

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

Juan Pablo Uribe

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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?
 - Are there any unintended consequences?
 - What happens if these policies are removed?
 - How big are the efficiency costs?



- ▶ I use a quasi-experiment to estimate a housing market model.
- ▶ Counterfactual policy evaluation and welfare analysis.

1. The question the big question that i'm going to be addressing is our market oriented housing policies effect.
2. So, particularly since the 90s an many governments addopted a market oriented policy approach, which means that there is not direct government construction. Governments, are the policies are intended to promote housing construction or homeownership and usually this type of policies, take the form of tax subsidies.
3. subsidies or tax incentives, you can think about is about this as a first time homebuyer programs in the US or tax incentives to developers build inclusionary house, so the the natural question that we can ask the questions that I address in this paper.
4. There are to types of questions that arise
5. I address two questions first i'm interested in understanding what is the market effect and by these I mean what is the effect on process quantities.
6. I address two questions first i'm interested in understanding what is the market effect and by these I mean what is the effect on process quantities. But, more importantly, and the focus of these papers in the type of housing, that is being built, and second, we want to know whether these incentives.
7. To promote homeownership work and whether this is a good idea, and so, for example here the The Economist argue what against what they call the obsession against.
8. The obsession with homeownership it's and they said that it's very harmful so.
9. To be able to say something about this we need an economic model and empirical estimates that allow us to address questions such as: ***
10. So what I do in this paper is a to use a quasi-experiment to estimate the housing recovery model, and I use the estimator parameters and the model to do counterfactual policy evaluation and evaluate the welfare effects of of this.

COLOMBIAN HOUSING POLICY

► Policy tools:

1. Subsidies to low-income households low-cost housing.
2. Tax incentives to developers who build low-cost housing.
3. A price cap defining low-cost housing.

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

► Empirical advantages:

1. Price cap
 - Discontinuous incentives for developers and households to bunch at the cutoff.
2. Unique and novel data
 - Census data for all new construction projects.
 - Administrative records for the subsidies.
3. Subsidy expansion (2006-18)

1. I focus on the Colombian housing policy which allows me to do this,

2. Colombia has three policy tools.

3. ***The tool ***

4. you can think about this as a definition for projects, for example in in the US if if there was like a prize information to to know which housing units are project and which are not and only projects are.

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:

Step 1: Equilibrium characterization \rightarrow *Detailed data and literature best practices*

Step 2: Preferences and cost function parameters \xrightarrow{new} *bunching and policy tools*

III. Proposed policy counterfactual and welfare

- Colombian 2021 tax reform – remove tax incentives to developers
- Policy change – phasing out price caps

\rightarrow 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	Hedonic	Housing Policy
<ul style="list-style-type: none">▶ Housing market▶ Link to model▶ Supply and demand	<ul style="list-style-type: none">▶ Policy notch▶ Supply side▶ Identification	<ul style="list-style-type: none">▶ Evidence▶ Welfare▶ Counterfactuals
<ul style="list-style-type: none">- Housing market applications Best et al. (2019), DeFusco and Paciorek (2017)- Methodology <i>Notches >> Kinks</i>: Kleven (2016), Bertanha et al. (2021), Blomquist et al. (2021)	<ul style="list-style-type: none">- 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)	<ul style="list-style-type: none">- 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

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

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



DATA

1. Administrative Records from Minister of Housing

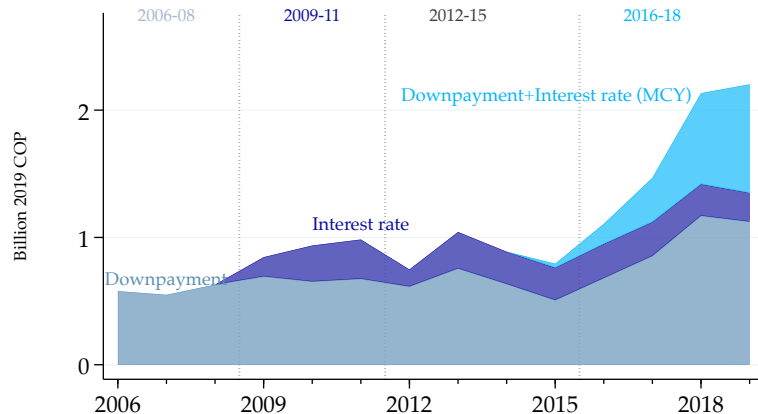
- Subsidy size
 - Mortgage information
- Government expenditure on each subsidy

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

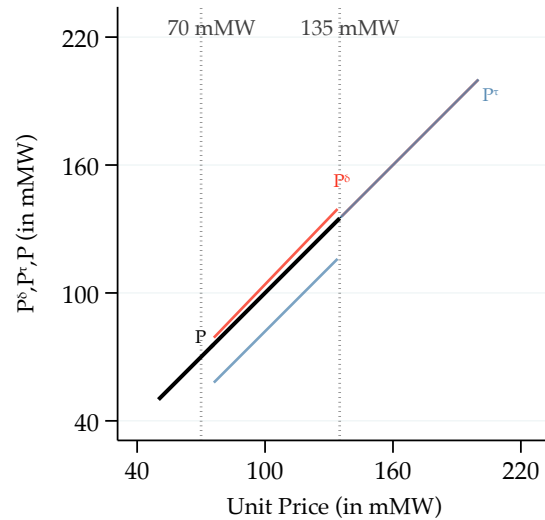


► Four different periods of expansion.

