Flip or Flop?
Tobin Taxes in the Real Estate Market

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MOTIVATION: TAXES AND HOUSING AFFORDABILITY

- Rising housing unaffordability in major global RE markets has led to proposals to tax arms-length transactions

- How to target speculators while minimizing efficiency losses?
    - Non-residents/second homes: based on where tax bill gets sent
    - Vacancies: higher rate if vacant > 6 months of tax year
    - Flippers: higher tax rate for short-term sales (Tobin tax)

- What are the potential efficiency losses?
    - Emphasis on demand instead of inventory or capital "lock-in" effects
    - Theoretically ambiguous whether prices/volatility go up or down!

WHAT WE DO

- **First paper to quantify optimal flip tax in the RE market**
  - ▶ Extend sufficient statistics formulas derived for financial transaction taxes (FTTs)
  - ▶ Add in investors' housing tenure choices, rental risk, and search costs

- Empirical setting: tax surcharge on short-term sales of second homes in Taiwan
  - ▶ Flippers pay 15% on sales within 1 year, 10% if within 2 years

- This tax did <u>not</u> work as policymakers intended
  - ▶ Overall muted neg. effects on prices and volatility
  - ▶ Tax prevents trades even at longer horizons (unraveling)

- Punchline: Tobin taxes struggle to redistribute housing wealth and improve affordability due to market segmentation and lock-in effects

Our empirical application in one picture
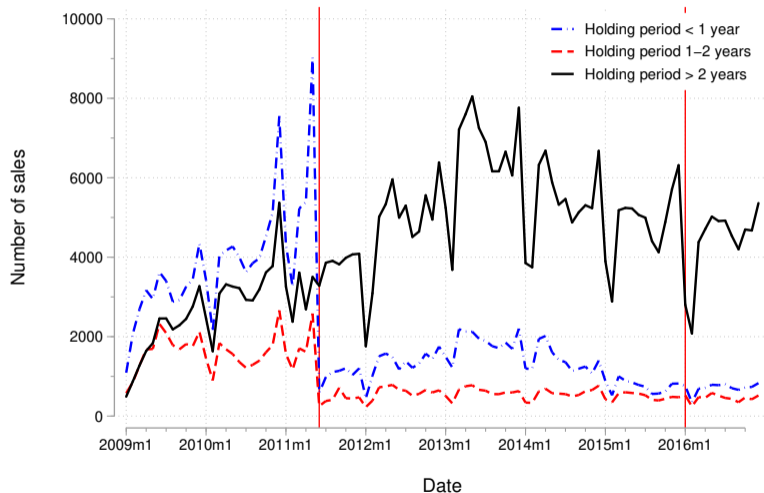
- 90% drop from pre-reform peak in sales within two-year HP

- Second homeowners delay transactions beyond 2 years to avoid tax

OUR CONTRIBUTIONS

① Optimality of transfer taxes on second-homes

- ▶ Key parameters: drop in sales volume and *ex ante* noise trading share
- ▶ Administrative data $\implies$ can estimate model-implied regressions to recover optimal taxes on specific groups of investors (renters, owner-occupiers, landlords)

② Share of noise trading $\rightarrow$ spatial/time variation in typhoon severity

- ▶ Idea: persistently bad weather induces speculators to forgo flips

- On top of this, clean setting and comprehensive data to quantify... `Literature`
  - ▶ Price/quantity effects of targeted tax on property flips
    - ★ Tax stays in place for 4 years rather than being constantly tweaked

  - ▶ Heterogeneity in **tax-adjusted** holding period returns (net cap gains + net income)

Optimal Real Estate Tobin Tax Framework

OPTIMAL TOBIN TAXES: EXECUTIVE SUMMARY

- Two ways to think about how to set optimal (linear) transfer tax w/biased beliefs

  1. Beliefs approach: set τ^* to eliminate gap in avg. expected returns between buyers/sellers
  2. Volume ("Pigouvian") approach: set τ^* to tax away non-fundamental trading

- Under the volume approach optimal tax is non-fundamental share s_{NF} over volume semi-elasticity $\epsilon = d \log V/d\tau$

$$\tau^* \approx \frac{s_{NF}\{\tau = 0\}}{-d \log V/d\tau|_{\tau=0}} \tag{1}$$

- In our case semi-elasticity $= -75\%/15$ p.p. $= -5$ (one-year flips)
- Hence, a 20% noise trading share $\implies \tau^* = 0.04$, or a 4% tax on very short-term second home flips **(govt. taxed too much!)**

OUR FRAMEWORK: EXTEND INTUITION TO HOUSING MARKET

- Basic building blocks from Dávila (2021) on financial Tobin taxes:

  - ▸ Equilibrium model of heterogeneous investors who differ in risk aversion and beliefs

  - ▸ One risk-free asset and one asset in fixed supply w/risky dividend (e.g. equities)

  - ▸ Planner cares about pricing efficiency and can only use linear taxes

- **We add the following features to mimic microstructure of housing market:**

  1. Risky asset (housing) carries both price (capital gain) and rental (dividend) risk

  2. Cost H to consuming housing embeds rents/imputed dividends (Sinai & Souleles 2005)

  3. Asset demands X divide investors into renters ($X < 1$), owner-occupiers ($X = 1$), and landlords ($X > 1$)

- Similar math when buyers pay a search cost...we'll come back to this later   Jump to

Housing investor's problem

- Investors i start with housing endowment $X_{i,0}$, pay tax τ on trades in period 1, receive stochastic income $Y_{i,2}$, pay housing costs, and consume everything in period 2

- Lifetime consumption budget:

$$C_{i,2} = Y_{i,2} + P_2 \cdot X_{i,1} + \underbrace{P_1 \cdot (X_{i,0} - X_{i,1})}_{\text{realized cap gain}} \underbrace{-\tau \cdot P_1 |\Delta X_{i,1}| + T_{i,1}}_{\text{net tax bill}} - H_{i,2} \qquad (2)$$

- Housing costs enter negatively for renters, but positively for owners

$$H_{i,2} = (1 - X_{i,1}) \cdot r_2 \quad \text{with} \quad r_2 \sim_i N(\mu_i^r, (\sigma^r)^2) \qquad (3)$$

- We assume $P_1 > 0$ is always positive, and $P_2 \sim_i N(\mu_i^p, (\sigma^p)^2)$

HOUSING DEMANDS BY TENURE CHOICE

- Assume CARA utility with absolute risk aversion A_i for investor i

- Choose a housing scale $X_{i,1}$ to max exp. utility, which yields a demand system:

$$\Delta X_{i,1}(P_1) = \begin{cases} \Delta X_{i,1}^+(P_1) = \frac{(\mu_i^p + \mu_i^r) - A_i\Omega_i - P_1(1+\tau)}{A_i\Omega} - X_{i,0} & \text{if } \Delta X_{i,1}^+(P_1) > 0 \text{ (buyers)} \\ 0 \text{ (no trade)} & \text{if } \Delta X_{i,1}^+(P_1) \le 0, \Delta X_{i,1}^-(P_1) \ge 0 \\ \Delta X_{i,1}^-(P_1) = \frac{(\mu_i^p + \mu_i^r) - A_i\Omega_i - P_1(1-\tau)}{A_i\Omega} - X_{i,0} & \text{if } \Delta X_{i,1}^-(P_1) < 0 \text{ (sellers)} \end{cases}$$

- Ω_i and Ω are variance-covariance terms which capture hedging needs

$$\Omega_i = \underbrace{Cov(Y_{i,2}, P_2) + Cov(Y_{i,2}, r_2)}_{\text{fundamental risk}} + \underbrace{Cov(P_2, r_2)}_{\text{affordability risk}} - (\sigma^r)^2 \tag{4}$$

$$\Omega = (\sigma^p)^2 + (\sigma^r)^2 - 2Cov(P_2, r_2) \tag{5}$$

Planner's problem with uniform tax rate τ

- Govt. runs balanced budget (no revenue constraint) $\implies$ lump-sum transfers $T_{i,1}$

- Investor's certainty equivalent from the planner's perspective is given by:

$$\mathsf{CE}_i^p(\tau) = \left[(\mu_p^p + \mu_p^r) - P_1 - \Omega_i\right] \cdot X_{i,1}(\tau) + P_1(\tau) \cdot X_{i,0} - \frac{A_i}{2}\Omega \cdot (X_{i,1}(\tau))^2 + \widetilde{T}_{i,1}(\tau) - \mu_p^r \quad (6)$$

Lemma (sufficient statistics formula)

The optimal tax satisfies: $\tau^* = \text{argmax}_\tau \int CE_i^p(\tau)dF(i)$, which recovers the formula

$$\tau^* \approx \frac{s_{NF}\{\tau = 0\}}{-d\log V\{\tau = 0\}/d\tau}$$

Importantly, this expression <u>does not</u> depend on what the planner considers to be the "correct" set of beliefs $\mu_p^p + \mu_p^r$.

ALLOWING FOR GROUP OR INVESTOR-SPECIFIC TAXES

- Investors self-select into <u>4 groups</u> based on their housing positions ΔX:

$$
\begin{cases}
X_{i,1}^{-}(\tau_i') < X_{i,0} \leq 1 & \text{renter-seller (RS)} \\
\max\{1, X_{i,1}^{-}(\tau_i')\} < X_{i,0} & \text{landlord-seller (LS), or "flippers"} \\
X_{i,0} \leq \max\{1, X_{i,1}^{+}(\tau_i')\} & \text{renter-buyer (RB)} \\
1 < X_{i,0} < X_{i,1}^{+}(\tau_i') & \text{landlord-buyer (LB)}
\end{cases}
$$

- Taxes targeting individual investors are increasing in optimism $(\mu_i^p + \mu_i^r)$:

$$
\tau_i^* = \frac{sgn(\Delta X_{i,1}) \cdot (\mu_i^p + \mu_i^r - \Upsilon)}{P^*} \tag{7}
$$

- Market-clearing price P^* satisfies $\int \Delta X_{i,1}(P^*)dF(i) = 0$ `Pricing effects`

- To calibrate we set $\Upsilon = \mu_p^p + \mu_p^r \implies$ investors own developers who supply housing

# Empirical Application: Flip Taxes in Taiwan

TAIWAN'S TRANSFER TAX EXPERIMENT

- Govt. worried about rapid price gains in Taipei area in 2008-11 `HPI` `PR ratio` `Global`

    - Announce surcharge on short-term second home flips in January 2011

    - Reasoning: pre-existing tax rates very low on short-term sales

    - Implemented June 1, 2011 to December 31, 2015

- Sellers pay tax surcharge rate τ as function of holding period T:

$$\tau = \begin{cases} 15\% & \text{if} \quad T < 1 \\ 10\% & \text{if} \quad 1 \leq T < 2 \\ 0\% & \text{if} \quad T \geq 2 \end{cases} \tag{8}$$

- Only applies to arms-length transactions (housing or commercial)

Small drop ($\approx 7\%$) in HPI around reform date
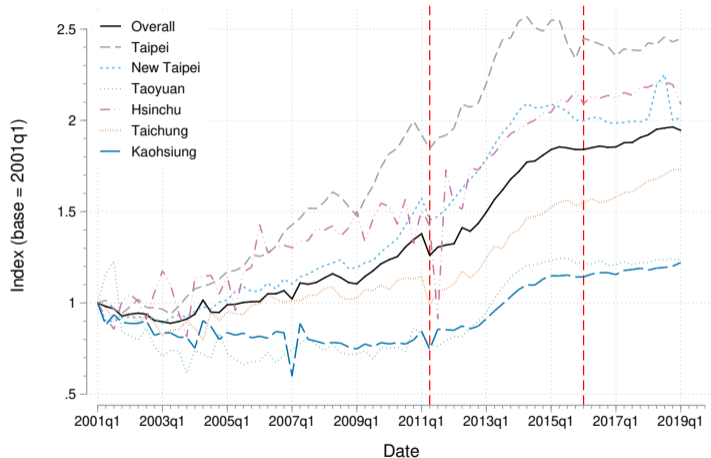
$$\log P_{i,t}^c = \delta_t^c + \gamma_i^c + \beta^{c\prime} \cdot \mathbf{X_{i,t}^c} + \epsilon_{i,t}^c$$

with $P_t^c = \exp(\delta_t^c)$

- Unlike official indexes, ours include short-term, non-realty sales

Details Compare Translog

TAX DATA AND TRANSACTION RECORDS

- Four main datasets from Ministry of Finance (2006-16)

  1. Building property tax records → owner-occupied status, property use, number of houses owned by taxpayer

  2. Deed tax records → buyer/seller identifiers, transaction dates, appraised values

  3. Personal income tax returns → buyer/seller address, rental income, gifts/inheritances

  4. Personal wealth estimates → vehicles, equities, bonds, deposits

- Merge with a newly compiled database of market prices and rents from public records and compute coordinates (2000-16)

