Equilibrium Effects of Housing Subsidies: Evidence from a Policy Notch in Colombia

Juan Pablo Uribe January 18, 2022

ARE MARKET-ORIENTED HOUSING POLICIES EFFECTIVE?

- ► Governments implement various **market-oriented** policies to promote housing construction and home-ownership
 - Subsidies or tax incentives
- ► Housing market effect?
 - Prices, quantities, type of housing
- ▶ Does incentivizing home-ownership work?
 - How big are the efficiency costs?
 - Are there any unintended consequences?
 - How much households and developers benefit?
 - What happens if these policies are removed?



- ► I use quasi-experimental variation to estimate a housing market equilibrium model.
- ► Counterfactual policy evaluation and welfare analysis.

COLOMBIAN HOUSING POLICY

- ▶ Policy tools:
 - Subsidies to low-income households low-cost housing.
 - Tax incentives to developers who build low-cost housing.
 - A price cap defining low-cost housing.

 135 monthly minimum wages (mMW) ≈ 40,000 \$USD
- ► Empirical advantages of Colombian setting:
 - Price cap
 - Discontinuous incentives for developers and households to bunch at the cutoff.
 - Unique and novel data
 - Census data for all new construction projects.
 - Administrative records for the subsidies.
 - Subsidy expansion (2006-18)

THIS PAPER

I. Descriptive evidence

- Policy description and characterization of observed equilibrium.
- Evidence of housing market responding to the subsidy scheme.

II. Hedonic equilibrium of housing supply and demand

- Product differentiation and heterogeneous developers and households.
- Identification using bunching an policy changes.

III. Proposed policy counterfactual and welfare

- Colombian 2021 tax reform Remove tax incentives to developers.
- Policy change phasing out price caps
- → Effects on households and developers

RESULTS

- I. Behavioural responses induced by the subsidy scheme.
 - Bunching at price cutoff
 - Larger response as the subsidies increase \rightarrow market share at cutoff went from 1% to 7%
 - Households downsize \rightarrow they buy units up to 30% percent smaller to benefit from the subsidy

II. Estimate a model that rationalizes the market observed equilibrium

Elasticity of substitution between on housing and consumption is 0.9

III. Effects of the proposed policies

- Colombian 2021 tax reform proposal could create a housing shortage.
- Removing the price cap increases welfare.

LITERATURE AND CONTRIBUTION

Integrates the bunching and hedonic literatures to propose a method to think about welfare consequences of housing policies

Bunching	Hedonic	Housing Policy
Housing marketLink to modelSupply and demand	Policy notchSupply sideIdentification	EvidenceMethodWelfare
 Housing market applications Best et al. (2019), DeFusco and Paciorek (2017) Methodology Notches >> Kinks: Kleven (2016), Bertanha et al. (2021), Blomquist et al. (2021) 	 Seminal paper S. Rosen (1974), Epple (1987) Recent Contributions Bajari and Benkard (2005), Heckman et al. (2010), Epple et al. (2020), Chernozhukov et al. (2021) Reviews Kuminoff et al. (2013), 	 Developers subsidies Baum-Snow and Marion (2009), Soltas (2020), Sinai and Waldfogel (2005) Households Subsidies Carozzi et al. (2020) Incidence and welfare Poterba (1992), Galiani et al. (2015)

Greenstone (2017)

I. DESCRIPTIVE ANALYSIS: DATA, POLICY AND OBSERVED

EQUILIBRIUM

POLICY TOOLS

1. Supply Subsidies

• Value Added Tax (VAT) refund

2. Demand Subsidies

- Downpayment
- Interest rate
 Income ≤ 4 monthly minimum wages (mMW) classify

3. Targeting tool for the subsidy:

• Only new *low cost* units are eligible

$$Low cost = \begin{cases} 1 & \text{if } P_t \leq 135 \text{ } mMW_t \\ 0 & \text{if } P_t > 135 \text{ } mMW_t \end{cases}$$

