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

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Is a Market-Oriented Housing Policy Effective?

- Governments implement various **market-oriented** policies to promote housing construction and promote homeownership

→ Subsidies or tax incentives

- Policies affect
  - 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?

Colombian Housing Policy

- I study the Colombian **market-oriented** housing policy.
  - 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 between 2006-18
- I use this discontinuity and the changes over time to evaluate the housing market response to subsidies.

This Paper

I. Descriptive evidence

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

II. Model of housing equilibrium

- 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 (1% → 7% market share at cutoff)
   - Households downsize up to 30% percent to benefit from the subsidy

II. Model of housing equilibrium
   - Rationalizes the bunching response.
   - Motivates the identification strategy to recover the model parameters.
   - Elasticity of substitution between on housing and consumption is 0.9

III. Policy and welfare analysis
   - The 2021 tax proposal, removing the tax incentives to developers could create a shortage.
   - Welfare gains if we remove the cutoff.

Literature and Contribution

Integrates the bunching and hedonic literatures 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

- Housing market applications Best et al. (2019), DeFusco and Paciorek (2017)
- Methodology *Notches >> Kinks*: Kleven (2016), Bertanha et al. (2021), Blomquist et al. (2021)
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- 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. Demand Subsidies
   - Downpayment
   - Interest rate

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

2. Supply Subsidies
   - Value Added Tax (VAT) refund

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

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

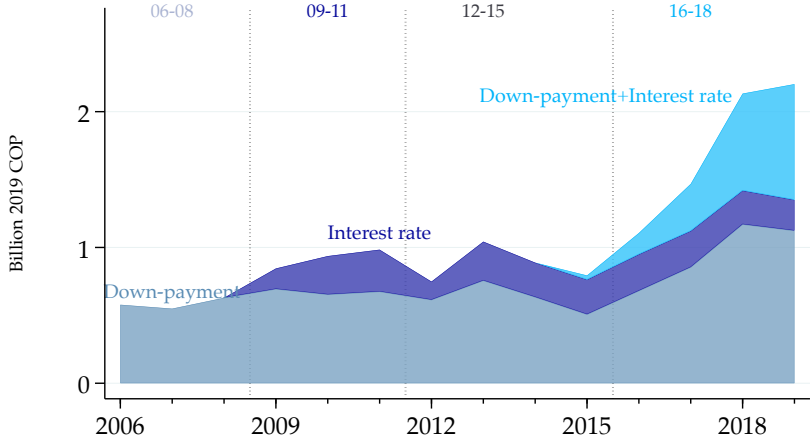
Note: $\mathbf{135}\, mMW \approx 40,000\, \$USD$

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
   - Unit Characteristics: **size**,location, # rooms, # bathrooms, etc.
   - Prices sales prices.
   - Quantities

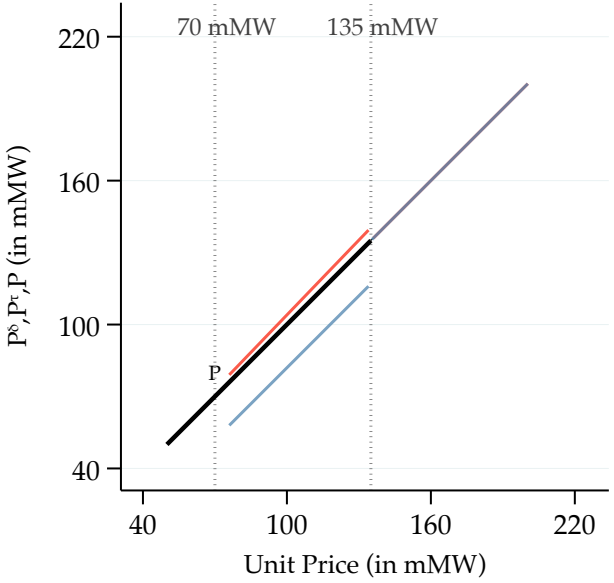
Government Expenditure and Policy Expansion



