonnegative. Section 4.6 replaces bargaining by posted prices.

Liquidity shocks. A liquidity shock is an unanticipated change in matching efficiency A or in qualification ϕ with $(G, F, r, k, \kappa_b, s, \delta, w_0)$ unchanged, so that the distribution of housing-service values is the same before and after.

Assumption 1 (Match-value distribution). G is continuous with a density g that is positive on the interior of its support and has a finite mean. Where stated, G is IFR (increasing failure rate: $1 - G$ is log-concave), which holds whenever g is log-concave (Bagnoli and Bergstrom, 2005); the truncated normal of the baseline parameterisation satisfies this, the exponential is the boundary case, and the Pareto violates it.

Three functions of G recur. The expected surplus function $H(v) = \int (w - v)^+ dG(w) = \int_v^{w_H} (1 - G(w)) dw$ is nonincreasing and convex with $H'(v) = -(1 - G(v))$; the hazard function is $h_G(v) = g(v)/(1 - G(v))$; and the mean residual valuation is $M(v) = H(v)/(1 - G(v)) = E[w - v \mid w \geq v]$. Two facts are used repeatedly: $M'(v) = -1 + h_G(v)M(v) > -1$ wherever $g(v) > 0$, with $M' \leq 0$ under IFR; and $gH \leq (1 - G)^2$ under IFR.

4.2. Value functions, trade and prices

Let U be the value of an active buyer. A listed seller of type c solves

$$(r + \delta)V(c) = -c + \delta w_0 + \Lambda_s \beta H(V(c) + U), \quad (4)$$

and an active buyer solves

$$rU = -\kappa_b + \Lambda_b (1 - \beta) \int H(V(c) + U) dN(c). \quad (5)$$

The match surplus is $\Sigma(w, c) = w - V(c) - U$, so trade occurs iff $w \geq v^*(c) \equiv V(c) + U$, the *reservation valuation* of a type- c seller; $V(c)$ is the seller's reservation price and $w - U$ the buyer's. The Nash price is

$$p(w, c) = V(c) + \beta \Sigma(w, c) = (1 - \beta)V(c) - \beta U + \beta w. \quad (6)$$

The *sale hazard* of a type- c listing is $\eta(c) = \Lambda_s[1 - G(v^*(c))]$, the product of the meeting hazard and the conditional sale probability; the exit hazard is $\eta(c) + \delta$; the survival of a listing is $e^{-(\eta(c) + \delta)\tau}$; the expected listing duration is $1/(\eta(c) + \delta)$ and the probability of eventual sale is $\eta(c)/(\eta(c) + \delta)$. The expected transaction price of type c is

$$\bar{p}(c) \equiv E[p \mid \text{sale}, c] = V(c) + \beta M(v^*(c)), \quad (7)$$

the reservation price plus the seller's share of the mean surplus of accepted matches.

4.3. Stocks, composition and equilibrium

In a stationary state the inflow of type- c listings equals their outflow, so that $sf(c) = (\eta(c) + \delta)n(c)$ and

$$n(c) = \frac{sf(c)}{\eta(c) + \delta}, \quad S = \int n(c) dc, \quad B = \theta S, \quad Q = \int \eta(c)n(c) dc, \quad \omega(c) = \frac{\eta(c)n(c)}{Q}, \quad (8)$$

where Q is the sales flow and ω the *transaction composition*, the distribution of carrying costs among houses that sell. Three weightings are therefore distinguished: the listing cohort f , the stock N , and the transactions ω . Buyers exit only by purchase, so the buyer entry flow equals Q .

Definition 1 (Stationary equilibrium). Given primitives $(r, \delta, w_0, s, F, G, A, \alpha, \phi, \beta, k, \kappa_b)$, a stationary equilibrium with free entry is a tuple $(\theta, U, V(\cdot), n(\cdot))$ such that (4) holds for every c , (5) holds, buyers enter until $U = k$, and the stock equations (8) hold. A *partial equilibrium* fixes θ , sets $U = k$,

and drops (5).

Free entry pins the buyer's value at the entry cost at every tightness. This has two consequences that organise the analysis. First, the seller block (4) can be studied at a given Λ_s with $U = k$, and all comparative statics of reservation prices, hazards and prices with respect to arrival rates are partial-equilibrium statements that hold conditionally on tightness. Second, tightness itself responds: a fall in ϕ or A lowers the surplus buyers expect per meeting, buyers exit, θ falls, and sellers meet buyers even less often. Proposition 3 characterises this feedback.

Listing is worthwhile for a type- c seller iff $V(c) \geq w_0$. Proposition 1(iv) gives the threshold carrying cost $\bar{c} = \Lambda_s \beta H(w_0 + k) - rw_0$ above which a seller would not list; the baseline parameterisation satisfies $c_H < \bar{c}$, and the condition is checked in every reported equilibrium.

4.4. Transition dynamics

An unanticipated permanent or temporary shock to A or ϕ at date zero leaves the stock of listings predetermined and moves the economy along a path $(\theta_t, V_t(\cdot), n_t(\cdot))$. Buyers enter or exit freely at every instant, so $U_t = k$ throughout. The seller value obeys the backward equation

$$\dot{V}_t(c) = (r + \delta)V_t(c) + c - \delta w_0 - \Lambda_s(\theta_t) \beta H(V_t(c) + k), \quad (9)$$

free entry holds pointwise and the stock evolves forward,

$$rk = -\kappa_b + \Lambda_b(\theta_t)(1 - \beta) \int H(V_t(c) + k) dN_t(c), \quad \dot{n}_t(c) = sf(c) - (\eta_t(c) + \delta)n_t(c). \quad (10)$$

The observed transaction-price index is $P_t = \int \bar{p}_t(c) \omega_t(c) dc$; a fixed-composition index $P_t^{fix} = \int \bar{p}_t(c) \omega_0(c) dc$ holds the pre-shock transaction weights fixed, so that

$$\ln P_t - \ln P_0 = \underbrace{[\ln P_t^{fix} - \ln P_0]}_{\text{within-type (liquidity)}} + \underbrace{[\ln P_t - \ln P_t^{fix}]}_{\text{composition (selection)}}. \quad (11)$$

Because G is unchanged, a fundamental index is flat and the whole movement of P_t is non-fundamental. Section 8.7 signs the composition term.

4.5. Financing contingency: cash and mortgage buyers

In the baseline the qualification screen ϕ multiplies both contact rates, so that A and ϕ enter every equilibrium condition only through the product ϕA (Proposition 3): a qualification shock and a matching-efficiency shock are observationally equivalent. The extension of this subsection breaks the equivalence by modelling the financing step explicitly. A buyer is a cash buyer with

probability π and a mortgage buyer otherwise, the type being drawn at entry. A cash agreement closes immediately. A mortgage agreement at price p enters a *pending* state: the lender's decision arrives at rate v and is favourable with probability ϕ_m ; on failure the house returns to the market and the buyer to search. During the pending spell the seller keeps paying c and the buyer κ_b . The pending values are

$$P_s(c, p) = \frac{-c + v\phi_m p + v(1 - \phi_m)V(c)}{r + v}, \quad P_b(w, p) = \frac{-\kappa_b + v\phi_m(w - p) + v(1 - \phi_m)U_m}{r + v}, \quad (12)$$

where U_m is the value of a searching mortgage buyer and U_c that of a cash buyer. The joint surplus of a mortgage agreement is $\Sigma_m(w, c) = [v\phi_m(w - V - U_m) - c - \kappa_b - r(V + U_m)]/(r + v)$, so a mortgage agreement requires

$$w \geq v_m^*(c) \equiv V(c) + U_m + \frac{c + \kappa_b + r(V(c) + U_m)}{v\phi_m}, \quad (13)$$

whereas a cash agreement requires $w \geq v_c^*(c) = V(c) + U_c$. Sellers meet cash buyers in a share $\tilde{\pi}$ of meetings that is determined by the stocks of searching buyers of each type; buyers of each type solve their own version of (5); ex-ante free entry requires $\pi U_c + (1 - \pi)U_m = k$; and the stock equations account for pending houses and for houses returning to the market. Appendix B states the full system. The baseline is the limit $v \rightarrow \infty$ with $\phi = \tilde{\pi} + (1 - \tilde{\pi})\phi_m$.

4.6. Posted prices

As a robustness protocol the seller commits to a price p before the buyer's valuation is drawn, and the buyer accepts iff $w - p \geq U$. Writing $y = p + U$, the seller solves

$$(r + \delta)V(c) = -c + \delta w_0 + \Lambda_s \max_y [1 - G(y)] (y - U - V(c)), \quad (14)$$

whose interior optimum satisfies $y(c) - U - V(c) = 1/h_G(y(c))$. Prices are deterministic within a type, so all dispersion among identical houses is urgency-driven under this protocol.

4.7. Welfare

The steady-state flow of surplus generated by the market is

$$\Omega = \int \eta(c)n(c) (E[w | w \geq v^*(c)] - w_0) dc - \int c n(c) dc - \kappa_b B - kQ, \quad (15)$$

the value created by sales net of the own-use value forgone, carrying costs, search costs and entry costs. Under free entry buyers earn zero net of entry, so Ω accrues to sellers in equilibrium; the

ex-ante value of a listing cohort is $s \int (V(c) - w_0) dF(c)$. This flow criterion ignores discounting across cohorts and transition costs; the Hosios condition $\beta = 1 - \alpha$ of the discounted problem (Hosios, 1990) is used as a reference point, not as a theorem about (15).

5. Analytical results

Proofs are in Appendix A. Unless stated otherwise, the buyer value U is held fixed (under free entry $U = k$) and $\Lambda_s > 0$ is given; results that involve the response of tightness are stated separately.

Lemma 1 (Scale invariance in quality). *Let $w = q\varepsilon$ with $\varepsilon \sim G_\varepsilon$, $c = q\kappa$, $k = q\tilde{k}$ and $\kappa_b = q\tilde{\kappa}_b$. If (θ, U, V, n) is a stationary equilibrium of the economy with $q = 1$, then (θ, qU, qV, n) is a stationary equilibrium of the economy with quality q ; prices scale by q , while hazards, durations, tightness, the transaction composition and the discounts $D(c)$ are invariant.*

Lemma 2 (Seller value). *For any U , $\Lambda_s > 0$ and $c \geq 0$, equation (4) has a unique solution $V(c)$, continuously differentiable in (c, Λ_s, U) , with*

$$\frac{\partial V}{\partial c} = \frac{-1}{(r + \delta) + \Lambda_s \beta (1 - G(v^*))}, \quad \frac{\partial V}{\partial \Lambda_s} = \frac{\beta H(v^*)}{(r + \delta) + \Lambda_s \beta (1 - G(v^*))}, \quad \frac{\partial V}{\partial U} \in (-1, 0]. \quad (16)$$

Lemma 3 (Spurious negative duration dependence). *If the exit hazard $\mu(c) = \eta(c) + \delta$ is non-degenerate under F , the population exit hazard $\bar{h}(\tau) = -\frac{d}{d\tau} \ln \int e^{-\mu(c)\tau} dF(c)$ is strictly decreasing in listing duration τ , although every individual hazard is constant.*

Proposition 1 (Seller urgency). *(i) The reservation price falls with the carrying cost, by less than one-for-one in present-value terms: $V'(c) \in (-1/(r + \delta), 0)$. (ii) The sale hazard $\eta(c)$ is nondecreasing in c , strictly where $g(v^*(c)) > 0$, and the expected listing duration is nonincreasing. (iii) The expected transaction price is strictly decreasing in c , $\bar{p}'(c) = V'(c) [1 + \beta M'(v^*(c))]$ with $1 + \beta M' > 1 - \beta > 0$, and under IFR $|\bar{p}'(c)| \leq |V'(c)|$: the price falls by less than the reservation price. The urgency discount $D(c)$ is therefore zero at c_L , nonnegative and strictly increasing. (iv) Under free entry a type- c seller prefers listing to keeping the house iff $c \leq \bar{c} \equiv \Lambda_s \beta H(w_0 + k) - rw_0$.*

Part (i) is the classical reservation-value result of Lippman and McCall (1976) in the present setting and the continuous-type counterpart of the desperate-seller effect of Albrecht et al. (2007); it is stated for completeness and because the magnitude of the slope, $1/[(r + \delta) + \beta \eta(c)]$, is what later results build on. Part (iii) contains the less obvious point that transaction prices respond to urgency *less* than reservation prices. An urgent seller accepts lower matches, but conditional on acceptance the buyer's surplus is larger on average, and the seller captures the share β of it. No log-concavity is needed for the sign; IFR is needed only for the attenuation.

Proposition 2 (Effective arrival rate). (i) $\partial V/\partial \Lambda_s > 0$ and $\partial \bar{p}/\partial \Lambda_s > 0$ whenever $v^* < w_H$. (ii) If G is IFR, $\partial \eta/\partial \Lambda_s > 0$: a decline in buyer arrivals or in qualification lengthens expected time on market. The sign can reverse without IFR: for the Pareto distribution $G(w) = 1 - (w_L/w)^a$, $a > 1$,

$$\frac{\partial \eta}{\partial \Lambda_s} < 0 \iff \beta \eta(c) > (a-1)(r+\delta) \iff c > \delta w_0 + (r+\delta)U, \quad (17)$$

a condition that does not depend on Λ_s . (iii) Under IFR the reservation-value gap $V(c_L) - V(c)$ is strictly decreasing in Λ_s for every $c > c_L$: lower liquidity widens the cross-sectional dispersion of reservation prices. (iv) For the patient type $c = 0$ with $U = k \leq w_L$ and $w_H < \infty$, $\bar{p} \rightarrow \beta(E[w] - k)$ as $\Lambda_s \rightarrow 0$ and $\bar{p} \rightarrow w_H - k$ as $\Lambda_s \rightarrow \infty$; if $\beta(E[w] - k) < p^* < w_H - k$, which holds iff $H(w_H - k) < rk$, the market liquidity gap Γ is positive in thin markets and negative in thick ones.

Part (ii) is the result that a more liquid market shortens time on market, together with the condition under which it fails. A higher arrival rate raises the seller's reservation valuation (part (i)); whether the hazard rises depends on whether the direct effect of more meetings dominates the indirect effect of greater selectivity. Under IFR the mean residual valuation is bounded by the reciprocal hazard, $M \leq 1/h_G$, which is exactly what is needed. With heavy-tailed valuations the seller's option to wait for an exceptional buyer becomes more valuable faster than buyers arrive, and the condition in (17) shows that this happens for every sufficiently urgent seller, at every arrival rate. The empirical counterpart is a segment of unique or luxury properties in which greater buyer traffic does not shorten marketing time. Part (iv) is the formal reason for not calling Γ a liquidity premium.

Proposition 3 (Free entry and tightness). (a) With homogeneous sellers the free-entry residual $R(\theta) = -\kappa_b + \phi \lambda_b(\theta)(1 - \beta)H(V(\theta) + k) - rk$ is continuous and strictly decreasing from $+\infty$ to $-\kappa_b - rk$, so equilibrium tightness θ^* is unique; $d\theta^*/d\phi > 0$, $d\theta^*/dA > 0$, and $d \ln \Lambda_s/d \ln \phi = 1 + \alpha d \ln \theta^*/d \ln \phi > 1$. In the baseline, A and ϕ enter all equilibrium conditions only through the product ϕA . (b) With heterogeneous sellers an equilibrium exists; uniqueness is not guaranteed, because the stock composition N depends on θ , and is verified numerically.

