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

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Research Questions

- Different type of policies are implemented to deal with the lack of housing.
  1) Public housing
  2) Market oriented approaches

  → Subsidies or tax incentives to promote new housing construction and home-ownership.

- What is the market response?
  - Prices
  - Quantities
  - **Type of housing that is build**
- Is this market-oriented approach effective?
  - Are there efficiency costs?
  - What are the unintended consequences?
  - Who benefits the most? Households or developers?

This paper

- I study the Colombian **market-oriented** approach.
  - Subsidies to low-income households.
  - Tax incentives to developers who build low-cost housing.
  - A price cap defining eligibility.
- Empirical advantages of Colombian setting:
  - Price cap on units qualifying for the subsidy.
    - Discontinuous Budget Constraint.
    - Incentives to developers and households to bunch.
  - Unique and novel data:
    - Census data for all new construction projects.
    - Administrative records for the subsidies.
  - Subsidy expansion
- I use this discontinuity and the changes over time to evaluate the housing market response to subsidies.

Preview

I. Descriptive evidence

- Characterization of observed equilibrium.
- Evidence of housing market responding to the subsidy scheme.

II. Economic model of housing equilibrium

- The model rationalizes the bunching response.
- Motivates the identification strategy to recover the model parameters.

III. Welfare Analysis

- Would removing the tax incentives create a rationing problem?
- What is the effect on households if we remove the cutoff?

Results

I. Behavioural responses induced by the subsidy scheme.
   - Bunching at price cutoff
   - Larger response as the subsidies increase
     - Bunching: 1 % $\rightarrow$ 7%
   - Households reduce consumption in up to 30% percent to benefit from the subsidy

II. The mix of policy tools and economic model allow me to recover the parameters of the model
   - Elasticity of substitution between consumption on housing and consumption on other goods 0.9
   - Parameter describing the cost function changed from 2.5 to 1.7

III. Welfare Analysis
   - Removing the tax incentives to developers could create a shortage problem.
   - Welfare gains if we remove the cutoff.

Literature and Contribution

Integrates the *old* hedonic literature and bunching literature to propose a method to think about welfare consequences of housing policy

Bunching	Hedonic	Housing Policy
▶ Housing Markets	▶ Policy Notch	▶ Evidence
▶ Supply,Demand	▶ Supply side	▶ Method
▶ Identification of SP	▶ Identification	▶ Welfare

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)
- Reviews
  Kuminoff et al. (2013),Greenstone (2017)
- Recent Contributions
  Bajari and Benkard (2005),Bishop and Timmins (2019),Heckman et al. (2010),Epple et al. (2020),Chernozhukov et al.

- 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

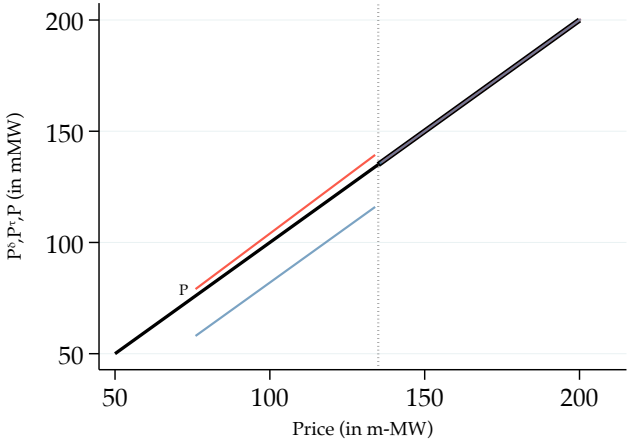
1. Demand Subsidies
   - Cash transfer for the downpayment
   - Subsidized interest rate
2. Supply Subsidies
   - Value Added Tax (VAT) tax refund
3. Targeting tool

$$\text{Low cost housing} = \begin{cases} 1 & \text{if } P_t \leq \lambda_t \\ 0 & \text{if } \lambda_t < P_t \end{cases}$$

   - Only *low cost housing* is eligible for the subsidies.
   - Price cap, λ_t, defining subsidy's eligibility

$\lambda_t =$ **135** monthly minimum wages (mMW) $\approx 40,000\$USD$

The Notch



Transaction Price

$\mathbf{P}$

Developers Price

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

δ =Tax refund

Households price

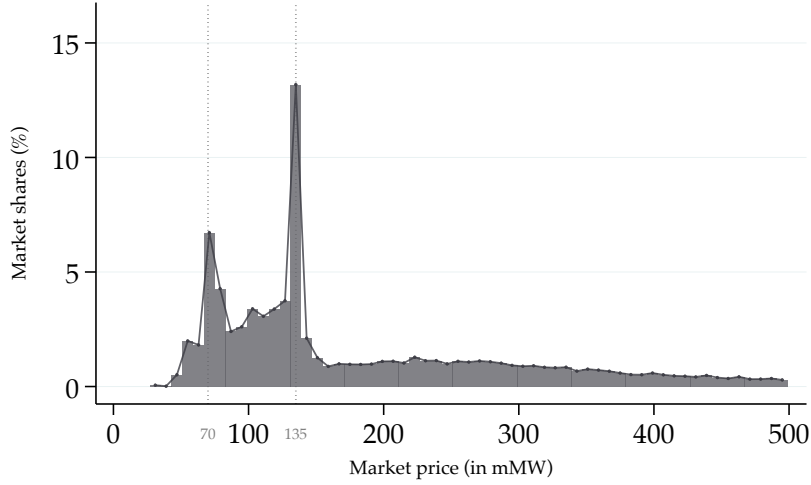
$\mathbf{P}^{\tau} = P - \tau$

τ =Subsidy

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

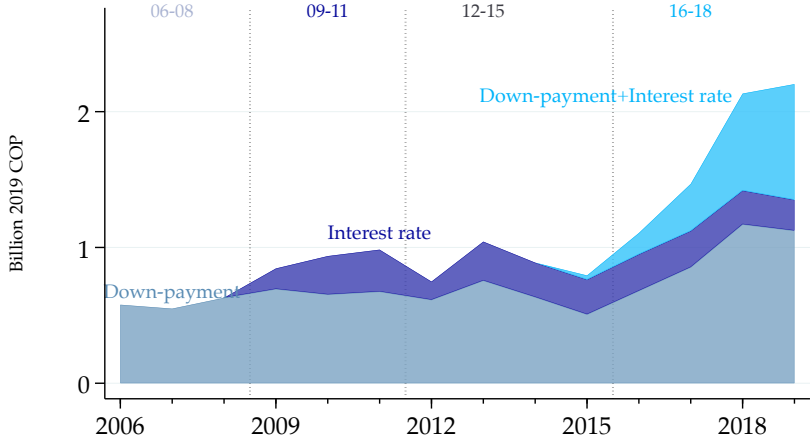
- Data: Administrative Records from Minister of Housing
- Notch: Mean government expenditure

