The Impact of Airbnb on the Housing Market: Estimates from New York City Before COVID-19

Sophie Calder-Wang

November 13, 2020

Motivation

- Rapid growth of the sharing economy facilitated by technology
  - Reduction in transaction costs
  - Under-utilized assets become accessible online
  - Services are produced by individuals rather than firms
- Prominent home-sharing platform Airbnb
  - YoY growth of over 30% for the last decade
  - Over 7 million listings, larger than any hotels
  - Transform the housing market
- Active political and regulatory debates

Active Political and Regulatory Debates

The New York Times

New York City Looks to Crack Down on Airbnb Amid Housing Crisis

A crowd protesting Airbnb in front of City Hall last month.
Rick Loomis for The New York Times

By Zoe Greenberg

July 18, 2018

The New York Times

Judge Blocks New York City Law Aimed at Curbing Airbnb Rentals

Protesters rallying against Airbnb in Manhattan in June. City officials say online home-sharing sites have aggravated New York's housing shortage.
Rick Loomis for The New York Times

By Benjamin Weiser and J. David Goodman

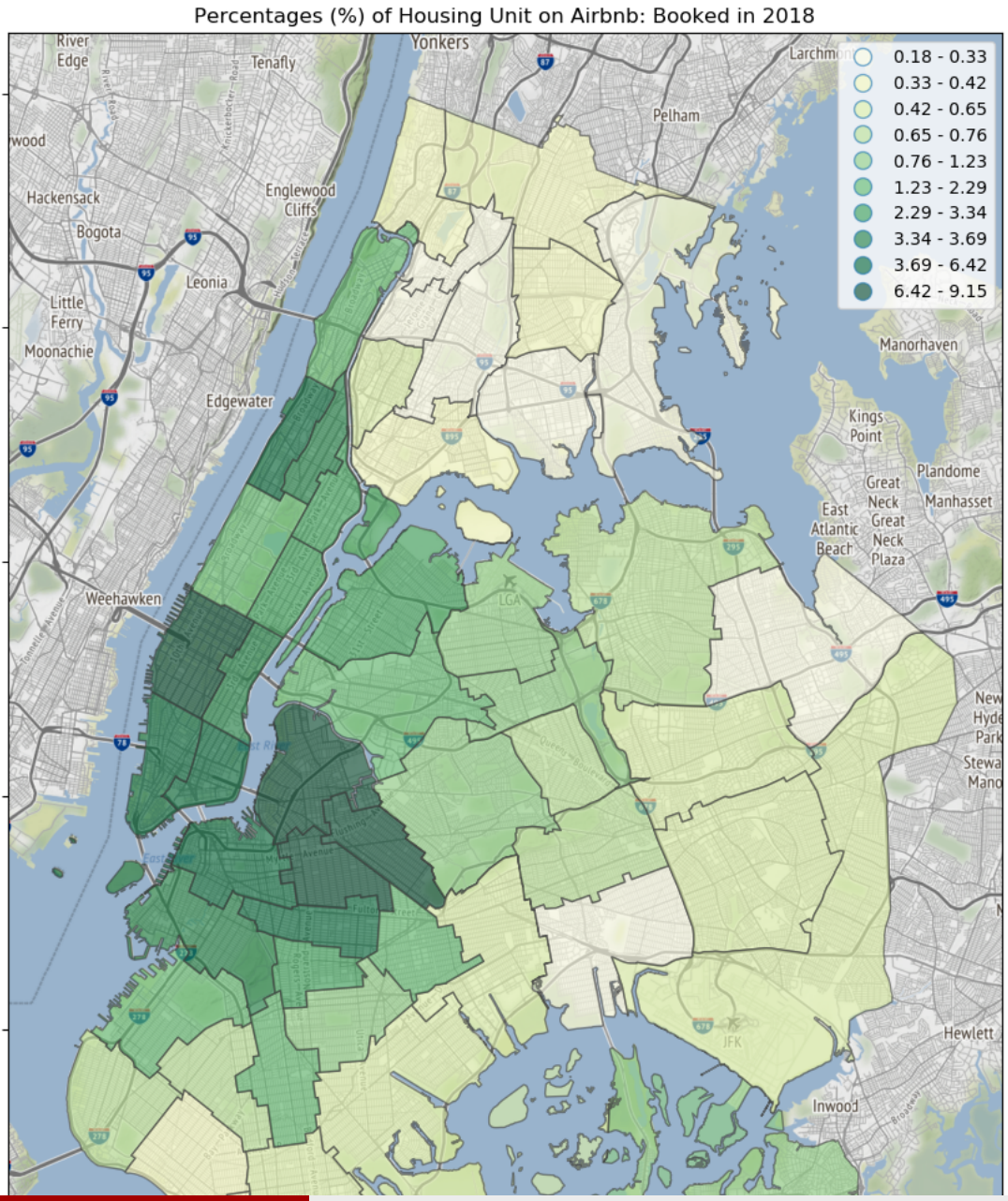
Jan. 3, 2019

Research Question

What is the impact of the sharing economy on participants of the housing market?

- What is the welfare and distributional impact of Airbnb on renters of NYC?
  - **Utilization effects**
    - Benefit residents who share their homes
  - **Reallocation effects**
    - Raise rents as landlords reallocate housing units away
  - How does it vary by income, education, race, and family structure?

Setting: Airbnb in New York City



- Largest Airbnb market in the US
- Substantial variation by geography:
  - Chelsea, Williamsburg: $> 8\%$
  - Dedicated entire homes: 0.7%

Preview

- **Approach**
  - A structural model of an integrated housing market
  - Housing as a differentiated-product market with many attributes
  - Heterogeneity in housing demand and Airbnb supply

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- **Approach**
  - A structural model of an integrated housing market
  - Housing as a differentiated-product market with many attributes
  - Heterogeneity in housing demand and Airbnb supply

- **Findings**
  1. Reallocation effects dominate the utilization effects for renters
     - Loss from rent increases -$2.7bn
     - Gain from host surpluses +$300mm
  2. Increased rent burden falls more on high-income, educated, and white renters
  3. Utilization gains help only a small fraction of low-cost hosts

Outline

Literature

- Residential choices and housing policy:
  - Housing choice: McFadden (1978), Quigley (1985), Bayer, Ferreira, McMillan (2007), Bayer, McMillan, Murphy, Timmins (2016), Epple, Quintero, Sieg (2019)
  - Housing policy: Gyourko (2009), Gyourko and Molloy (2015), Autor, Palmer, Pathak (2014), Diamond, McQuade, and Qian (2017), Ganong and Shoag (2017), Hsieh and Moretti (2019), Favilukis, Mabille, Van Nieuwerburgh (2019), Nathanson (2019)
- Nascent literature on the sharing economy:
  - Car/Ride Sharing: Cramer and Krueger (2016), Cohen, Levitt, Metcalfe (2016), Hall, Horton, and Knoepfle (2017), Fraiberger and Sundararajan (2017), Cook, Diamond, Hall, List, and Oyer (2018), Asadpour, Lobel, and van Ryzin (2020)
  - Home Sharing: Edelman, Luca, and Svirsky (2017), Farronato and Fradkin (2018), Horn and Merante (2017), Barron, Kung, and Proserpio (2017), Garcia-Lopez, Jofre-Monseny, Mazza, and Segu (2019), Valentin (2019), Jaffe, Levitt, and Popov (2019)
- This paper:
  - The first structural model to estimate the impact of Airbnb on the housing market
  - Distributional implications through heterogeneous preferences
  - A novel way to estimate a heterogeneous supply system

Data

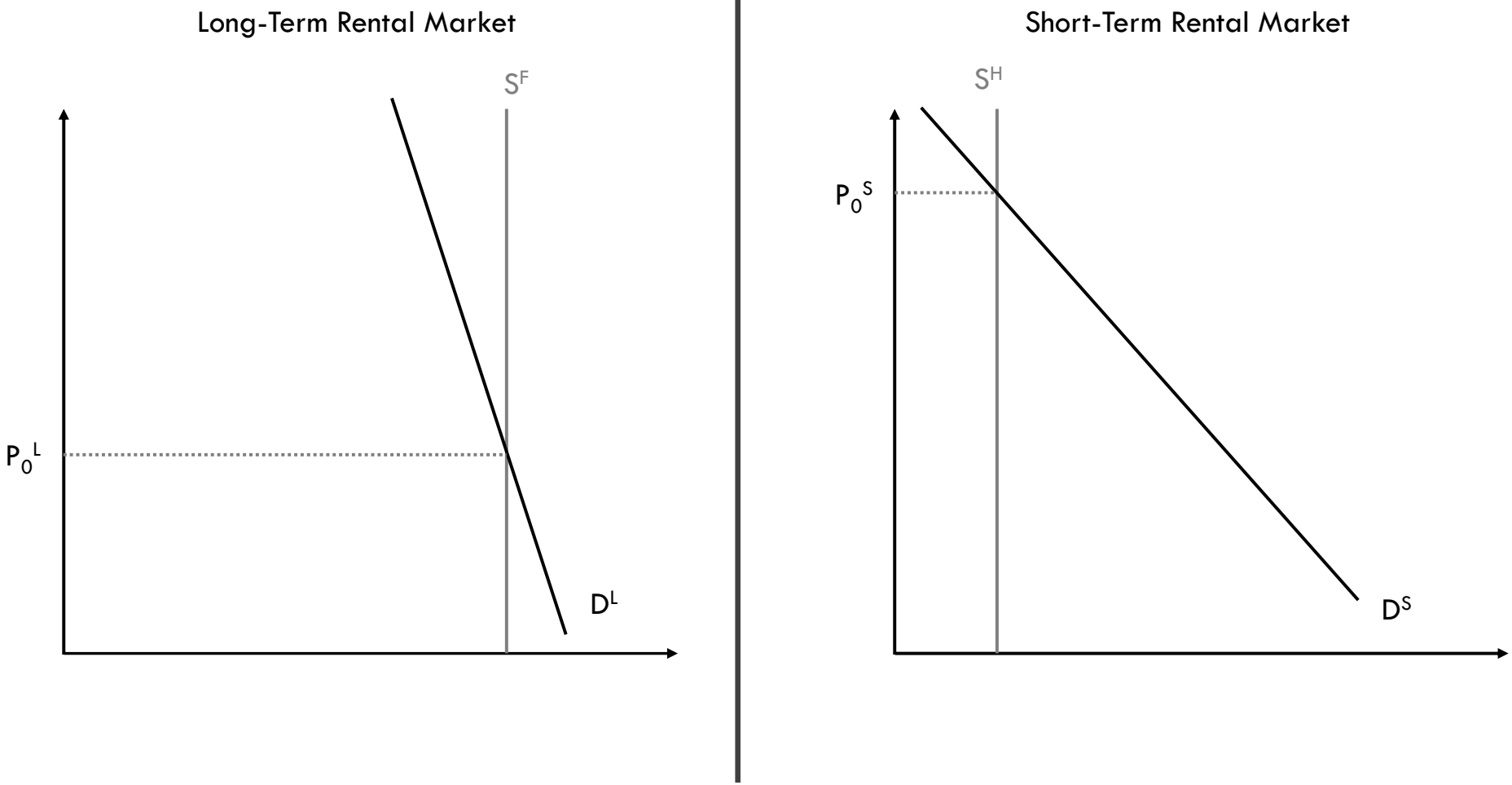
- Airbnb Usage
  - Scraped Airbnb.com data by a third party since 2014
  - Property characteristics:
    - Location (latitude and longitude)
    - Type of property, number of bedrooms
  - Detailed transaction-level data:
    - Daily performance of each property in New York
    - Price and quantity

- American Community Survey (ACS) Microdata
  - Individual-level housing choices
    - Demographics: Income, education, race, age, household size etc.
    - Housing: location, rent, physical attributes
    - Approximate neighborhoods:
      NYC has 55 public-use micro areas (PUMA)

Outline

A Stylized Model

Reallocation from Long-term to Short-term Rental



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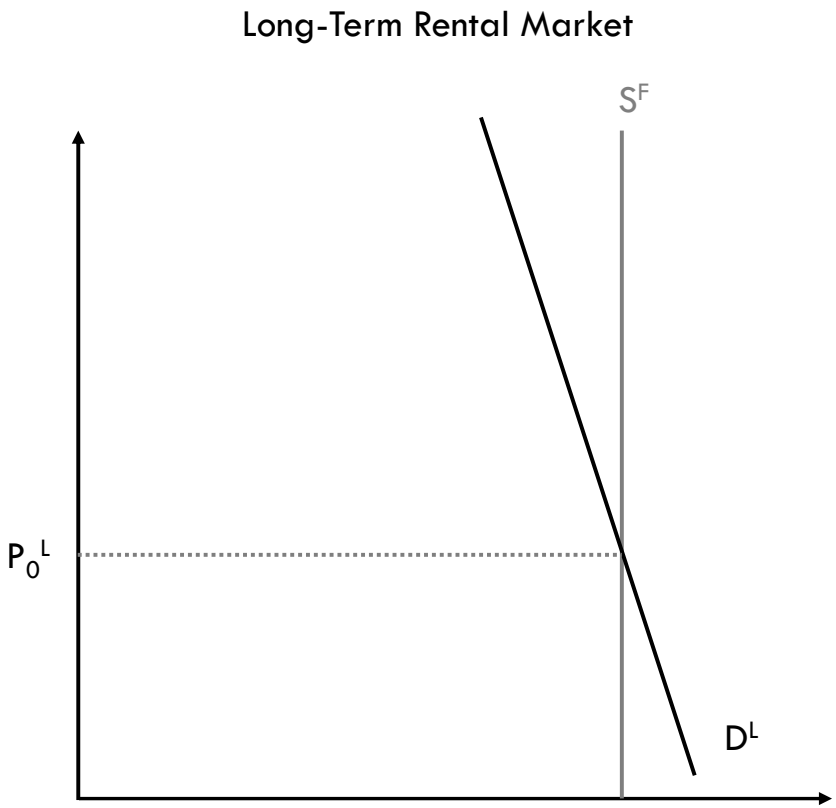

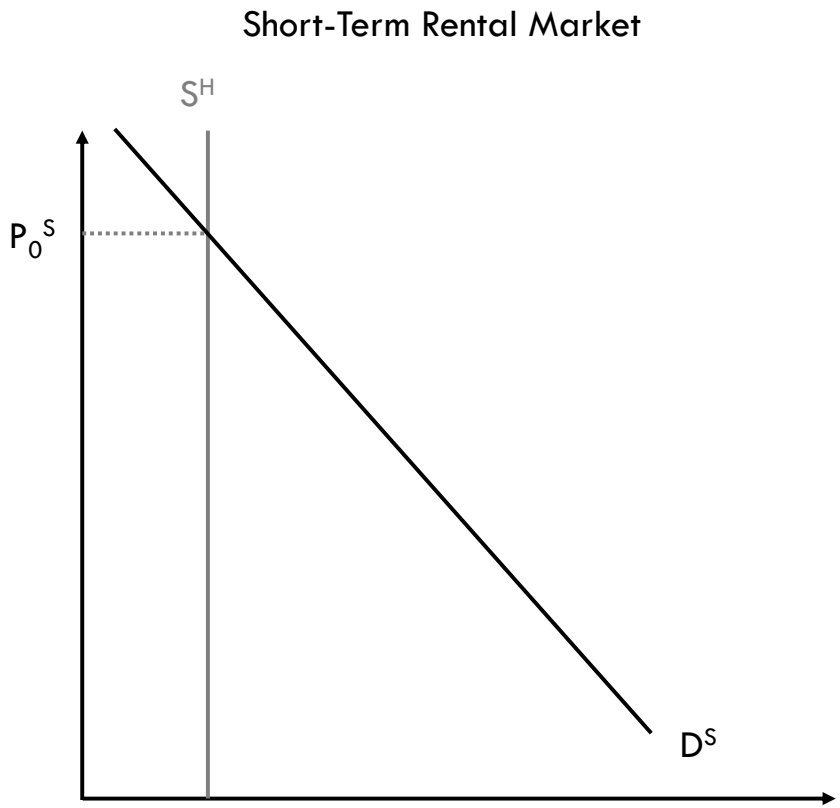

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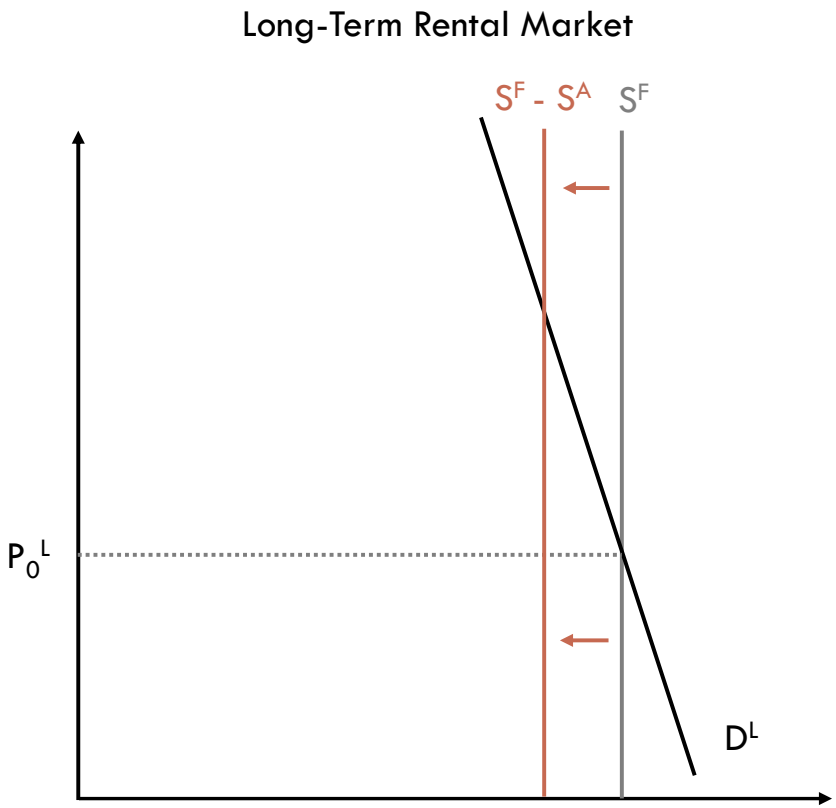

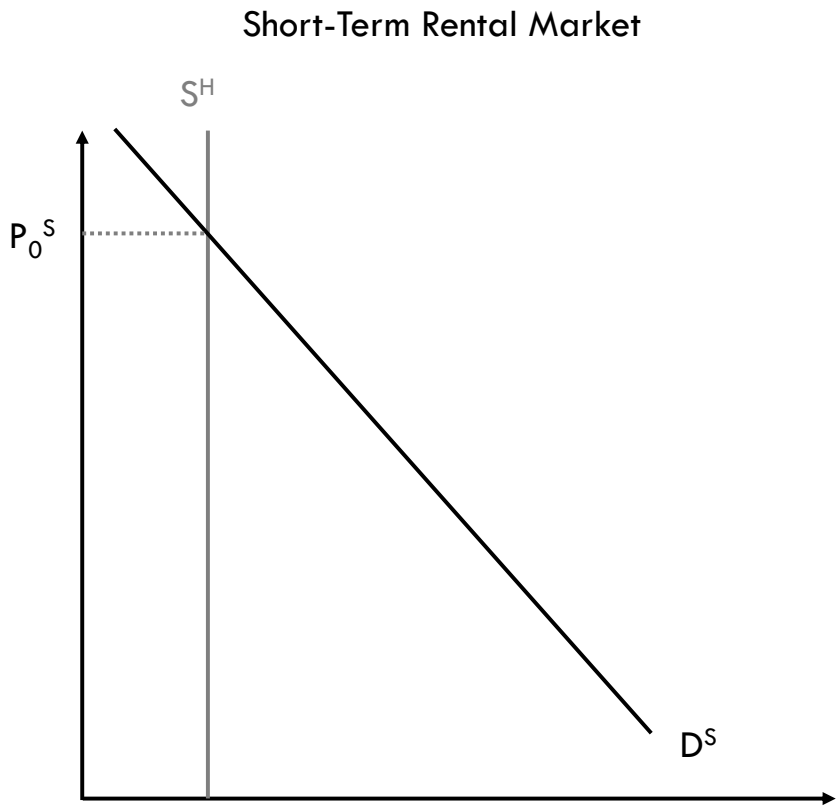

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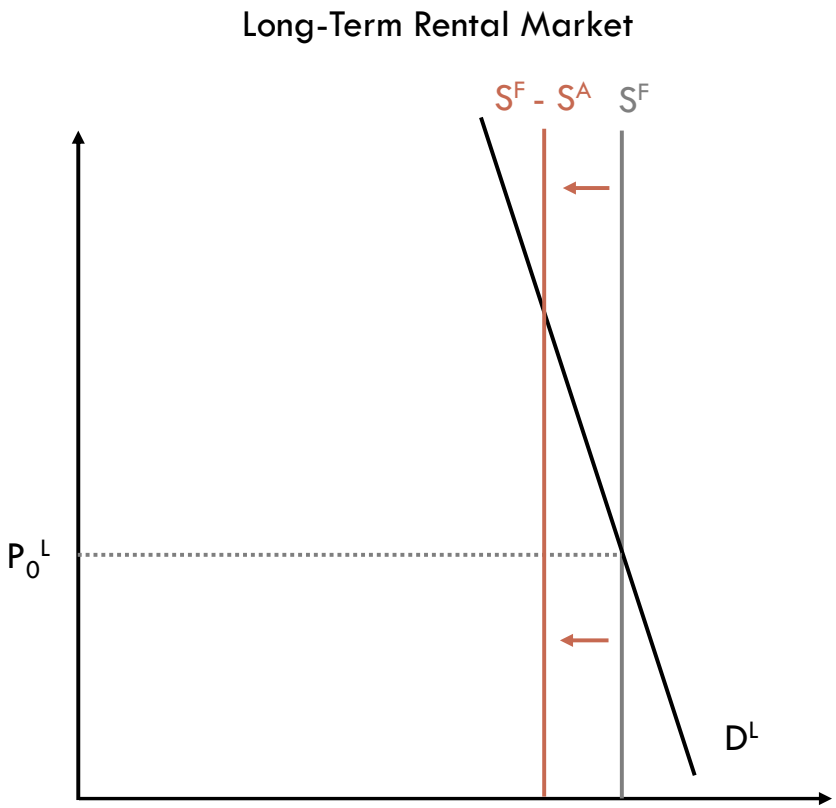

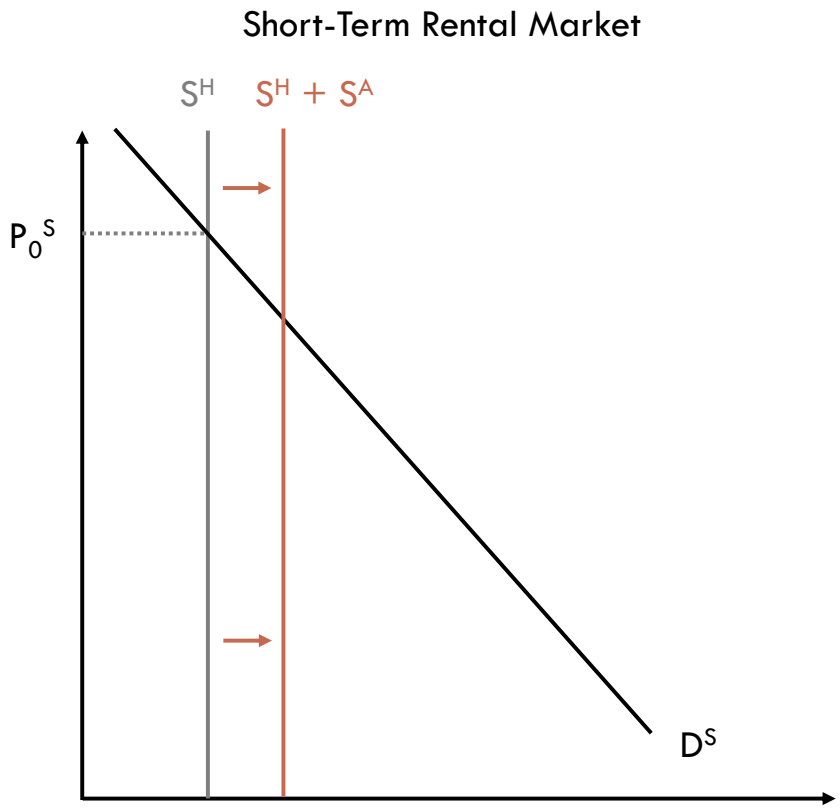

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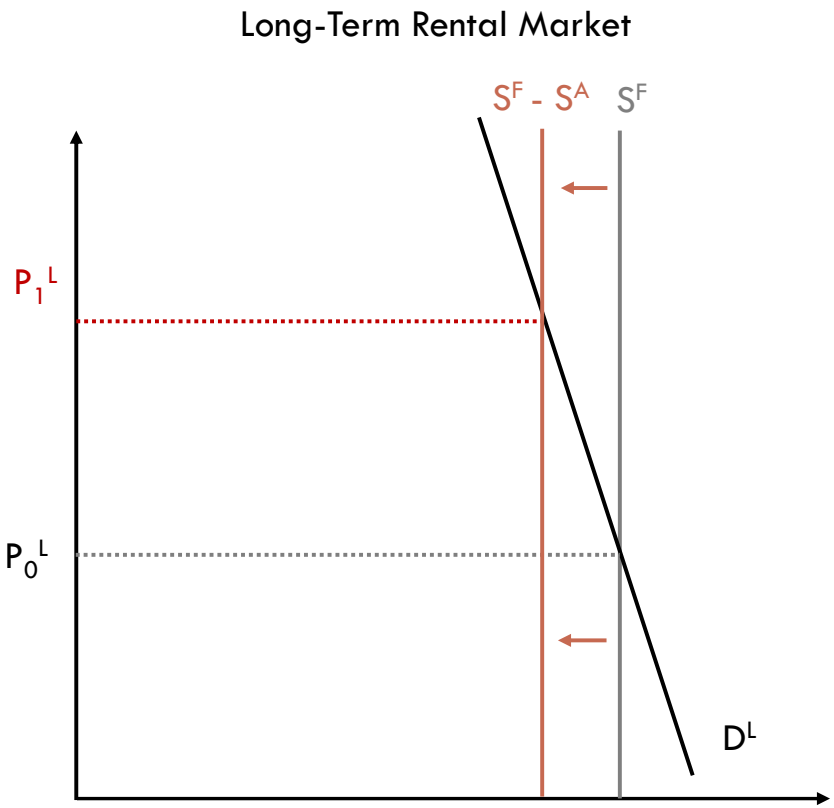