Proposition 4 (A liquidity shock without a fundamental shock). Let G be IFR. A fall in A or in ϕ with all other primitives unchanged (i) lowers $V(c)$ and $\bar{p}(c)$ for every c , in partial equilibrium and, since θ^* falls as well, in general equilibrium with homogeneous sellers; (ii) lowers every sale hazard and the sales flow on impact, when the stock of listings is predetermined; (iii) raises the steady-state inventory S and mean listing duration; (iv) lowers the steady-state sales flow if and only if $\delta > 0$: with $\delta = 0$ every listing eventually sells and the steady-state sales flow equals the listing inflow whatever the level of liquidity. Transaction prices and volume therefore co-move, and inventory and time on market move inversely, with no change in the distribution of housing-service values.

Part (iv) is a diagnostic rather than a curiosity. In a market where listings are rarely withdrawn, a permanent fall in liquidity lowers volume only during the transition; a persistent fall in the sales-to-listings ratio across steady states requires withdrawals or relistings, which the duration literature finds to be common (Anglin et al., 2003; Benefield and Hardin, 2015).

Proposition 5 (Price dispersion among identical houses). *Conditional on sale,*

$$\text{Var}_\omega(p) = \beta^2 E_\omega [\text{Var}(w \mid w \geq v^*(c))] + \text{Var}_\omega[\bar{p}(c)]. \quad (18)$$

(i) *The between-type component is strictly positive iff the transaction composition is non-degenerate.*
(ii) *With $\beta = 0$ all dispersion is urgency-driven and $\text{Var}_\omega(p) \leq \text{Var}_\omega(c)/(r + \delta)^2$; under IFR the range of expected prices satisfies $\bar{p}(c_L) - \bar{p}(c_H) \leq (c_H - c_L)/(r + \delta)$.* (iii) *Under IFR the between-type reservation-value gap widens when Λ_s falls.*

Proposition 6 (Sale selection and transaction-price indices). (i) *If $\delta = 0$, the steady-state transaction composition equals the listing composition, $\omega = f$, for every Λ_s : comparisons across steady states contain no composition effect.* (ii) *On impact of an unanticipated change $d \ln \Lambda_s$ with the stock predetermined, let $\varepsilon(c) = \partial \ln \eta(c) / \partial \ln \Lambda_s = 1 - \beta \eta(c) h_G(v^*) M(v^*) / [(r + \delta) + \beta \eta(c)]$. Then $d \ln \omega(c) = [\varepsilon(c) - E_\omega \varepsilon] d \ln \Lambda_s$ and*

$$d \ln P = E_\omega [d \ln \bar{p}(c)] + \frac{\text{Cov}_\omega(\bar{p}(c), \varepsilon(c))}{P} d \ln \Lambda_s. \quad (19)$$

If ε is decreasing in c the covariance is positive and the index moves by more than every within-type price (selection amplifies); if ε is increasing in c the covariance is negative and selection dampens. (iii) *For exponential G , $\varepsilon(c) = (r + \delta) / [(r + \delta) + \beta \eta(c)]$ is strictly decreasing in c , and for Pareto G likewise; a sufficient condition for amplification is that $v \mapsto h_G(v) M(v)$ be nonincreasing. When $h_G M$ is increasing, as for light-tailed distributions such as the truncated normal, ε can be increasing in c and selection dampens.* (iv) *With $\delta = 0$ the composition returns to f in the new steady state, so the impact composition effect is transitory.*

The economics of part (ii) is a race between two forces. After a fall in arrivals every seller lowers the valuation she accepts, and the share of sales made by each type changes in proportion to the elasticity of its hazard. Urgent sellers already accept most offers, so their hazard is less elastic to arrivals through the acceptance margin, which pushes the sales mix toward them and pulls the index down by more than the fall in any individual price; this is the mechanism of Goetzmann and Peng (2006) seen from the supply side. But urgent sellers also sit lower in the valuation distribution, where the product of the hazard function and the mean residual valuation of G can be smaller, which makes their acceptance threshold more responsive. The exponential distribution, for which

$h_G M = 1$, is the knife-edge where only the first force operates; for lighter tails the second force can dominate. The sign of the selection bias in a transaction index is therefore a property of the distribution of buyer valuations, not a general law; Section 8.7 quantifies both cases.

Proposition 7 (Financing contingency). *In the extension of Section 4.5, for a seller of type c and a match w acceptable to both buyer types,*

$$p_m(w, c) - p_c(w, c) = \underbrace{\frac{(1 - \beta)[c + rV(c)] - \beta[\kappa_b + rU_m]}{v\phi_m}}_{\Delta_b(c) \text{ (delay-bargaining term)}} + \underbrace{\beta(U_c - U_m)}_{\text{outside-option term}}. \quad (20)$$

(i) $\Delta_b(c)$ is positive iff the seller's bargaining-weighted flow cost of waiting, $(1 - \beta)[c + rV(c)]$, exceeds the buyer's, $\beta[\kappa_b + rU_m]$; it is nondecreasing in c and vanishes as $v \rightarrow \infty$. (ii) The acceptance thresholds differ by $v_m^*(c) - v_c^*(c) = [c + \kappa_b + r(V + U_m)]/(v\phi_m) - (U_c - U_m)$, a pending wedge increasing in c net of the cash buyers' outside-option advantage; the observed mean price gap conditional on sale adds the selection term $\beta\{E[w | w \geq v_m^*] - E[w | w \geq v_c^*]\}$, which has the sign of $v_m^* - v_c^*$ and can be negative for patient sellers. (iii) The baseline screen is the limit $v \rightarrow \infty$.

Equation (20) says that the party with the larger bargaining-weighted cost of delay pays for the financing contingency. When sellers are urgent and buyers patient, mortgage buyers pay more than cash buyers for the same house: this is the cash discount of Han and Hong (2024) and Reher and Valkanov (2024), derived rather than assumed. When buyers bear the larger cost of waiting, or when sellers have most of the bargaining power and extract less from a buyer whose own waiting cost reduces the surplus, the sign reverses. The measured gap adds two further terms. Cash buyers have a better continuation value, which lowers the price they pay by $\beta(U_c - U_m)$, and the two types of agreement are selected from different parts of the valuation distribution. The third term is the one that Reher and Valkanov (2024) attribute to “heterogeneity in selling conditions”; the proposition shows that it need not be positive.

Proposition 8 (Posted prices). *Let g be log-concave. (i) The posted-price problem (14) has a unique interior solution $y(c)$ with $y(c) - U - V(c) = 1/h_G(y(c))$. (ii) $V(c)$ is unique with $V'(c) = -1/[(r + \delta) + \Lambda_s(1 - G(y(c)))] < 0$; the posted price and the acceptance threshold are strictly decreasing in c and the hazard is increasing in c . (iii) At equal (V, U) , $y(c) > V(c) + U$: posted-price sellers hold out for better matches than bargaining sellers.*

Two statements are made numerically rather than proved: the uniqueness of tightness with heterogeneous sellers (Proposition 3(b)), and the location of the welfare-maximising bargaining share relative to the Hosios value. Both are reported in Section 9 with the parameter regions in which they were checked.

6. Numerical solution, parameterisation and validation

6.1. Algorithms

The seller block (4) is solved type by type as the unique root of the strictly decreasing function $\Phi(V) = -c + \delta w_0 + \Lambda_s \beta H(V + U) - (r + \delta)V$ (Lemma 2) by Brent's method with a bracket that is widened automatically when the support of G is unbounded. The distribution of carrying costs F is discretised into 9 types at the conditional means of equiprobable-mass bins of a Beta distribution; the expected surplus H , the mean residual valuation M and the conditional variance of G are computed in closed form for the truncated normal, exponential, Pareto and Weibull families. Equilibrium tightness is found by scanning the free-entry residual on a logarithmic grid of 60 points in $[0.02, 60]$ and applying Brent's method on every sign change; the number of roots is recorded, so that multiplicity would be reported rather than hidden. The posted-price protocol nests the seller's first-order condition inside the value root. The financing extension is solved as a three-equation root problem in $(\ln \theta, U_c, \text{logit } \tilde{\pi})$ with U_m imposed by ex-ante free entry; a damped fixed-point iteration on the buyer values was tried first and diverged, because the buyer map has a slope of order λ_b/r , and was replaced. The planner's steady-state problem maximises (15) over tightness and the vector of acceptance thresholds by derivative-free optimisation started at the decentralised allocation. Transition paths solve the backward equation (9) by a semi-implicit scheme, the forward stock equation by implicit Euler, and the pointwise free-entry condition by damped iteration on the tightness path until the maximum update falls below 10^{-7} . Tolerances, iteration counts and residuals are stored with every result file; Appendix B gives details.

6.2. Parameterisation

The parameterisation is illustrative. No moment is estimated and no data are used; the values in Table 1 are chosen so that the baseline equilibrium displays durations, discounts and dispersion of the order of magnitude reported in the literature reviewed in Section 2, and every experiment reports how the results move when they change. Time is measured in years and values in units of the mean buyer valuation of the segment. The discount rate is 4 percent. Match values are normally distributed with a 10 percent standard deviation and truncated at three standard deviations, which makes G log-concave. Carrying costs range from 2 percent of the house value per year (maintenance and property taxes for an owner who still lives in the house) to 30 percent (a seller carrying two homes, a bridge loan or a relocation deadline) with a right-skewed Beta(2, 4) shape, so that most sellers are patient and a minority urgent. Withdrawals occur at the rate 0.5 per year, which at baseline hazards removes about a tenth of listings, and a withdrawing seller keeps a house worth 0.8 to her. A buyer pays an entry cost of 2 percent of the house value and a flow search cost of 5 percent

per year, a figure that includes temporary housing and that must be comparable to sellers' carrying costs for the free-entry condition to deliver a tightness of a few buyers per listing; 85 percent of meetings are with qualified buyers. The matching function is Cobb–Douglas with elasticity one half and efficiency 4.5 meetings per year per side at unit tightness: a meeting is a serious offer, not a visit. The seller's Nash share is one half, the Hosios value for $\alpha = 1/2$. The financing extension uses a 30 percent share of cash buyers, a one-month expected financing decision and an approval probability of 0.85.

Table 1. Baseline parameterisation (illustrative; units of the mean buyer valuation, time in years)

Symbol	Parameter	Value	Units	Illustrative justification
r	discount rate	0.04	per year	real rate of 4%; standard in housing search models
s	listing inflow	1.0	listings per year	normalisation
δ	withdrawal hazard	0.50	per year	10–20% of listings withdrawn at baseline hazards
w_0	own-use value on withdrawal	0.80	units of q	gains from trade of about 20% plus match component
$[c_L, c_H]$	carrying-cost support	[0.02, 0.30]	share of value per year	maintenance and taxes to double housing / distress
F	carrying-cost distribution	Beta(2,4), 9 types	–	right-skewed: most sellers patient, a minority urgent
k	buyer entry cost	0.02	units of q	search set-up, inspections
κ_b	buyer flow search cost	0.05	units of q per year	temporary housing, time; comparable to seller carrying costs
ϕ	qualification probability	0.85	per meeting	pre-approval screen
A	matching efficiency	4.5	meetings per year at $\theta = 1$	meetings = serious offers, not viewings
α	matching elasticity (buyers)	0.50	–	symmetric Cobb–Douglas
β	seller Nash share	0.50	–	symmetric; Hosios value $1 - \alpha$
G	match-value distribution	$N(1.0, 0.10^2)$ on [0.7, 1.3]	units of q	log-concave (IFR); 10% dispersion of buyer valuations
π, v, ϕ_m	financing extension	0.30, 12, 0.85	–, per year, –	cash share; one-month approval; approval probability

6.3. Validation

Twenty-four unit tests cover the closed forms of the distributions, the residuals and uniqueness of the seller value, the analytic derivatives of Lemma 2 against finite differences, each part of

Propositions 1 to 8 on the baseline parameterisation, the Pareto counterexample in both regions of (17), the exponential elasticity formula of Proposition 6, boundary cases (zero urgency and no withdrawal, a frozen market with $\Lambda_s \rightarrow 0$, a very liquid market with $\Lambda_s = 10^7$ in which $v^* \rightarrow w_H$ and $\bar{p} \rightarrow w_H - k$), the equilibrium stock equations and probability sums, and the convergence of the equilibrium in the type grid and the root tolerance. All tests pass. Independently of the analytic solution, the listing process was simulated listing by listing (type draw, Poisson meetings, exponential withdrawal, match draws and the acceptance rule) for 100,000 listings and three seeds; the simulated sold share, durations, meetings per listing, mean and standard deviation of prices agree with the analytic moments to within 0.39 percent, and the per-type mean prices to within 0.50 percent. With 9 seller types the mean price differs from the solution with 81 types by 2.2e-04 percent (Figure 14); tightness is invariant to the root tolerance between 10^{-6} and 10^{-12} ; and the transition solver converges at first order in the time step. Appendix B reports these diagnostics in full.

7. The baseline equilibrium

7.1. Tightness, durations and prices

Figure 1 shows the free-entry residual and the matching technology. The residual is strictly decreasing in tightness and crosses zero once, at $\theta^* = 4.39$ buyers per listing, so the equilibrium is unique in the baseline; the same sign pattern obtains in all 60 random parameter draws of Section 8.9. At this tightness a listing meets a qualified buyer 8.01 times per year and a buyer meets a listing 1.83 times per year. Table 2 reports the baseline moments and Table 3 the cross-section by seller type.

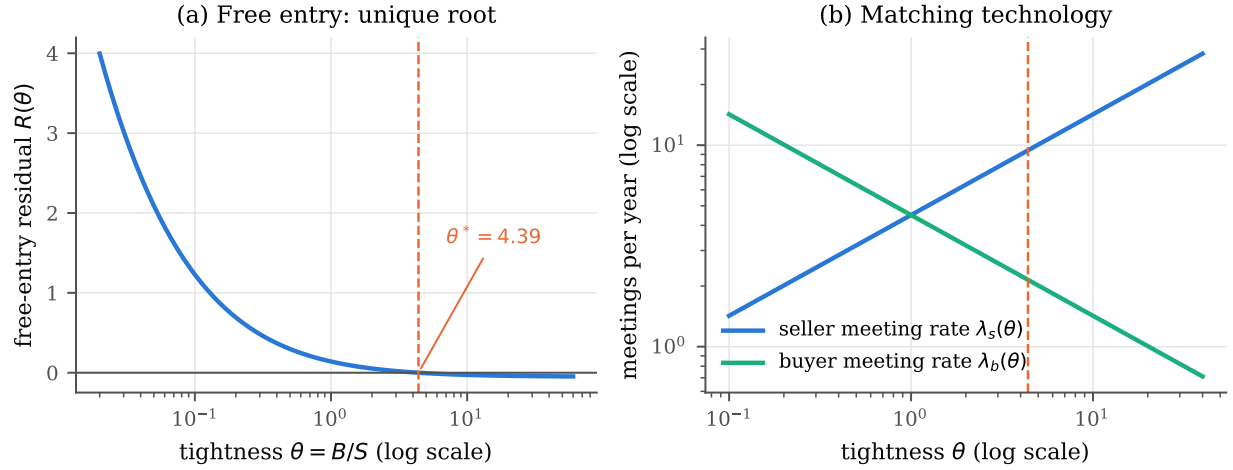


Figure 1. Free entry and matching in the baseline. Panel (a): the free-entry residual $R(\theta)$ (model-generated, baseline parameterisation of Table 1) and its unique root. Panel (b): seller and buyer meeting rates implied by the Cobb–Douglas matching function; the dashed line marks equilibrium tightness.