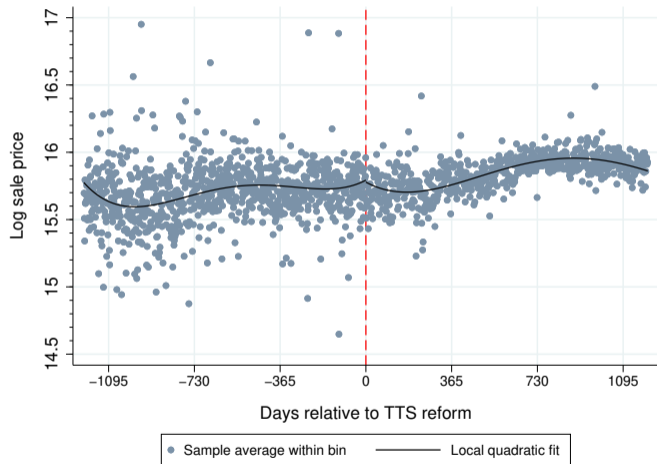- Listings data from an anonymous (large) realty firm → time on market

Transfer process Other taxes Example Wealth details

No clear discontinuity in sale prices

- Notably much lower variance in sales prices after the reform

- Similarly, no clear break in unit prices either

  Grandfathered Unit price Salience

- Segmentation: price drop concentrated in low end of the market where cap gain $<< \Delta\tau$, but price hike at high end

  Low end High end Inheritances

  Residualized Spillover

BUNCHING: DEFINING A COUNTERFACTUAL

- Goal: compute number of sales prevented by the tax

- Two common approaches in the literature inappropriate here:
  1. Use the distribution by holding period in the pre-reform period Pre-reform dist.
  2. Estimate local polynomial using data in the post-reform period in an "unaffected region" away from the notches

- Problem: tax changes sales composition even far from the notches
  - Delaying a sale today affects sales volume tomorrow, and the next day, etc.

- Solution: compute what the distribution would have looked like, conditional on property amenities in available housing stock

AN HEDONIC-LOGIT MODEL OF FLIPS

- Use pre-reform property characteristics to estimate a logit model for sale probability $f_{i,t}$:

$$f_{i,t} = \Pr\Big(y_{i,t} = 1 | \mathbf{X_{i,t}}, \delta_t, \beta\Big) = \frac{1}{1 + \exp(-\delta_t - \beta' \cdot \mathbf{X_{i,t}})} \tag{9}$$
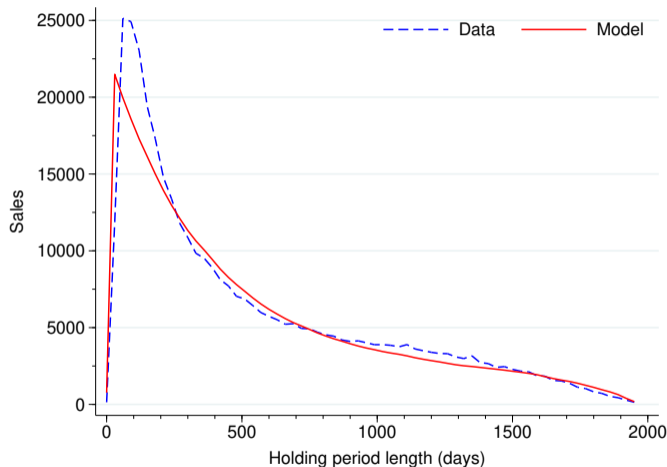
$$y_{i,t} = \mathbb{1}\{\delta_t + \beta' \cdot \mathbf{X_{i,t}} + \epsilon_{i,t} > 0\} \tag{10}$$

- Compute predicted prob. $\widehat{f}$ in post-reform period with $\widehat{\beta}'$ and integrate over properties within holding period bin j

$$\widehat{q}_j = \sum_{i=1}^{N_j} \widehat{f}\Big(\mathbf{X_{i,t}}; \ \widehat{\delta_t}, \widehat{\beta}\Big) \tag{11}$$
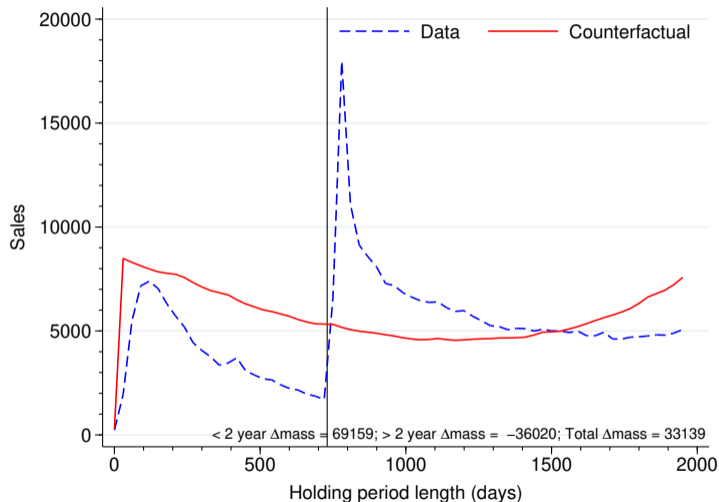
- Identifying assumption: w/o tax reform market would have priced amenities in $\mathbf{X_{i,t}}$ in the same way as in pre-reform period   Pre-trends

- Underestimate the missing mass at < 1 yr. $\implies$ overestimate the optimal tax (upper bound) `Cond. prob.`

- K-S tests fail to reject the null of no difference between the empirical and model distributions `K-S tests`

MARKET UNRAVELING: ≈ 33,000 TOTAL MISSING SALES

Figure: Sales vs. Holding period length (days). Data (blue dashed) and Counterfactual (red). Vertical line near 730 days. Annotation: "< 2 year Δmass = 69159; > 2 year Δmass = −36020; Total Δmass = 33139"

- 40% drop in overall second home sales volume but 75% drop in one-year flips

- Missing mass for long holding periods (> 1,500 days)

- Owners seeking to offload depreciated properties no longer can → unraveling

  Heterogeneity   TOM

Semi-elasticity stable across models

	(1)	(2)	(3)	**(4)**	(5)	(6)	(7)
	Full sample	Full sample	Full sample	**Full sample**	Full sample	Age ≥ 5	Age ≥ 10
ϵ_{1-year}	4.8	4.7	4.7	**5.1**	6.3	7.7	6.8
ϵ_{2-year}	4.8	4.7	4.7	**3.7**	6.8	9.2	7.5
$\Delta mass_{<720}$	71,411	70,977	70,961	**69,159**	85,762	69,407	57,087
$\Delta mass_{\geq720}$	$-28,488$	$-28,568$	$-28,592$	**$-36,020$**	$-25,888$	$-12,946$	$-16,091$
$\Delta mass_{<365}$	31,156	30,855	30,827	**33,546**	41,455	35,966	29,088
NW^B, NW^S		✓					
HNW^B, HNW^S			✓				
Material, Use, Month FE				✓	✓	✓	✓
Realty dummy					✓		
N	12,163,977	12,163,977	12,163,977	12,163,977	11,939,191	8,281,861	7,171,456

Notes: All logit models include floor number, floor area, total floors in the unit, and quadratics in holding period length and age.

WHO ARE THE NOISE TRADERS HERE?

- Literature: non-residents earn lower (gross) capital gains

  - Non-residents often used as a synonym for "misinformed" speculators (Chinco & Mayer 2016) or bad bargainers (Cvijanović & Spaenjers 2021)

- *But are speculators also noise traders?*

- We compute total <u>tax-adjusted</u> holding period returns and show... (Details)

  1. Only after tax reform do locals earn premium when selling to OOT buyers
  2. Annualized HPRs decline linearly with wealth
  3. Sellers of mortgaged properties earn similar capital gains
  4. Stock market participants earn <u>lower</u> returns
  5. Term structure of realized returns is downward sloping, and tax flattens the curve

(Fact #1) (Fact #2) (Fact #3) (Fact #4) (Fact #5)

NOISE TRADING: GONE WITH THE ~~WIND~~ RAIN

- **Idea: severe typhoon season raises cost of listing and selling properties**
  - ▶ Fundamental traders: people who persist with sale due to family/work commitments even when weather limits outdoor activity
  - ▶ Inspired by literature on weather effects on economic activity

- Season runs from July to September, but severe storms also possible in June and October
  - ▶ On average, Taiwan experiences 5 typhoons per year, with 2 making direct landfall
  - ▶ Classification relies on wind speed $\geq$ 118 km/h (74 mph) $\implies$ typhoon   Classification
  - ▶ Accompanied by low air pressure and significant rainfall   Tracking   Cyclicality

- We find volume declines by 15-20% during severe storm seasons, with little evidence of pent-up demand in the following months

HEAVY RAIN REDUCES AGGREGATE SALES VOLUME

$$Volume_t = \beta \cdot (Weather_t \times Summer_t) + \delta_t + \gamma' \cdot \mathbf{X_t} + \varepsilon_t$$

	(1)	(2)	(3)	(4)	(5)	(6)
Max WS $\times Summer$	-2.27^{**}		-1.16			
Rainfall $\times Summer$		-0.32^{***}	-0.26^{***}	-0.31^{***}		-0.24^{***}
$\mathbb{1}\{T > 32°C\}$				5.14		
$\mathbb{1}\{27 < T \leq 32°C\}$				1.51		
$\mathbb{1}\{\text{Max WS} \geq 74\text{mph}\}$					-65.98^{***}	-27.49^{**}
$\mathbb{1}\{55 \leq \text{Max WS} < 74\text{mph}\}$					-10.88^{**}	-9.18
7-day FEs	✓	✓	✓	✓	✓	✓
Day-of-week FEs	✓	✓	✓	✓	✓	✓
Damages controls	✓	✓	✓	✓	✓	✓
N	1,973	1,973	1,973	1,973	1,973	1,973

- Typhoon-level rainfall shock $\implies$ 20% drop in sales volume in Greater Taipei metro
- Consistent with other papers: people don't like to do things in the rain! `Factor analysis`

Volume does not bounce back after rain subsides

$$Volume_t = \beta_1 \cdot (Rain_t \times Summer_t) + \delta_t + \beta_2 \cdot (\overline{Rain}_{t-L,t-1} \times Summer_t) + \gamma' \cdot \mathbf{X_t} + \varepsilon_t$$

	(1)	(2)	(3)	(4)
$Rain_t \times Summer_t$	-0.33^{***}	-0.33^{***}	-0.32^{***}	-0.32^{***}
$\overline{Rain}_{t-1w,t-1} \times Summer_t$	-0.57			
$\overline{Rain}_{t-2w,t-1} \times Summer_t$		-0.30		
$\overline{Rain}_{t-4w,t-1} \times Summer_t$			0.47	
$\overline{Rain}_{t-8w,t-1} \times Summer_t$				0.83
7-day FEs	✓	✓	✓	✓
Day-of-week FEs	✓	✓	✓	✓
Damages controls	✓	✓	✓	✓
N	1,973	1,973	1,973	1973

- Also, no pent-up demand even if very long and severe typhoon season   Event studies   Severe

- Problem: weather reduces sales by crowding out noise trades + raising search costs for non-noisy traders

- Model this by adding stochastic search costs (e.g. weather) paid by buyers   To model

  - This means that $\widehat{\beta}$ from weather shock regressions will generally yield $\widehat{s}_{NF} + error$

- In a special case of the model where investors have symmetric risk preferences $A_i = A$ and Gaussian trading motives, search costs c_1/P_1 enter linearly, and

$$\lim_{c_1/P_1 \to 0} \tau^* = \frac{\widehat{s}_{NF}\{\tau = 0\}}{-d\log V/d\tau|_{\tau=0}}$$

- We estimate $c/P \approx 0.36\%$ by looking at jump in time on the market around weather events then scaling by average daily wages $\implies$ small downward correction to τ^*

Optimal Tax Calibration Exercises

SUFFICIENT STATISTICS $\implies$ UNIFORM TAX RATE OF 4%-5%

- Recall our sufficient statistics formula of $\tau^* = -s_{NF}\{\tau = 0\}/\epsilon$

  ► Semi-elasticity (ϵ) estimates from bunching design range from $4.8 - 5.1$ for one-year flips, or $3.7 - 4.8$ including two-year flips

  ► Noise trading estimates fall between $15\% - 20\%$ from the weather design

- **Putting two pieces together yields** $3\% \leq \tau^* \leq 5\%$

  ► Upward biased: logit model under-fits the pre-reform data, and weather shocks related to both non-fundamental trading and search costs

  ► Using the revised sufficient statistics formula with c/P search costs leads to at most a 0.22 p.p. reduction in τ^* `Details`

  ► This range of τ is at high-end of flat transfer rates in place in global markets

FOOD FOR THOUGHT: WHO BEARS THE COSTS OF FLIP TAXES?
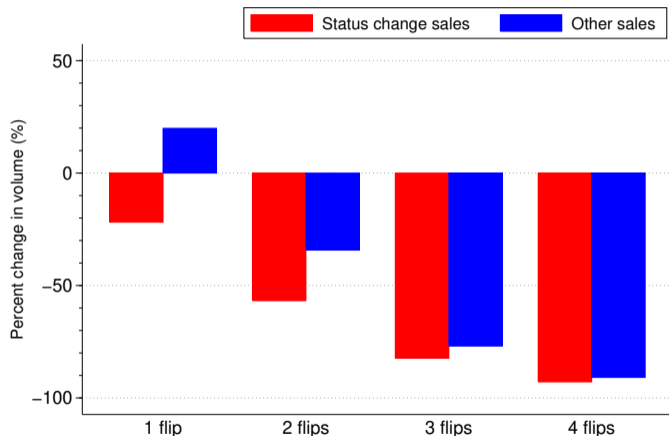
- Missing sales at holding periods > 2 years disproportionately from non-speculators who sell due to employment/marriage change [red] Levels

- Implies tax distorts household location choice

- Echoes mobility lock-in effects documented elsewhere (e.g. Hilber & Kyytikäinen 2017)

CALIBRATING INVESTOR-SPECIFIC TAXES

- **Question:** should we tax flippers and subsidize everyone else?