Bunching around the Low-Cost Housing Price Limit



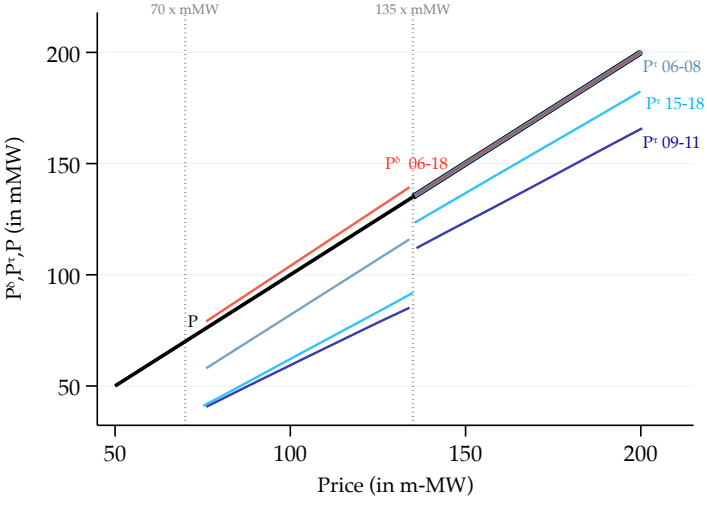
Data:Census of new construction in Colombia 2006-2018

Government Expenditure Doubled Between 06-18



- 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 Demand Notch Increases Over Time



Supply Notch δ

06-18 4%

Demand Notch τ_t

06-08: 19.7

09-11: 26.4

16-18: 33.1

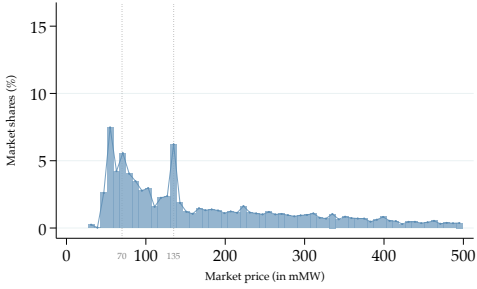
units: mMW

12-15: Omitted

Too many changes and free housing at $70mMW$

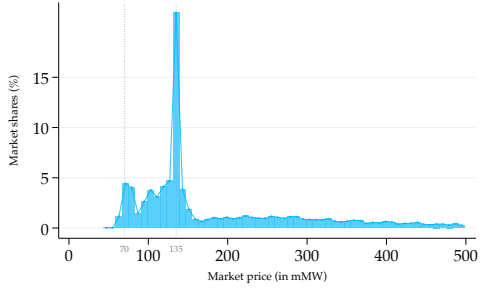
A Bigger Notch Leads to a More Pronounced Response

2006-08



Notch: 19.7

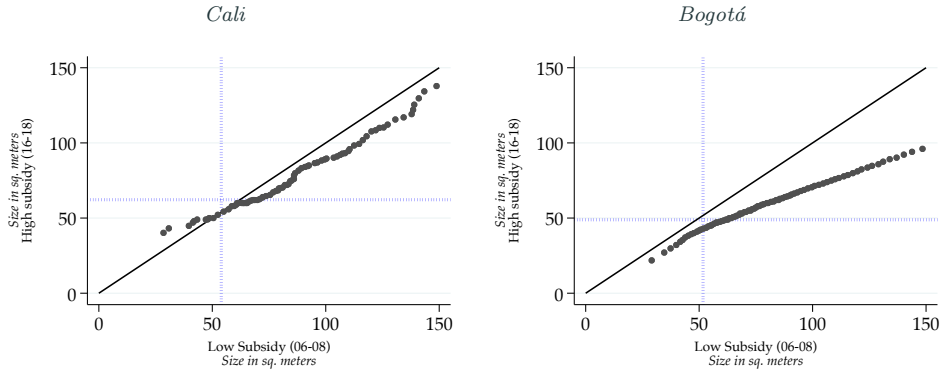
2016-18



Notch: 33.1

Market Adjustment

1. Changes in unit characteristics
   - changes in size



   - Competitive market
   - No incentives to build bigger units when for the same price households would buy smaller units.

2. Prices change without changes in characteristics (Alternative explanation)

Observed Equilibrium: Prices, Quantities, and Size

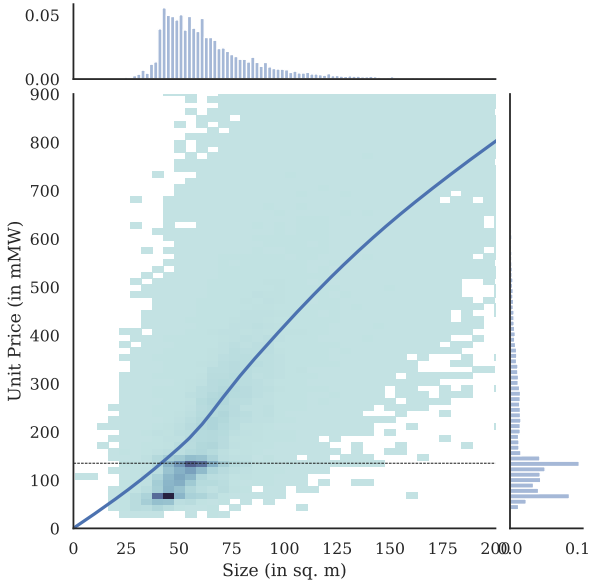
Data

- All Cities: 126 Municipalities
- All Years: 2006-2018
- Unit Characteristics:
  size,location, # rooms, # bathrooms, etc.

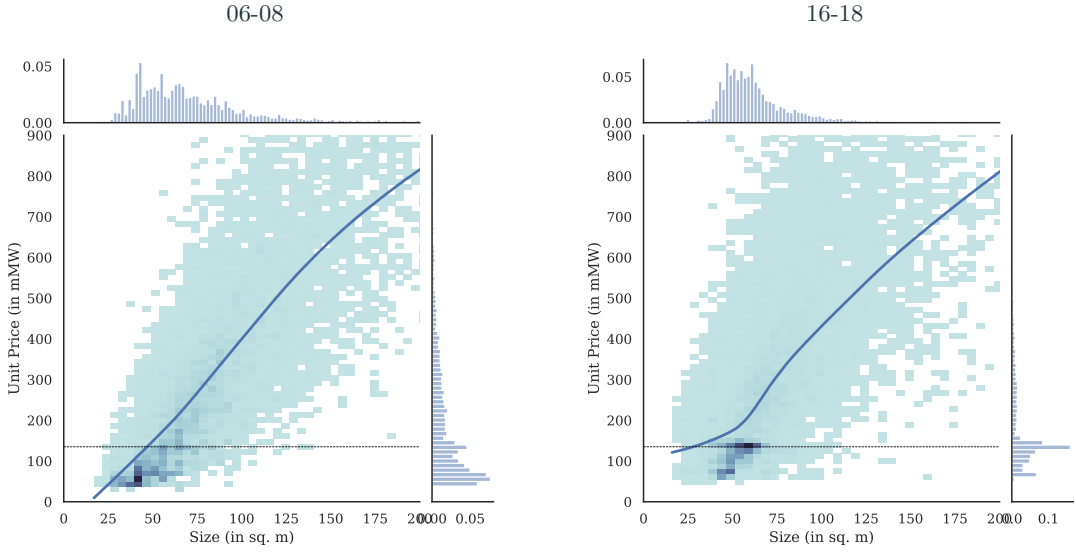
Source: New Construction Census (Camacol)