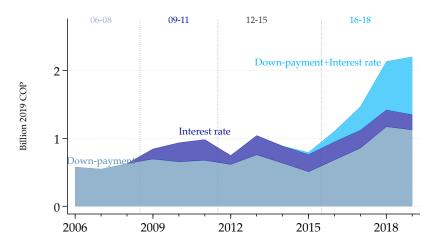


Note: 135 mMW \approx 40,000 \$USD

DATA

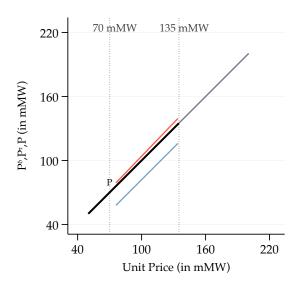
- 1. Administrative Records from Minister of Housing
 - Subsidy size
 - Mortgage information
 - $\rightarrow \ Government\ expenditure\ on\ each\ subsidy$
- 2. New Construction Census (Camacol)
 - 126 Municipalities
 - Years: 2006-2018
 - Sale prices and quantities
 - Unit characteristics: **size**, location, # rooms, # bathrooms, etc.
 - Development characteristics: lot size, # towers, # floors, developer id, etc.

GOVERNMENT EXPENDITURE AND POLICY EXPANSION



- Total housing subsidies beneficiaries 100'000 in 2019
- 2 billion COP $\sim 0.25\%$ Colombian GDP
- Colombian Conditional Cash Transfers 3, 6 billon COP for 2.3 million households

THE NOTCH



Transaction Price P Developers Price

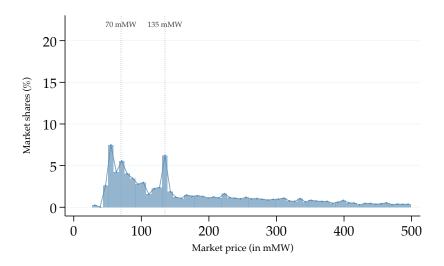
$$\mathbf{P}^{\delta} = P \cdot (1 + \delta)$$
:
 $\delta = \text{Tax refund}$
Households price

$$\mathbf{P}^{\tau} = P - \tau$$
$$\tau = \text{Subsidy}$$

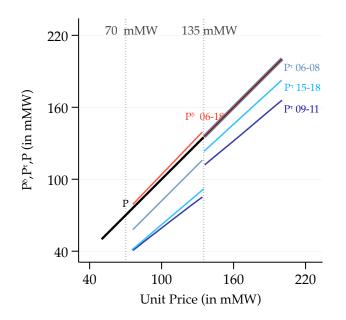
Agents benefit from buying/selling *low cost housing* ($P \le 135 \text{mMW}$)

BUNCHING AT THE LOW-COST HOUSING PRICE LIMIT

Only downpayment subsidy 2006-08



THE DEMAND NOTCH INCREASES OVER TIME



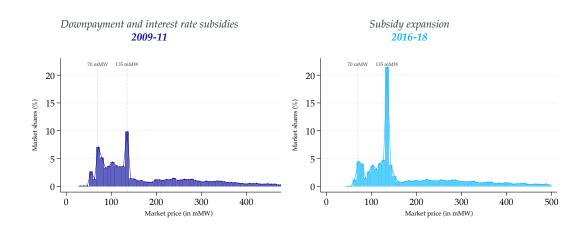
Supply Notch δ 2006-18 4%

Demand Notch τ_t

2006-08: 18 mMW 2009-11: 26 mMW 2016-18: 33 mMW

Note: 2012-15 Too many changes and free housing at 70 mMW

LARGER BUNCHING AS NOTCH INCREASES



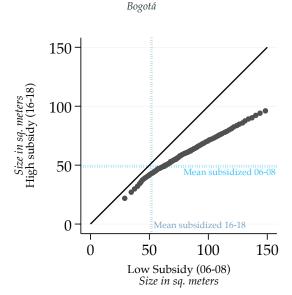
Notch: 33 mMW

Notch: 18 mMW

13 / 40

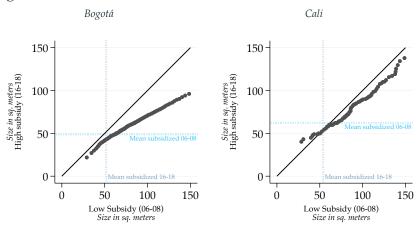
CHANGES IN HOUSING STOCK CHARACTERISTICS

► Changes in unit size (quantile to quantile plot)



CHANGES IN HOUSING STOCK CHARACTERISTICS

Changes in unit size



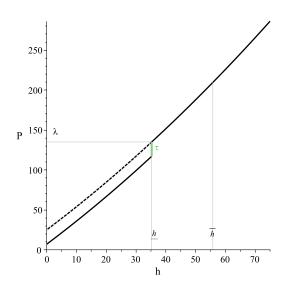
- ► Why size?
 - Continuous, easy to measure, monotonic relationship with price and income.
 - In contrast to most datasets, I observe it.