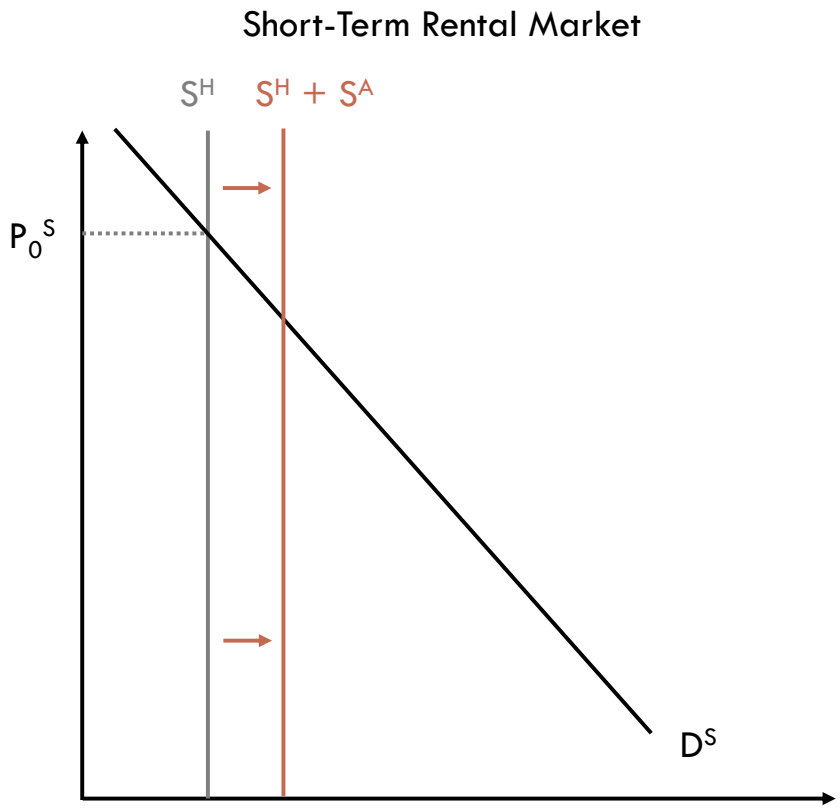

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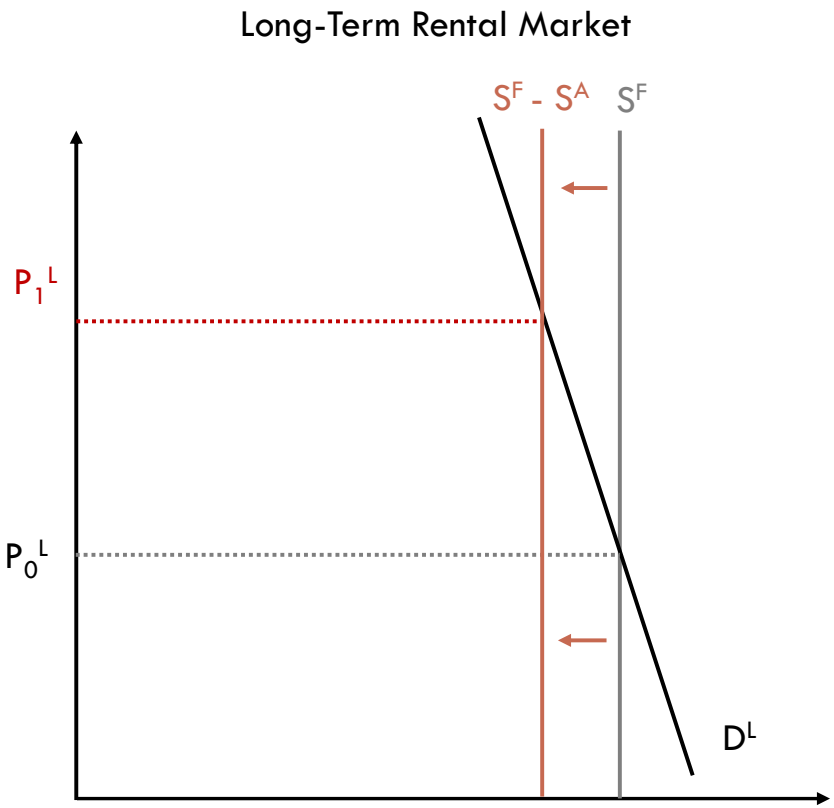

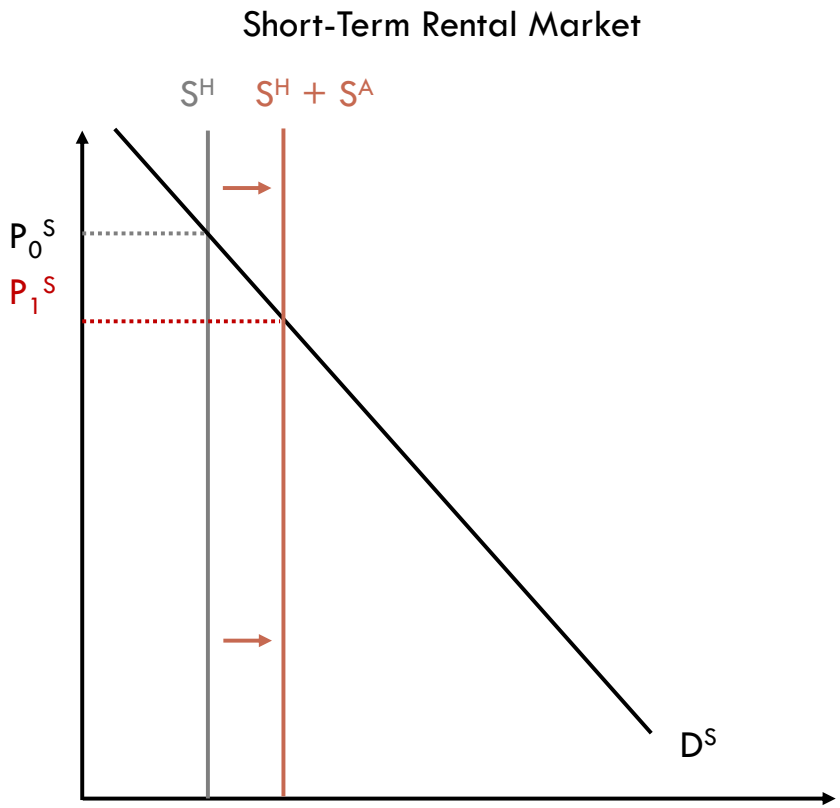

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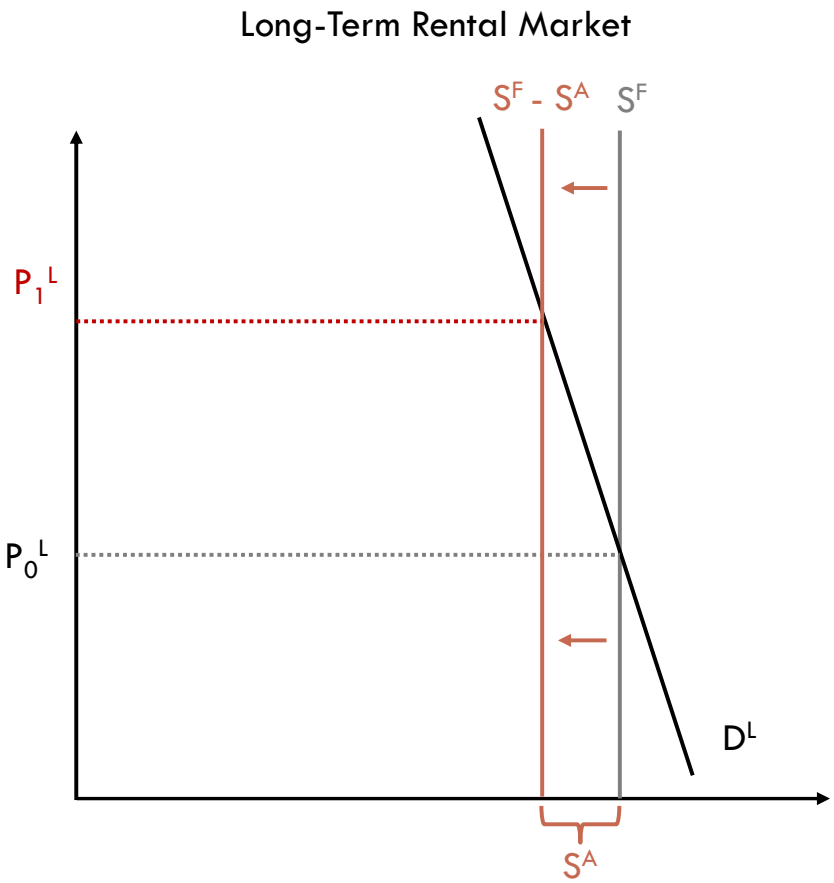

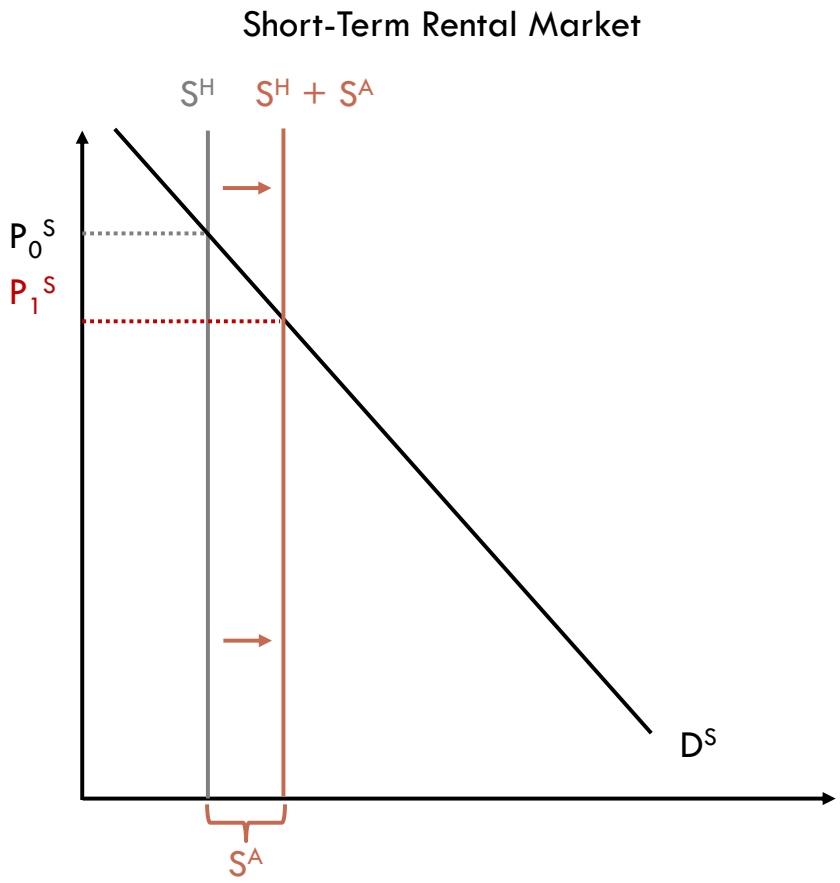

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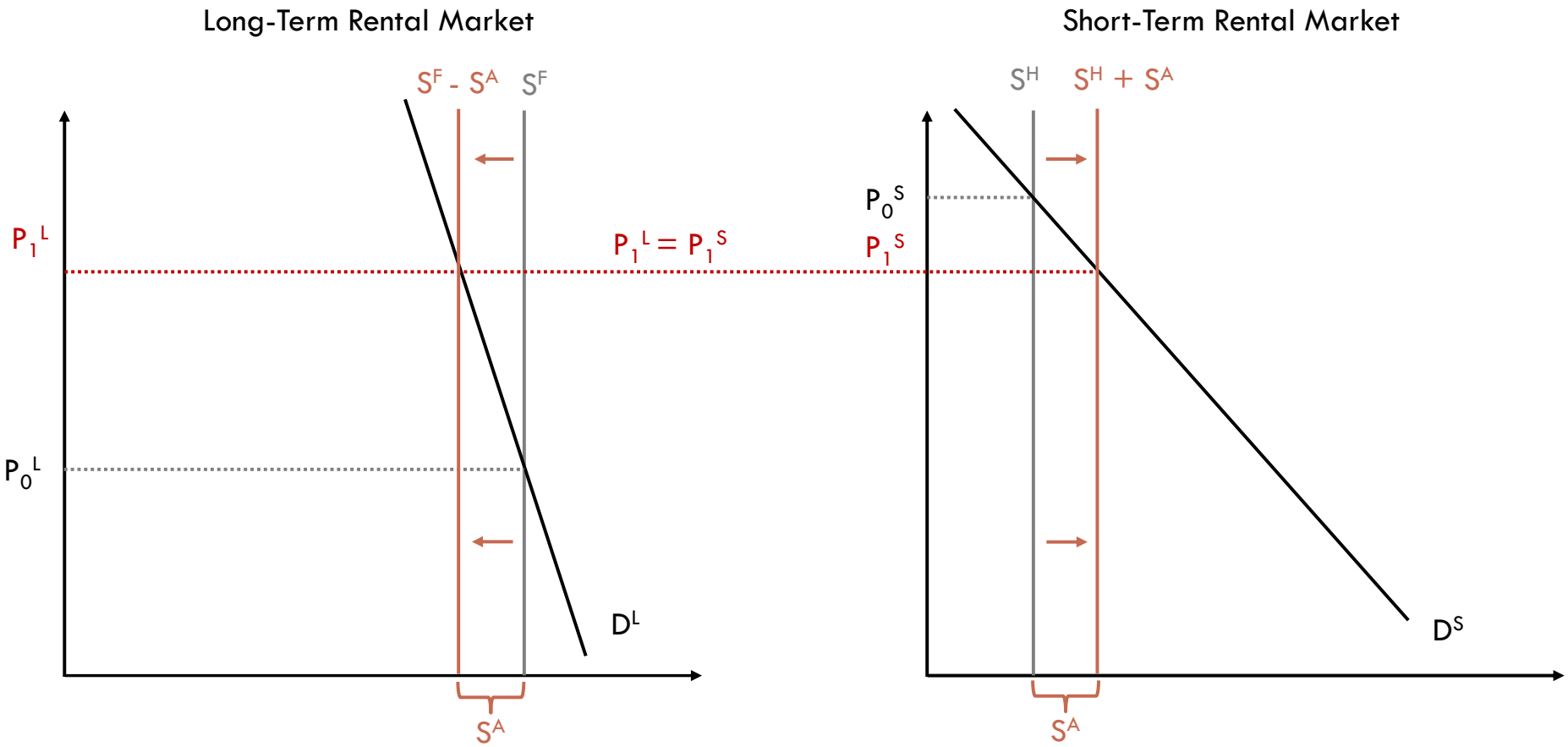

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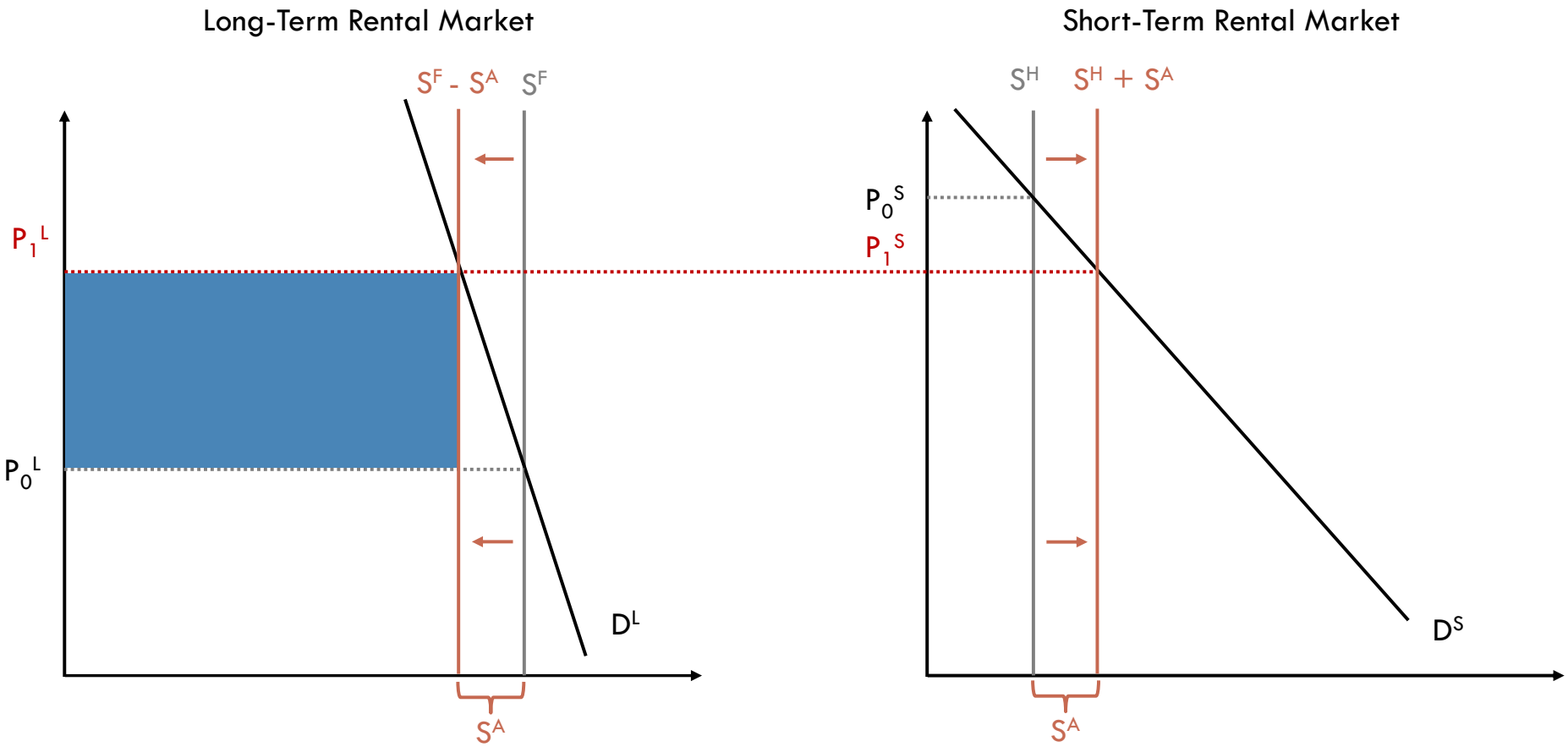

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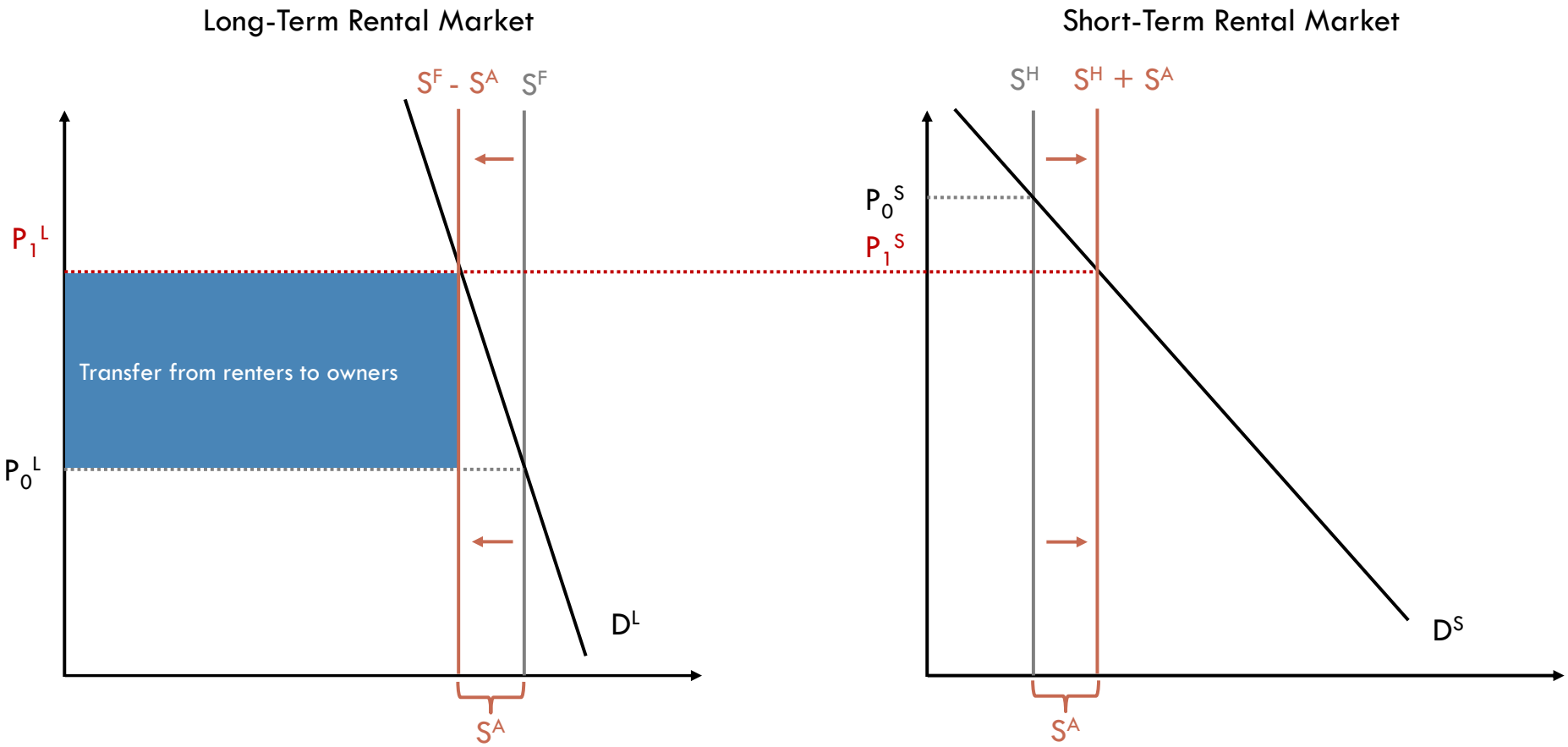

