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Behavioral Lock-In: Aggregate Implications of Reference Dependence in the Housing Market

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Motivation & preview of the results

- Housing market at the center of public policy debate in many countries.
  - In this market, strong micro evidence for behavioral attachment to nominal anchors.
    (Han et al., 2023; Coven et al., 2024; Bracke and Tenreyro, 2021; Andersen et al., 2022)
- Growing literature studies implications of such behavioral frictions for tax policy.
  (Mullainathan et al., 2012; Chetty, 2015; DellaVigna et al., 2017; Taubinsky and Rees-Jones, 2018; Farhi and Gabaix, 2020)
- What we do:
  - Document that a single statistic, share of "paper losses" summarizes aggregate outcomes.
  - Introduce nominal anchoring into a dynamic heterogeneous-agent model of housing market with realistic preferences and constraints.
  - Implications for optimal tax policy: Ongoing property taxation, and transaction taxes.

Roadmap

1. Data and Stylized Facts
2. Rational expectations housing search model
3. Untargeted aggregate moments
4. Optimal tax policy with behavioral frictions
5. Conclusion

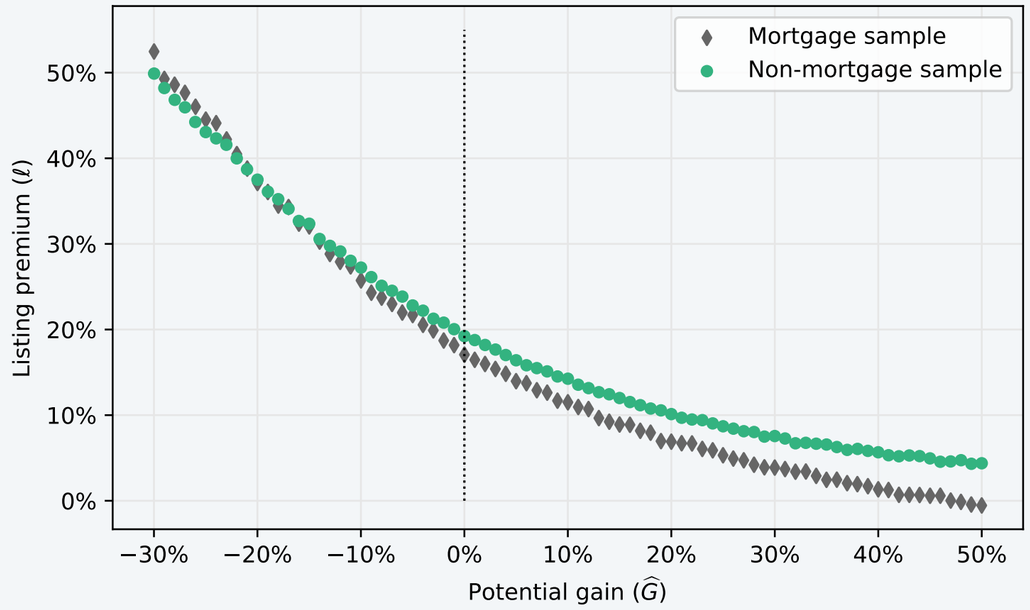
Data

- HM Land Registry records of transactions at the deed level. (1995–2022)
- Royal Mail residential address data.
- Listings of properties for sale on Rightmove.com. (2010–2022)
  - Online search behavior linked to each listing.
- Bank of England mortgage data at the loan level. (2015–2022)
- Comprehensive information on the recent evolution of the U.K. housing market with 29 million unique postal units, 27 million transactions, 21 million sales listings, and over 8 million mortgage contracts.

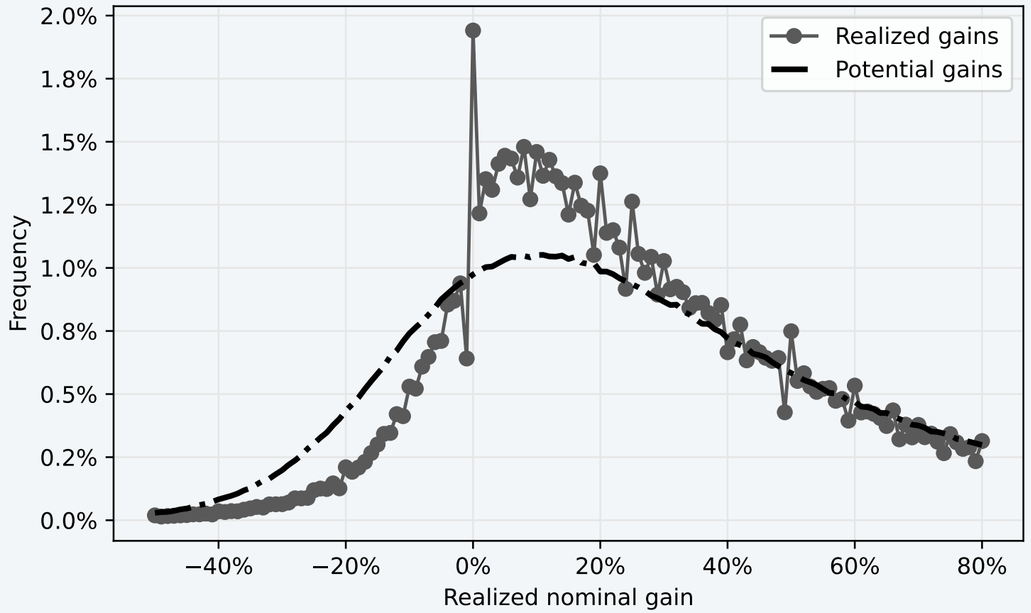
Nominal realized gains bunch at 0 due to seller mark-up behavior

- Define: Potential ***gain*** ≡ Hedonic valuation / Original purchase price - 1.
- Sellers facing paper losses mark up listing price to avoid losses
- Loss aversive list prices translate to bunching at zero realized gains.