- Model admits regression relating housing demand and hedging needs to movements in the tax bill $P_t \cdot \tau_{i,t}$:

$$\widehat{\Omega} \cdot X_{i,t} + \widehat{\Omega}_i = \alpha_i \cdot P_t \times (1 + \mathcal{D}_{i,t} \cdot \tau_{i,t}) + e_{i,t} \tag{12}$$

$$\text{where} \quad \mathcal{D}_{i,t} = \begin{cases} -1 & \text{if } X_{i,t} < X_{i,t-1} \quad \text{(sellers)} \\ 1 & \text{if } X_{i,t} > X_{i,t-1} \quad \text{(buyers)} \end{cases}$$

- $\widehat{\Omega}$ and $\widehat{\Omega}_i$ are the empirical variance-covariance terms from our administrative tax data covering histories of incomes, prices, and rents

- Use time-variation in $\tau_{g,t}$ to estimate the regression for each of the 4 groups $g \in \{RS, LS, RB, LB\}$ to obtain vector of fixed effects $\widehat{\alpha}_i$ `Step-by-step`

Optimal Tobin taxes impose 4%-5% rate on flippers

- Use renter-sellers (RS) as reference category and compute vector of tax rates for two versions of model:
  1. Continuous scale (X is floor space): $\{\widetilde{\tau}_{LS}^*, \widetilde{\tau}_{RB}^*, \widetilde{\tau}_{LB}^*\} = \widetilde{\tau}_{RS}^* + \{5.50\%, -0.09\%, -0.72\%\}$
  2. Discrete housing choice (X is # of houses): $\{\widetilde{\tau}_{LS}^*, \widetilde{\tau}_{RB}^*, \widetilde{\tau}_{LB}^*\} = \widetilde{\tau}_{RS}^* + \{4.19\%, 0.33\%, 0.55\%\}$
     - ★ Share vector $\{s_{RS}, s_{LS}, s_{RB}, s_{LB}\} = \{16.75\%, 45.94\%, 14.49\%, 22.82\%\} \implies$ similar homeownership rates to U.S.

- **Pricing counterfactuals: moving from the pre-existing tax regime to the optimal regime results in <u>higher</u> prices**
  - $(\widehat{P} - P)/P = 2.7\%$ for discrete calibration vs. 0.8% for continuous calibration
  - Mirrors pos. pricing effects we find in the RD analysis at high-end of market

CONCLUSION

- **Introduce a new framework to estimate optimal Tobin taxes on housing**

  - Derive sufficient statistics formula with housing tenure choice, rental risk, search costs
  - Use model to estimate investor-specific optimal tax rates, show implied $dP/d\tau > 0$

- **We apply the model to the Taiwan RE market and show...**

  - Targeting flips reduces volume, flattens term structure, but no overall drop in prices/volatility
  - Tax makes RE even less liquid (unraveling)
  - Govt. taxed way too much! ($\tau^* = 4\%$ vs. $\tau = 15\%$)

- **Related work in progress**

  - Macroprudential considerations: can we tax away leverage?
  - Alternative policy instruments such as loan-to-value (LTV) limits

THANK YOU!

Appendix

RELATED WORK

- Speculators in the housing market

  - OOT shock: Chinco & Mayer (2016); Badarinza & Ramadorai (2018); Cvijanović & Spaenjers (2021); Bayer et al. (2020); Favilukis & Van Nieuwerburgh (2021)

  - Tax policy: Dachis, Duranton, Turner (2012); Besley, Meads, Surico (2014); Kopczuk & Munroe (2015); Suher (2016); Slemrod et al. (2017); Best & Kleven (2018); Deng, Tu, Zhang (2019); Gao, Sockin, Xiong (2020); Agarwal et al. (2020); Gorback & Keys (2020)

- Financial transaction taxes (FTTs) and excess volatility

  - Empirics: Umlauf (1993); Jones & Seguin (1997), Hau (2006); Foucault, Sraer, Thesmar (2011); Colliard & Hoffmann (2017); Deng, Liu, Wei (2018); Cai et al. (2020)

  - Theory: Tobin (1978); Kupiec (1996); Scheinkman & Xiong (2003); DeFusco, Nathanson, Zwick (2017); Vives (2017); Biais & Rochet (2020); Dávila (2021)

- Weather shocks to economic activity

  - Hirshleifer & Shumway (2003); Goetzmann & Zhu (2005); Goetzmann et al. (2014); Dell, Jones, Olken (2014); Cortés, Duchin, Sosyura (2016); Cho (2020)

PRICING EFFECTS IN THE MODEL

- Sign of $dP/d\tau$ is *ex ante* ambiguous in the model

- Implicit equilibrium pricing function:

$$P_1 = \frac{\int_{i \in \mathcal{T}(P_1)} \left(\frac{(\mu_i^p + \mu_i^r)}{a_i} - A\left(\Omega_i + \Omega X_{0i}\right) \right) dF(i)}{1 + \tau \cdot \left(\int_{i \in \mathcal{B}(P_1)} \frac{1}{a_i} dF(i) - \int_{i \in \mathcal{S}(P_1)} \frac{1}{a_i} dF(i) \right)} \tag{13}$$

$$\text{where } A \equiv \left(\int_{i \in \mathcal{T}(P_1)} A_i^{-1} dF(i) \right)^{-1} \quad \text{and } a_i = A_i/A \tag{14}$$

- Prices are inc. in expected payoff $\mu_i^p + \mu_i^r$ and dec. in rental risk premium

- $dP_1/d\tau > 0$ if $\int_{i \in B(P_1^*)} \frac{1}{a_i} dF(i) \leq \int_{i \in S(P_1^*)} \frac{1}{a_i} dF(i)$, or tax hike reduces owners' willingness to sell to such an extent that inventory goes down

- Keep the basic setup the same except now impose a proportional search cost c_1 paid by buyers in period 1, so lifetime consumption is:

$$C_{i,2} = Y_{i,2} + P_2 \cdot X_{i,1} + P_1 \cdot (X_{i,0} - X_{i,1}) - \tau \cdot P_1 |\Delta X_{i,1}| + T_{i,1}$$

$$- c_1 \cdot (X_{i,1} - X_{i,0}) \times \mathbb{1}\{X_{i,1} > X_{i,0}\} - H_{i,2} \qquad (15)$$

- Make **symmetry** assumption: traders have identical risk preferences $A_i = A$ and symmetric distribution of beliefs, hedging needs, and initial endowments

- Then the new equilibrium price $P = P^* - c_1/2$, with P^* the price without search frictions

- Introduce persistent shock to housing search costs (e.g. storms, or iBuyers):

$$c_t = z_t \cdot w_t \quad \text{and} \quad z_t \sim_i N(\mu_i^z, (\sigma^z)^2) \qquad (16)$$

$$w_t = \phi \cdot w_{t-1} + \varepsilon_t^w \qquad (17)$$

Main deck

- Decomposition of trading volume into four components:

$$P_1 V(\tau) = \underbrace{\Theta_F(\tau)}_{\text{fundamental}} + \underbrace{\Theta_{NF}(\tau)}_{\text{non-fundamental}} - \underbrace{\Theta_\tau(\tau)}_{\text{reduction due to tax}} - \underbrace{\color{red}\Theta_{WS}(\tau)}_{\color{red}\text{reduction due to weather}} \quad (18)$$

- Symmetry + Gaussian trading motives $\implies$ changes to V due to ε_1^w are not due to changes in fundamental volume $\Theta_F(\tau)$, which leads to the lemma:

Lemma (sufficient statistics with search costs)

The optimal tax satisfies: $\tau^* = \text{argmax}_\tau \int CE_i^p(\tau) dF(i)$, which recovers the formula

$$\tau^* \approx \frac{s_{NF}\{\tau = 0\}}{-d\log V\{\tau = 0\}/d\tau} - \frac{1}{2}\frac{c_1}{P_1}$$

This <u>does not</u> depend on what the planner considers to be the "correct" set of beliefs.

Main deck

DETAILS: OPTIMAL TAX ESTIMATES W/WEATHER SHOCKS

- We estimate regressions of the form: $Volume_t = \beta \cdot Weather_t + \delta_t + \varepsilon_t^w \to \widehat{\beta}$, where $Weather_t$ is a typhoon shock

- We can show that $\frac{\partial V}{\partial \varepsilon_1^w} = s_{NF}(\varepsilon_1^w) - \underbrace{s_{WS}(\varepsilon_1^w = 1)}_{\propto c_1/p_1}$

- We estimate the cost c in days by running: $TOM_t = \gamma \cdot Weather_t + \delta_t + \varepsilon_t^w$, where TOM is time on market from listings data in pre-reform period

  - The highest $\widehat{\gamma}$ we estimate is 21 days (3 week delay)
  - Translates to an opportunity cost in lost wages of roughly 0.36% of median home sale price

- Therefore, using the revised sufficient statistics formula, the optimal uniform τ^* is only $(0.36/2)/\epsilon + 0.36/2 = 0.216$ p.p. lower for $\epsilon = 5$

I. Compute the variance-covariance terms $\widehat{\Omega}$ and $\widehat{\Omega}_i$ using gross taxable income (from the tax returns), and index levels of home prices and rents

II. Determine actual tax rates faced by each investor on sales before the transfer tax reform – this includes stamp duty, land value increment, and local house transfer income taxes

III. Estimate the model-implied regression using the investor-specific rates τ_i from the previous step and the index levels P_t:

$$\widehat{\Omega} \cdot X_{i,t} + \widehat{\Omega}_i = \alpha_i \cdot P_t \times (1 + \mathcal{D}_{i,t} \cdot \tau_{i,t}) + e_{i,t}$$

IV. Recover the investor fixed effects $\widehat{\alpha}_i$ from the above regression and set the free parameter $\Upsilon = \mu_p^p + \mu_p^r$, or the sum of mean prices and mean annual rents

- Back out an estimate for the market-clearing price $\widehat{P}$ under the optimal tax regime by rearranging the expression:

$$\sum_i \Delta \widehat{X}_i = \sum_i \Delta \left\{ \frac{-\widehat{A}_i \cdot \widehat{\Omega}_i - \widehat{P} + \Upsilon}{\widehat{A}_i \cdot \widehat{\Omega}} \right\} = 0$$

- We plug $\widehat{P}, \widehat{A}_i, \widehat{\Omega}, \widehat{\Omega}_i$ into the demand system to retrieve counterfactual housing demand $X_i(\tau_i^*)$ under the optimal tax rates τ_i^* for each investor:

$$\mathsf{X}_{i,1}(\tau_i^*) = \frac{-A_i \cdot \Omega_i - P^* + \Upsilon}{A_i \cdot \Omega}$$

- Sort investors into groups $g \in \{RS, LS, RB, LB\}$ based on their housing positions $X_i(\tau_i^*) - X_{i,0}$, where $X_{i,0}$ is housing held at the beginning of the sample

- Separately run the model-implied regression for each group g, recover group-specific fixed effects $\widehat{\alpha}_g$, and then plug back into optimal tax formula to obtain τ_g^*