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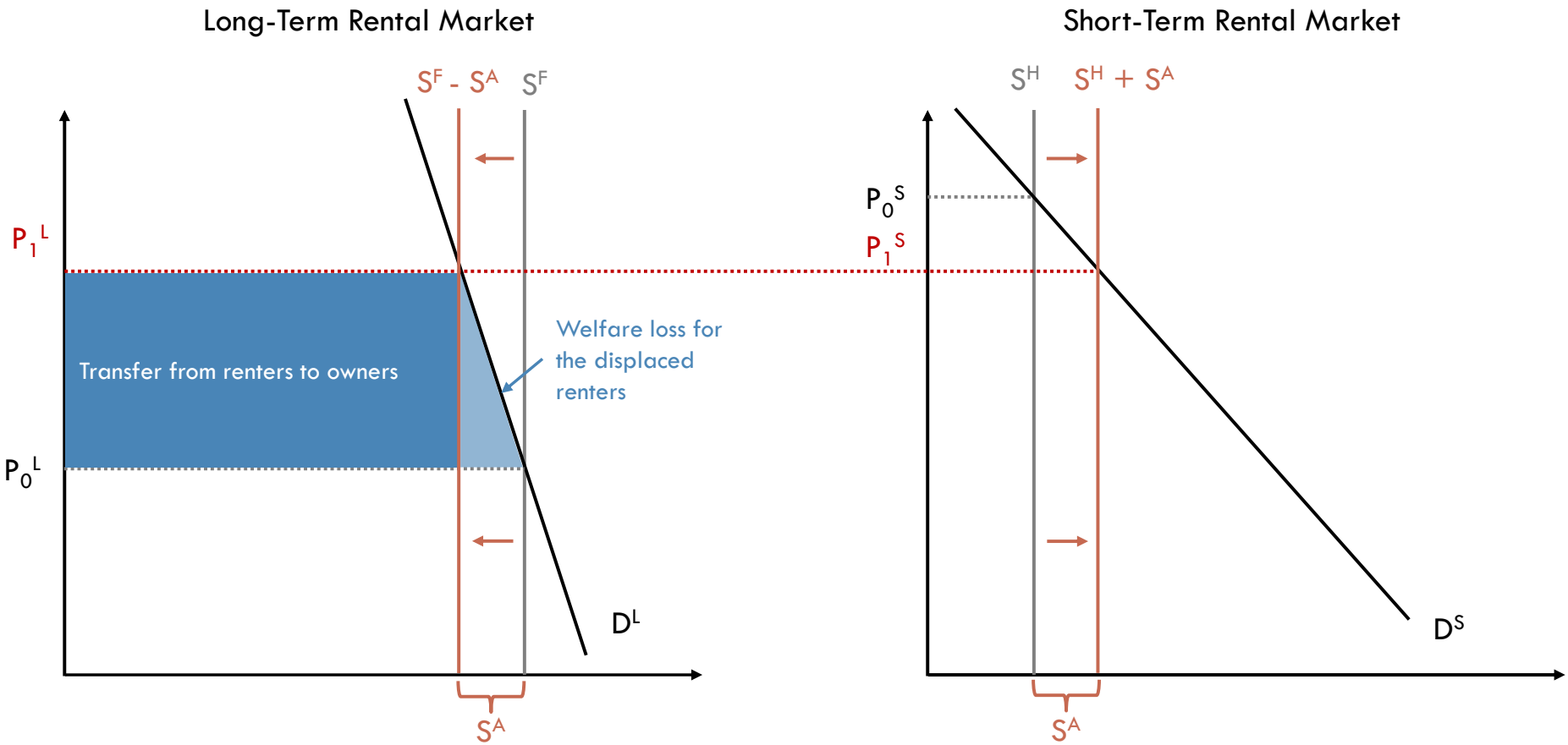

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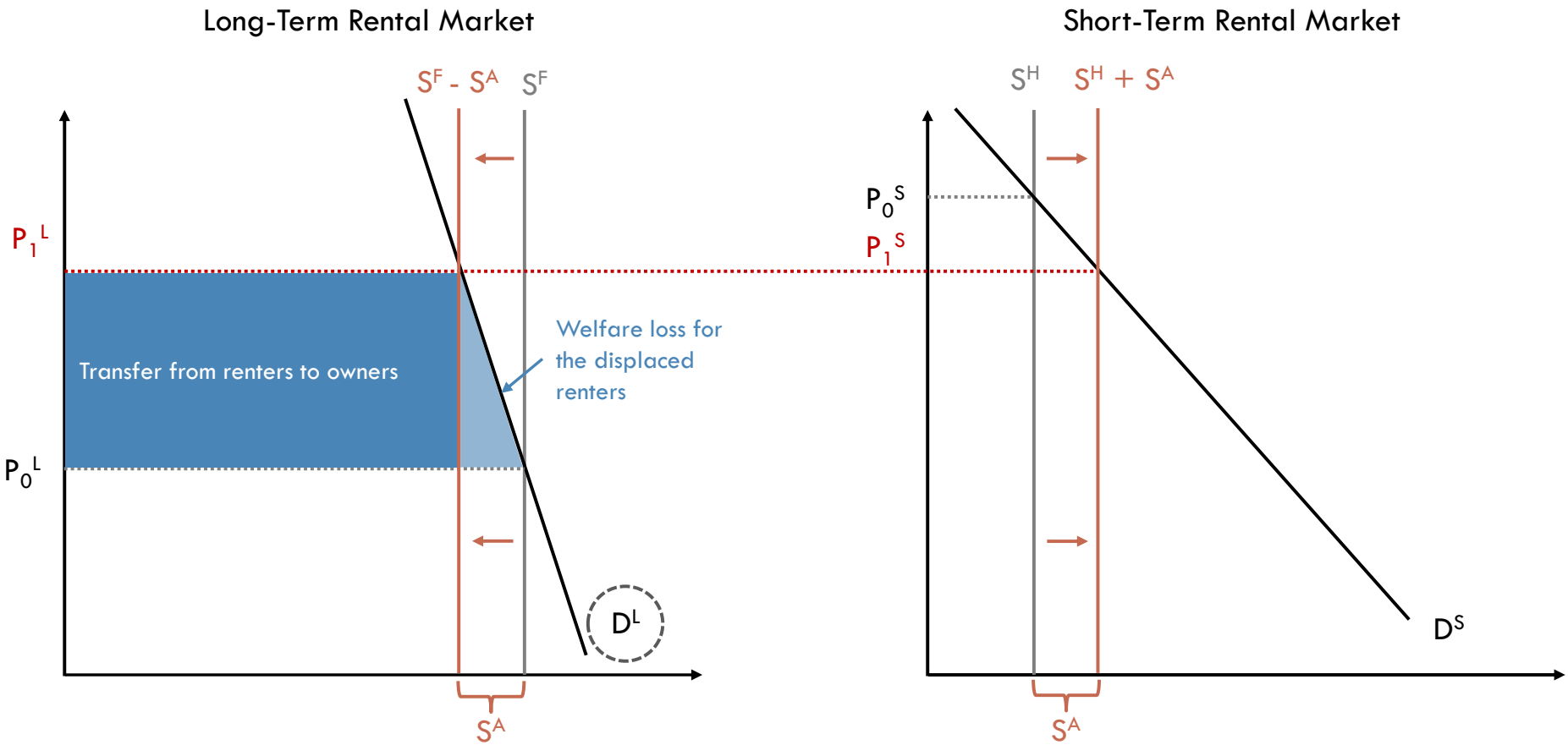

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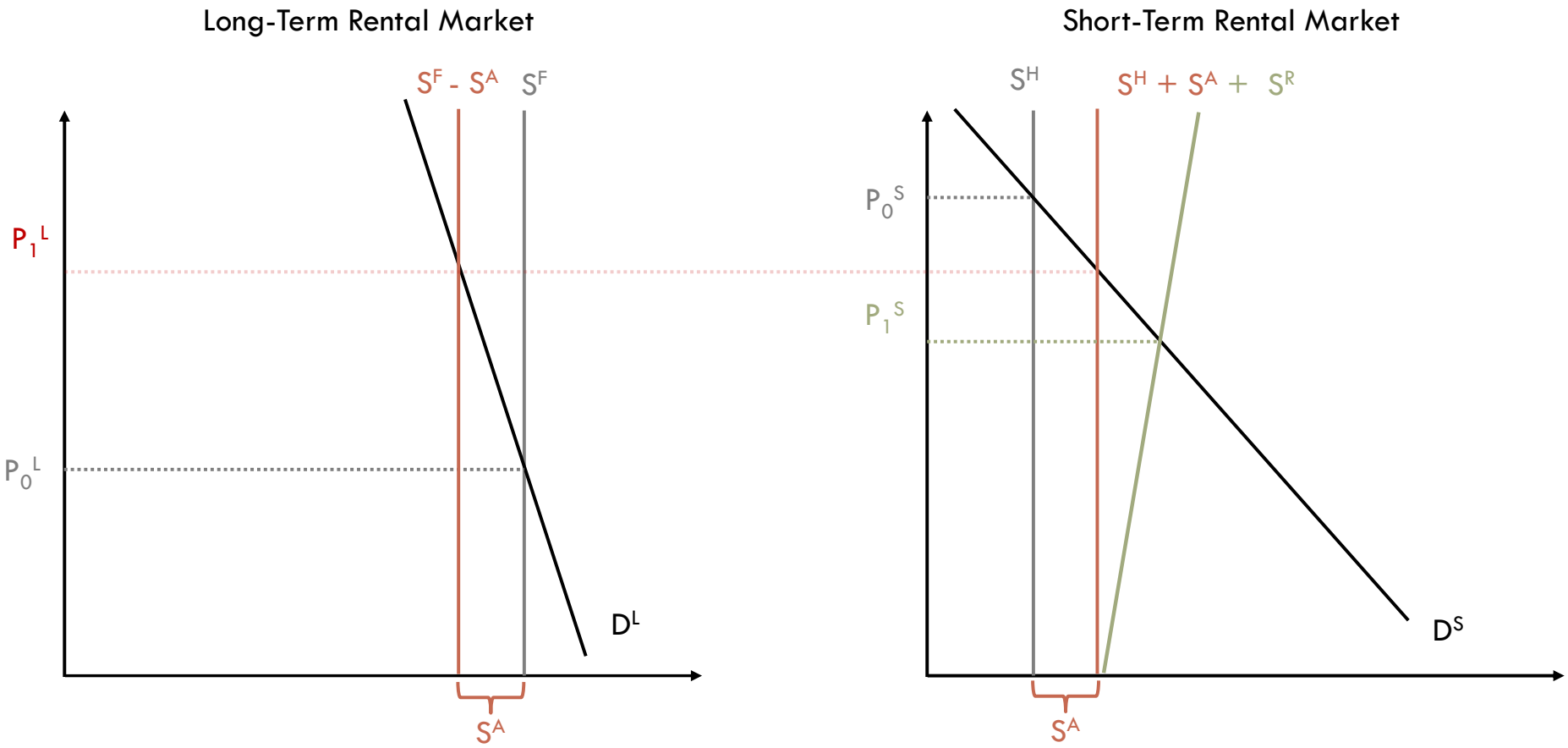
Increased Utilization in Short-term Rental



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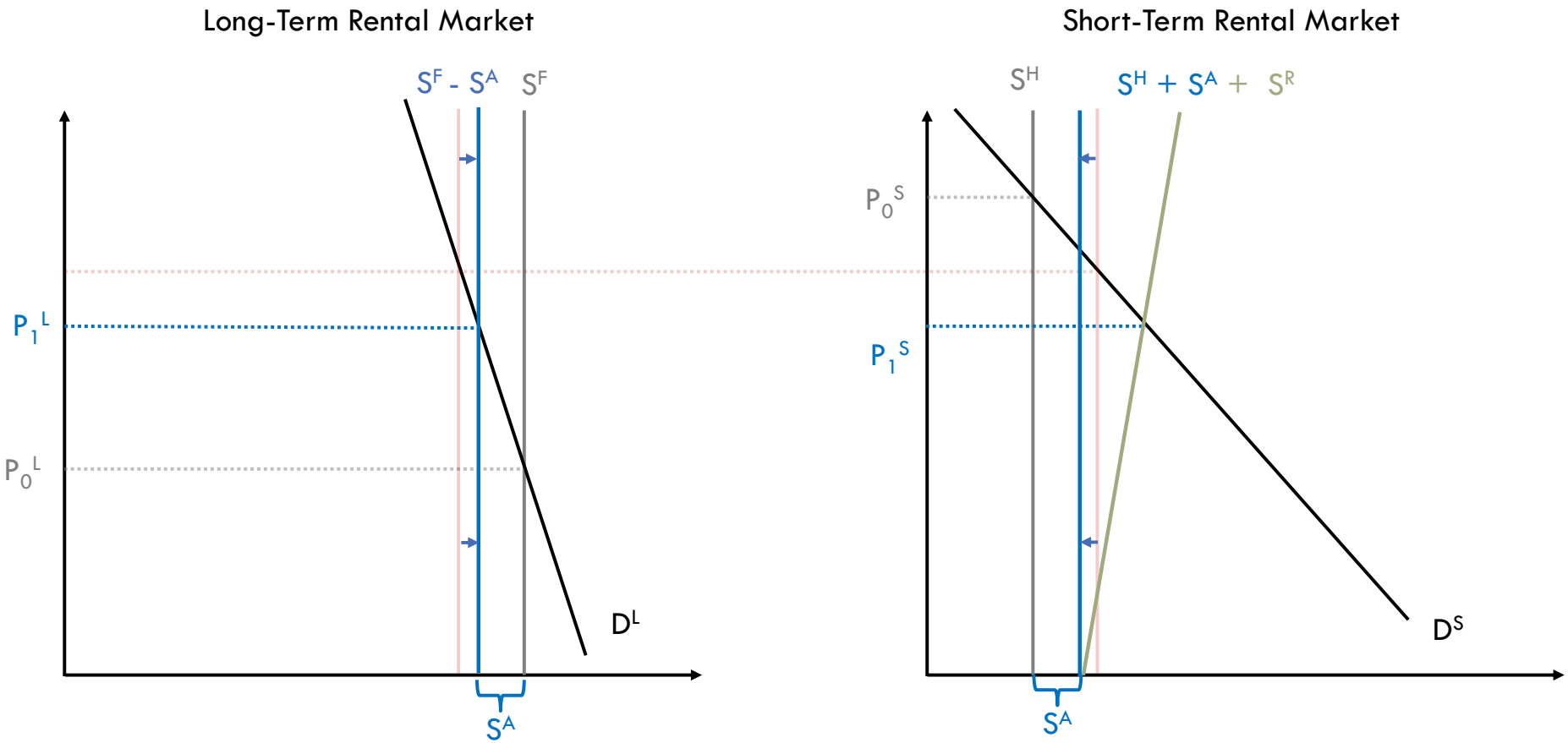

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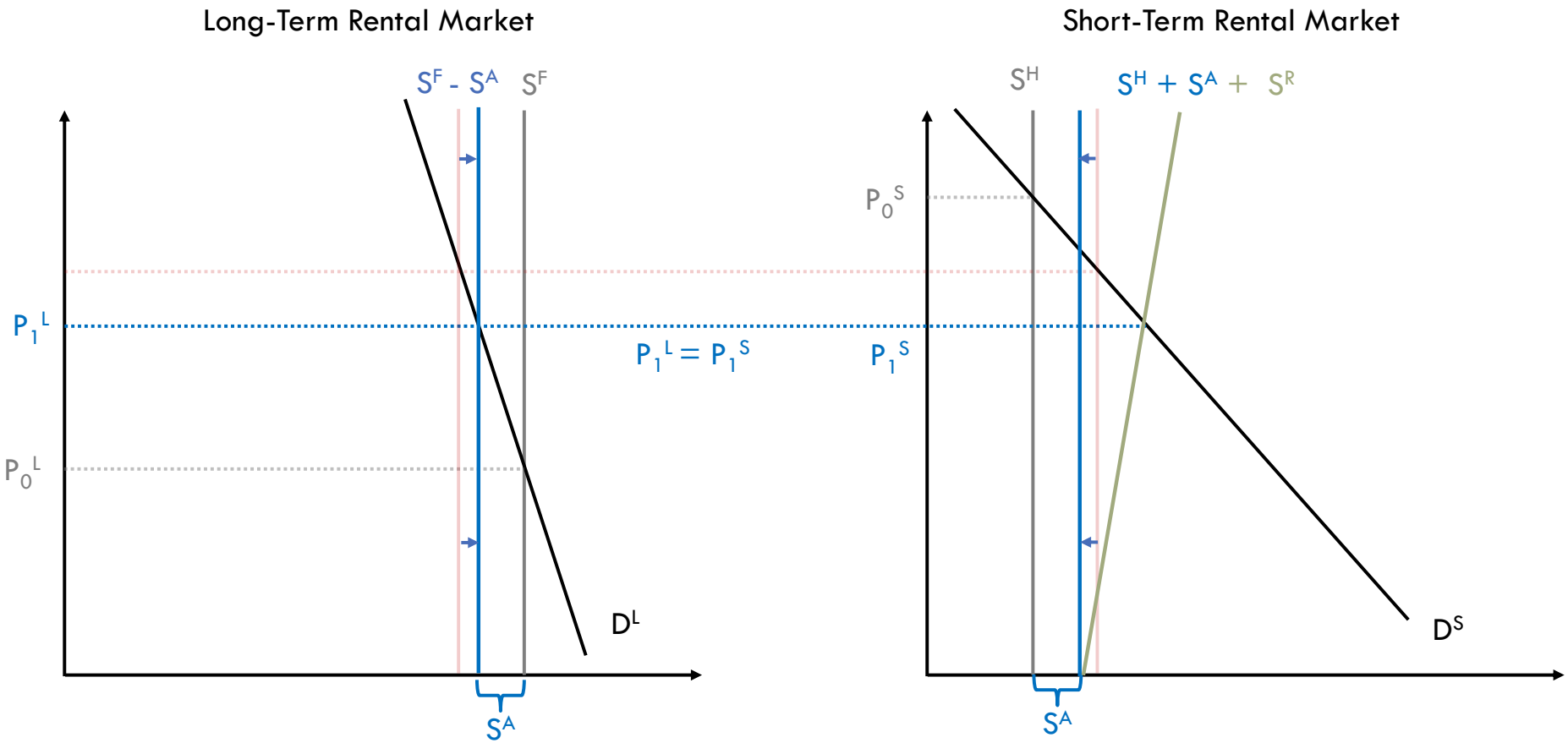

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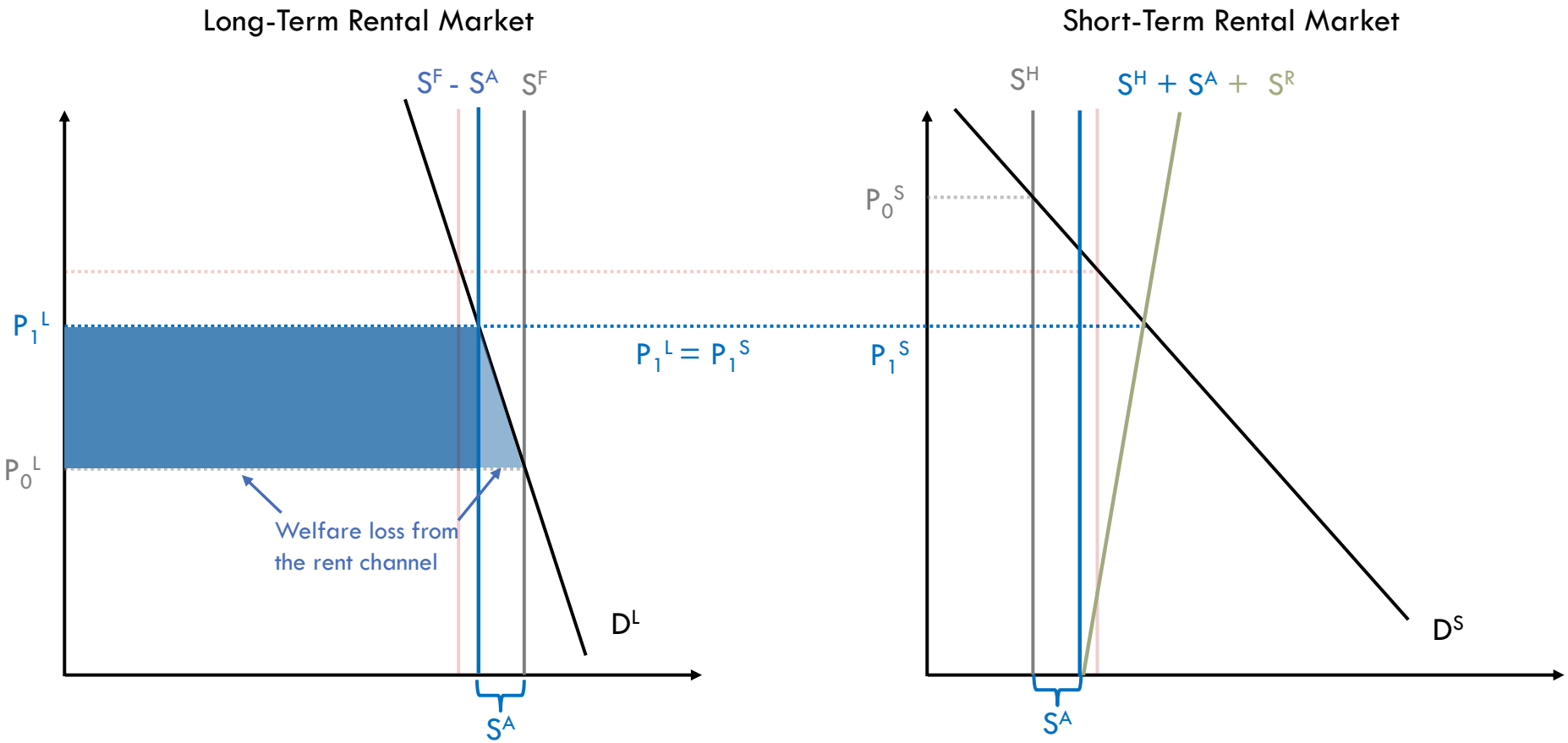

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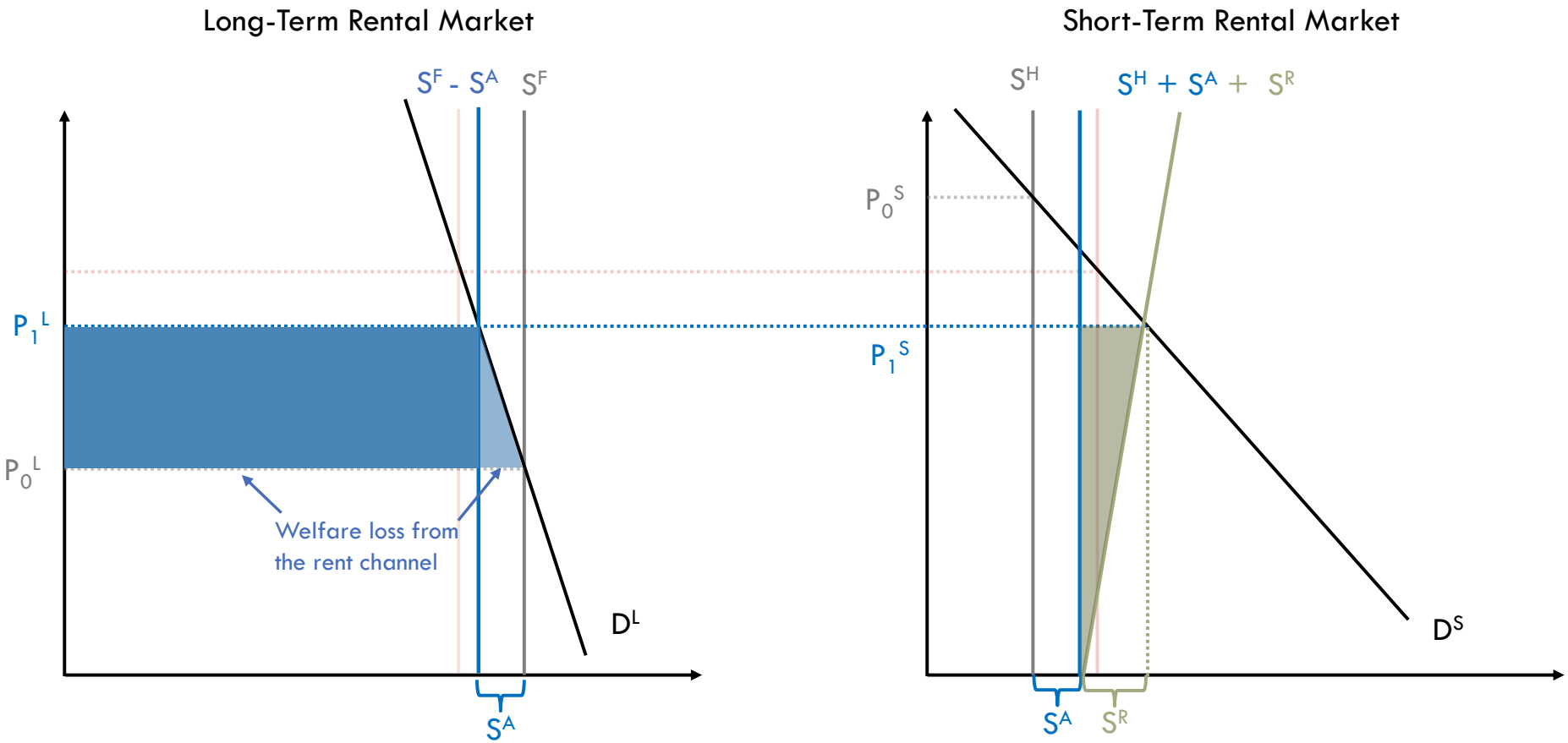