Listing premium

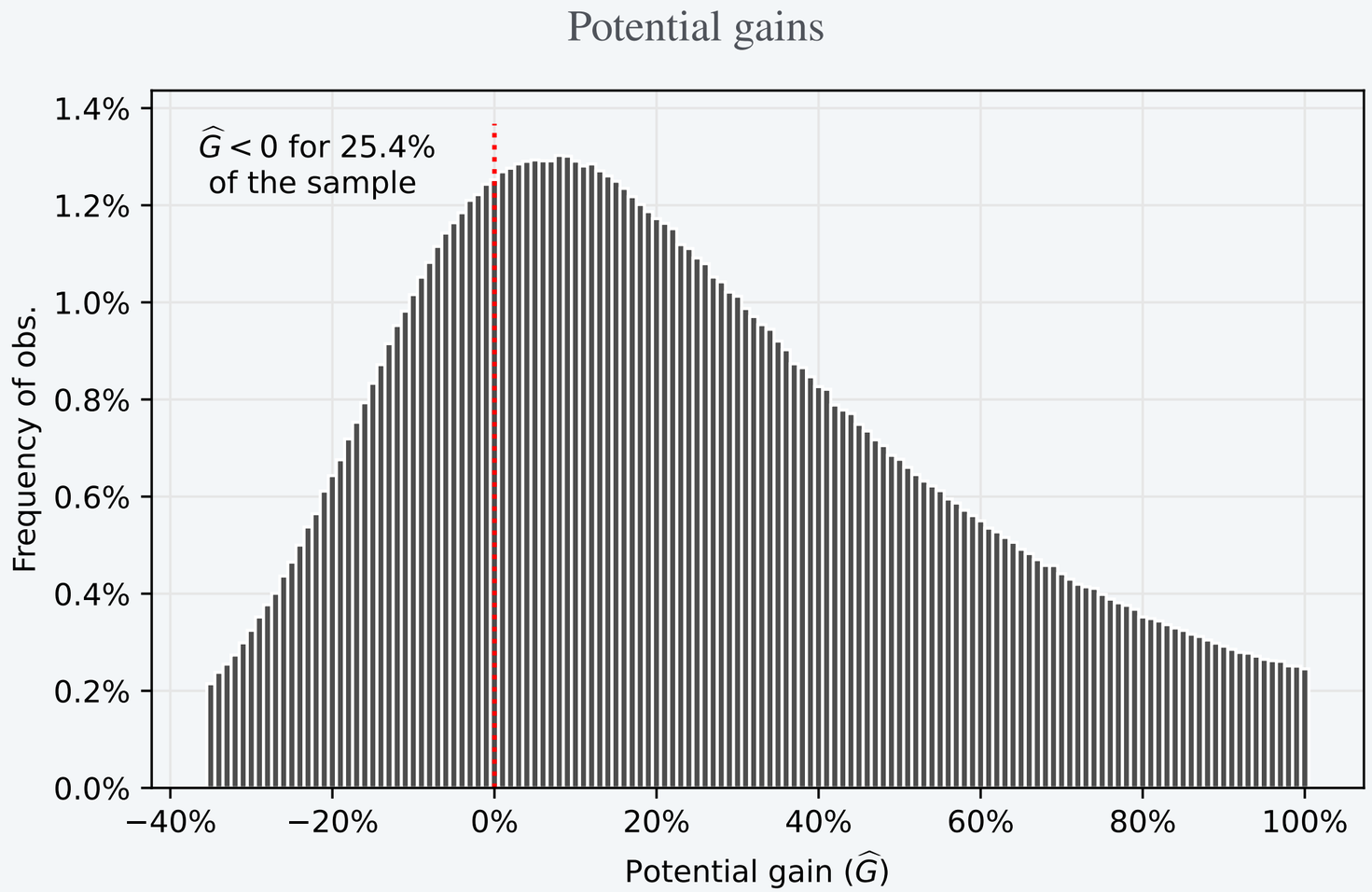


Transaction bunching



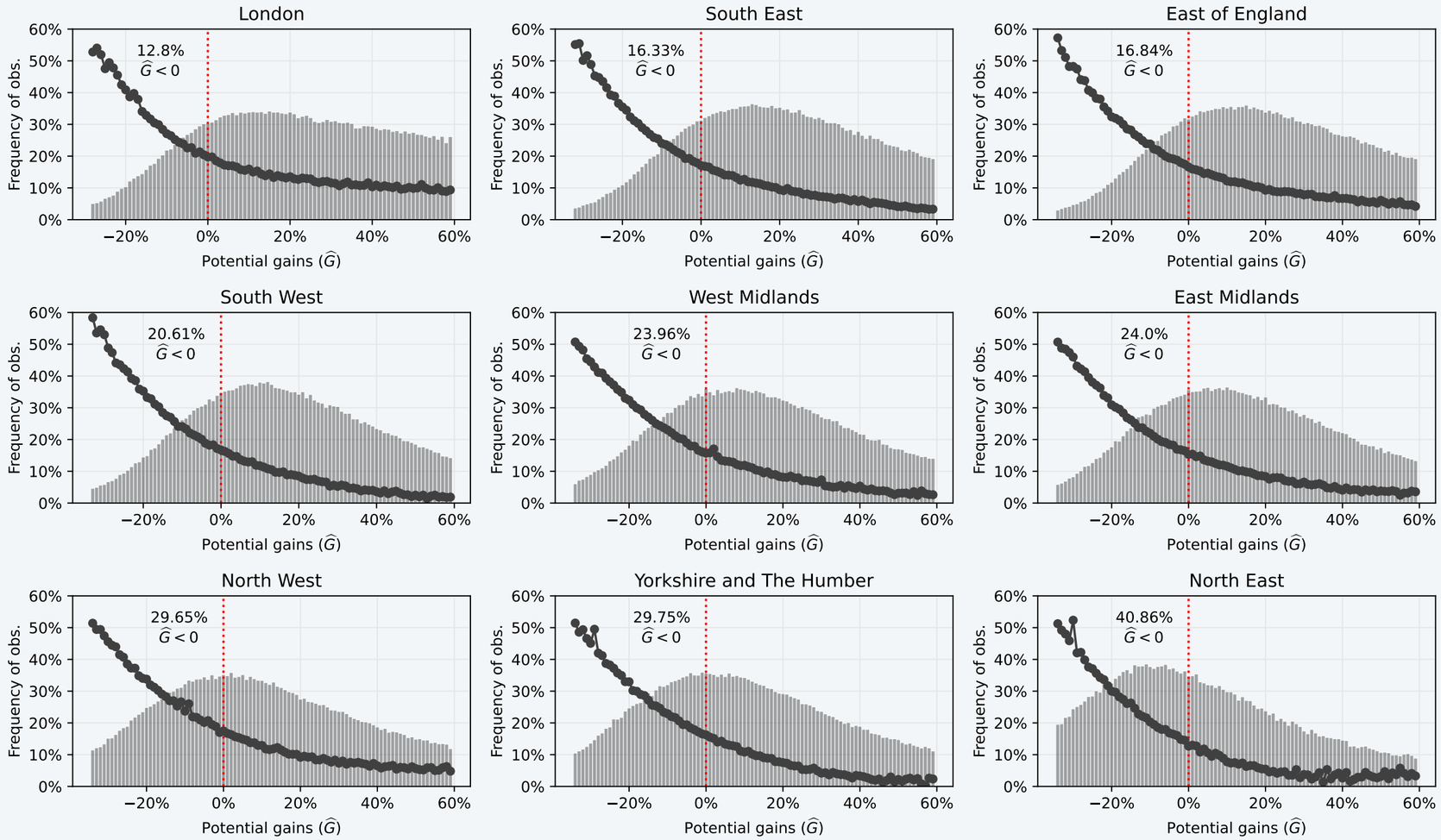
25% of U.K. home sellers face nominal losses

- Aggregate significance of behavioral anchoring depends on how many sellers are facing losses.



Loss shares vary regionally from 13% in London to 41% in North East

- While loss shares vary, “hockey stick” listing profiles remarkably stable across regions.



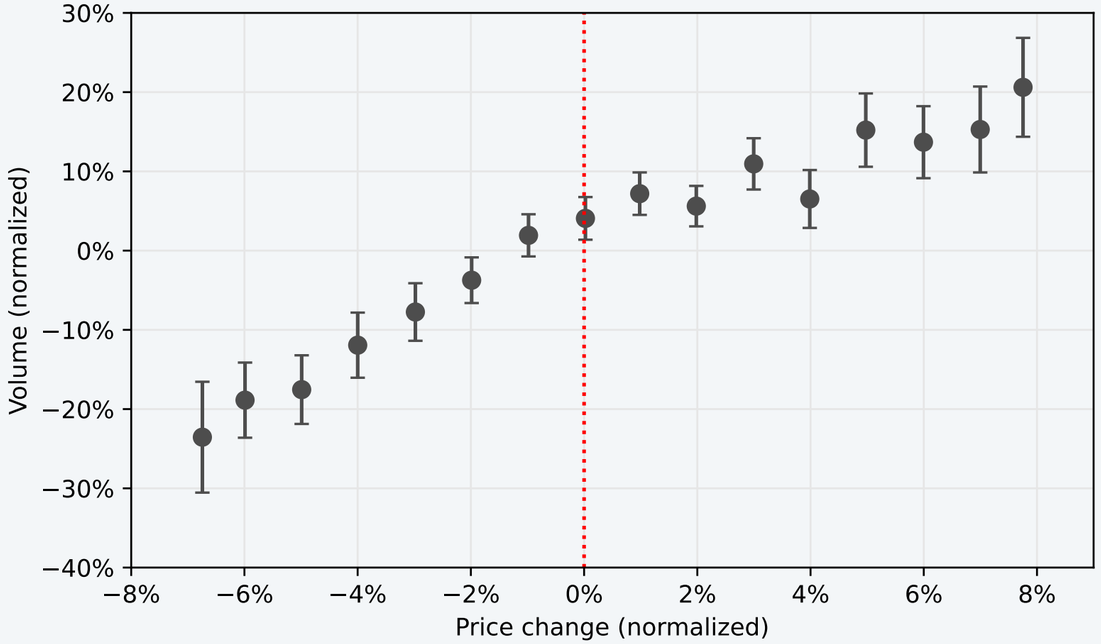
What do “paper losses” indicate?

- At the individual level:
  - Sellers are unwilling to realize a loss.
  - Tolerate higher times-on-the-market (low selling probabilities).
- At the aggregate level:
  - Prices respond sluggishly to price-relevant shocks/policy interventions = Nominal rigidity.
  - Volumes absorb variation that would otherwise show up in prices.
  - In some regions: Low transaction volume = Behavioral lock-in.

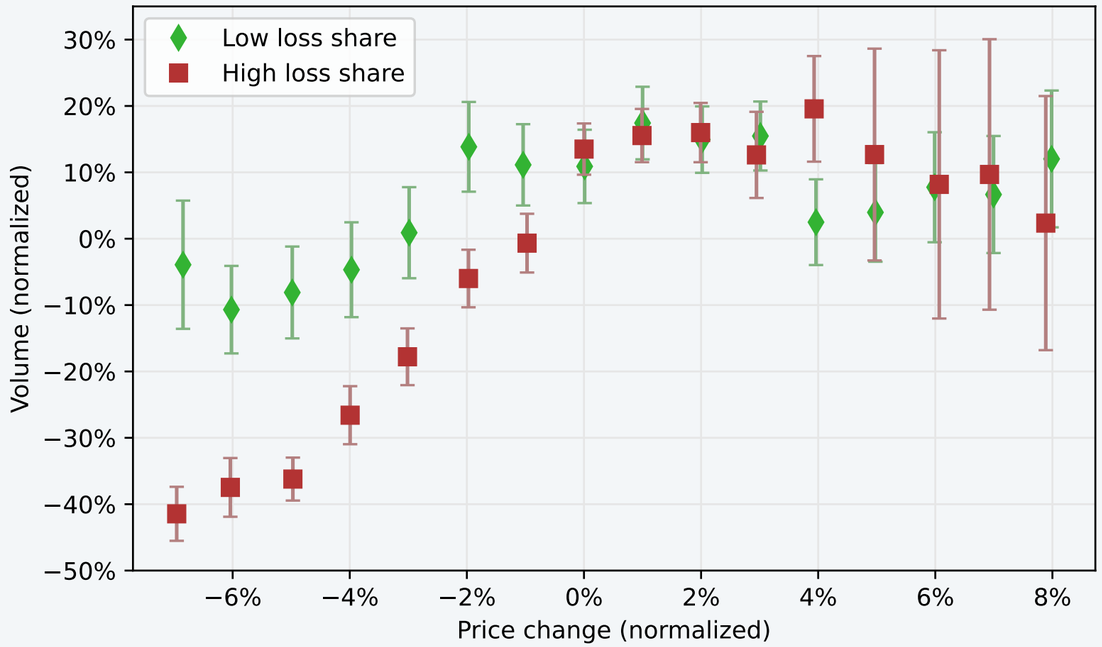
Fact 1: Positive price-volume correlation

- Calculate prices and volumes at the level of 35 ITL2 regions (UK) and states (USA), for the period between January 2010 and December 2022.

USA (Zillow)



UK (Rightmove)

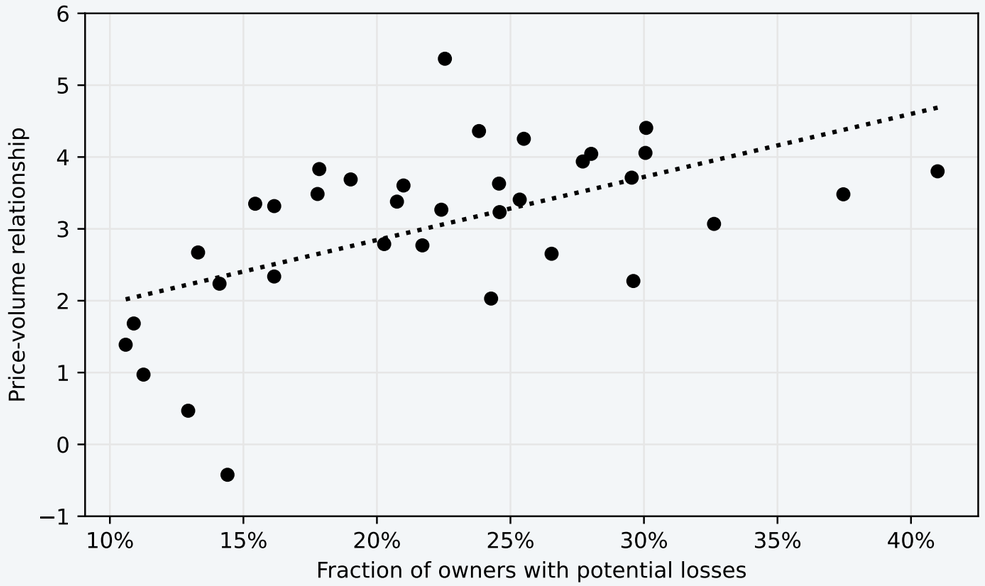


Note: Year-on-year price changes and volumes are normalized by eliminating location fixed effects.