PROPERTY TRANSFER TAXES IN GLOBAL CONTEXT

- We collect tax parameters for top markets by investable RE stock   `Main deck`

- Patterns in transfer tax regimes:
  - High tax rates (>3%) and holding period notches fairly rare
  - 19 out of the top 25 impose a flat tax $\implies$ rate does not rise progressively with sale price (only 3 have no tax)
  - Legal incidence: about half impose on buyer, other half on seller
  - Rarely have a separate capital gains tax for RE

- Typical exemptions: inheritances/gifts (separate tax), refinancing, collateral, divorce, court orders

Taxes in the top 10 RE cities + 4 Asian Tigers

	RE stock value	Transfer tax	Capital gains tax	Rate	Holding period notch	Incidence
Taiwan	**254**	✓	✓	**10-15% (flat)**	**✓ (both)**	**Seller**
Hong Kong	197	✓	✗	1.5-20% (progressive)	✓ (buyer surcharge)	Seller & buyer surcharge
Singapore	217	✓	✗	0.33-16% (progressive)	✓ (seller stamp tax)	Buyer & seller (separate rates)
South Korea	758	✓	✗	4.6% (flat)	✗	Buyer
Tokyo	711	✓	✓	3% (flat)	✓ (CGT)	Buyer
New York	657	✓	✗	1-2.625% (flat)	✗	Seller
Los Angeles	482	✓	✗	0.45% (flat)	✗	Seller
Paris	342	✓	✗	0.71-6.41% (flat)	✗	Seller
London	334	✓	✓	2-12% (progressive)	✗	Buyer
San Francisco	307	✓	✗	0.5-2.5% (flat)	✗	Buyer
Chicago	300	✓	✗	1.05% (flat)	✗	70-30 buyer-seller
Seoul	291	✓	✗	0.02-5% (flat)	✗	Buyer
Osaka	288	✓	✓	3% (flat)	✓ (CGT)	Buyer
Houston	255	✗	✗	–	–	–

Note: RE stock value in billions of USD. Progressive means rates rise with sale price. Main deck

Estimating investable RE stock

- We use a rule of thumb applied in CRE investment firms to estimate and rank markets by the aggregate size of investable real estate: [Main deck]

$$\text{Investable RE stock} = 0.45 \cdot \text{GDP} \times \left[\left(\frac{\text{per capita GDP}}{27,800 \text{ USD}} \right)^{\alpha} \right]$$

- Based on observation that discontinuity in country-level RE investment flows occurs around 27,800 per capita GDP

  - Relationship is actually stronger at city-level for CBDs

  - Key assumption: long-run share of RE in aggregate physical capital stock is about $1/3$

- Estimate for Taiwan: $0.45 * 586,104,000,000 \times (24,828/27,806)^{1/3} \approx$ \$253,973 million

- Compared to the investment flow of \$111,425 million of all properties transacted in 2017

DETAILS: HOW TO TRANSFER PROPERTY OWNERSHIP

1. Buyer signs contract, pays 0.1% stamp duty tax, and a 5-10% contract fee (1 to 3 days)

2. Seller files transaction tax return and waits for bill (7 to 21 days)

3. Seller pays transaction and CG taxes, and any outstanding bills – must be paid within 30 days after signing the contract

4. Sellers files ownership transfer and pays stamp duty tax remitted to them by the buyer plus 0.1% flat fee (3 to 5 days)

5. Buyer pays remaining balance on property and completes transfer

- We estimate finalizing a transfer takes 38 days at maximum

- Realty companies estimate average time on market of 90-115 days in the top six cities

Main deck

Pre-existing property tax bases

- In addition to the surcharge on short-term flips, transfers subject to four other taxes:

  1. Deed tax: buyers pay 6% of triennial appraisal value

  2. Stamp duty tax: buyers pay 0.1% of appraised building value and annually assessed current land value

  3. Land value increment tax: second home sellers pay flat-rate tax on current land value which declines with holding period (20% to 40% rates)

  4. House transfer income tax: sellers pay a tax sale price which depends on a local scale factor (0.08 to 0.37) and personal income tax bracket

- In practice, for typical single-family home in Taipei, surcharge doubled the seller's total transfer tax bill

Main deck

CALCULATING TAX BILLS: A SIMPLE EXAMPLE

- Mr. Lee sells his 125 m^2 second home in Taipei for 65 million NTD ($\approx$ 2.2 million USD) while the transfer tax surcharge is in effect

- 1.5 years ago Mr. Lee paid 170,000 NTD per m^2 and the current land value (CLV) is 200,000 NTD per m^2

- Land value increment tax: for holding period $<$ 20 years, 20% tax rate on CLV less deductions for inflation and renovations $\approx$ 700,000 NTD

- House transfer income tax: Mr. Lee is in the top income tax bracket, so (0.4×0.37) on 33.6 million NTD assessment $\approx$ 5 million NTD

- Transfer tax surcharge: 10% of 65 million NTD = 6.5 million NTD $\implies$ the total tax bill increases from 8.7% of the sale price to 18.7%

Main deck

DETAILS: PERSONAL WEALTH ESTIMATES

- Wealth is the sum of all tangible (land + buildings + vehicles) and financial assets (cash + deposits + bonds + equities) `Main deck`

  1. Real estate: separate procedure for land/building

     - Building appraisal values from property tax base, inflated up to market value using our indices

     - Declared land value inflated up to market value using ratio of announced land value to transaction price reported by Local Land Office

  2. Vehicles: MSRP for vehicle make/model from DMV registration, less accumulated depreciation (linear)

  3. Savings/deposits: personal interest income $r \cdot s$ where r is aggregate interest income divided by deposits with all banks from the CB

  4. Bond holdings: personal interest income on ST bonds + public debt + corporate bonds + bank debentures divided by avg. nominal rate across all bonds in TEJ Database

  5. Equities: OTC stocks at face value, and publicly-traded stocks at closing price of annual ex-right date (July 31st if no dividends)

CONSTRUCTING THE MATCHING ESTIMATOR INDEX

- Index comes from a hybrid repeat-sales/hedonic valuation model

$$\log P_{i,t}^c = \delta_t^c + \gamma_i^c + \beta^{c\prime} \cdot \mathbf{X_{i,t}^c} + \epsilon_{i,t}^c \tag{19}$$

$$P_t^c = \exp(\delta_t^c) \tag{20}$$

- Idea: limit the selection problem in repeat sales by defining γ_i^c as an "almost" repeat sale and use $\mathbf{X_{i,t}^c}$ to control for small differences

- Matching estimator à la McMillen (2012) and Fang et al. (2015)

  - Assign unique panel id to half-block level (range of 30 house #'s)
  - $\mathbf{X_{i,t}^c}$ includes polynomial of age, land and floor area – accounts for rounding errors and differences in unit floor plans
  - Check bias as we move closer to defining γ_i^c as unique property
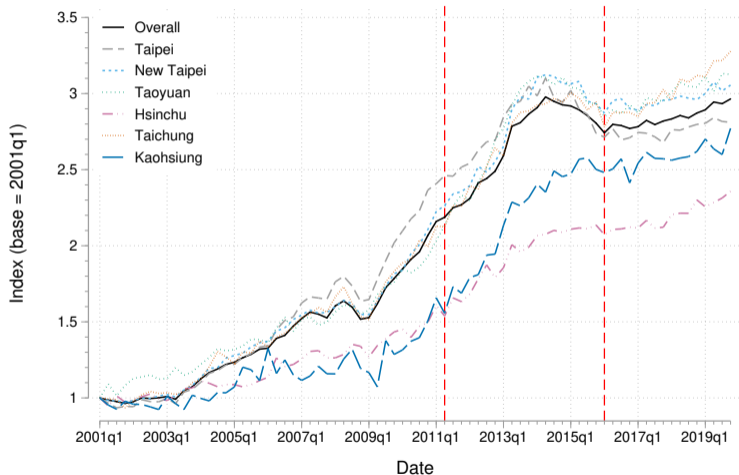
Main deck

- Hedonic index which shows 116% gain (94% real) in 10 years before reform

- Created from realty data and excludes flips within a year Main deck

COMPARISON OF QUARTERLY HOUSING PRICE INDICES
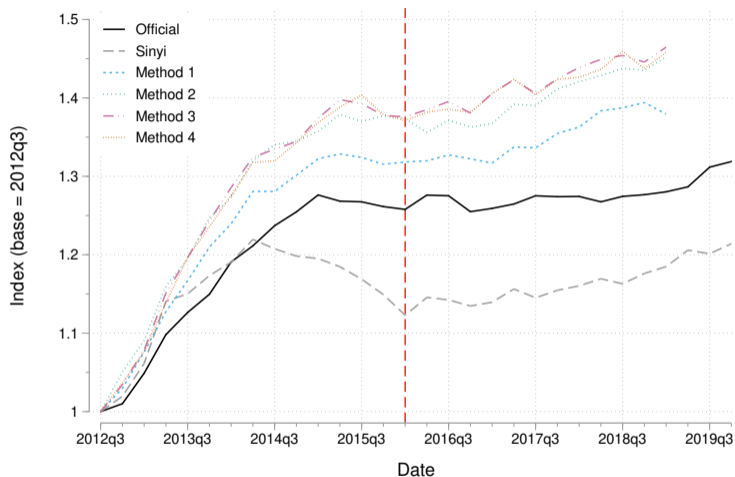
- Selection bias problem: prices become more inflated as we adopt more stringent definition of repeat sales (Method 1 → Method 4) Main deck

ALTERNATIVE: ESTIMATE TRANSLOG PRODUCTION FUNCTION

- Estimate annual depreciation rate using hedonic model with translog function of land and structure size `To index`

$$\log P_{i,j,t} = \alpha_0 + f(A, S, L, D) + \beta_1 \log S_i + \beta_2 (\log S_i)^2$$

$$+ \beta_3 \log L_i + \beta_4 (\log L_i)^2 + \beta_5 D_i + \beta_6 D_i^2 + \beta_7 D_i^3$$

$$+ \beta_8 \log S_i \times \log L_i + \beta_9 \log S_i \times D_i + \beta_{10} \log L_i \times D_i$$

$$+ \psi' \cdot \mathbf{X_{i,j,t}} + \gamma_j + \delta_t + \epsilon_{i,j,t}$$

$$f(A, S, L, D) = \alpha_1 A_i + \alpha_2 A_i \times \log S_i + \alpha_3 A_i \times \log L_i + \alpha_4 A_i \times \log D_i$$

- Alternatively, use piecewise linear function to see how marginal effects evolve with building age

$$f(A, S, L, D) = \sum_g \left[\alpha_{1,g} \mathbb{1}_g + \alpha_{2,g} \mathbb{1}_g \times \log S_i + \alpha_{3,g} \mathbb{1}_g \times \log L_i + \alpha_{4,g} \mathbb{1}_g \times D_i \right]$$

$$\log P_{i,j,t}^c = \alpha_0 + f(A, S, L, D) + \psi' \cdot \mathbf{X_{i,j,t}} + \gamma_j^c + \delta_t^c + \epsilon_{i,j,t}^c \quad \text{with } P_t^c = \exp(\delta_t^c)$$
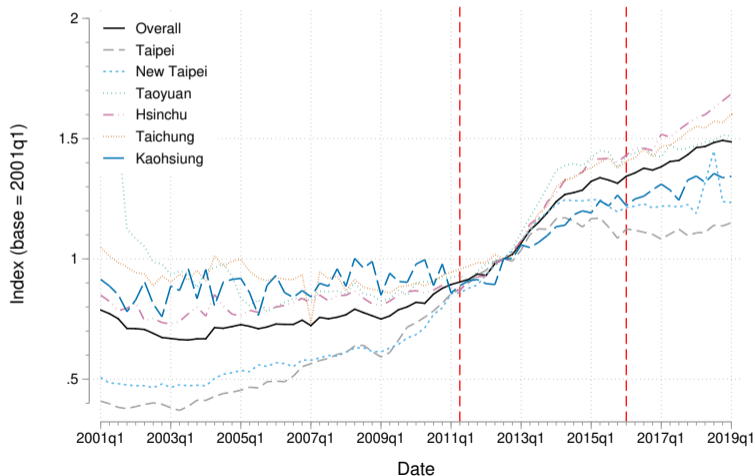
PRICE-RENT RATIOS WERE APPROACHING BUBBLE TERRITORY
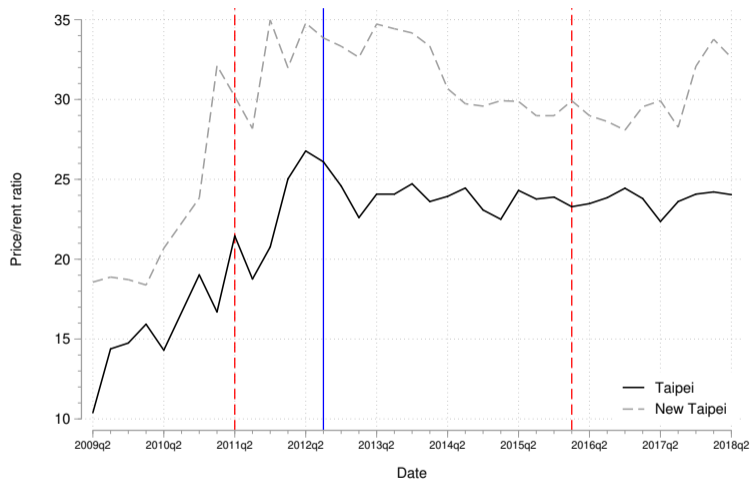
- Greater Taipei area had similar trajectory to HK: PR ratio went from 20 to 30 (2009-11)