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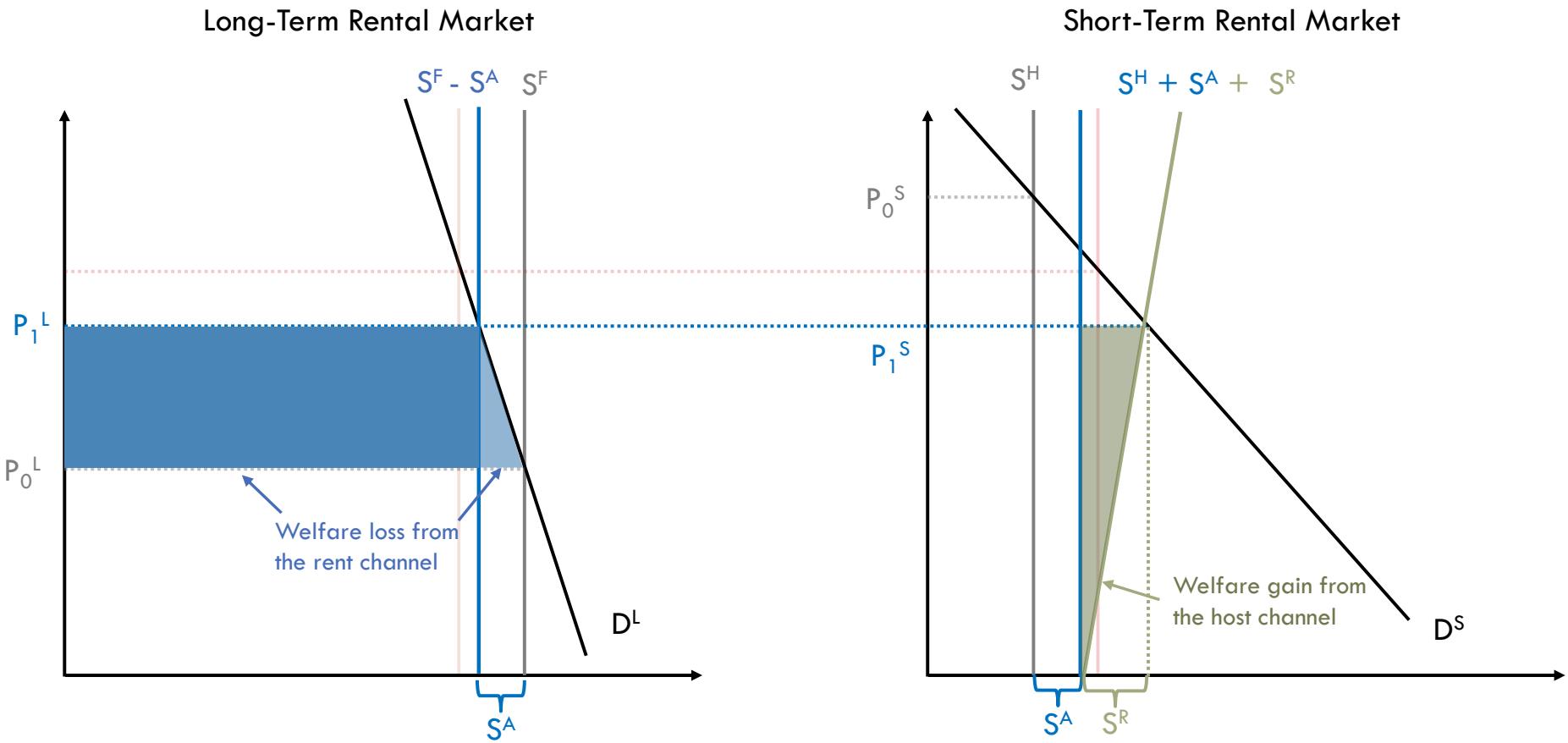

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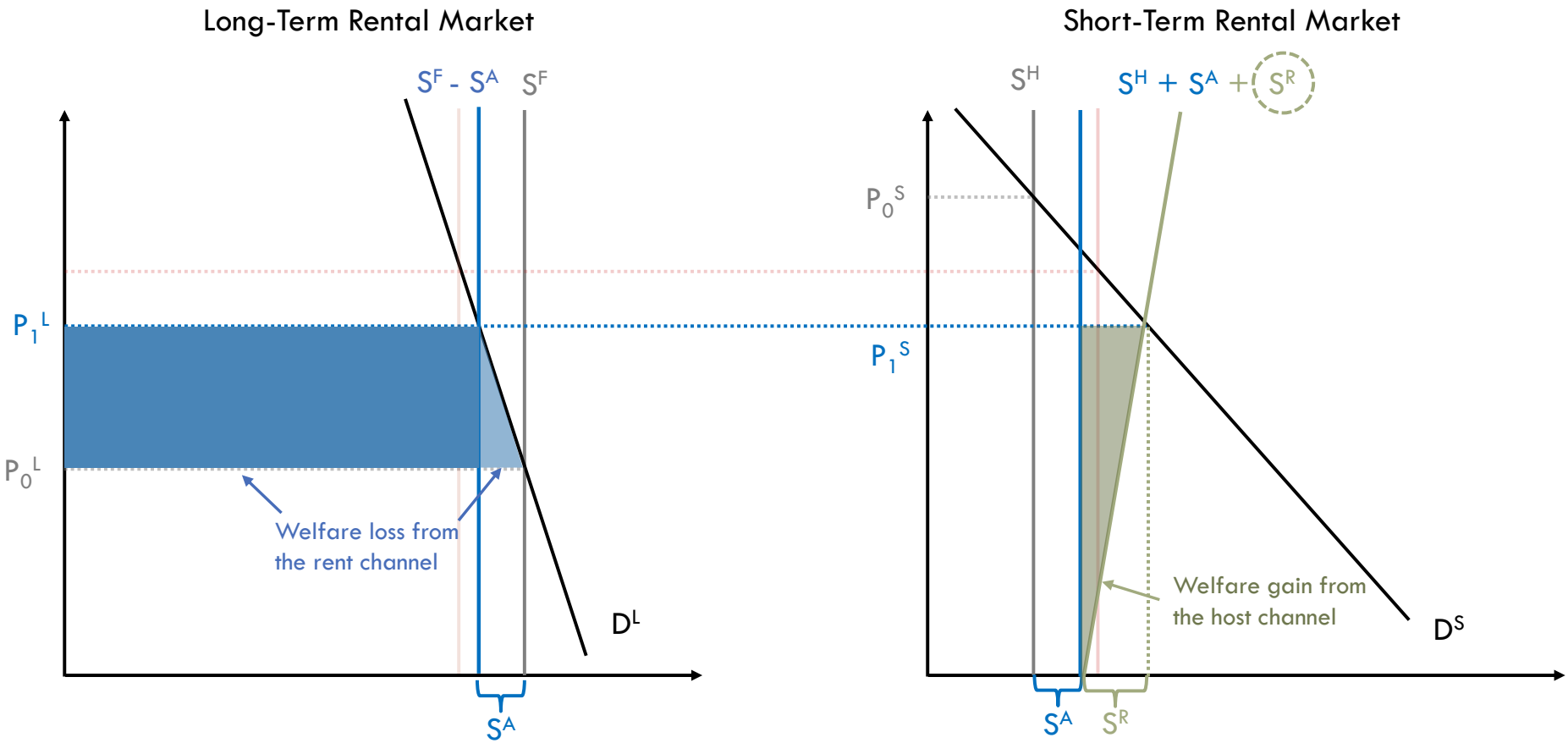

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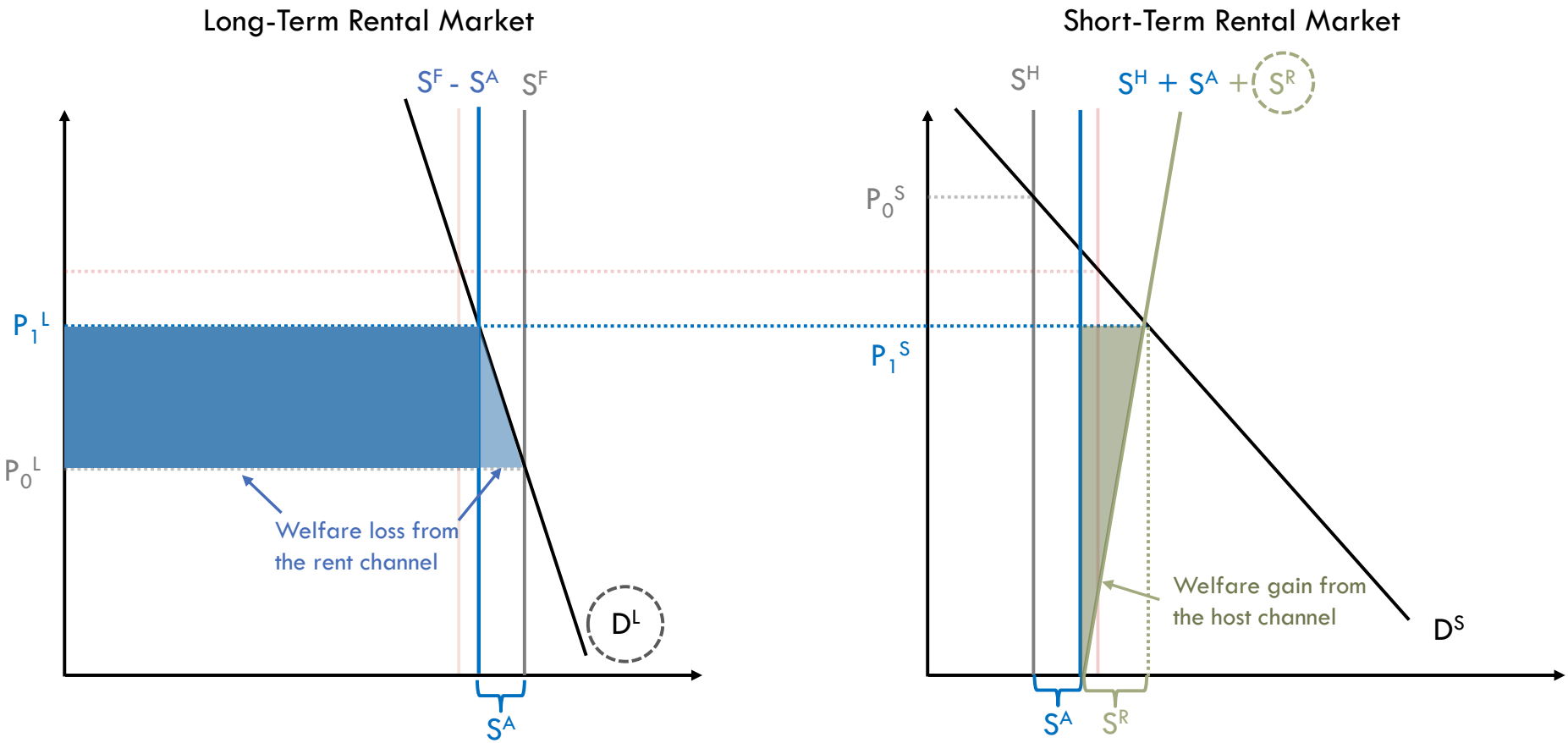
Summary



1. Estimate the long-term rental demand to capture the loss from housing reallocation

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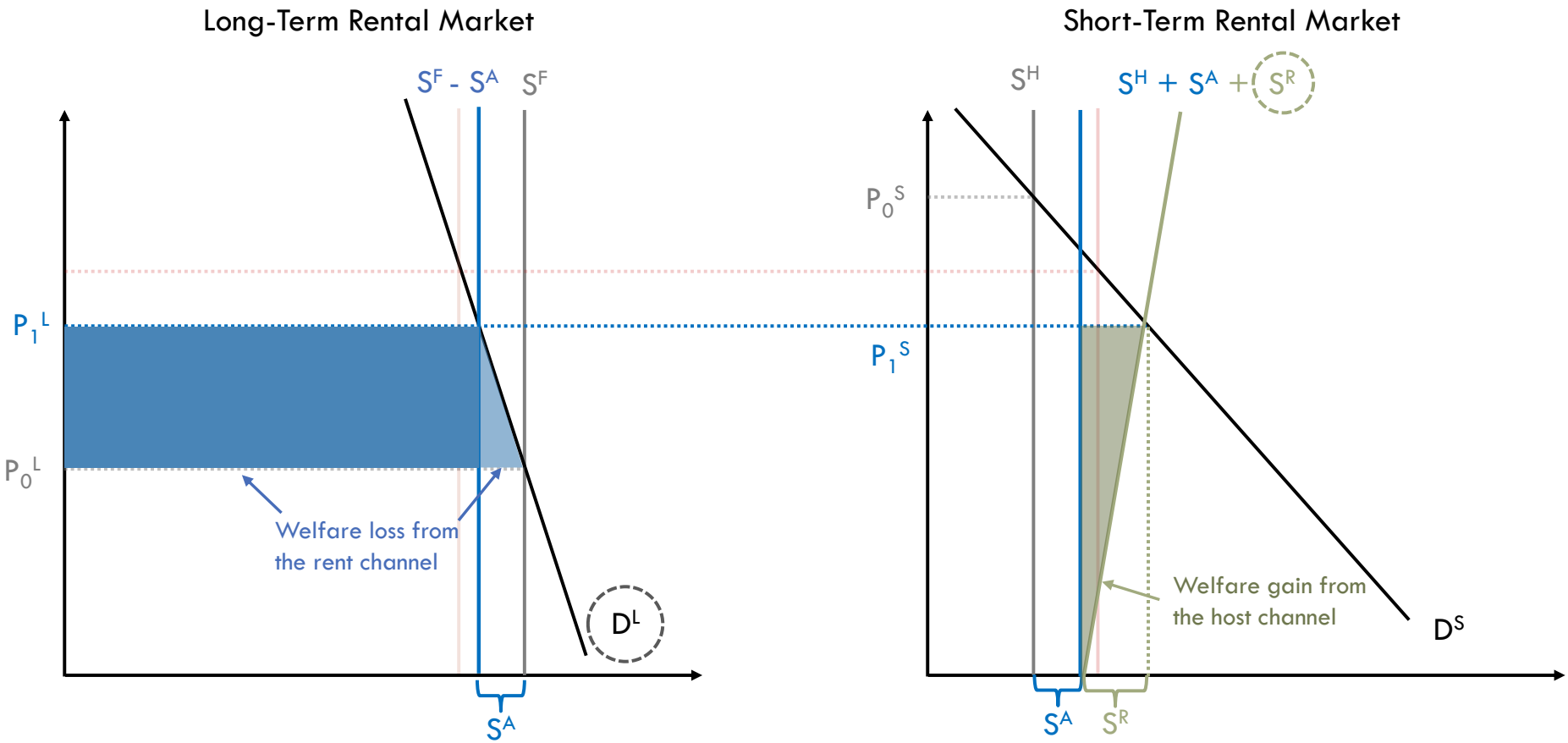

1. Estimate the long-term rental demand to capture the loss from housing reallocation
2. Estimate the short-term rental supply to capture the gain from increased utilization

Why A Structural Model?

- Rationale:
  1. Equilibrium effects
     - Households allowed to re-optimize
     - Neighborhoods without Airbnbs may also experience rent increases
  2. Substitution patterns
     - Substitution towards similar housing types
  3. Distributional implications
     - Random coefficients captures preference heterogeneity

- Assumptions:
  - Supply of physical structures for long-term rental is fixed NYC
  - Dynamic considerations are ignored
  - Negative externalities are ignored

Outline

Outline

Model Part A. Demand for Long-Term Rental

- Utility for household i renting housing unit j of type h:

$$u_{i,j}^{L} = \alpha_i^{L} \underbrace{p_h^{L}}_{\text{rental price}} + \beta_i^{L} \underbrace{\mathbf{X_h^L}}_{\text{housing attributes}} + \xi_h^{L} + \epsilon_{i,j}^{L}$$

  - $\mathbf{X_h^L}$:
    - Including physical attributes, neighborhood attributes, location attributes
    - Dividing the housing stock in 1050 types

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- Individual optimization: $y_i^L = j \iff u_{i,j}^L > u_{i,-j}^L$

- Long-term rental demand for housing type h:
  - Integral of all those who choose h: $D_h^L(p_h^L, p_{-h}^L) = \int_{A_h^L} dP(\epsilon^L) dP_D^*(z)$
  - z_i is drawn from the distribution of the entire metro market

Model Part A. Supply of Long-Term Rental

- The supply of physical structures available for long-term rental is **fixed** at S_h^F
- Market clearing without Airbnb:

$$\forall h: \quad D_h^L(p_h^L, p_{-h}^L) = S_h^F$$

- Market clearing with Airbnb reallocation:

$$\forall h: \quad D_h^L(p_h^L, p_{-h}^L) = S_h^F - S_h^A(p_h^L, p_{h,\cdot}^A)$$

Outline

Model Part B: Supply of Short-Term Rental
By Absentee Landlords

- An absentee landlord reallocates from long-term to short-term if more profitable
- Quantity reallocated depends on prices in both markets:

$$S_h^A(p_h^L, p_{h,\cdot}^A)$$

  - S_h^A obtained from data

Model Part B: Supply of Short-Term Rental
By Residents

- Utility of providing an Airbnb room for household i in neighborhood n on day t:

$$u_{i,t}^R = \alpha_i^R \underbrace{p_{n,t}^A}_{\substack{\text{Airbnb price for} \\ \text{a room in nbhd. } n}} + \beta_i^R \underbrace{X_{n,t}^R}_{\substack{\text{constant,} \\ \text{time FEs}}} + \xi_{n,t}^R + \epsilon_{i,t}^R$$

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  - α_i^R and β_i^R for the constant term is a function of demographics z_i

Model Part B: Supply of Short-Term Rental
By Residents

- Utility of providing an Airbnb room for household i in neighborhood n on day t:

$$u^R_{i,t} = \underbrace{\alpha^R_i}_{\text{price coef.}} \underbrace{p^A_{n,t}}_{\substack{\text{Airbnb price for} \\ \text{a room in nbhd. } n}} + \underbrace{\beta^R_i}_{\substack{\text{household-specific} \\ \text{cost of hosting}}} \underbrace{X^R_{n,t}}_{\substack{\text{constant,} \\ \text{time FEs}}} + \underbrace{\xi^R_{n,t}}_{\text{unobserved cost}} + \epsilon^R_{i,t}$$

  - α^R_i and β^R_i for the constant term is a function of demographics z_i
  - Unobserved cost $\xi^R_{n,t}$ allowed to be correlated with price

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  - α_i^R and β_i^R for the constant term is a function of demographics z_i
  - Unobserved cost $\xi_{n,t}^R$ allowed to be correlated with price

- Resident i hosts if better than alternative personal use: $y_{i,t}^R = 1 \iff u_{i,t}^R > 0$

- Short-term rental supply in neighborhood n day t:
  - Integral of all those who host: $S_{n,t}^R(p_{n,t}^A) = \int_{A_{n,t}^R} dP(\epsilon^R) dP_{D_n}^*(z)$
  - z_i drawn from neighborhood n

Model C: Market Equilibrium

- A sorting equilibrium characterized by the price vectors:

$$p_h^L, \quad p_{h,\cdot}^A$$

- Clearing of the long-term rental market of each type:

$$\forall h: \quad D_h^L(p_h^L, p_{-h}^L) = S_h^F - S_h^A(p_h^L, p_{h,\cdot}^A) \tag{1}$$

- Clearing of the short-term rental market of each type each period:

$$\forall h, t: \quad D_{h,t}^A(p_{h,t}^A, p_{-h,t}^A) = S_{h,t}^A(p_h^L, p_{h,\cdot}^A) + S_{h,t}^R(p_{h,t}^A) \tag{2}$$

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Estimation of Long-Term Rental Demand: Overview

- Long-term rental utility for household i for housing unit j of type h:

$$u_{i,j}^{L} = \alpha_i^L \, p_h^L + \beta_i^L \, \mathbf{X_h^L} + \xi_h^L + \epsilon_{i,j}^L$$

$$\begin{bmatrix} \alpha_i^L \\ \beta_i^L \end{bmatrix} = \underbrace{\begin{bmatrix} \alpha^L \\ \beta^L \end{bmatrix}}_{\text{common to all}} + \underbrace{\begin{bmatrix} \pi_{\alpha,1}^L \dots \pi_{\alpha,K}^L \\ \pi_{\beta,1}^L \dots \pi_{\beta,K}^L \end{bmatrix}}_{\text{household-specific}} \begin{bmatrix} z_{i,1} \\ \vdots \\ z_{i,k} \end{bmatrix}$$

Estimation of Long-Term Rental Demand: Overview

- Long-term rental utility for household i for housing unit j of type h:

$$u^L_{i,j} = \alpha^L_i \, p^L_h + \beta^L_i \, \mathbf{X^L_h} + \xi^L_h + \epsilon^L_{i,j}$$

$$\begin{bmatrix} \alpha^L_i \\ \beta^L_i \end{bmatrix} = \underbrace{\begin{bmatrix} \alpha^L \\ \beta^L \end{bmatrix}}_{\text{common to all}} + \underbrace{\begin{bmatrix} \pi^L_{\alpha,1} \dots \pi^L_{\alpha,K} \\ \pi^L_{\boldsymbol{\beta},1} \dots \pi^L_{\boldsymbol{\beta},K} \end{bmatrix}}_{\text{household-specific}} \begin{bmatrix} z_{i,1} \\ \vdots \\ z_{i,k} \end{bmatrix}$$

$\downarrow$

Identified from individual-level choices

- Moment conditions
  - Cov (housing attributes, household characteristics) to identify $\pi^L_{b,k}$

details eq placebo

Estimation of Long-Term Rental Demand: Overview

- Long-term rental utility for household i for housing unit j of type h:

$$u_{i,j}^{L} = \alpha_i^{L} p_h^{L} + \beta_i^{L} \mathbf{X_h^L} + \xi_h^{L} + \epsilon_{i,j}^{L}$$

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common to all → BLP instruments adapted for housing

household-specific → Identified from individual-level choices

- Moment conditions
  - Cov (housing attributes, household characteristics) to identify $\pi_{b,k}^{L}$
  - Housing attributes as product characteristics
    - Relative scarcity in housing attributes acts as a supply shifter

details eq placebo

Estimation of Long-Term Rental Demand: Results

WTP ($ mo)	*Demographic Characteristics*					
Nbhd. Attributes	Ln Income	HH Size	Black	Hispanic	Asian	College
Pct Black (Std)	56.7	-47.9	774.4	330.6	272.1	67.6
	(20.3)	(15.9)	(232.6)	(101.2)	(86.6)	(27.9)
Pct Hispanic (Std)	56.3	-22.8	376.9	469.3	221.5	94.8
	(19.9)	(9.4)	(115.8)	(141.5)	(71.5)	(33.7)
Pct Asian (Std)	47.8	-14.3	98.2	138.0	410.0	-37.7
	(16.9)	(7.1)	(39.0)	(44.9)	(123.9)	(19.2)
Pct College (Std)	145.9	-54.0	185.9	37.0	93.8	260.2
	(45.7)	(18.5)	(68.1)	(32.2)	(44.7)	(81.7)
Inside NYC	-337.8	-421.2	120.0	29.1	299.0	-2.3
	(106.9)	(128.6)	(97.6)	(83.9)	(129.4)	(68.6)
Commuting Time (Std)	38.7	-6.3	127.7	50.7	210.4	8.4
	(19.9)	(11.9)	(56.9)	(43.0)	(76.8)	(33.1)

Estimation of Long-Term Rental Demand: Results

WTP ($ mo)	*Demographic Characteristics*					
Housing Attributes	Ln Income	HH Size	Black	Hispanic	Asian	College
One Bedroom	75.8	255.1	-40.3	-67.0	-177.1	-86.4
	(31.2)	(78.6)	(55.1)	(54.5)	(75.6)	(48.3)
Two Bedroom	59.1	520.5	98.1	-24.2	-273.4	-212.6
	(28.8)	(156.4)	(63.8)	(54.1)	(101.0)	(76.9)
Three Bedroom	32.4	717.6	143.8	-37.2	-329.1	-214.6
	(28.7)	(214.9)	(80.7)	(64.8)	(121.0)	(82.6)
Four Bedroom	85.0	884.9	-206.5	-328.3	-297.9	-244.9
	(66.7)	(266.0)	(172.3)	(171.9)	(170.2)	(134.0)
Built After 1980	22.4	-35.9	157.9	55.1	42.3	-27.8
	(14.7)	(13.7)	(56.4)	(33.3)	(36.7)	(25.0)
Built 1940-1980	-102.6	6.1	137.0	125.4	-84.8	58.6
	(34.3)	(10.1)	(55.6)	(50.6)	(47.5)	(32.6)
5+ Units	9.7	58.6	-3.8	-118.4	-110.6	-6.7
	(9.5)	(18.6)	(25.9)	(41.3)	(40.1)	(17.6)
Monthly Rent	0.33	-0.03	-0.36	-0.23	-0.18	0.21
	(0.10)	(0.02)	(0.13)	(0.10)	(0.10)	(0.08)