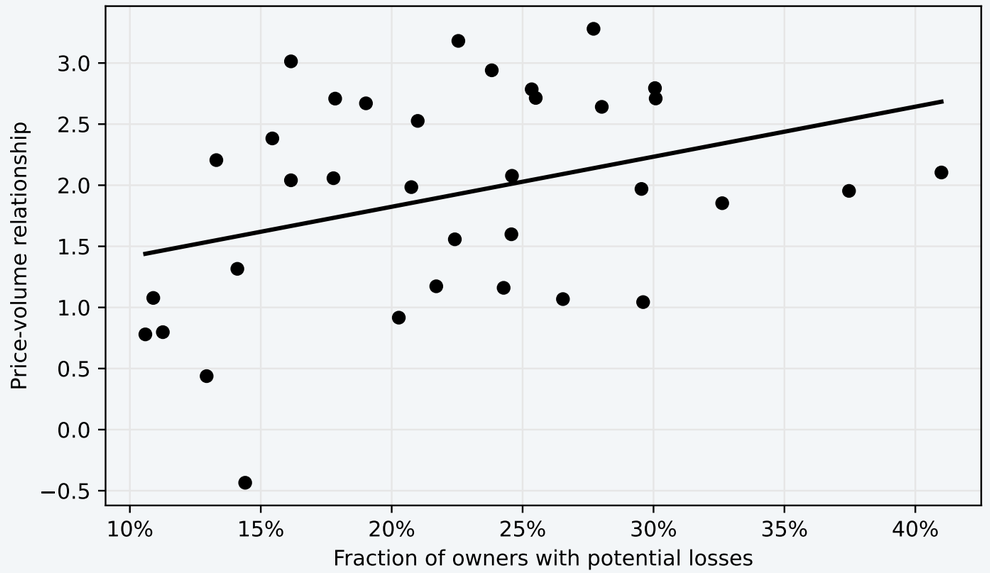
Fact 2: Price-volume correlation depends on the “paper loss” share

- Calculate share of sellers with “paper losses” in each location.

Non-mortgage sample



Mortgage sample

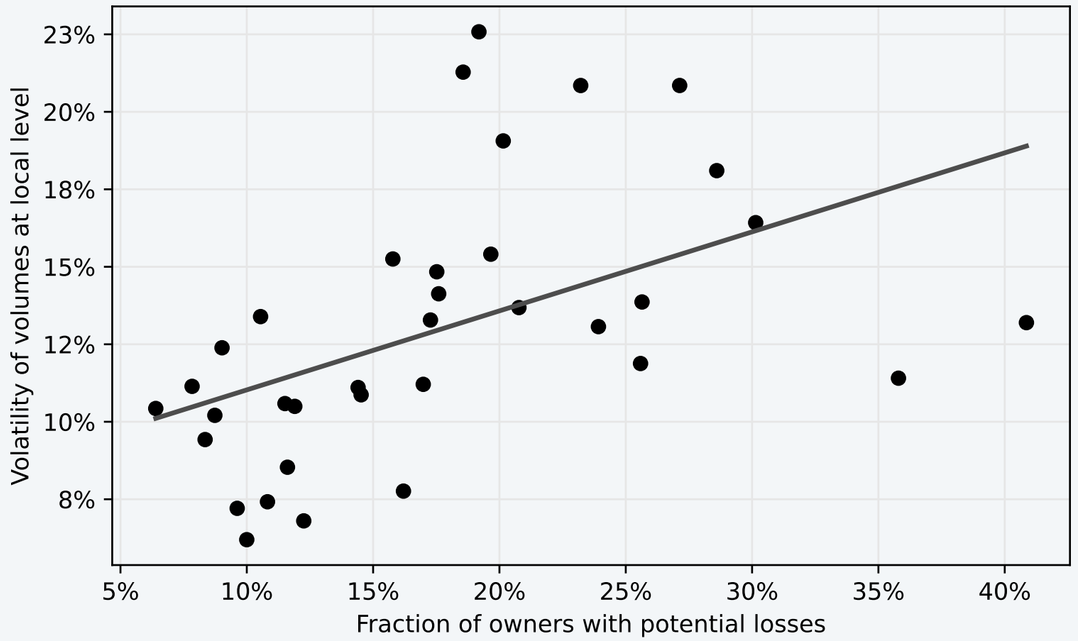


Note: The non-mortgage sample refers to transaction volumes and “paper loss” shares computed using Land Registry transactions for which neither the buyer nor the seller are associated with a mortgage contract.

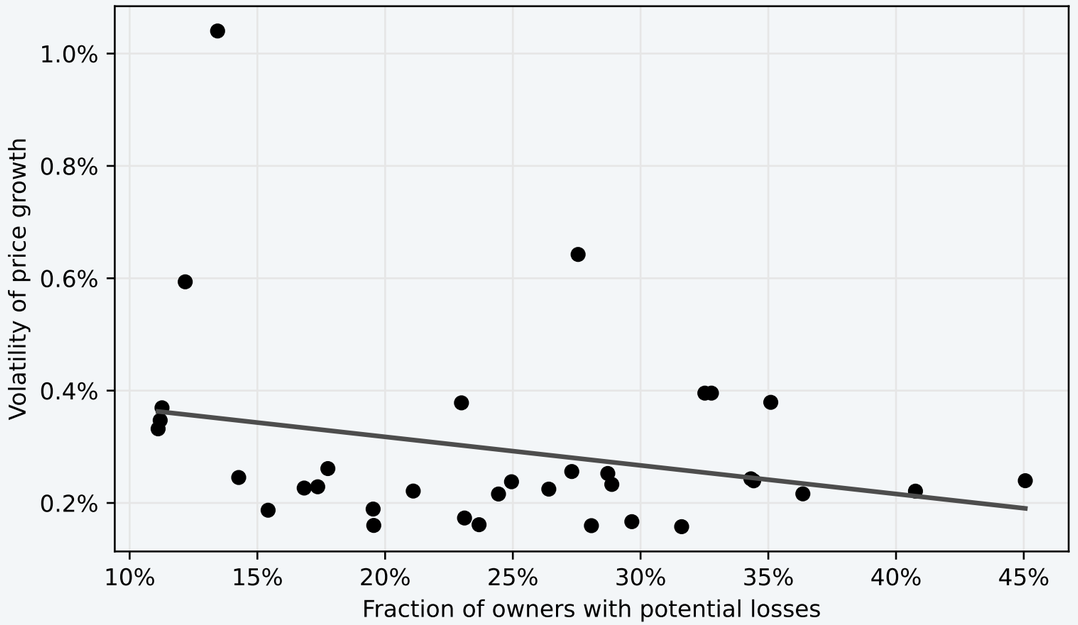
Full sample | Regression results | Spatial variation

Fact 3: Quantities react, rather than prices

Transaction volumes



Transaction prices



- Higher local loss share mainly associated with volatility of volumes.

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Homeowner problem

- Unit mass of homeowners with heterogeneous reference prices r_i and mortgage balances m_{it}
- Each period a homeowner draws an iid moving opportunity shock θ_{it} and decides whether to list and on a *take-it-or-leave-it* asking (log) price p_{it}.
- Upon a sale, receives utility $U(p_{it}, r_i, m_{it}) + \theta_{it}$, where

$$U(p_{it}, r_i, m_{it}) = p_{it} + \underbrace{\eta(p_{it} - r_i)_+ - \eta\lambda(p_{it} - r_i)_-}_{\text{Behavioural component}} - \underbrace{\mu(\gamma - (p_{it} - m_{it}))_+^2}_{\text{Downsizing penalty}},$$

where $\eta \geq 0, \lambda \geq 1$.

Mortgage interest by LTV

Search, matching, and buyer's problem

- Search and matching set-up, where a constant exogenous mass of buyers randomly search for properties; match rate given by the aggregate matching function
  - Cobb-Douglas with constant returns to scale
    (Badarinza, Balasubramaniam and Ramadorai, 2024)
- Upon a meeting, buyers draw:
  - A taste shock and optimally choose whether to accept the offer.
  - A random mortgage balance $m_{i,t+1}$ calibrated to match Bank of England mortgage data.
- Buyer's decision rule generates an endogenous demand curve that sellers incorporate in their optimal listing decision.

Equilibrium

- Sellers' optimal price setting rules generate an endogenous list price distribution faced by buyers.
  - Buyers compare the seller's offer and the continuation value, given rational expectations on the list price distribution.
- Each transaction encodes the transaction price as the reference price for the new homeowner:
  - An endogenous stationary distribution of reference prices (and mortgage balances).
  - Sellers' endogenous listing and pricing decisions and buyers purchase decisions determine the evolution of the homeowner distribution: (i) stayers, (ii) leavers, and (iii) new entrants.

Structural estimation

- Target well-known micro-level empirical moments used in existing literature:
  - Unconditional probability of listing, and conditional probability of sale ("concave demand").
  - Listing premium by potential gain; listing premium by home equity.
- Structural parameters:
  - Set $\beta = 0.99$ (period is half a year), $u = 0.046$ (average property value equal to 1), and $N_B = 0.08$ (market tightness), $\mu = 5.20$ (mortgage interest cost), $\phi = 0.02$ (hassle factor). Mortgage interest by LTV
  - Normal distributions of moving and taste shocks: F_θ and F_ε.
  - Reference dependence $\eta = 0.51$ and loss aversion $\lambda = 3.46$.
- Generate model-implied (untargeted) aggregate moments.
  - Price-volume comovement.
  - Variation in price-volume comovement with share of "paper losses".

