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

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January 30, 2022

Cornerstone

Hello Everyone thanks for being here. I am very excited to present what I have learned about housing subsidies and the housing market in Colombia.

Are Market-Oriented Housing Policies Effective?

- Governments implement various **market-oriented** policies to promote housing construction and home-ownership.
  - Subsidies or tax incentives

Questions:

1. Housing market effect?
   - Prices, quantities, **type of housing**
2. 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 a quasi-experiment 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) $\approx 40,000$ $\$USD$

- 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 → market share at cutoff went from 1% to 7%
- Households downsize → 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 housing and consumption is 0.9

III. Effects of the proposed policy reforms

- 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

- Housing market
- Link to model
- Supply and demand

Hedonic

- Policy notch
- Supply side
- Identification

Housing Policy

- Evidence
- Method
- Welfare

- 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), Greenstone (2017)

- 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)

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 $\leq$ 4 monthly minimum wages (mMW) classify

3. Targeting tool for the subsidy:
   - Only new *low cost* units are eligible

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

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

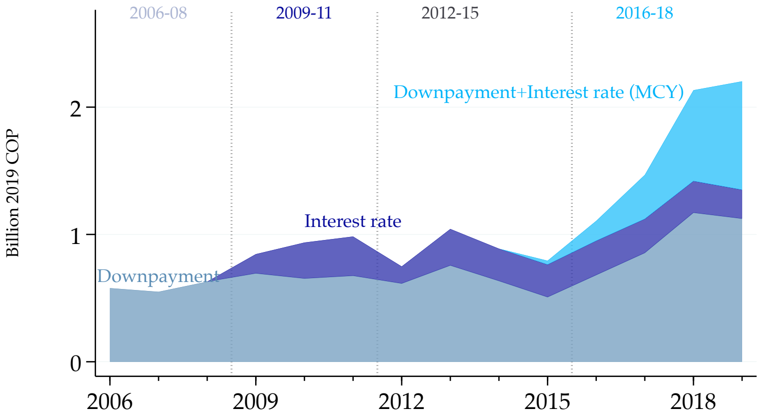
Data

1. Administrative Records from Minister of Housing
   - Subsidy size
   - Mortgage information

   → 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.

Everything measured in monthly minimum wages (*mMW*) or 2019 *COP* Inflation and *mMW* change

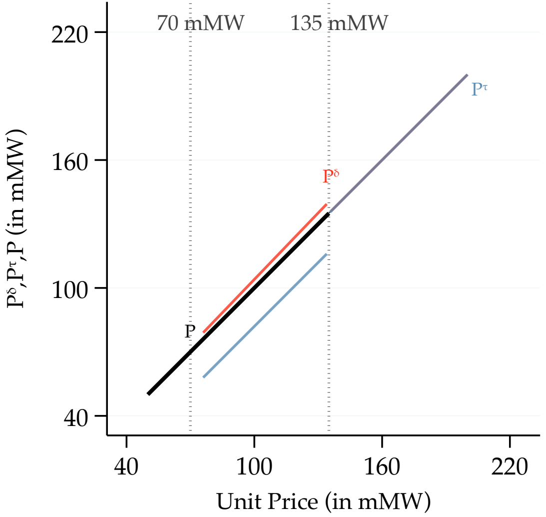
Government Expenditure and Policy Expansion



- Four different periods of expansion.
  - 2006-08: Downpayment only for formal employees
  - 2009-11: + Interest rate subsidy
  - 2012-15: Focus on extremely poor population (Subsidies targeted at 70*mMW*)
  - 2016-18: + *Mi Casa Ya–MCY* (downpayment **and** interest for informal and formal employees.)

Colombian Conditional Cash Transfers 3, 6 billon COP for 2.3 million households vs 2 billion for 100 thousand subsidies.

The Notch



Transaction Price

P

Developers Price

$\mathbf{P}^{\delta} = P \cdot (1 + \delta)$:

$\delta =$Tax refund

Households price

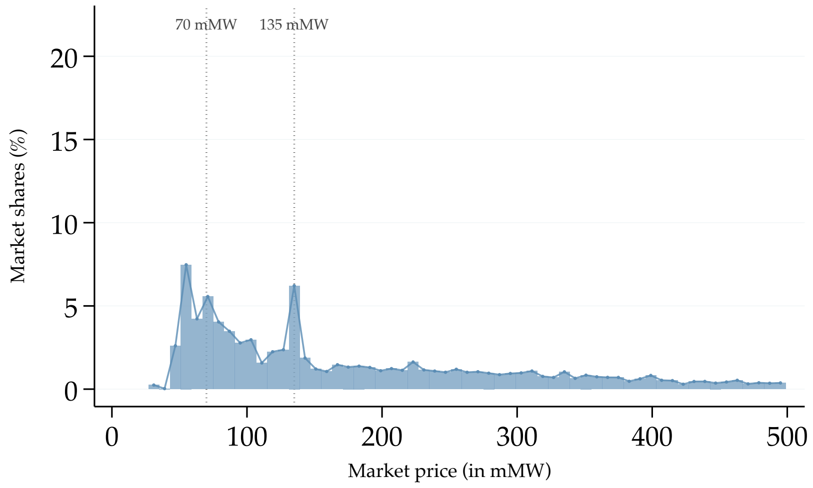
$\mathbf{P}^{\tau} = P - \tau$

$\tau =$Subsidy

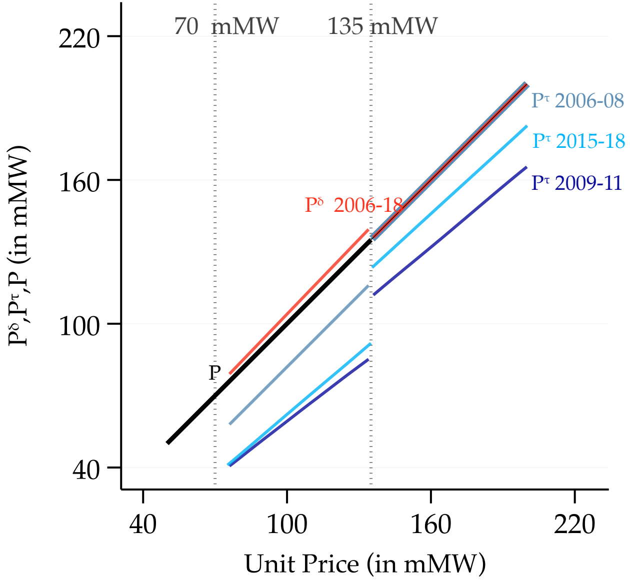
Agents benefit from buying/selling *low cost housing* ($P \leq 135mMW$)