Estimation of Long-Term Rental Demand: Results

	(1) OLS	(2) Instrumented	(3) ($) WTP Mo.
Monthly Rent ($k)	0.0213	-2.044***	
	(0.0341)	(0.609)	
One-Bedroom	0.425***	0.929***	454.5***
	(0.0447)	(0.188)	(78.2)
Two-Bedroom	0.528***	1.325***	648.2***
	(0.0465)	(0.280)	(93.5)
Three-Bedroom	0.271***	1.392***	681.0***
	(0.0555)	(0.393)	(76.7)
Built After 1980	-0.114***	0.139	68.2
	(0.0402)	(0.145)	(60.9)
Built 1940 to 80	-0.00917	-0.242**	-118.4**
	(0.0337)	(0.105)	(43.9)
5+ Units	0.00182	-0.209**	-102.3**
	(0.0282)	(0.0974)	(41.2)
Commuting Time (Std)	0.119***	-0.782***	-382.6***
	(0.0215)	(0.279)	(28.2)
Inside NYC	-1.026***	2.536**	1240.7***
	(0.0683)	(1.036)	(147)
N	1050	1050	1050

- First stage F-statistics is 15.7
- Aggregate price elasticity ϵ: 1.0
  - 1.0% contraction in supply
  - 1.0% increase in price

Outline

Outline

Estimation of Short-Term Rental Supply: Overview

- Utility of providing an Airbnb room for household i in neighborhood n on day t:

$$u_{i,t}^R = \alpha_i^R \, p_{n,t}^A + \beta_i^R \, \mathbf{X}_{n,t}^R + \xi_{n,t}^R + \epsilon_{i,t}^R$$

$$\begin{bmatrix} \alpha_i^R \\ \beta_i^R \end{bmatrix} = \underbrace{\begin{bmatrix} \alpha^R \\ \beta^R \end{bmatrix}}_{\text{common to all}} + \underbrace{\begin{bmatrix} \pi_{\alpha,1}^R \cdots \pi_{\alpha,K}^R \\ \pi_{\beta,1}^R \cdots \pi_{\beta,K}^R \end{bmatrix}}_{\text{household-specific}} \begin{bmatrix} z_{i,1} \\ \vdots \\ z_{i,k} \end{bmatrix}$$

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↓

Multiple markets with demographic variations

- Novel:
  - Adapt BLP to estimate the peer production function with random coefficients
  - Match market shares in each neighborhood and every day
    - Over 70,000 market-share observations: MPEC

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common to all → Use demand seasonality to instrument for price

household-specific → Multiple markets with demographic variations

- Novel:
  - Adapt BLP to estimate the peer production function with random coefficients
  - Match market shares in each neighborhood and every day
    - Over 70,000 market-share observations: MPEC
- Price instrument:
  - Seasonality in tourism demand
    - Number of hotel bookings in NYC on the same day seven years ago
    - Month, day of week, and holiday FE

Estimation of Short-Term Rental Supply: Results

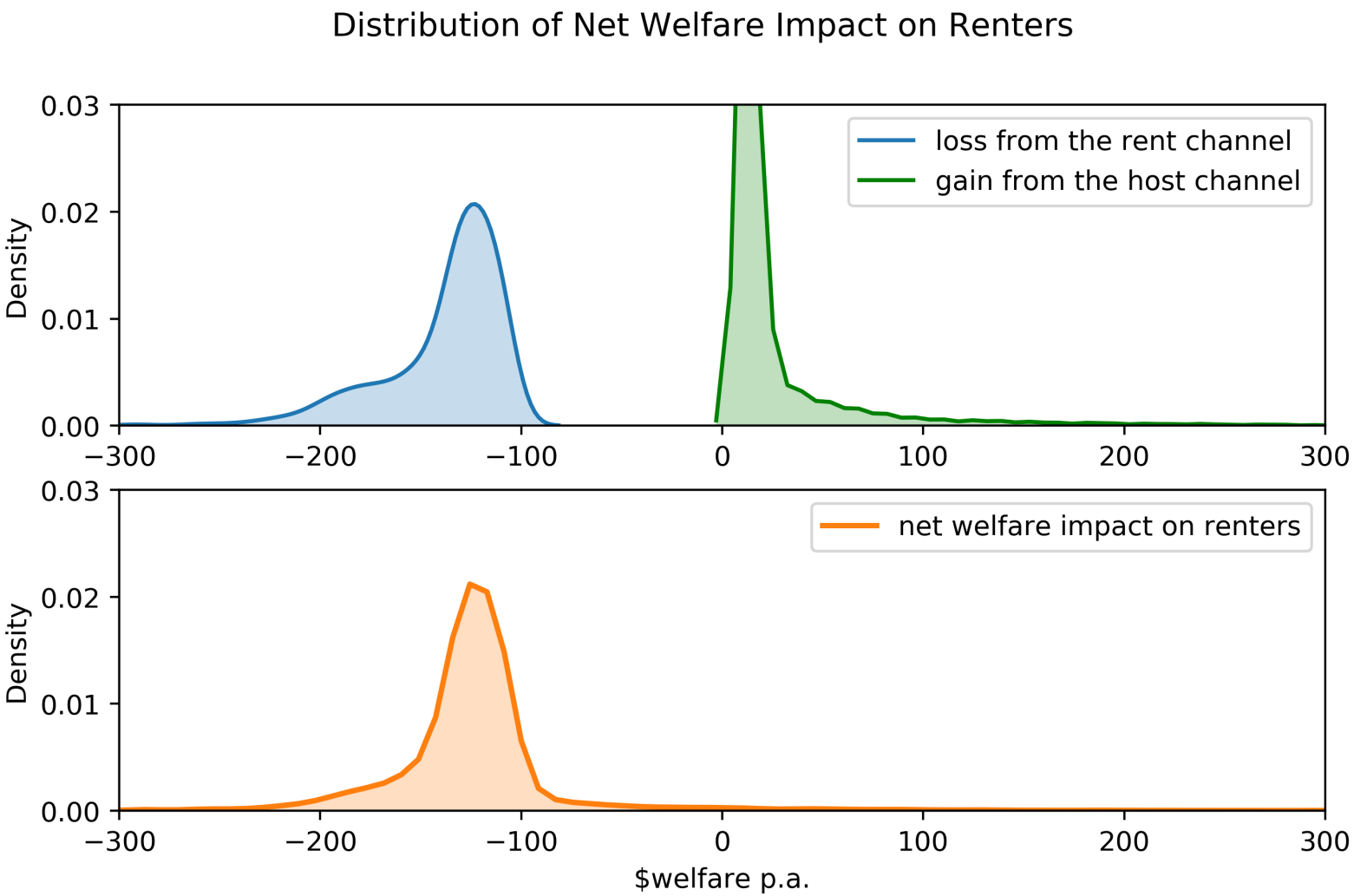
		(1) Naïve	(2) Naïve	(3) IV	(4) IV	(5) ($) per diem
Linear Coef.	*Non-Linear Coef.*					
Price		0.006	0.007	0.052	0.056	
		(0.002)	(0.001)	(0.002)	(0.002)	
	x ln(income)	-0.018	-0.018	-0.018	-0.011	
		(0.001)	(0.002)	(0.003)	(0.006)	
Cost		15.44	15.51	22.07	21.36	224.3
		(0.10)	(0.09)	(0.12)	(0.11)	(12.7)
	x Has College	-1.17	-2.55	-3.47	-3.27	-58.9
		(0.68)	(0.24)	(0.27)	(0.25)	(4.8)
	x Has Children	2.40	2.58	1.95	2.60	46.7
		(0.42)	(0.36)	(0.53)	(0.44)	(8.1)
	x Age (yr)	0.094	0.093	0.091	0.097	1.8
		(0.005)	(0.005)	(0.006)	(0.006)	(0.1)
	x ln(income)	0.24	-0.14	-0.39	-0.29	-5.1
		(0.09)	(0.13)	(0.26)	(0.48)	(8.7)
Quad. Time		Yes	Yes	Yes	Yes	
Month FE		No	Yes	No	Yes	
Day of Week FE		No	Yes	No	Yes	
Holiday FE		No	Yes	No	Yes	
N		75,895	75,895	75,895	75,895	

- First-stage F: 25.4
- Supply elasticity ϵ: 5.96
  - Income -1std : 6.70
- Low-cost suppliers:
  - Have college degrees
  - Have no children
  - Young

Outline

1. Introduction
2. Literature and Data
3. Model
4. Counterfactuals
    1. Loss from the Rent Channel (Reallocation Effects)
    2. Gain from the Host Channel (Utilization Effects)
    3. Net Welfare Impact

Overview of the Welfare Analysis



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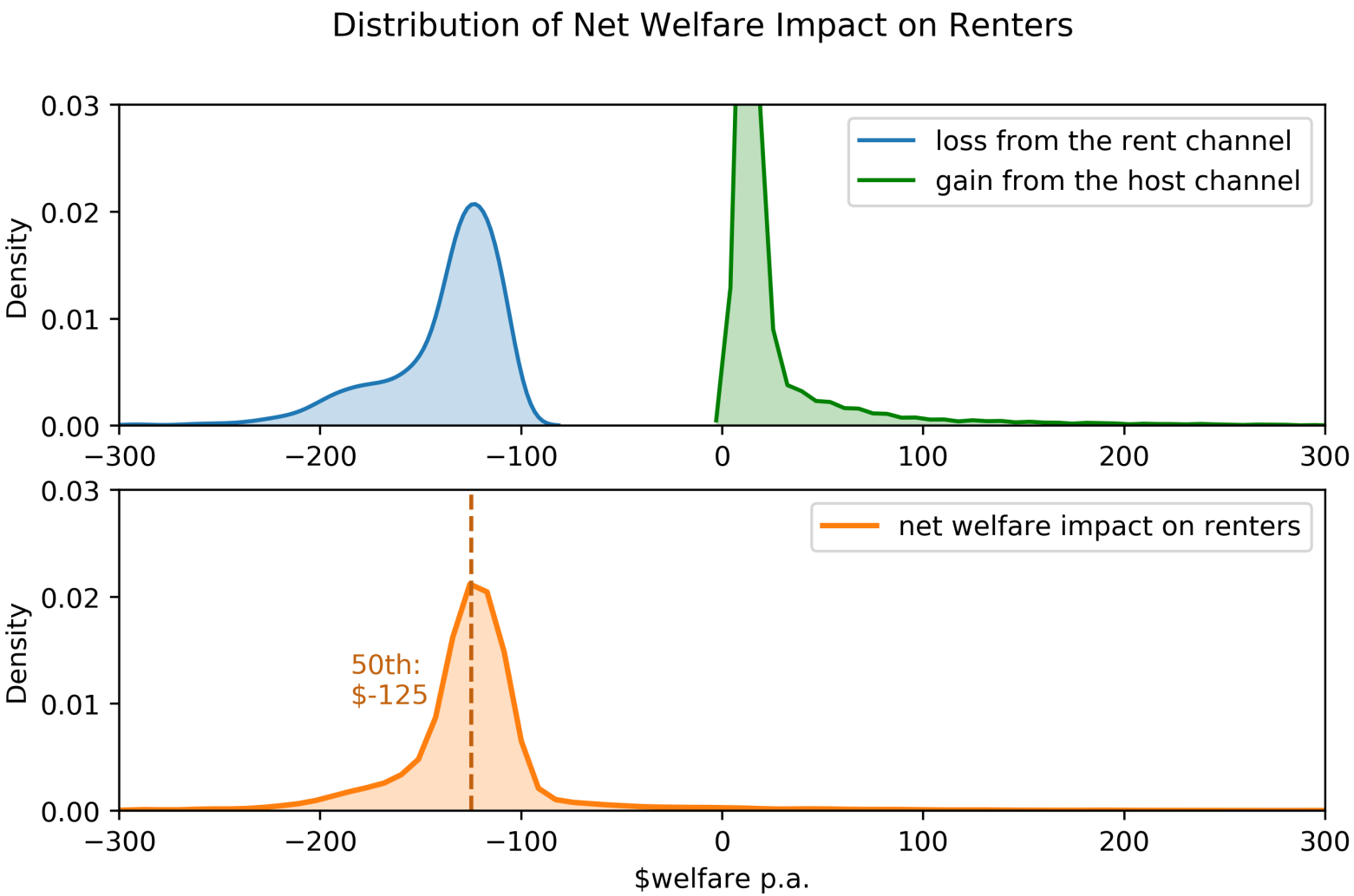

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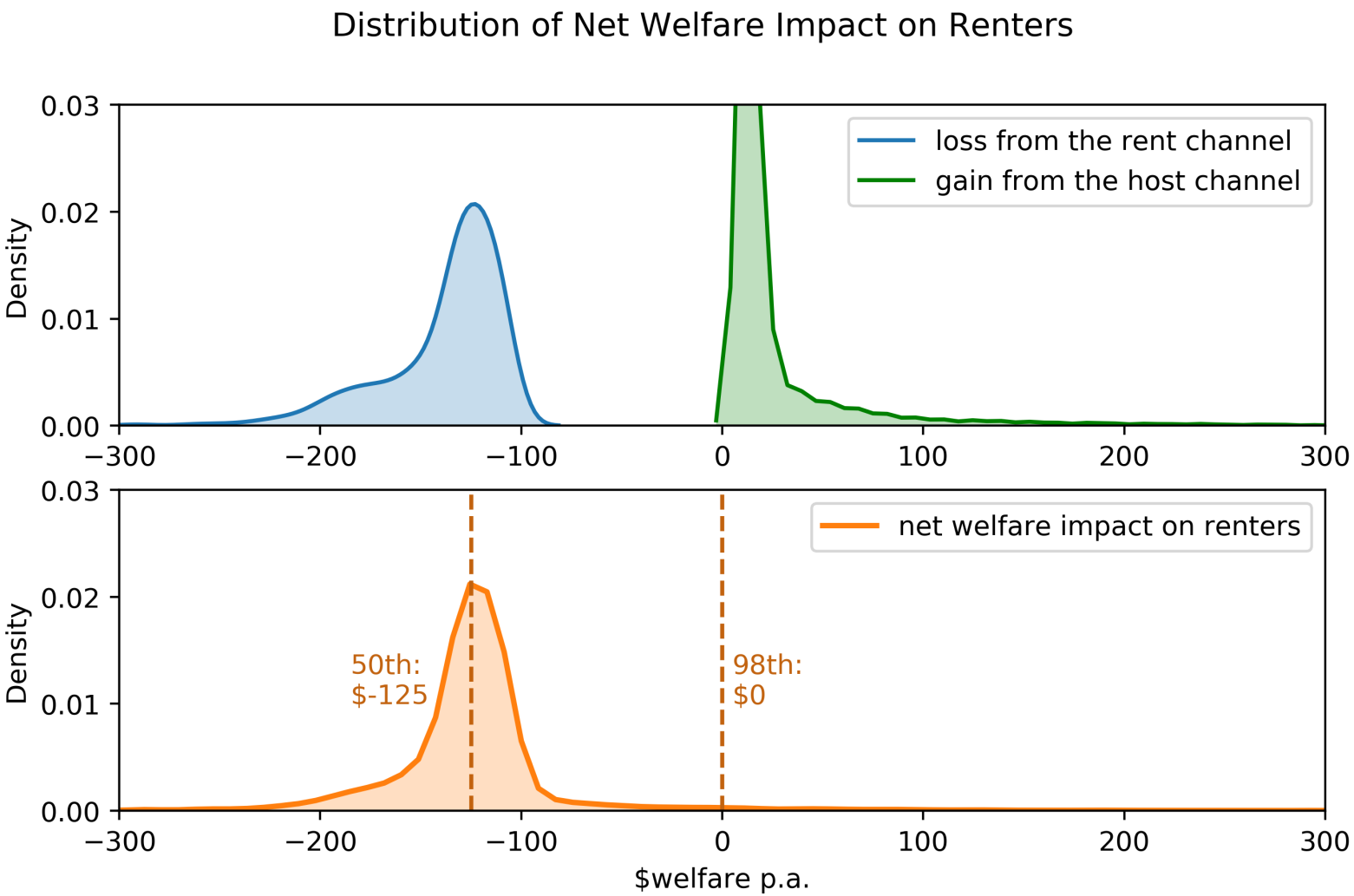

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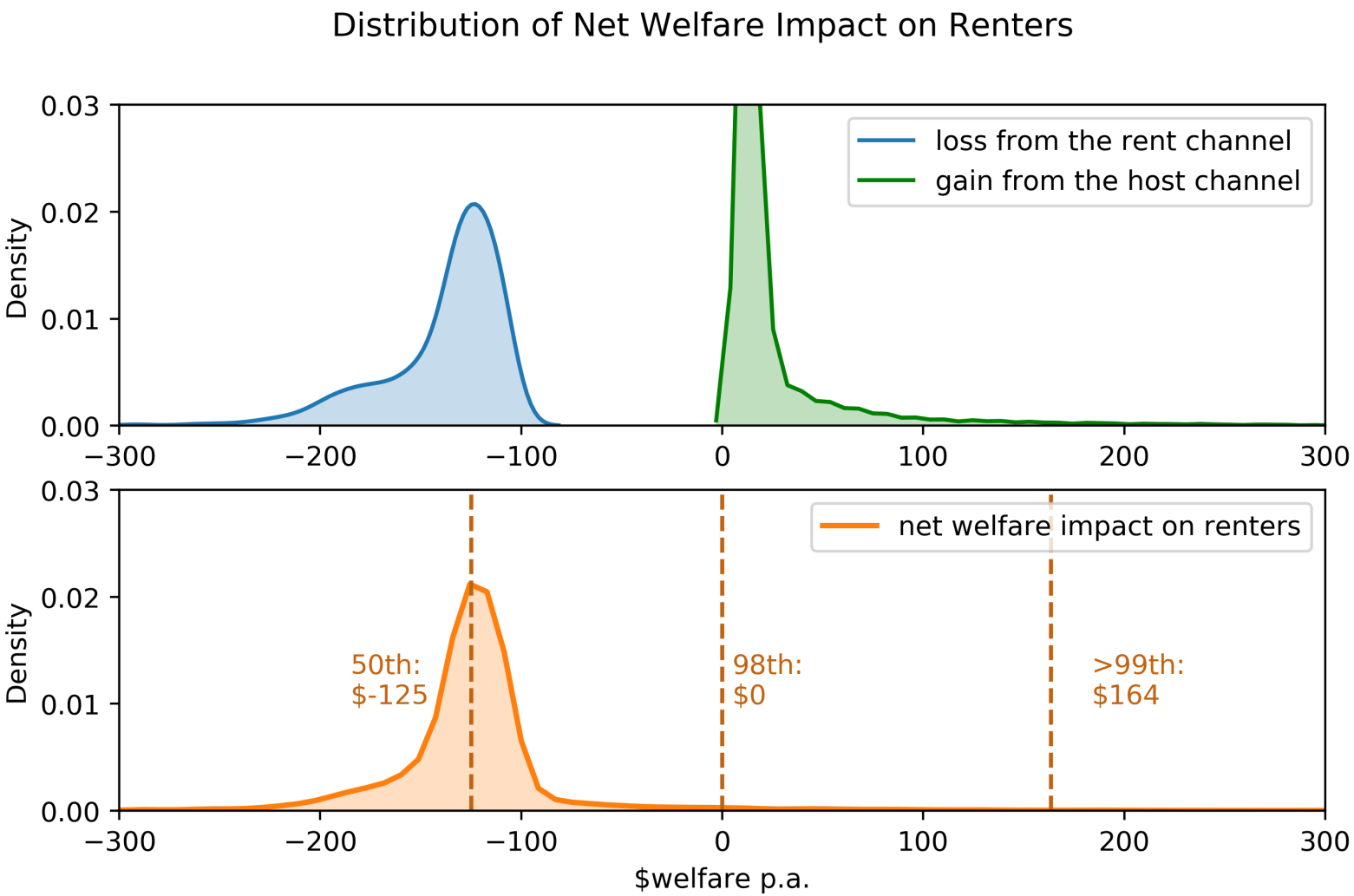

Loss from the Rent Channel (Reallocation Effects)

1. Counterfactual specification:
   - "Return" reallocated housing units to the long-term rental market

2. Recompute the new market-clearing equilibrium prices:

$$\forall h : D_h^L(p_h^{L,\text{ No Airbnb}}, p_{-h}^{L,\text{ No Airbnb}}) = S_h^F \tag{3}$$

   - Fraction of the total housing market reallocated to Airbnb: 0.68%
   - Average rent change due to the reallocation: 0.71%

3. Compensating variation for logit errors:

$$CV_i^L = \frac{1}{\alpha_i^L}\left(\ln \sum_{j \in \mathcal{S}^F \setminus \mathcal{S}^A} \exp\left(V_{i,j}^L\right) - \ln \sum_{j \in \mathcal{S}^F} \exp\left(V_{i,j}^{L,\text{No Airbnb}}\right)\right) \tag{4}$$

   - CV computed for all renters in the city

Loss from the Rent Channel

Distribution by Household Demographics

Loss from the Rent Channel

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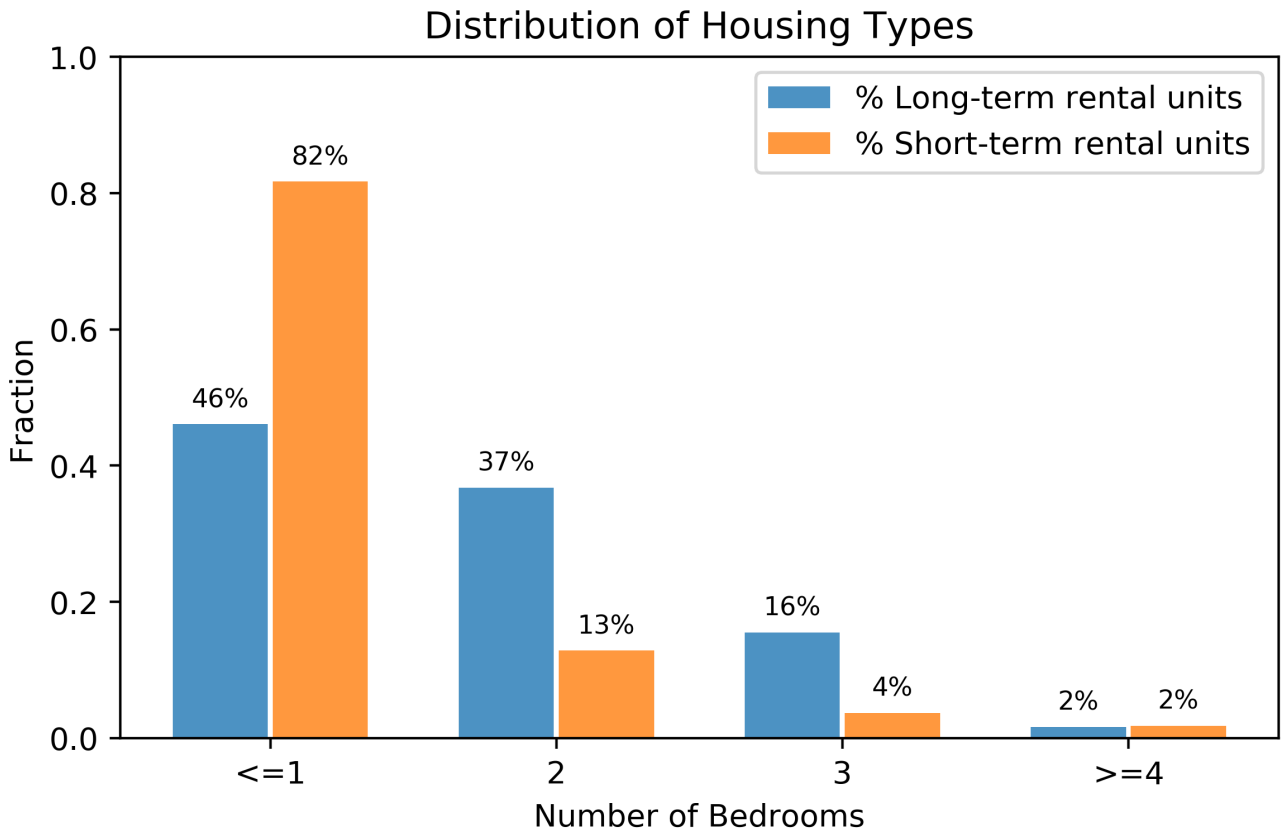

