Retail Demand Estimation using Public Spatial Data

An Equilibrium Configuration Approach

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Motivation

Retail Demand Estimation & Merger Simulation

Typical Application:

- Retail chain mergers/store acquisitions
  - Price effects
  - Distribution efficiencies
  - Store divestiture/branding remedies

Typical Model:

- Store-level retail demand system
  - Household discrete choice of store

Typical Estimator:

- Requires proprietary data
  - Store-level revenues
  - Store-level quantity shares
  - Store-level prices
  - Consumer-level microdata
- Competition agency implementation:
  - Costly/unavailable data ✗
  - Confidentiality-restricted findings ✗

This Paper's Approach:

- Requires only public spatial data
  - Store locations
  - Distribution center locations
  - Household locations & demography
  - Retail precinct locations & sizes
- Competition agency implementation:
  - Free, available data ✓
  - Publishable findings ✓

Related Literature:

- Store-level retail demand estimation ▶
- Retail entry in continuous geographic space
- Profit inequality estimation of entry games
- Gowrisankaran & Krainer (2011 RJE)

Existing Papers:

- Store-level quantity/revenue/price data ✗
  - Thomadsen (2005 RJE; 2007 MS)
  - Davis (2006 RJE)
  - Manuszak (2010 IJIO)
  - Ho & Ishii (2011 IJIO)
  - Houde (2012 AER)
  - Seim & Waldfogel (2013 AER)
  - Aguirregabiria & Vicentini (2016 JIE)
  - Ellickson, Grieco & Khvastunov (2020 RJE)
- Consumer-level store choice data ✗
  - Chernew, Gowrisankaran & Fendrick (2002 JHE)
  - Gaynor, Kleiner & Vogt (2003 RJE; 2013 JIE)
  - Smith (2004 RES; 2006 RJE)
  - Klopack (2024 RJE)

This Paper:

- Public store location data ✓

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Existing Papers:

- Reduced form variable profit functions ✗
  - Seim (2006 RJE)
  - Zhu & Singh (2009 QME)
  - Datta & Sudhir (2013 QME)
  - Orhun (2013 QME)
  - Caoui, Hollenbeck & Osborne (2025)
- Conditional on pre-estimated demand system ✗
  - Chernew, Gowrisankaran & Fendrick (2002 JHE)
  - Aguirregabiria & Vicentini (2016 JIE)

This Paper:

- Microfounded demand system ✓
- Directly estimated ✓

Related Literature:

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- Reduced form variable profit functions ✗
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- Conditional on pre-estimated demand system ✗
  - Crawford & Yurukoglu (2012 AER)
  - Eizenberg (2014 RES)
  - Pakes, Porter, Ho & Ishii (2015 E)
  - Berry, Eizenberg & Waldfogel (2016 RJE; 2016 JIE)
  - Aguirregabiria, Clark & Wang (2016 RJE)
  - Kuehn (2018 RJE; 2020 JIE)
  - Wollman (2018 AER)
  - Fan & Yang (2020 AEJM; 2025 JPE)

This Paper:

- Direct estimation of demand system ✓

Related Literature:

- Store-level retail demand estimation
- Retail entry in continuous geographic space
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- Gowrisankaran & Krainer (2011 RJE) ▶
  - Microfounded, store-level demand system ✓
  - Continuous geographic space ✓
  - Endogenous store presences ✓
  - Public store location data ✓

Gowrisankaran & Krainer (2011 RJE):

- Regulated, market-level prices ✗

This Paper:

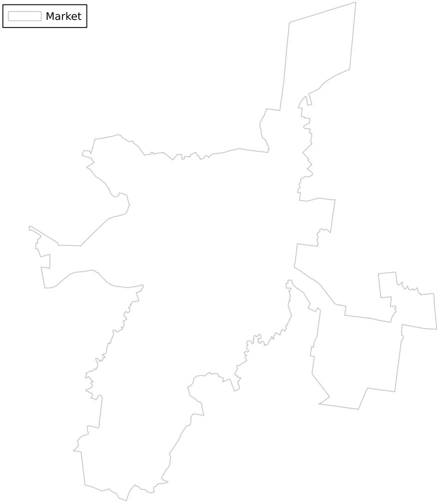
- Profit-maximizing, store-level prices ✓
  - Localized competitive price effects ✓

Model

Data Requirements & Notation

Data Requirements:

- Markets: $m \in \mathcal{M}$
  - Location set: $\mathcal{L}_m$
- Households types: $h \in \mathcal{H}$
  - Income: i_h
  - Location: l_h
  - Population: n_h
- Retail shopping precincts: $r \in \mathcal{R}$
  - Location set: $\mathcal{L}_r$
  - Agglomeration: a_r
- Stores: $s \in \mathcal{S}$
  - Location: l_s
  - Brand: b_s
  - Owner: o_s
- Wholesale distribution centres: $w \in \mathcal{W}$
  - Location: l_w
  - Brand(s) supplied: $\mathcal{B}_w$



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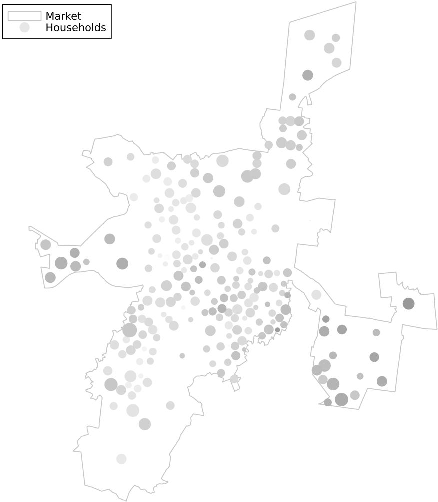

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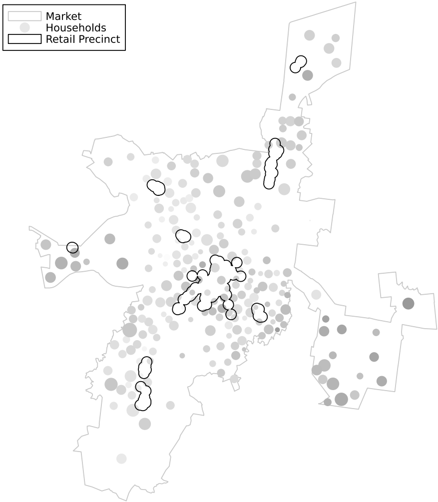

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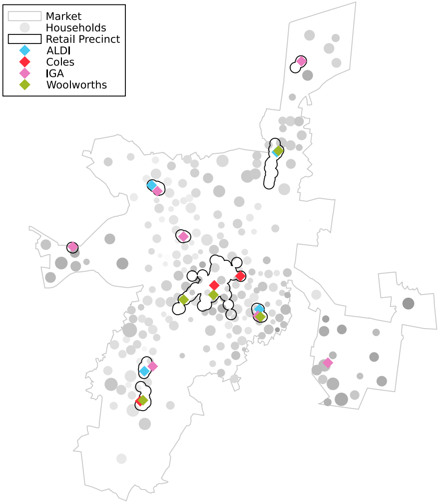

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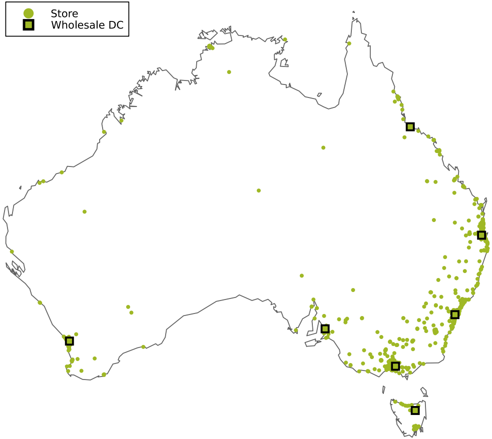


Model

Store-Level Demand, Owner Profits & Price Equilibrium

Household Store Choice

- Brand differentiation
  - Horizontal: ρ
  - Vertical: β_b
- Location differentiation
  - Distance: δ
  - Agglomeration: α
- Price disutility
  - f(income): η_0, η_i

$$u_{hs} = \underbrace{\alpha a_r + \beta_b + \delta d_{hs} + \eta_h p_s}_{\overline{u}_{hs}} + \underbrace{\epsilon_{hb} + (1-\rho)\epsilon_{hs}}_{\nu_{hs}}$$

$$\eta_h = \eta_0 + \eta_i i_h \text{ and } \mathrm{Corr}[\nu_{hs}, \nu_{hs'}] = \rho \text{ for } s, s' \in \mathcal{S}_b$$

$$q_s = \sum_h n_h \underbrace{\frac{\exp(\frac{\overline{u}_{hs}}{1-\rho})}{\Sigma_{bh}}}_{\Pr[s_h = s | b_h = b]} \cdot \underbrace{\frac{{\Sigma_{bh}}^{1-\rho}}{1 + \sum_b {\Sigma_{bh}}^{1-\rho}}}_{\Pr[b_h = b]} \text{ with } \Sigma_{bh} = \sum_{s \in \mathcal{S}_b} \exp(\frac{\overline{u}_{hs}}{1-\rho})$$