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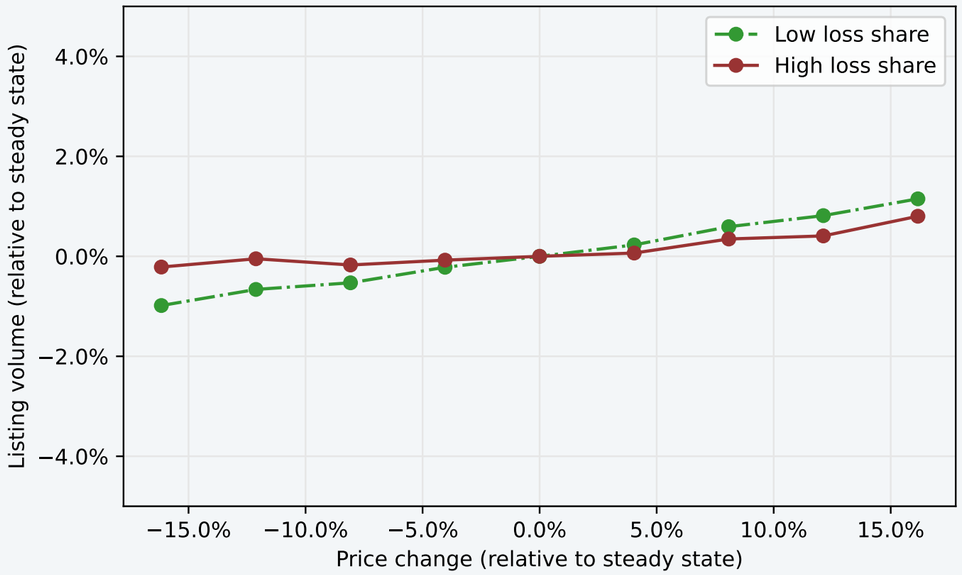
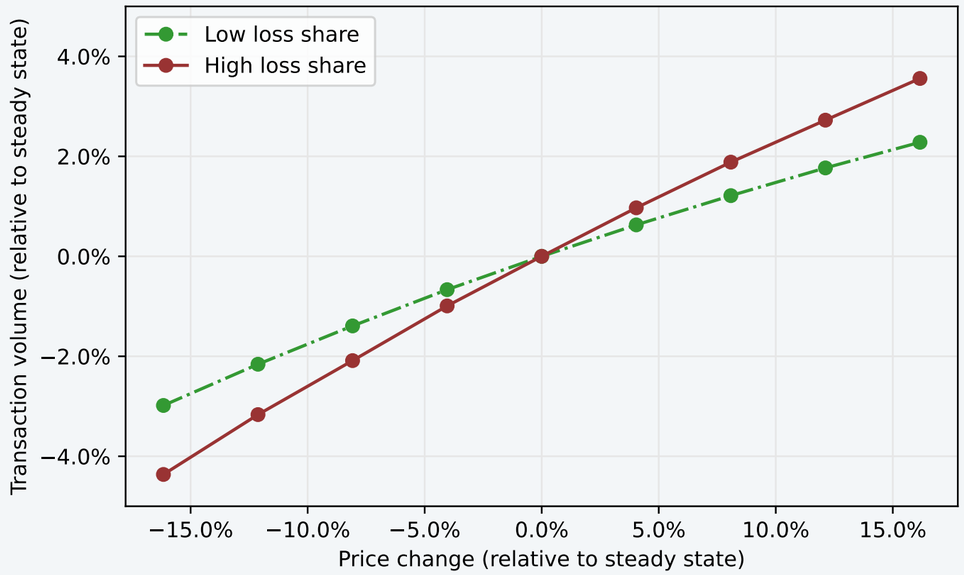
Model-implied price-volume comovement

- Model qualitatively delivers asymmetry in the price-volume relationship.
- Correctly attributes price-volume comovement to the intensive margin.

Listing volume



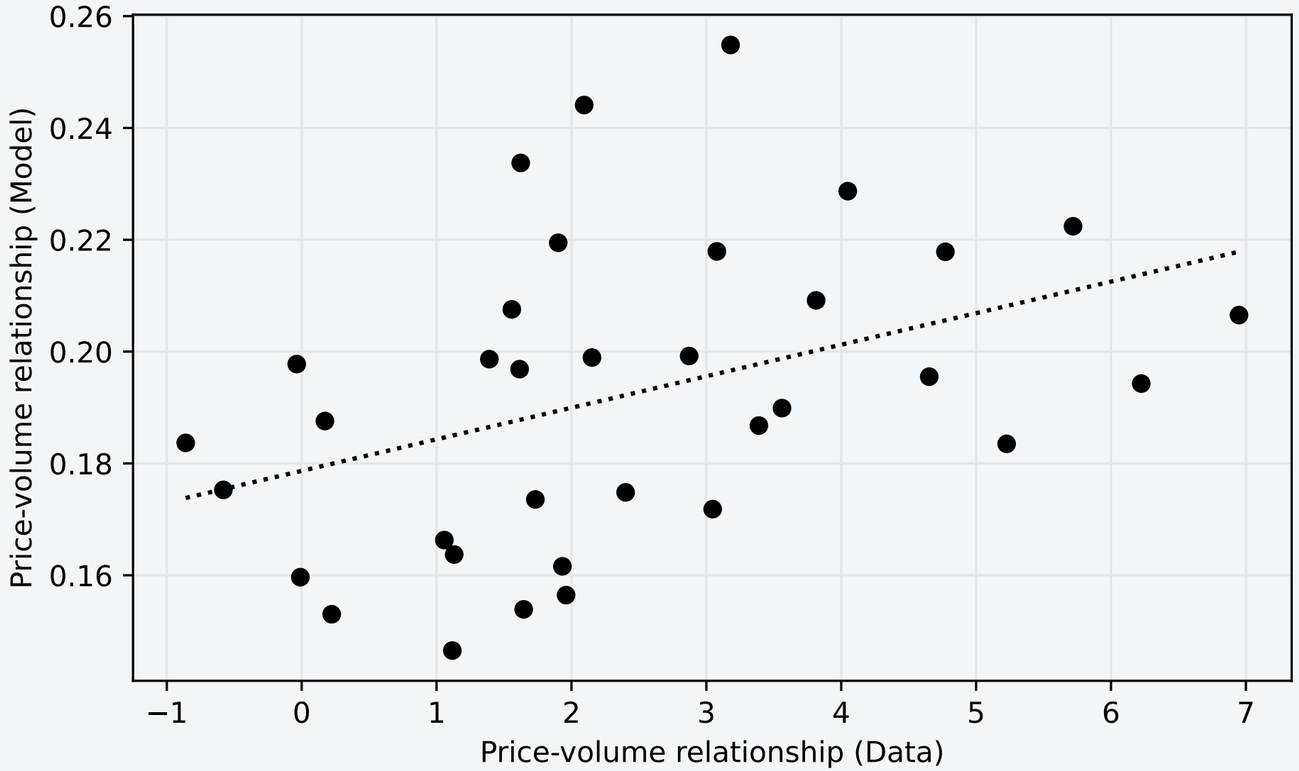
Transaction probability



Note: Partial equilibrium solution approach, conditional on steady-state policy functions. Price changes are approximated by shifting the reference price distribution. Shares of "paper losses" are calibrated to capture variation between the top and bottom 10% of regions in the data.

Untargeted aggregate moments

- Model qualitatively captures the cross-sectional variation of the price-volume correlation.



Note: Partial equilibrium solution approach, conditional on steady-state policy functions. Price changes are approximated by shifting the reference price distribution. Shares of "paper losses" are calibrated to match levels observed in the data for each region.

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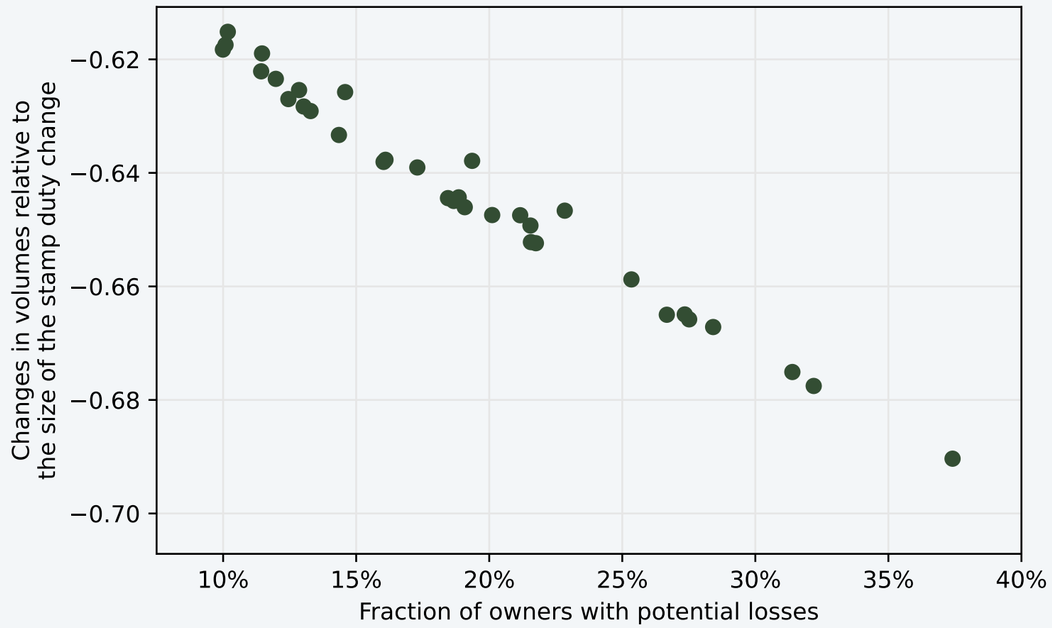
Aggregate effects of taxes

- Short term response to tax policy:
  - Tax increase (both buyer stamp duty and ongoing) leads to drop in prices and volumes.
  - With behavioral and financial frictions, prices respond less and volumes more than in the frictionless model.
    - Why? Sellers don't allow prices to drop.
    - Accept higher time-on-the-market/lower probability of sale.
- In the long term:
  - Ongoing (local council) tax: No volume response in **steady state**.
    - Why? Reference points adjust proportionally with property values.
  - Stamp duty: Persistent volume decrease.
    - Higher tax level decreases the buyer's acceptance probability.
    - Persistent willingness-to-pay-willingness-to-accept gap.