- 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

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



Transaction Price

P

Developers Price

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

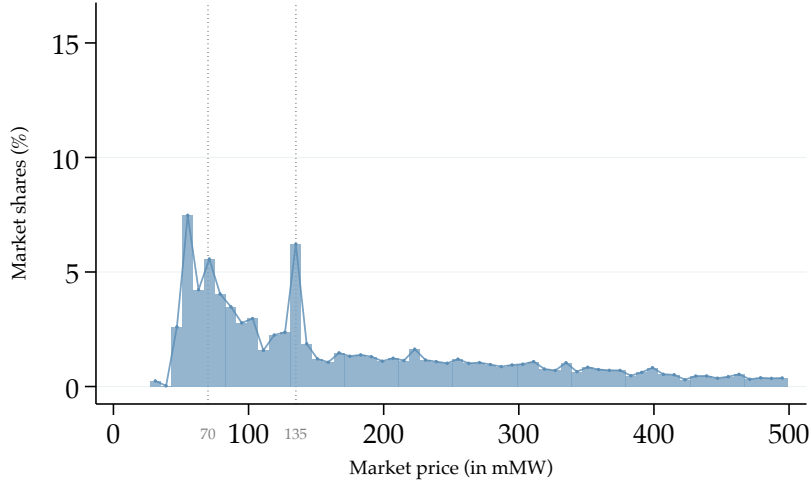
δ =Tax refund

Households price

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

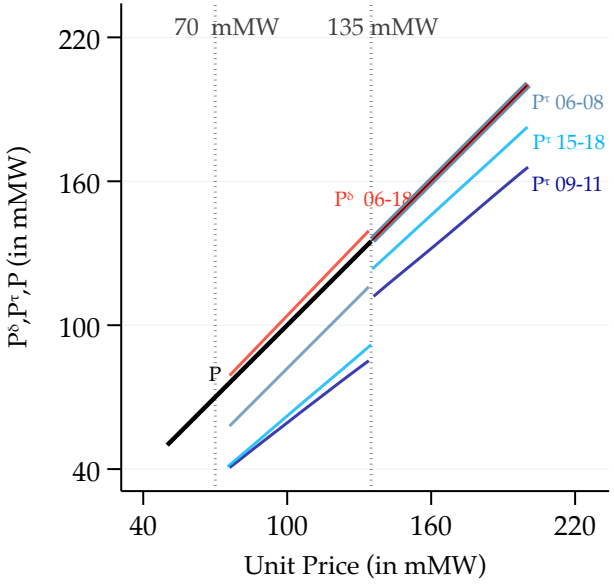
τ =Subsidy

Bunching at the Low-Cost Housing Price Limit



Data:Census of new construction in Colombia 2006-18

The Demand Notch Increases Over Time



Supply Notch δ

2006-18 4%

Demand Notch τ_t

2006-08: 19.7 mMW

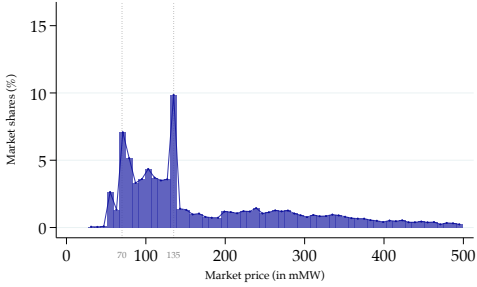
2009-11: 26.4 mMW

2016-18: 33.1 mMW

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

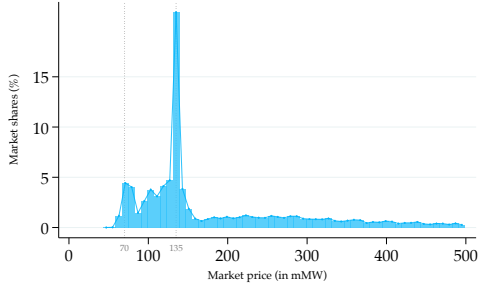
Larger Bunching as Notch Increases

2009-11



Notch: 19.7

2016-18



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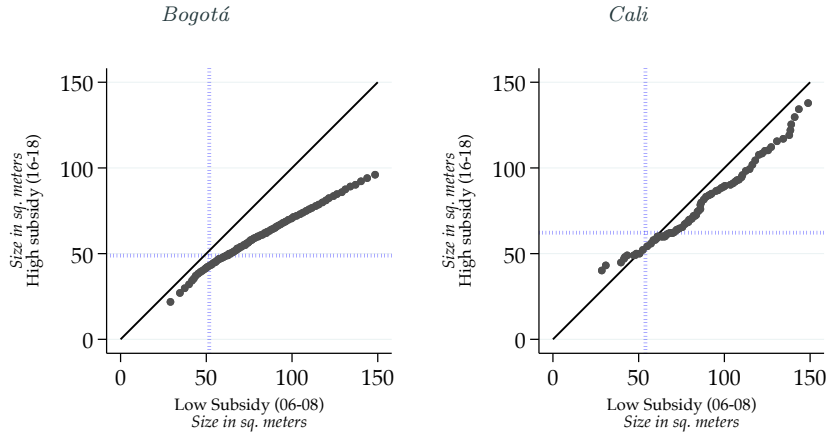
Changes in the Characteristics of the Housing Stock

- Changes in unit size



- Not only changes in prices
- Size is not the only characteristic

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}

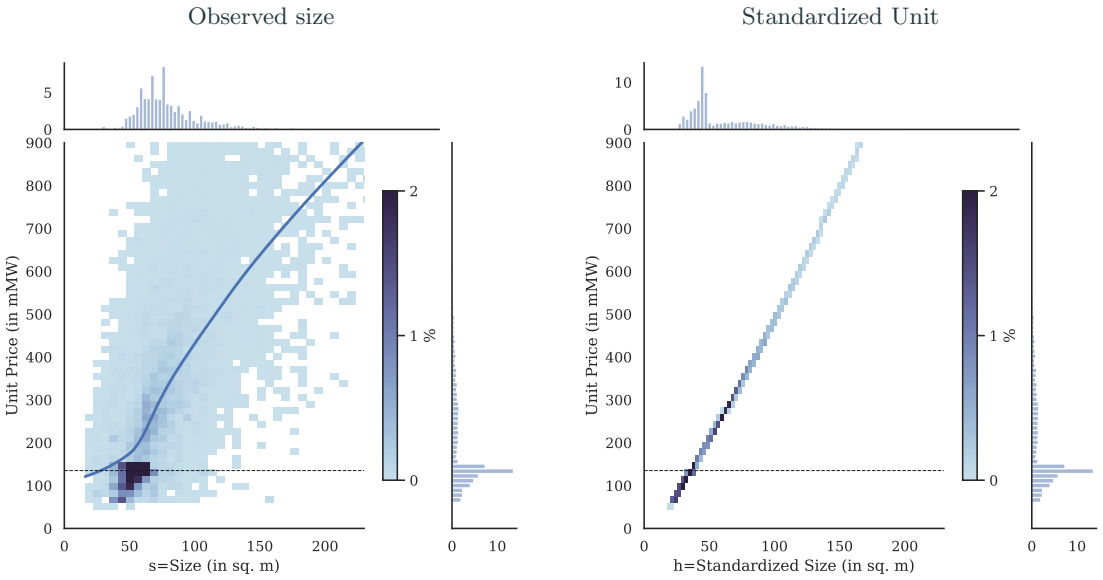
$$\rho\left(h_{ltc}\right) + \Gamma' \bar{X}_{ltc} + \bar{\omega}_{ltc} = \rho\left(s_{ltc}\right) + \Gamma' X_{ltc} + \omega_{ltc} \tag{2}$$

  - 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: $\mathrm{E}\left(s_{ltc} | X_{ltc}, \omega_{ltc}\right) = 0$