II. EQUILIBRIUM MODEL OF HOUSING SUPPLY AND DEMAND

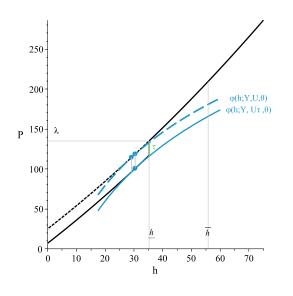
A STYLIZED HOUSING MARKET MODEL

1. Housing

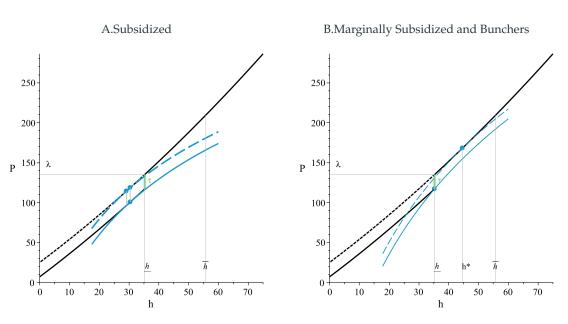
- Differentiated product described by its size $h \in \mathcal{H}$
- Price depends on size P(h)
- 2. **Households** $i \in I$, Heterogeneous in Income $Y_i \sim F_Y$
 - Choose h_i and consumption C_i to maximize Utility $U(C_i, h_i; \theta)$
- 3. **Developers** $j \in J$, Heterogeneous in Productivity $A_j \sim G_A$
 - Choose h_i to maximize profits
 - Building costs $B(A_j, h_j, Q(h_j); \beta)$
- 4. Competitive Market Equilibrium
 - Price function $P(h) \rightarrow$ clears the market $\forall h \in \mathcal{H}$

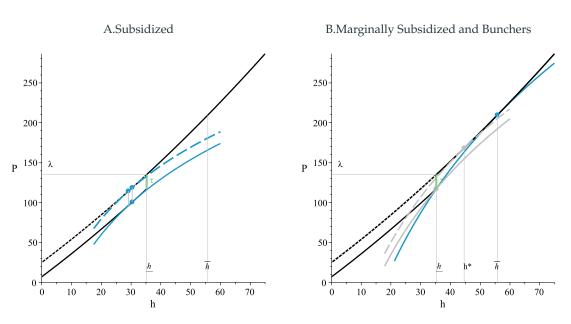


- **Implicit Price Function** P(h)
- Subsidy τ



- **Implicit Price Function** *P*(*h*)
- Subsidy τ
- **Bid functions** $\varphi_D(h, Y, \bar{U}; \theta)$
 - $\bar{U} = U(h, Y_i \varphi_D; \theta)$
 - $\bar{U}_{\tau} = U(h, Y_i \varphi_D + \tau; \theta)$





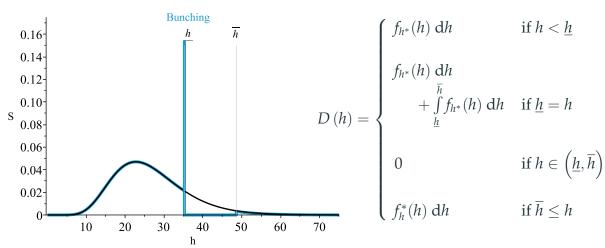
HOUSEHOLDS' DEMAND FUNCTION

$$h^{\mathrm{D}}\left(Y_{i}\right) = \begin{cases} h^{*}\left(Y_{i}, \tau; \theta, \boldsymbol{\rho}, \lambda\right) & \text{if } Y_{i} \leq \underline{Y} \\ \\ \underline{h} & \text{if } \underline{Y} < Y_{i} < \overline{Y} \\ \\ h^{*}\left(Y_{i}, \tau; \theta, \boldsymbol{\rho}, \lambda\right) & \text{if } \overline{Y} \leq Y_{i} \end{cases}$$

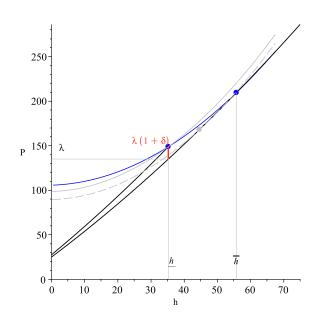
- Tangency conditions: $h^*(Y_i, \tau; \theta, \rho, \lambda)$
- Income and unit size: $Y_i = \tilde{Y}(h, \tau; \theta, \rho, \lambda) = h^{*-1}(h_i, \tau; \theta, \rho, \lambda)$