The housing market responds
→ Bunching

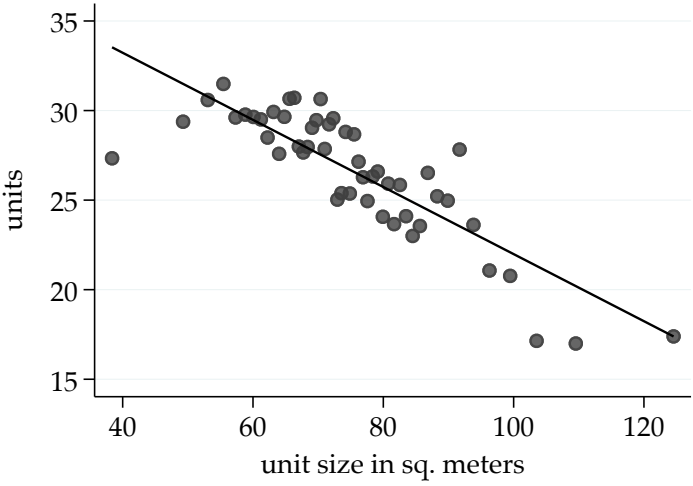
Note: Bunching at $70mMW$ free housing (12-15)



1. Observed Equilibrium: Prices, Quantities, and Size Over Time



Quantities by size



Hedonic Prices and Standardized Housing Unit

- Hedonic price/Implicit price for housing size

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

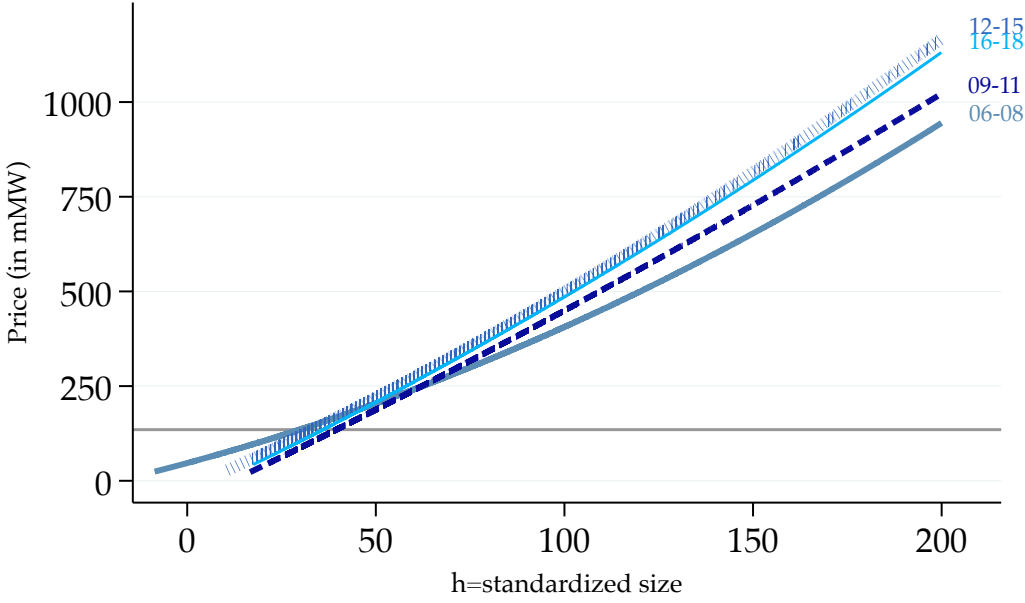
- Standard Unit Size h_{ltc}

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

$$h_{ltc} = \rho^{-1}\Big(\rho\left(s_{ltc}\right) + \Gamma'\left(X_{ltc} - \bar{X}_{ltc}\right) + \left(\omega_{ltc} - \bar{\omega}_{ltc}\right)\Big) \tag{3}$$

  - Characteristics of the standard house: $\bar{X}_{ltc}$, $\bar{\omega}_{ltc}$
  - Simplifying assumption: $\rho\left(s_{ltc}\right) = \rho_1 \cdot s_{ltc} + \rho_2 \cdot {s^2}_{ltc}$
  - Identifying assumption: $\mathrm{E}\left(s_{ltc} | X_{ltc}, \omega_{ltc}\right) = 0$
- Why size?
  - In contrast to most datasets, I observe it.
  - Continuous variable and easy to measure.
  - Monotonic relationship.

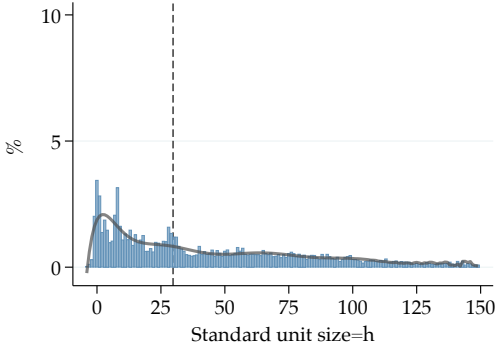
Implicit Prices for Housing Size Overtime



Larger Bunching as Notch Increases

Downpayment Assistance

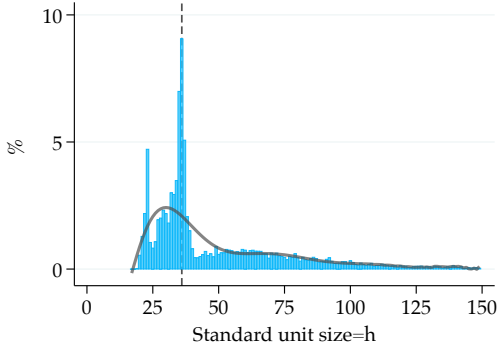
2006-08



Notch: 18.0 mMW

Expansion–Mi Casa Ya

2016-18



Notch: 32.5 mMW

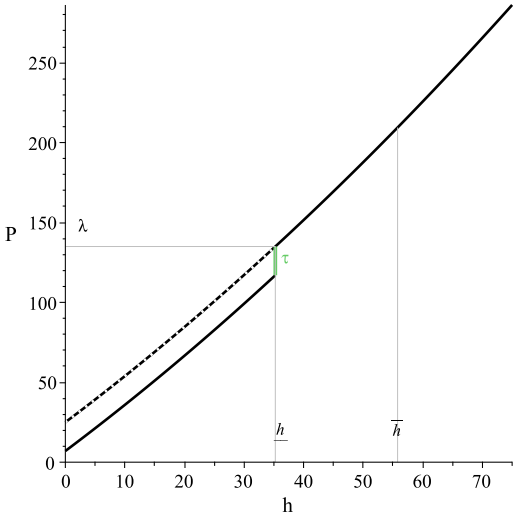
II. Economic Framework

A Stylized Housing Market Model

1. **Housing**
   - Differentiated product
   - Described by its size $h \in \mathcal{H}$
   - Price $P(h)$
2. **Households** $i \in N$
   - Heterogeneous in Income $Y_i \sim F_Y$
   - Pick h_i and consumption C_i to optimize Utility $U(C_i, h_i; \theta)$
3. **Developers** $j \in J$
   - Heterogeneous in Productivity $A_j \sim G_A$
   - Pick h_j to maximize profits
   - An exogenous function determines the number of units $Q_j(h_j; \boldsymbol{\alpha})$
   - Building costs $B(h_j, Q(h_j); \beta)$
4. **Equilibrium**
   - Competitive Market
   - Price function $P^*(h) \rightarrow$ clears the market