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

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

THE NOTCH



Transaction Price

P

Developers Price

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

δ = Tax refund

Households price

$$P^\tau = P - \tau$$

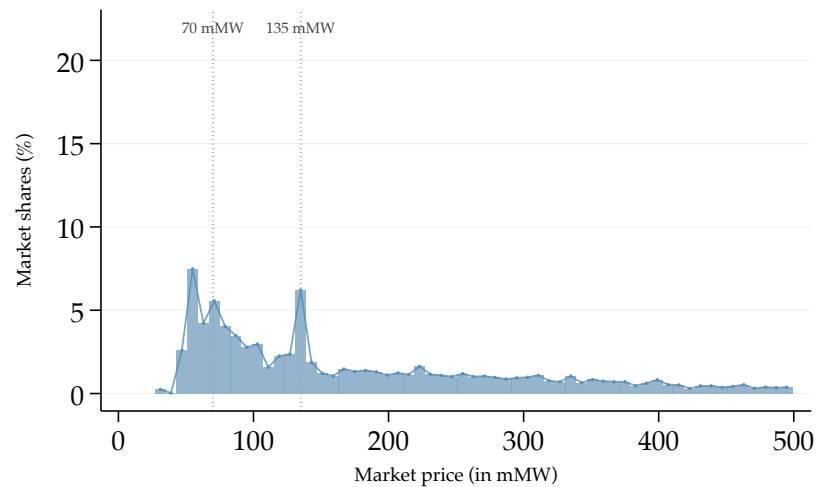
τ = Subsidy

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

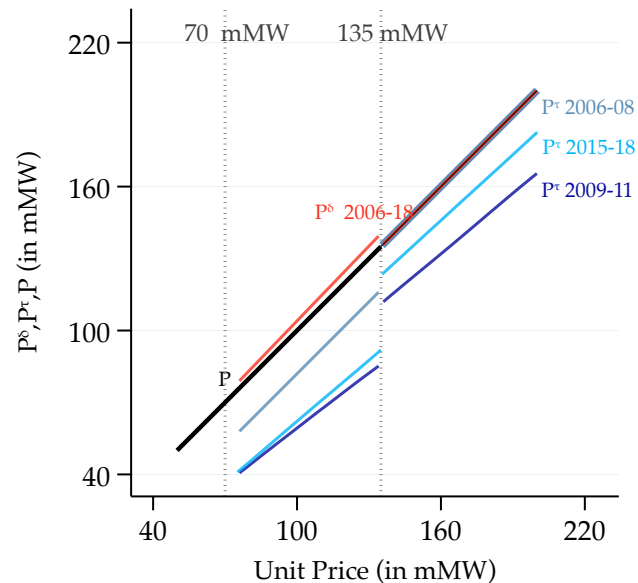
BUNCHING AT THE LOW-COST HOUSING PRICE LIMIT

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

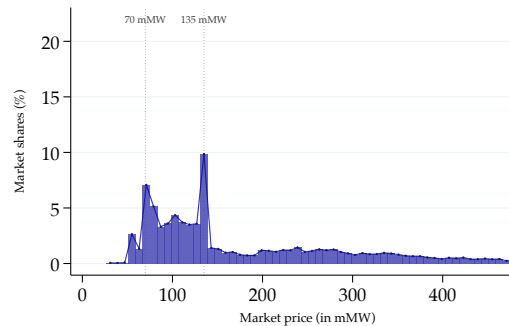
2009-11: 26 mMW

2016-18: 33 mMW

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

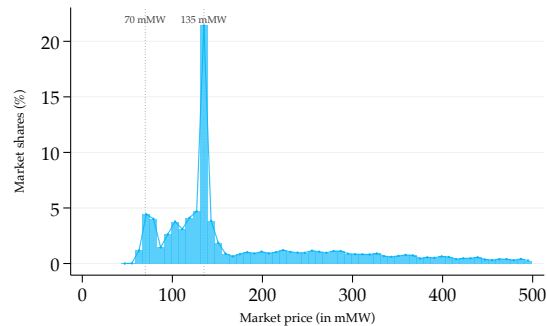
LARGER BUNCHING AS NOTCH INCREASES

Downpayment and interest rate subsidies
2009-11



Notch: 26 mMW

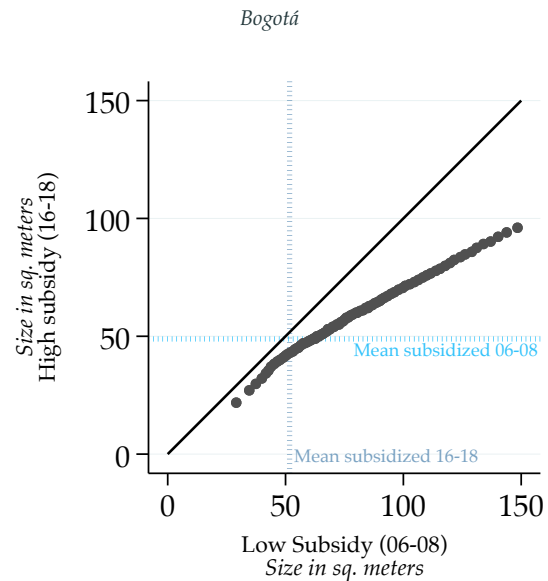
Subsidy expansion
2016-18



Notch: 33 mMW

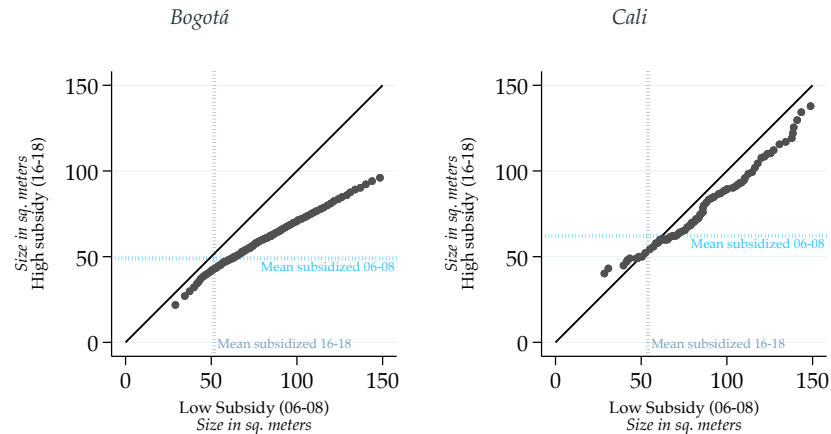
CHANGES IN HOUSING STOCK CHARACTERISTICS

- 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

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 $U(C_i, h_i; \theta)$

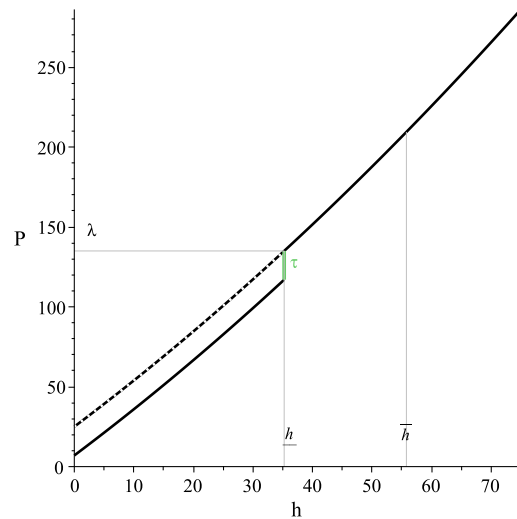
3. Developers $j \in J$, Heterogeneous in Productivity $A_j \sim G_A$

- Choose h_j to maximize profits
- Building costs $B(A_j, h_j, Q(h_j); \beta)$

4. Competitive Market Equilibrium

- Price function $P(h) \rightarrow$ clears the market $\forall h \in \mathcal{H}$

HOUSEHOLDS' OPTIMAL CHOICES



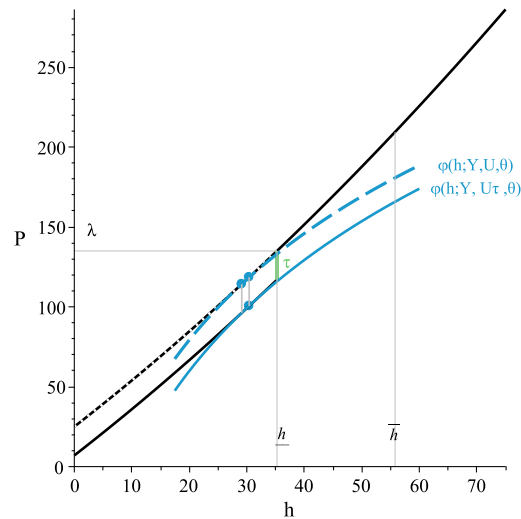
- **Implicit Price Function**

$P(h)$

- **Subsidy**

τ

HOUSEHOLDS' OPTIMAL CHOICES



- **Implicit Price Function**

$$P(h)$$

- **Subsidy**

$$\tau$$

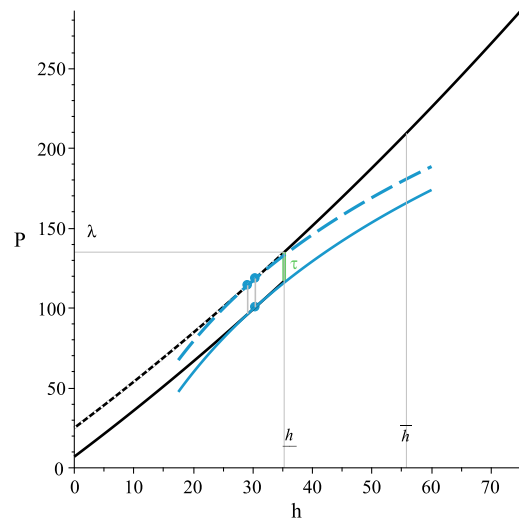
- **Bid functions**

$$\varphi_D(h, Y, \bar{U}; \theta)$$

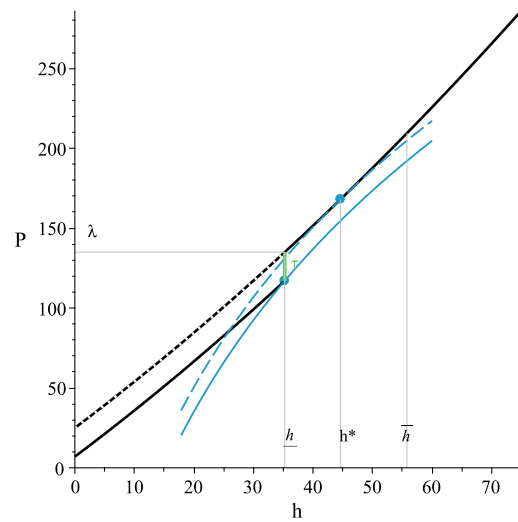
- $\bar{U} = U(h, Y_i - \varphi_D; \theta)$
- $\bar{U}_\tau = U(h, Y_i - \varphi_D + \tau; \theta)$