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%

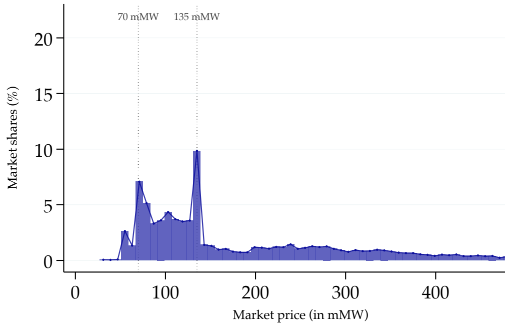
Demand Notch τ_t

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

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

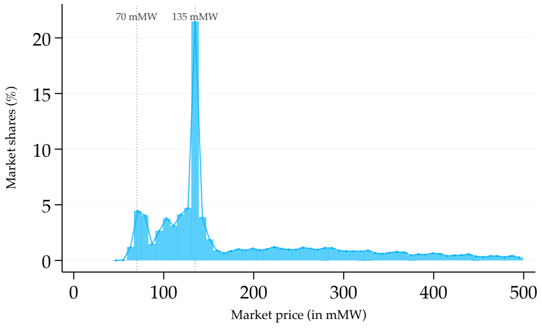
Larger Bunching as Notch Increases

Downpayment and interest rate subsidies
2009-11



Notch: 18 *mMW*

Subsidy expansion
2016-18



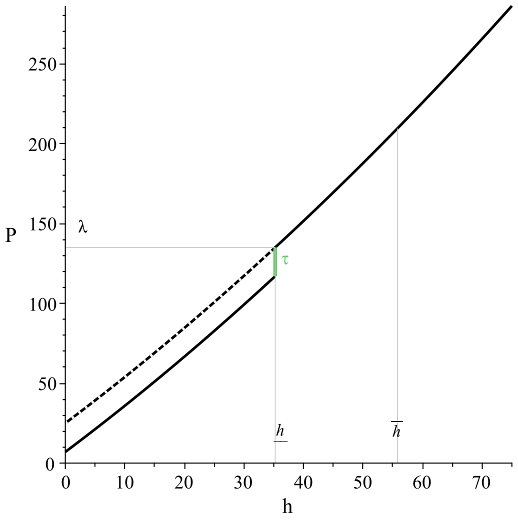
Notch: 33 *mMW*

II. Equilibrium Model of Housing Supply and Demand

Housing Market Equilibrium Model

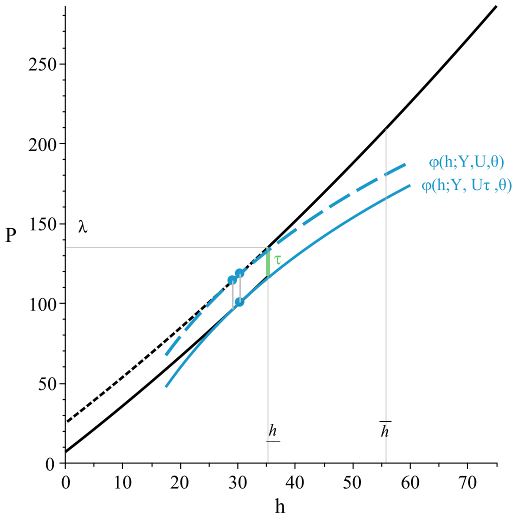
1. **Housing**
   - Differentiated product described by its size $h \in \mathcal{H}$
   - Price depends on size $P(h)$
2. **Households** $i \in I$, Heterogeneous in Income $Y_i \sim F_Y$
   - Choose h_i and consumption C_i to maximize Utility $U(C_i, h_i; \theta)$
3. **Developers** $j \in J$, Heterogeneous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

HOUSEHOLDS' OPTIMAL CHOICES



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

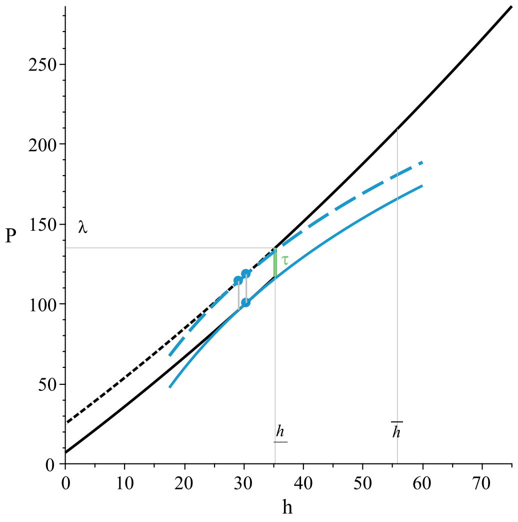
Households' Optimal Choices



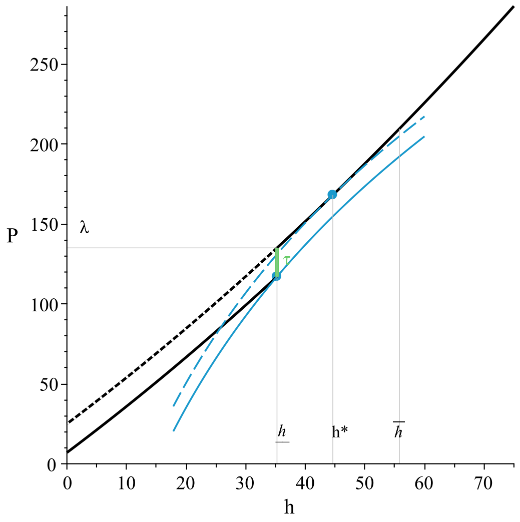
- **Implicit Price Function**
  $P(h)$
- **Subsidy**
  τ
- **Bid functions**
  $\varphi_D\left(h, Y, \bar{U}; \theta\right)$
  - $\bar{U} = U\left(h, Y_i - \varphi_D; \theta\right)$
  - $\bar{U}_\tau = U\left(h, Y_i - \varphi_D + \tau; \theta\right)$