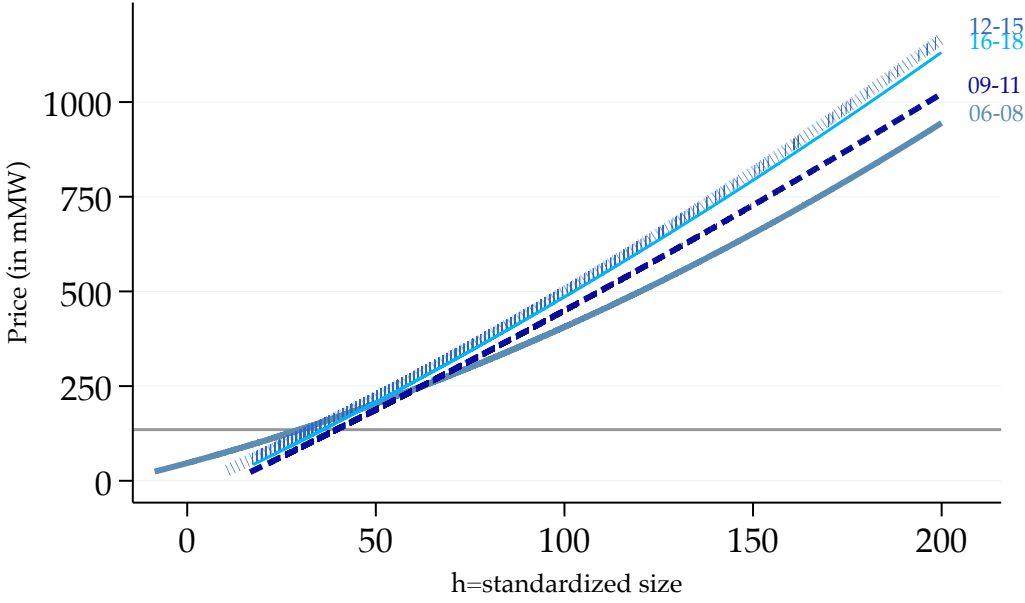
- Why size?
  - Continuous, easy to measure, monotonic relationship with price.
  - In contrast to most datasets, I observe it.

Observed Equilibrium: Prices, Quantities, and Size

2016-18



Implicit Prices for Housing Size Over Time



Behavioural Responses Induced by the Policy

- Behavioural responses recover from the observed distribution
- *Observed Distribution:* f_{h^*}
  $\rightarrow$ histogram
- *Counterfactual Distribution:* f_{h_0}
  $\rightarrow$ predicted density using a flexible polynomial and excluding observations around the cutoff.

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

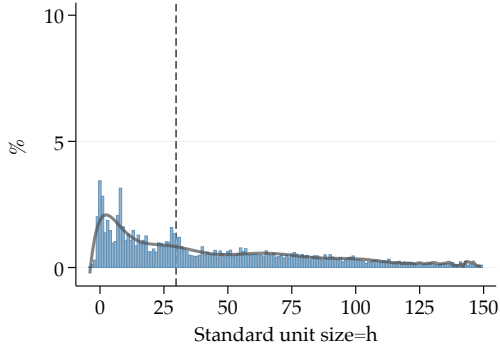
$$\hat{f}_{h_0} = \hat{l}\left(h_b\right) = \sum_{p=0}^{T} \hat{\imath}_p h_b^p$$

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

Standard approach (Kleven, 2016)

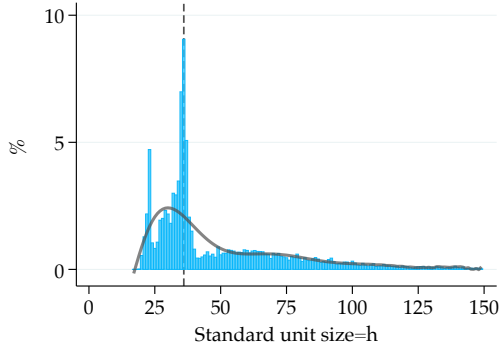
Bunching in Housing Characteristics (Size of std. Unit)

2006-08



Notch: 18.0 mMW

2016-18



Notch: 32.5 mMW

The Policy Effect on Observed Outcomes

Table 1: Behavioral Responses Estimates'

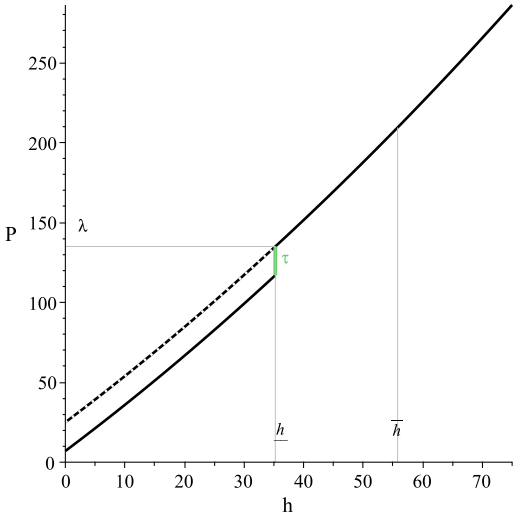
	06-08	09-11	12-15	16-18
$\int_{h_{min}}^{\underline{h}^-} T(h)\mathrm{d}h$	1.03	0.86	3.83	7.28
$\hat{T}(\underline{h})$	0.50	2.02	4.02	6.97
$\int_{h_{min}}^{\underline{h}} T(h)\mathrm{d}h$	1.53	2.88	7.85	14.2
$\int_{\underline{h}}^{\overline{h}} T(h)\mathrm{d}h$	-0.096	-6.25	-4.13	-3.42
$h_{h^0}(\underline{h})$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