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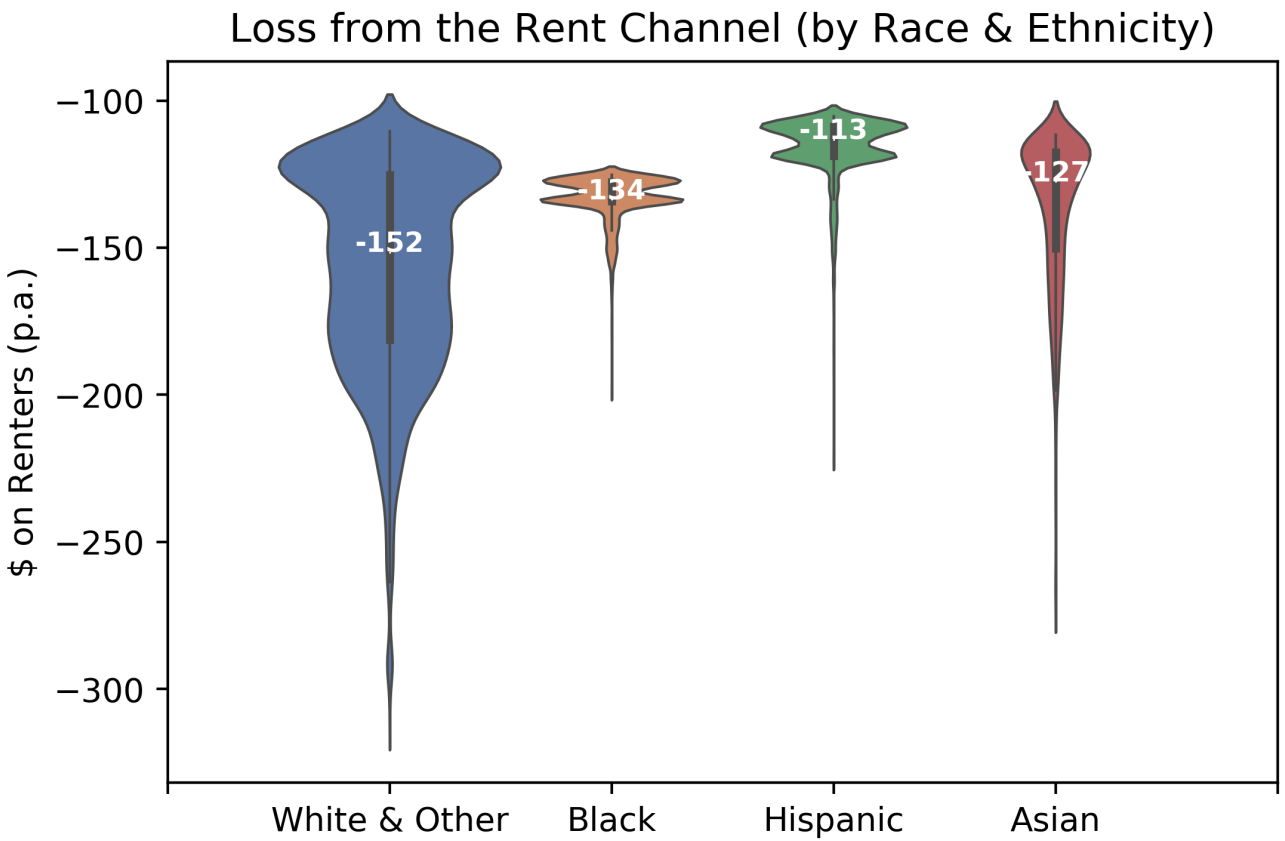

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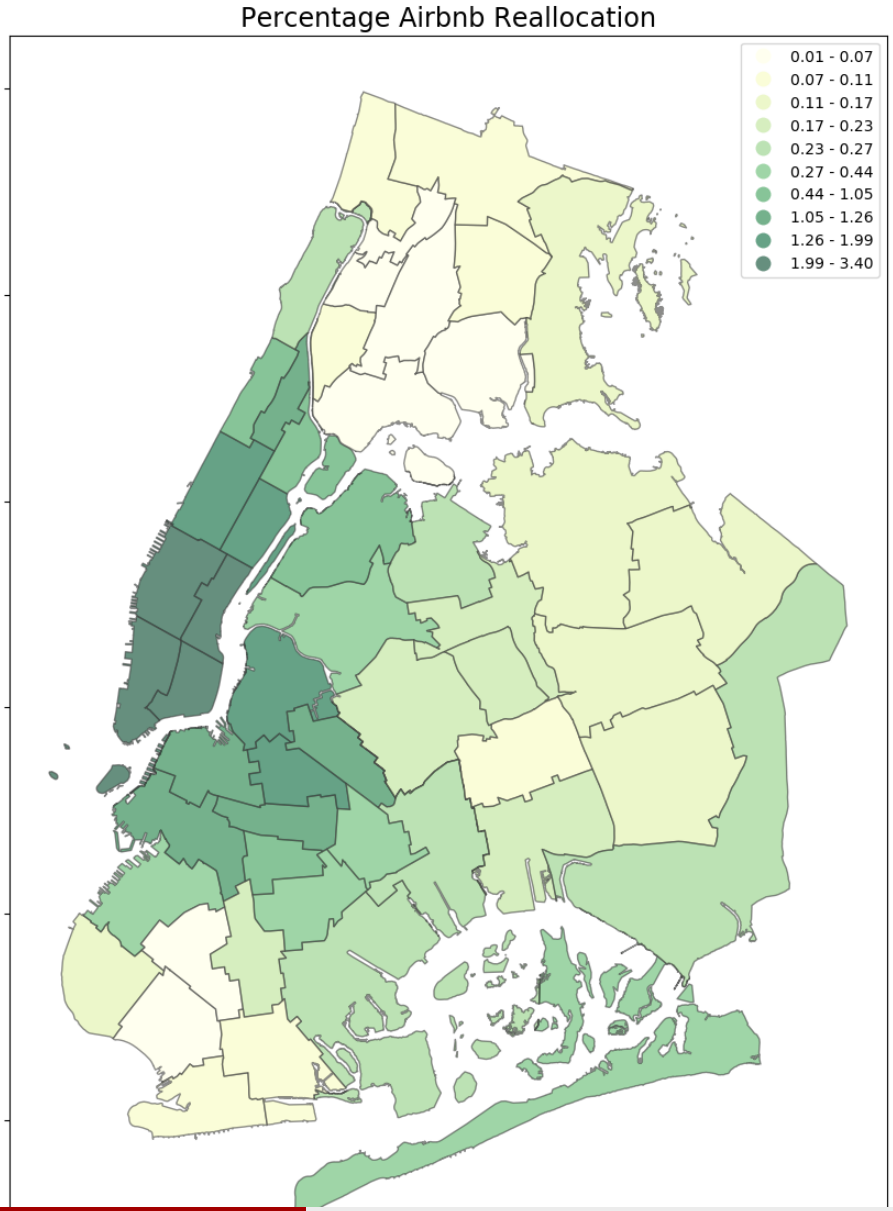

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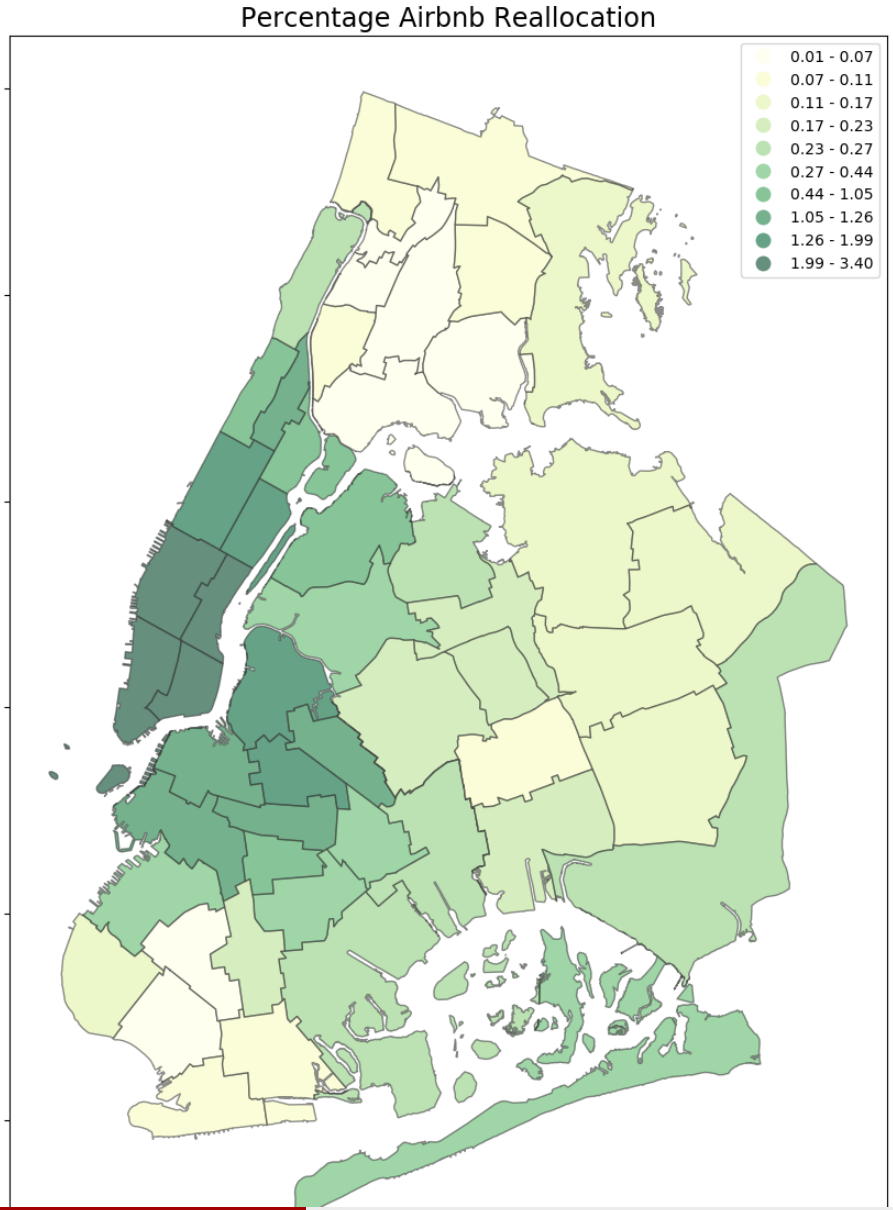

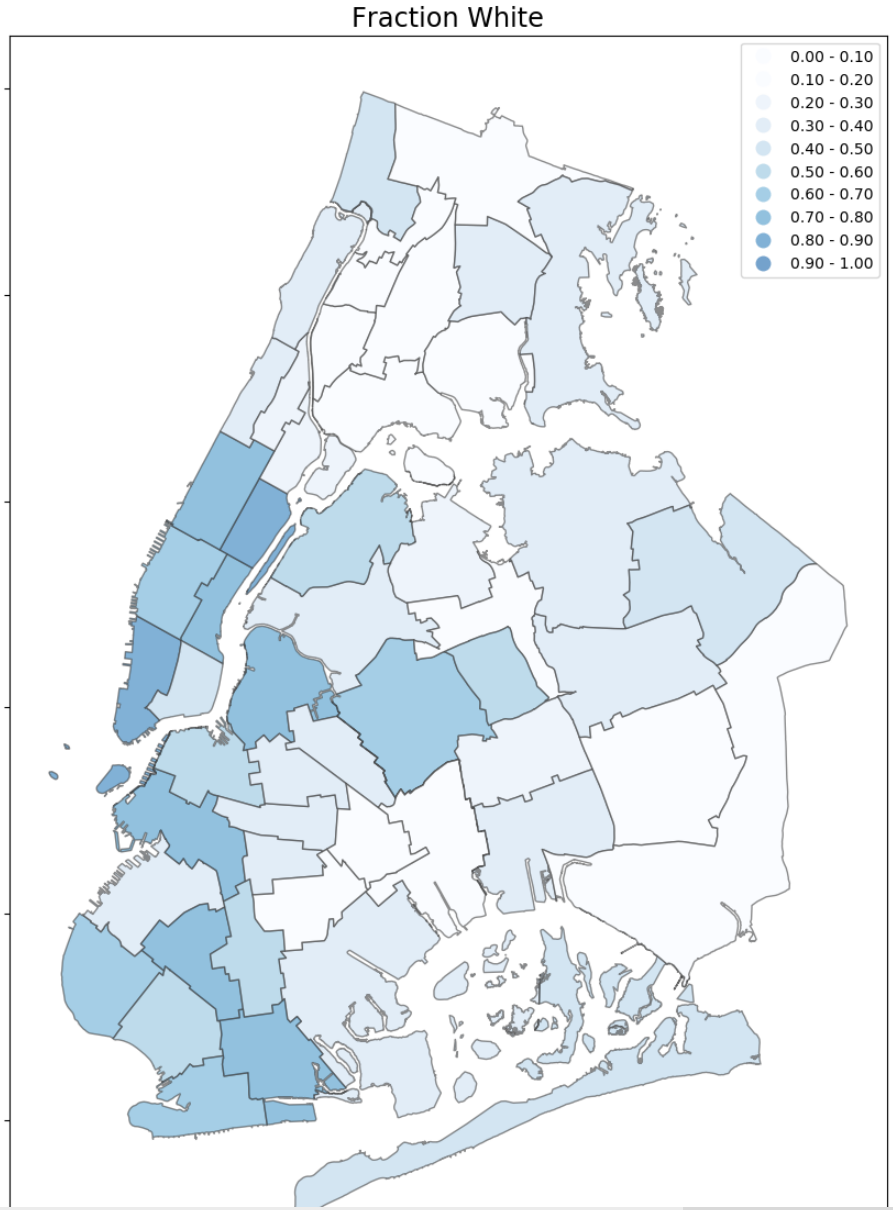

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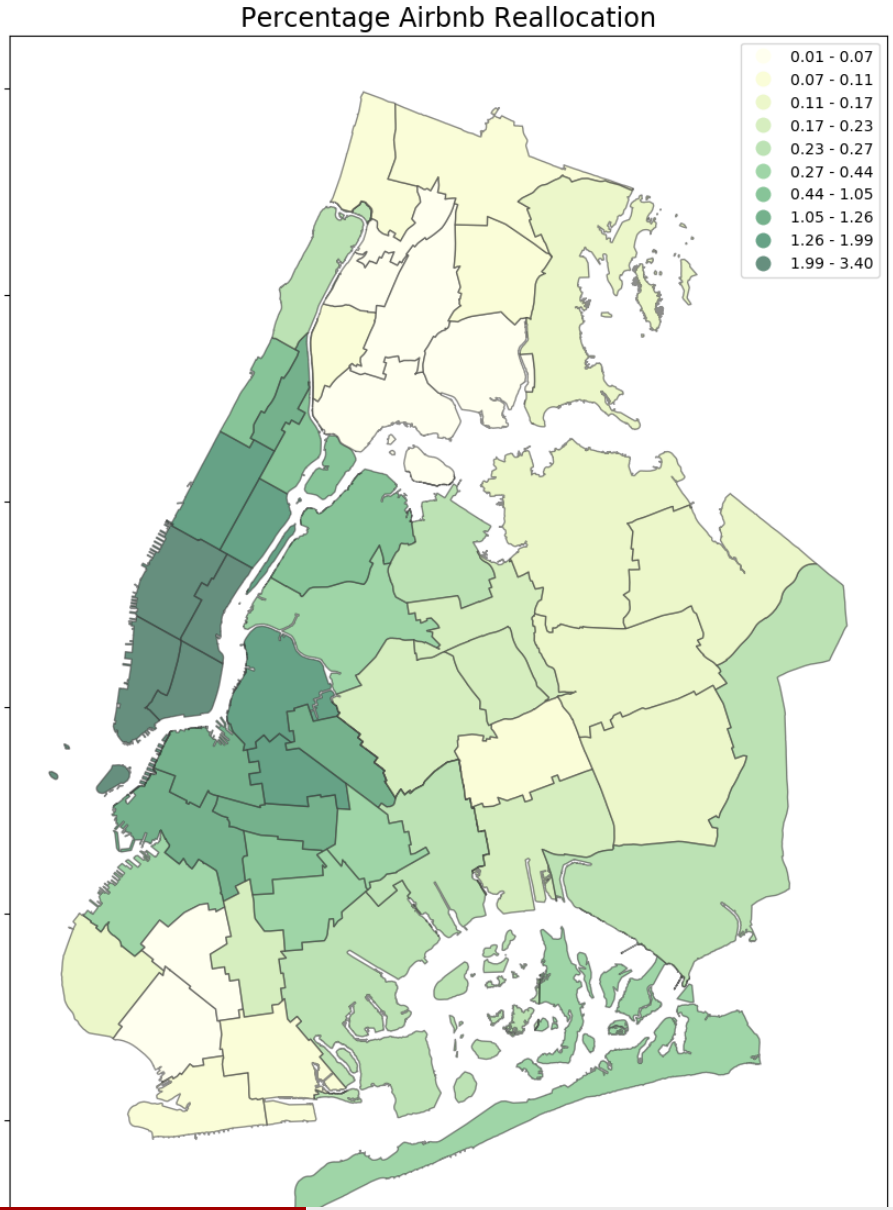

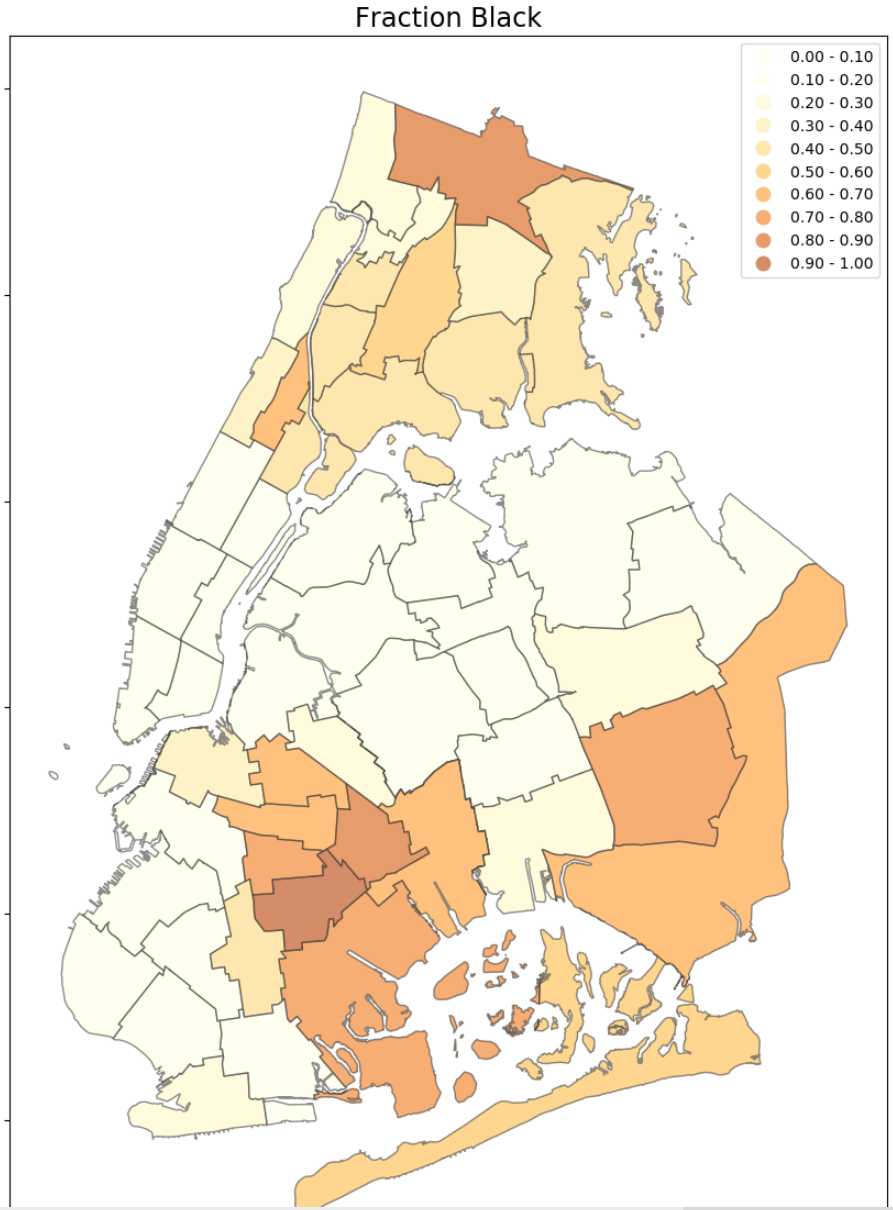

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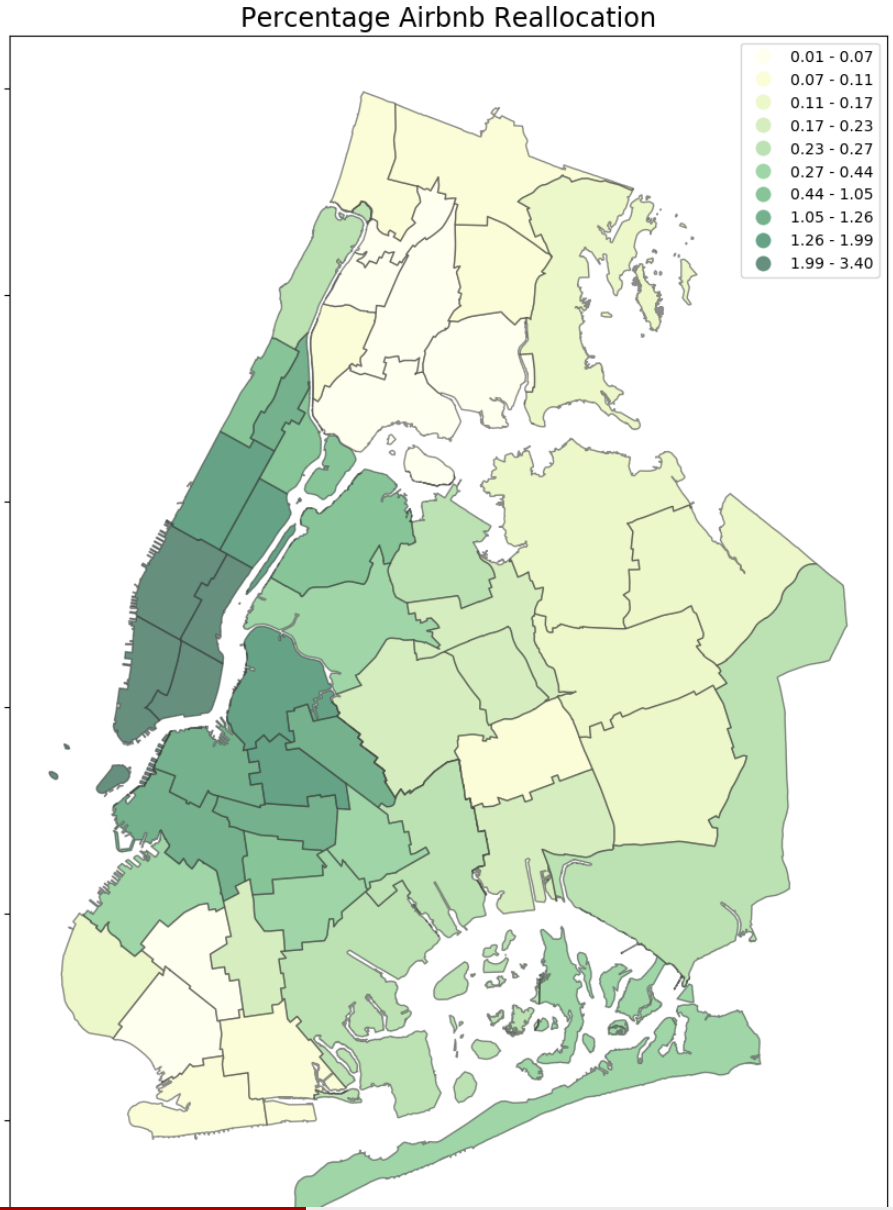