AGGREGATE DEMAND DENSITY

How to aggregate? \rightarrow Change of variable formula using F_y



DEVELOPERS' CHOICES



- Implicit Price Function P(h)
- Tax incentives $P(h) \cdot (1 + \delta)$
- Offer Functions $\varphi_S(h, A_i, \bar{\pi}; \beta)$

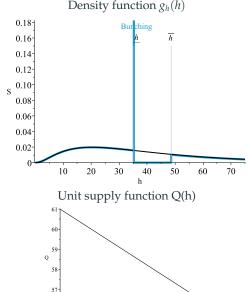
$$\bar{\pi} = \pi \left(h, A_j, P(h); \beta \right)$$
$$\bar{\pi}_{\delta} = \pi \left(h, A_j, P(h) * (1 + \delta) \right); \beta \right)$$

ASSUMPTION:

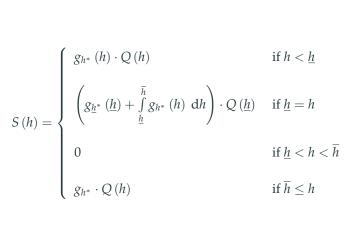
$$Q_j = \alpha_0 + \alpha_1 \cdot h_j$$
 exogenous

DEVELOPERS AGGREGATE SUPPLY DENSITY

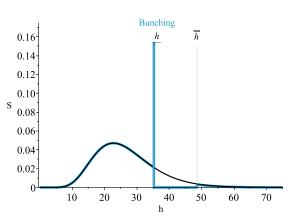


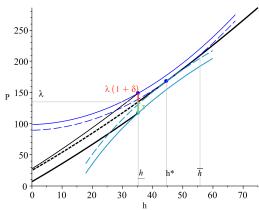


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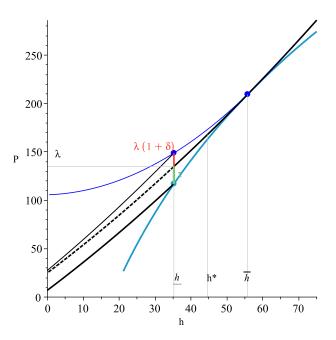
EQUILIBRIUM





IDENTIFICATION

MARGINAL BUNCHER CONDITION



MARGINAL BUNCHER CONDITION

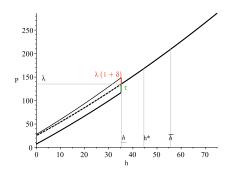
Marginal Buncher Condition		
Household	$V_D = U\left(\overline{Y} - P\left(\overline{h}\right), \overline{h}; \theta\right) - U\left(\overline{Y} - P^{\tau}\left(\underline{h}\right), \underline{h}; \theta\right) = 0$	
Developer	$V_{D} = U\left(\overline{Y} - P\left(\overline{h}\right), \overline{h}; \boldsymbol{\theta}\right) - U\left(\overline{Y} - P^{\tau}(\underline{h}), \underline{h}; \boldsymbol{\theta}\right) = 0$ $V_{S} = \pi\left(Q(\overline{h}), \overline{A}, P\left(\overline{h}\right); \boldsymbol{\beta}\right) - \pi\left(Q(\underline{h}), \overline{A}; P^{\delta}(\underline{h}); \boldsymbol{\beta}\right) = 0$	
Optimality Conditions		
Income	$\overline{Y} = \tilde{Y}\left(\overline{h}; \theta, P(h), \lambda\right)$	
Productivity	$egin{aligned} \overline{Y} &= ilde{Y} \left(\overline{h}; oldsymbol{ heta}, P(h), \lambda ight) \ \overline{A} &= ilde{A} \left(\overline{h}; oldsymbol{eta}, P(h), \lambda ight) \end{aligned}$	
Functional Fori	ns	
Implicit Price	$P = \rho_0 + \rho_1 \cdot h + \rho_2 \cdot h^2$	
Utility	$U = \left[rac{1}{2}\cdot C^{ heta} + rac{1}{2}\cdot h^{ heta} ight]^{rac{1}{ heta}}$	
Unit Supply	$Q = \alpha_0 + \alpha_1 h$	
Cost	$B = A_j \cdot Q \cdot h^{\beta}$	