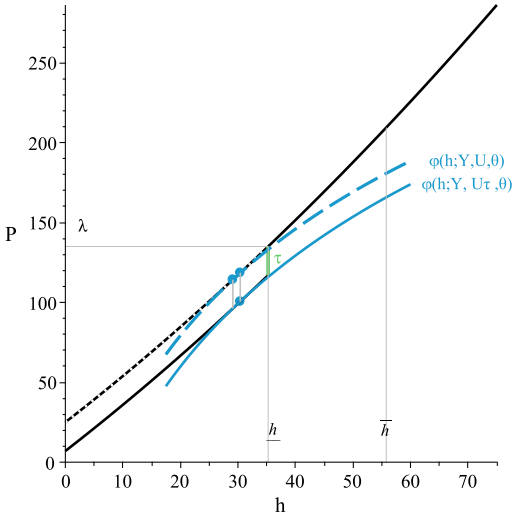
   i.e. Supply = Demand $\forall h \in H$

Households' Optimal Choices



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

Households' Optimal Choices

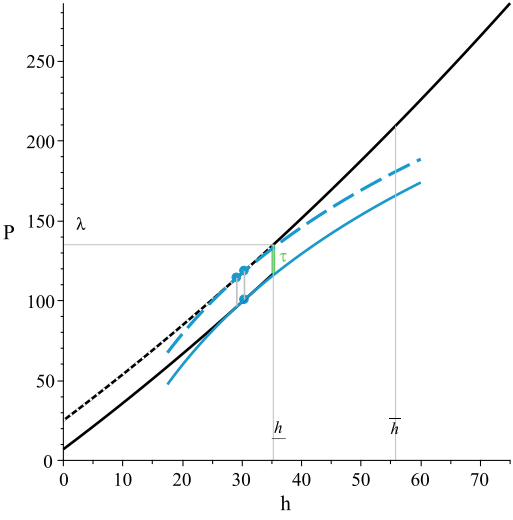


- **Implicit Price Function**: $P(h)$
- **Subsidy** τ
- **Bid functions** $\varphi_D\left(h, Y, \bar{U}; \theta\right)$

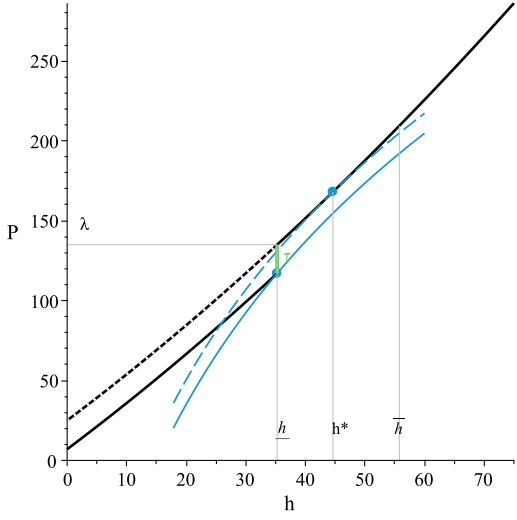
$$\bar{U} = U\left(h, Y_i - \varphi_D; \theta\right)$$
$$\bar{U}_\tau = U\left(h, Y_i - \varphi_D + \tau; \theta\right)$$

Households' Optimal Choices

A.Subsidized

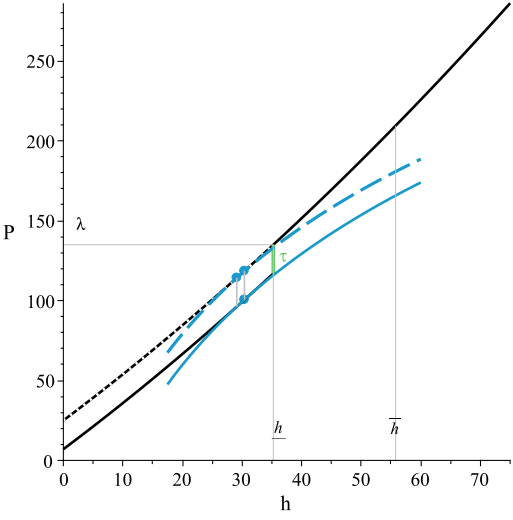


B.Marginally Subsidized and Bunchers



Households' Optimal Choices

A.Subsidized



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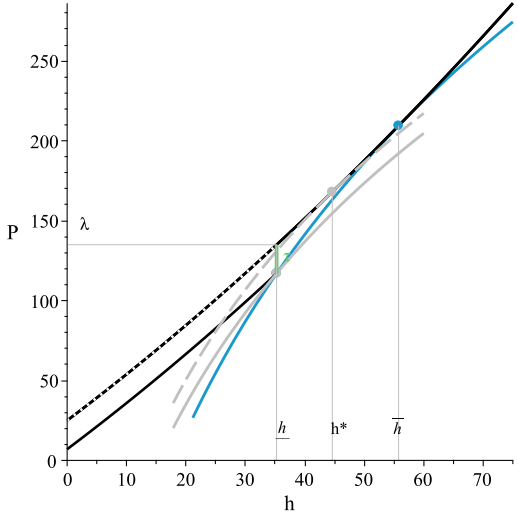


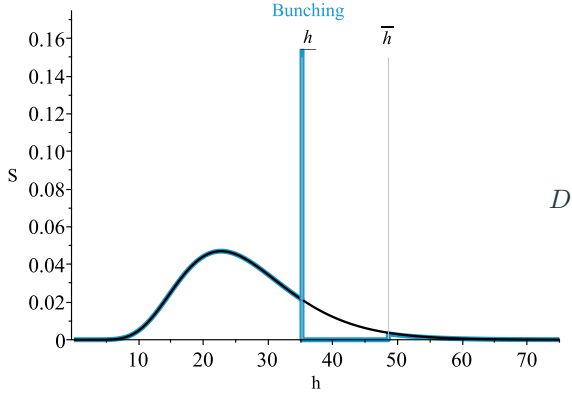
Households Demand Function

- Housing demand:

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

- Optimally conditions: $h^*\left(Y_i, \tau; \theta, \boldsymbol{\rho}, \lambda\right)$

Aggregate Demand Density



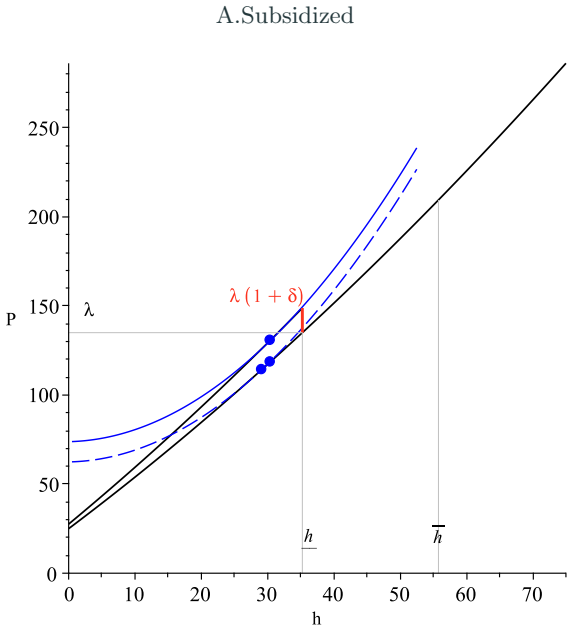
$$D(h) = \begin{cases} f_{h^*}(h)\ \mathrm{d}h & \text{if } h < \underline{h} \\ f_{h^*}(h)\ \mathrm{d}h + \int_{\underline{h}}^{\overline{h}} f_{h^*}(h)\ \mathrm{d}h & \text{if } \underline{h} = h \\ 0 & \text{if } h \in \left(\underline{h}, \overline{h}\right) \\ f_h^*(h)\ \mathrm{d}h & \text{if }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