HOUSEHOLDS' OPTIMAL CHOICES

A. Subsidized

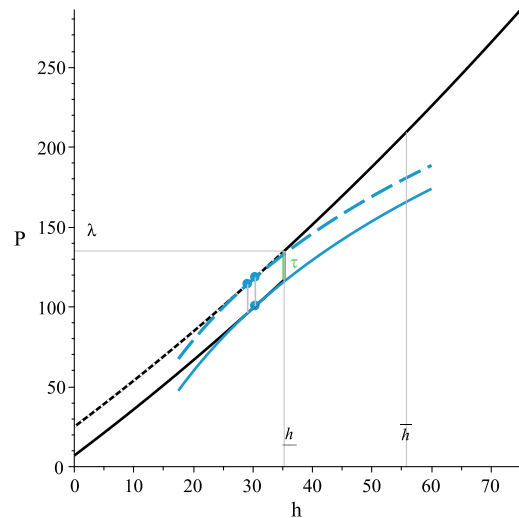


B. Marginally Subsidized and Bunchers

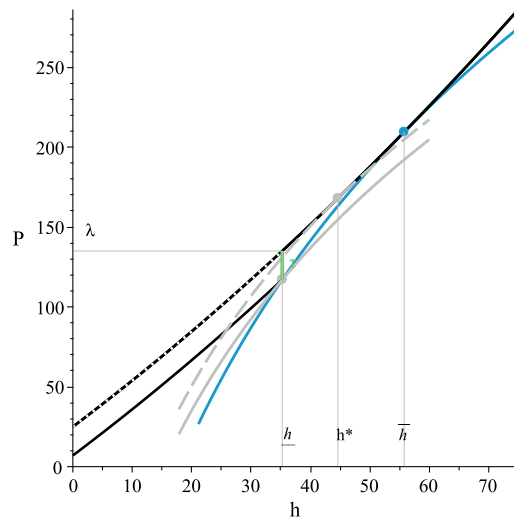


HOUSEHOLDS' OPTIMAL CHOICES

A.Subsidized



B. Marginally Subsidized and Bunchers



Housing demand function

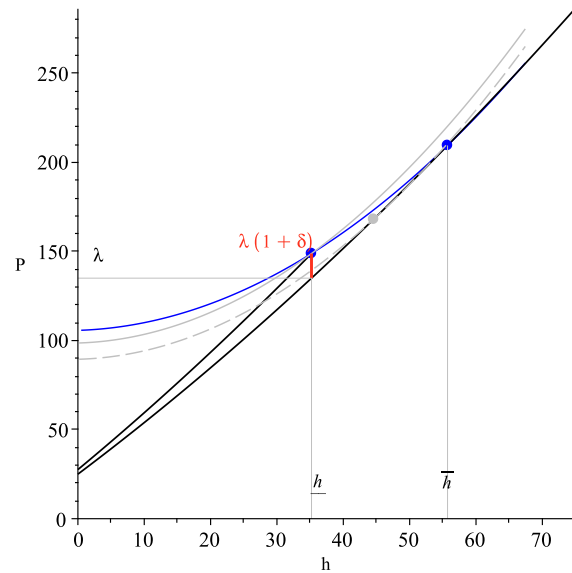
- Price function and subsidy

- 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**

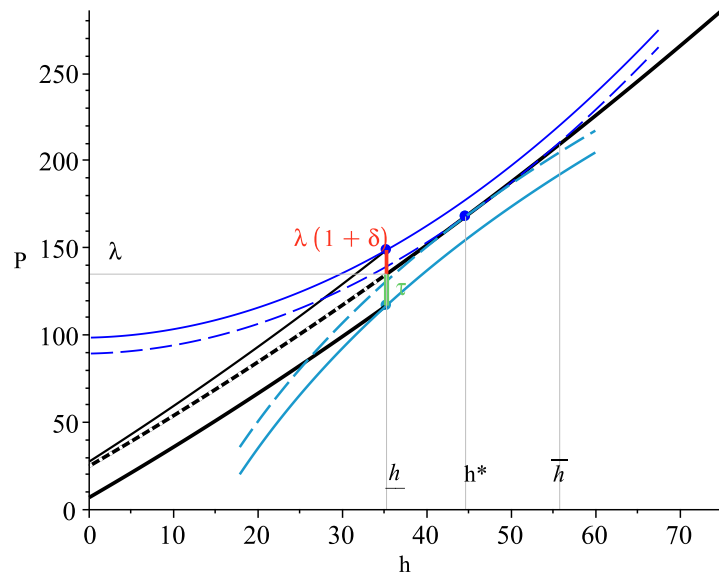
$$\varphi_S(h, A_j, \bar{\pi}; \beta)$$

$$\bar{\pi} = \pi(h, A_j, P(h); \beta)$$

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

- Following the same logic than on the demand side.

EQUILIBRIUM: DEVELOPERS AND HOUSEHOLDS MATCH

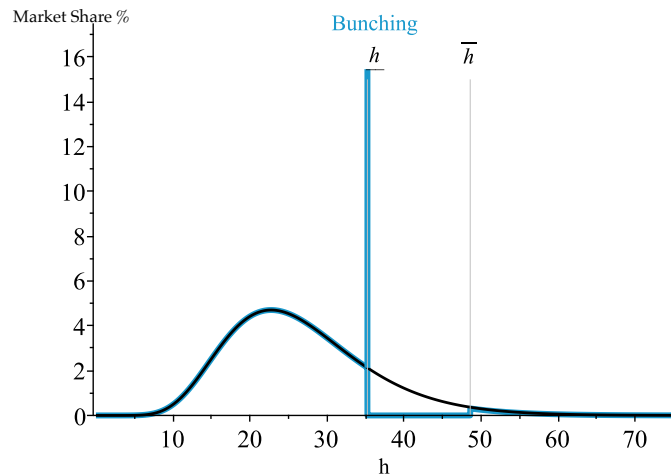


Implicit price: Envelop of offer and bid curves.

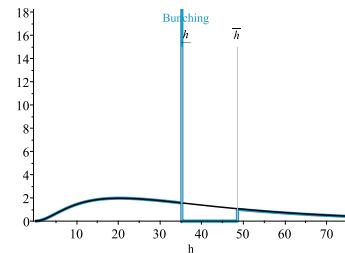
EQUILIBRIUM: AGGREGATE DEMAND AND SUPPLY DENSITY

How to aggregate? → Change of variable formula optimal choices (h^*) and the density of households (F_y) and developers (G_y) [details](#)

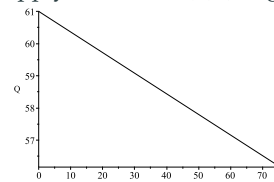
Demand Density Function



Housing types density function $g_h(h)$



Unit supply function $Q(h)$ (exogenous)

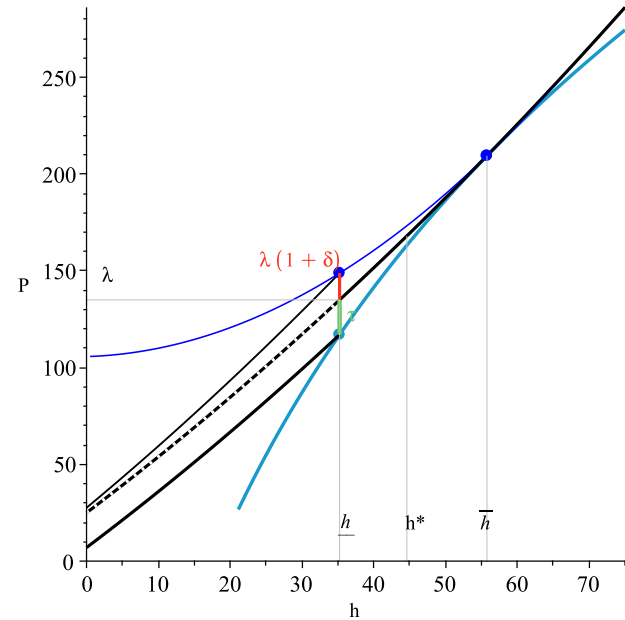


- I use the density of h to get the aggregate demand.