Table 2. Baseline stationary equilibrium: aggregate moments (model-generated)

Moment	Value
Tightness θ^* (buyers per listing)	4.39
Effective seller contact rate Λ_s (per year)	8.01
Effective buyer contact rate Λ_b (per year)	1.83
Inventory of listings S (inflow = 1)	0.186
Sales flow Q (share of listings eventually sold)	0.907
Mean time on market of sold listings (months)	2.23
Mean buyer search duration (months)	10.79
Transaction-weighted mean price	0.9960
Price s.d. among identical houses	0.0347
Between-type share of price variance	0.131
Expected price, most patient / most urgent type	1.0162 / 0.9594
Urgency discount D , most urgent type / transaction-weighted (%)	5.59 / 1.98
Sale hazard, most patient / most urgent type (per year)	4.14 / 6.28
Walrasian free-entry benchmark p^* ; gap Γ (%)	1.195; 16.6
Welfare flow: total / sellers / holding costs	0.1582 / 0.1505 / 0.0202
Max. seller residual / free-entry residual	3.9e-13 / 1.6e-17

The most patient sellers accept 51.67 percent of qualified offers and sell at the hazard 4.14 per year; the most urgent accept 78.39 percent and sell at 6.28 per year. The mean time on market of houses that sell is 2.23 months and 90.72 percent of listings eventually sell; the remainder are

withdrawn. A buyer searches for 10.79 months on average, longer than a seller because free entry crowds the buyer side of the market until the surplus a buyer expects per meeting just covers the cost of searching. The transaction-weighted mean price is 0.996, close to the mean buyer valuation by construction of the units, with reservation prices between 0.902 and 0.976.

Table 3. Baseline cross-section by seller type (model-generated; c in units of value per year, durations in months)

c	$f(c)$	$V(c)$	$v^*(c)$	$1 - G(v^*)$	$\eta(c)$	$E[\tau]$ (mo.)	$\bar{p}(c)$	$D(c)$ (%)	stock share	sales share
0.040	0.098	0.9758	0.9958	0.517	4.14	2.59	1.0162	0.00	0.114	0.097
0.067	0.211	0.9657	0.9857	0.557	4.46	2.42	1.0080	0.80	0.228	0.209
0.098	0.230	0.9551	0.9751	0.599	4.80	2.27	0.9996	1.63	0.234	0.230
0.128	0.196	0.9450	0.9650	0.637	5.11	2.14	0.9916	2.41	0.188	0.197
0.159	0.139	0.9353	0.9553	0.673	5.39	2.04	0.9842	3.14	0.127	0.140
0.189	0.080	0.9260	0.9460	0.706	5.66	1.95	0.9772	3.83	0.070	0.081
0.220	0.035	0.9172	0.9372	0.736	5.90	1.88	0.9706	4.48	0.030	0.036
0.249	0.009	0.9090	0.9290	0.762	6.11	1.82	0.9646	5.07	0.008	0.010
0.275	0.001	0.9017	0.9217	0.784	6.28	1.77	0.9594	5.59	0.001	0.001

Note: $f(c)$ is the listing composition, “stock share” the share of type c in the stock of listings and “sales share” its share in transactions. $D(c)$ is the urgency discount (1).

7.2. The urgency discount and its attenuation

The most urgent sellers obtain 0.959 against 1.016 for the most patient, an urgency discount of 5.59 percent; weighted by transactions the discount is 1.98 percent because most sellers are patient. The reservation-price gap between the two extreme types is larger than the gap in expected prices, as Proposition 1(iii) predicts: urgent sellers accept lower valuations, but conditional on acceptance the buyer’s surplus is larger, and the seller’s share of it recovers part of the concession. Figures 2 and 3 trace the reservation value, the expected price, the sale hazard and the expected duration along a fine grid of carrying costs for five levels of matching efficiency, holding tightness at its baseline value. Three properties of Proposition 1 and 2 are visible. The schedules are monotone in c ; they shift down (prices) and up (hazards) when matching efficiency falls; and they become steeper, so that the gap between patient and urgent sellers widens when the market is less liquid. The slope of the reservation value equals the analytic expression $-1/[(r + \delta) + \beta\eta(c)]$ along the whole grid.

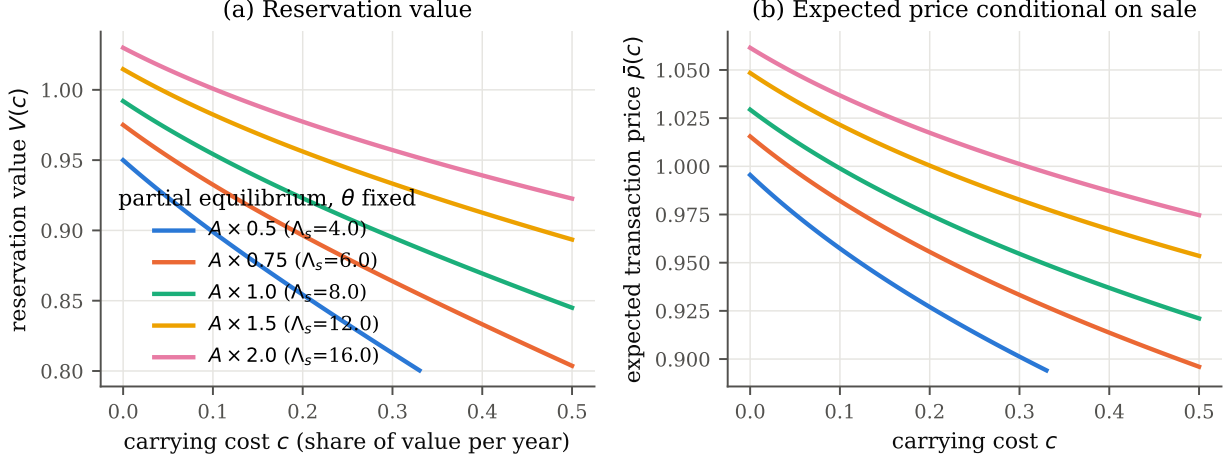


Figure 2. Urgency, reservation values and expected prices (model-generated, partial equilibrium with tightness fixed at its baseline value). Each curve corresponds to a multiple of baseline matching efficiency; the effective arrival rate Λ_s is given in the legend. Panel (a): reservation value $V(c)$. Panel (b): expected transaction price $\bar{p}(c)$ conditional on sale.

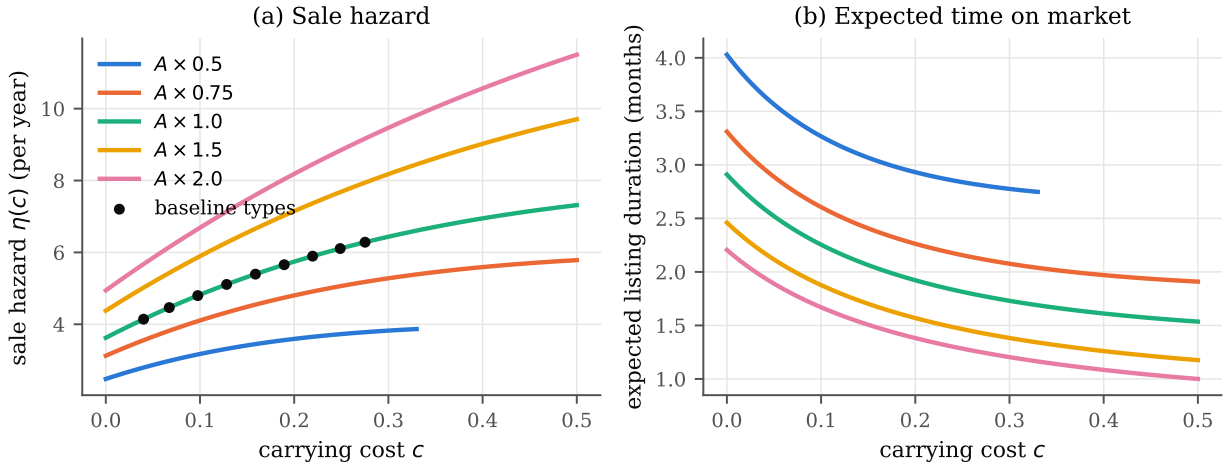


Figure 3. Urgency and the sale hazard (model-generated, partial equilibrium). Panel (a): sale hazard $\eta(c)$ per year for five levels of matching efficiency; dots mark the nine baseline types. Panel (b): expected listing duration in months.

7.3. Dispersion, survival and duration dependence

Among identical houses the standard deviation of transaction prices is 3.47 percent of the mean, of which 13.06 percent of the variance is between seller types and the remainder reflects the match-specific component of the Nash price. Figure 4 shows the mixture density of prices by seller type: urgent sellers populate the left tail, and a fall in matching efficiency shifts and widens the whole distribution. Figure 5 shows the survival functions of listings for three types and for the population,

and the population exit hazard, which declines with duration as Lemma 3 requires although every individual hazard is constant. The decline is modest in the baseline because the dispersion of hazards across types is modest; it would be invisible in a sample of the size usually available, which is why the duration literature's finding of positive dependence (Zuehlke, 1987; Jud et al., 1996) is not evidence against heterogeneity but evidence that other mechanisms, such as list-price revisions and learning (Knight, 2002; Anenberg, 2016), dominate.

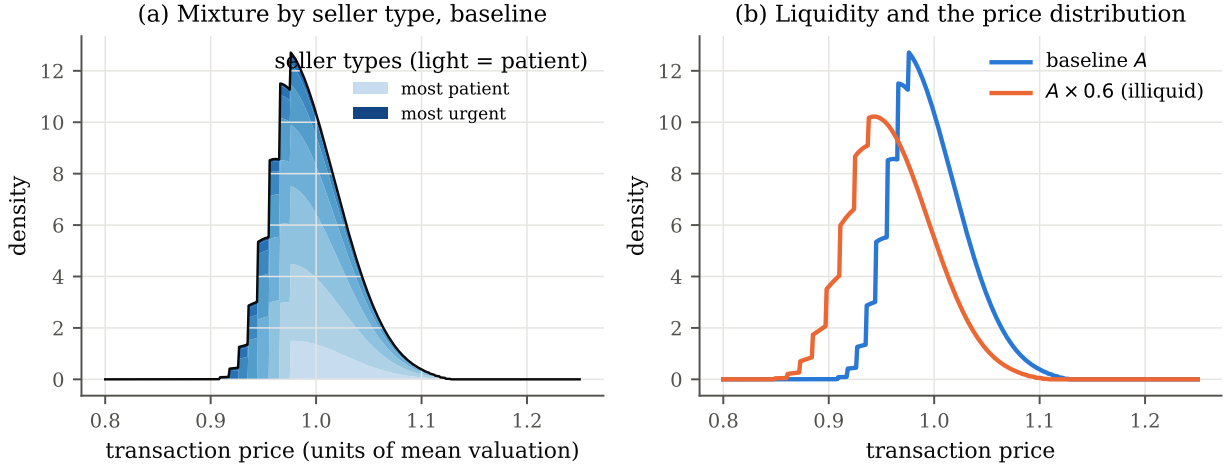


Figure 4. Transaction-price distributions among identical houses (model-generated). Panel (a): mixture density of transaction prices in the baseline, stacked by seller type from the most patient (light) to the most urgent (dark). Panel (b): the same density at baseline matching efficiency and at 60 percent of it.

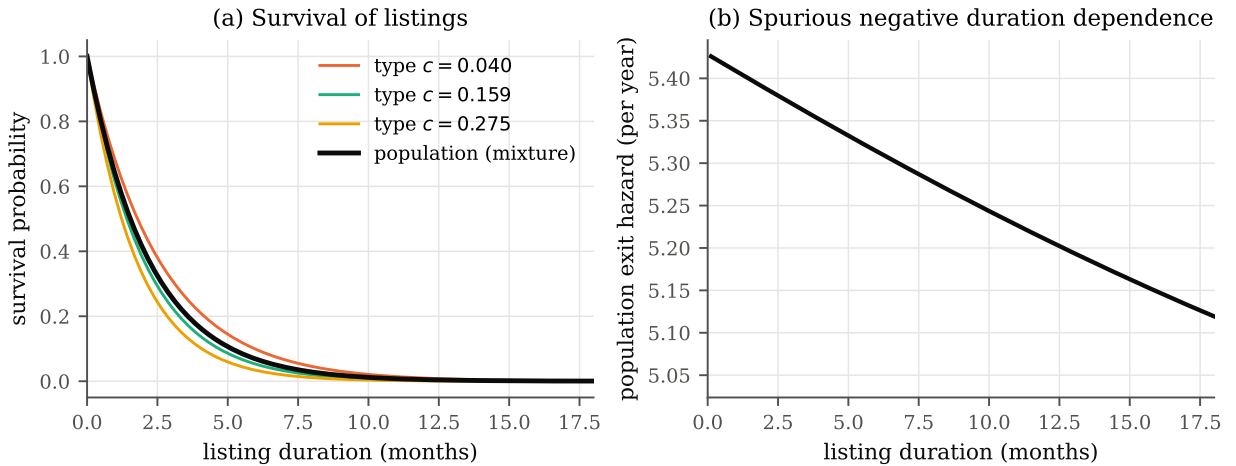


Figure 5. Survival of listings and duration dependence (model-generated). Panel (a): survival functions of three seller types and of the population mixture. Panel (b): population exit hazard (sale or withdrawal) as a function of elapsed duration; individual hazards are constant.

7.4. The Walrasian benchmark

The frictionless free-entry price is $p^* = 1.19$ and the market liquidity gap is $\Gamma = 16.63$ percent in the baseline. Figure 6(c) traces Γ for the patient type across effective arrival rates from 0.05 to 2,000 per year: the gap is 43 percent in a frozen market, falls monotonically, and turns negative beyond about 135 contacts per year, as Proposition 2(iv) predicts. At that point the seller's option to wait for a high-valuation buyer is worth more than the delay costs, and the search price exceeds the uniform Walrasian price. The baseline is far from this region, so the gap is positive and of the same order as the discounts reported for distressed sales, but the sign change is the reason the paper does not interpret Γ as a liquidity premium.

8. Counterfactuals: arrivals, financing, heterogeneity, dynamics and selection

Each experiment of this section was pre-registered with a hypothesis, run from the stored configuration, and saved with its diagnostics before any text was written; the hypotheses and outcomes are listed in Appendix C.