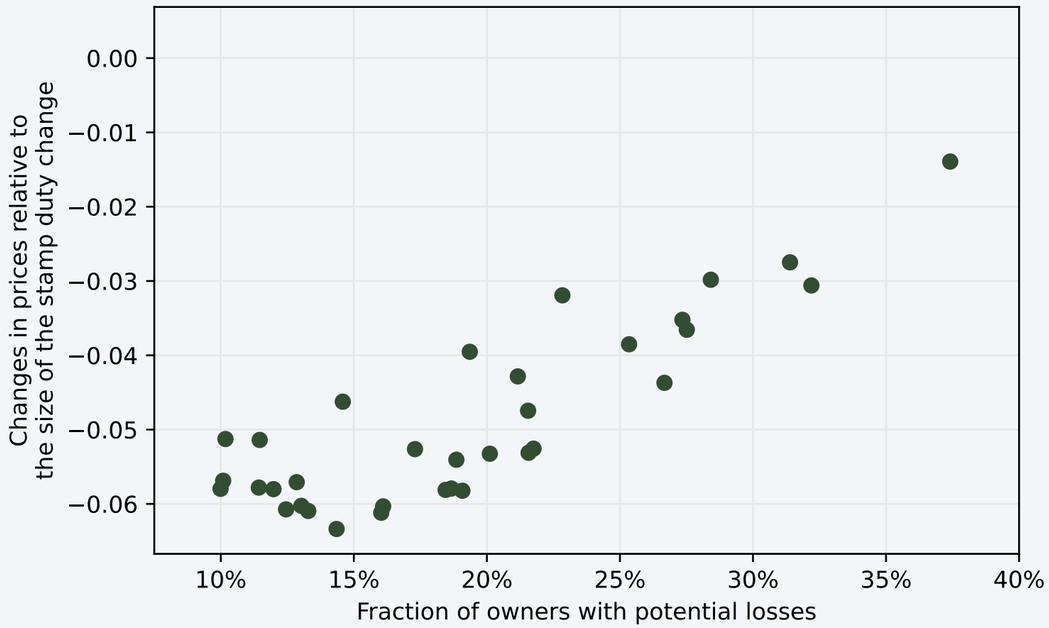
“Paper losses” affect tax elasticity

Transfer tax (stamp duty)

Transaction volumes

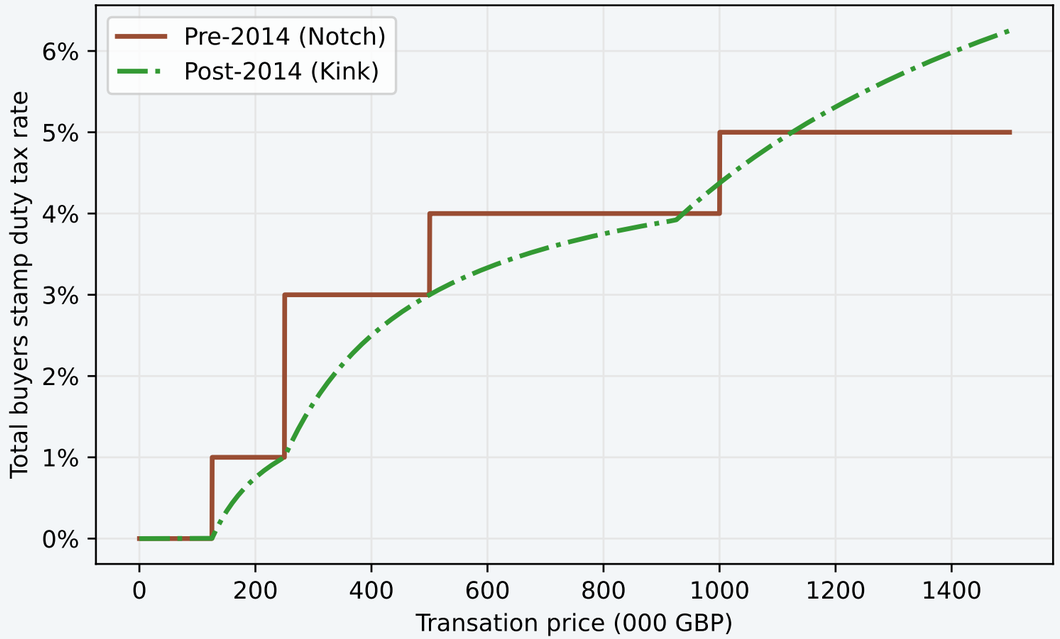


Transaction prices



Empirical evidence: “Paper losses” affect tax elasticity

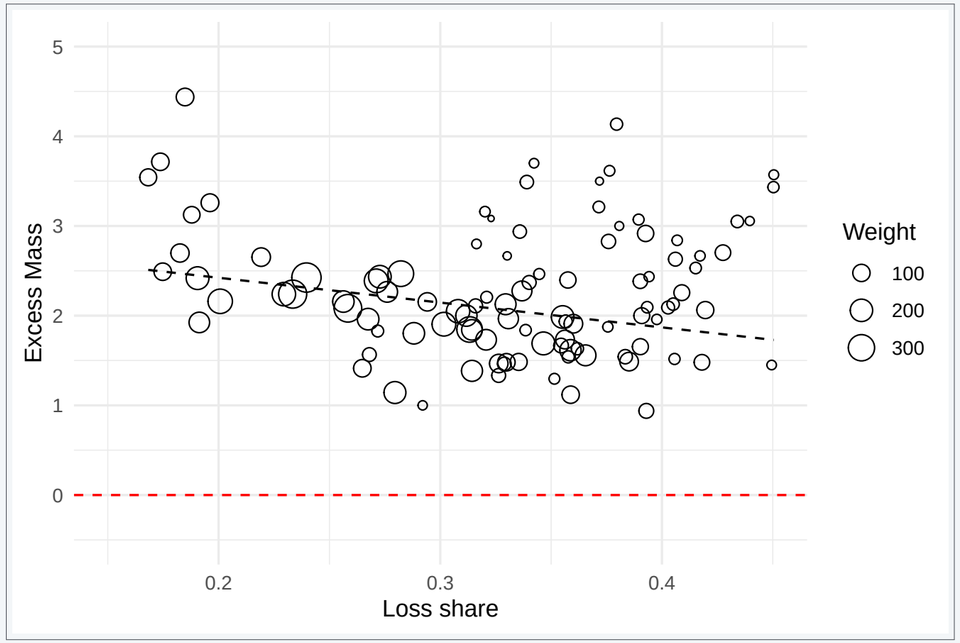
- Historically: “Notch” regime, which implied a discontinuous jump in the tax rate at particular price levels.
- Reform of Stamp Duty Land Tax system in December 2014.
  - Replaces the prevailing schedule with continuous adjustment of rates at price thresholds (“kink”).



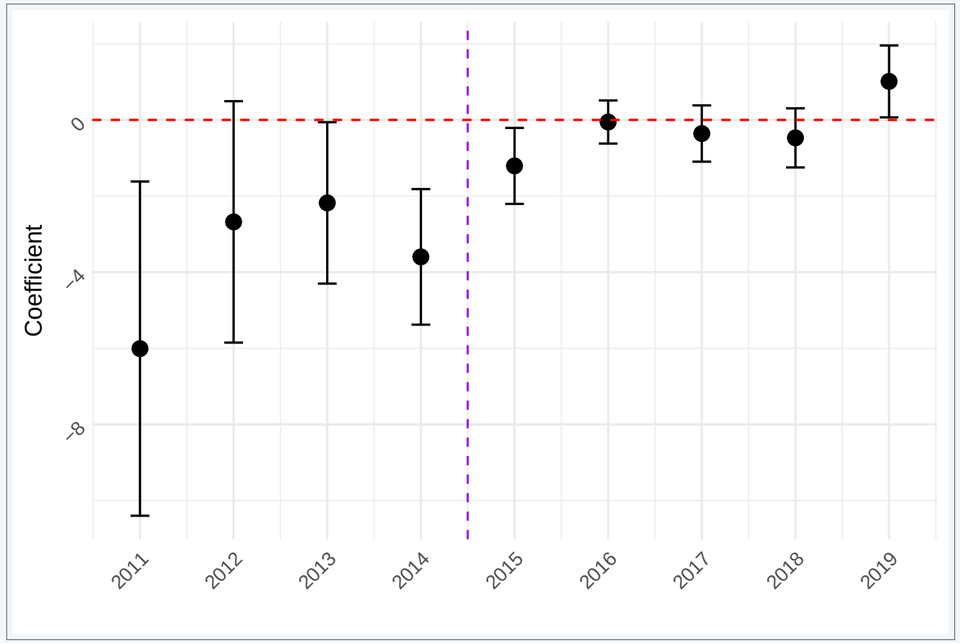
Empirical evidence: “Paper losses” affect tax elasticity

- Magnitude of bunching at price thresholds depends on the regional loss share:

Pre-2014 (“Notch” regime)