II. Equilibrium Model of Housing Supply and Demand

A Stylized Housing Market Model

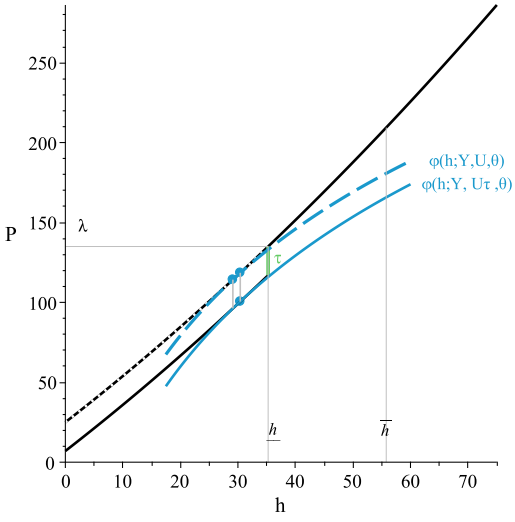
1. **Housing**
   - Differentiated product described by its size $h \in \mathcal{H}$
   - Price depends on size $P(h)$
2. **Households** $i \in I$, Heterogeneous in Income $Y_i \sim F_Y$
   - Choose h_i and consumption C_i to maximize Utility $U(C_i, h_i; \theta)$
3. **Developers** $j \in J$, Heterogeneous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

Households' Optimal Choices



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

Households' Optimal Choices

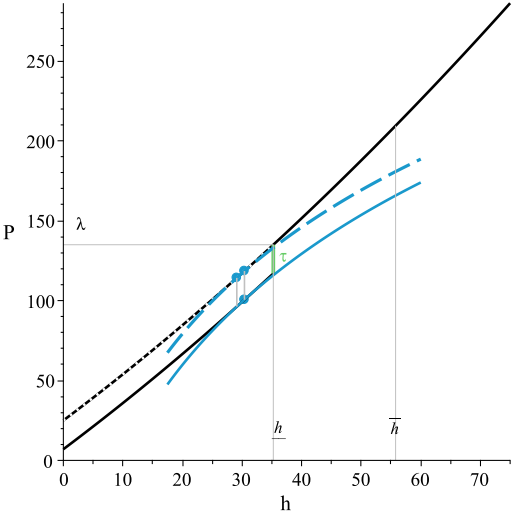


- **Implicit Price Function**: $P(h)$
- **Subsidy** τ
- **Bid functions** $\varphi_D\left(h, Y, \bar{U}; \theta\right)$

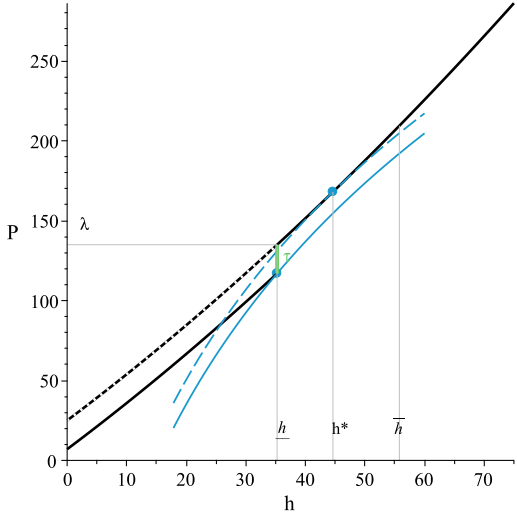
$$\bar{U} = U\left(h, Y_i - \varphi_D; \theta\right)$$
$$\bar{U}_\tau = U\left(h, Y_i - \varphi_D + \tau; \theta\right)$$

Households' Optimal Choices

A.Subsidized



B.Marginally Subsidized and Bunchers



Households' Optimal Choices

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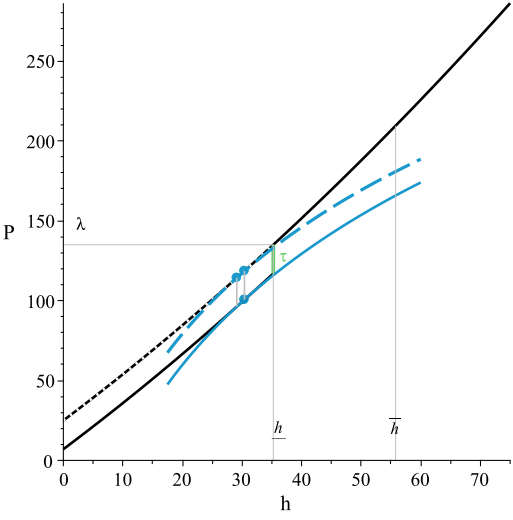

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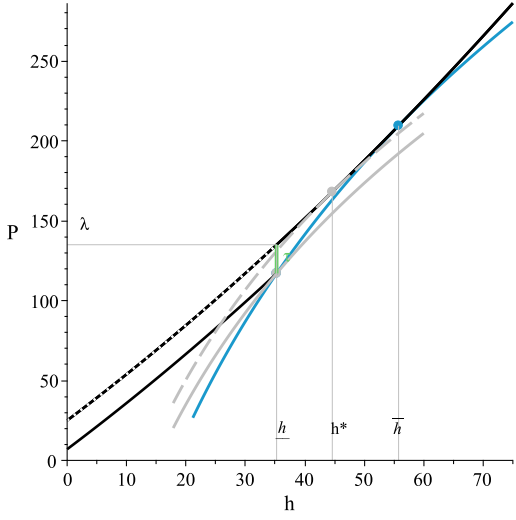