8.1. A collapse in buyer arrivals

Table 4 and Figure 6 vary matching efficiency between 20 and 300 percent of its baseline value, in general equilibrium (tightness re-solved) and in partial equilibrium (tightness fixed). Halving A lowers the transaction-weighted price by 4.8 percent in general equilibrium against 4.3 percent with tightness fixed, lengthens the time on market of sales from 2.23 to 3.4 months, raises the inventory of listings from 0.19 to 0.284, lowers tightness from 4.39 to 3.73, and raises the urgency discount of the most urgent type from 5.59 to 7.6 percent. The amplification through entry is modest but systematic: the elasticity of the effective contact rate with respect to matching efficiency is 1.10 in general equilibrium against exactly one in partial equilibrium, and the elasticities of prices and durations are correspondingly larger (0.064 against 0.059 for prices, -0.53 against -0.49 for time on market). Because A and ϕ are observationally equivalent in the baseline (Proposition 3), the same table describes a tightening of qualification; Table 14 in Appendix C reports the ϕ experiment directly.

Table 4. Comparative statics of matching efficiency in general (GE) and partial (PE) equilibrium (model-generated)

A/A_0	Eq.	θ	Λ_s	price	TOM (mo.)	S	Q	D_{urg} (%)	$\bar{D}$ (%)	s.d. price	Γ (%)
0.50	GE	3.73	3.69	0.9485	3.41	0.284	0.858	7.56	2.67	0.0420	20.6
0.50	PE	4.39	4.01	0.9536	3.24	0.270	0.865	7.32	2.59	0.0412	20.2
0.70	GE	4.07	5.40	0.9723	2.73	0.228	0.886	6.50	2.30	0.0382	18.6
0.70	PE	4.39	5.61	0.9746	2.68	0.223	0.888	6.41	2.27	0.0379	18.4
0.85	GE	4.25	6.70	0.9854	2.44	0.203	0.898	5.98	2.12	0.0363	17.5
0.85	PE	4.39	6.81	0.9864	2.41	0.201	0.899	5.95	2.11	0.0361	17.4
1.00	GE	4.39	8.01	0.9960	2.23	0.186	0.907	5.59	1.98	0.0347	16.6
1.00	PE	4.39	8.01	0.9960	2.23	0.186	0.907	5.59	1.98	0.0347	16.6
1.20	GE	4.54	9.78	1.0075	2.03	0.169	0.915	5.19	1.84	0.0331	15.7
1.20	PE	4.39	9.62	1.0065	2.04	0.170	0.915	5.22	1.86	0.0333	15.8
1.50	GE	4.71	12.45	1.0209	1.82	0.152	0.924	4.75	1.69	0.0313	14.5
1.50	PE	4.39	12.02	1.0190	1.85	0.154	0.923	4.81	1.71	0.0316	14.7
2.00	GE	4.92	16.97	1.0374	1.61	0.134	0.933	4.27	1.52	0.0293	13.2
2.00	PE	4.39	16.03	1.0345	1.64	0.137	0.931	4.35	1.55	0.0296	13.4

Note: PE holds tightness at its baseline value. D_{urg} is the urgency discount of the most urgent type, $\bar{D}$ the transaction-weighted discount, Γ the gap to the Walrasian free-entry price.

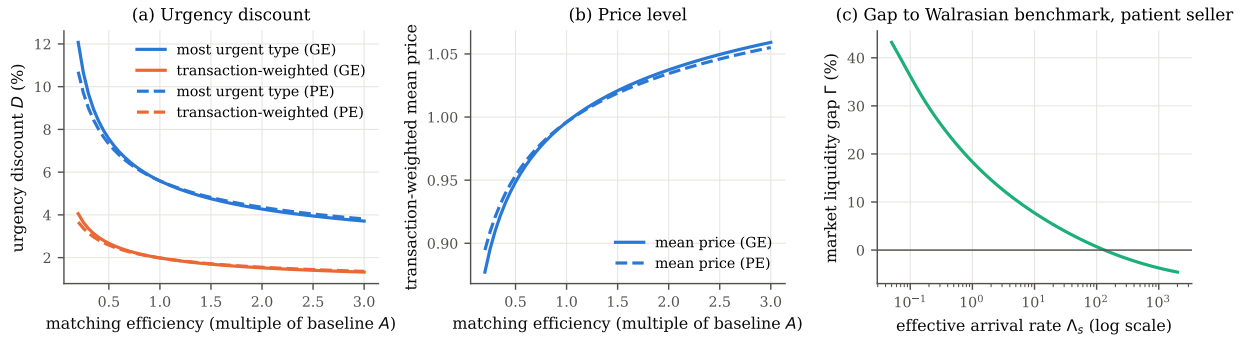


Figure 6. Liquidity and the urgency discount (model-generated). Panel (a): urgency discount of the most urgent type and transaction-weighted discount as functions of matching efficiency, in general (solid) and partial (dashed) equilibrium. Panel (b): transaction-weighted mean price. Panel (c): market liquidity gap Γ of the patient type relative to the Walrasian free-entry price as a function of the effective arrival rate, partial equilibrium with $\delta = 0$.

Figure 7 plots the comovement that the experiment generates. Across liquidity states the steady-state sales flow and the mean price move together and inventory and time on market move inversely, all with the same distribution of buyer valuations. The movement of the steady-state sales flow is entirely due to withdrawals: with $\delta = 0$ every listing eventually sells and the sales flow equals the

listing inflow at every level of liquidity (Proposition 4(iv)), as verified in the $\delta = 0$ experiment of Section 8.6.

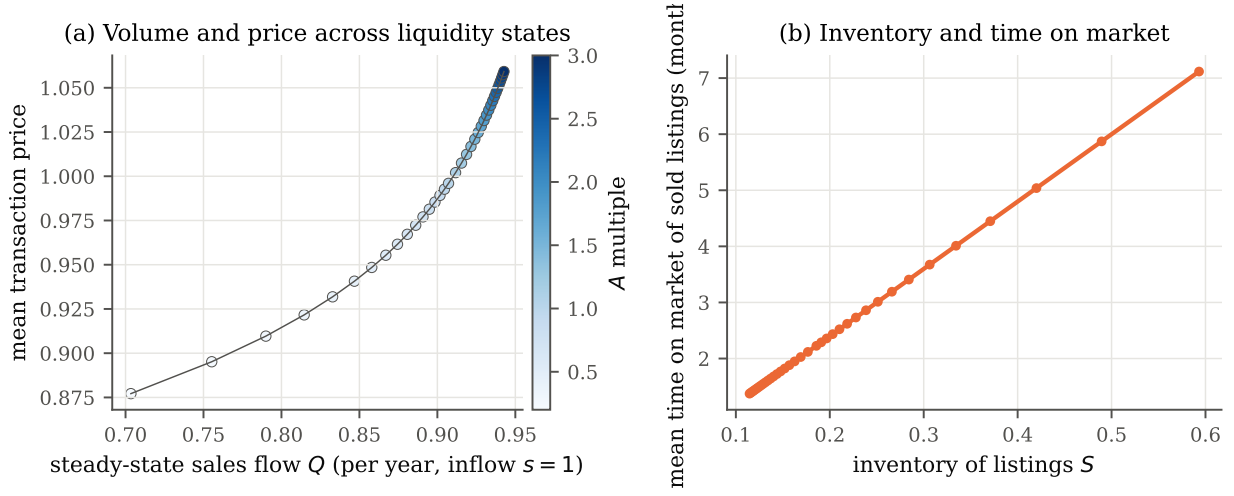


Figure 7. Volume, price, inventory and time on market across liquidity states (model-generated, general equilibrium). Each point is a stationary equilibrium for a different matching efficiency, from 20 to 300 percent of the baseline. Panel (a): sales flow and mean price. Panel (b): inventory of listings and mean time on market of sales.

8.2. Financing: qualification, approval delay and the cash–mortgage gap

In the extension with cash and mortgage buyers, the baseline equilibrium has tightness close to the baseline screen, a share $\tilde{\pi} = 0.284$ of meetings with cash buyers (below their 30 percent entry share, because mortgage buyers spend longer searching), and buyer values $U_c = 0.0426$ against $U_m = 0.0103$: a cash buyer's search is worth four times a mortgage buyer's. Table 5 and Figure 8 report the decomposition of Proposition 7. For the same house, mortgage buyers pay 1.73 percent more than cash buyers on average, 1.12 percent when the seller is the most patient and 2.96 percent when she is the most urgent. The delay-bargaining term rises from 0.14 to 1.28 percent across types, as part (i) of the proposition requires; the outside-option term is 1.61 percent for every type; and the selection term is negative for patient sellers, because cash buyers' better outside option raises the valuation at which a cash deal is struck above the valuation at which a mortgage deal is struck, and turns positive only for the most urgent sellers, for whom the pending wedge dominates. On average the selection term is -0.37 percent. The measured gap is therefore smaller than the sum of its bargaining and outside-option components, and its cross-sectional gradient in urgency comes entirely from the delay-bargaining term.

Table 5. Financing extension: the cash–mortgage gap and its components as the approval probability varies (model-generated)

ϕ_m	θ	U_c	U_m	$\bar{\pi}$	Δ_b (%)	outside (%)	selection (%)	gap (%)	listed (mo.)	to closing (mo.)	S	$U_m \geq 0$
0.50	3.89	0.0862	-0.0084	0.232	0.83	4.73	-1.63	3.93	1.98	4.07	0.236	no
0.60	4.04	0.0699	-0.0014	0.250	0.69	3.56	-1.20	3.06	2.05	3.63	0.215	no
0.70	4.16	0.0572	0.0041	0.266	0.60	2.66	-0.84	2.42	2.12	3.31	0.201	yes
0.75	4.21	0.0518	0.0064	0.272	0.56	2.27	-0.67	2.16	2.15	3.18	0.195	yes
0.80	4.26	0.0470	0.0084	0.279	0.52	1.93	-0.52	1.93	2.19	3.07	0.189	yes
0.85	4.30	0.0426	0.0103	0.284	0.49	1.61	-0.37	1.73	2.22	2.97	0.185	yes
0.90	4.34	0.0385	0.0121	0.290	0.47	1.32	-0.24	1.55	2.25	2.88	0.181	yes
0.95	4.38	0.0347	0.0137	0.295	0.44	1.05	-0.11	1.39	2.28	2.80	0.177	yes
1.00	4.41	0.0313	0.0152	0.300	0.42	0.80	0.01	1.24	2.31	2.72	0.174	yes

Note: components are listing-weighted averages across seller types, in percent of the house value; “listed” is the expected duration in the listed state and “to closing” the expected total duration including pending spells (Little’s law). Rows with $U_m < 0$ violate the mortgage buyers’ participation constraint and are not used in the text.

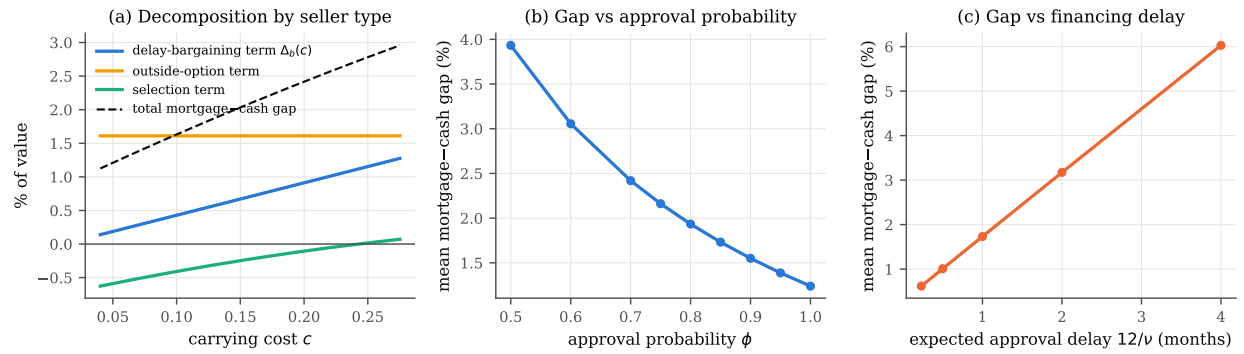


Figure 8. The cash–mortgage gap (model-generated, financing extension). Panel (a): decomposition of the gap by seller type at the baseline into the delay-bargaining term $\Delta_b(c)$, the outside-option term and the selection term. Panel (b): listing-weighted gap as a function of the approval probability ϕ_m (values below 0.70 violate buyer participation). Panel (c): gap as a function of the expected approval delay.

Tighter approval widens the gap: at $\phi_m = 0.70$ the average gap is 2.42 percent and at $\phi_m = 0.60$ the value of searching as a mortgage buyer turns negative, so that the model’s assumption that buyers never exit is violated and the economy is no longer admissible (Table 5, last column); results are reported only for $\phi_m \geq 0.70$. A longer approval delay widens the gap almost linearly, from 0.6 percent with a one-week decision to 6.0 percent with a four-month decision (Table 15, Appendix C), while the baseline screen corresponds to the instantaneous limit in which the gap collapses to the outside-option term. Bargaining power shifts the sign of the delay term: with $\beta = 0.8$ the delay term is negative for patient sellers, who then compensate mortgage buyers for the risk the buyers bear (Table 16). The magnitudes are in the range of the 2–3.9 percent structural discount of Han and Hong (2024) and well below the 11 percent reduced-form premium of Reher and Valkanov

(2024), which is the pattern the decomposition leads one to expect when the selection term is small or negative.

8.3. Matching efficiency versus approval

The extension distinguishes the two shocks that the baseline cannot. Table 6 compares a 30 percent fall in matching efficiency with a fall in the approval probability from 0.85 to 0.70. The first lowers prices by 2.34 percent and raises the expected time to closing from 2.97 to 3.44 months; the second lowers prices by 0.94 percent, raises the time to closing to 3.31 months, and widens the cash–mortgage gap from 1.73 to 2.41 percent, whereas the matching shock leaves the gap almost unchanged (1.81 percent). An approval shock also *raises* the hazard of agreements in the listed state, because mortgage buyers whose search is worth less accept more readily, while lowering the hazard of completed sales. The two shocks therefore have different signatures: a fall in matching efficiency shows up in durations and prices alike, a fall in approval shows up in the cash–mortgage gap and in the ratio of agreements to closings.

Table 6. Matching-efficiency versus approval shocks in the financing extension (model-generated)

shock	value	agreement hazard	θ	price	listed (mo.)	to closing (mo.)	S	Q	gap (%)	$U_m \geq 0$
A	0.70	3.928	3.99	0.9732	2.71	3.44	0.226	0.887	1.81	yes
A	0.85	4.455	4.16	0.9861	2.42	3.16	0.202	0.899	1.76	yes
A	1.00	4.910	4.30	0.9965	2.22	2.97	0.185	0.908	1.73	yes
A	1.15	5.309	4.41	1.0052	2.07	2.82	0.172	0.914	1.71	yes
A	1.30	5.665	4.51	1.0126	1.95	2.70	0.162	0.919	1.69	yes
ϕ_m	0.55	5.458	3.97	0.9748	2.01	3.83	0.225	0.888	3.44	no
ϕ_m	0.70	5.159	4.16	0.9871	2.12	3.31	0.201	0.900	2.41	yes
ϕ_m	0.75	5.070	4.21	0.9905	2.15	3.18	0.195	0.903	2.16	yes
ϕ_m	0.80	4.987	4.26	0.9936	2.19	3.07	0.189	0.905	1.93	yes
ϕ_m	0.85	4.910	4.30	0.9965	2.22	2.97	0.185	0.908	1.73	yes
ϕ_m	0.95	4.769	4.38	1.0016	2.28	2.80	0.177	0.911	1.39	yes
ϕ_m	1.00	4.706	4.41	1.0040	2.31	2.72	0.174	0.913	1.24	yes

8.4. Bargaining power and entry costs

A higher seller share β raises prices, lowers tightness sharply because buyers’ expected surplus per meeting falls, and lengthens time on market (Table 11): between $\beta = 0.2$ and $\beta = 0.8$ tightness falls from 16.8 to 1.0 buyers per listing and the time on market of sales rises from 1.1 to 3.8 months. The urgency discount falls with β , since the carrying cost enters the price with weight $1 - \beta$ in (6), but it does not vanish as $\beta \rightarrow 1$, because urgency still governs which matches are accepted. Entry and search costs work through the same channel: halving the buyer’s search cost raises tightness and prices and shortens sellers’ time on market (Table 17, Appendix C).