---

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

$$f_{h^*}(h) = \begin{cases} f_Y\left(\tilde{Y}(h, \tau \neq 0; \theta, \boldsymbol{\rho}, \lambda);\right) \cdot \frac{\mathrm{d}}{\mathrm{d}h}\tilde{Y}(h, \tau \neq 0; \theta, \boldsymbol{\rho}, \lambda) & \text{if } h < \underline{h} \\ f_Y\left(\tilde{Y}(h, \tau = 0; \theta, \boldsymbol{\rho}, \lambda); \boldsymbol{\gamma}\right) \cdot \frac{\mathrm{d}}{\mathrm{d}h}\tilde{Y}(h, \tau = 0; \theta, \boldsymbol{\rho}, \lambda) & \text{if } \underline{h} < h \end{cases}$$

Developers' Choices

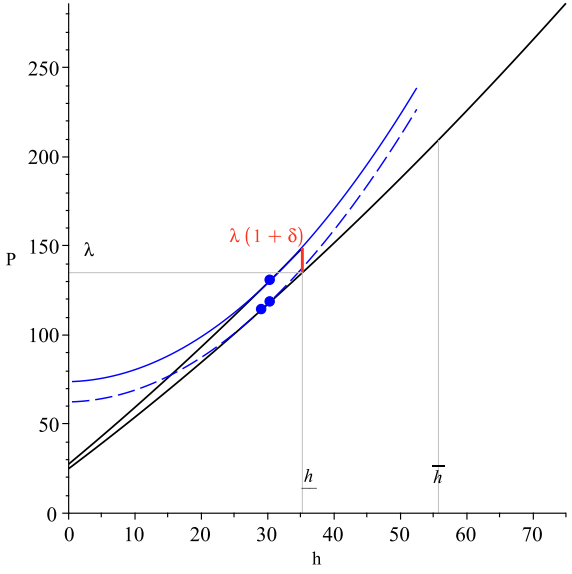


- **Implicit Price Function**: $P(h)$
- **Tax incentives**: $P(h) \cdot (1+\delta)$
- **Offer Functions** $\varphi_S\left(h, A_j, \bar{\pi}, \boldsymbol{\beta}\right)$

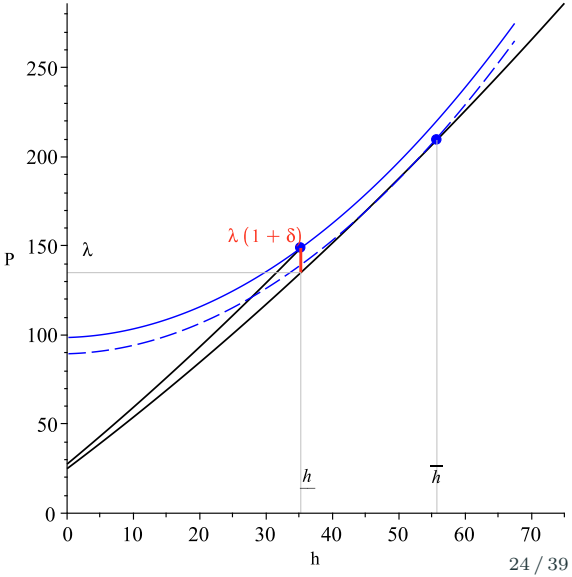
$$\bar{\pi} = \left(h, A_j, P\left(h\right), \boldsymbol{\beta}, \right)$$
$$\bar{\pi}_\delta = \left(h, A_j, P\left(h\right) * (1+\delta)\right), \boldsymbol{\beta}, \right)$$

Developers' Choices

A.Subsidized

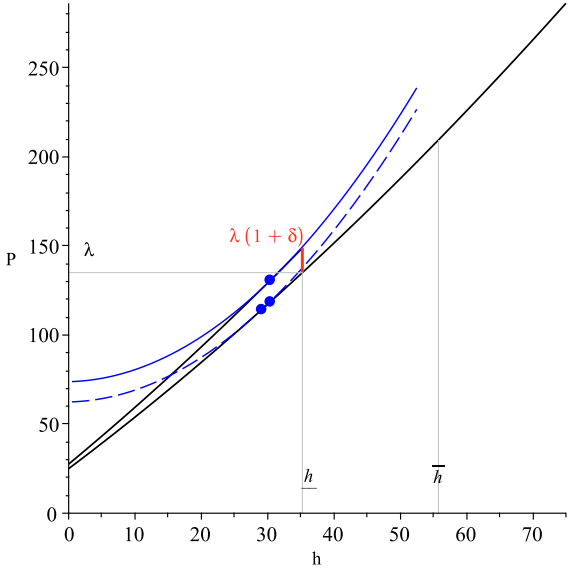


B.Marginally Subsidized and Bunchers



Developers' Choices

A.Subsidized



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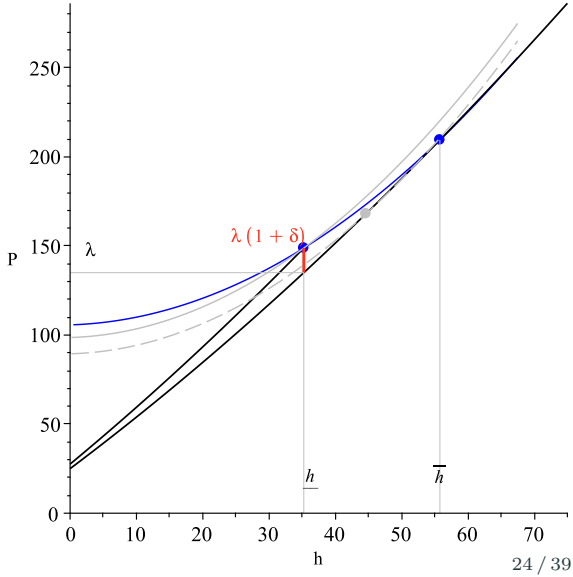
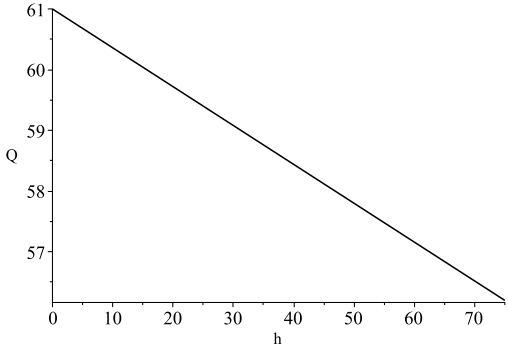
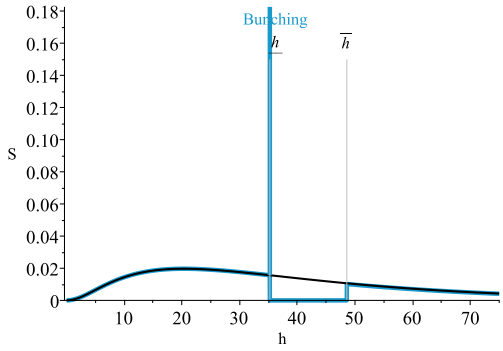