Main deck

EVOLUTION OF QUALITY-ADJUSTED PRICES AROUND REFORM

Average residualized price   Local quadratic fit
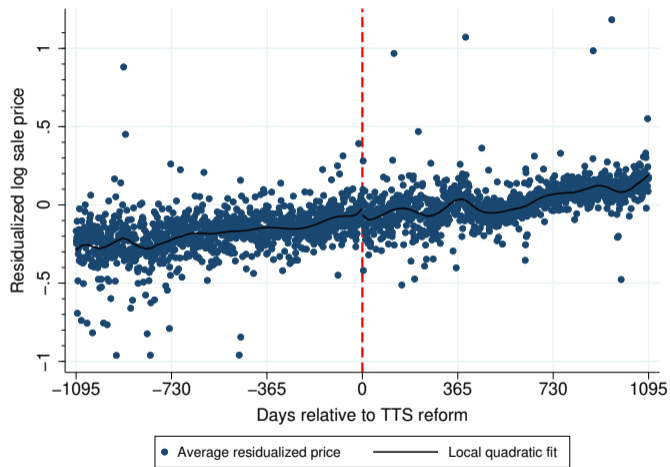
- Residualize log prices on block FEs, day of week FEs, floor number (for apartments), # of floors (SFHs), quadratics in age, floor space, land area

- Clear upward pricing trend with no break around reform date

- No jumps in prices elsewhere in distribution when we look at assessed value quantiles $\implies$ strong selection effects

Main deck

ALMOST COMPLETE PASS THROUGH TO OWNER-OCCUPIED SEGMENT

Weeks relative to TTS reform

○ Non-owner occupied   △ Owner-occupied
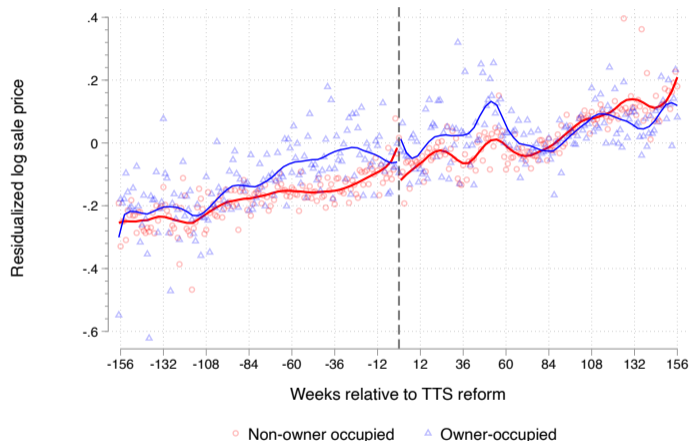
- Compare residualized prices for non-owner-occupied (taxed) vs. owner-occupied (not taxed) property sales

- Similar price rise across two segments $\implies$ pass through from taxed to untaxed units (liquidity crunch)

- Same pattern when we look at prices by segment $\times$ value quantiles

Main deck

No clear discontinuity in unit prices
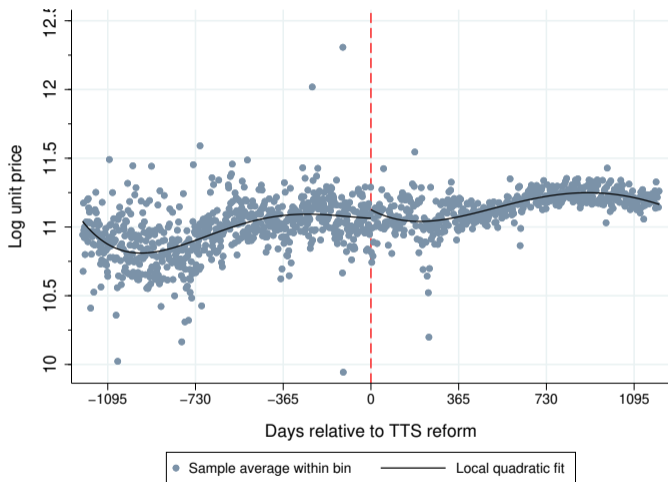
- Clear reduction in unit price variance after the reform   Main deck

No discontinuity around the grandfathered date
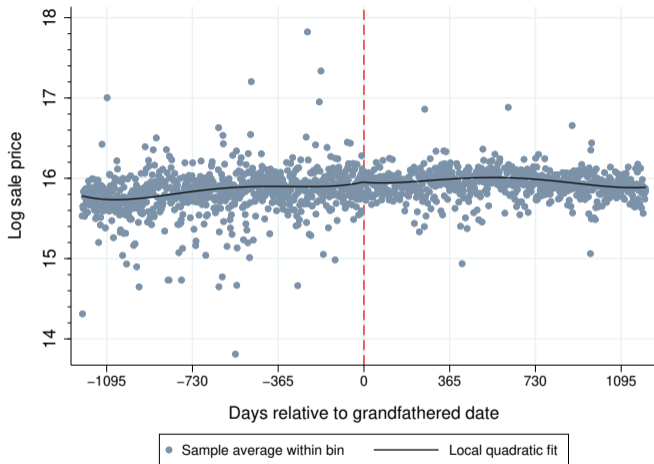
- Grandfathering: if flipped after implementation, tax still applies to anything bought after June 1, 2009 `Main deck`

TAX REFORM HIGHLY SALIENT FOR FLIPPERS \boxed{\text{Main deck}}
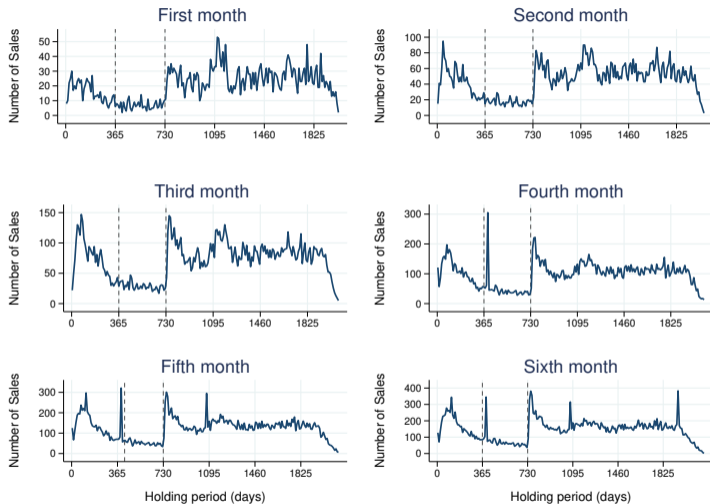
- Optimization frictions unlikely here – convergence to a new steady state within 6 months

TREND BREAK FOR LOW-VALUE PROPERTIES
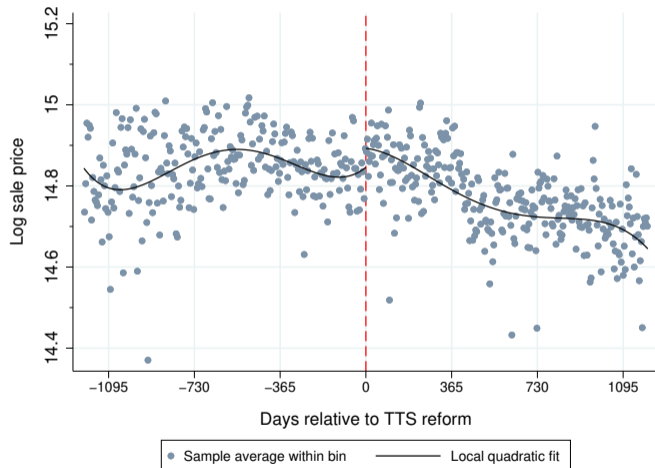
- Avg. sale prices in first quintile decline by $\approx 28\%$ over 3 yrs.

- Inaction region: less likely to pay tax bill to flip an apartment w/low cap gain `Main deck`

Prime property investors sell at premium to expedite

Days relative to TTS reform

• Sample average within bin — Local quadratic fit
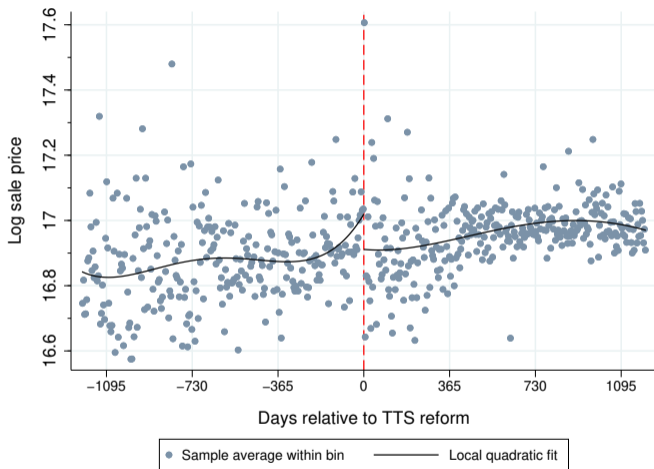
• Within the top quintile of assessed values, prices jump by 10% (full pass through) around
  reform, then revert to trend `Main deck`

Taxpayers buy and hold for two years to avoid tax

Pre-reform
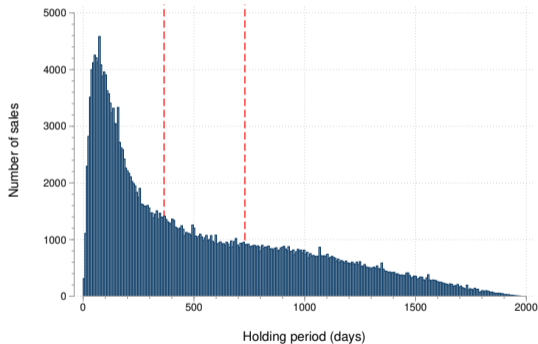
Post-reform
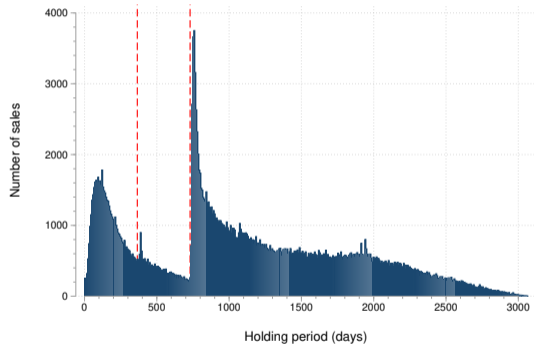
Main deck

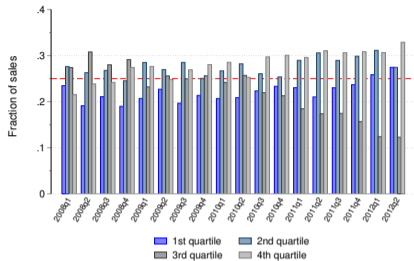# PREDICTED SALES FUNCTION FLATTENS AFTER TAX
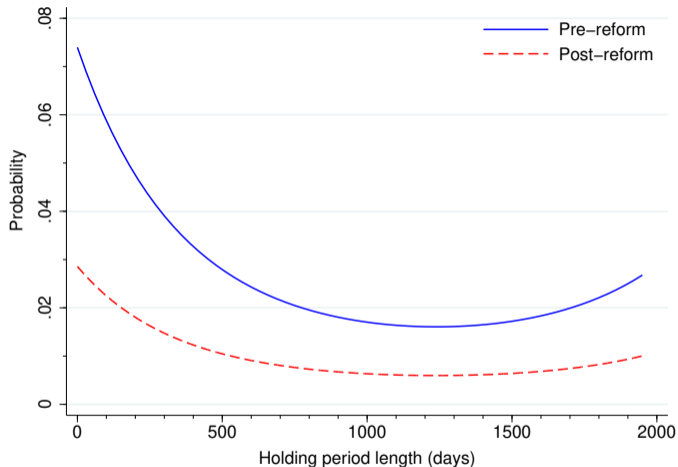
- Level shift: lower post-reform sale probability at each holding period Main deck
- Slope shift: weaker post-reform relationship between holding period and sale probability
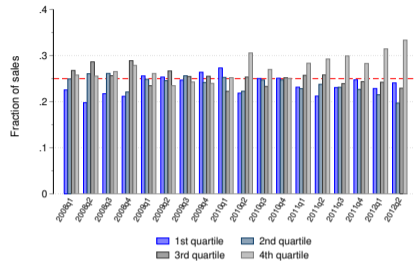
K-S TESTS OF MODEL FIT TO PRE-REFORM DATA