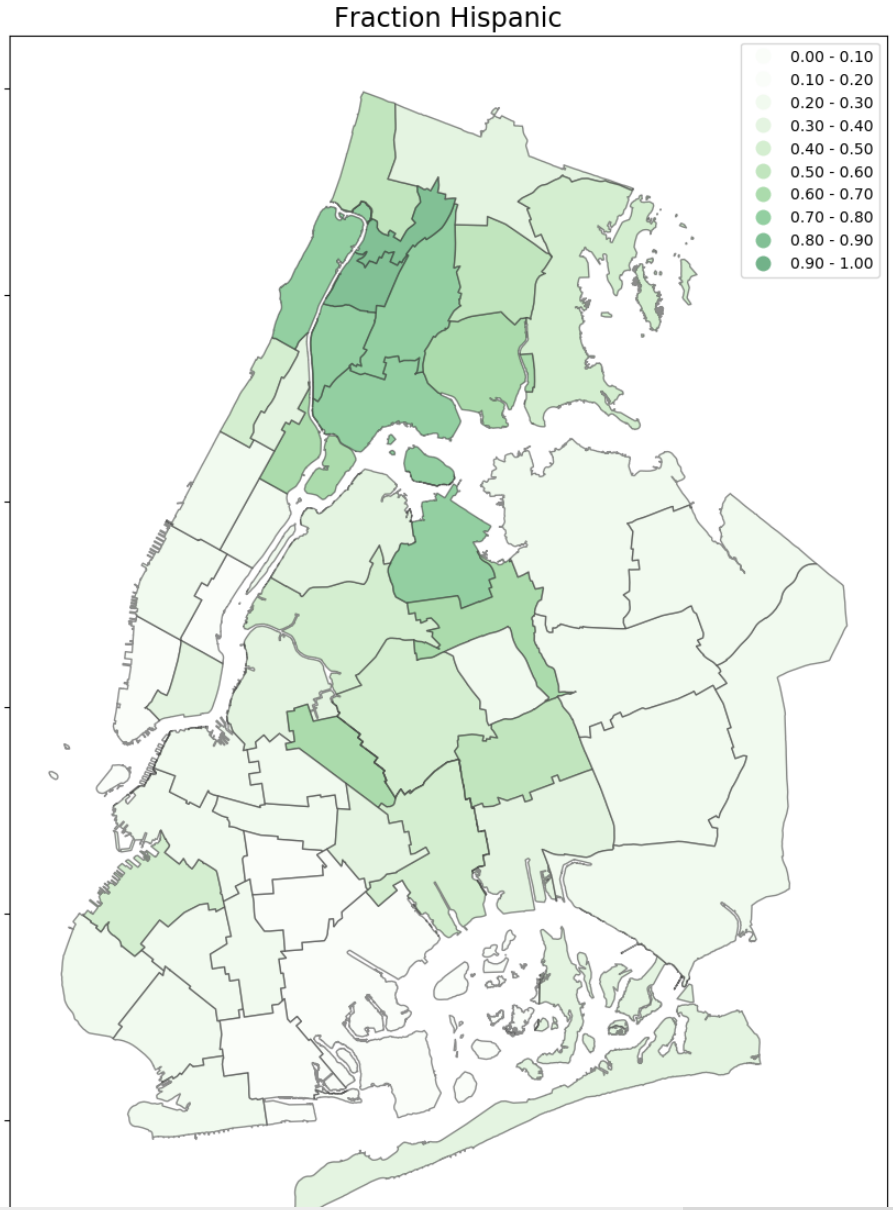

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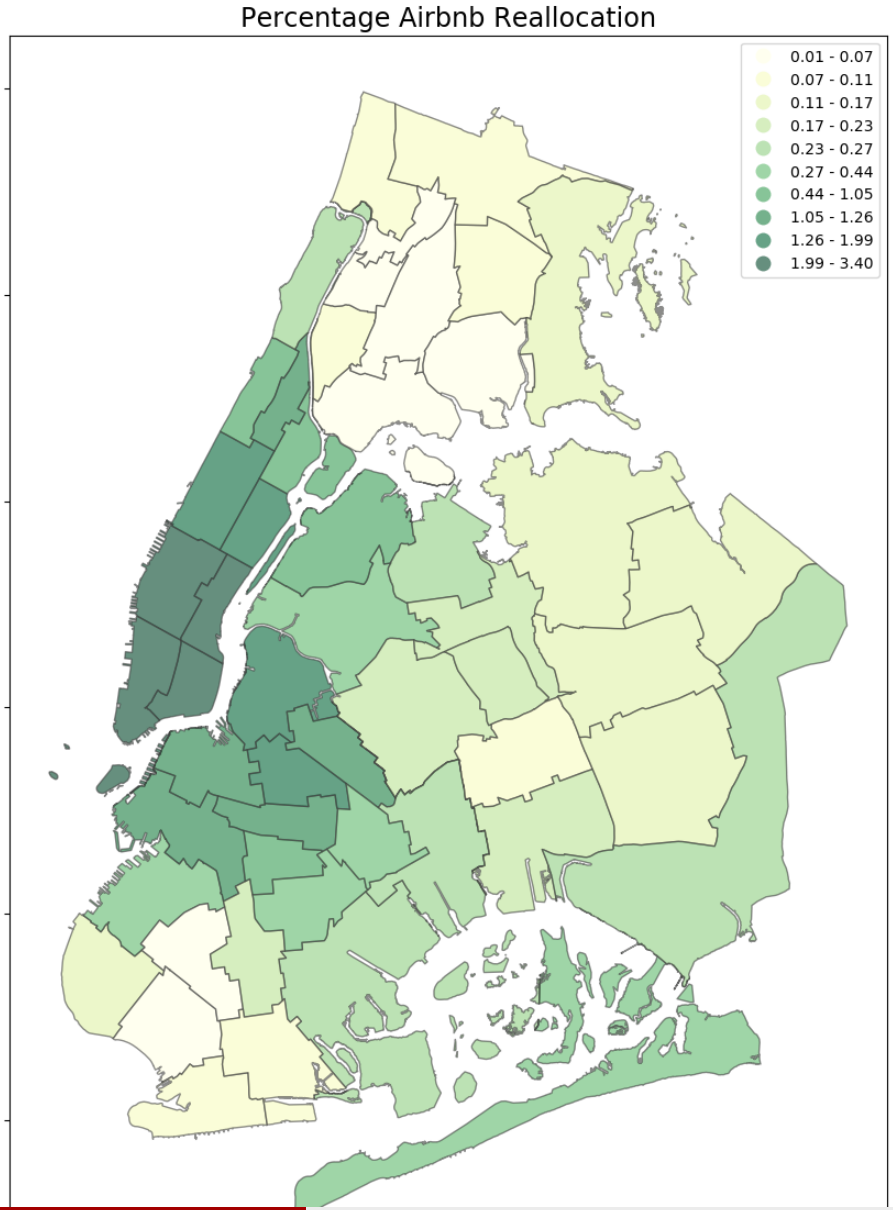

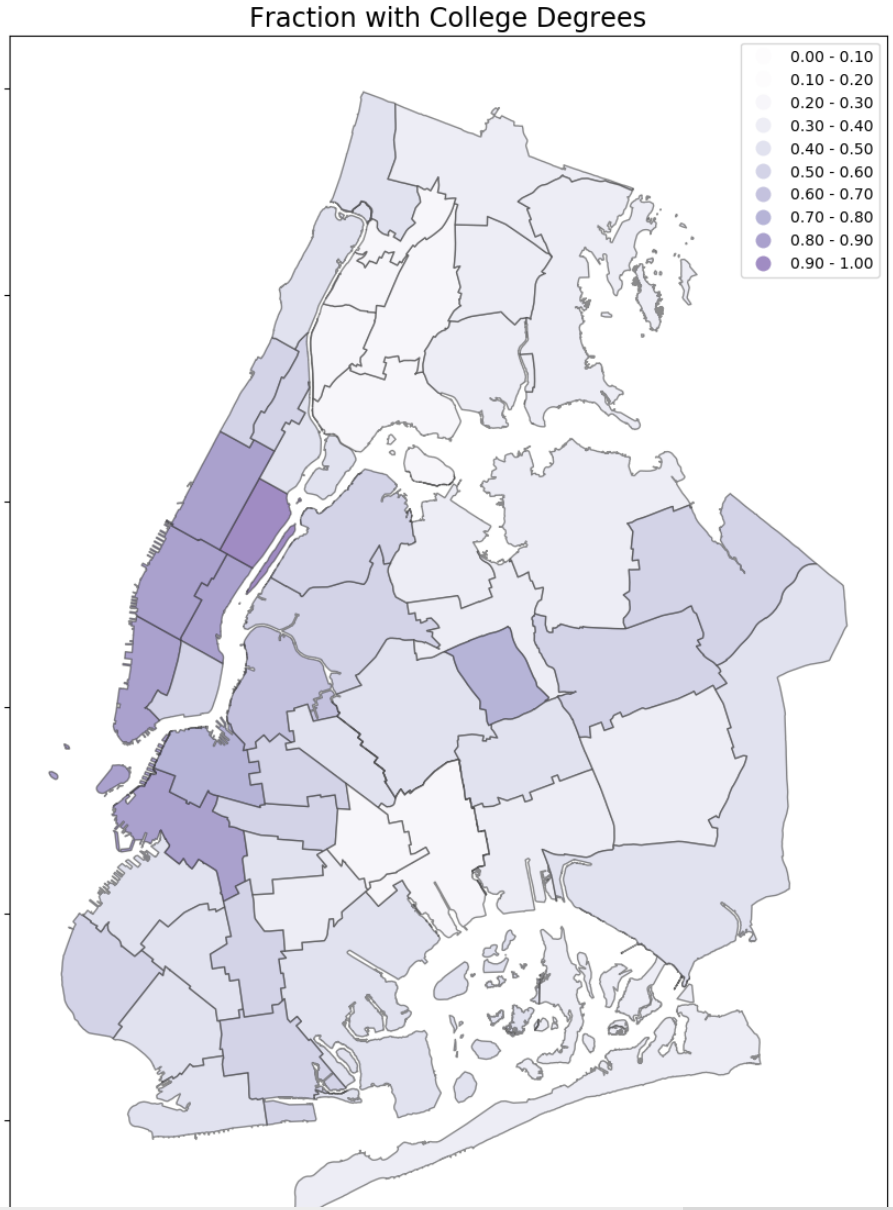

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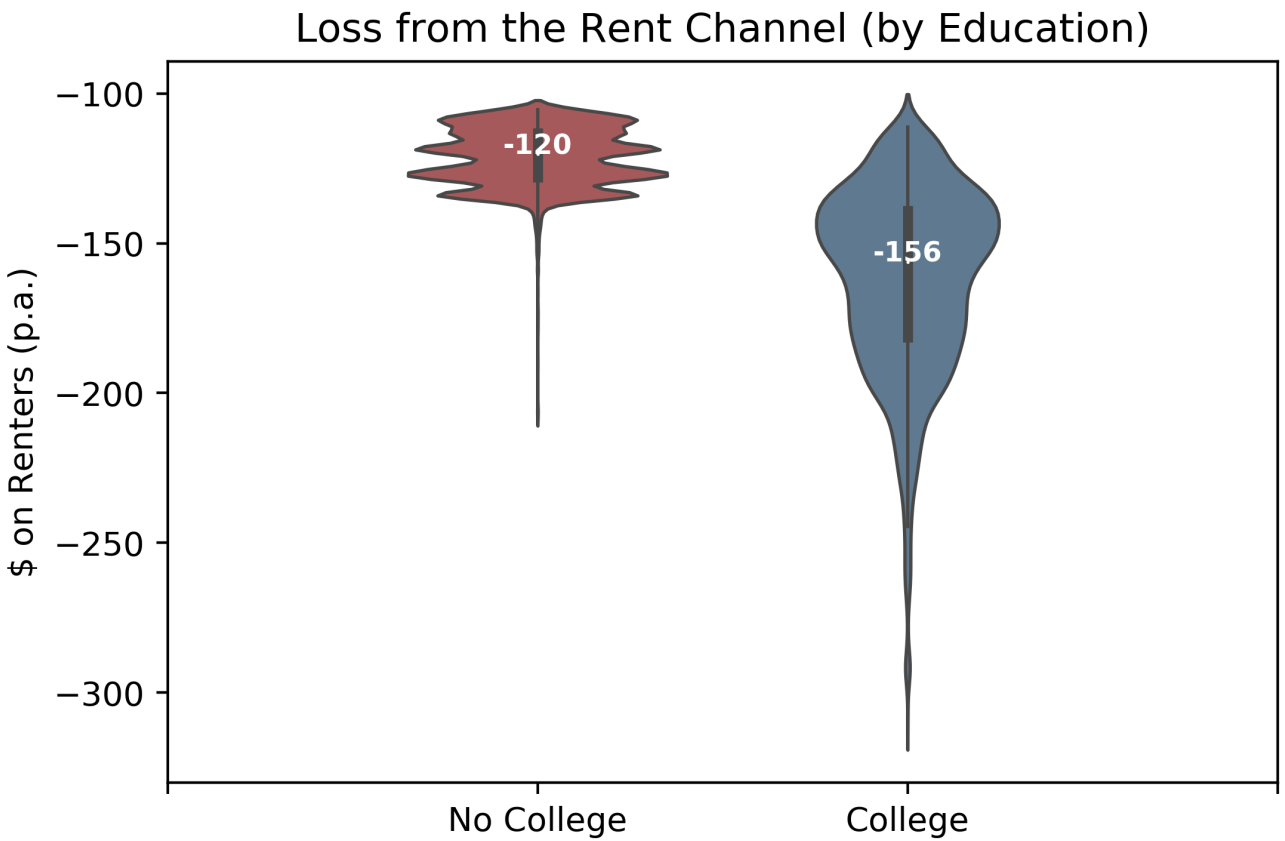

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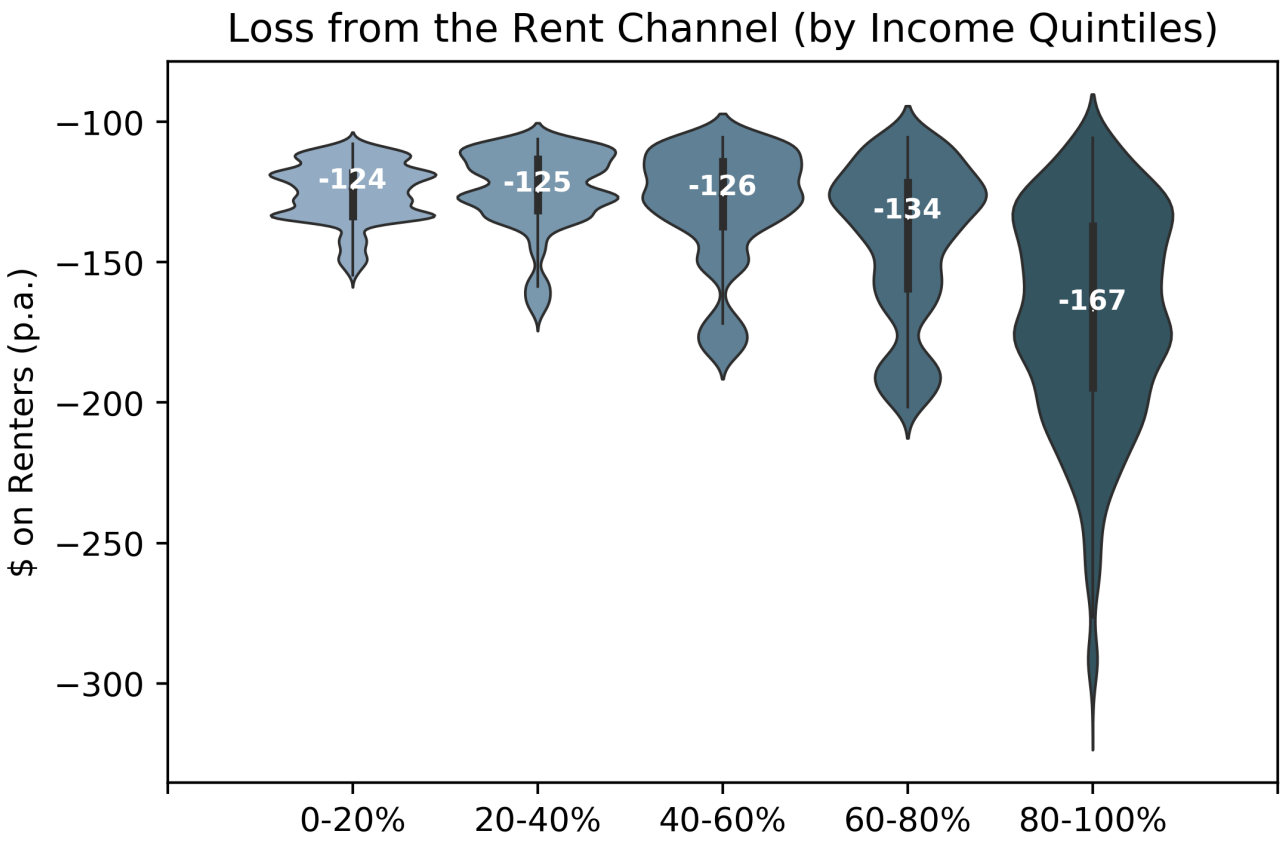

Loss from the Rent Channel

Drivers of Distributional Differences:

1. Geography
   - More Airbnb reallocation in high-income, educated, and white neighborhoods
2. Willingness-to-Pay
   - Higher-income households have higher WTP for all housing attributes
   - Geography remains dominant
     - Comparison to a hypothetical uniform Airbnb entry
3. Demographic Clustering
   - Housing preferences are clustered along demographic lines
   - "Spreading" to neighborhoods with similar demographics
     - White, educated neighborhoods further away from city centers

Outline

Gain from the Host Channel (Utilization Effects)

1. Counterfactual specification:
   - Take away residents ability to host on Airbnb
2. Compensating variation for logit errors:

$$CV_i^R = \frac{1}{\alpha_i^R} \sum_t \ln\left(1 + \exp(V_{i,t}^R)\right) \qquad V_{i,t}^R = \alpha_i^R p_{n,t}^A + \beta_i^R X_{n,t}^R + \xi_{n,t}^R$$

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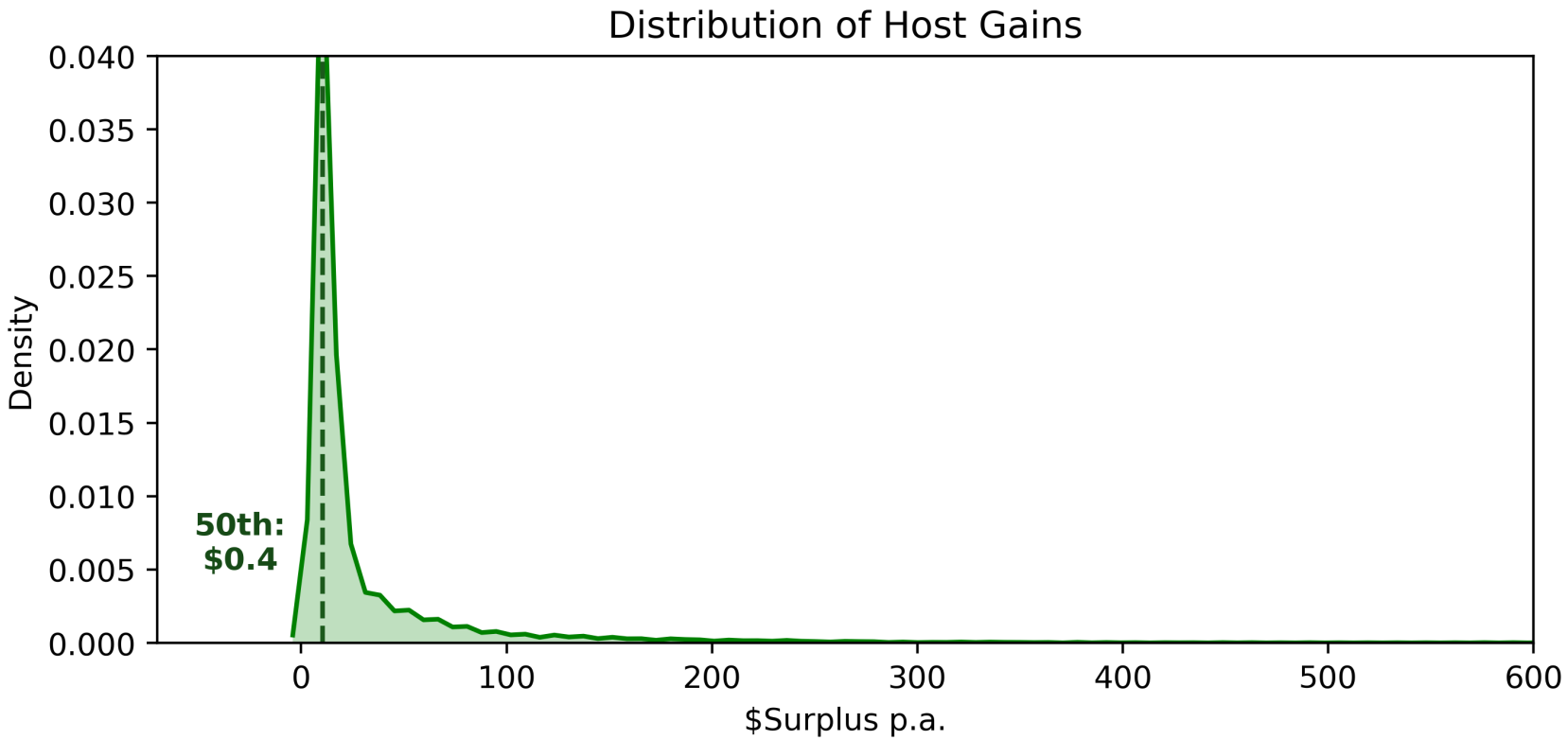

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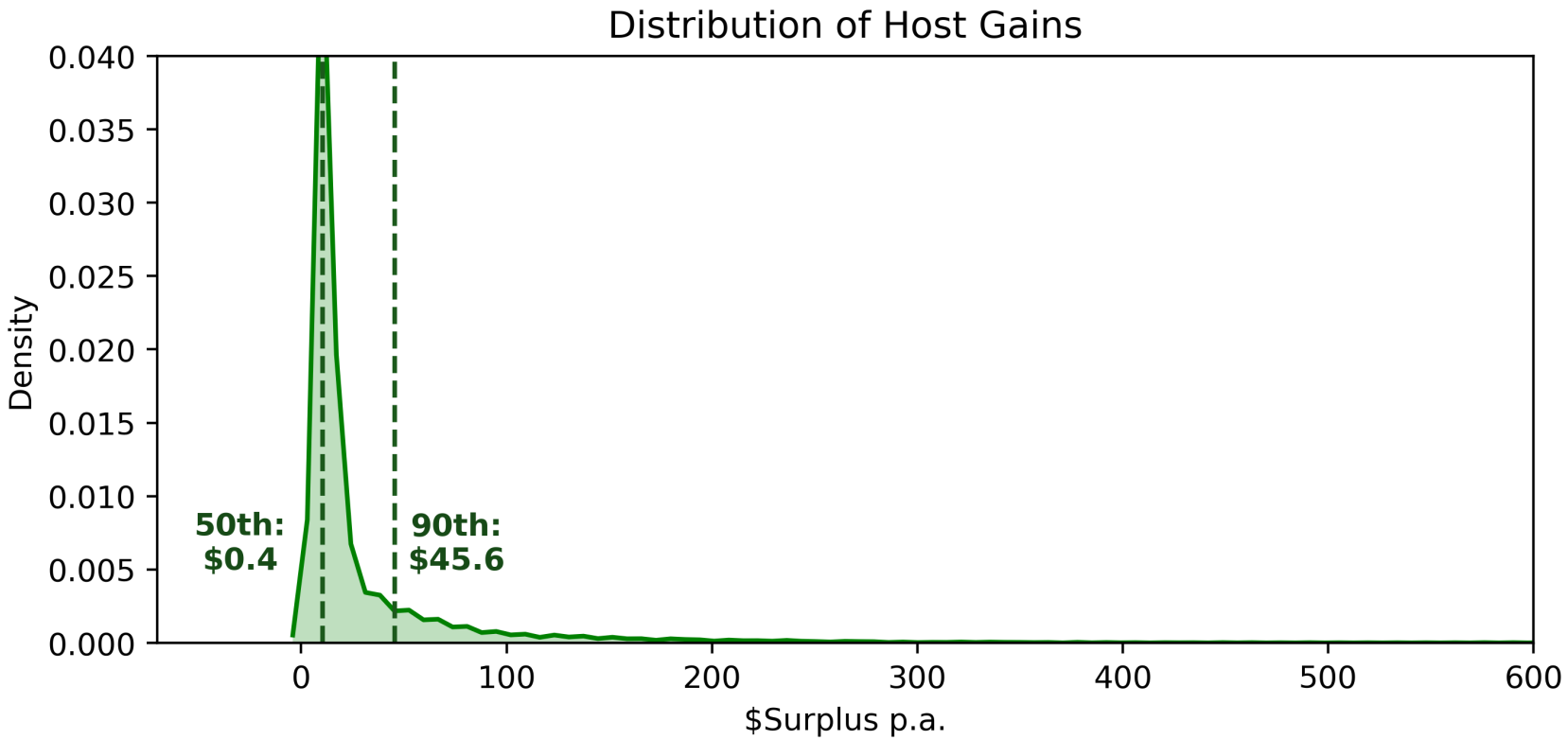