Owner Profits

- Marginal costs
  - f(brand, distance): μ_b, ω
- Fixed costs
  - f(brand): F_b

$$\pi_o = \sum_{s \in \mathcal{S}_o} \pi_s \text{ with } \pi_s = (p_s - c_s) q_s - f_s \text{ and } c_s = \mu_b + \omega d_{sw}$$

$$, \Pr[f_s < x] = F_b(x)$$

Price Equilibrium

- Nash-Bertrand

$$\boldsymbol{p}_o^* = \arg\max_{\boldsymbol{p}_o} \pi_o(\boldsymbol{p}_o, \boldsymbol{p}_{-o}) \quad \forall o \in \mathcal{O}$$

Spatial Equilibrium
Sutton (1997 RJE; 1998; 2000; 2007):
Equilibrium configuration

- Mutual best response in store networks
  - Testable marginal profit inequalities:

    $$\Delta\pi_s := \pi_o[s \in \mathcal{S}|\mathcal{S}_{-s}] - \pi_o[s \notin \mathcal{S}|\mathcal{S}_{-s}]$$

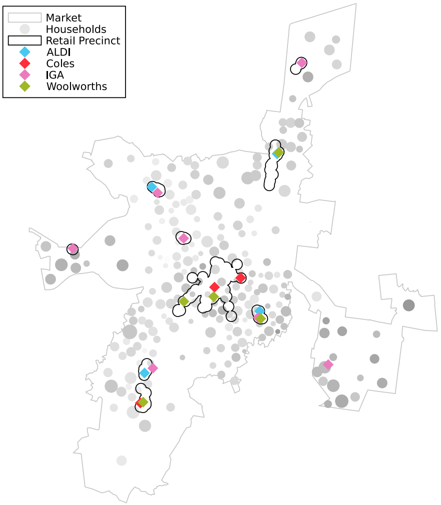
    - Observed stores: marginally profitable

      $$\Delta\pi_s \geq 0 \quad \forall s \in \mathcal{S}$$

    - Unobserved stores: marginally unprofitable

      $$\Delta\pi_s \leq 0 \quad \forall s \notin \mathcal{S}$$

- Agnostic to order of entry, equilibrium selection
  - Robust to first mover advantages, multiple equilibria
- Long run interpretation
  - Iterated store network updating



Conditional Store Existence Probabilities:

- Store-level observables: $\boldsymbol{\mathcal{X}}_s = (b_s, l_s, o_s, \mathcal{S}_{-s}, \mathcal{H}, \mathcal{R}, \mathcal{W})$
- Conditional independence assumption: $F_b(\cdot|\boldsymbol{\mathcal{X}}_s) = F_b(\cdot)$
- Conditional store existence probabilities: $\underbrace{\Pr[s \in \mathcal{S}|\boldsymbol{\mathcal{X}}_s]}_{\text{Observed}} = \Pr[\Delta\pi_v(\boldsymbol{\mathcal{X}}_s) - f_s \geq 0|\boldsymbol{\mathcal{X}}_s] = F_b\big(\Delta\pi_v(\boldsymbol{\mathcal{X}}_s)\big)$

Fixed & Variable Profit Decomposition:

Matzkin (1992 E; 1994), Berry & Tamer (2006)

- $F_b(\cdot)$, $\Delta\pi_v(\cdot)$ recoverable:
  - Shape restriction: $\Delta\pi_v(\cdot) \propto$ household population multiplier
  - Special regressor: $\Delta\pi_v(\cdot)$ continuous, monotone decreasing in full support d_{sw}

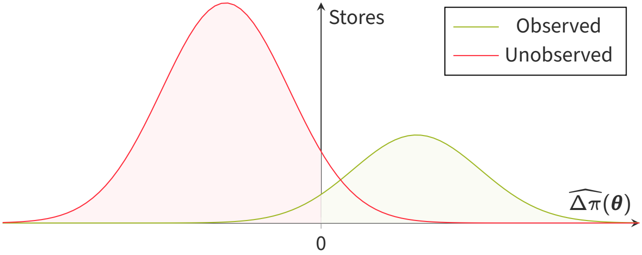
Variable Profit Parameters:

- $\Delta\pi_v(\boldsymbol{\mathcal{X}}_s; \boldsymbol{\theta}_v)$ identifies variable profit parameters: $\boldsymbol{\theta}_v = (\alpha, \delta, \eta_0, \eta_i, \rho, \omega, \boldsymbol{\mu}', \boldsymbol{\beta}')$
  - High dimensional, nonlinear system of equations
    - $|\boldsymbol{\theta}_v| = 6 + 2|\mathcal{B}|$ parameters
    - $\prod_{\boldsymbol{\mathcal{X}} \in \mathcal{D}_{\boldsymbol{\mathcal{X}}}} (2|\mathcal{S}_m(\boldsymbol{\mathcal{X}}_s)| - 1)$ first order conditions
  - Numerical verification
    - Latent equilibrium prices

Estimator:
Maximize weighted log-likelihood of conditional store existence & non-existence probabilities

$$\ell(\boldsymbol{\theta}) := |\mathcal{S}|^{-1} \sum_{s \in \mathcal{S}} \log \Big[\underbrace{F_b\big(\Delta\pi_v(\boldsymbol{\mathcal{X}}_s; \boldsymbol{\theta}_v); \boldsymbol{\theta}_f\big)}_{\Pr[s \in \mathcal{S}]} \Big] + |\mathcal{B} \times \mathcal{R}|^{-1} \sum_{s \in \mathcal{B} \times \mathcal{R}} \log \Big[\underbrace{1 - F_b\big(\Delta\pi_v(\boldsymbol{\mathcal{X}}_s; \boldsymbol{\theta}_v); \boldsymbol{\theta}_f\big)}_{\Pr[s \notin \mathcal{S}]} \Big]$$

- Outcome-based sampling
  - $|\mathcal{S}|$ observed stores
  - $|\mathcal{B}| \times |\mathcal{R}|$ unobserved stores
    - Extra store of each brand at each retail precinct
- Parametric fixed cost assumption
  - $F_b : f_b \sim N(\phi_b, \sigma)$
    - Brand-specific means: ϕ_b
    - Common shocks: $N(0, \sigma)$



Equilibrium Price Computation

Morrow & Skerlos (2011 OR):

- Vectorized Nash-Bertrand first order conditions:

$$\boldsymbol{p} = \boldsymbol{c} + \left(\boldsymbol{O} \odot \text{-}\boldsymbol{\nabla}(\boldsymbol{p})\right)^{-1} \boldsymbol{q}(\boldsymbol{p})$$

$$\text{with } \nabla_{ij} = \frac{\partial q_i}{\partial p_j}(\boldsymbol{p}) \text{ and } O_{ij} = 1[o_i = o_j] \quad \forall i, j \in \mathcal{S}$$

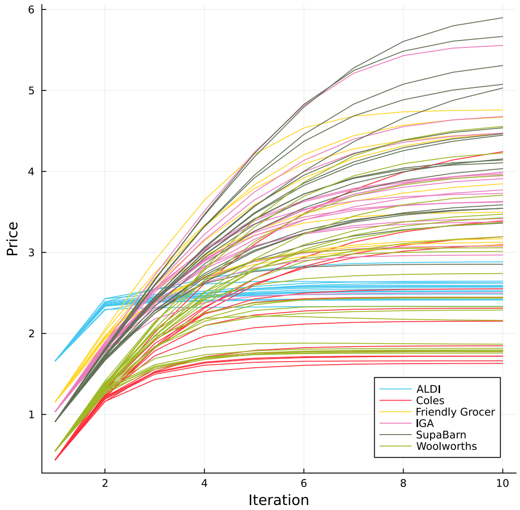
- Analytic demand derivative matrix decomposition:

$$\boldsymbol{\nabla} = \boldsymbol{\Lambda} - \boldsymbol{\Gamma} \text{ with } \Lambda_{ii} = \sum_h \eta_h \psi_{hi} \quad \forall i \in \mathcal{S}$$

$$\text{and } \Gamma_{ij} = \sum_h \eta_h \psi_{hi} \psi_{hj} \quad \forall i, j \in \mathcal{S}$$

- Fixed point iteration:

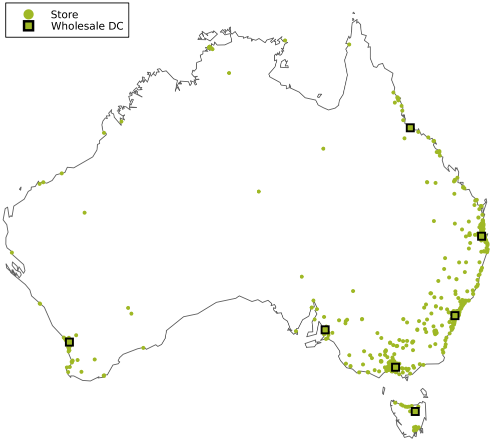
$$\boldsymbol{p} \leftarrow \boldsymbol{c} + \boldsymbol{\Lambda}(\boldsymbol{p})^{-1} \Big(\left(\boldsymbol{O} \odot \boldsymbol{\Gamma}(\boldsymbol{p})\right)(\boldsymbol{p} - \boldsymbol{c}) - \boldsymbol{q}(\boldsymbol{p}) \Big)$$