- 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	$V_D = U \left(\bar{Y} - P \left(\bar{h} \right), \bar{h}; \theta \right) - U \left(\bar{Y} - P^\tau \left(\underline{h} \right), \underline{h}; \theta \right) = 0$
Developer	$V_S = \pi \left(Q(\bar{h}), \bar{A}, P \left(\bar{h} \right); \beta \right) - \pi \left(Q(\underline{h}), \bar{A}; P^\delta \left(\underline{h} \right); \beta \right) = 0$

Optimality Conditions

Income	$\bar{Y} = \tilde{Y} \left(\bar{h}; \theta, P(h), \lambda \right)$
Productivity	$\bar{A} = \tilde{A} \left(\bar{h}; \beta, P(h), \lambda \right)$

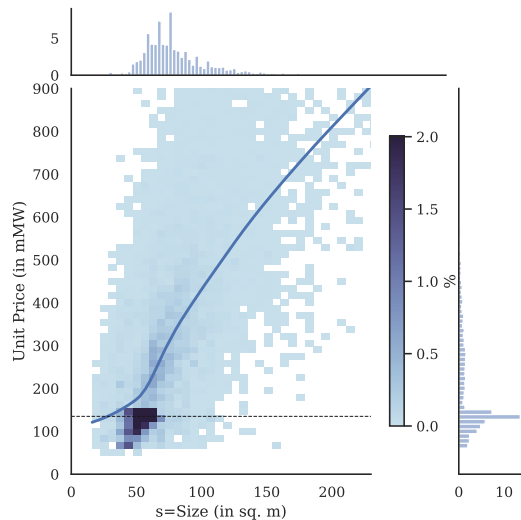
Functional Forms

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

ESTIMATION

OBSERVED EQUILIBRIUM: PRICES, QUANTITIES, AND SIZE

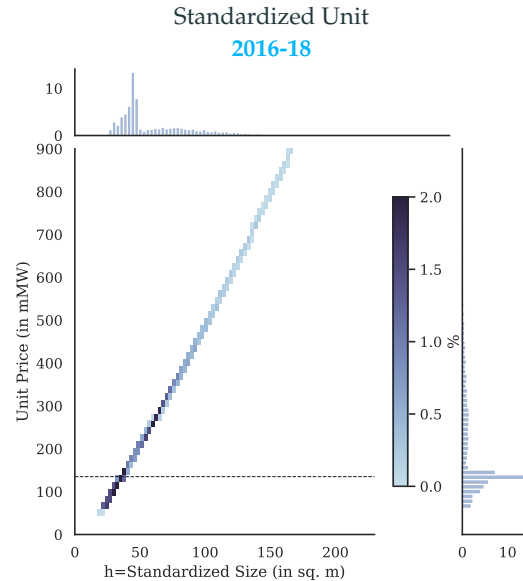
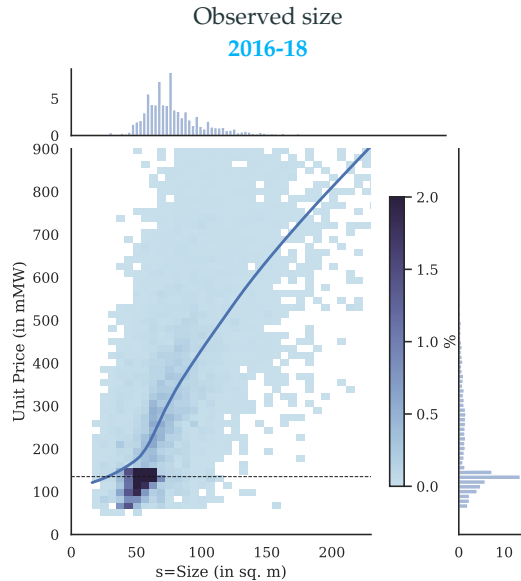
2016-18



- Solid line: price vs size
→ hedonic price function
- Multiple characteristics
→ Reduce to a single characteristic
- Standard unit size (h):
→ Size of a unit with average characteristics that costs the same price

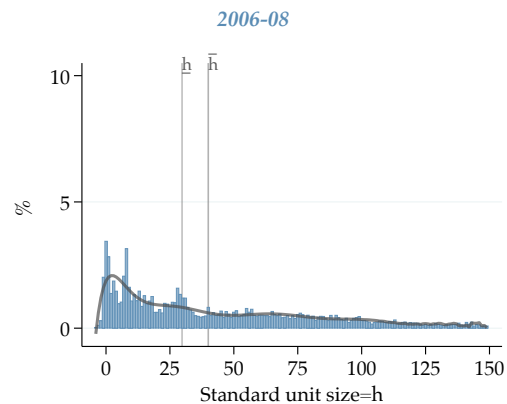
details

OBSERVED EQUILIBRIUM: PRICES, QUANTITIES, AND SIZE

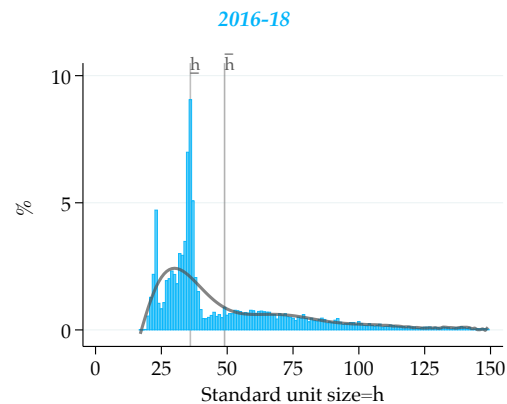


BUNCHING IN HOUSING CHARACTERISTICS

(SIZE OF STD. UNIT)



Notch: 19.7 *mMW*
 Bunching: 1.53 % *market share*
 Δh 11.2 m^2



Notch: 33.1 *mMW*
 Bunching: 14.2 % *market share*
 Δh 13 m^2

STEP I: EQUILIBRIUM CHARACTERIZATION

► Using the observed hedonic equilibrium

- Price function: $P(h)$
- Size threshold: $\underline{h} = P^{-1}(\lambda = 135mMW)$
- Standard Unit Size: \bar{h}

► Behavioural Responses:

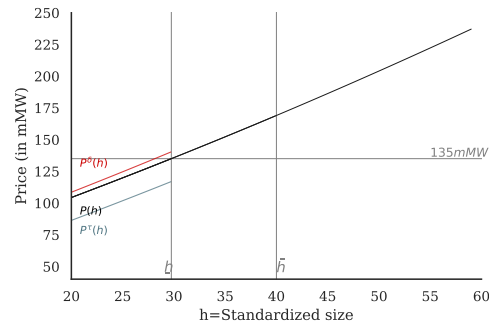
- Housing size for marginal buncher: \bar{h}

► Unit Supply Function:

- $Q = \alpha_0 + \alpha_1 \cdot h_{ltc}$ see

► Policy Parameters:

- Notches: τ_t, δ see



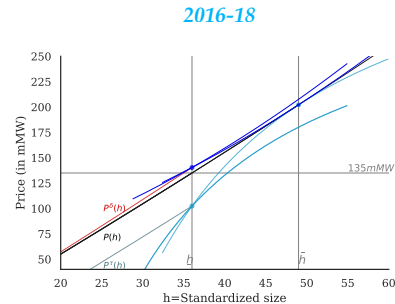
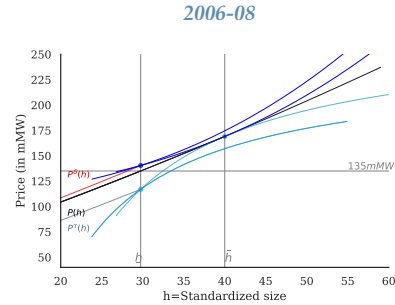
STEP II: STRUCTURAL PARAMETERS

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

Identification equations:

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

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



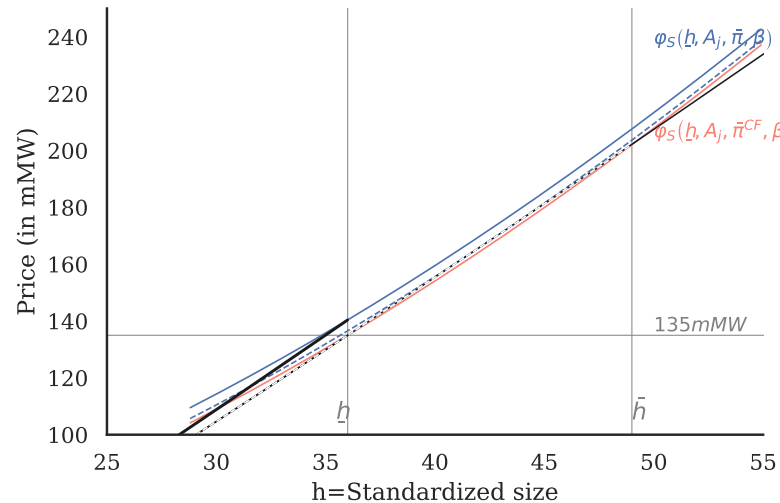
III. POLICY EVALUATION:

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”
source: El Tiempo (2021)
- ▶ Question: What happens to the marginally subsidized developers?

EFFECT ON marginALLY SUBSIDIZED DEVELOPERS

2016-18



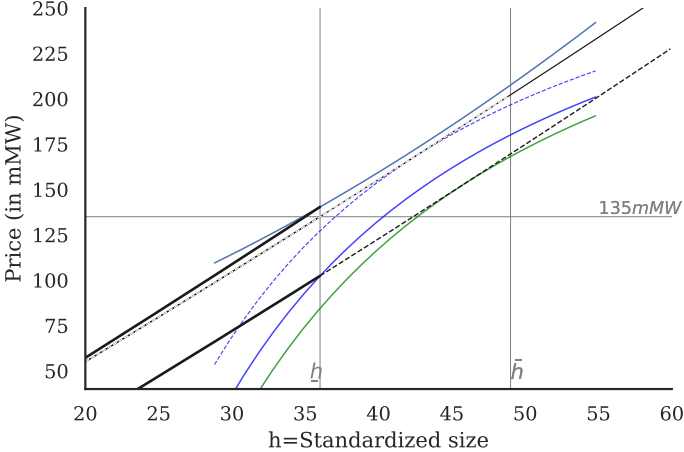
<i>Changes in profits (%)</i>	
period	$\frac{\pi - \pi^{CF}}{\pi}$
2006-08	-4.9
2009-11	-15.9
2012-15	-9.3
2016-18	-12.3

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



<i>Changes in welfare (mMW)</i>		
period	Welfare \uparrow	Efficiency \downarrow
2006-08	13.8	-10.2
2009-11	19.5	-12.1
2012-15	22.4	-16.2
2016-18	24.8	-17.9

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 \rightarrow 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.
- ▶ Two 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.
- ▶ Further, it can be applied to other markets (e.g., labor markets, drugs, etc.)

RESEARCH AGENDA

- ▶ In my research I exploit natural experiments using administrative and census data to study the impacts of large scales government investments.
 - What are effects on the population?
 - Are there any unintended consequences?
 - How do we evaluate costs?
 - What are the welfare effects?
 - How should we target subsidies?
 - Should governments invest directly or through subsidies?
 - Can we be more efficient in the way we spend the money?
- ▶ In my current projects I address these questions by studying subsidies to utilities, a push in internet expansion, the construction of the US interstate highway system and housing subsidies.

CURRENT PROJECTS

- ▶ Does the US have an Infrastructure Cost Problem? Evidence from the Interstate Highway System (2021)
with *Neil Mehrotra* and *Matthew A. Turner*
- ▶ The Effect of Location-Based Subsidies on the Housing Market (2021)
- ▶ Internet Expansion and School Performance: Evidence from Colombia (2021)
with *Aaron Weisbrod*
- ▶ The Expansion of Higher Education in Colombia: Bad Students or Bad Programs? (2021)
with *Adriana Camacho* and *Julian Messina*

WHAT'S NEXT?

I want to keep finding setting to explore these questions and propose methods to evaluate the effects of government expenditures.

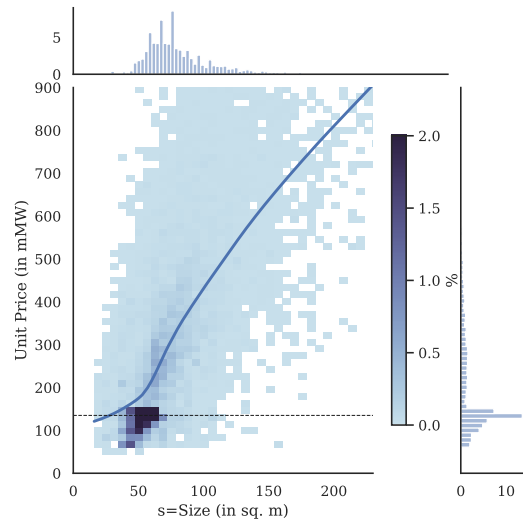
- ▶ Focus on housing subsidies
 - Study different policy approaches
 - Keep exploring the role of supply
 - Financial sector and inter-temporal decisions
 - Effects of housing policies on the labor market and other sectors
- ▶ Effects of highways or other policies like the *estratos* on urban shape and segregation patterns.

Appendix

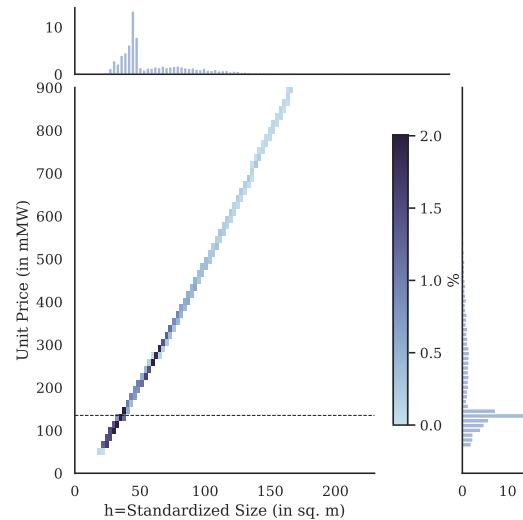
FROM SIZE s TO STANDARDIZED SIZE h

Subsidy expansion 2016-18

Observed size



Standardized Unit



HEDONIC PRICES AND STANDARDIZED HOUSING UNIT

- Hedonic price/Implicit price for housing size

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

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

- Simplifying assumption: $\rho(s_{ltc}) = \rho_1 \cdot s_{ltc} + \rho_2 \cdot s_{ltc}^2$
- Identifying assumption: $E(s_{ltc}|X_{ltc}, \omega_{ltc}) = 0$