Annual slope estimates



Household welfare and the Laffer curve

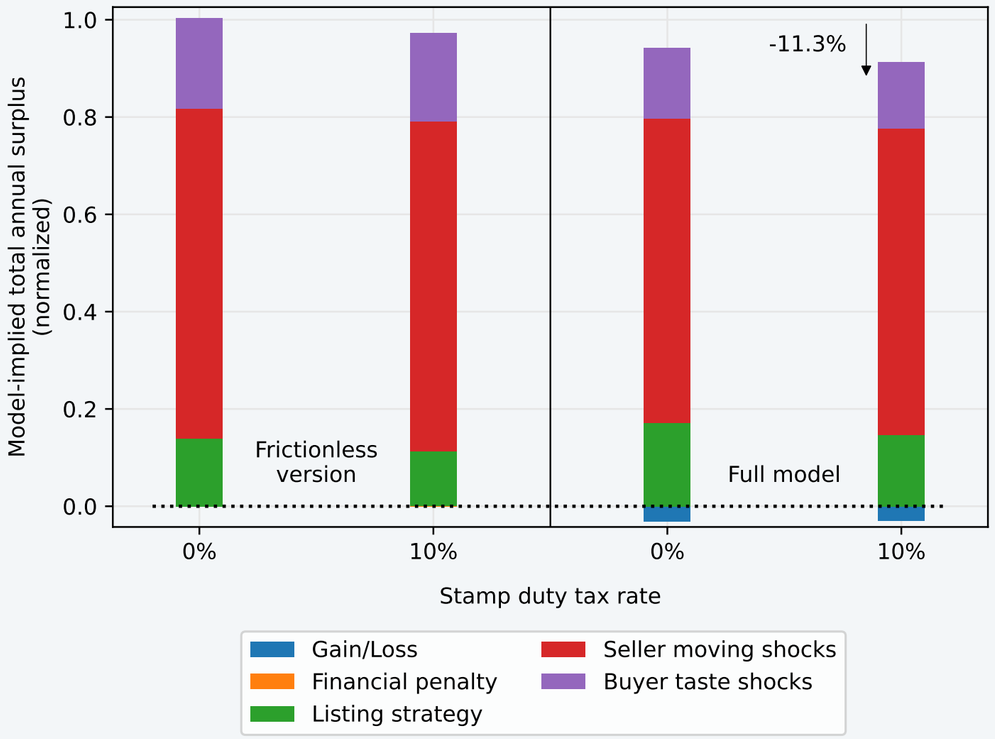
- Behavioral frictions affect the shape of the Laffer curve:
  - Prices are higher, and less sensitive to a tax change.
  - Higher level of revenue-maximizing tax rate.
- But we need to account for buyer and seller surplus.
- Denote by w the contribution of government tax revenue to total welfare and calculate the weighted sum of tax revenue and total surplus.
  (Saez, 2001; Saez and Stantcheva, 2016; Anagol et al., 2024).

$$\text{Welfare} = w \cdot \underbrace{\text{Tax revenue}}_{\text{Laffer curve}} + (1 - w) \cdot \text{Total surplus} \tag{1}$$

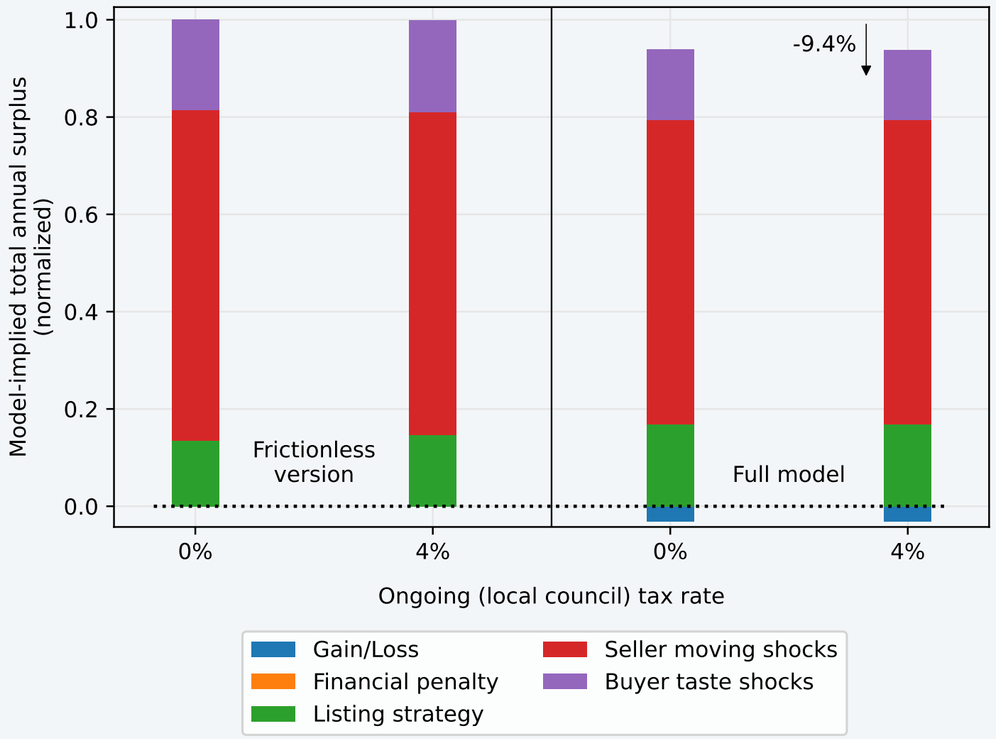
Total buyer and seller surplus in the model

- Quantify additional expected value of gains/losses, financial constraints, and the seller's trading surplus from "fishing" (listing premium).