Households' Optimal Choices

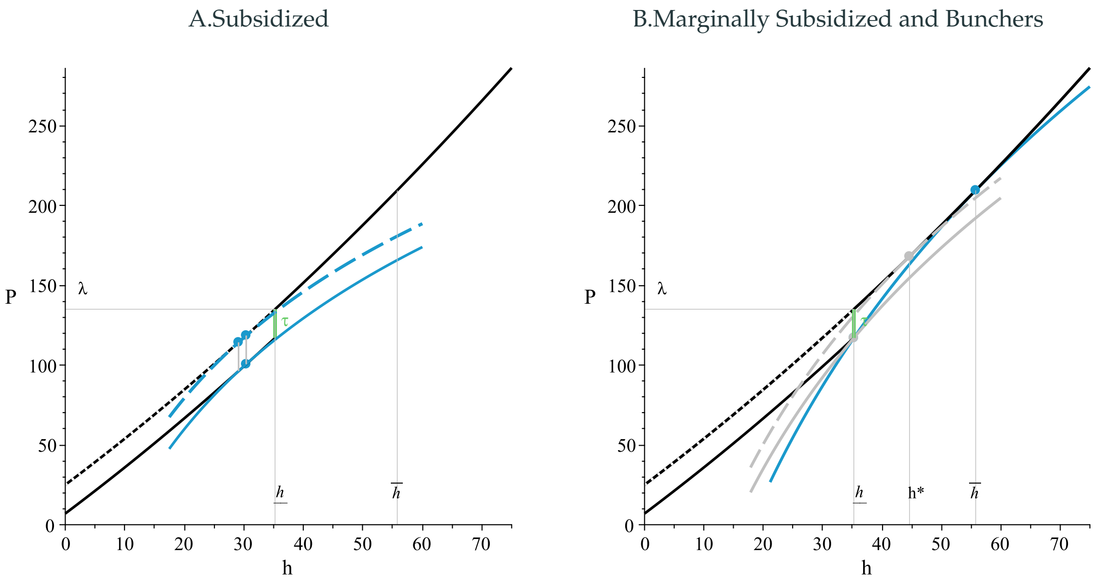
A.Subsidized



B.Marginally Subsidized and Bunchers



HOUSEHOLDS' OPTIMAL CHOICES



Housing demand function

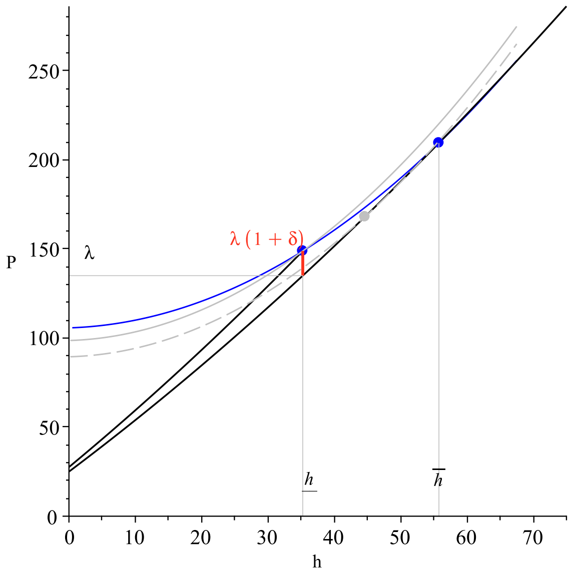
- Price function and subsidy

- x axis y axis

- Preferences: Here the bid functions are all the combinations of size and prices that make individuals get the same utility. Represent all the combinations of prices P and unit size h that provide the same level of utility $\bar{U}$ to a household individual with income Y_i. This is φ_D is such that

- LEts now study what happens to **individuals with different income**.

Developers' Optimal Choices

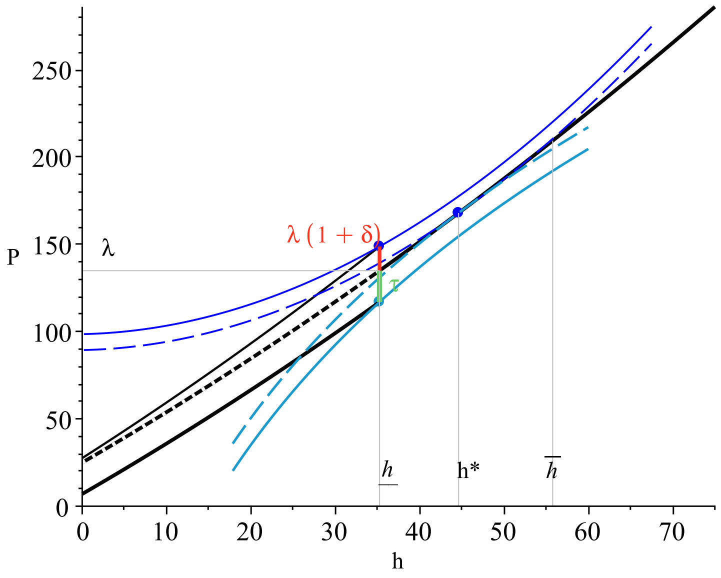


- **Implicit Price Function**
  $P(h)$
- **Tax incentives**
  $P(h) \cdot (1+\delta)$
- **Offer Functions**
  $\varphi_S\left(h, A_j, \bar{\pi}; \beta\right)$

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

- Following the same logic than on the demand side.

Equilibrium: Developers and Households Match

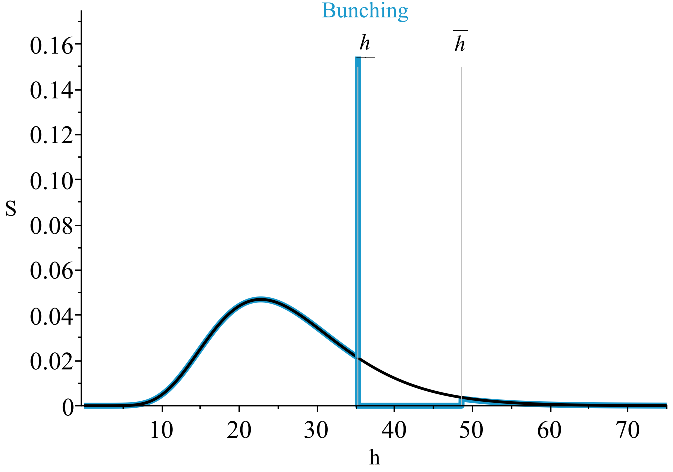


Implicit price: Envelop of offer and bid curves.