ESTIMATION

ESTIMATING THE MODEL

STEP I: Equilibrium Characterization

- Using the observed hedonic equilibrium
 - Price function: $\rho_t = \rho_{0t}, \rho_{1t}, \rho_{2t}$
 - Size threshold: $\underline{h} = P^{-1}(\lambda; \rho)$
 - Standard Unit Size: h
- Behavioural Responses:
 - Housing size for marginal buncher: \bar{h}
- Unit Supply Function:
 - $Q = \alpha_0 + \alpha_1 \cdot h_{ltc}$
- Policy Parameters:
 - Notches: τ_t , δ



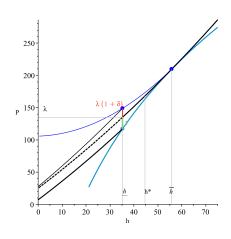
ESTIMATING THE MODEL

STEP I: Equilibrium Characterization

- Observed hedonic equilibrium
 - Price function: $\rho_t = \rho_{0t}, \rho_{1t}, \rho_{2t}$
 - Size threshold: $\underline{h} = P^{-1}(\lambda; \rho)$ Standard Unit Size: h
 - Behavioural Responses:
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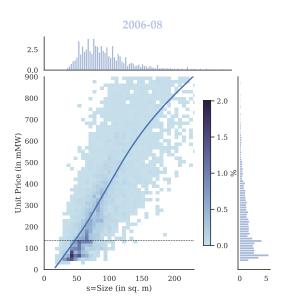
STEP II: Structural Parameters

$$\begin{split} V_{D}\left(\boldsymbol{\theta}|\underline{h},\overline{h},P\left(h\right),\tau,\lambda\right) &= 0\\ V_{S}\left(\boldsymbol{\beta}|\underline{h},\overline{h},P\left(h\right),\boldsymbol{\alpha},\delta,\lambda\right) &= 0 \end{split}$$



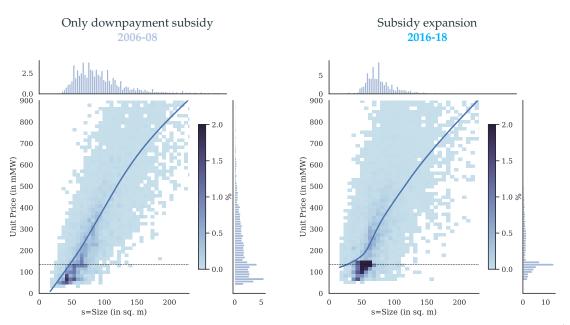
STEP I. EQUILIBRIUM CHARACTERIZATION

OBSERVED EQUILIBRIUM: PRICES, QUANTITIES, AND SIZE



- ► Solid line: price vs size
- \rightarrow hedonic price function
- Multiple characteristics
- ightarrow Reduce to a single characteristic

OBSERVED EQUILIBRIUM: PRICES, QUANTITIES, AND SIZE



HEDONIC PRICES AND STANDARDIZED HOUSING UNIT

► Hedonic price/Implicit price for housing size

$$P_{ltc} = \rho \left(s_{ltc} \right) + \Gamma' X_{ltc} + \omega_{ltc} \tag{1}$$

l, house type in a development, *t* year, *c* city

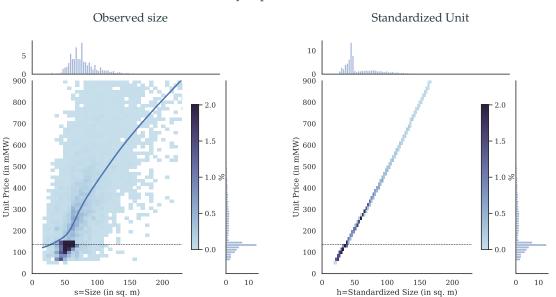
- Simplifying assumption: $\rho\left(s_{ltc}\right) = \rho_1 \cdot s_{ltc} + \rho_2 \cdot s_{ltc}^2$
- Identifying assumption: $E(s_{ltc}|X_{ltc},\omega_{ltc})=0$
- ightharpoonup Standard Unit Size h_{ltc}

$$\rho (h_{ltc}) + \Gamma' \bar{X} + \bar{\omega} = \rho (s_{ltc}) + \Gamma' X_{ltc} + \omega_{ltc}$$
 (2)