Developers Aggregate Supply Density

a. Unit supply function



b. Density function $g_h(h)$



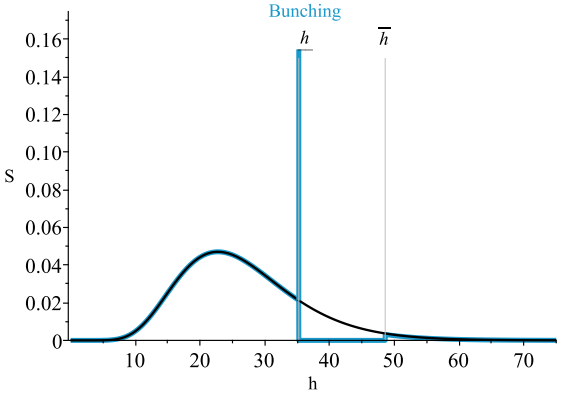
$$Q_j = \alpha_0 + \alpha_1 \cdot h_j$$

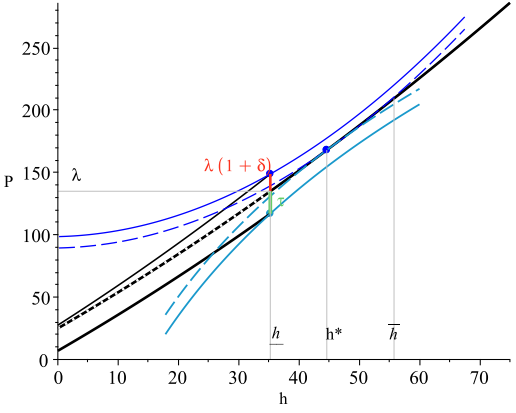
$$S(h) = \begin{cases} g_{h^*}(h) \cdot Q(h) & \text{if } h < \underline{h} \\ \left(g_{\underline{h}^*}(\underline{h}) + \int_{\underline{h}}^{\overline{h}} g_{h^*}(h)\ \mathrm{d}h \right) \cdot Q(\underline{h}) & \text{if } \underline{h} = h \\ 0 & \text{if } \underline{h} < h < \overline{h} \\ g_{h^*}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

Equilibrium

Price function makes the market clear:

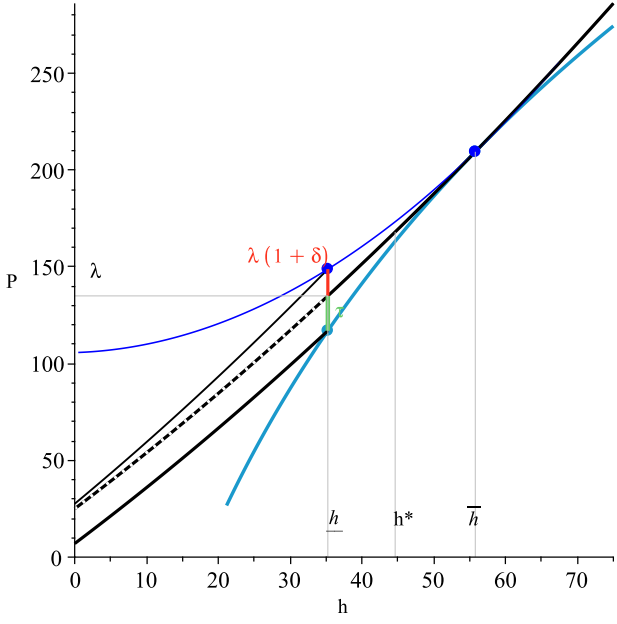
$$E = \left\{ P\left(h; \boldsymbol{\rho}\right) \in \mathcal{P} : D\left(h; \tau, \theta, \boldsymbol{\rho}, \boldsymbol{\gamma}, \lambda\right) = S\left(h; A_j, \boldsymbol{\rho}, \boldsymbol{\phi}\right) \forall h \in \mathcal{H} \right\}$$





Identification

Marginal Buncher Condition



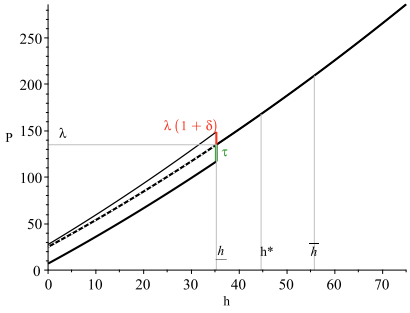
Marginal Buncher Condition

Marginal Buncher Condition	
Household	$V_D = U\left(\overline{Y} - P\left(\overline{h}\right), \overline{h}; \boldsymbol{\theta}\right) - U\left(\overline{Y} - P^{\tau}\left(\underline{h}\right), \underline{h}; \boldsymbol{\theta}\right) = 0$
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	$\overline{Y} = \tilde{Y}\left(\overline{h}; \boldsymbol{\theta}, P(h), \lambda\right)$
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	$U = \left[\frac{1}{2} \cdot C^{\boldsymbol{\theta}} + \frac{1}{2} \cdot h^{\boldsymbol{\theta}}\right]^{\frac{1}{\boldsymbol{\theta}}}$
Unit Supply	$Q = \alpha_0 + \alpha_1 h$
Cost	$B = A_j \cdot Q \cdot h^{\boldsymbol{\beta}}$

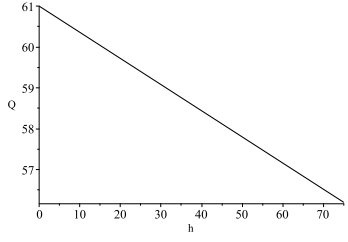
Estimation

Step I

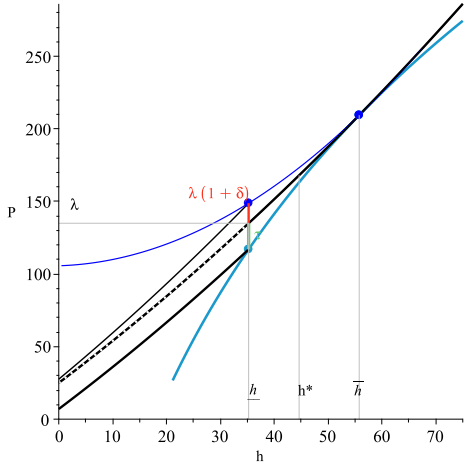
1. Price function:
   $\boldsymbol{\rho_t} = \rho_{0t}, \rho_{1t}, \rho_{2t}$
2. Policy Parameters:
   Notches: τ_t,δ
   Size threshold: $\underline{h} = P^{-1}(\lambda; \boldsymbol{\rho})$
3. Unit Supply Function:
   $\boldsymbol{\alpha} = \alpha_0, \alpha_1$
4. Behavioural Responses:
   Housing size for marginal buncher without subsidy: $\overline{h}$



Unit Supply Function $Q(h)$



Step II



$$V_D\left(\boldsymbol{\theta}|\underline{h},\overline{h},P\left(h\right),\tau,\tilde{Y}\left(\overline{h},\boldsymbol{\theta},P\left(h\right),\lambda\right)\right)=0$$
$$V_S\left(\boldsymbol{\beta}|\underline{h},\overline{h},P\left(h\right),\boldsymbol{\alpha},\delta,\tilde{A}\left(\overline{h};\boldsymbol{\beta},P\left(h\right),\lambda\right)\right)=0$$

Estimates

	06-08	09-11	12-15	16-18
Price Function				
ρ_0	17.0	-300.0	-243.5	-240.6
ρ_1	2.70	4.75	4.48	4.66
ρ_2	0.90	0.32	0.73	0.60
Policy Parameters				
τ	18.0	25.9	29.5	32.6
Bunchers Interval				
$\overline{h}$	40	53	45	49
$\underline{h}$	29.8	39.4	33.0	36.0
Unit Supply Function				
α_0	70.5	12.7	81.1	33.3
α_1	-0.068	-0.020	-0.020	-0.042
Structural Parameters				
β	2.53	1.67	1.77	1.70
σ	0.85	0.97	0.90	0.90
θ	-0.17	-0.028	-0.11	-0.11

III. Welfare:

Counterfactual policies

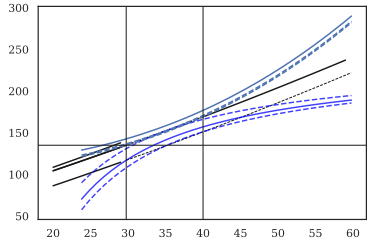
- Does the presence of a consumer housing subsidy and price caps create a problem of rationing in the absence of supply subsidies ?