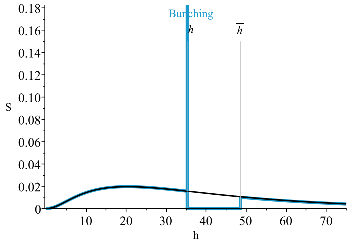
Equilibrium: Aggregate Demand and Supply Density

How to aggregate? $\rightarrow$ Change of variable formula optimal choices (h^*) and the density of households (F_y) and developers (G_y) details

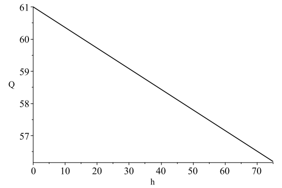
Demand Density Function



Housing types density function $g_h(h)$



Unit supply function Q(h) (exogenous)

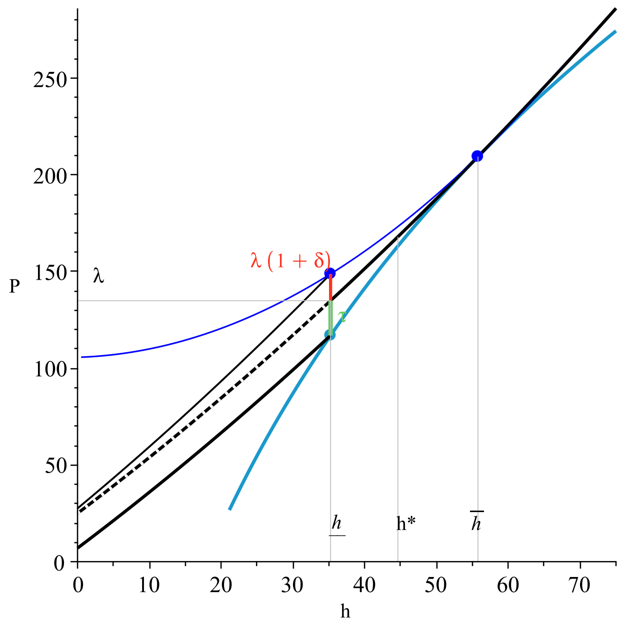


- I use the density of h to get the aggregate demand.

- The aggregate demand is obtain by aggregating all the households that consume a certain unit type

IDENTIFICATION

Marginal Buncher Condition



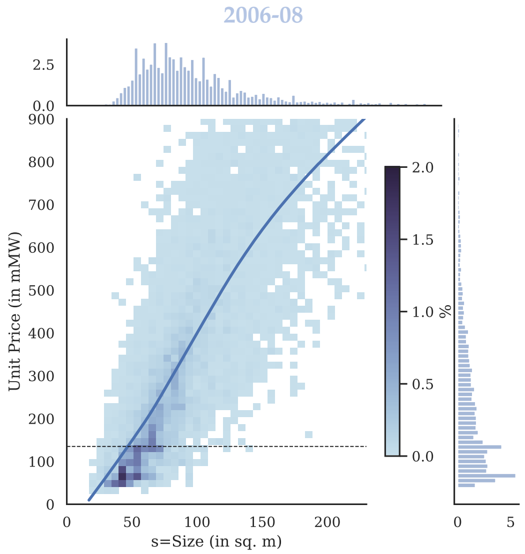
Marginal Buncher Condition

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	$V_S = \pi\left(Q(\overline{h}), \overline{A}, P\left(\overline{h}\right); \boldsymbol{\beta}\right) - \pi\left(Q(\underline{h}), \overline{A}; P^{\delta}\left(\underline{h}\right); \boldsymbol{\beta}\right) = 0$
Optimality Conditions	
Income	$\overline{Y} = \tilde{Y}\left(\overline{h}; \theta, P(h), \lambda\right)$
Productivity	$\overline{A} = \tilde{A}\left(\overline{h}; \boldsymbol{\beta}, P(h), \lambda\right)$
Functional Forms	
Implicit Price	$P = \rho_0 + \rho_1 \cdot h + \rho_2 \cdot h^2$
Utility	$U = \left[\frac{1}{2} \cdot C^{\theta} + \frac{1}{2} \cdot h^{\theta}\right]^{\frac{1}{\theta}}$
Unit Supply	$Q = \alpha_0 + \alpha_1 h$
Cost	$B = A_j \cdot Q \cdot h^{\boldsymbol{\beta}}$

Estimation

Step I. Equilibrium Characterization

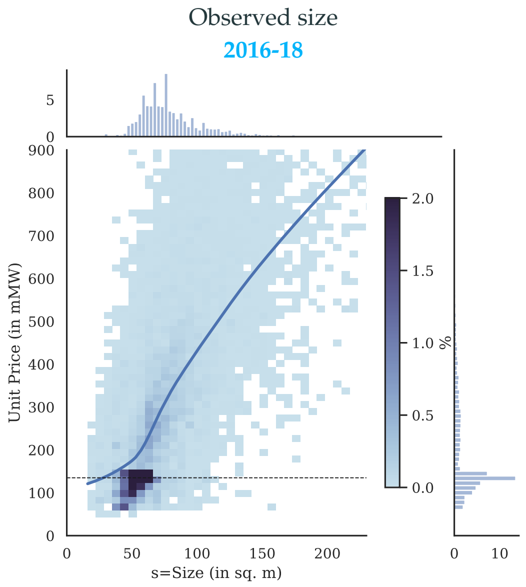
Observed Equilibrium: Prices, Quantities, and Size