	Baseline	Age < 5	Age 5-10	Age > 10	OOT	non-OOT	$Q_1(NW_s)$	$Q_3(NW_s)$	$Q_5(NW_s)$
K-S stat	0.105	0.149	0.090	0.149	0.105	0.119	0.149	0.119	0.075
p-value	0.858	0.444	0.951	0.444	0.858	0.726	0.444	0.726	0.992

- Fail to reject the null of no difference in the distribution of sales by holding period for the CF model vs. data along several cuts:

  ▸ Young vs. middle-aged vs. old properties $\implies$ unobserved renovations and tax avoidance in new builds not playing a role in model fit

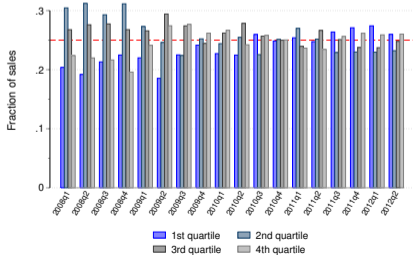 ▸ OOT vs. non-OOT sellers
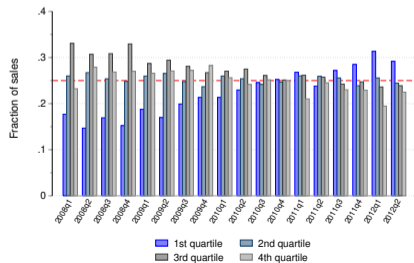
  ▸ By quantiles of seller net worth

Main deck

Building age — Fraction of sales

Distance to train station — Fraction of sales

Floor space — Fraction of sales

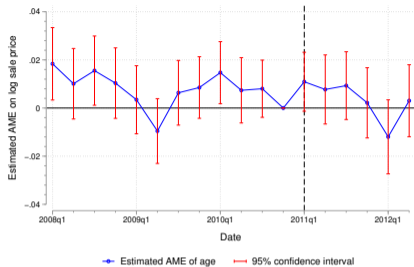**Land plot size** — Fraction of sales

1st quartile · 2nd quartile · 3rd quartile · 4th quartile
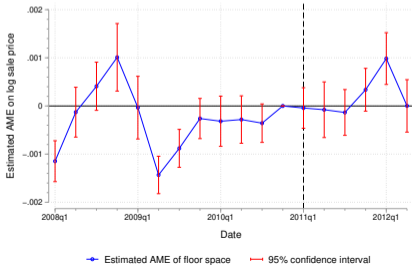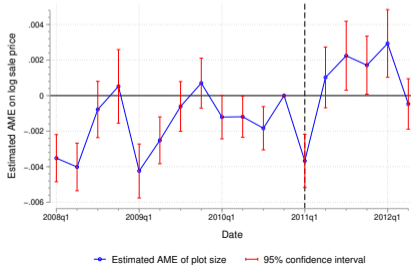
Main deck

Building age

High-rise apartment dummy
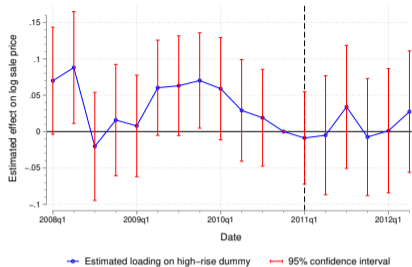
Floor space
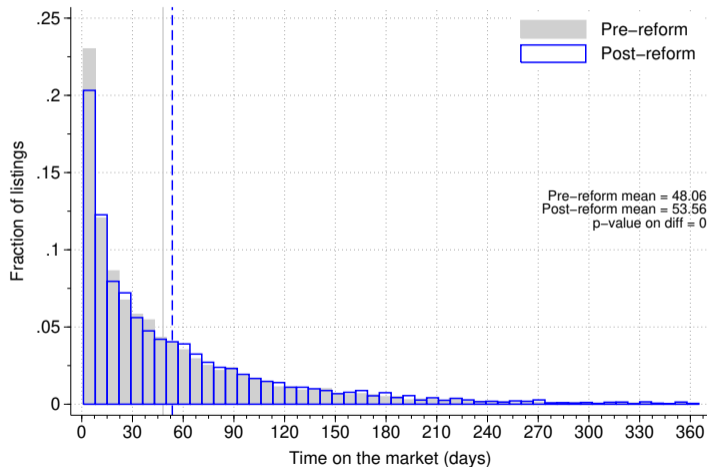
Land plot size

Main deck

HALF OF MISSING SALES FROM VERY LOW-WEALTH SELLERS

Missing mass by seller's net worth quintile

	HP $\leq$ 2 yrs.	HP $>$ 2 yrs.	Net missing	% of total
First quintile	32,669	$-17,999$	14,670	44%
Second quintile	520	137	657	2%
Third quintile	4,958	-65	4,893	15%
Fourth quintile	11,999	$-6,693$	5,306	16%
Fifth quintile	19,013	$-11,400$	7,613	23%
Total	69,159	$-36,020$	33,139	100%

Main deck

Time on market (TOM) ↑ by a week after the tax

All listings

Pre-reform mean = 48.06
Post-reform mean = 53.56
p-value on diff = 0

Pre-reform
Post-reform

- Data: listings which close within 1-year window around the reform

- Definition: days between initial listing date and removal date

- ≈ 3 p.p. drop in fraction of listings closing within a week driven by bottom of price distribution

- Increase in properties with very long TOM driven by top of price distribution [Main deck]

Heterogeneous effects on TOM mirror those for prices

First quintile
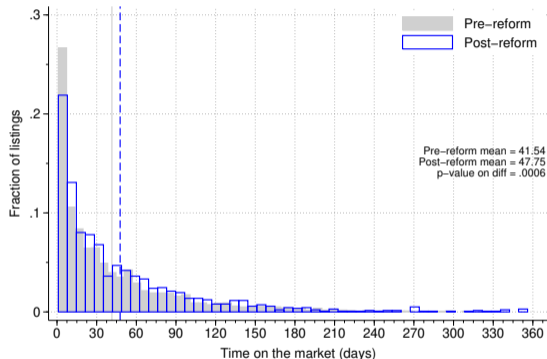
Top quintile
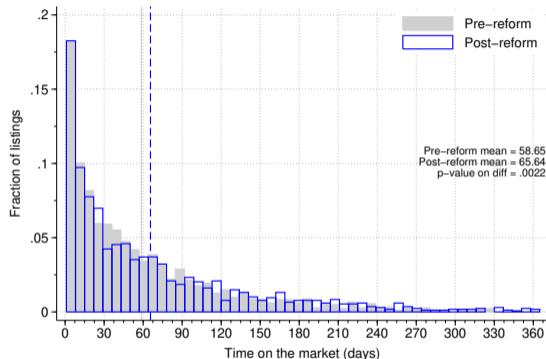
- Avg. TOM grew by 7 days (Q1), 9 days (Q5), but by a statistically insignificant 3-4 days in the middle of the distribution Main deck
- Liquidity crunch worse for unique properties (Q5) and low cap gain apartments (Q1)

WHY DIDN'T PRICES FALL AFTER THE TOBIN TAX?

- Govt. enacted tax thinking it would help with housing affordability   Main deck

- Demand for investment properties declined but so did supply
  - Even if demand shift dominates for some properties, price fall may not pass through to other segments (Stroebel, Piazzesi, Schneider 2020)
  - Critical then to understand <u>who</u> are the investors

- Standard disagreement model would say more price-sensitive investors are those with beliefs closer to fundamentals

- Do high housing wealth taxpayers extract sale premium to offset tax?
  - Problem: wealth is obviously endogenous to taxpayer outcomes
  - Solution: use windfall housing inheritances from decedents who <u>unexpectedly died</u> shortly before reform

EMPIRICAL STRATEGY: DEATH AND TAXES

- Compute cumulative inheritances IW over $k = 4$ years prior to the reform `Main deck`

- Heirs anticipate inheritance (Bernheim, Shleifer, Summers 1985), so use untimely deaths

  - Decedent age 2 s.d. below average age at death (i.e. 47.35 y.o. or younger)

  - And/or sudden cause of death (e.g. heart attack, stroke, accident)

- 2SLS estimation: regress net worth on inheritance shock, then use pass through as measure of portfolio exposure to flip tax

$$Y_{i,t} = \alpha_2 + \beta_2 \cdot \left(NW_{i,\tau} \times Post_t \right) + \gamma' \cdot \mathbf{X_{i,t}} + \delta_t + \epsilon_{i,t} \tag{21}$$

$$NW_{i,\tau} = \alpha_1 + \beta_1 \cdot \underbrace{\sum_{t=0}^{k} IW_{i,\tau-t}}_{\equiv NWShock_{i,\tau}} + \eta_i \tag{22}$$

- Exclusion: $NWShock$ can only influence outcome Y through effect on seller's net worth

SELLER'S TOTAL IW DELIVERS STRONGEST SHOCK

|	(1)	(2)	(3)	(4)
$NWShock$ (β_1)	1.923***	0.562***	0.936***	0.929***
	(0.225)	(0.171)	(0.003)	(0.009)
First stage $Y \times Post$ (β_2)	0.018***	0.013***	0.020***	0.020***
	(0.003)	(0.004)	(0.001)	(0.001)
First stage Y	HNW^S	NW^S	$ln(HNW^S)$	$ln(NW^S)$
IV	IHW^S	IW^S	$ln(IHW^S)$	$ln(IW^S)$
Montiel Olea & Pflueger F-test	14.67	125.08	10,209.35	8,827.90
Time & district FEs	✓	✓	✓	✓
Property controls	✓	✓	✓	✓
Adj R^2	0.70	0.70	0.71	0.71
N	182,646	182,646	22,914	27,078

- Focus on shock to sellers to isolate shift in the supply curve `Main deck`
- Preferred estimate: \$0.56 of every \$1 inherited passes through to seller's net worth

Wealthy sellers pass through tax hike to buyers

	(1)	(2)	(3)	(4)	(5)	(6)
$NW^S \times Post$	0.0003**	0.0090**	0.0097**	0.0130**	0.0129**	0.0129**
	(0.0001)	(0.0031)	(0.0032)	(0.0043)	(0.0043)	(0.0047)
Estimation	OLS	2SLS	2SLS	2SLS	2SLS	2SLS
Montiel Olea & Pflueger F-test	–	127.56	125.37	125.08	336.06	177.51
Property controls	✓		✓	✓	✓	✓
Time & district FEs	✓			✓	✓	✓
Clustering	$district^P$	$district^P$	$district^P$	$district^P$	$district^S$	$district^B$
Adj. R^2	0.67	0.01	0.09	0.69	0.69	0.69
N	182,646	183,007	182,660	182,646	180,256	179,634

- Sale price increases by 1% for every 1 million NTD ($\approx$ 35k USD) increase in seller's net worth (extensive $\times$ intensive margin effect) Main deck

- Or, 1 s.d. $\uparrow$ in inherited wealth $\implies$ seller charges 9.3% $\uparrow$ relative to pre-reform period

High HW taxpayers sell off right before reform hits
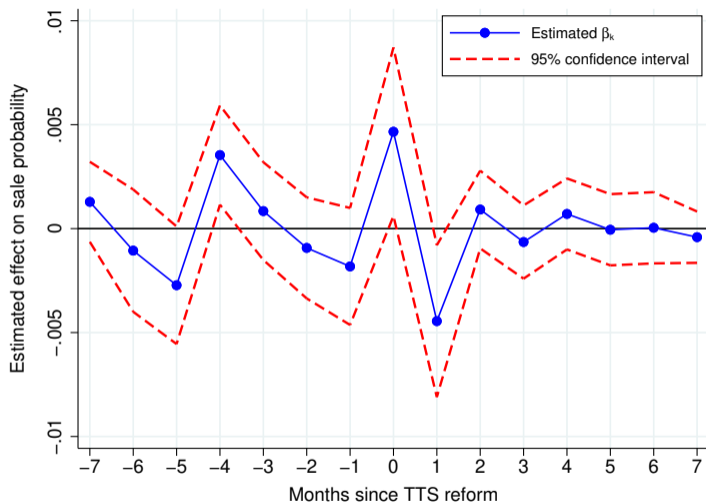
- 1% ↑ in sudden IHW $\implies$ 0.3 p.p. ↑ in sale probability in announcement month and 0.5 p.p. ↑ just prior to implementation Main deck