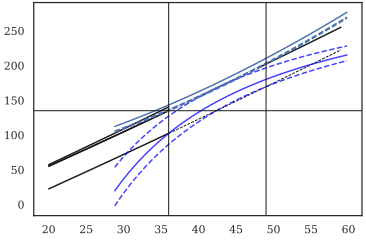
  Ongoing policy debate:

  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)

- What happens if the same households get the subsidy but there is not a price cutoff.

Welfare evaluation Illustration





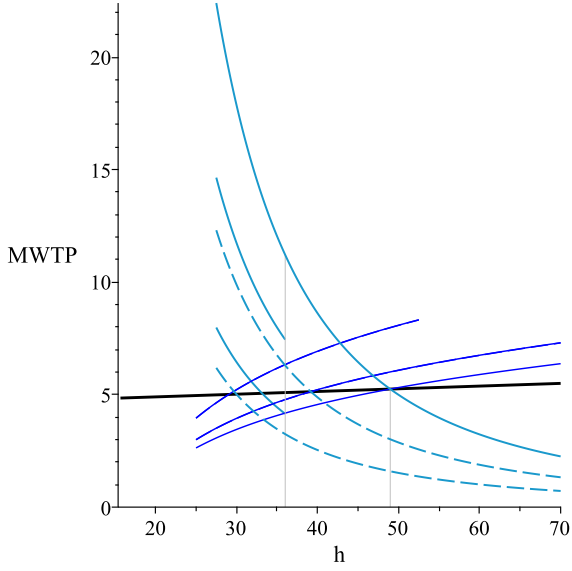
Estimates: Developers

	Developers			
	2006-08	2009-11	2012-15	2016-18
$\underline{A}$	0.0068	0.26	0.19	0.25
A_*	0.0054	0.23	0.17	0.22
$\overline{A}$	0.0045	0.21	0.15	0.20
$MgC\left(\underline{h}, Q\left(\underline{h}\right), \underline{A}\right)$	214.4	59.5	398.2	160.7
$MgC\left(\underline{h}, Q\left(\underline{h}\right), A_*\right)$	219.0	59.0	404.4	161.2
$MgC\left(h^*, Q\left(h^*\right), A_*\right)$	172.4	53.7	356.0	144.9
$MgC\left(\overline{h}, Q\left(\overline{h}\right), \overline{A}\right)$	223.4	58.6	410.6	161.7
$\pi\left(Q\left(\underline{h}\right), \underline{A}; P\left(\underline{h}\right)\right)$	6725.5	205.8	3449.4	881.6
$\pi\left(Q\left(\underline{h}\right), A_*; P^{\delta}\left(\underline{h}\right)\right)$	7588.2	406.1	4668.9	1388.9
$\pi\left(Q\left(\underline{h}\right), A_*; P\left(\underline{h}\right)\right)$	7218.6	341.6	4234.4	1217.2
$\pi\left(Q\left(h^*\right), A_*; P^{\delta}\left(h^*\right)\right)$	7740.0	439.8	4889.1	1478.6
$\pi\left(Q\left(h^*\right), A_*; P\left(h^*\right)\right)$	7326.4	359.9	4359.1	1266.4
$\pi\left(Q\left(\overline{h}\right), \overline{A}; P\left(\overline{h}\right)\right)$	7930.5	512.2	5262.2	1646.0

Estimates: Households

	Households			
	2006-08	2009-11	2012-15	2016-18
$\underline{Y}$	215.7	324.0	275.6	291.5
Y_*	248.7	392.5	333.7	355.6
$\overline{Y}$	282.8	461.7	393.2	421.1
$U\left(\underline{Y} - P\left(\underline{h}\right), \underline{h}\right)$	47.9	85.6	66.3	72.9
$U\left(\underline{Y} - P^{\tau}\left(\underline{h}\right), \underline{h}\right)$	52.5	91.2	72.4	79.5
$U\left(Y_* - P\left(h^*\right), h^*\right)$	56.8	100.7	78.9	86.6
$U\left(Y_* - P^{\tau}\left(\underline{h}\right), \underline{h}\right)$	59.6	104.3	82.7	90.7
$U\left(Y_* - P^{\tau}\left(h^*\right), h^*\right)$	61.4	106.3	84.9	93.2
$U\left(\overline{Y} - P\left(\overline{h}\right), \overline{h}\right)$	65.9	116.0	91.7	100.5

Alternative Representation of the Equilibrium. Demand and Supply for Size



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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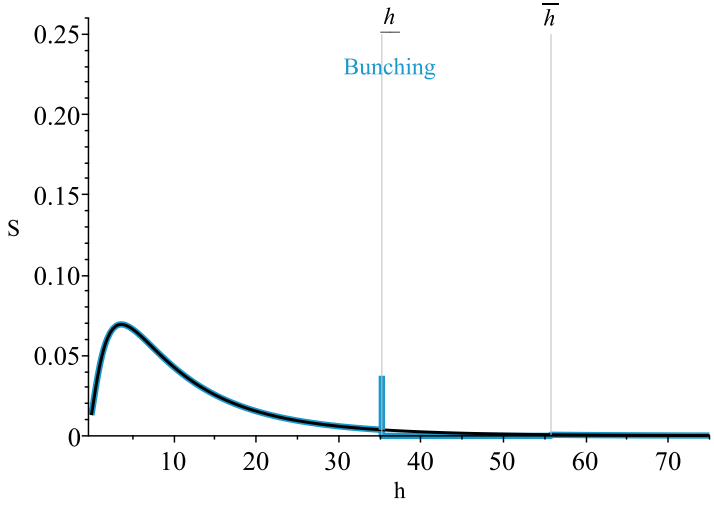
Appendix

06-08


h
$\overline{h}$
Bunching
0.25
0.20
0.15
S
0.10
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0
10
20
30
40
50
60
70
h

back

4. Behavioral Responses (Estimation)

Subsidy Induced Equilibrium Density Change.

$$\Delta(\tilde{h}) = D\left(\tilde{h}\right) - f_{h_0}\left(\tilde{h}\right)$$

- Observed distribution

$$D\left(\tilde{h}\right) = \frac{1}{N}\sum_{l=1}^{N} \mathbb{1}\left[\tilde{h}_{ltc} \in (b-\epsilon, b+\epsilon)\right]$$

- Counterfactual distribution

$$\tilde{h}_b = l\left(\tilde{h}_b\right) + exc_L^H\left(\tilde{h}_b\right) + v_b$$

$$\rightarrow \qquad \hat{f}_{h_0}\left(\tilde{h}_b; \epsilon, L, H, p\right) = \hat{l}\left(h_b\right) = \sum_{p=0}^{T} \hat{\iota}_p \tilde{h}_b^p$$