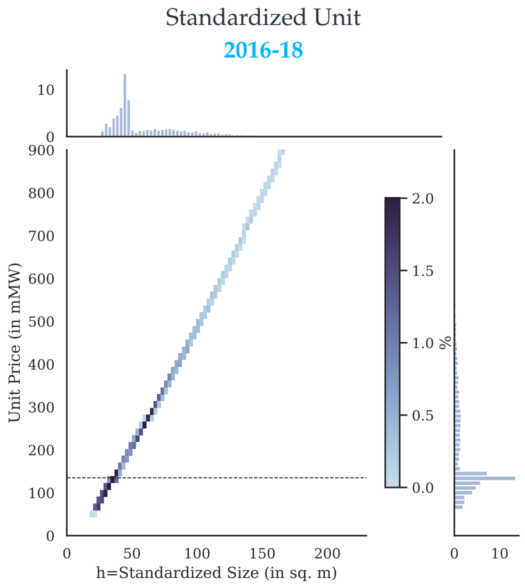


- Solid line: price vs size
  → hedonic price function

- Multiple characteristics
  → Reduce to a single characteristic

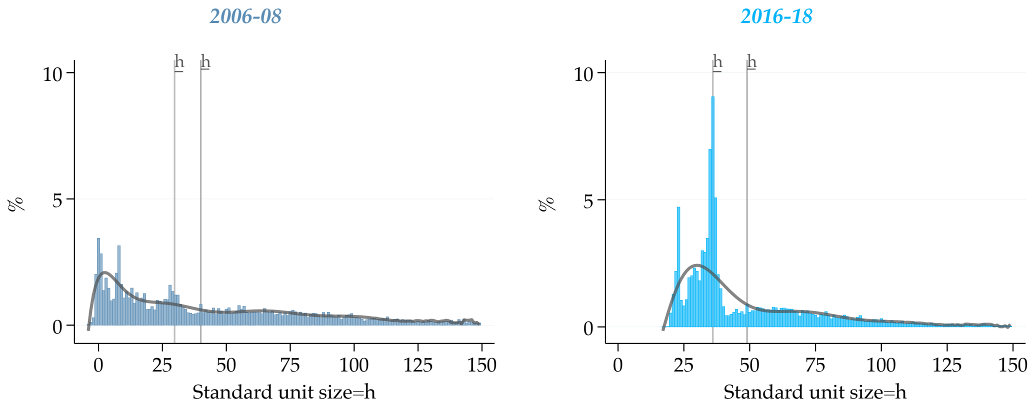
OBSERVED EQUILIBRIUM: PRICES, QUANTITIES, AND SIZE





details

Bunching in Housing Characteristics (Size of std. Unit)

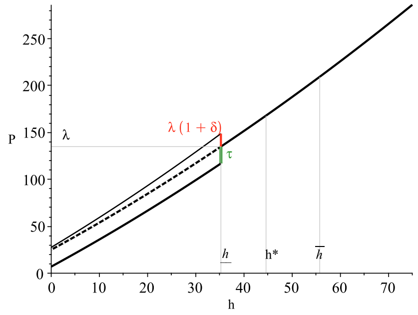


	2006-08	2016-18
Notch:	19.7 *mMW*	33.1 *mMW*
Bunching:	1.53 % *market share*	14.2 % *market share*
Δh	11.2 m^2	13 m^2

Estimation details

STEP I: EQUILIBRIUM CHARACTERIZATION

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



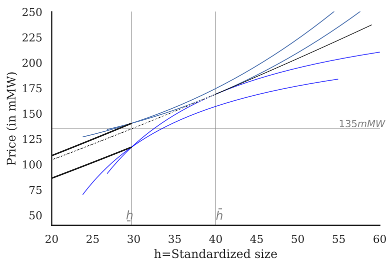
STEP II: STRUCTURAL PARAMETERS

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

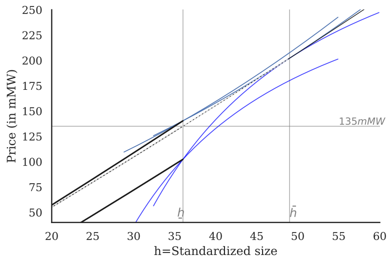
- Identification equation:
- $V_D\left(\theta | \underline{h}, \bar{h}, P(h), \tau, , \lambda\right) = 0$
- $V_S\left(\beta | \underline{h}, \bar{h}, P(h), \boldsymbol{\alpha}, \delta, \lambda\right) = 0$

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

2006-08



2016-18



III. Policy Evaluation:

Counterfactual Policy I: Proposed tax reform

- Policy proposal: Remove the tax incentives to developers

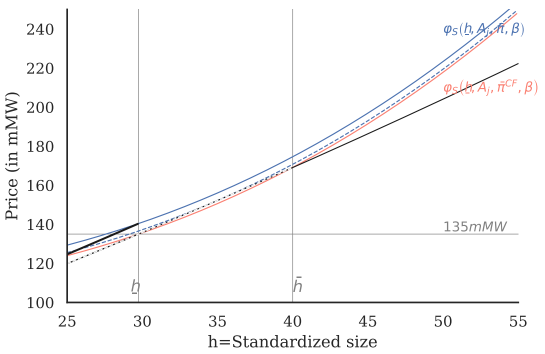
- Developers reaction:

  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)

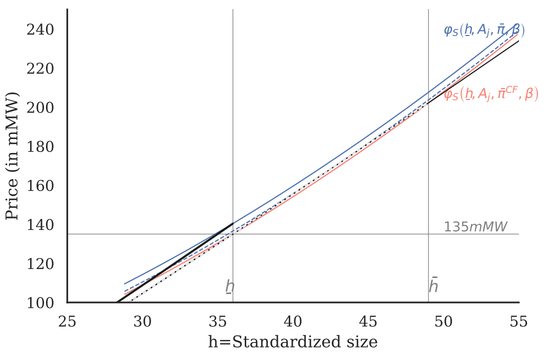
- Question: What happens to the marginally subsidized developers?