8.5. Heterogeneity and dispersion

Table 7 varies the upper bound of the carrying-cost distribution, which scales its dispersion, and the seller’s bargaining share. Widening the support from $c_H = 0.3$ to 0.6 raises the between-type share of price variance from 13.1 to 26.5 percent and the discount of the most urgent type from 5.59 to 8.9 percent; lowering matching efficiency to 70 percent of baseline raises the between-type share from 13.06 to 14.0 percent and the total standard deviation from 3.47 to 3.82 percent, the widening of Proposition 5(iii). As $\beta \rightarrow 0$ the within-type component vanishes and all dispersion is urgency-driven; as $\beta \rightarrow 1$ the between-type component shrinks but, as noted, does not vanish (Table 19, Appendix C).

Table 7. Seller heterogeneity and price dispersion among identical houses (model-generated)

c_H	s.d.(c)	A/A_0	θ	price	s.d. price	between (%)	D_{urg} (%)	$\bar{p}$ range	TOM (mo.)
0.05	0.005	0.7	2.71	0.9881	0.0334	0.4	0.97	0.0096	3.54
0.05	0.005	1.0	3.00	1.0096	0.0307	0.3	0.84	0.0085	2.90
0.05	0.005	1.3	3.20	1.0246	0.0289	0.3	0.75	0.0077	2.54
0.10	0.014	0.7	2.98	0.9845	0.0342	2.2	2.39	0.0237	3.33
0.10	0.014	1.0	3.28	1.0065	0.0313	2.0	2.05	0.0208	2.72
0.10	0.014	1.3	3.48	1.0218	0.0295	1.9	1.85	0.0190	2.39
0.20	0.032	0.7	3.53	0.9780	0.0361	7.9	4.69	0.0466	2.99
0.20	0.032	1.0	3.84	1.0009	0.0330	7.3	4.03	0.0409	2.44
0.20	0.032	1.3	4.05	1.0168	0.0309	6.9	3.62	0.0373	2.14
0.30	0.049	0.7	4.07	0.9723	0.0382	14.0	6.50	0.0647	2.73
0.30	0.049	1.0	4.39	0.9960	0.0347	13.1	5.59	0.0568	2.23
0.30	0.049	1.3	4.60	1.0124	0.0325	12.5	5.03	0.0518	1.95
0.45	0.075	0.7	4.89	0.9649	0.0413	21.8	8.66	0.0863	2.44
0.45	0.075	1.0	5.22	0.9895	0.0373	20.6	7.44	0.0757	1.98
0.45	0.075	1.3	5.43	1.0065	0.0348	19.8	6.69	0.0691	1.73
0.60	0.102	0.7	5.71	0.9584	0.0441	27.9	10.39	0.1036	2.21
0.60	0.102	1.0	6.04	0.9839	0.0397	26.5	8.91	0.0907	1.79
0.60	0.102	1.3	6.25	1.0013	0.0369	25.7	8.02	0.0828	1.57

Note: c_H is the upper bound of the carrying-cost support (Beta(2, 4) shape rescaled), “between” the share of the transaction-price variance between seller types, “ $\bar{p}$ range” the gap in expected price between the most patient and the most urgent type.

8.6. Propagation and recovery

Figure 9 and Table 8 show transition paths after a permanent 20 percent fall in matching efficiency, a permanent 20 percent rise, and a temporary 20 percent fall that lasts one year. Prices adjust

immediately: the observed index falls by -1.46 percent on impact and stays there, because the seller value is forward-looking and tightness, pinned by free entry at every instant, barely moves along the path. Quantities adjust slowly: the sales flow falls by -13.1 percent on impact and recovers to -1.4 percent below its initial level as the stock of listings builds up, inventory rises by 13.2 percent with a half-life of 1.9 months, and the time on market of completed sales rises and stays up. After the temporary shock, the end of the shock releases the accumulated inventory in a burst of sales 27.9 percent above the initial flow before the economy returns to its original steady state. A permanent fall in qualification produces the same path as the fall in A , by the observational equivalence of the baseline.

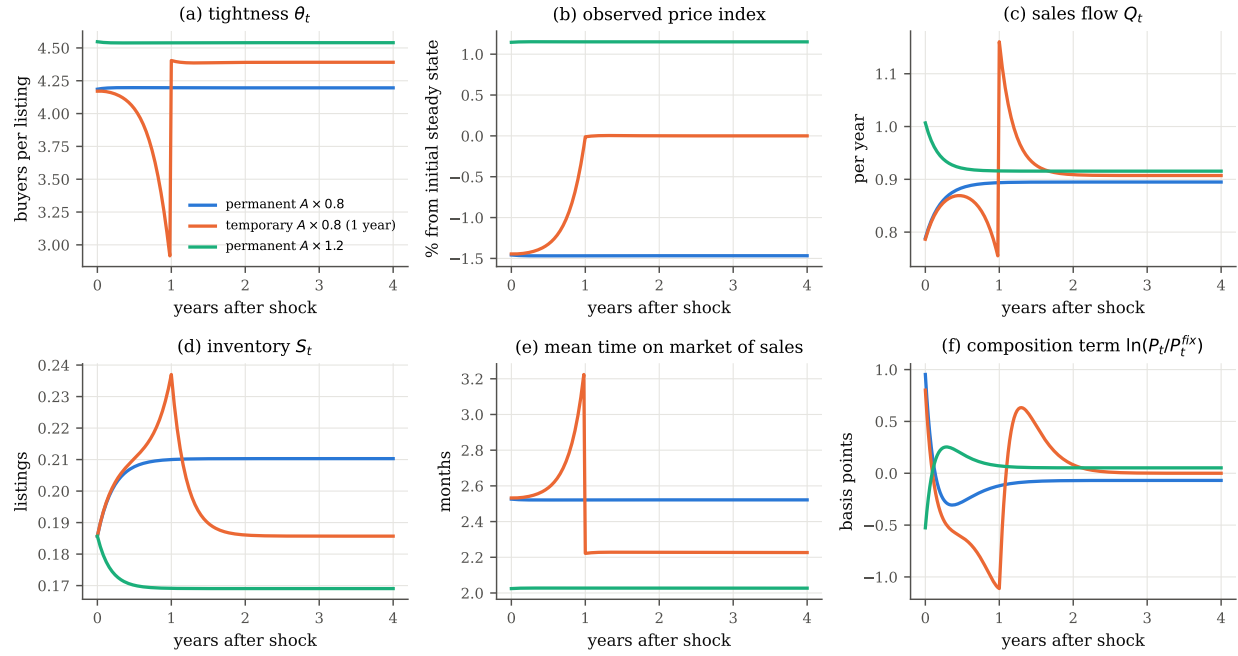


Figure 9. Transition paths after liquidity shocks at date zero (model-generated, free entry at every instant). Permanent and temporary 20 percent changes in matching efficiency. Panel (a): tightness. Panel (b): observed transaction-price index relative to the initial steady state. Panel (c): sales flow. Panel (d): inventory of listings. Panel (e): mean time on market of completed sales. Panel (f): composition term $\ln(P_t/P_t^{fix})$ in basis points, where P_t^{fix} uses the pre-shock transaction weights.

Table 8. Transition experiments: impact and long-run values (model-generated)

scenario	θ_{0+}	θ_{∞}	P_{0+}	P_{∞}	comp. 0 ⁺ (bp)	max comp. (bp)	Q_{0+}	Q_{min}	Q_{∞}	S_{max}	conv.	iter.
perm_A_minus20	4.19	4.20	0.9815	0.9814	1.0	1.0	0.789	0.789	0.895	0.210	yes	28
perm_A_plus20	4.55	4.54	1.0074	1.0075	-0.5	0.5	1.007	0.915	0.915	0.186	yes	27
temp_A_minus20_1y	4.17	4.39	0.9816	0.9960	0.8	1.1	0.786	0.755	0.907	0.237	yes	46
perm_phi_minus20	4.19	4.20	0.9815	0.9814	1.0	1.0	0.789	0.789	0.895	0.210	yes	28
perm_A_minus20_exponential	2.58	2.58	0.8455	0.8456	-4.7	4.9	0.752	0.752	0.807	0.386	yes	27
perm_A_minus20_delta0	2.79	2.81	0.9952	0.9949	3.2	3.2	0.904	0.904	1.000	0.325	yes	30

Note: “comp.” is the composition term $\ln(P_t/P_t^{fix})$ in basis points; “conv.” and “iter.” report the convergence flag and the number of iterations on the tightness path.

8.7. Sale selection and the observed price index

The composition term of (11) is at most 0.95 basis points along every transition path in Table 8, against a within-type price change of about 150 basis points: in the baseline, selection is an order of magnitude smaller than the liquidity effect it accompanies, and it dampens rather than amplifies. Table 9 and Figure 10 apply the impact decomposition of Proposition 6 to four match-value distributions and three widths of the carrying-cost distribution, for 30 percent falls and rises in matching efficiency. The sign condition works as the proposition states. For the truncated normal and the Weibull with shape two, both light-tailed with $h_G M$ increasing over the relevant range, the hazard elasticity rises with urgency, the sales mix shifts toward patient sellers after a negative shock, and the index falls by *less* than within-type prices (ratio below one). For the exponential, where $h_G M = 1$, and for the Pareto, where $h_G M$ is a constant above one, the elasticity falls with urgency and the index falls by more. The magnitudes are small in every case: the largest composition term is 0.15 log-percent (pareto, $c_H = 0.6$, $A \times 0.7$), and the ratio of the observed to the within-type change lies between 0.979 and 1.023. In the baseline distribution with $c_H = 0.3$ the within-type change after a 30 percent fall in A is -2.40 percent and the composition term 0.017 percent; with exponential valuations the figures are -4.21 and -0.081 percent. Steady-state composition effects, which exist only through withdrawals, are smaller still.

Table 9. Impact decomposition of the observed price index by match-value distribution (model-generated, general equilibrium, ± 30 percent matching-efficiency shocks)

G	c_H	A/A_0	within (%)	comp. impact (%)	comp. s.s. (%)	ratio	$\varepsilon(c_L)$	$\varepsilon(c_H)$	selection
truncnorm	0.1	0.7	-2.21	0.002	-0.000	0.9993	0.633	0.678	dampens
truncnorm	0.1	1.3	1.51	-0.001	0.000	0.9996	0.557	0.587	dampens
truncnorm	0.3	0.7	-2.40	0.017	-0.001	0.9928	0.596	0.760	dampens
truncnorm	0.3	1.3	1.63	-0.007	0.001	0.9957	0.526	0.646	dampens
truncnorm	0.6	0.7	-2.62	0.056	-0.001	0.9787	0.560	0.867	dampens
truncnorm	0.6	1.3	1.76	-0.024	0.001	0.9864	0.496	0.735	dampens
exponential	0.1	0.7	-3.66	-0.014	-0.008	1.0038	0.601	0.472	amplifies
exponential	0.1	1.3	2.72	0.007	0.004	1.0025	0.532	0.421	amplifies
exponential	0.3	0.7	-4.21	-0.081	-0.034	1.0193	0.510	0.250	amplifies
exponential	0.3	1.3	3.06	0.041	0.015	1.0135	0.459	0.232	amplifies
exponential	0.6	0.7	-4.58	-0.033	-0.033	1.0073	0.425	1.140	amplifies
exponential	0.6	1.3	3.37	0.078	0.021	1.0233	0.392	0.315	amplifies
weibull	0.1	0.7	-2.76	0.000	-0.001	0.9999	0.573	0.583	dampens
weibull	0.1	1.3	1.93	0.000	0.000	1.0000	0.507	0.508	amplifies
weibull	0.3	0.7	-3.00	0.010	-0.003	0.9968	0.531	0.621	dampens
weibull	0.3	1.3	2.07	-0.003	0.002	0.9988	0.474	0.519	dampens
weibull	0.6	0.7	-3.26	0.046	-0.005	0.9859	0.491	0.747	dampens
weibull	0.6	1.3	2.23	-0.015	0.003	0.9932	0.440	0.585	dampens
pareto	0.1	0.7	-8.77	-0.005	-0.002	1.0006	0.326	0.254	amplifies
pareto	0.1	1.3	6.60	0.003	0.001	1.0004	0.283	0.221	amplifies
pareto	0.3	0.7	-9.20	-0.052	-0.016	1.0056	0.295	0.087	amplifies
pareto	0.3	1.3	6.86	0.026	0.008	1.0038	0.258	0.078	amplifies
pareto	0.6	0.7	-9.69	-0.155	-0.037	1.0159	0.257	-0.066	amplifies
pareto	0.6	1.3	7.17	0.080	0.018	1.0112	0.227	-0.060	amplifies

Note: “within” is $\ln(P^{fix}/P_0)$, “comp. impact” is $\ln(P^{obs}/P^{fix})$ with the pre-shock stock, “comp. s.s.” the same across steady states, “ratio” the observed over the within-type log change, $\varepsilon(c)$ the hazard elasticity of the most patient and most urgent type.

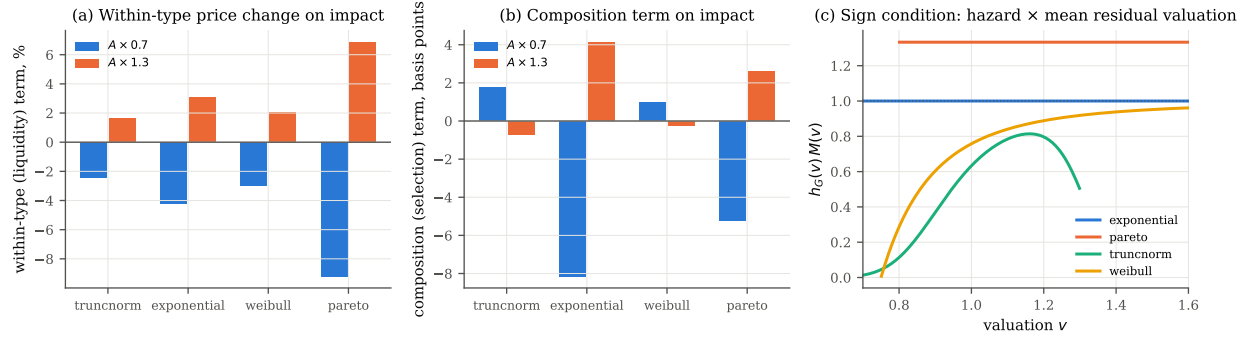


Figure 10. Sale selection and the transaction-price index (model-generated, $c_H = 0.3$). Panel (a): within-type (liquidity) term of the impact decomposition for four match-value distributions. Panel (b): composition (selection) term in basis points. Panel (c): the sign condition of Proposition 6: the product of the hazard function and the mean residual valuation, $h_G(v)M(v)$, is constant for the exponential and the Pareto and increasing for the truncated normal and the Weibull.