Data

Full Sample - Australian Supermarkets

- $|\mathcal{M}| \approx 800$ markets
  - ASGS 2021 Urban Centres & Localities
    - Defined based on contiguous urban/residential density
- $|\mathcal{H}| \approx 700{,}000$ household types
  - 2021 Australian census
    - i_h: ln(Weekly household income)
    - l_h: SA1 centroid
    - n_h: Population
- $|\mathcal{R}| \approx 2{,}000$ shopping precincts
  - OpenStreetMap
    - $\mathcal{L}_r$: Buffer around density-based shop clusters (DBScan)
    - a_r: ln(Number of shops in cluster)
- $|\mathcal{S}| \approx 4{,}500$ supermarkets
  - Brand websites
- $|\mathcal{B}| = 11$ brands



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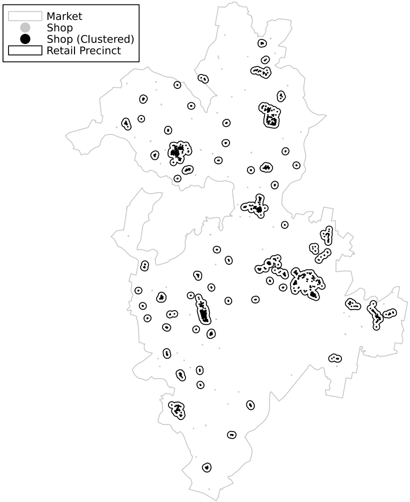

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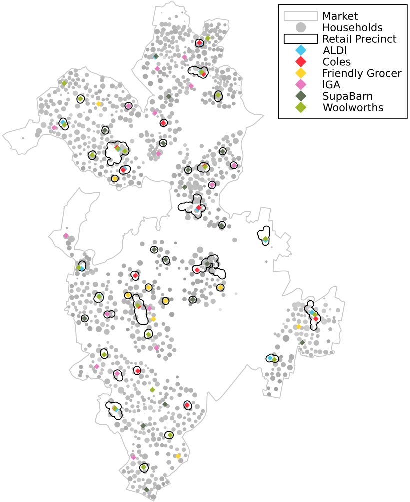
Brand	Stores	Markets	DCs
ALDI	609	139	5
Coles	865	190	6
CostCo	15	8	1
Drakes	65	25	2
FoodLand	90	46	1
IGA	1264	519	6
Woolworths	1134	256	7
FoodWorks	319	181	5
Friendly Grocer	205	94	3
SPAR	110	66	1
SupaBarn	21	3	1

Data

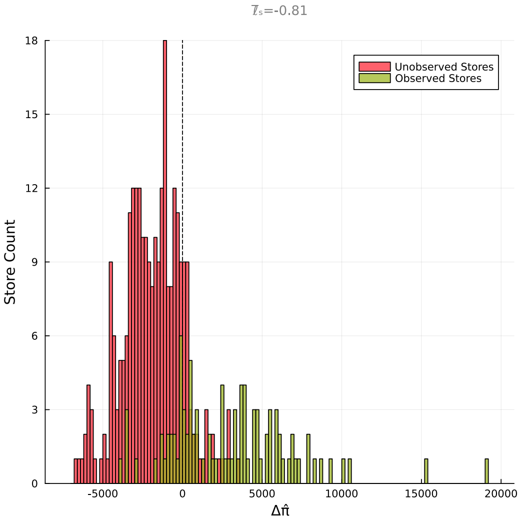
Subsample - Canberra-Queanbeyan

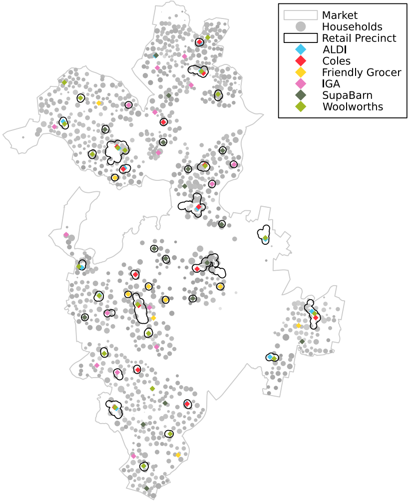
- $|\mathcal{M}| = 1$ market
- $|\mathcal{H}| = 4,494$ household types
  - $\sum_h n_h = 340,770$ total population
  - $|\mathcal{L}_h| = 1,194$ household locations
  - $|\mathcal{I}_h| = 6$ household income bins
- $|\mathcal{S}| = 94$ observed stores
- $|\mathcal{R}| = 45$ shopping precincts
- $|\mathcal{B}| = 6$ brands
  - ALDI
  - Coles
  - Friendly Grocer
  - IGA
  - SupaBarn
  - Woolworths
- $|\mathcal{S}| + |\mathcal{B}||\mathcal{R}| = 364$ profit inequalities