Effect on Marginally Subsidized Developers

2006-08



2016-18



Changes in profits (%)

	2006-08	2009-11	2012-15	2016-18
$\frac{\pi - \pi^{PC}}{\pi}$	4.9	15.9	9.3	12.3

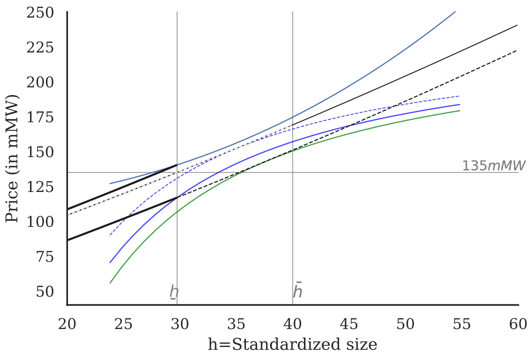
Counterfactual Policy II: Remove Price Cutoff

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

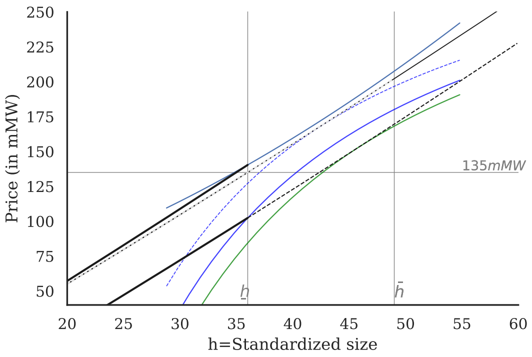
- Question: How much better off households are?

Effect on Marginally Subsidized Households

2006-08



2016-18



Changes in utility (%)

	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

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.
- 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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Appendix

Behavioural Responses Induced by the Policy

- Recovered by comparing observed and counterfactual distribution

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

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

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

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

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

Figures

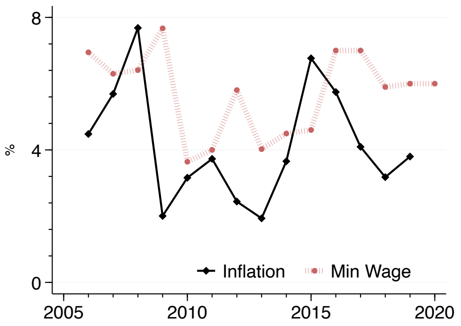
EQUILIBRIUM: DEVELOPERS AGGREGATE SUPPLY DENSITY

$$D\left(h\right)=\begin{cases} f_{h^*}\left(h\right)\,\mathrm{d}h & \text{if } h<\underline{h} \\ f_{h^*}\left(h\right)\,\mathrm{d}h \\ \qquad +\int_{\underline{h}}^{\overline{h}} f_{h^*}\left(h\right)\,\mathrm{d}h & \text{if } \underline{h}=h \\ 0 & \text{if } h\in\left(\underline{h},\overline{h}\right) \\ f_h^*\left(h\right)\,\mathrm{d}h & \text{if } \overline{h}\leq h \end{cases}
\qquad
S\left(h\right)=\begin{cases} g_{h^*}\left(h\right)\cdot Q\left(h\right) & \text{if } h<\underline{h} \\ \left(g_{\underline{h}^*}\left(\underline{h}\right)+\int_{\underline{h}}^{\overline{h}} g_{h^*}\left(h\right)\ \mathrm{d}h\right)\cdot Q\left(\underline{h}\right) & \text{if } \underline{h}=h \\ 0 & \text{if } \underline{h}<h<\overline{h} \\ g_{h^*}\cdot Q\left(h\right) & \text{if } \overline{h}\leq h \end{cases}$$

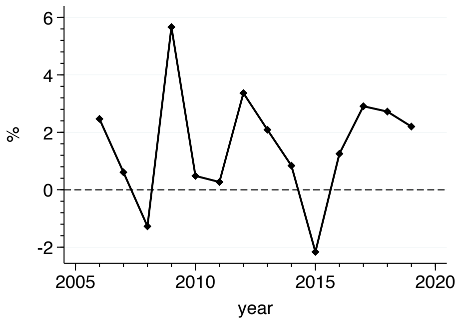
Equilibrium Figures

- Derived using the same logic as the demand side

Inflation and minimum wages.



a. Min wage and Inflation

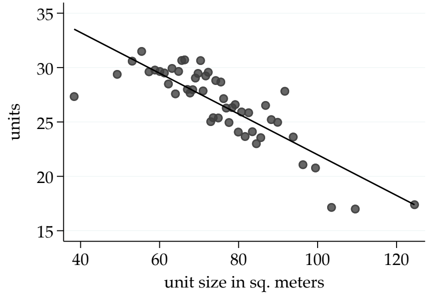


b. Min wage and Inflation

Data

Developers Choices of Size and Unit Supply

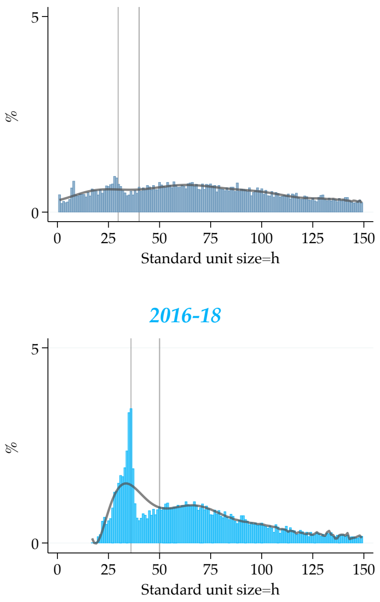
All data



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

	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

Product type density (g_h)



Notches

- Demand Notch Overtime

	Notch *(in mMW)*			# Subsidies *(in thousand)*		
	τ^M	τ^i	τ	*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

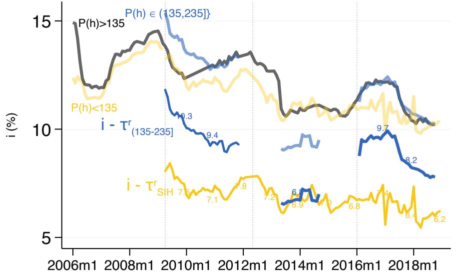
Step I

DATA: MORTGAGES AND INTEREST RATES

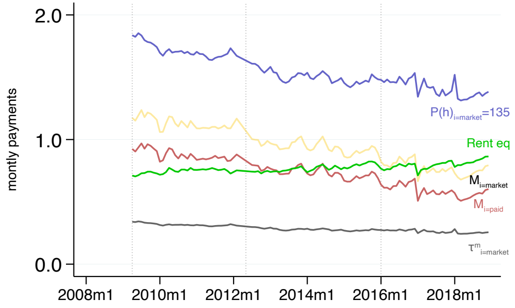
rent equivalent ((?, ?), (Bishop & Timmins, 2019) assume it is 0.05)