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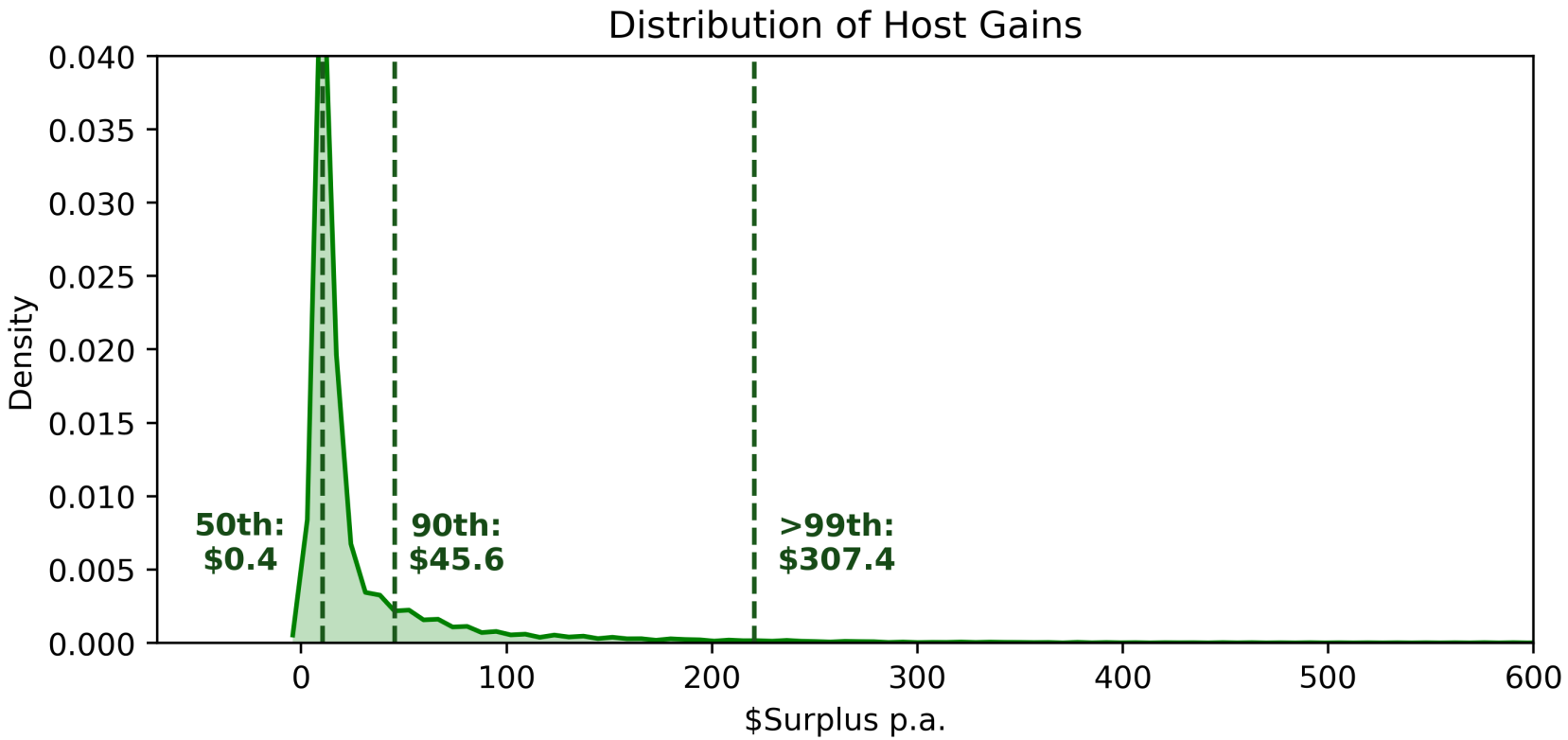

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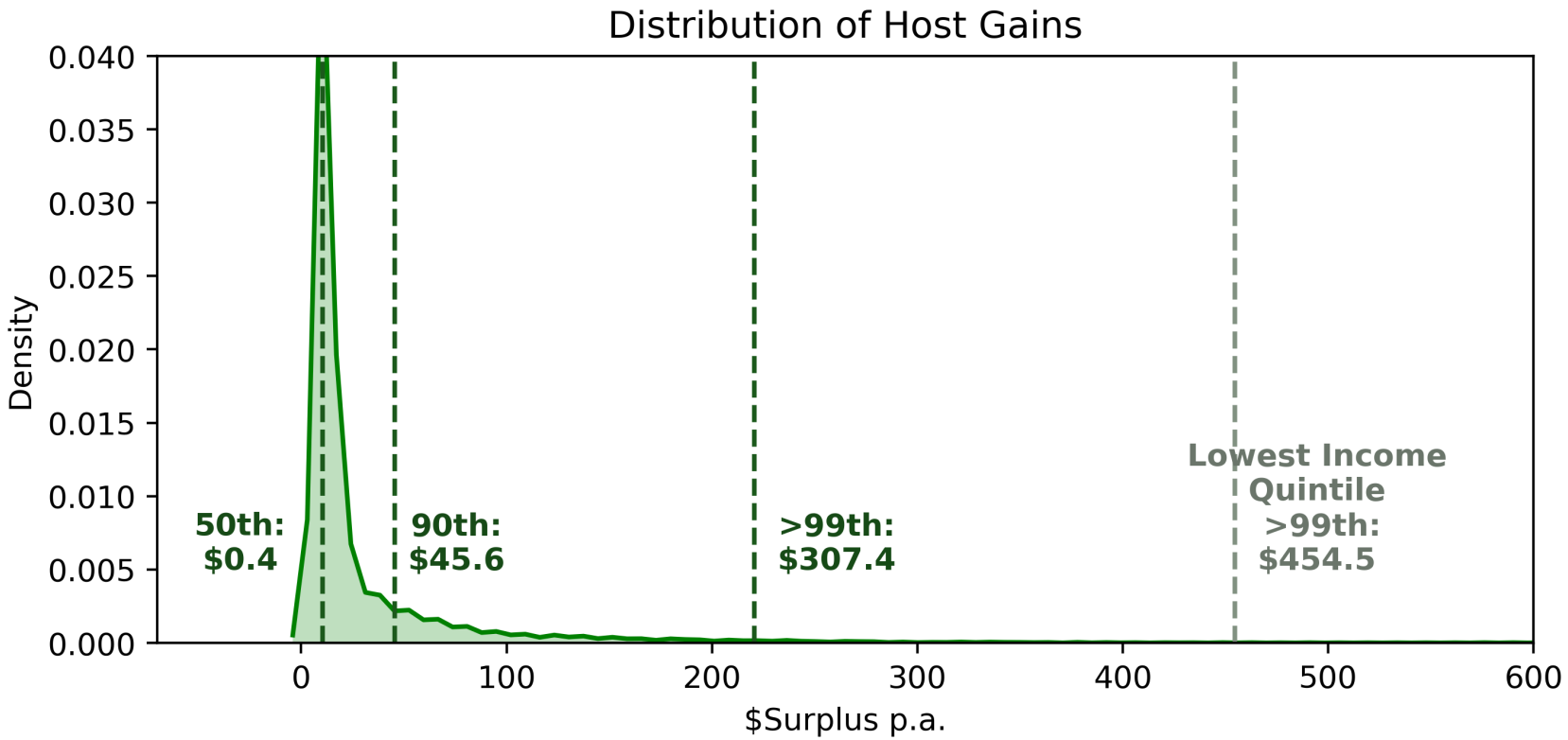
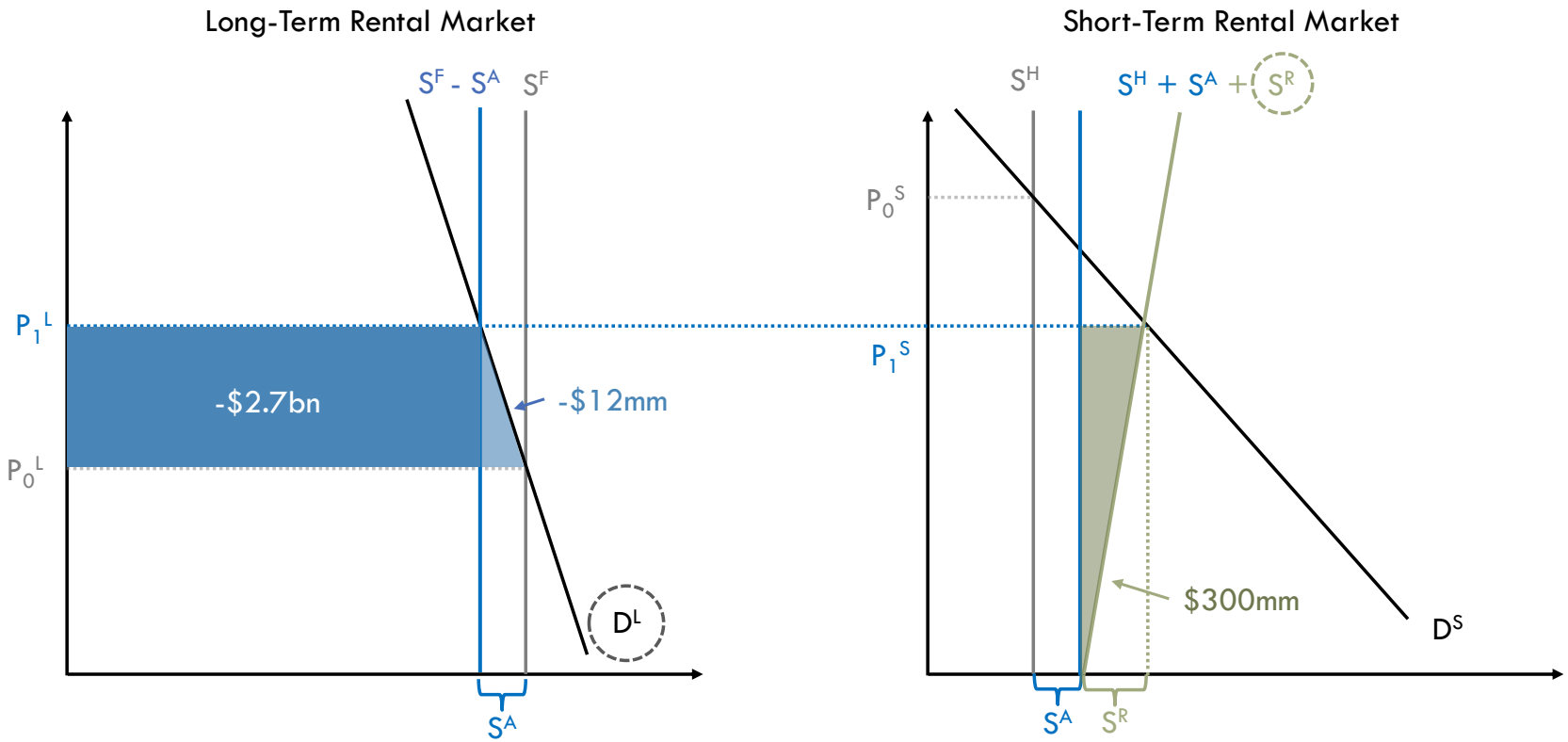


Outline

Net Welfare Impact on Renters

- The reallocation channel dominates the utilization channel
  - The median renter making $47k loses $125 p.a.
  - Larger welfare losses suffered by educated and high-income renters
  - Losses widespread, gains concentrated
- Aggregate and capitalize the impact:



Net Welfare Impact for the Social Planner

- The social planner's problem:
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  - Owners
  - Tourists and hotels

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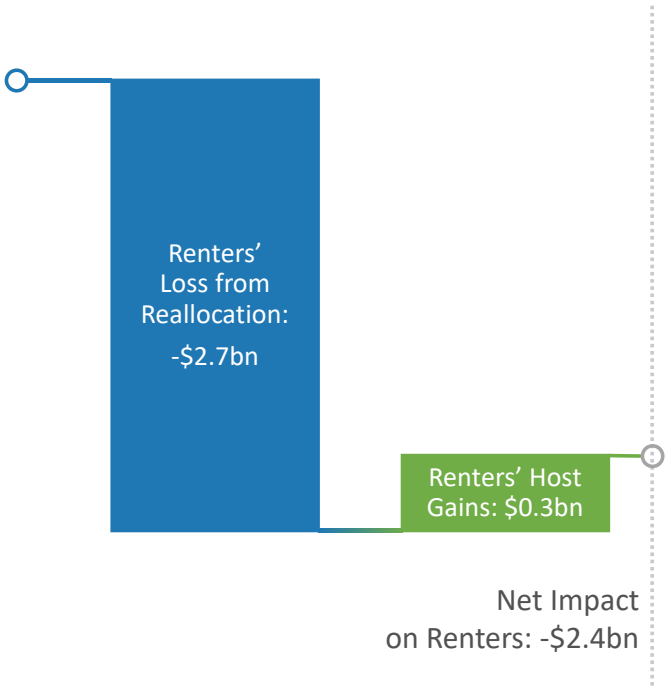

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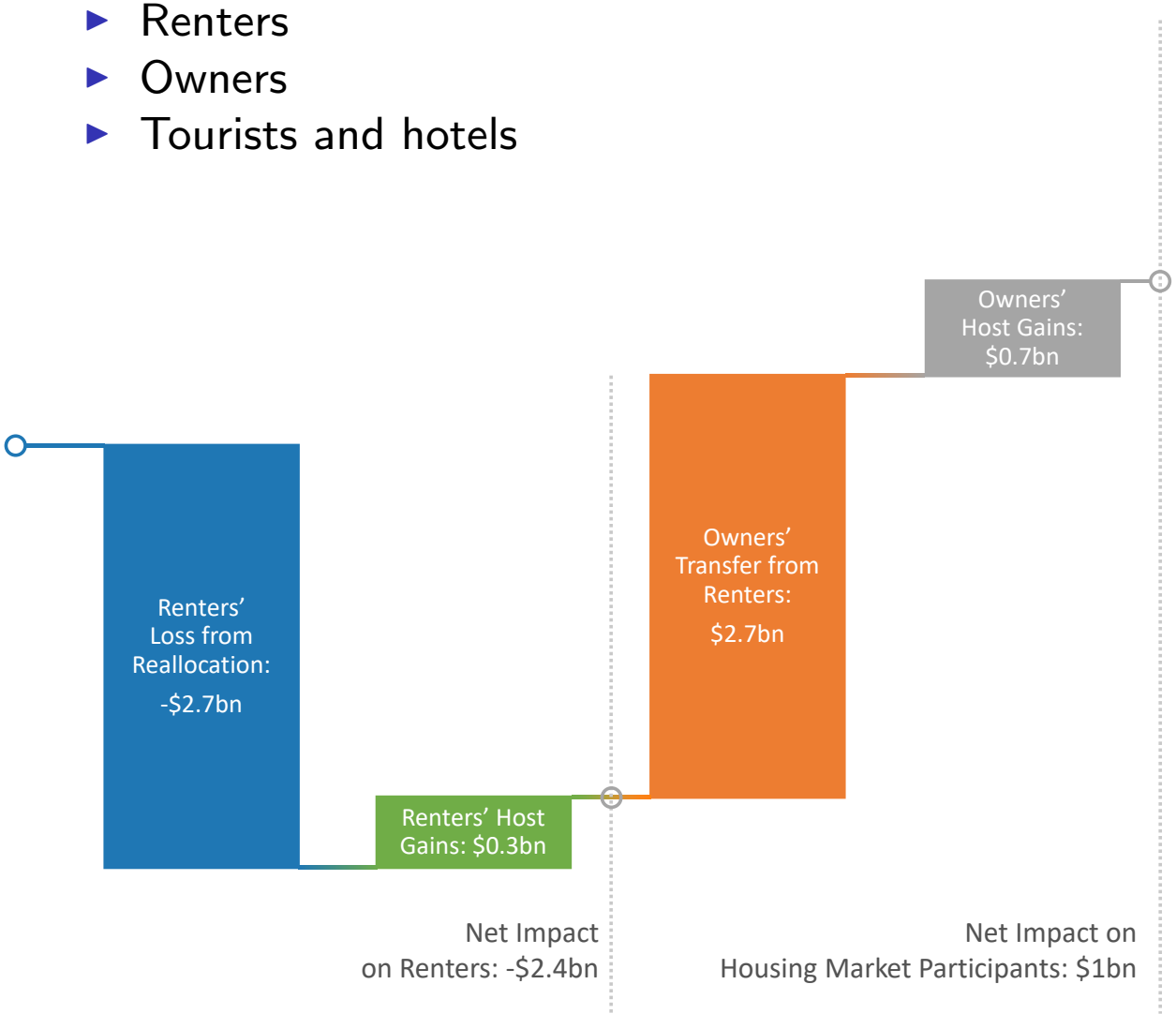
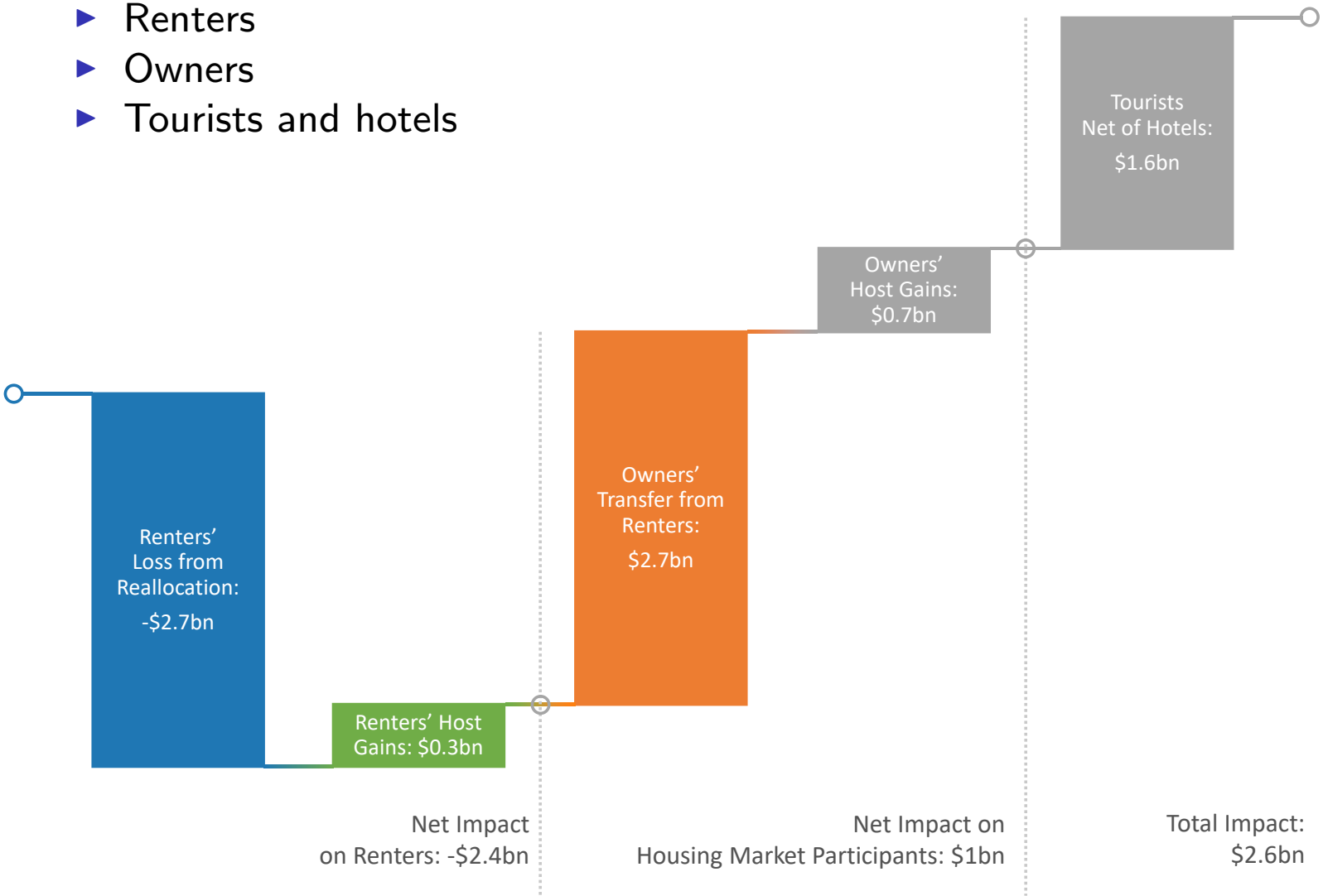
  - Owners
  - Tourists and hotels



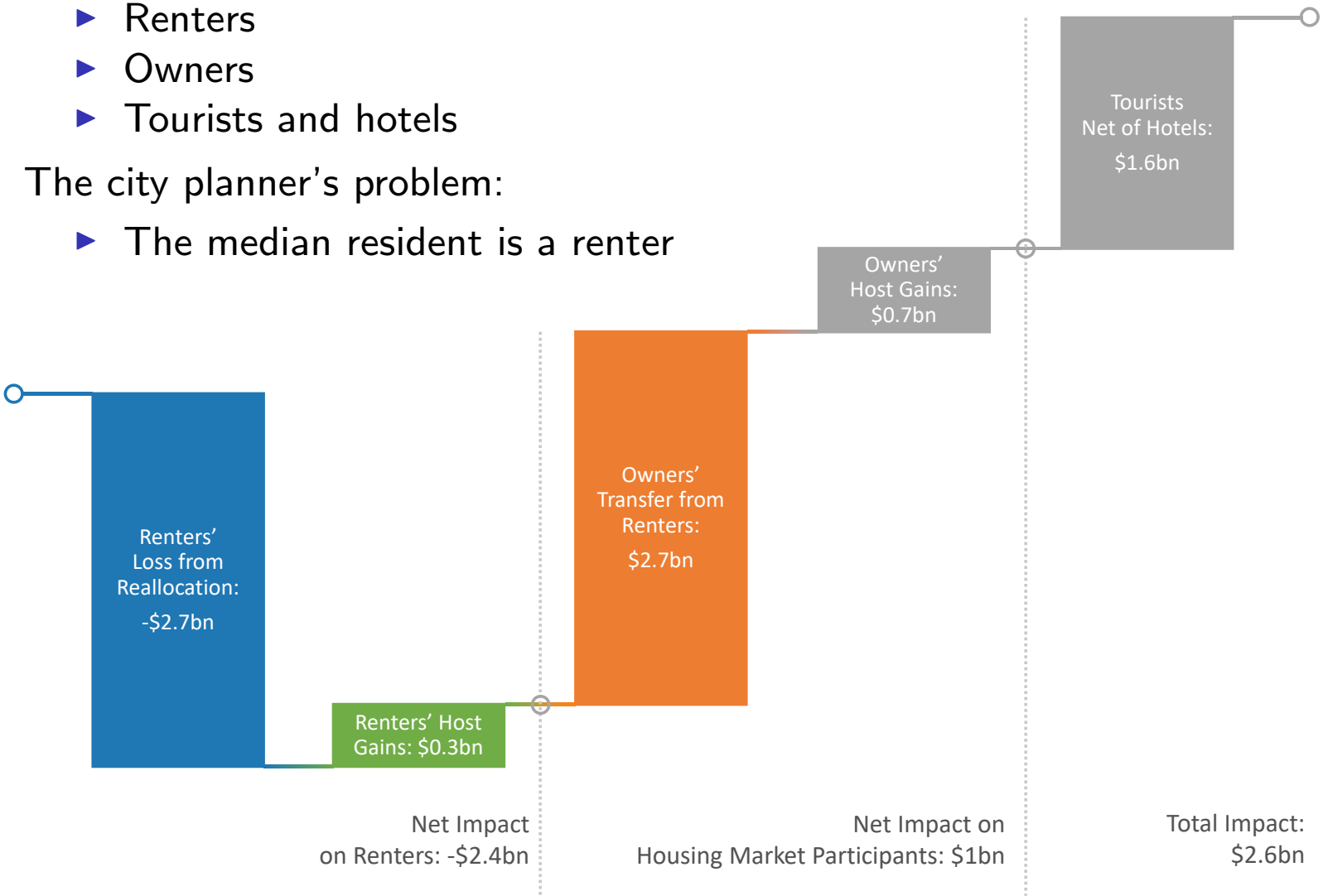
Net Welfare Impact for the Social Planner

- The social planner's problem:
  - Renters
  - Owners
  - Tourists and hotels



Net Welfare Impact for the Social Planner

- The social planner's problem:
  - Renters
  - Owners
  - Tourists and hotels
- The city planner's problem:
  - The median resident is a renter



Limitations / Extensions

- Long-term rental demand unchanged
  - No income effects
  - No re-optimization based on expected host gains
- A frictionless, static approximation
  - No switching costs
  - No explicit rent stabilization

Concluding Thoughts

- The impact of Airbnb on NYC residents:
  - Built a structural model of an integrated housing market:
    - Material welfare losses suffered by most renters (-$2.4bn NPV)
  - Rich preference heterogeneity for the distributional impact:
    - Larger losses for high income, educated, and white renters
    - Host gains accrue to a concentrated few

- What are the policy implications?
  - The popular solution is to restrict Airbnb reallocation
    - A reverse transfer from property owners back to renters
    - Reduce aggregate welfare

- The importance of existing market structures for policy
  - An inelastic housing supply remains the underlying challenge
  - How the pie is cut will affect the size of the pie

Thank you!

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