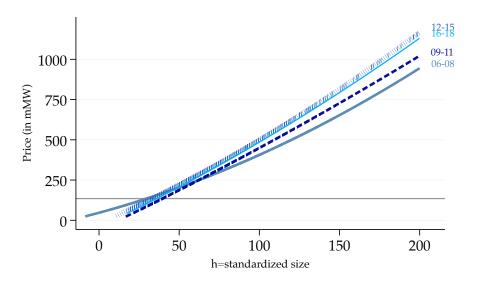
• Characteristics of the standard house: \bar{X} , $\bar{\omega}$

From size s to Standardized Size h

Subsidy expansion 2016-18

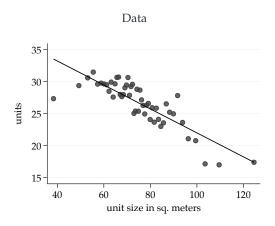


IMPLICIT PRICES FOR HOUSING SIZE OVER TIME



Plotted lines: $P_{ltc} = \hat{\rho}_1 \cdot h_{ltc} + \hat{\rho}_2 \cdot h^2_{ltc} + \Gamma' \bar{X} + \bar{\omega}$

UNIT SUPPLY FUNCTION



$$Q_{ltc} = \alpha_0 + \alpha_1 s_{ltc} + \alpha_x' X_{ltc} + \epsilon_{ltc}^{Q}$$

	06-08	09-11	12-15	16-18
α_0	70.5	12.7	81.1	33.3
α_1	-0.068	-0.020	-0.020	-0.042

NOTCHES

► Demand Notch Overtime

	Notch (in mMW)		# Subsidies (in thousand)			
	$ au^M$	$ au^i$	au	down payment	i rate	Mi Casa Ya
2006-2008	18.0	•	18.0	47.1		•
2009-2011	20.0	5.85	25.9	46.4	16.7	
2012-2015	19.9	9.55	29.5	41.1	22.2	
2016-2018	25.3	7.24	32.6	44.5	23.4	16.8

► Supply Notch: 4 percent

BEHAVIOURAL RESPONSES INDUCED BY THE POLICY

Recovered by comparing observed and counterfactual distribution

Observed
$$f_{h^*} \rightarrow \text{histogram}$$

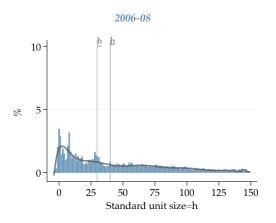
Counterfactual $f_{h_0} \rightarrow$ predicted density excluding observations around the cutoff (Kleven, 2016)

$$h_b = \sum_{p=0}^{T} \hat{\iota}_p h_b^p + \sum_{k=L}^{H} \kappa_k \cdot \mathbb{1} [h_k = h_b] + v_b$$

$$\hat{f}_{h_0} = \sum_{p=0}^T \hat{\iota}_p h_b^p$$

Choice parameters: bin size, bounds for excluded area (L,H) and polynomial degree p

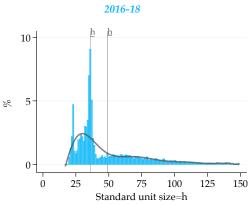
BUNCHING IN HOUSING CHARACTERISTICS (SIZE OF STD. UNIT)



Notch: 19.7 mMW

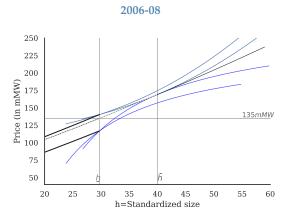
Bunching: 1.53 % market share

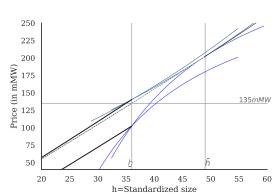
Ah 11.2 m²



Notch: 33.1 mMW Bunching: 14.2 % market share Δh : 13 m²

GRAPHICAL REPRESENTATION OF THE EQUILIBRIUM





2016-18

$$B = A_j \cdot Q \cdot h^{\beta}$$

$$U = \left[\frac{1}{2} \cdot C^{\theta} + \frac{1}{2} \cdot h^{\theta}\right]^{\frac{1}{\theta}}$$
Elasticity of Substitution: $\sigma = \frac{1}{1-\theta}$

Structural Parameters						
	2006-08	2009-11	2012-15	2016-18		
β	2.53	1.67	1.77	1.70		
σ	0.85	0.97	0.90	0.90		

III. POLICY EVALUATION:

COUNTERFACTUAL POLICY I: PROPOSED TAX REFORM.