Households' Demand Function

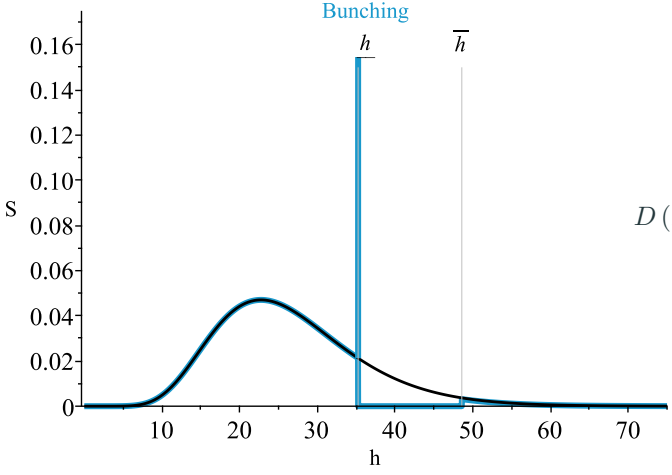
Tangency conditions: $h^* \left(Y_i, \tau; \theta, \boldsymbol{\rho}, \lambda \right)$

- Housing demand:

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

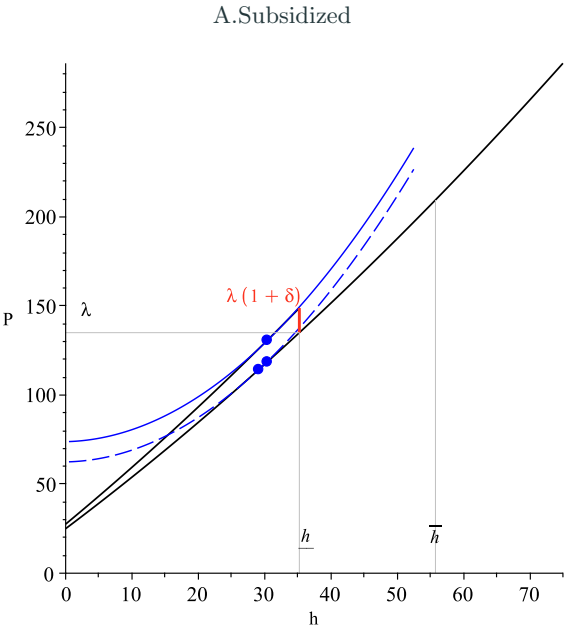
- How to aggregate:
  - Income and unit size: $Y_i = \tilde{Y} \left(h, \tau; \theta, \boldsymbol{\rho}, \lambda \right) = h^{*-1} \left(h_i, \tau; \theta, \boldsymbol{\rho}, \lambda \right)$
  - change of variable formula using the distribution of income

Aggregate Demand Density



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

Developers' Choices

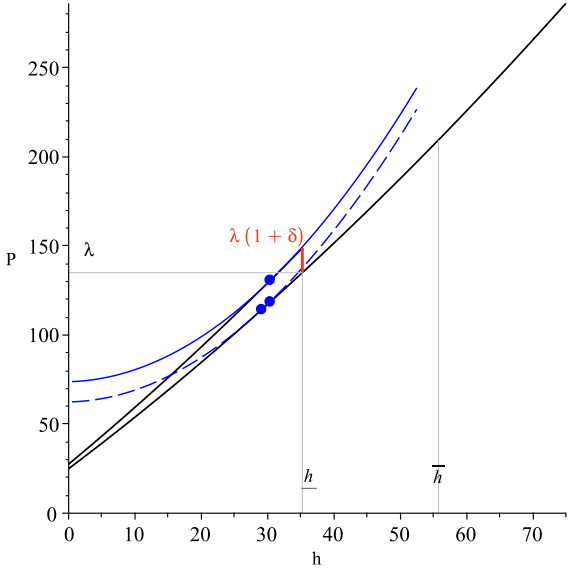


- **Implicit Price Function**: $P(h)$
- **Tax incentives**: $P(h) \cdot (1+\delta)$
- **Offer Functions** $\varphi_S\left(h, A_j, \bar{\pi}, \boldsymbol{\beta}\right)$

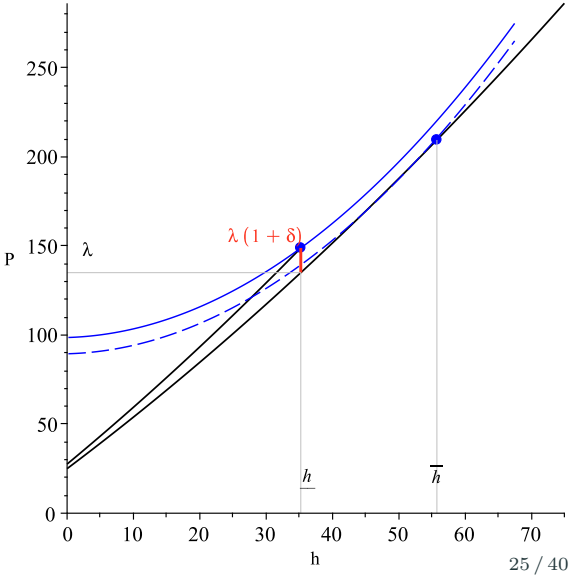
$$\bar{\pi} = \left(h, A_j, P\left(h\right), \boldsymbol{\beta}, \right)$$
$$\bar{\pi}_\delta = \left(h, A_j, P\left(h\right) * (1+\delta)\right), \boldsymbol{\beta},)$$