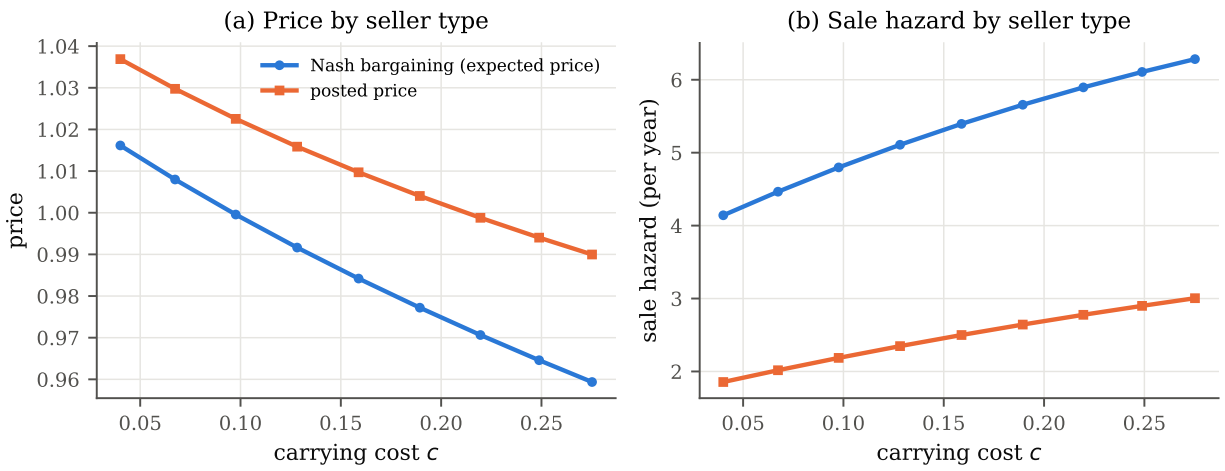
The conclusion for measurement is twofold. A transaction-price index can move by one to two percent, in either direction, with no change in the distribution of housing-service values, and the movement is almost entirely a within-type liquidity effect that a hedonic or repeat-sales index cannot remove, because the carrying cost of the seller is not a characteristic of the house. The additional bias from the changing composition of sellers who transact, the object of [Gatzlaff and Haurin \(1997\)](#) and [Goetzmann and Peng \(2006\)](#), is of second order under the present mechanism and has a sign that depends on the shape of the distribution of buyer valuations. Larger composition effects would require a wider dispersion of urgency than the one assumed, or mechanisms outside the model, such as the foreclosure externalities of [Guren and McQuade \(2020\)](#).

8.8. Posted prices

Under posted prices sellers hold out for better matches: tightness falls to 2.91, the time on market of sales rises to 4.38 months, the expected price conditional on sale rises to 1.0195, and the sales flow falls (Table 10, Figure 11). All dispersion is between types by construction, and the total standard deviation of prices falls to 2.80 percent. The urgency gradient is preserved, with a discount of 4.52 percent for the most urgent type, and flow welfare is -11.2 percent lower than under bargaining, because the monopoly mark-up that each seller applies to her own listing delays trade without creating surplus. The qualitative results of the previous subsections do not depend on the price-setting protocol.

Table 10. Nash bargaining versus posted prices at three levels of matching efficiency (model-generated)

protocol	A/A_0	θ	price	TOM (mo.)	s.d. price	between (%)	D_{urg} (%)	welfare	Q
nash	0.7	4.07	0.9723	2.73	0.0382	14.0	6.50	0.1285	0.886
posted	0.7	2.53	0.9998	5.26	0.0300	14.7	5.01	0.1088	0.780
nash	1.0	4.39	0.9960	2.23	0.0347	13.1	5.59	0.1582	0.907
posted	1.0	2.91	1.0195	4.38	0.0280	14.2	4.52	0.1404	0.817
nash	1.3	4.60	1.0124	1.95	0.0325	12.5	5.03	0.1780	0.919
posted	1.3	3.17	1.0336	3.88	0.0266	13.8	4.19	0.1615	0.838

**Figure 11.** Price-setting protocols (model-generated, baseline). Panel (a): expected price by seller type under Nash bargaining and the posted price under commitment. Panel (b): sale hazard by seller type.

8.9. Sensitivity and robustness

Figure 12 and Table 21 (Appendix C) report one-at-a-time changes of ± 25 percent in every parameter, together with the dispersion of match values and the width of the carrying-cost distribution. The urgency discount is most sensitive to the width of the carrying-cost distribution, to the own-use value of withdrawal and to the dispersion of valuations; time on market is most sensitive to the own-use value, the dispersion of valuations and bargaining power. In 150 random draws of all parameters within wide ranges, an equilibrium exists and is unique in every draw, the urgency discount is positive and expected prices are decreasing in urgency in 100.0 percent of draws, and hazards are increasing in urgency in 98.7 percent (the exceptions are draws in which hazards are flat to numerical precision, not reversals); time on market ranges from 0.6 to 10.7 months and the discount of the most urgent type from 2.9 to 20.3 percent. Alternative match-value families (Table 22, Appendix C) preserve every sign; heavy-tailed families produce equilibria with prices

above the mean valuation and a between-type share of dispersion above 90 percent, which is why they are used only to illustrate the sign conditions.

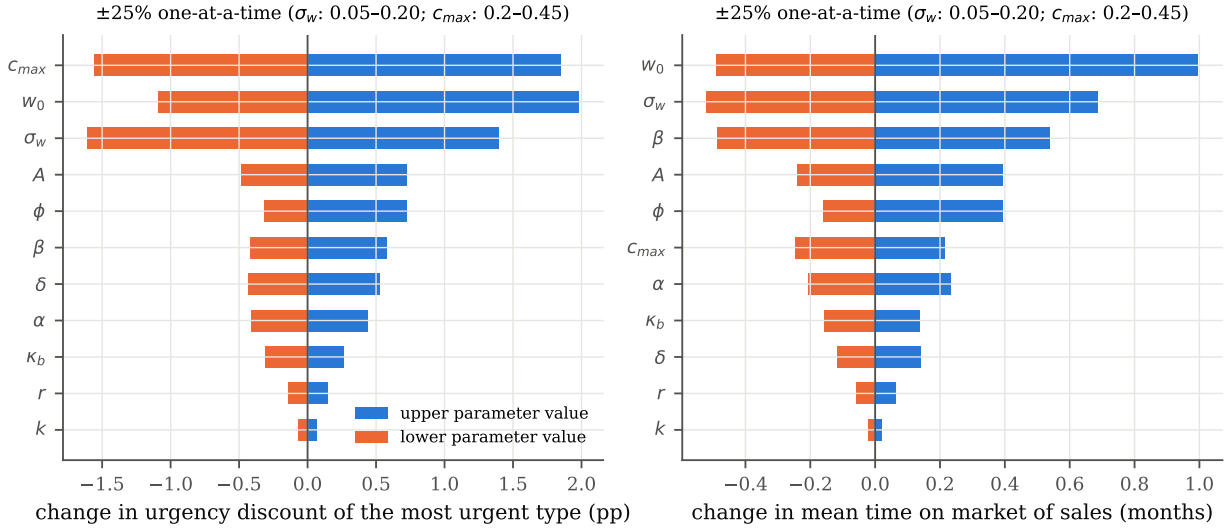


Figure 12. One-at-a-time sensitivity (model-generated). Change in the urgency discount of the most urgent type (left) and in the mean time on market of sales (right) when each parameter is set to 75 and 125 percent of its baseline value (σ_w : 0.05 and 0.20; c_{max} : 0.2 and 0.45).

9. Welfare and policy

Table 11 and Figure 13 report the steady-state flow surplus (15) across bargaining shares and matching elasticities, for the baseline economy with heterogeneous sellers and for an economy with a single seller type at the mean carrying cost. Welfare is hump-shaped in the seller's share. Too low a share crowds the market with buyers who search long and transact at low prices; too high a share deters entry and leaves sellers waiting. The welfare-maximising share is $\beta = 0.55$ in both economies, slightly above the Hosios value $1 - \alpha = 0.5$; the welfare loss at the Hosios value is 0.11 percent and the loss at $\beta = 0.2$ is 14.1 percent. Across matching elasticities the welfare-maximising share tracks the Hosios line with a small upward displacement (Figure 13(a)). The displacement reflects the criterion, not heterogeneity: the flow surplus does not discount across cohorts, whereas the Hosios condition characterises the discounted problem, and the homogeneous economy displays the same displacement. Heterogeneity in carrying costs adds a wedge that is numerically negligible at the baseline dispersion: the planner's flow optimum exceeds the decentralised one by 0.30 percent with heterogeneous sellers and by 0.24 percent with homogeneous sellers, with lower tightness in both cases (3.80 against 4.39 buyers per listing), and the planner's acceptance thresholds are flatter across urgency types than the decentralised ones (Table 20, Appendix C). These are numerical statements for the flow criterion, not theorems, and they do not extend to economies with endogenous listing,

where [Gabrovski and Ortego-Marti \(2025\)](#) show that two-sided entry breaks the Hosios condition.

Table 11. Bargaining power and steady-state flow welfare, heterogeneous and homogeneous sellers (model-generated, $\alpha = 0.5$)

β	sellers	θ	price	TOM (mo.)	welfare	sellers' value	holding costs	D_{urg} (%)
0.20	heterogeneous	16.77	0.9514	1.08	0.1360	0.1314	0.0098	7.64
0.20	homogeneous	17.03	0.9513	1.06	0.1359	0.1314	0.0100	0.00
0.35	heterogeneous	8.08	0.9790	1.65	0.1527	0.1466	0.0150	6.31
0.35	homogeneous	8.21	0.9789	1.62	0.1525	0.1465	0.0153	0.00
0.50	heterogeneous	4.39	0.9960	2.23	0.1582	0.1505	0.0202	5.59
0.50	homogeneous	4.46	0.9959	2.19	0.1580	0.1504	0.0207	0.00
0.55	heterogeneous	3.59	1.0002	2.43	0.1584	0.1501	0.0221	5.41
0.55	homogeneous	3.65	1.0001	2.39	0.1582	0.1500	0.0226	0.00
0.65	heterogeneous	2.34	1.0069	2.89	0.1562	0.1466	0.0263	5.10
0.65	homogeneous	2.38	1.0067	2.84	0.1559	0.1465	0.0268	0.00
0.80	heterogeneous	1.05	1.0114	3.79	0.1436	0.1315	0.0347	4.71
0.80	homogeneous	1.06	1.0111	3.74	0.1432	0.1314	0.0353	0.00

Note: “welfare” is the flow surplus [\(15\)](#); “sellers’ value” the ex-ante value of a listing cohort net of the own-use value; “holding costs” the flow of carrying costs paid by the stock of listings.

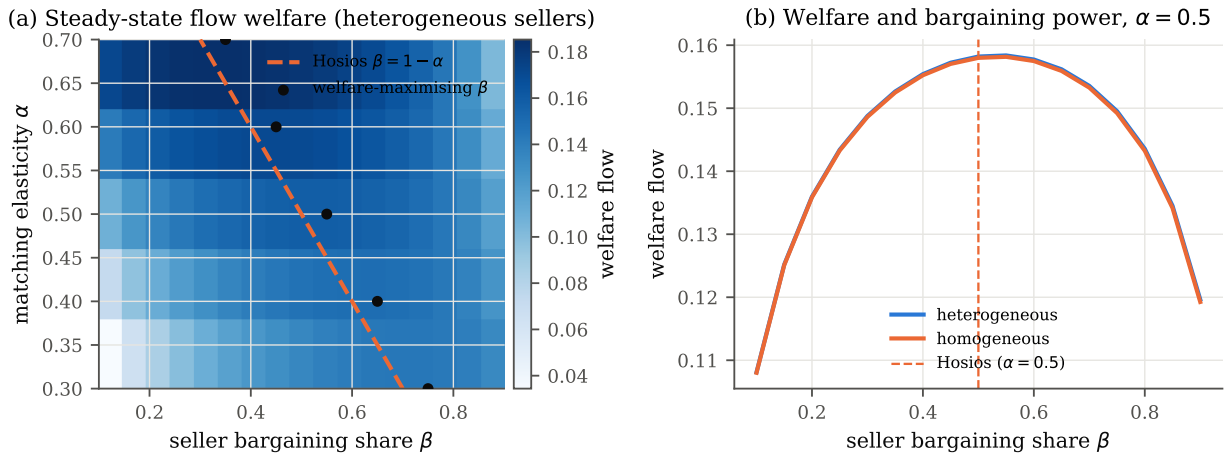


Figure 13. Welfare and market frictions (model-generated). Panel (a): steady-state flow surplus over the seller’s bargaining share and the matching elasticity, heterogeneous sellers; the dashed line is the Hosios locus $\beta = 1 - \alpha$ and the dots the welfare-maximising share at each elasticity. Panel (b): welfare as a function of the bargaining share at $\alpha = 0.5$ for heterogeneous and homogeneous sellers.

Three policy readings follow, each conditional on the model’s assumptions. First, measures that raise matching efficiency or qualification, such as faster or more reliable mortgage decisions, raise prices, shorten durations and narrow the urgency discount, and part of their effect works through

buyer entry; the general-equilibrium elasticities of Section 8.1 exceed the partial-equilibrium ones by about ten percent. Second, the welfare cost of a liquidity shock is borne by sellers in proportion to their urgency: the holding-cost flow and the reservation-value gap both rise when arrivals fall, so that policies that reduce the carrying cost of urgent sellers (bridge financing, forbearance) have a distributional rationale even when total surplus is little affected. Third, the welfare of the market is insensitive to the split of the surplus in a wide neighbourhood of the Hosios share but falls steeply outside it, and institutions that shift bargaining power toward one side, such as the bidding wars documented by [Han and Strange \(2014\)](#) or the brokerage arrangements studied by [Levitt and Syverson \(2008\)](#), matter for welfare through their effect on entry rather than through the price level.

10. Limitations, falsifiable predictions and conclusion

10.1. Limitations

The model is stationary and local, with exogenous listing inflow, no construction and no spillovers across segments. Urgency is a permanent, nonnegative carrying cost, so sellers whose reservation price rises with their constraints, as in [Genesove and Mayer \(1997\)](#) and [Genesove and Mayer \(2001\)](#), and mechanisms that generate positive duration dependence, such as list-price revisions, learning ([Anenberg, 2016](#)) and stigma ([Taylor, 1999](#)), are outside its scope. Information is complete within a match, so the adverse-selection channels of [Kurlat and Stroebe \(2015\)](#) and [Garmaise and Moskowitz \(2004\)](#) are absent. Buyers never exit, which makes the financing extension inadmissible when the approval probability is low. The welfare criterion is a steady-state flow, and the welfare results are numerical statements for that criterion. Transition paths assume unanticipated shocks and free entry at every instant, which makes prices jump; anticipation or sluggish entry would smooth them. Quality is a scale factor, so the correlation between distress and condition that confounds measured forced-sale discounts ([Clauret and Daneshvary, 2009](#)) is not modelled. Finally, no data were used: all magnitudes are illustrative, and the paper claims nothing about any particular market.