Stamp duty



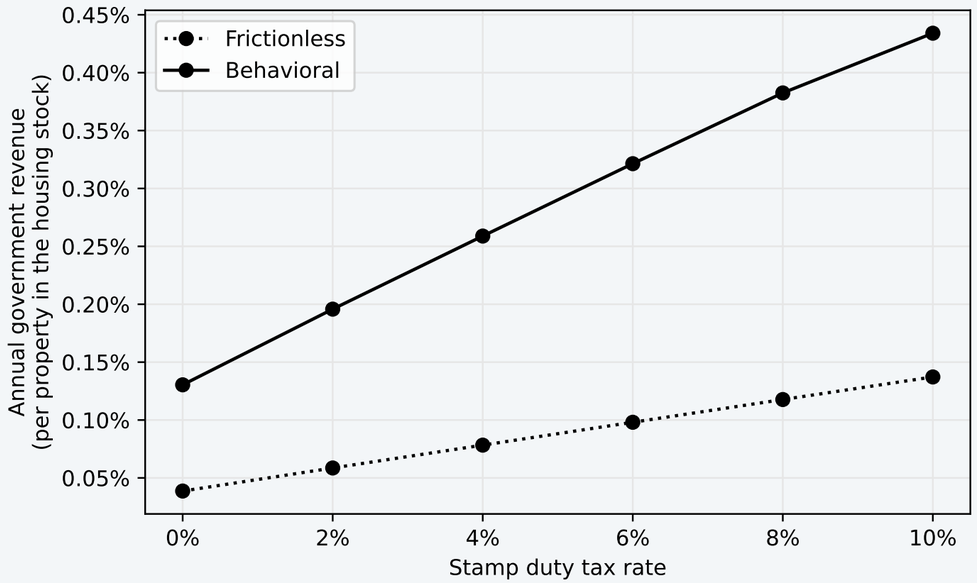
Ongoing property tax



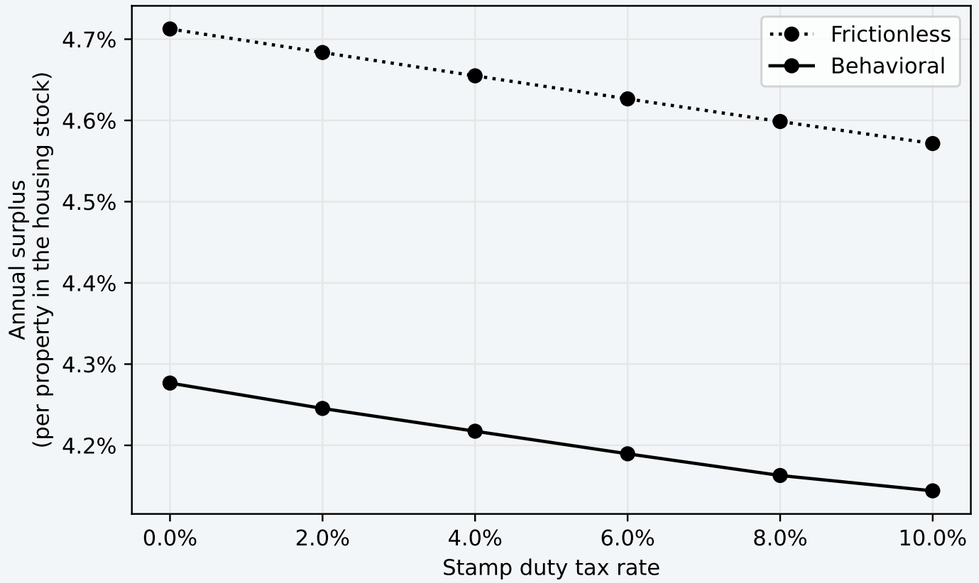
Demand elasticity

Effect of stamp duty on welfare

Tax revenue



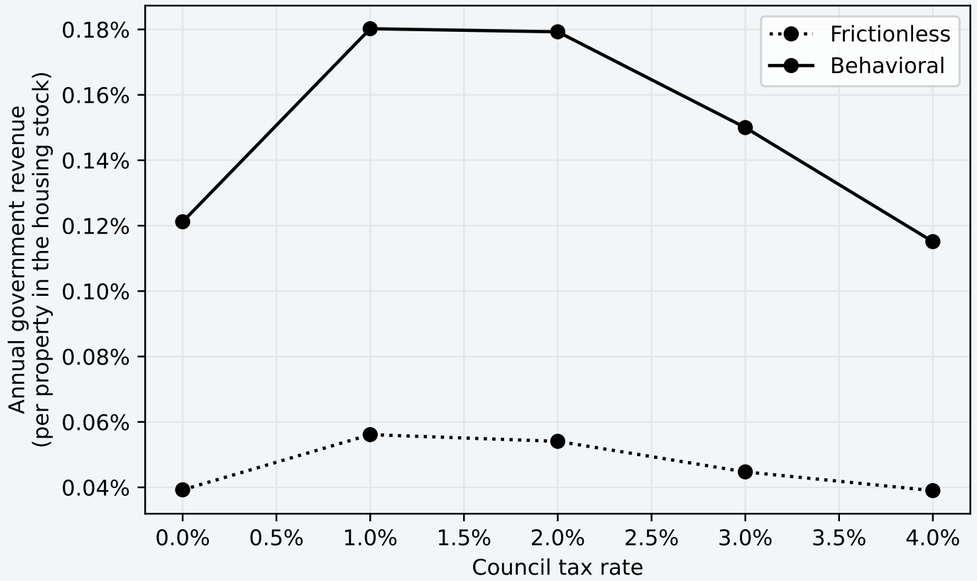
Total surplus



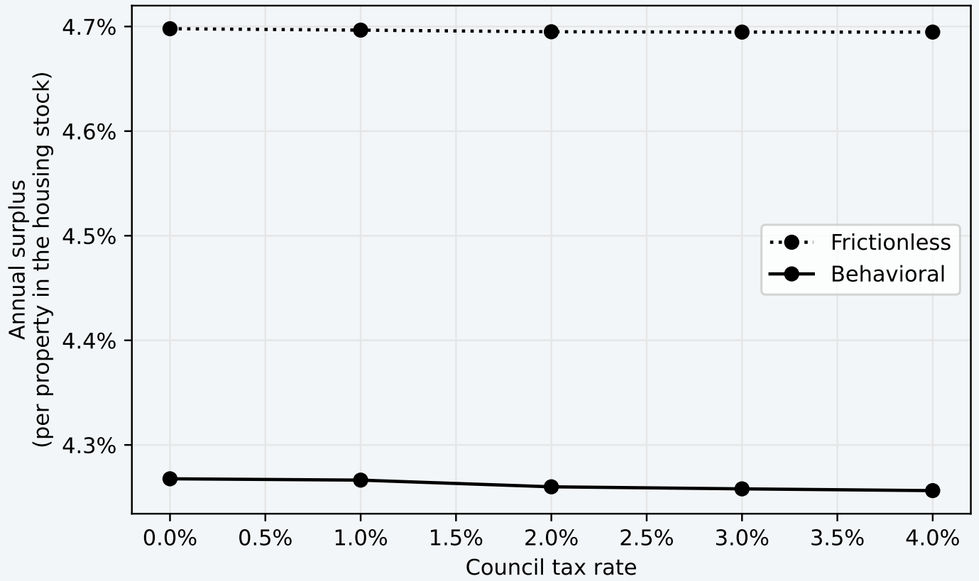
- Transaction volumes respond to tax change, but elasticity is not large enough to decrease government revenue significantly (for levels of the tax below 10%).
- Similar to other consumption taxes, Laffer curve does not peak (Trabandt and Uhlig, 2011).
- Behavioral frictions increase tax revenue and decrease surplus.

Effect of ongoing property tax on welfare

Tax revenue



Total surplus

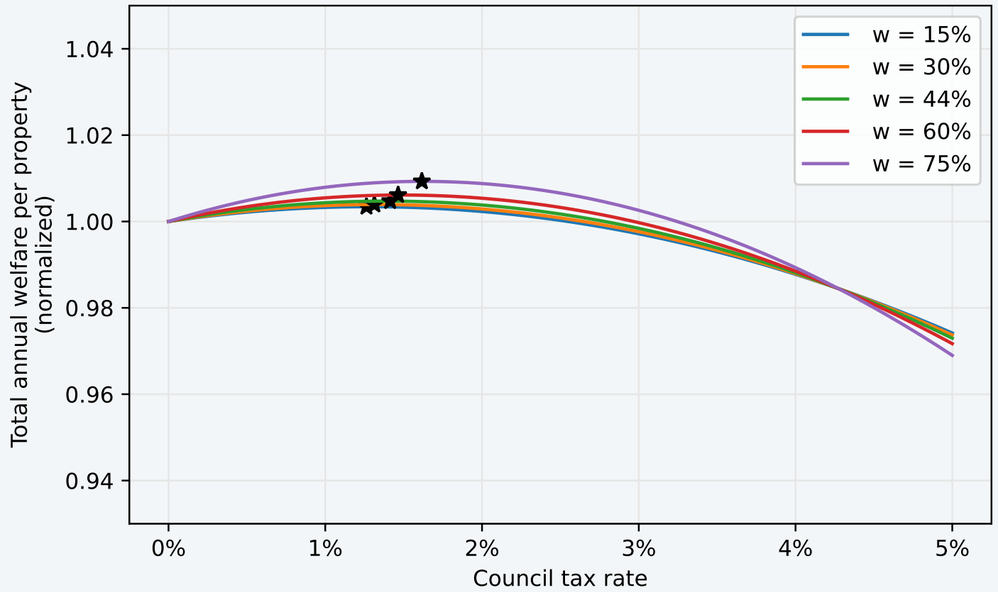


- Ongoing taxes have a strong effect on average property values → Laffer curve peaks.

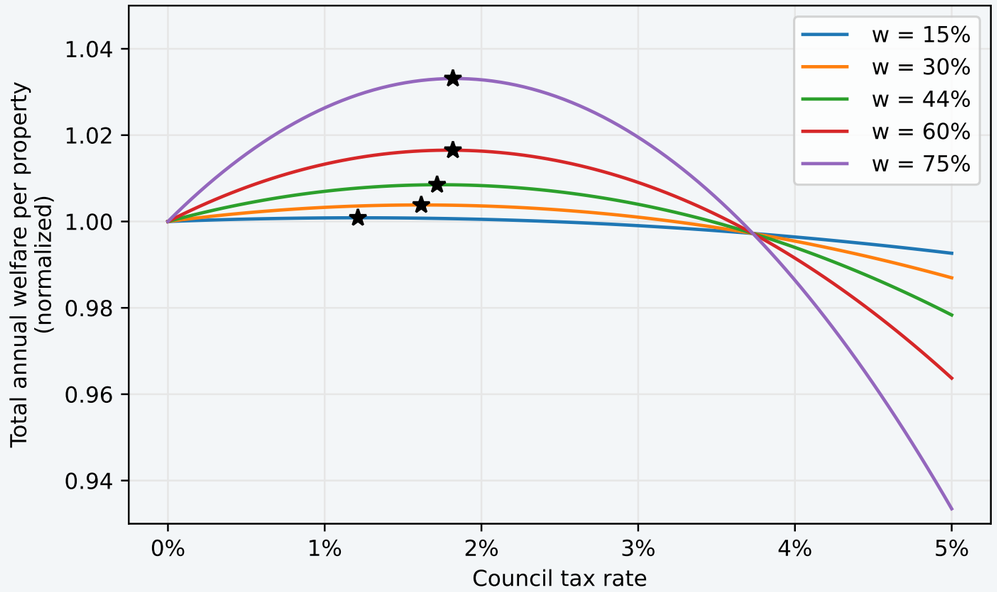
Optimal level of ongoing property tax

- Calculate welfare function for different weights on government revenue (w):

Frictionless model



Behavioral model



- Behavioral frictions increase the revenue-maximizing level of ongoing property taxes.

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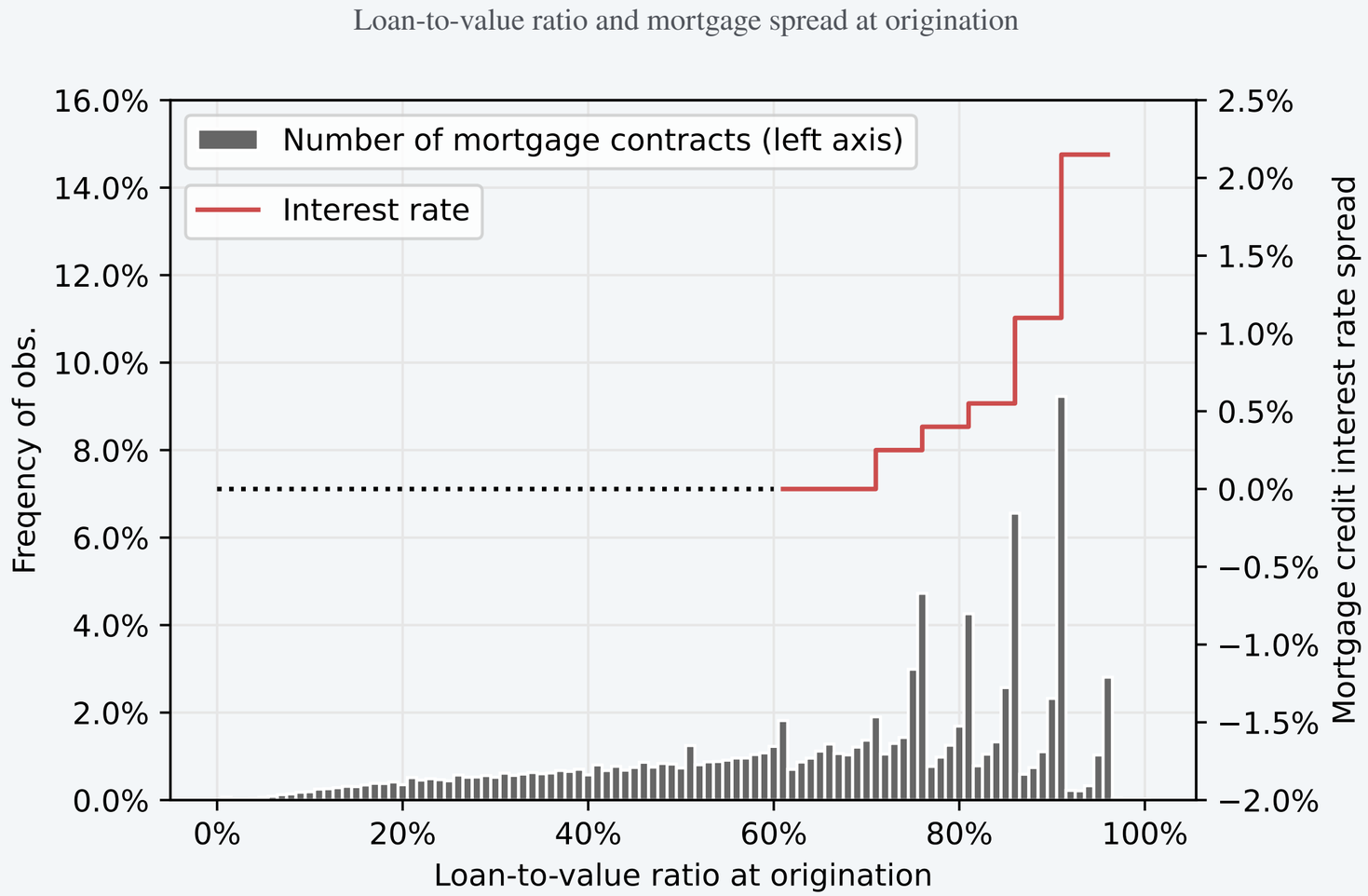
Conclusion

- A new sufficient statistic for explaining housing market outcomes: fraction of homeowners facing "paper losses".
  - Price-volume correlation.
  - Intensive vs. extensive margin effects.
  - Volatility of market liquidity/transaction volumes.
- Dynamic search-and-matching model of the housing market with behavioral frictions used to explain the empirical findings at the aggregate level.
- Policy implications for tax design:
  - "Loss share" is an important determinant of policy impact.
  - Behavioral frictions increase the revenue-maximizing level of ongoing property taxes.