Developers' Choices

A.Subsidized

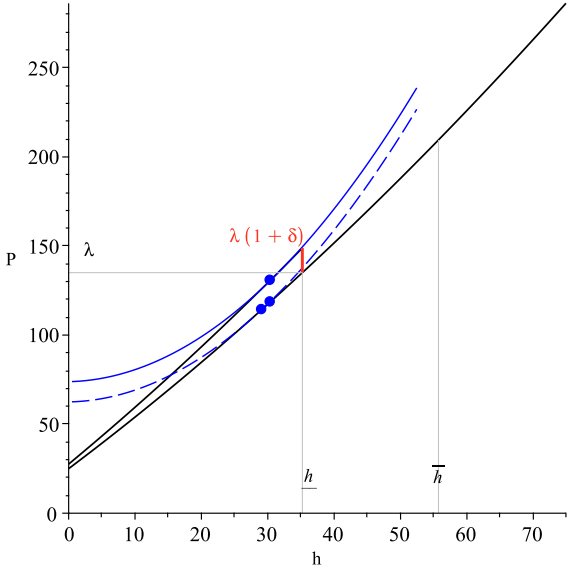


B.Marginally Subsidized and Bunchers



Developers' Choices

A.Subsidized



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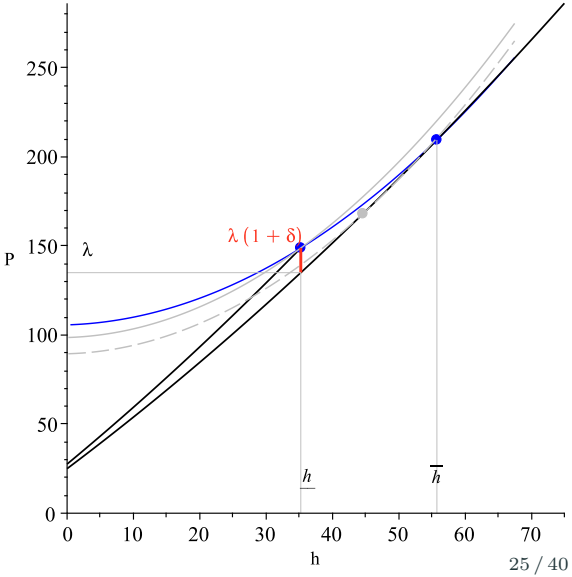
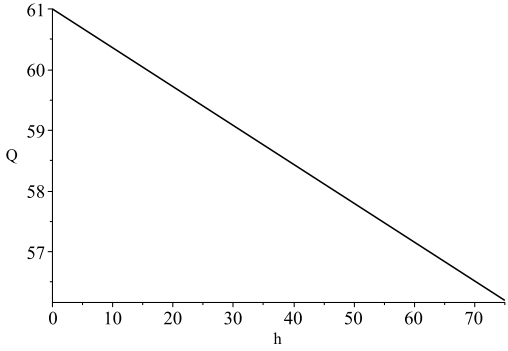
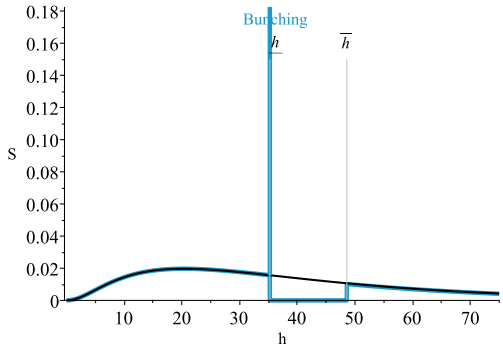


Developers Aggregate Supply Density

a. Unit supply function



b. Density function $g_h(h)$



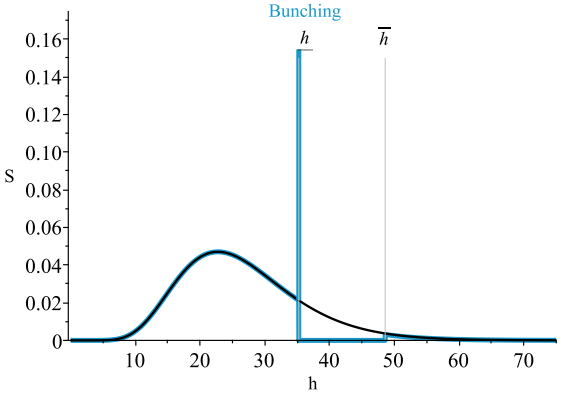
$$Q_j = \alpha_0 + \alpha_1 \cdot h_j$$

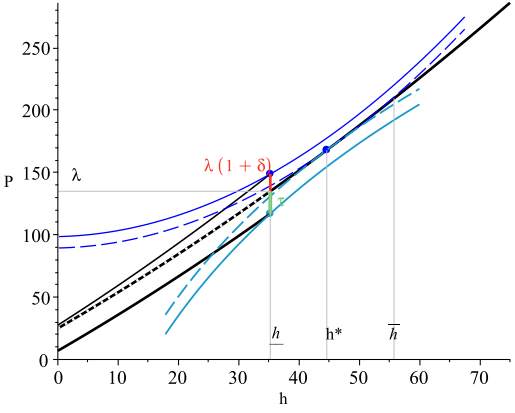
$$S(h) = \begin{cases} g_{h^*}(h) \cdot Q(h) & \text{if } h < \underline{h} \\ \left(g_{\underline{h}^*}(\underline{h}) + \int_{\underline{h}}^{\overline{h}} g_{h^*}(h)\ \mathrm{d}h \right) \cdot Q(\underline{h}) & \text{if } \underline{h} = h \\ 0 & \text{if } \underline{h} < h < \overline{h} \\ g_{h^*}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

Equilibrium

Price function makes the market clear:

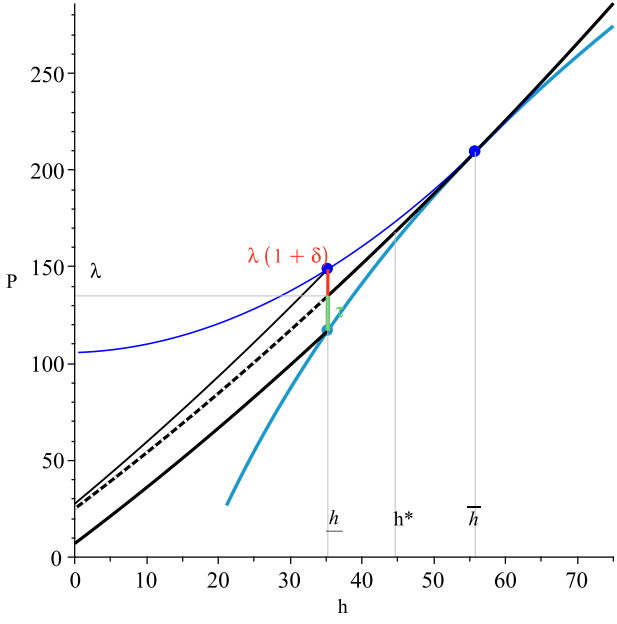
$$E = \left\{ P\left(h;\boldsymbol{\rho}\right) \in \mathcal{P} : D\left(h;\tau,\theta,\boldsymbol{\rho},\boldsymbol{\gamma},\lambda\right) = S\left(h;A_j,\boldsymbol{\rho},\boldsymbol{\phi}\right) \forall h \in \mathcal{H} \right\}$$