- 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:

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

Households' Demand Function

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

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

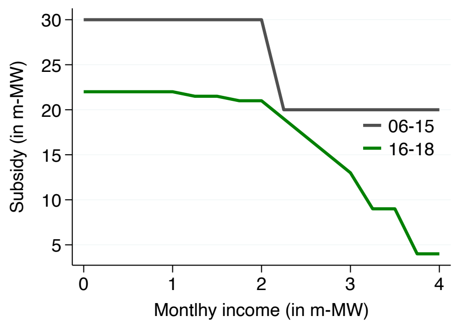
Graphs

- Income has a one-to-one relationship between housing and income
- households demand for housing: math so what I just said is that the housing demand depends on the income.

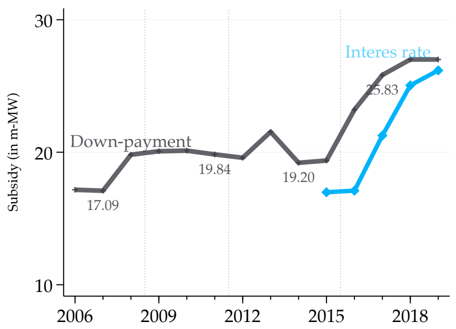
  The income distribution and optimal choices I get the density of housing that satisfy the optimality conditions.

The Notch: Down Payment Subsidy

Subsidy by household income

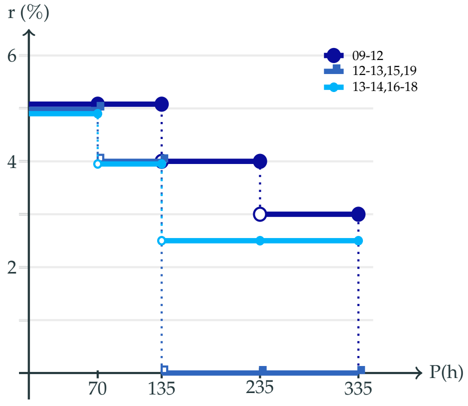


Average subsidy over time

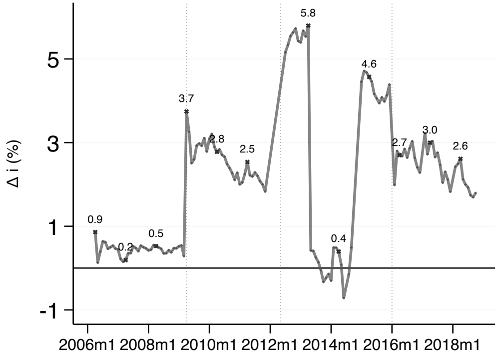


- Varies by income.
- Increase in 2016.
- Expanded trough *mi casa YA*

The Notch: Interest Rate Subsidy

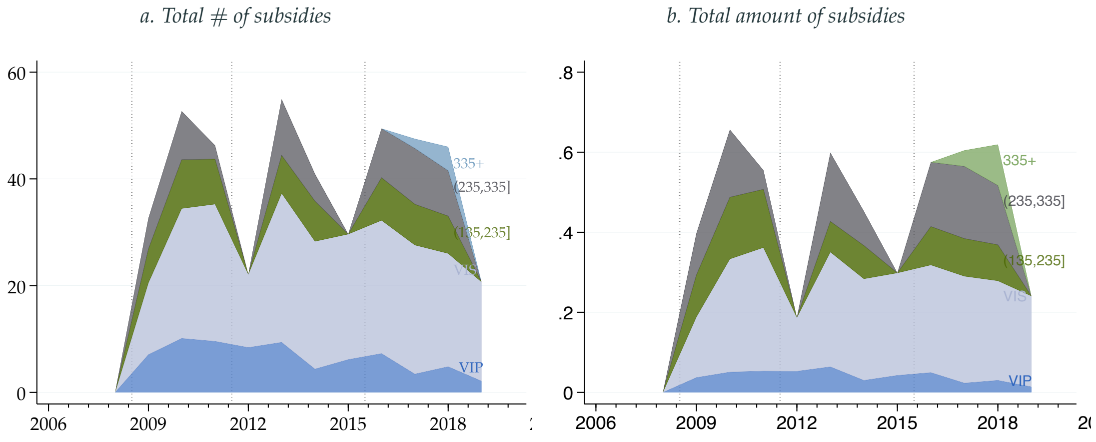


Comparing monthly payments around P(h)=135 m-MW



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

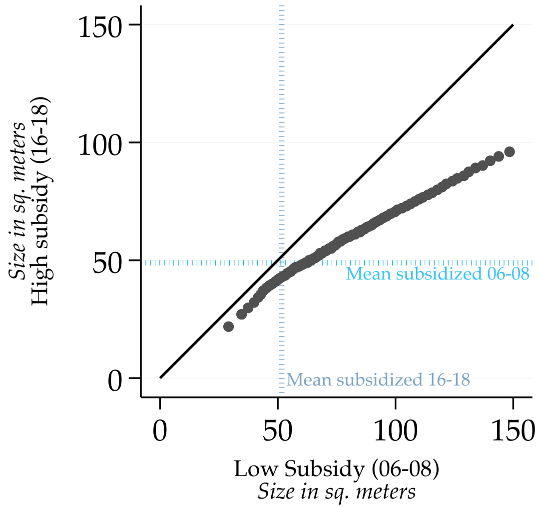
This figure shows the interest rate subsidies for all different price levels