Bunching Estimates (I)

- Bunching

$$\hat{\Delta}(\underline{h}) = \hat{f}_{h^*} - f_{h_0}\left(\underline{h}; \boldsymbol{\rho}, \theta, \boldsymbol{\gamma}\right) = \int_{\underline{h}}^{\overline{h}} f_{h_0}\left(h; \boldsymbol{\rho}, \theta, \boldsymbol{\gamma}\right) \, \mathrm{d}h$$

- Marginal buncher optimality condition $\overline{h}$

$$\overline{h} = min[h : h > \underline{h} \text{ and } D_b - \hat{f}\left(h_b\right) = 0]$$

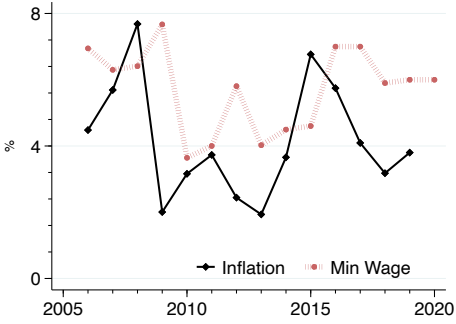
back

Colombian Housing Policy

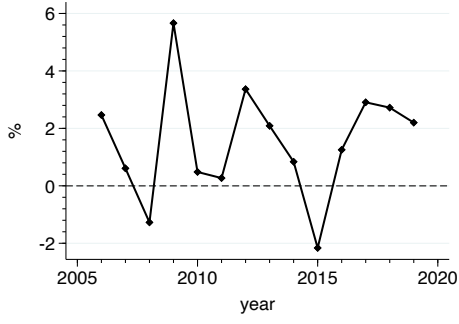
- **Goals**
  - Provide a decent home and suitable living.
  - Increase and promote homeownership.
- **Policy Approach**
  - In the 90's changed from public housing to a market-based approach.
  - *Ahorro,Bonos,Credito–ABC* (Savings,Bonds and Credit) promoted by the WB in LAC.
  - Relies on the competitive housing market.

Making Colombia a ***country of homeowners*** *is possible by addressing the main problems that make it difficult for all households, especially the poorest, to have access to the right to housing contemplated in the National Constitution. To achieve this objective, the National Government will implement a* ***housing financing strategy****, so that the resources of savings,* ***subsidies and complementary credit*** *are adequately articulated* (PND 2002-2006)

Inflation and minimum wages.



a. Min wage and Inflation



b. Min wage and Inflation

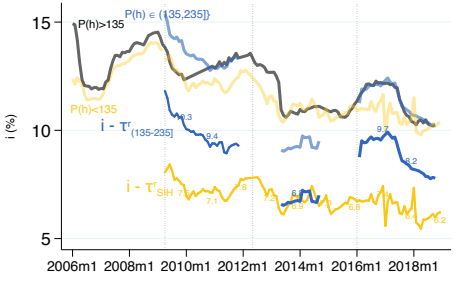
back

Data: Mortgages and Interest Rates

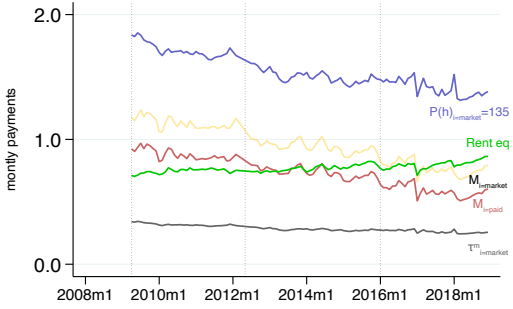
rent equivalent ((?, ?), (Bishop & Timmins, 2019) assume it is 0.05)

- 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. $P(h) < 135$

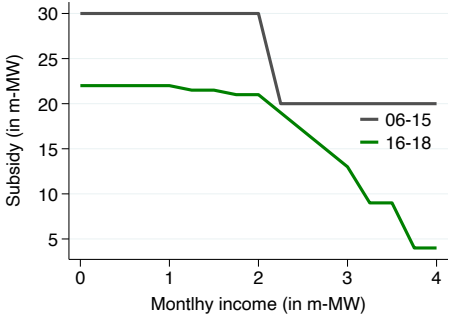


- To convert the magnitudes into monthly payments I use:

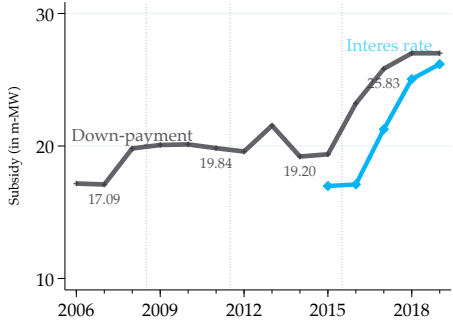
$$X_{montly} = X \cdot \kappa(i,n) \; ; \; \kappa(i,n) = \frac{\frac{i}{12} \cdot \left(1 + \frac{i}{12}\right)^{12 \cdot n}}{\left(1 + \frac{i}{12}\right)^{n \cdot 12} - 1}$$

The Notch: Down Payment Subsidy

Subsidy by household income

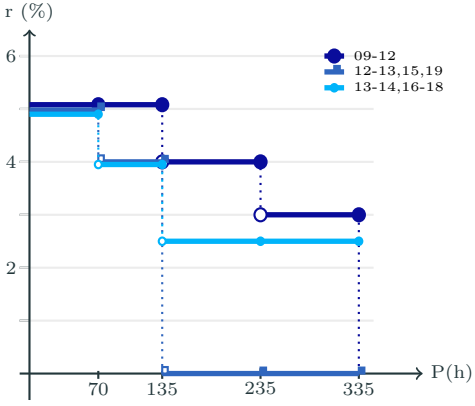


Average subsidy over time

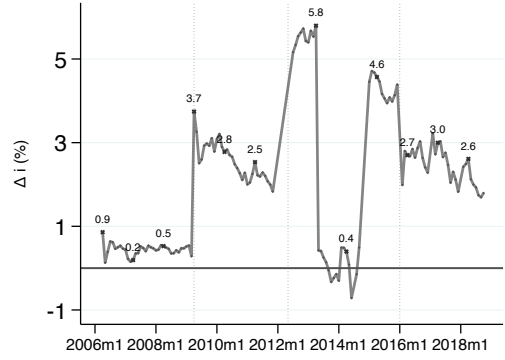


- Varies by income.
- Increase in 2016.
- Expanded trough *mi casa YA*

The Notch: Interest Rate Subsidy



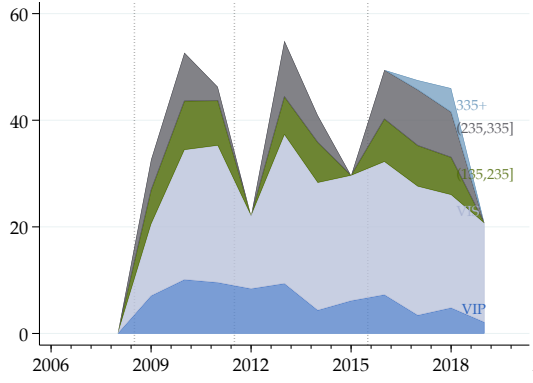
Comparing monthly payments around P(h)=135 m-MW



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

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

a. Total # of subsidies



b. Total amount of subsidies