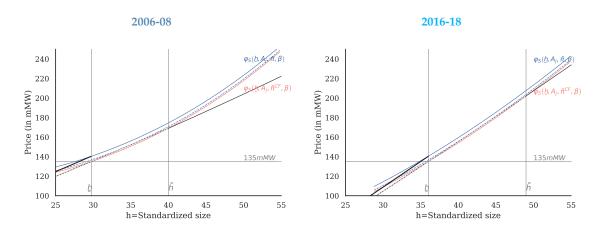
▶ Policy proposal: Remove the tax incentives to developers

▶ Developers reaction:

If these items are repealed, in Valle del Cauca we would go from having an offer of SH and sales of 23,000 homes, average year, to one of sales of 4,600 homes El Tiempo (2021)

Question: What happens to the marginally subsidized developers?

EFFECT ON MARGINALLY SUBSIDIZED DEVELOPERS



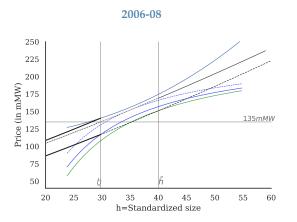
Changes in profits $(\%)$						
2006-08 2009-11 2012-15 2016-18						
$\frac{\pi - \pi^{PC}}{\pi}$	4.9	15.9	9.3	12.3		

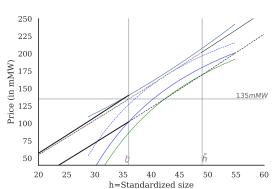
COUNTERFACTUAL POLICY II: REMOVE PRICE CUTOFF

► Same households get subsidy but they can buy any house.

Question: How much better off households are?

EFFECT ON MARGINALLY SUBSIDIZED HOUSEHOLDS





2016-18

Changes in utility (70)						
	2006-08	2009-11	2012-15	2016-18		
$\frac{U^{PC}-U}{U}$	2.9	1.9	2.7	2.7		
$\frac{U-U^0}{U}$	4.7	3.4	4.5	4.5		

Changes in utility (07)

CONCLUSION (I): THE PAPER

- ► Characterization of the equilibrium.
- compelling evidence of the market responding to subsidies.
- ► An hedonic housing market equilibrium with heterogeneous agents can rationalize the response.
- ▶ Propose a identification strategy to recover the model parameters.
- ightharpoonup Model+estimates \rightarrow Welfare.
- ▶ Policy design matters: need to be careful of how agents respond to incentives.

CONCLUSION (II): GENERALIZATION

- ► The method I propose could be used to evaluate housing policy more generally.
- ▶ 2 facts suggest this could be potentially effective.

1. There is increasing evidence to bunching responses to nonlinear incentives (e.g., help to buy, housing programs in the USA)

2. Many other sources of non linear incentives in housing markets.

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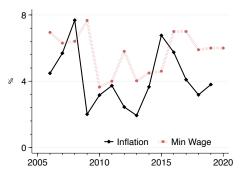
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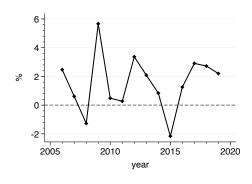
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Appendix

Inflation and minimum wages.



a. Min wage and Inflation



b. Min wage and Inflation

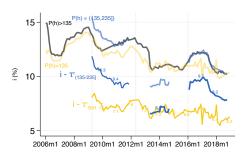
Data

DATA: MORTGAGES AND INTEREST RATES

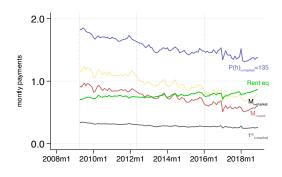
rent equivalent ((?, ?), (Bishop & Timmins, 2019) assume it is 0.05)

- ➤ Size of the mortgages and interest rate.
- ▶ Identifier for SIH.