DETAILS: HOLDING PERIOD RETURN FORMULAE

$$r_t^j = \frac{\sum_{i=1}^n (1-\tau_{i,t}) \cdot \widetilde{V}_{i,t}^j + (1-c_{i,t}^j) \cdot Y_{i,t}^j - T_{t-1,t}^j}{\sum_{i=1}^n \widetilde{V}_{i,t-1}} - 1$$

$$\widetilde{V}_{i,t} = (1-\delta) \cdot V_{i,t-1} \times \frac{\widehat{P_{i,t}}}{\widehat{P_{i,t-1}}}$$

- $\widetilde{V} \to$ current market value, defined as either the sale price within filing year t, or the last observed sale price inflated up using our MSA-level index $\widehat{P}$ Main deck

- $\tau \to$ taxes triggered by property sale ($\tau = 0$ if no sale occurs at t)

- $T \to$ property holding taxes, usually proportional to assessed values

- $\delta \to$ linear rate of depreciation between $t-1$ and t (2% for SFH or 3% for apartments)

- $c_{i,t} \to$ tax rate on rental income Y less any mortgage interest deductions

	Local buyer	OOT buyer	Difference
OOT seller	11.43%	12.89%	**1.46*****
Local seller	14.99%	16.98%	**1.99*****
Difference	**3.56*****	**4.09*****	**0.53*****

- Local sellers always earn a premium relative to OOT sellers
- Local premium is 0.53 p.p. higher for sales to OOT buyer

	Pre-reform	*Post-reform*	**Difference**
OOT seller	25.18%	8.71%	$-\mathbf{16.47}^{***}$
Local seller	23.43%	14.19%	$-\mathbf{9.24}^{***}$
Difference	**-1.75**	**5.48*****	**7.23*****

- Statistically no difference in pre-reform annualized HPRs for local or OOT investors
- Tax creates a wedge of 7.23 p.p. between local and OOT sellers

	Pre-reform	*Post-reform*	**Difference**
OOT seller	22.06%	8.13%	$-\mathbf{13.93}^{***}$
Local seller	25.98%	16.30%	$-\mathbf{9.68}^{***}$
Difference	$\mathbf{3.92}^{**}$	$\mathbf{8.17}^{***}$	$\mathbf{4.25}^{***}$

- Local premium exists if define local to be at neighborhood level (OON)
- Suggests investment activity may reflect an urban-suburban divide

Pre-reform

	Local buyer	OOT buyer	Difference
OOT seller	25.06%	25.17%	0.11***
Local seller	23.16%	24.09%	0.93***
Difference	−1.90	−1.08	0.82

Post-reform

	Local buyer	OOT buyer	Difference
OOT seller	7.96%	9.37%	1.41***
Local seller	13.42%	15.69%	2.27***
Difference	5.46***	6.32***	0.86***

- ΔDDD estimate = 0.86 - 0.82 = 0.04 (p-value = 0.98)

Annualized holding period return (%): by wealth quintile

	μ_{HPR}	P_{50}^{HPR}	σ_{HPR}	N
First quintile	28.01	4.83	108.04	9,881
Second quintile	25.06	3.55	104.84	9,819
Third quintile	21.28	3.48	92.25	9,850
Fourth quintile	19.47	2.68	93.15	9,850
Fifth quintile	18.33	1.60	89.66	9,849

- Goes against idea in literature that novices with less housing wealth perform worse in flipping properties

Year	Investor type	μ_{HPR}	$\mu_{capital}$	μ_{rental}	$\mu_{interest}$
2008	Mortgaged	2.06	2.61	0.23	0.65
	Owned	3.41	3.07	0.71	0.00
2009	Mortgaged	-0.24	-0.31	0.78	0.60
	Owned	-0.22	-0.48	0.61	0.00
2010	Mortgaged	9.14	8.92	1.28	0.87
	Owned	6.47	6.22	0.64	0.00
2011	Mortgaged	6.94	9.46	0.61	2.97
	Owned	8.56	8.00	1.04	0.00
2012	Mortgaged	6.52	6.88	0.78	0.98
	Owned	6.35	5.87	0.91	0.00
2013	Mortgaged	10.59	10.70	1.30	1.18
	Owned	11.39	10.92	0.89	0.00
2014	Mortgaged	8.30	8.18	1.15	0.87
	Owned	8.59	8.17	0.69	0.00

- Caveat: proxy mortgage with itemized deduction for interest expense

Annualized holding period return (%): by stock market participation

	μ_{HPR}	P_{HPR}^{50}	σ_{HPR}	N
Non-stock holders	24.80	3.21	107.17	17,657
Stock holders	12.67	2.05	74.54	79,649

- 83% of homeowners with wealth estimates in our sample hold stocks (p-value < 0.001 on difference in means)

- Returns declining in equities as share of wealth
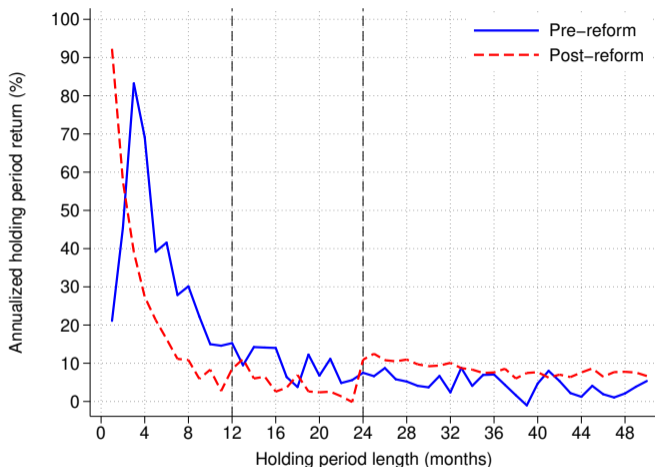
- Mirrors results for other asset classes (van Binsbergen & Koijen 2017)
- Reform flattens short end but shifts profits to HP > 24 mos.

# Estimating economic depreciation of properties

- Model real estate production function as generalized CES of structure and land quantities

- Property owner maximizes profits subject to paying shadow prices for structure and land inputs (Epple, Gordon, Sieg 2010)

- Under these assumptions can show property depreciation rate is the structure depreciation rate times the structure input share $s_{t,a}$

$$-\frac{\partial \log P_{t,a}}{\partial a} = \delta_a \cdot s_{t,a} \equiv \delta \tag{23}$$
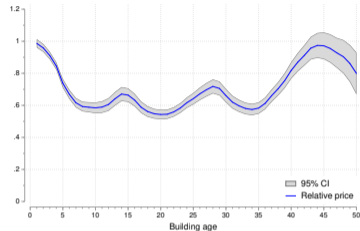
- Compute average marginal effect (AME) implied by estimated translog production function to get $\delta \approx 2\%$ for SFH (3% for apartments)
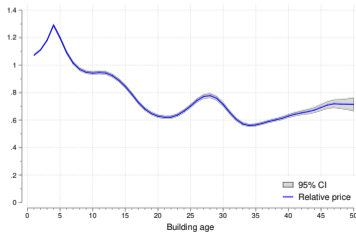
Main deck   Translog

Residential, Non-Top Six
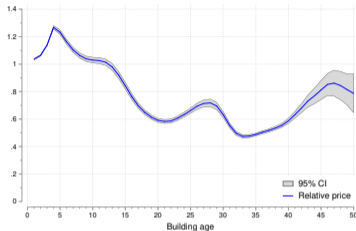
Commercial, Non-Top Six
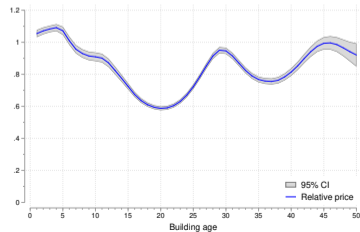
Residential, Top Six

Commercial, Top Six

| | Top Six Metros | | | | Outside Top Six Metros | | | |
| | Single family | | Apartment | | Single family | | Apartment | |
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Building age	0.013***		0.017***		0.010***		0.016***	
	(0.000)		(0.000)		(0.000)		(0.000)	
$\mathbb{1}$(1-5 years)		0.000		−0.002**		−0.012***		−0.009***
		(0.000)		(0.001)		(0.001)		(0.001)
$\mathbb{1}$(6-10 years)		0.025***		0.022***		0.010***		0.025***
		(0.001)		(0.001)		(0.002)		(0.001)
$\mathbb{1}$(11-15 years)		0.036***		0.042***		0.025***		0.060***
		(0.001)		(0.001)		(0.001)		(0.001)
$\mathbb{1}$(16-20 years)		0.062***		0.067***		0.059***		0.078***
		(0.001)		(0.000)		(0.001)		(0.001)
$\mathbb{1}$(21-25 years)		0.068***		0.072***		0.062***		0.077***
		(0.001)		(0.000)		(0.001)		(0.000)
$\mathbb{1}$(26-30 years)		0.057***		0.077***		0.040***		0.076***
		(0.001)		(0.000)		(0.002)		(0.001)
$\mathbb{1}$(31-35 years)		0.060***		0.085***		0.049***		0.087***
		(0.001)		(0.000)		(0.002)		(0.001)
$\mathbb{1}$(36-40 years)		0.055***		0.087***		0.038***		0.086***
		(0.001)		(0.001)		(0.002)		(0.001)
$\mathbb{1}$(41-45 years)		0.041***		0.092***		0.023***		0.078***
		(0.003)		(0.001)		(0.005)		(0.002)
$\mathbb{1}$(46-50 years)		0.045***		0.095***		−0.006		0.083***
		(0.005)		(0.002)		(0.010)		(0.003)
Controls	✓	✓	✓	✓	✓	✓	✓	✓
Location FEs	✓	✓	✓	✓	✓	✓	✓	✓
N	81,434	81,434	356,386	356,386	47,126	47,126	141,617	141,617
Adj. R^2	0.761	0.773	0.846	0.852	0.759	0.775	0.788	0.801

Classification system for Tropical Cyclones
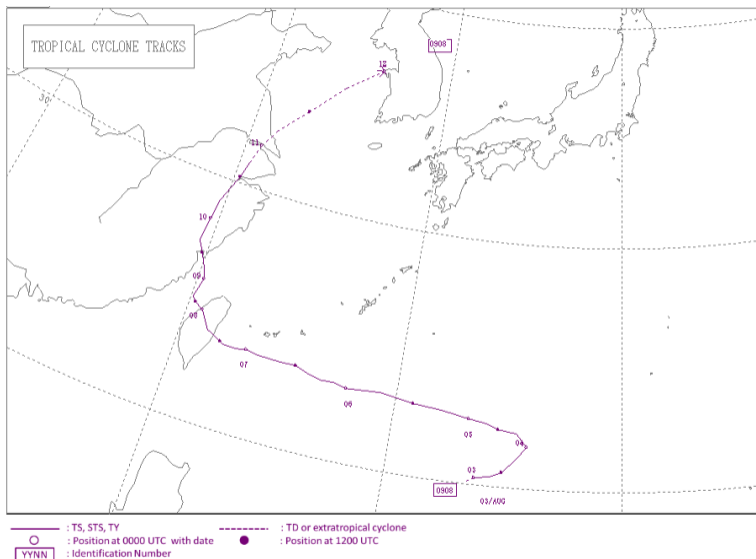
Category	Sustained wind speed
Violent typhoon	≥ 105 knots (121 mph)
Very strong typhoon	85-104 knots (98-120 mph)
Typhoon	64-84 knots (74-97 mph)
Severe tropical storm	48-63 knots (55-73 mph)
Tropical storm	34-47 knots (39-54 mph)
Tropical depression	≤ 33 knots (38 mph)

Source: World Meteorological Organization Technical Document, Typhoon Committee Operational Manual

Cyclicality in typhoon season length and storm incidence
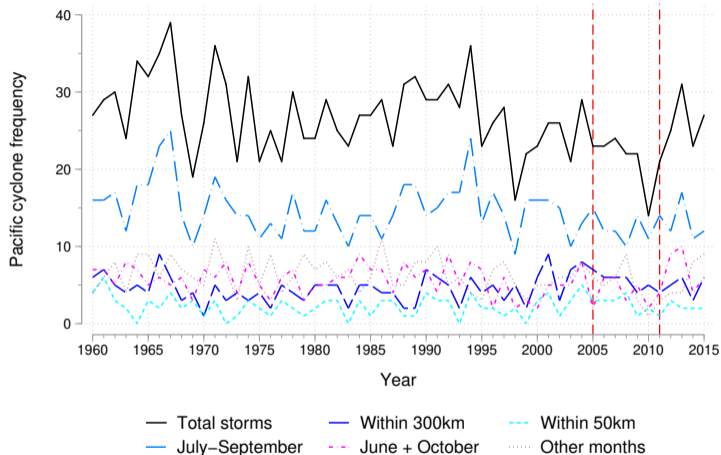
- Cyclonic Niño effects explain why uptick in incidence every 10 years `Main deck`
- But average severity (wind speed and rainfall) on the rise due to climate change

TAIWAN TYPHOON SUMMARY STATISTICS

	Taipei/New Taipei		Other Metros	
	Peak season	Non-peak	Peak season	Non-peak
Avg. # typhoon warning days	15.8	3.9	15.8	3.9
Max daily precipitation (in)	17.5	16.7	37.8	26.7
Cumulative precipitation (in)	38.9	82.4	47.0	48.9
Avg. wind speed (mph)	3.9	4.0	3.8	4.3
Max wind gust (mph)	101.4	88.3	153.9	126.6
Avg. station pressure (hPa)	989.7	997.4	965.4	973.1
Min. station pressure (hPa)	896.5	907.4	627.8	634.0
Avg. daily high temperature (°F)	89.5	73.6	86.3	74.6
Max daily high temperature (°F)	116.6	115.8	112.7	111.5
N	19,944	64,440	74,790	241,650
# Stations	36	36	135	135

Note: Includes observations from a balanced panel of stations (N = 171) reporting key typhoon forecasting variables.