Estimates

Subsample - Canberra-Queanbeyan - Profit Differences



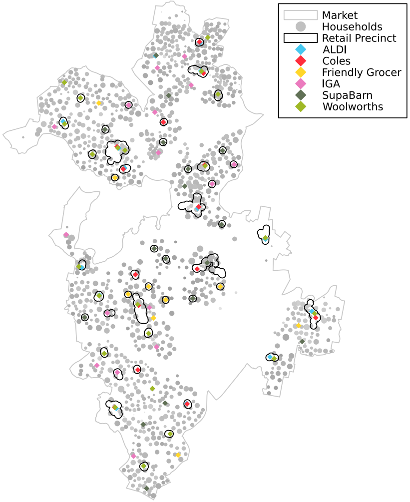


Estimates

Subsample - Canberra-Queanbeyan - Brand Summaries

b	$\overline{p}$	$\overline{c}$	$Q^{-1}\Sigma q_s$	S
ALDI	2.55	1.51	7.94	15
Coles	2.43	0.4	20.07	14
Friendly Grocer	3.93	1.05	7.01	9
IGA	3.83	0.94	15.08	17
SupaBarn	4.41	0.83	21.1	17
Woolworths	2.8	0.5	28.79	22

- Lowest marginal costs: Coles, Woolworths
- Highest prices: SupaBarn, Friendly Grocer, IGA
- Highest shares: Woolworths, SupaBarn, Coles



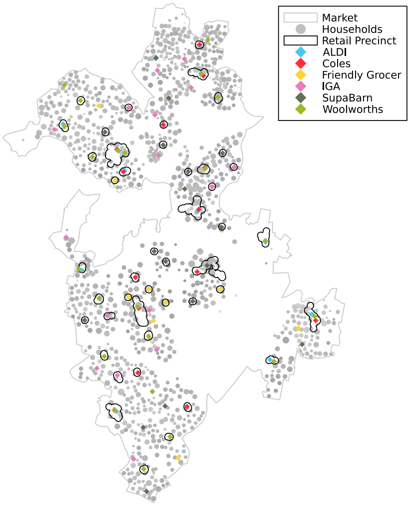
Estimates

Subsample - Canberra-Queanbeyan - Parameter Estimates

α	δ	η_0	η_i	ρ	ω
0.10	-4.73	-4.00	0.35	0.69	0.00

b	β_b	μ_b	φ_b
ALDI	9.68	1.51	1424.45
Coles	10.38	0.40	5032.99
Friendly Grocer	10.46	1.05	4767.18
IGA	10.52	0.94	3887.07
SupaBarn	11.17	0.83	6468.49
Woolworths	10.41	0.50	3646.20

- Distance disutility: $\widehat{\delta} = -4.73$
- Price disutility: $\widehat{\eta}_h \in [-2.6, -0.85] \quad (i_h \in [4, 9])$
- Horizontal differentiation: $\widehat{\rho} = 0.69$
- Vertical differentiation: $\widehat{\beta}_b \in [9, 12]$



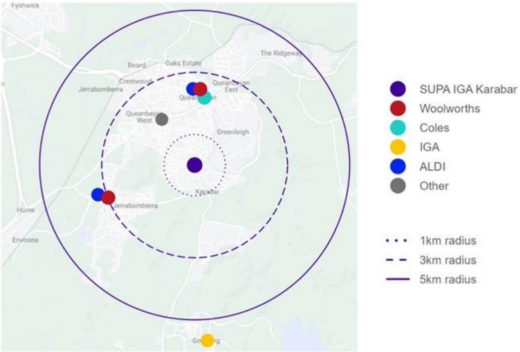
Counterfactuals

Woolworths-IGA Karabar - ACCC (2023)

ACCC (2023)