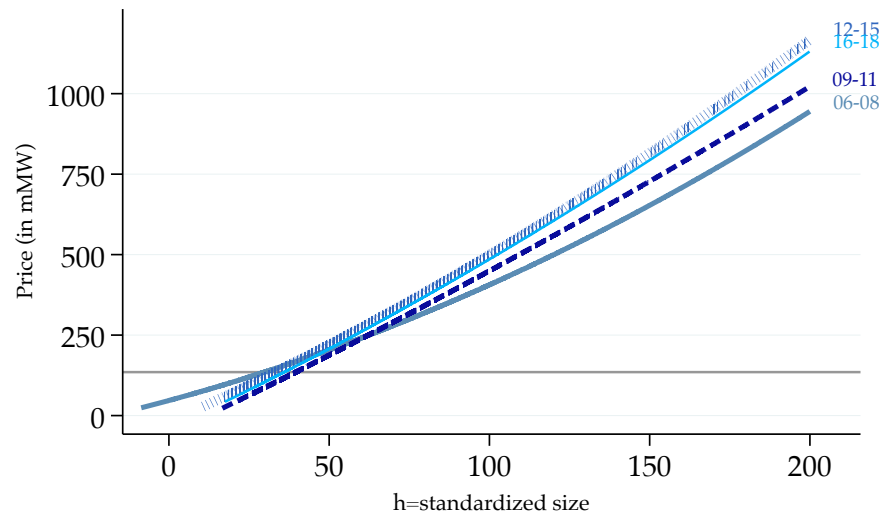
- Standard Unit Size h_{ltc}

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

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

figures

IMPLICIT PRICES FOR HOUSING SIZE OVER TIME



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

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)

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

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

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

Figures

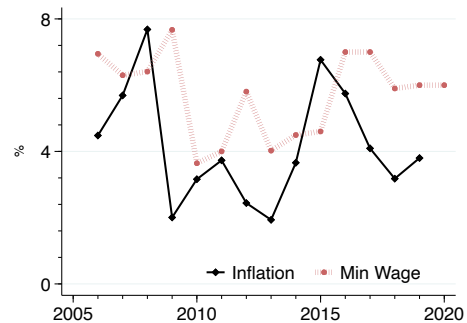
EQUILIBRIUM: DEVELOPERS AGGREGATE SUPPLY DENSITY

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

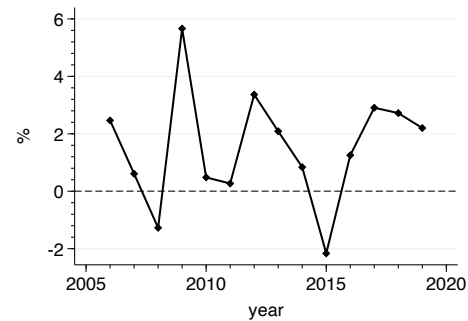
Equilibrium Figures

- Derived using the same logic as the demand side

Inflation and minimum wages.



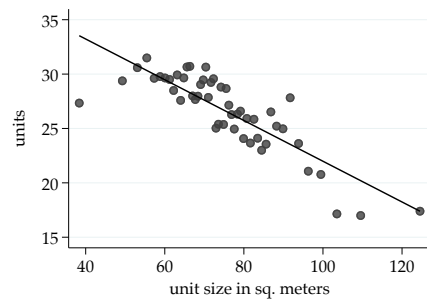
a. Min wage and Inflation



b. Min wage and Inflation

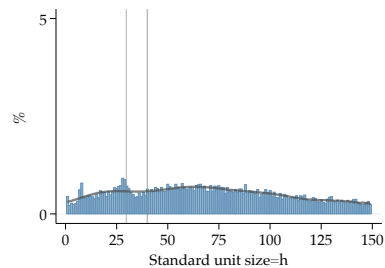
DEVELOPERS CHOICES OF SIZE AND UNIT SUPPLY

All data

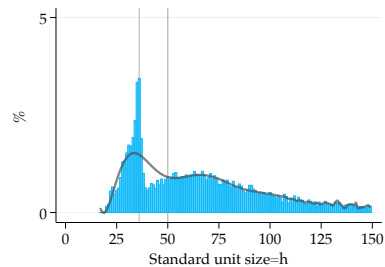


Product type density (g_h)

2006-08



2016-18



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

	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 (<i>in mMW</i>)			# Subsidies (<i>in thousand</i>)		
	τ^M	τ^i	τ	<i>down payment</i>	<i>i rate</i>	<i>Mi Casa Ya</i>
2006-08	18.0	.	18.0	47.1	.	.
2009-11	20.0	5.85	25.9	46.4	16.7	.
2012-15	19.9	9.55	29.5	41.1	22.2	.
2016-18	25.3	7.24	32.6	44.5	23.4	16.8

► Supply Notch: 4 percent

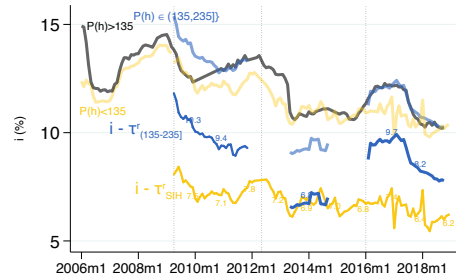
Step I

DATA: MORTGAGES AND INTEREST RATES

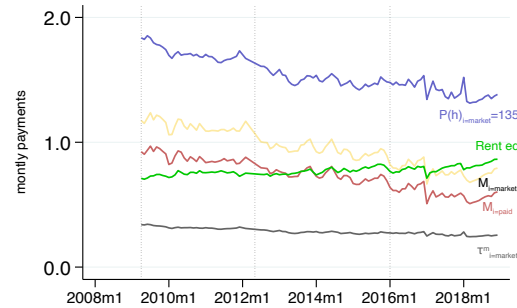
rent equivalent ((?, ?), (Bishop & Timmins, 2019) assume it is 0.05)

- 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:

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

HOUSEHOLDS' DEMAND FUNCTION

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

- 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

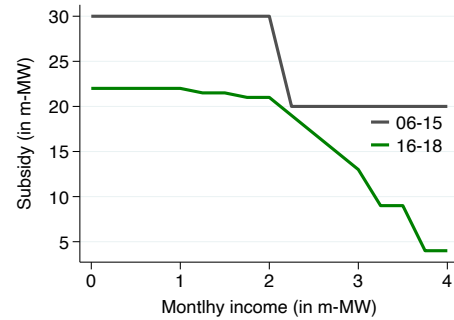
- Income has a one-to-one relationship between housing and income

- households demand for housing: math so what I just said is that the housing demand depends on the income.

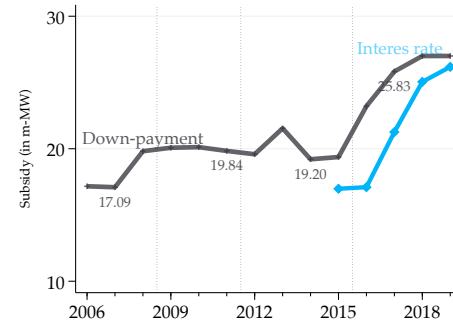
The income distribution and optimal choices I get the density of housing that satisfy the optimality conditions.