Roadmap

6 APPENDIX

Mortgage costs higher for high LTVs



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Price-volume correlation depends on the “paper loss” share

- Calculate share of sellers with nominal losses in each location.

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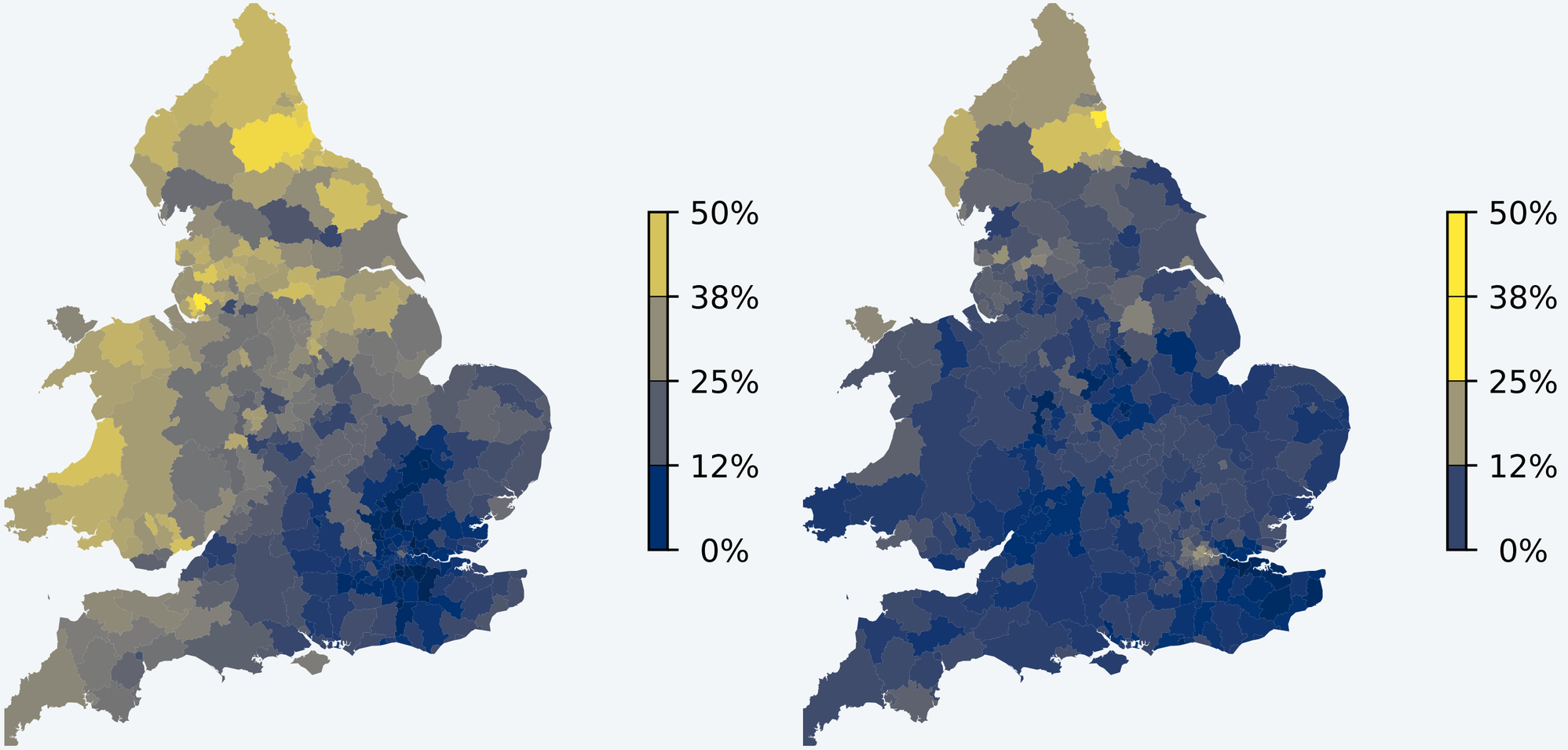
“Paper loss” shares vary both across regions and through time



July 2015

July 2022

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Loss shares, prices, and volumes

Calculated using repeat-sales price indexes

	Dependent variable: Log(**Transaction Volume**) across regions × time				
	U.K. (Land Registry)				USA (Zillow and SCF)
				Non-mortgage sample	
Price growth	2.39***		0.508*	1.728***	0.751***
	(0.107)		(0.190)	(0.173)	(0.135)
Loss share		-1.70***	-1.54***	-1.526***	-0.829***
		(0.064)	(0.108)	(0.068)	(0.063)
ITL2 / State FE	Yes	Yes	Yes	Yes	Yes
Observations	7595	7595	7595	5005	5927
R^2	0.167	0.325	0.330	0.751	0.930

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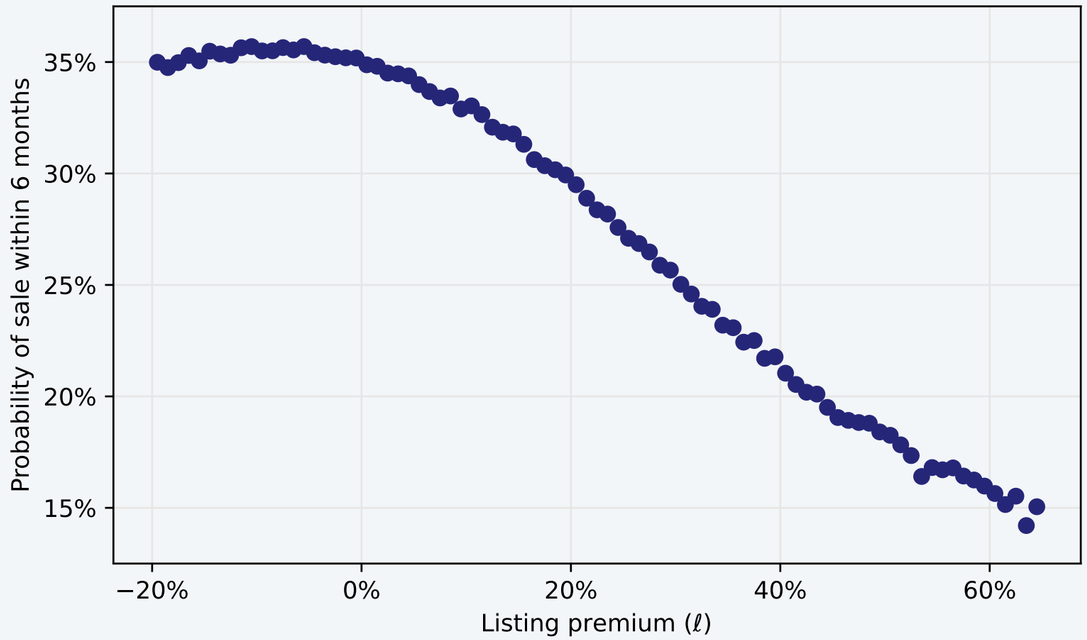
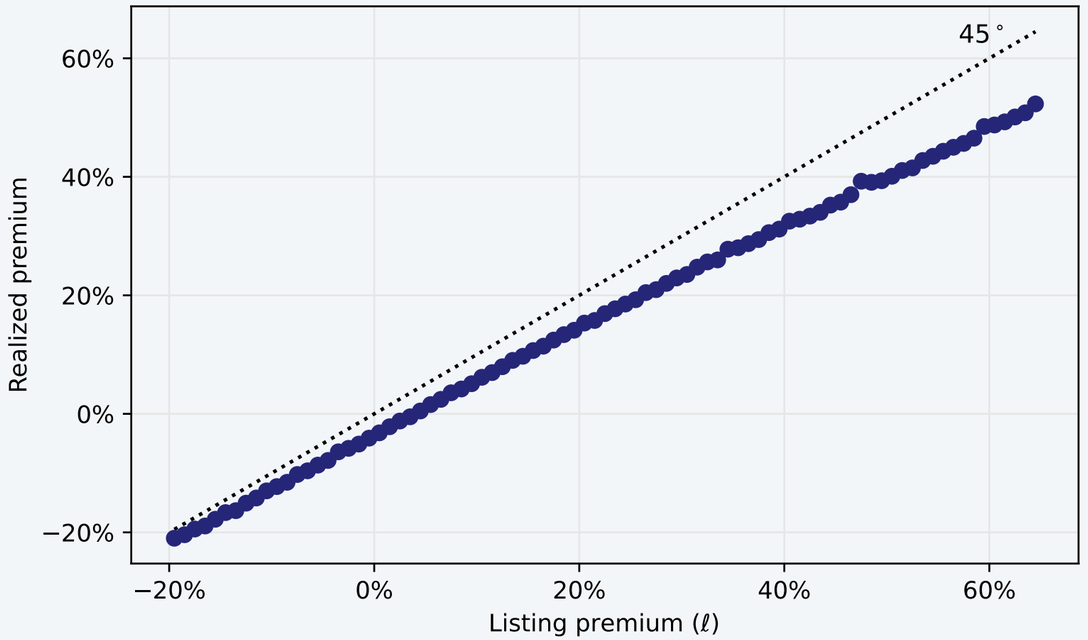
Concave demand

- The probability of transaction within 6 months of first listing (left)
- Realized premium conditional on listing premium (right)

Transaction probability



Transaction price



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