Identification

Marginal Buncher Condition



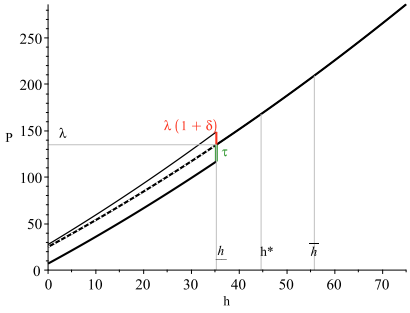
Marginal Buncher Condition

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

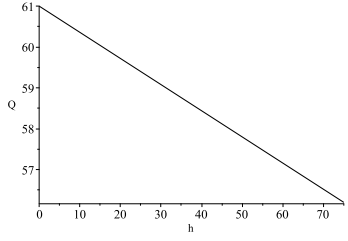
Estimation

Step I

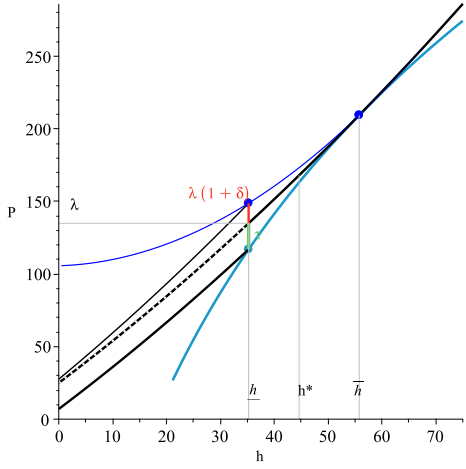
1. Price function:
   $\boldsymbol{\rho_t} = \rho_{0t}, \rho_{1t}, \rho_{2t}$
2. Policy Parameters:
   Notches: τ_t,δ
   Size threshold: $\underline{h} = P^{-1}(\lambda; \boldsymbol{\rho})$
3. Unit Supply Function:
   $\boldsymbol{\alpha} = \alpha_0, \alpha_1$
4. Behavioural Responses:
   Housing size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



Unit Supply Function $Q(h)$



Step II



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

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. Policy Evaluation:

Counterfactual policies

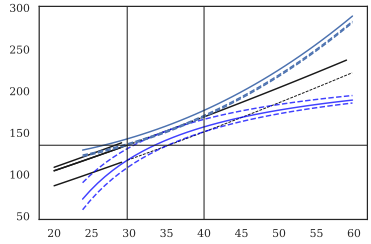
- Does the presence of a consumer housing subsidy and price caps create a problem of rationing in the absence of supply subsidies ?

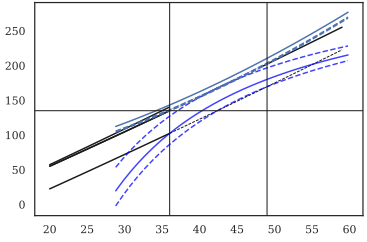
  Ongoing policy debate:

  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





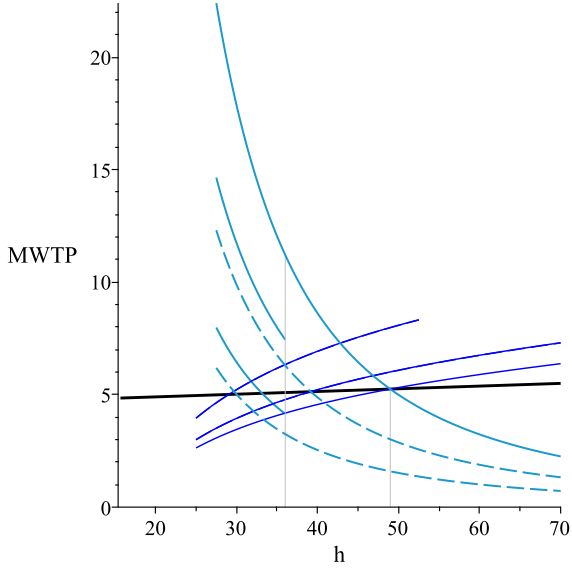
Estimates: Developers

	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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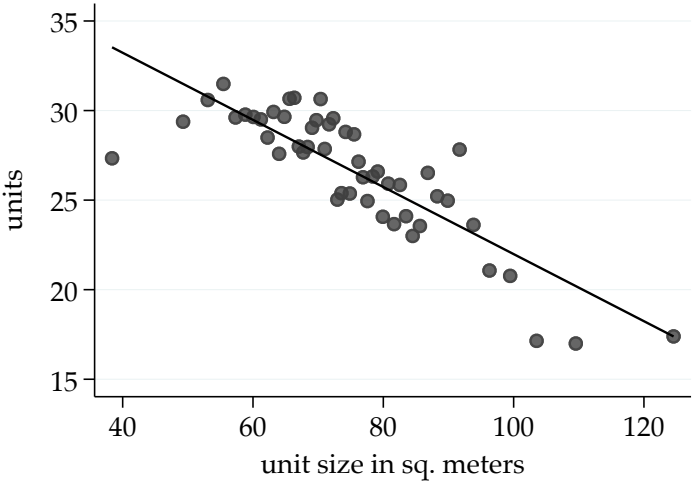
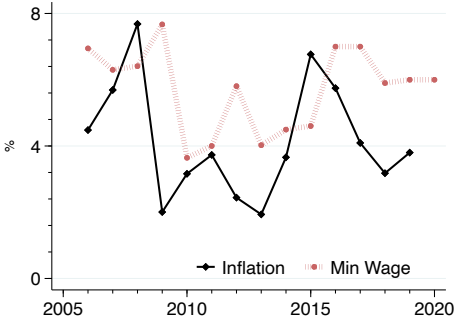
Appendix