THE NOTCH: DOWN PAYMENT SUBSIDY

Subsidy by household income

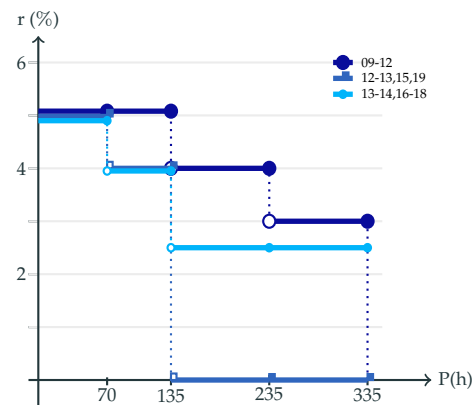


Average subsidy over time

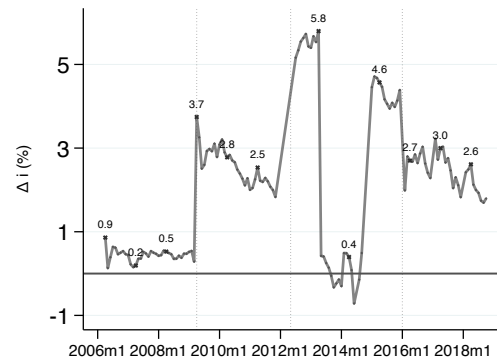


- Varies by income.
- Increase in 2016.
- Expanded trough *mi casa YA*

THE NOTCH: INTEREST RATE SUBSIDY

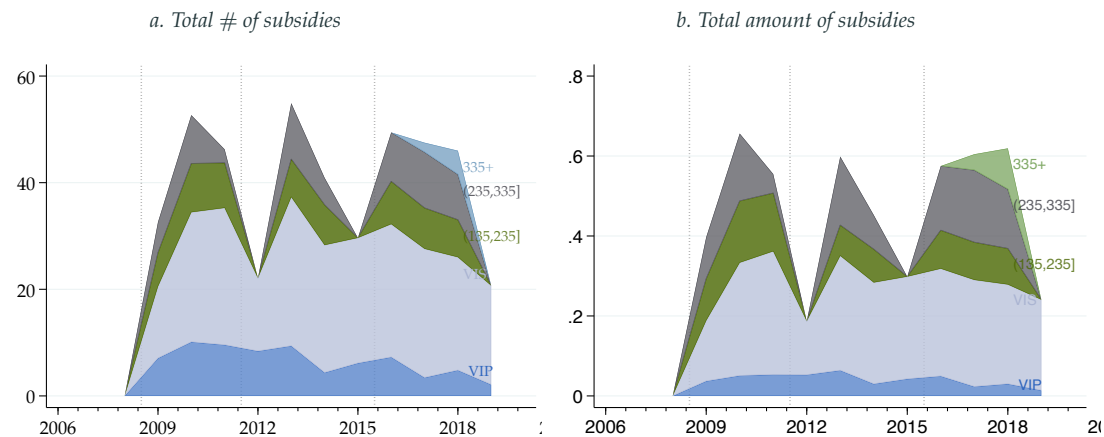


Comparing monthly payments around $P(h)=135$
m-MW



SUBSIDIES AND GOVERNMENT EXPENDITURE (VIP- $P(h) < 70$)

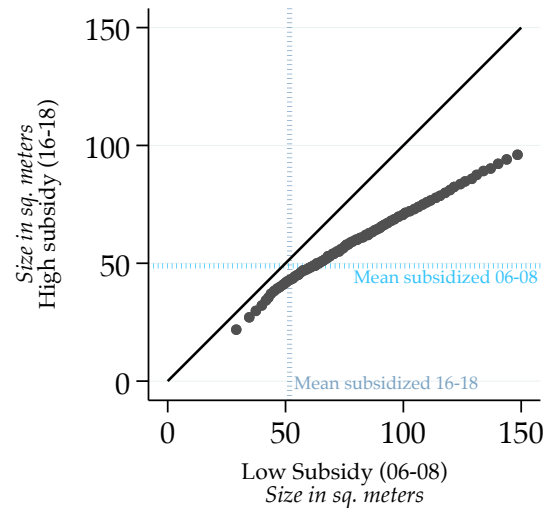
This figure shows the interest rate subsidies for all different price levels



CHANGES IN HOUSING STOCK CHARACTERISTICS

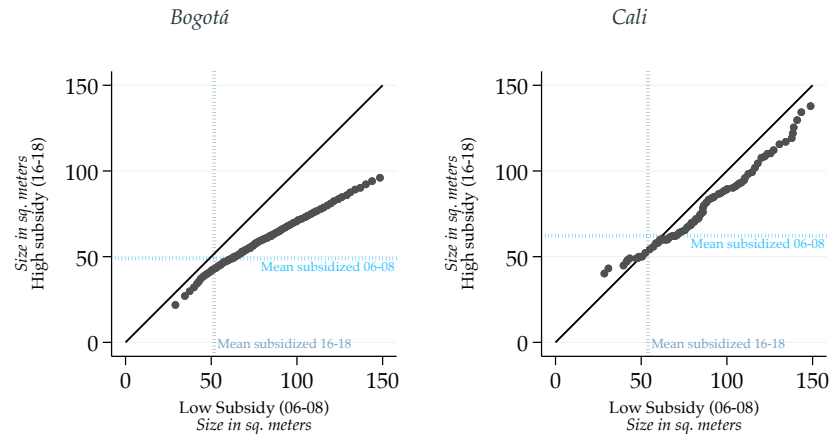
► Changes in unit size (quantile to quantile plot)

Bogotá



CHANGES IN HOUSING STOCK CHARACTERISTICS

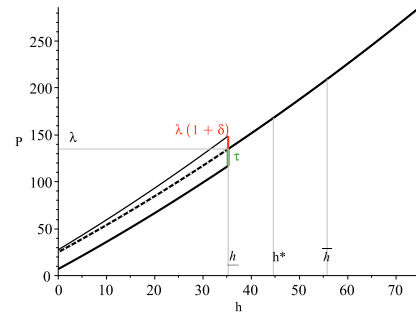
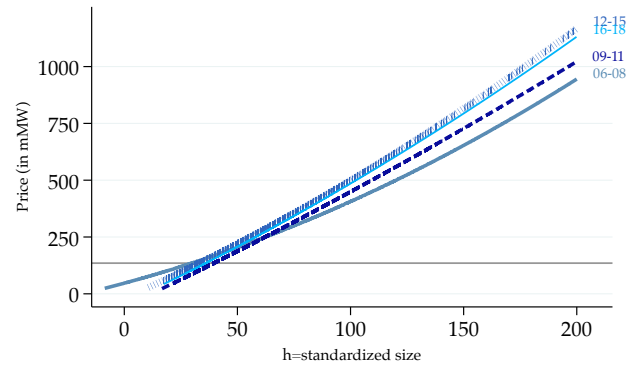
► Changes in unit size



► Why size?

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

PRICES



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THE POLICY EFFECT ON OBSERVED OUTCOMES

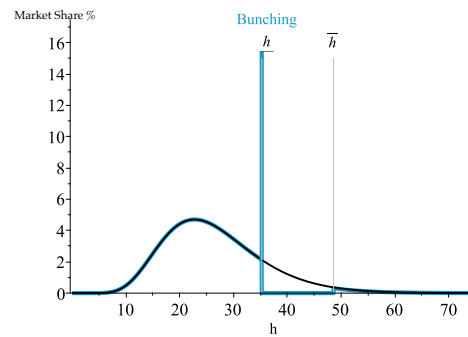
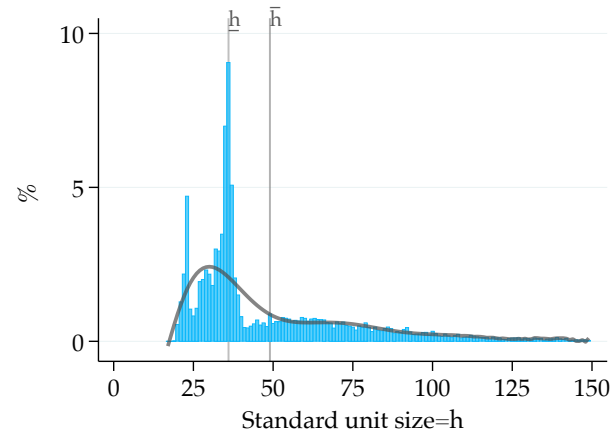
Table 1: Behavioral Responses Estimates'

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

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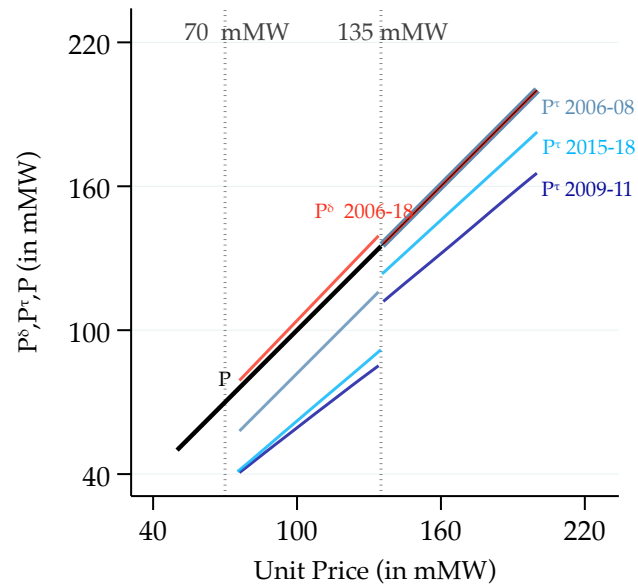
BEHAVIORAL RESPONSES