10.2. Falsifiable predictions

Six predictions distinguish the mechanism from its alternatives. (1) Among observationally identical houses, the price concession of urgent sellers is larger, and their sale hazard higher, in markets with fewer buyers per listing. (2) The dispersion of prices among identical houses rises when matching efficiency or qualification falls. (3) After a liquidity shock, within-type prices adjust at once while inventories and volumes adjust over months, and a temporary shock is followed by a rebound of sales. (4) The cash–mortgage gap rises with seller urgency and with approval delay, and its selection component can be negative for patient sellers, so that measured gaps understate the

delay-bargaining compensation when sellers are patient. (5) The steady-state sales-to-listings ratio falls with liquidity only in markets with non-trivial withdrawal. (6) In segments with heavy-tailed buyer valuations, greater buyer traffic can lengthen the time on market of urgent sellers. The natural data are listing-level records with time on market, withdrawals, financing type and a proxy for the seller's circumstances, as in [Glower et al. \(1998\)](#) or [Andersen and Nielsen \(2017\)](#), with the competing-risks structure that Lemma 3 implies.

10.3. Conclusion

The paper has formalised the housing liquidity discount as the price of urgency in a search market and has shown how it is determined jointly with sale hazards, tightness and the composition of transactions. Four results carry the weight. The expected transaction price falls with the seller's carrying cost by less than the reservation price does, and the gap between patient and urgent sellers widens when buyers are scarce, provided the distribution of buyer valuations has an increasing failure rate; with heavy-tailed valuations a more liquid market can lengthen time on market, under a condition that depends on the seller's carrying cost but not on the arrival rate. A fall in matching efficiency or in qualification moves prices, volume, inventory and durations together with no change in the distribution of housing-service values, and buyer entry amplifies the response. The composition of transactions changes after such a shock in a direction that depends on the shape of the valuation distribution, and its effect on a transaction-price index is an order of magnitude smaller than the within-type liquidity effect that no quality adjustment can remove. The gap between what mortgage and cash buyers pay decomposes into a delay-bargaining term that rises with urgency and whose sign depends on who bears the larger cost of waiting, an outside-option term, and a selection term that can be negative. The frictionless benchmark against which these objects are measured is not a liquidity premium in the usual sense, since a seller with the option to wait for a high-valuation buyer may obtain more than the Walrasian price in a sufficiently thick market. The next step is empirical: the predictions above are stated in terms of objects that listing-level data can measure.

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Appendices

A. Proofs

Throughout, U is given, $h_G = g/(1 - G)$ and $M = H/(1 - G)$. Two facts are used repeatedly. (F1) $H'(v) = -(1 - G(v))$ and $M'(v) = -1 + h_G(v)M(v)$, so $M' > -1$ wherever $g > 0$; under IFR $M(v) = \int_v^{w_H} \exp(-\int_v^w h_G) dw \leq \int_v^\infty e^{-h_G(v)(w-v)} dw = 1/h_G(v)$, hence $M' \leq 0$. (F2) $\frac{d}{dv}E[w | w \geq v] = 1 + M'(v) = h_G(v)M(v) > 0$ wherever $g > 0$; under IFR $gH = g(1 - G)M \leq (1 - G)^2$.

Lemma 1. $H_q(qv) = \int (q\varepsilon - qv)^+ dG_\varepsilon = qH_1(v)$ and $1 - G_q(qv) = 1 - G_\varepsilon(v)$. Substituting $V_q = qV$, $U_q = qU$ into (4) and (5) gives the $q = 1$ equations multiplied by q ; hazards, stocks and θ are unchanged; free entry reads $qU = q\tilde{k}$; prices scale by (6). $\square$

Lemma 2. $\Phi(V) = -c + \delta w_0 + \Lambda_s \beta H(V + U) - (r + \delta)V$ is continuous and strictly decreasing, $\Phi' = -\Lambda_s \beta(1 - G) - (r + \delta) \leq -(r + \delta)$; $\Phi \rightarrow +\infty$ as $V \rightarrow -\infty$ because $H(v) = E[w] - v$ for $v \leq w_L$, and $\Phi \rightarrow -\infty$ as $V \rightarrow +\infty$ because $H \geq 0$. Hence a unique root. Φ is C^1 in all arguments and $\Phi_V < 0$, so the implicit function theorem applies with $\Phi_c = -1$, $\Phi_{\Lambda_s} = \beta H(v^*)$ and $\Phi_U = -\Lambda_s \beta(1 - G(v^*))$. $\square$

Lemma 3. $\bar{h}(\tau) = \int \mu e^{-\mu\tau} dF / \int e^{-\mu\tau} dF = E_\tau[\mu]$ under the tilted measure $dF_\tau \propto e^{-\mu\tau} dF$, and $\bar{h}'(\tau) = -\text{Var}_\tau(\mu) < 0$. $\square$

Proposition 1. (i) is Lemma 2. (ii) $\eta'(c) = -\Lambda_s g(v^*)V'(c) \geq 0$. (iii) Conditional on sale $p = V + \beta(w - v^*)$, so $\bar{p} = V + \beta M(v^*)$ and $\bar{p}' = V'[1 + \beta M'(v^*)]$ since $v^{*'} = V'$; by (F1) $1 + \beta M' > 1 - \beta > 0$, and under IFR $1 + \beta M' \leq 1$. $D(c) = 1 - \bar{p}(c)/\bar{p}(c_L)$ inherits monotonicity when $\bar{p}(c_L) > 0$. (iv) The root of the decreasing Φ is at least w_0 iff $\Phi(w_0) \geq 0$, i.e. $-c + \delta w_0 + \Lambda_s \beta H(w_0 + k) - (r + \delta)w_0 \geq 0$. $\square$

Proposition 2. (i) Lemma 2 and $\partial \bar{p} / \partial \Lambda_s = \partial V / \partial \Lambda_s [1 + \beta M']$. (ii) $\partial \eta / \partial \Lambda_s = (1 - G) - \Lambda_s g \partial V / \partial \Lambda_s$; multiplying by the positive denominator of (16), the sign is that of $(1 - G)(r + \delta) + \Lambda_s \beta [(1 - G)^2 - gH]$, positive under IFR by (F2). Pareto: $1 - G = (w_L/v)^a$, $g = a w_L^a v^{-a-1}$, $M = v/(a - 1)$, so $gH = \frac{a}{a-1} (w_L/v)^{2a}$ and $(1 - G)^2 - gH = -(1 - G)^2/(a - 1)$; the sign becomes that of $(r + \delta) - \beta \eta/(a - 1)$. Since $H(v^*) = (1 - G(v^*))v^*/(a - 1)$, equation (4) reads $(r + \delta)V + c - \delta w_0 = \beta \eta v^*/(a - 1)$ with $v^* = V + U$, i.e. $\beta \eta = (a - 1)(r + \delta) + (a - 1)[c - \delta w_0 - (r + \delta)U]/v^*$, whence $\beta \eta > (a - 1)(r + \delta)$ iff $c > \delta w_0 + (r + \delta)U$. (iii) $V(c_L) - V(c) = \int_{c_L}^c du / [(r + \delta) + \beta \eta(u)]$ by (i) of Proposition 1, and $\eta(u)$ is increasing in Λ_s by (ii). (iv) As

$\Lambda_s \rightarrow 0$, (4) gives $V \rightarrow (-c + \delta w_0)/(r + \delta)$, which is 0 for $c = 0$, $w_0 = 0$; then $v^* \rightarrow k \leq w_L$, $M(k) = E[w] - k$ and $\bar{p} \rightarrow \beta(E[w] - k)$. As $\Lambda_s \rightarrow \infty$, $H(v^*) = [(r + \delta)V + c - \delta w_0]/(\Lambda_s \beta) \rightarrow 0$ forces $v^* \rightarrow w_H$, so $V \rightarrow w_H - k$ and $M \rightarrow 0$. $p^* < w_H - k$ iff $H(p^*) = rk > H(w_H - k)$ since H is decreasing. $\square$

Proposition 3. (a) $\lambda_b = A\theta^{\alpha-1}$ is strictly decreasing; V is increasing in θ through $\Lambda_s = \phi A\theta^\alpha$, so $H(V + k)$ is nonincreasing; the product of a strictly decreasing positive function and a nonincreasing positive function is strictly decreasing. As $\theta \rightarrow \infty$, $\lambda_b \rightarrow 0$ and $R \rightarrow -\kappa_b - rk$; as $\theta \rightarrow 0$, $\lambda_b \rightarrow \infty$ and $H(V + k) \rightarrow H(k + (\delta w_0 - c)/(r + \delta)) > 0$. $\partial R/\partial \phi = (1 - \beta)\lambda_b[H - \phi(1 - G)\partial V/\partial \phi]$ with $\partial V/\partial \phi = \lambda_s \beta H/[(r + \delta) + \Lambda_s \beta(1 - G)]$, so $\partial R/\partial \phi = (1 - \beta)\lambda_b H(r + \delta)/[(r + \delta) + \Lambda_s \beta(1 - G)] > 0$ and $d\theta^*/d\phi = -R_\phi/R_\theta > 0$; the same algebra applies to A . Observational equivalence: $\Lambda_s = \phi A\theta^\alpha$ and $\Lambda_b = \phi A\theta^{\alpha-1}$. (b) R is continuous in θ because $V(c; \theta)$, η , n and N are, with the same limits, so the intermediate value theorem applies. $\square$

Proposition 4. (i) Proposition 2(i), and Proposition 3(a) for the fall in θ^* . (ii) Proposition 2(ii) with n fixed in $Q = \int \eta n$. (iii) $n(c) = sf(c)/(\eta(c) + \delta)$ and $1/(\eta + \delta)$ rise. (iv) $Q_{ss} = s \int \eta/(\eta + \delta) dF$ is strictly increasing in each η iff $\delta > 0$. $\square$

Proposition 5. Law of total variance with $p = (1 - \beta)V(c) - \beta U + \beta w$ and $\text{Var}(p | c) = \beta^2 \text{Var}(w | w \geq v^*(c))$. (i) $\bar{p}$ is strictly monotone. (ii) V is Lipschitz with constant $1/(r + \delta)$; for Lipschitz f with constant L , $\text{Var}f(X) = \frac{1}{2}E[(f(X) - f(X'))^2] \leq L^2 \text{Var}X$; under IFR $|\bar{p}'| \leq |V'| \leq 1/(r + \delta)$. (iii) Proposition 2(iii). $\square$

Proposition 6. (i) $\omega = \eta n/Q$ with $n = sf/\eta$ and $Q = s$. (ii) $\omega^+ \propto \eta^+ n$ with n fixed, so $d \ln \omega = d \ln \eta - d \ln Q = (\varepsilon - E_\omega \varepsilon) d \ln \Lambda_s$. Then $dP = \int \bar{p} d\omega + \int \omega d\bar{p}$ and $\int \bar{p} d\omega = \text{Cov}_\omega(\bar{p}, \varepsilon) d \ln \Lambda_s$. Two functions that are both decreasing in c are comonotone and positively correlated under any ω (Chebyshev's sum inequality), strictly if both are strictly monotone and ω is non-degenerate; two functions of opposite monotonicity are negatively correlated. The formula for ε : $\partial \ln \eta / \partial \ln \Lambda_s = 1 - h_G(v^*)\Lambda_s \partial V / \partial \Lambda_s = 1 - h_G \Lambda_s \beta H / [(r + \delta) + \Lambda_s \beta(1 - G)]$ and $\Lambda_s H = \eta M$. (iii) Exponential: $h_G M = 1$. Pareto: $h_G M = a/(a - 1)$. If $h_G M$ is nonincreasing in v , then as c rises v^* falls, $h_G M$ rises and $\beta \eta / (r + \delta + \beta \eta)$ rises, so ε falls; if $h_G M$ is increasing the two factors move in opposite directions and no general sign obtains. (iv) is (i). $\square$

Proposition 7. Pending values are linear in p with slopes $\pm v \phi_m / (r + v)$, so the Nash product is maximised where $P_s - V = \beta \Sigma_m$. Writing $\Sigma_m = [v \phi_m (w - V - U_m) - c - \kappa_b - r(V + U_m)] / (r + v)$ and solving $P_s - V = \beta \Sigma_m$ for p gives $p_m = V + \beta(w - V - U_m) + \{(1 - \beta)[c + rV] - \beta[\kappa_b +$

$rU_m\}}/(v\phi_m)$; subtracting $p_c = V + \beta(w - V - U_c)$ yields (20). (i) $1 + rV' = [\delta + \lambda_s\beta(\cdot)]/[(r + \delta) + \lambda_s\beta(\cdot)] \geq 0$, where $(\cdot)$ is the positive acceptance mass of the two buyer types. (ii) $\Sigma_m \geq 0$ iff $w \geq v_m^*$; subtract $v_c^* = V + U_c$; $E[w \mid w \geq v]$ is strictly increasing by (F2). (iii) Direct. $\square$

Proposition 8. (i) $\ln[(1 - G(y))(y - a)]$ is strictly concave on (a, w_H) because log-concave g implies log-concave $1 - G$, and the objective vanishes at both ends; the first-order condition $-g(y)(y - a) + (1 - G(y)) = 0$ gives the characterisation. (ii) By the envelope theorem the maximised value has slope $-(1 - G(y))$ in V , so $\Phi_P(V) = -c + \delta w_0 + \Lambda_s \max_y(\cdot) - (r + \delta)V$ is strictly decreasing with a unique root, and the implicit function theorem gives V' . $\psi(y) = y - 1/h_G(y)$ is strictly increasing under IFR, so $y(c) = \psi^{-1}(U + V(c))$ is increasing in V and decreasing in c . (iii) $1/h_G(y) > 0$. $\square$

B. Computation

Discretisation of F . The carrying-cost distribution $\text{Beta}(a, b)$ on $[c_L, c_H]$ is represented by n types placed at the conditional means of n equal-probability bins, with the bins' masses as weights; the mean of the discretisation equals the Beta mean exactly. Convergence in n is reported in Table 12: with 9 types the mean price differs from the 81-type solution by 2.2e-04 percent.

Stationary equilibrium. For a given θ , $\Lambda_s = \phi A \theta^\alpha$ and $U = k$; each $V(c_i)$ is the Brent root of Φ with bracket $[(-c_i + \delta w_0)/(r + \delta), w_H - U]$ (widened by doubling when the support is unbounded), tolerance 10^{-12} ; hazards, stocks and the free-entry residual follow in closed form. The residual is evaluated on 60 log-spaced points of $[0.02, 60]$ and Brent's method is applied to every sign change; the number of roots is stored with each result. In the baseline and in all 60 random draws of Table 18 there is exactly one root (0 draws with several roots, 0 without).