QUINTILE

- N/A
- <3998
- (3998,5733)
- (5733,7335)
- (7335,9066)
- >9066
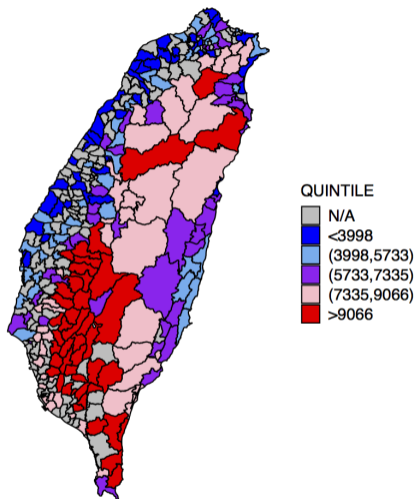
- Rains during typhoon season concentrated in the south/middle of island

Days
- N/A
- =0
- (0,1]
- (1,4]
- (4,8]
- >8
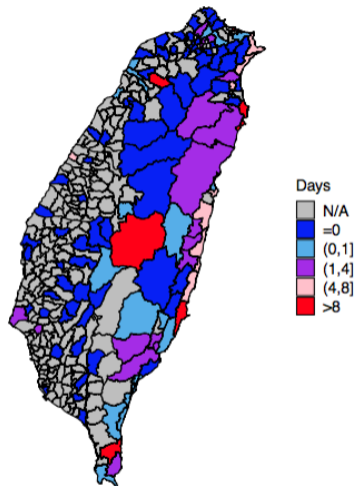
- While warnings set for entire island, majority of districts do not experience $\geq$ 74 mph winds in the average typhoon season (imperfect coverage)

Negative effects on volume in county cross-section

$$Volume_{j,t} = \beta \cdot (Weather_{j,t} \times Summer_t) + \delta_t + \psi_j + \gamma' \cdot \mathbf{X_t} + \varepsilon_{j,t}$$

	(1)	(2)	(3)	(4)	(5)
Max WS $\times Summer$	0.04			0.12	
Avg. WS $\times Summer$		−0.14			−0.01
Rainfall $\times Summer$			−0.04**	−0.03**	−0.04**
7-day FEs	✓	✓	✓	✓	✓
Day-of-week FEs	✓	✓	✓	✓	✓
County FEs	✓	✓	✓	✓	✓
Damages controls	✓	✓	✓	✓	✓
N	88,466	98,666	101,141	88,441	98,627

- 1 mm increase in rainfall $\implies$ 0.03% lower sales volume in the county-level cross-section

- DDD differences out common factors across locations which might be correlated with storm events (e.g. business shutdown responses) Main deck

FACTOR LOADINGS ON KEY WEATHER VARIABLES

	Factor 1 (Fair weather)	Factor 2 (Low pressure)	Factor 3 (Wind)	Factor 4 (Rain)
Avg. station pressure	0.37	−0.38	0.01	0.21
Max station pressure	0.37	−0.38	0.02	0.21
Min station pressure	0.37	−0.37	0.01	0.21
Avg. temperature	0.33	0.43	−0.01	0.19
Max temperature	0.33	0.44	−0.04	0.08
Min temperature	0.31	0.42	0.00	0.28
Avg. relative humidity	−0.34	0.04	−0.32	0.38
Min relative humidity	−0.33	−0.07	−0.19	0.46
Avg. wind speed	−0.13	−0.01	0.65	0.14
Max wind gust	−0.13	0.06	0.66	0.17
Cumulative precipitation	−0.14	0.02	0.00	0.58

- Identify four factors with eigenvalues > 1 (88% of variation) `Main deck`
- Includes data from all main + automated stations (N = 517)

	(1)	(2)	(3)	(4)	(5)	(6)
$Factor1 \times Summer$	17.54***					6.35
	(3.34)					(6.69)
$Factor2 \times Summer$		−4.46				5.63
		(6.90)				(7.27)
$Factor3 \times Summer$			−17.67***		−13.66***	−14.29***
			(2.89)		(2.74)	(2.93)
$Factor4 \times Summer$				−13.24***	−8.02***	−3.42
				(2.60)	(2.32)	(5.00)
7-day FEs	✓	✓	✓	✓	✓	✓
Day-of-week FEs	✓	✓	✓	✓	✓	✓
Damage Controls	✓	✓	✓	✓	✓	✓
N	4,681	4,681	4,681	4,681	4,681	4,681

$$\text{Volume}_t = \beta_1 \cdot (Rain_t \times Summer_t) + \delta_t + \beta_2 \cdot \mathbb{1}_{t-L,t-1}\{\overline{Rain} \geq 0.5\text{in.}\} + \gamma' \cdot \mathbf{X_t} + \varepsilon_t$$

	(1)	(2)	(3)	(4)
$Rain_t \times Summer_t$	-0.33^{***}	-0.33^{***}	-0.32^{***}	-0.31^{***}
$\mathbb{1}_{t-1w,t-1}\{\overline{Rain} \geq 0.5\text{in.}\}$	-10.33^{*}			
$\mathbb{1}_{t-2w,t-1}\{\overline{Rain} \geq 0.5\text{in.}\}$		-7.34		
$\mathbb{1}_{t-4w,t-1}\{\overline{Rain} \geq 0.5\text{in.}\}$			-3.03	
$\mathbb{1}_{t-8w,t-1}\{\overline{Rain} \geq 0.5\text{in.}\}$				18.85
7-day FEs	✓	✓	✓	✓
Day-of-week FEs	✓	✓	✓	✓
Damages controls	✓	✓	✓	✓
N	1,973	1,973	1,973	1,973
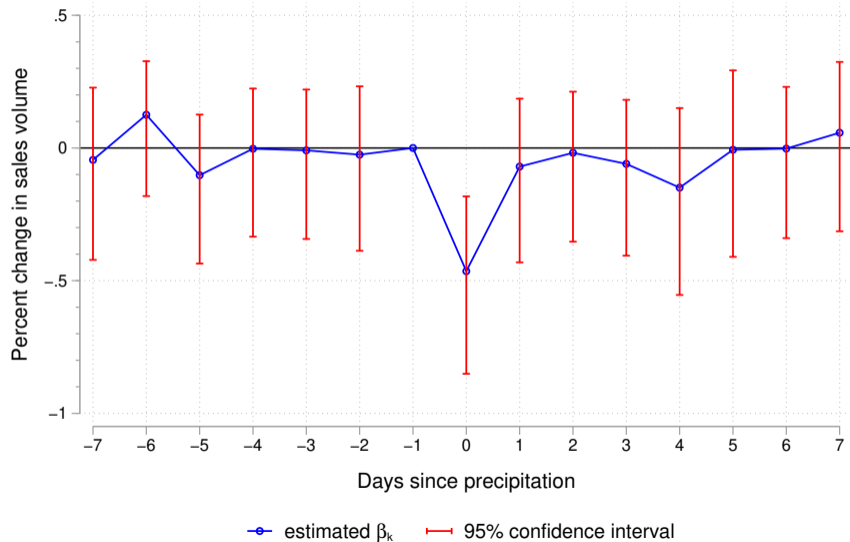
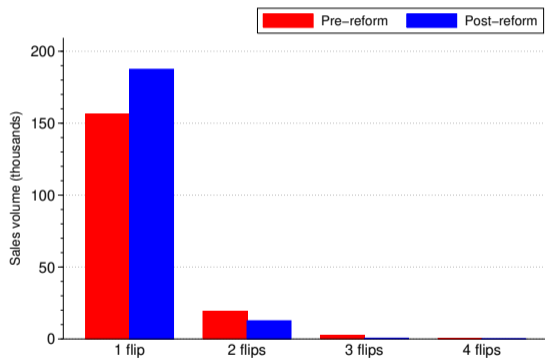# ALSO NO PRE-TREND IN VOLUME CONFIRMED TYPHOONS
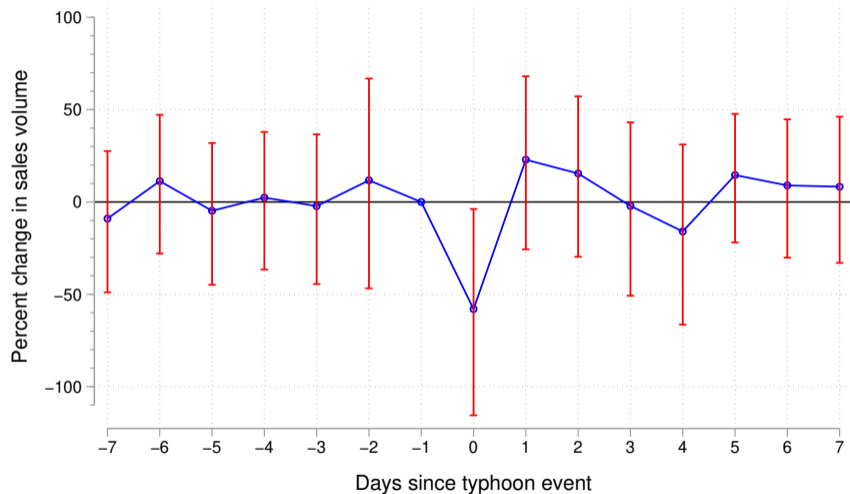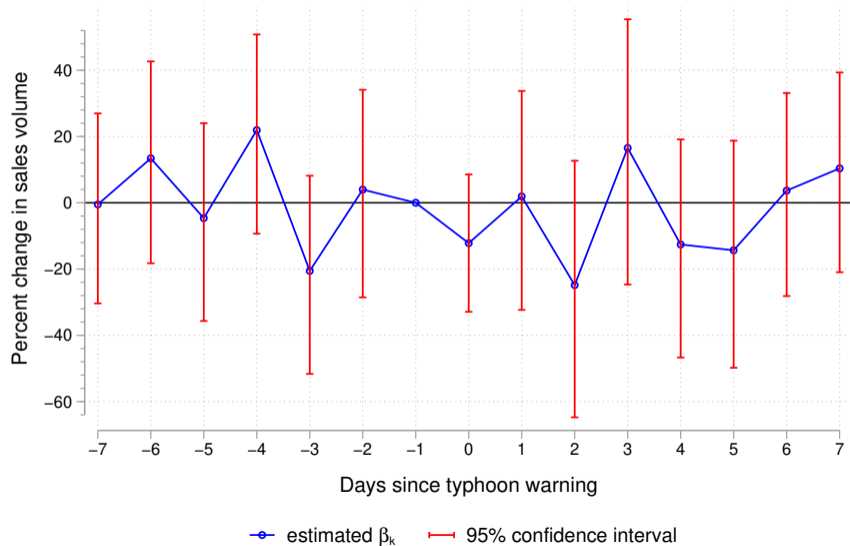
FOOD FOR THOUGHT: WHO BEARS THE COSTS OF FLIP TAXES?

Status change sales (fundamental)
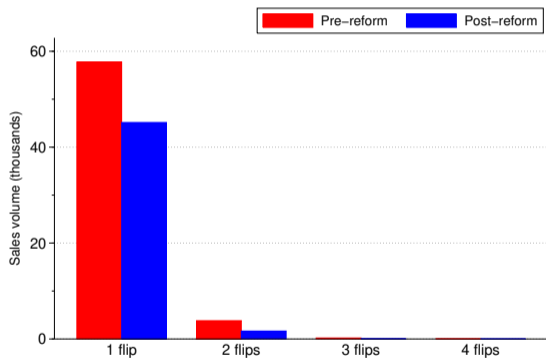
Other sales (non-fundamental)

Main deck