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

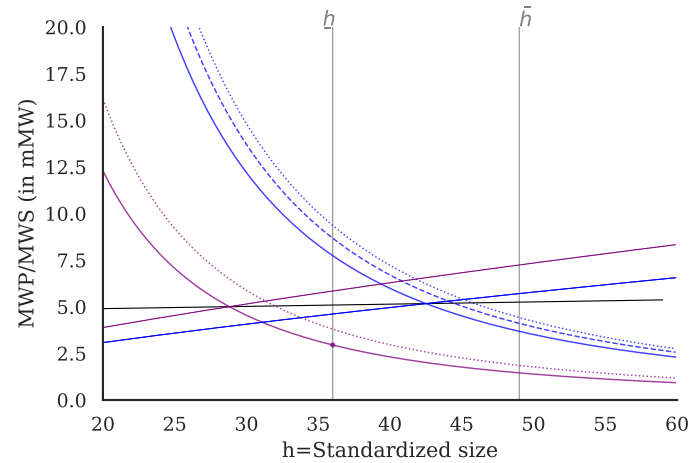
2016-18: 33.1 mMW

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

ALTERNATIVE REPRESENTATION OF THE EQUILIBRIUM.

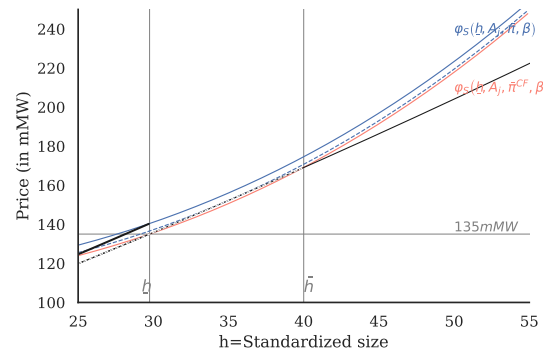
DEMAND AND SUPPLY FOR SIZE

Expansion period Mi Casa Ya 2016-18

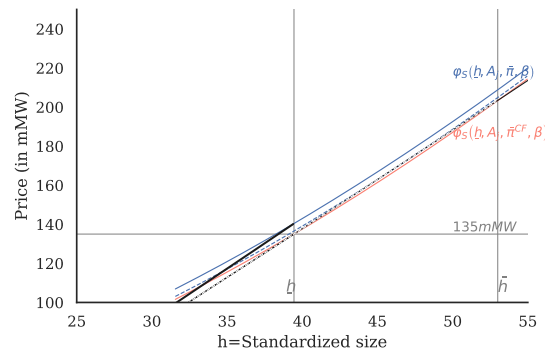


EFFECT ON marginALLY SUBSIDIZED DEVELOPERS

2006-08



2016-18

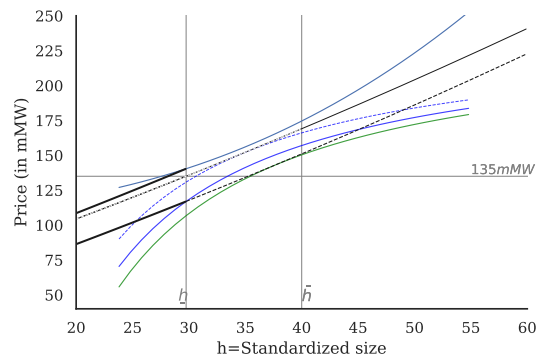


Changes in profits (%)

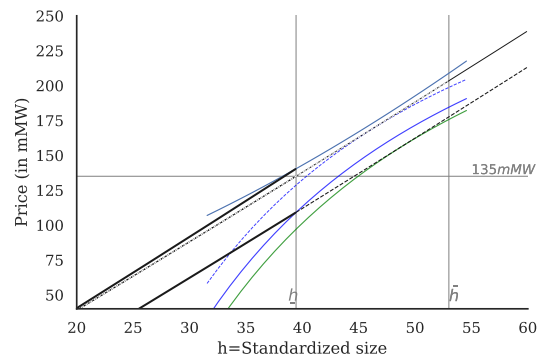
	2006-08	2009-11	2012-15	2016-18
$\frac{\pi - \pi^{PC}}{\pi}$	4.9	15.9	9.3	12.3

EFFECT ON marginALLY SUBSIDIZED HOUSEHOLDS

2006-08



2009-11



EQUATIONS

Optimality Conditions	
Income	$\bar{Y} = (2 \cdot h \cdot \rho_2 + \rho_1)^{-\frac{1}{\theta - 1}} \cdot h + h^2 \cdot \rho_2 + h \cdot \rho_1 + \rho_0$
Productivity	$\bar{A} = \frac{3 \cdot (\delta + 1) \cdot (h \cdot \alpha_1 + \alpha_0) \cdot \left(\left(h^2 \cdot \rho_2 + \frac{2}{3} \cdot h \cdot \rho_1 + \frac{1}{3} \cdot \rho_0 \right) \cdot \alpha_1 + \frac{2 \cdot \left(h \cdot \rho_2 + \frac{\rho_1}{2} \right) \cdot \alpha_0}{3} \right)}{h^{\beta_1 + 1} \cdot \alpha_1^2 + h^{\beta_1} \cdot \alpha_0 \cdot \alpha_1 + 2 \cdot h \cdot (h \cdot \alpha_1 + \alpha_0)^2}$
Marginal Buncher Condition	
Household	$0 = \left(\frac{\underline{h}^\theta + \left(\bar{h}^2 \rho_2 - \rho_2 \underline{h}^2 + \bar{h} \rho_1 + \bar{h} (2 \bar{h} \rho_2 + \rho_1)^{\frac{1}{1 - \theta}} - \rho_1 \underline{h} + \tau \right)^\theta}{2} \right)^{\frac{1}{\theta}} - \left(\frac{\left((2 \bar{h} \rho_2 + \rho_1)^{\frac{\theta}{1 - \theta}} + 1 \right) \bar{h}^\theta}{2} \right)^{\frac{1}{\theta}}$
Developer	$0 = \frac{\bar{h}^{\beta_1 + 1} \alpha_1 - \underline{h}^{\beta_1 + 1} \alpha_1 + \alpha_0 (\bar{h}^{\beta_1} - \underline{h}^{\beta_1})}{\bar{h}^{\beta_1 + 1} \alpha_1^2 + \bar{h}^{\beta_1} \alpha_0 \alpha_1 + 2 \bar{h} (\bar{h} \alpha_1 + \alpha_0)^2} - \frac{\left(-\rho_2 (1 + \delta) \underline{h}^3 - \rho_1 (1 + \delta) \underline{h}^2 - \rho_0 (1 + \delta) \underline{h} + \bar{h} \left(\bar{h}^2 \rho_2 + \bar{h} \rho_1 + \rho_0 \right) \right) \alpha_1 + \alpha_0 \left(-\rho_2 (1 + \delta) \underline{h}^2 - \rho_1 (1 + \delta) \underline{h} + \bar{h}^2 \rho_2 + \bar{h} \rho_1 - \delta \rho_0 \right)}{3 \left(\left(\bar{h}^2 \rho_2 + \frac{2}{3} \bar{h} \rho_1 + \frac{1}{3} \rho_0 \right) \alpha_1 + \frac{2 (\bar{h} \rho_2 + \frac{\rho_1}{2}) \alpha_0}{3} \right) (\bar{h} \alpha_1 + \alpha_0)}$