- Opposed Woolworths acquisition of IGA Karabar
- Geographic market definition:
  - 3-5km radius
  - Exclude IGA Bogong
- Product market definition:
  - 'Full-line' supermarkets
  - Exclude Friendly Grocer ('convenience')
- Counterfactual:
  - Status quo
    - No IGA exit
    - No alternative purchaser
- Substantial lessening of competiton:
  - Concentration: Woolworths 3/6 'full line' supermarkets
  - Differentiation:
    - Woolworths rebrand
    - Loss of differentiated IGA offering

Figure 1: Map of supermarkets in Karabar and surrounding suburbs



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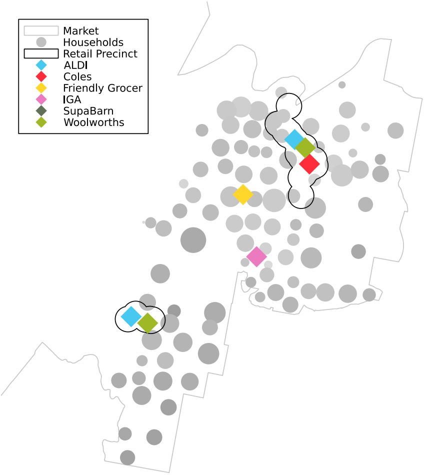
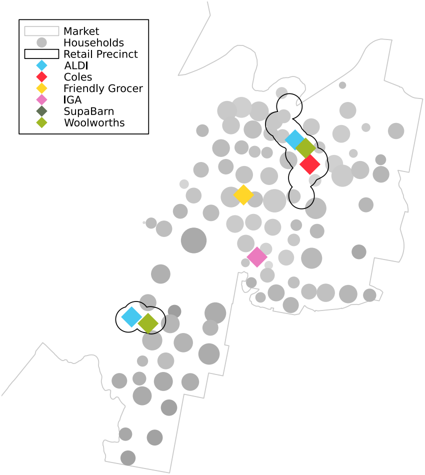


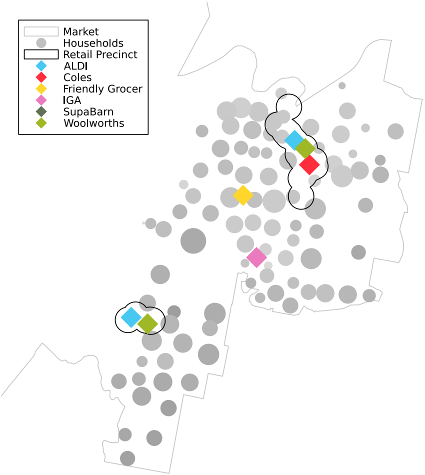
Counterfactuals

Woolworths-IGA Karabar - Merger Counterfactuals

Pre: IGA Karabar



Post: [IGA Woolworths SupaBarn] Karabar



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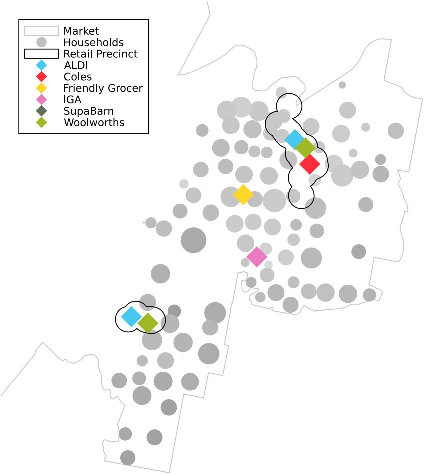
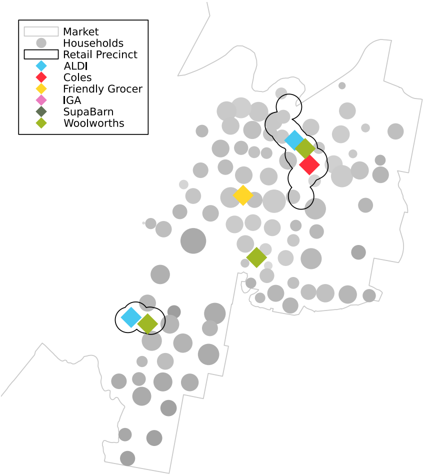