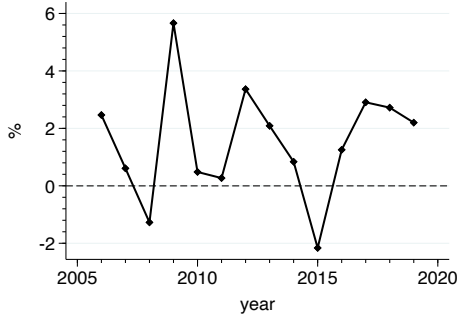
Quantities by size



Inflation and minimum wages.



a. Min wage and Inflation



b. Min wage and Inflation

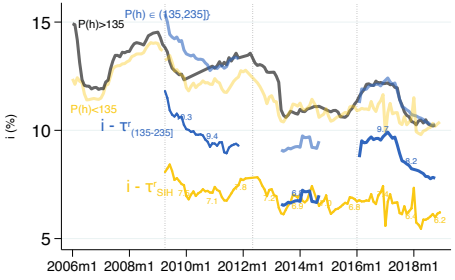
back

Data: Mortgages and Interest Rates

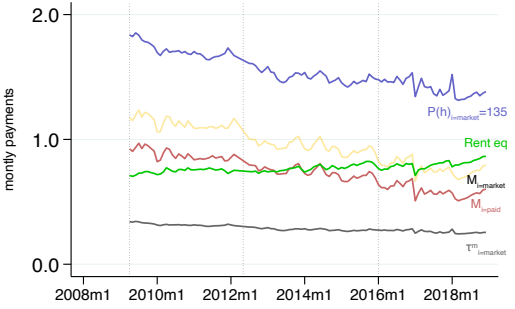
rent equivalent ((?, ?), (Bishop & Timmins, 2019) assume it is 0.05)

- 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. $P(h) < 135$

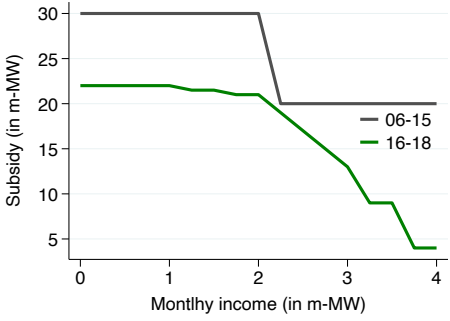


- To convert the magnitudes into monthly payments I use:

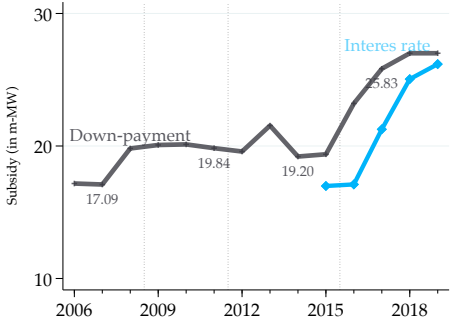
$$X_{montly} = X \cdot \kappa(i,n) \; ; \; \kappa(i,n) = \frac{\frac{i}{12} \cdot \left(1 + \frac{i}{12}\right)^{12 \cdot n}}{\left(1 + \frac{i}{12}\right)^{n \cdot 12} - 1}$$

The Notch: Down Payment Subsidy

Subsidy by household income

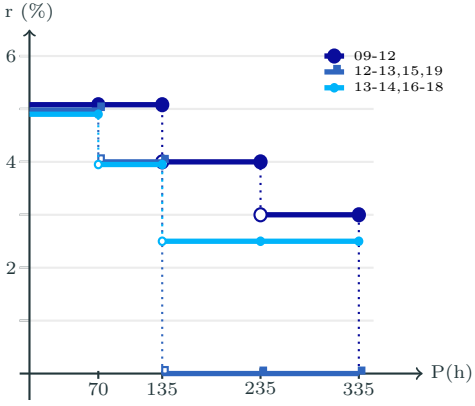


Average subsidy over time

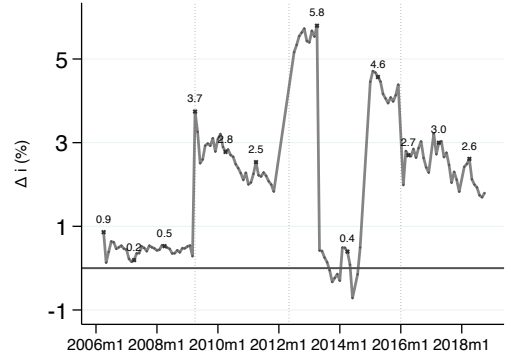


- Varies by income.
- Increase in 2016.
- Expanded trough *mi casa YA*

The Notch: Interest Rate Subsidy



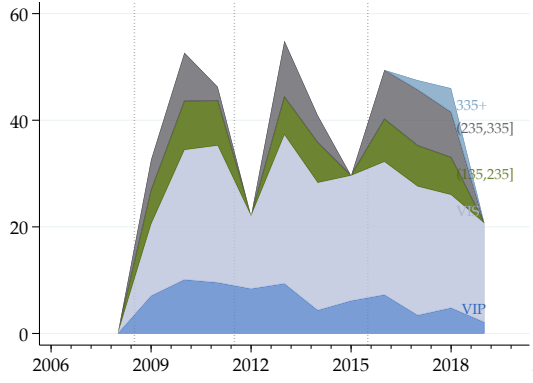
Comparing monthly payments around P(h)=135 m-MW



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