Market interest rate i and subsidy τ^r



Monthly payments and monthly equivalent for relevant values. P(h) < 135

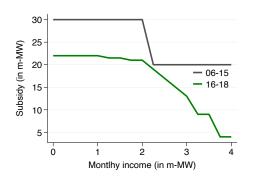


To convert the magnitudes into monthly payments I use:

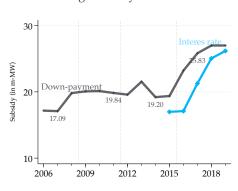
$$X_{monthy} = X \cdot \kappa(i, n) ; \kappa(i, n) = \frac{\frac{i}{12} \cdot \left(1 + \frac{i}{12}\right)^{12 \cdot n}}{\left(1 + \frac{i}{12}\right)^{n \cdot 12} - 1}$$

THE NOTCH: DOWN PAYMENT SUBSIDY

Subsidy by household income

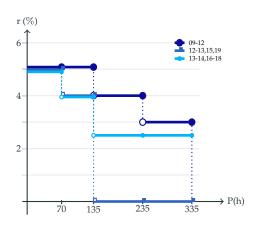


Average subsidy over time

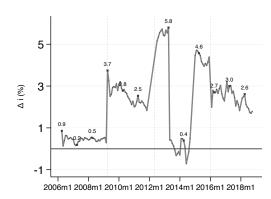


- ► Varies by income.
- ► Increase in 2016.
- Expanded trough *mi casa YA*

THE NOTCH: INTEREST RATE SUBSIDY

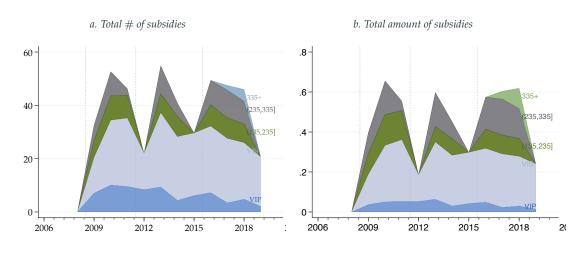


Comparing monthly payments around P(h)=135 m-MW

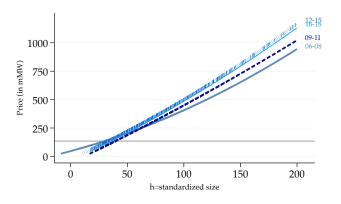


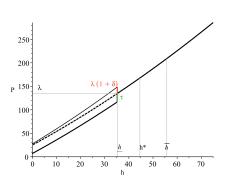
Subsidies and Government Expenditure (VIP-P(h) < 70)

This figure shows interest rate subsidies to all the different price levels



PRICES





back

THE POLICY EFFECT ON OBSERVED OUTCOMES

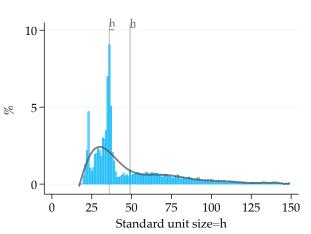
Table 1: Behavioral Responses Estimates'

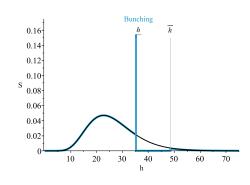
	06-08	09-11	12-15	16-18
$\int_{h_{min}}^{\underline{h}^{-}} T(h) dh$	1.03	0.86	3.83	7.28
$T(\underline{h})$	0.50	2.02	4.02	6.97
$\int_{h_{\underline{m}in}}^{\underline{h}} T(h) \mathrm{d}h$	1.53	2.88	7.85	14.2
$\int_{h}^{\overline{h}} T(h) dh$	-0.096	-6.25	-4.13	-3.42
$h_{h^0}^-$ (\underline{h})	0.72	1.28	1.06	1.44
h_{min}	26	37	29	32
$\frac{h}{h}$	29.8	39.4	33.0	36.0
\overline{h}	40	53	45	49

back

BEHAVIORAL RESPONSES

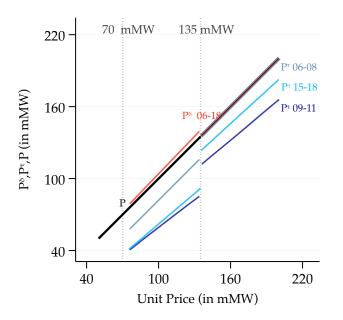






back

THE DEMAND NOTCH INCREASES OVER TIME



Supply Notch δ 2006-18 4%

Demand Notch τ_t

2006-08: 19.7 *mMW* 2009-11: 26.4 *mMW* 2016-18: 33.1 *mMW*

2012-15 Too many changes and free housing at 70mMW

ALTERNATIVE REPRESENTATION OF THE EQUILIBRIUM. DEMAND AND SUPPLY FOR SIZE