Changes in Housing Stock Characteristics

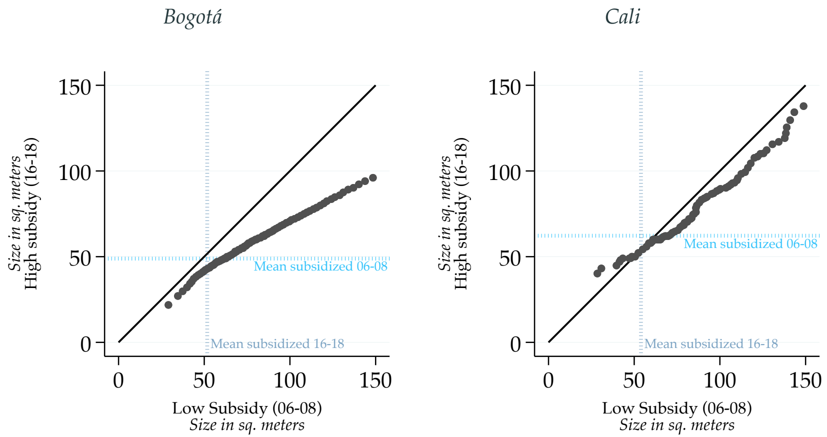
- Changes in unit size (quantile to quantile plot)

Bogotá



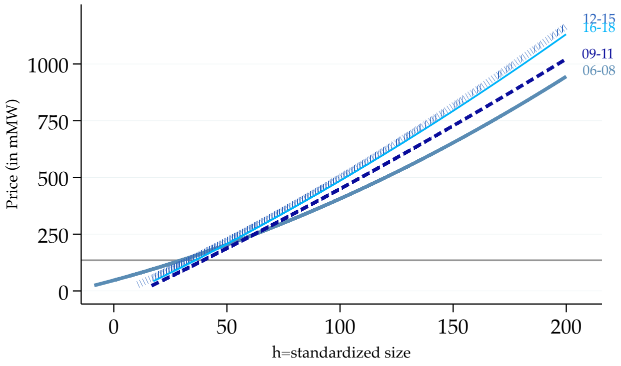
Changes in Housing Stock Characteristics

- Changes in unit size

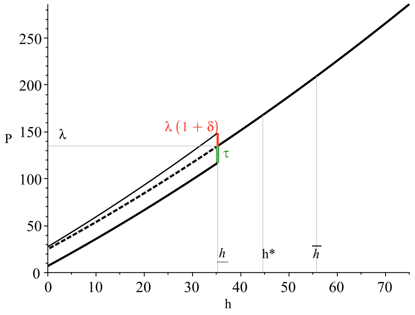


- Why size?
  - Continuous, easy to measure, monotonic relationship with price and income.
  - In contrast to most datasets, I observe it.

Prices



12-15
16-18
09-11
06-08
1000
750
500
250
0
Price (in mMW)
0
50
100
150
200
h=standardized size



250
200
150
100
50
0
P
λ
λ (1 + δ)
τ
h
h*
h̄
0
10
20
30
40
50
60
70
h

back

The Policy Effect on Observed Outcomes

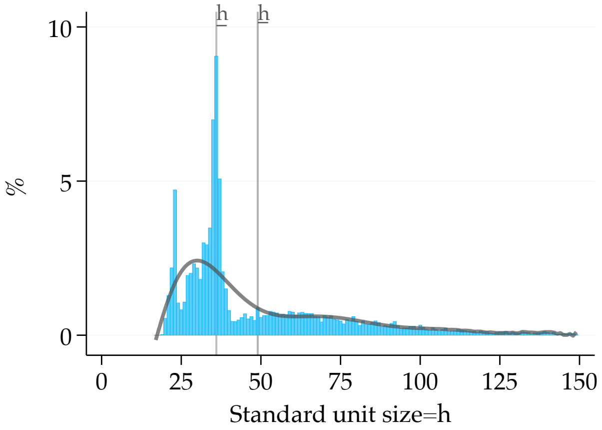
Table 1: Behavioral Responses Estimates'

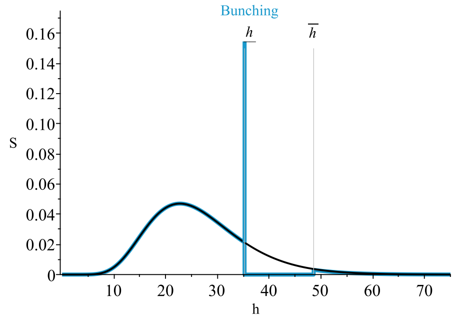
	06-08	09-11	12-15	16-18
$\int_{h_{min}}^{\underline{h}^-} T(h)\mathrm{d}h$	1.03	0.86	3.80	7.28
$\hat{T}(\underline{h})$	0.50	2.02	4.01	6.97
$\int_{h_{min}}^{\underline{h}} T(h)\mathrm{d}h$	1.54	2.88	7.81	14.2
$\int_{\underline{h}}^{\bar{h}} T(h)\mathrm{d}h$	-0.12	-6.23	-4.27	-3.38
$h_{h^0}(\underline{h})$	0.73	1.28	1.07	1.43
h_{min}	26	37	29	32
$\underline{h}$	29.8	39.4	33.0	36.0
$\bar{h}$	40	53	45	49

back

Behavioral responses

2016-18





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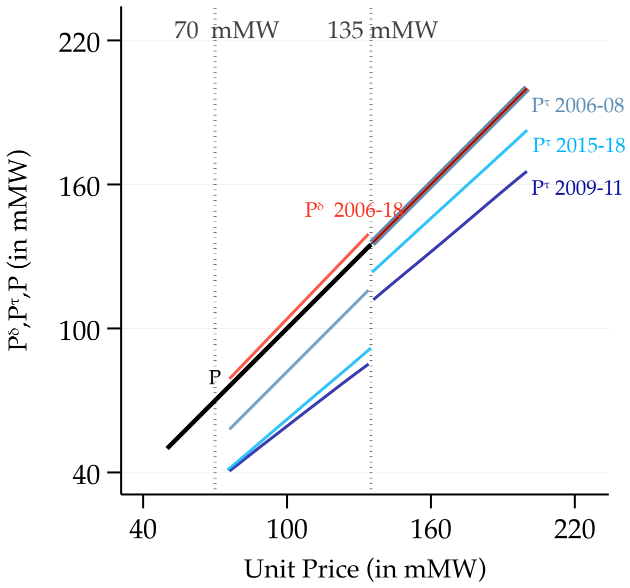
The Demand Notch Increases Over Time



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 70*mMW*

Alternative Representation of the Equilibrium. Demand and Supply for Size