Financing extension. With $x = (\ln \theta, U_c, \text{logit } \tilde{\pi})$ and $U_m = (k - \pi U_c)/(1 - \pi)$, the residual vector consists of the cash and mortgage buyer Bellman equations divided by r and of the stock-consistency condition $\tilde{\pi} = B_c/(B_c + B_m)$, where $B_c = \pi Q/\xi_c$, $B_m = (1 - \pi)Q/(\phi_m \xi_m)$, $\xi_c = \lambda_b \int (1 - G(v_c^*)) dN$, $\xi_m = \lambda_b \int (1 - G(v_m^*)) dN$, $n(c) = sf(c)/[\eta_c(c) + \phi_m \eta_m(c) + \delta]$ with $\eta_c = \lambda_s \tilde{\pi}(1 - G(v_c^*))$ and $\eta_m = \lambda_s(1 - \tilde{\pi})(1 - G(v_m^*))$, pending stock $m(c) = \eta_m n/v$, and $Q = \int (\eta_c + \phi_m \eta_m) n$. The identity $\theta = (B_c + B_m)/S$ is implied by the flow accounting and is reported as a diagnostic (it holds to 10^{-15}). The system is solved by a hybrid Powell method with a Levenberg–Marquardt fallback, from the baseline-screen equilibrium; all residuals are below 10^{-15} and three different starting points return the same solution. The expected mean prices by financing type are $\bar{p}_c = V + \beta M(v_c^*)$ and $\bar{p}_m = V + \beta[E(w \mid w \geq v_m^*) - V - U_m] + \Delta_b$.

Posted prices. $y(c)$ solves $(y - a)g(y) = 1 - G(y)$ by Brent’s method, nested inside the Brent root for V ; the buyer’s surplus per meeting with a type- c seller is $H(y(c))$.

Planner. The flow surplus (15) is maximised over $(\ln \theta, v^*(c_1), \dots, v^*(c_n))$ by Nelder–Mead followed by Powell’s method, started at the decentralised allocation; success flags and function evaluations are stored.

Transition. On a grid with step Δt (0.02 years in the reported experiments, horizon 8 years), the seller value is updated backward by $V_j = [V_{j+1} + \Delta t(-c + \delta w_0 + \Lambda_{s,j} \beta H(V_{j+1} + k))]/[1 + (r + \delta)\Delta t]$ from the terminal steady state; the stock is updated forward by $n_{j+1} = (n_j + \Delta t sf)/[1 + \Delta t(\eta_j + \delta)]$ from the initial steady state; the free-entry condition gives $\theta_j = \{(rk + \kappa_b)/[\phi_j A_j(1 - \beta) \int H(V_j + k)dN_j]\}^{1/(\alpha-1)}$; the tightness path is updated with damping 0.3 until the maximum change is below 10^{-7} (27 to 46 iterations). Terminal stocks match the new steady state to 10^{-12} ; convergence in Δt is reported in Table 13.

Monte Carlo validation. Listings are simulated individually: a type is drawn from f , meetings arrive at rate Λ_s , withdrawal at rate δ , each meeting draws $w \sim G$ and the sale occurs at the first $w \geq v^*(c)$ at the Nash price. Three seeds and $n \in \{2,000, 20,000, 100,000\}$ listings; the maximum absolute relative error between simulated and analytic moments at $n = 100,000$ is 0.39 percent, and identical seeds reproduce identical samples.

Reproducibility. All experiments are run by `python -m src.simulation -exp all` from `config/baseline.yaml` (SHA-256 hash of the configuration and the software versions are stored with each result), tables by `python -m src.tables`, figures by `python -m src.plotting`, tests by `pytest`, and the manuscript by `latexmk`; every number in the text is a macro generated from the result files.

Table 12. Convergence in the number of seller types (model-generated)

types	θ	price	TOM (mo.)	$\bar{D}$ (%)	seconds
1	4.45970	0.99589	2.1893	0.000	0.07
3	4.40627	0.99598	2.2182	0.977	0.19
5	4.39557	0.99599	2.2239	1.544	0.31
9	4.39075	0.99599	2.2265	1.984	0.55
15	4.38921	0.99599	2.2274	2.222	0.91
25	4.38864	0.99599	2.2277	2.370	1.51
41	4.38843	0.99599	2.2278	2.459	2.40
81	4.38833	0.99599	2.2279	2.528	4.73

Table 13. Convergence of the transition solver in the time step (permanent 20 percent fall in A , horizon 4 years)

Δt	θ_{0+}	P_{0+}	P_{1y}	Q_{1y}	S_{1y}	conv.	iter.	seconds
0.10	4.18693	0.98146	0.98137	0.89270	0.20977	yes	25	1.2
0.05	4.18627	0.98146	0.98137	0.89335	0.20993	yes	27	1.5
0.02	4.18581	0.98147	0.98137	0.89370	0.21001	yes	28	2.1
0.01	4.18565	0.98147	0.98137	0.89380	0.21004	yes	29	3.2

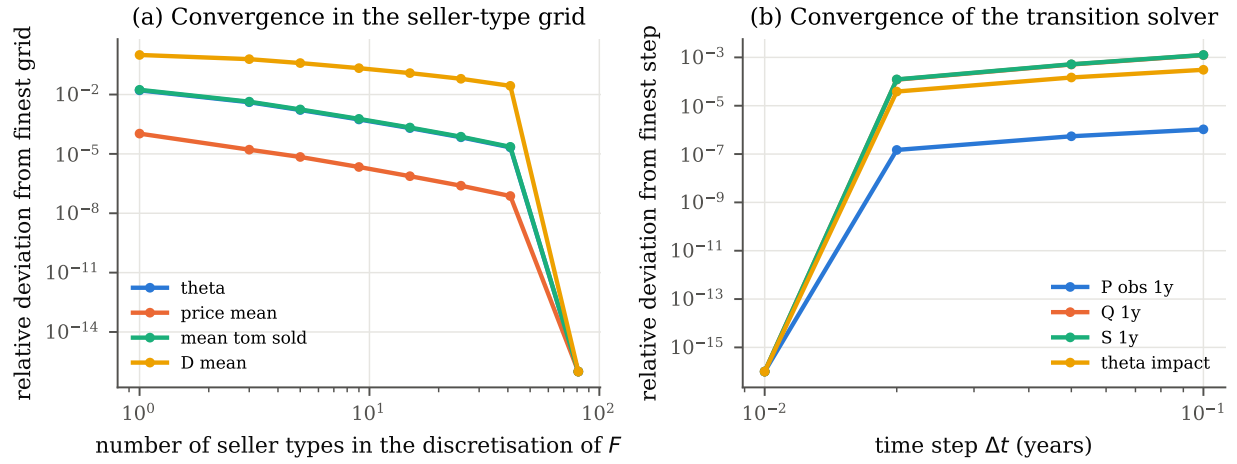


Figure 14. Numerical convergence (model-generated). Panel (a): relative deviation of equilibrium objects from the 81-type solution as the number of seller types increases. Panel (b): relative deviation of transition objects from the finest time step.

C. Additional tables and experiment register

Experiment register. Each experiment was pre-registered with the following hypothesis before it was run; the outcome column records whether the stored results support it.

- E1. Baseline: unique equilibrium, durations of a few months, urgency discount of a few percent, positive between-type dispersion, decreasing population hazard. Supported (Tables 2–3, Figures 1, 5).
- E2. Urgency gradient: monotone schedules, attenuation $|\bar{p}'| < |V'|$, steeper when arrivals fall. Supported (Figures 2–3).
- E3. Arrival collapse: lower prices and tightness, longer durations, more inventory, wider discount; GE exceeds PE; Γ changes sign. Supported (Table 4, Figure 6).

- E4. Financing: screen equivalent to A ; mortgage deals need better matches; three-term gap; Δ_b rising in urgency. Supported except that mortgage deals need better matches only for urgent sellers (selection term negative for patient sellers), and the extension is inadmissible for $\phi_m \leq 0.6$ (Table 5).
- E5. Bargaining power: hump-shaped welfare near the Hosios value; heterogeneity shifts the optimum. Supported for the hump; the optimum is at 0.55 for both economies, so the heterogeneity shift is not detectable (Table 11).
- E6. Matching versus approval: distinct signatures in the extension. Supported (Table 6).
- E7. Entry: monotone residual, amplification, entry costs. Supported (Tables 17, 18).
- E8. Heterogeneity: dispersion rises with the spread of F and when liquidity falls. Supported (Table 7).
- E9. Dynamics: impact fall of the index, inventory build-up, slow volume; composition transitory; sign depends on G . Supported, with the qualification that prices adjust fully on impact (Table 8).
- E10. Selection: small composition term, sign governed by $h_G M$. Supported (Table 9).
- E11. Posted prices: pickier sellers, between-type dispersion only, gradient preserved. Supported (Table 10).
- E12. Sensitivity and convergence: signs robust, objects converge, Monte Carlo agrees. Supported (Tables 21–22, Appendix B).

Table 14. Qualification screen ϕ in the baseline (model-generated, general equilibrium)

ϕ	θ	Λ_s	price	TOM (mo.)	D_{urg} (%)	S
0.40	3.66	3.45	0.9440	3.56	7.77	0.297
0.80	4.34	7.50	0.9921	2.30	5.73	0.192
0.85	4.39	8.01	0.9960	2.23	5.59	0.186

Table 15. Financing extension: approval delay (model-generated)

v	delay (mo.)	θ	Δ_b (%)	selection (%)	gap (%)	TOM (mo.)	cash sales (%)
3	4.00	3.92	1.96	-0.34	6.03	2.37	30.0
6	2.00	4.17	0.98	-0.36	3.17	2.26	30.0
12	1.00	4.30	0.49	-0.37	1.73	2.22	30.0
24	0.50	4.37	0.25	-0.38	1.01	2.20	30.0
52	0.23	4.40	0.11	-0.39	0.62	2.18	30.0
∞	0	4.43	0.00	-0.39	0.28	2.17	30.0

Table 16. Financing extension: bargaining power and the delay-bargaining term (model-generated)

β	θ	Δ_b (%)	outside (%)	selection (%)	gap (%)	Δ_b patient	Δ_b urgent
0.20	16.42	1.08	0.66	-0.15	1.59	0.52	2.33
0.35	7.91	0.79	1.13	-0.26	1.66	0.33	1.80
0.50	4.30	0.49	1.61	-0.37	1.73	0.14	1.28
0.65	2.30	0.20	2.11	-0.49	1.82	-0.05	0.74
0.80	1.03	-0.10	2.66	-0.60	1.96	-0.24	0.21

Table 17. Entry and search costs (model-generated, general equilibrium)

k/k_0	κ_b/κ_{b0}	θ	Λ_s	price	TOM (mo.)	D_{urg} (%)	S	Q
0.50	0.50	9.53	11.81	1.0268	1.84	4.75	0.154	0.923
0.50	1.00	4.53	8.14	1.0055	2.19	5.45	0.182	0.909
0.50	2.00	2.12	5.56	0.9825	2.66	6.31	0.222	0.889
1.00	0.50	9.18	11.59	1.0170	1.88	4.88	0.157	0.922
1.00	1.00	4.39	8.01	0.9960	2.23	5.59	0.186	0.907
1.00	2.00	2.06	5.49	0.9733	2.71	6.46	0.226	0.887
2.00	0.50	8.50	11.15	0.9974	1.96	5.15	0.163	0.918
2.00	1.00	4.13	7.77	0.9771	2.31	5.88	0.193	0.904
2.00	2.00	1.95	5.34	0.9548	2.80	6.79	0.234	0.883

Table 18. Uniqueness check: number of roots of the free-entry residual in 60 random parameter draws (model-generated)

Item	Value
draws	60
draws with exactly one root	60
draws with several roots	0
draws without a root	0
range of A	[2.30, 6.75]
range of β	[0.21, 0.80]
range of δ	[0.10, 1.00]
range of ϕ	[0.51, 0.99]
range of θ^*	[0.44, 24.76]

Table 19. Dispersion decomposition as a function of the seller's bargaining share (model-generated)

β	θ	within s.d.	between s.d.	between share (%)	D_{urg} (%)
0.00	60.00	0.0493	0.0909	77.3	65.32
0.25	12.79	0.0336	0.0153	17.1	7.08
0.50	4.39	0.0324	0.0126	13.1	5.59
0.75	1.42	0.0336	0.0112	9.9	4.84
1.00	0.02	0.0473	0.0037	0.6	1.23

Table 20. Planner's steady-state flow optimum versus the decentralised equilibrium (model-generated)

sellers	θ decentralised	θ planner	welfare decentralised	welfare planner	gain (%)
heterogeneous	4.391	3.802	0.15820	0.15867	0.299
homogeneous	4.460	3.850	0.15799	0.15838	0.243

Table 21. One-at-a-time sensitivity of baseline moments (model-generated)

parameter	value	θ	price	TOM (mo.)	D_{urg} (%)	between (%)	Q	conv.
r	0.030	4.24	0.9975	2.29	5.74	13.9	0.905	yes
r	0.050	4.54	0.9945	2.17	5.45	12.3	0.910	yes
delta	0.375	4.04	0.9988	2.37	6.12	15.8	0.924	yes
delta	0.625	4.73	0.9934	2.11	5.16	11.0	0.892	yes
w0	0.600	6.21	0.9836	1.74	4.49	7.7	0.928	yes
w0	1.000	2.62	1.0129	3.22	7.57	25.4	0.865	yes
k	0.015	4.46	1.0007	2.21	5.52	12.8	0.908	yes
k	0.025	4.32	0.9912	2.25	5.66	13.3	0.906	yes
kappa_b	0.037	5.98	1.0049	2.07	5.28	12.7	0.914	yes
kappa_b	0.062	3.45	0.9889	2.36	5.85	13.3	0.901	yes
phi	0.637	4.14	0.9770	2.62	6.31	13.8	0.891	yes
phi	0.980	4.51	1.0050	2.07	5.27	12.7	0.914	yes
A	3.375	4.14	0.9770	2.62	6.31	13.8	0.891	yes
A	5.625	4.57	1.0100	1.99	5.11	12.6	0.917	yes
alpha	0.375	4.23	0.9842	2.46	6.03	13.5	0.897	yes
alpha	0.625	4.55	1.0079	2.02	5.18	12.6	0.916	yes
beta	0.375	7.27	0.9824	1.74	6.17	14.8	0.927	yes
beta	0.625	2.62	1.0055	2.77	5.17	11.5	0.885	yes
sigma_w	0.050	4.18	0.9618	1.71	3.98	5.8	0.929	yes
sigma_w	0.150	4.73	1.0413	2.62	6.50	21.3	0.891	yes
sigma_w	0.200	5.14	1.0924	2.91	6.99	30.5	0.879	yes
c_max	0.200	3.84	1.0009	2.44	4.03	7.3	0.898	yes
c_max	0.450	5.22	0.9895	1.98	7.44	20.6	0.917	yes

Table 22. Alternative match-value distributions at the baseline parameters (model-generated)

G	IFR	θ	price	TOM (mo.)	D_{urg} (%)	between (%)	s.d. price	conv.
truncnorm	yes	4.39	0.9960	2.23	5.59	13.1	0.0347	yes
exponential	yes	2.82	0.8683	4.27	13.44	27.8	0.0531	yes
weibull	yes	4.21	0.9877	2.68	7.13	18.2	0.0376	yes
weibull_dfr	no	7.27	1.4166	5.07	10.91	93.9	0.0359	yes
pareto	no	7.26	1.4247	5.23	12.11	95.2	0.0404	yes