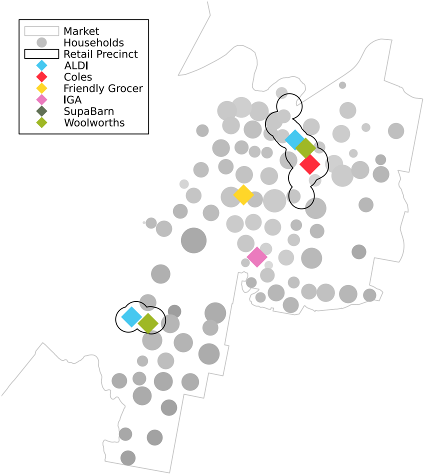
Post: [IGA Woolworths SupaBarn] Karabar



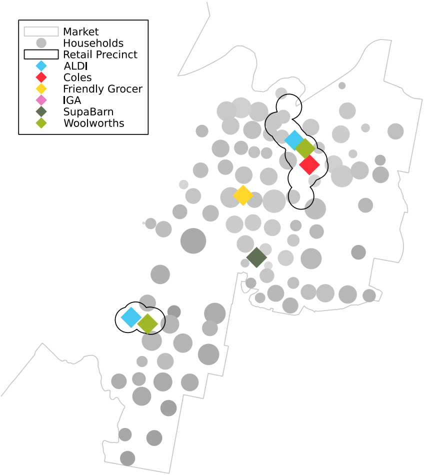
Counterfactuals

Woolworths-IGA Karabar - Merger Counterfactuals

Pre: IGA Karabar



Post: [IGA Woolworths SupaBarn] Karabar

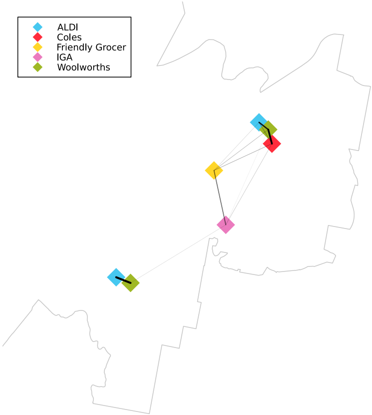


Counterfactuals

Woolworths-IGA Karabar - Pre-Merger - Diversion Ratios

[IGA Woolworths SupaBarn] Karabar

From \ To	AJ	AQ	CQ	FGQ	IK	WJ	WQ
ALDI Jerrabomberra	-1.0	0.0	0.0	0.01	0.02	0.78	0.0
ALDI Queanbeyan	0.0	-1.0	0.23	0.07	0.0	0.0	0.6
Coles Queanbeyan	0.0	0.11	-1.0	0.12	0.06	0.0	0.6
Friendly Grocer Queanbeyan	0.01	0.06	0.21	-1.0	0.26	0.01	0.18
IGA Karabar	0.02	0.0	0.13	0.3	-1.0	0.06	0.04
Woolworths Jerrabomberra	0.53	0.0	0.0	0.01	0.06	-1.0	0.0
Woolworths Queanbeyan	0.0	0.26	0.53	0.09	0.02	0.0	-1.0



- Diversion ratios: $D_{ij} = \left(\frac{\partial q_j}{\partial p_i}\right) / \left(\left|\frac{\partial q_i}{\partial p_i}\right|\right)$
  - Proportion of customers who leave i that switch to j
- Localized competition
  - $\widehat{\beta}_b \in [9, 12]$
  - $\widehat{\delta} = -4.73$
  - Extreme taste shock required to shop more than 2-3km away
  - Queanbeyan to Jerrabomberra: 6km

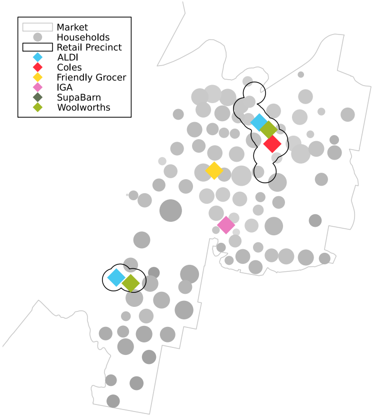
Counterfactuals

Woolworths-IGA Karabar - Status Quo - Store Summaries & Welfare

[IGA Woolworths SupaBarn] Karabar

s	p_s	c_s	q_s	π_s
ALDI Jerrabomberra	2.65	1.51	1132	-136
ALDI Queanbeyan	2.49	1.51	1369	-88
Coles Queanbeyan	1.85	0.4	4154	987
Friendly Grocer Queanbeyan	3.24	1.05	3484	2846
IGA Karabar	3.46	0.94	3439	4768
Woolworths Jerrabomberra	3.07	0.5	3761	6009
Woolworths Queanbeyan	1.79	0.5	4177	1759

- Consumer welfare: $\widehat{W}_h = 65,798$
  - $\widehat{W}_h = \sum_h n_h |\eta_h|^{-1} \ln[1 + \sum_b \Sigma_{bh}^{1-\rho}]$
- IGA Karabar: highest prices in local area
  - Local market power: $\widehat{\delta} = -4.73$
  - Higher marginal costs (0.94) than Coles (0.40), Woolworths (0.50)

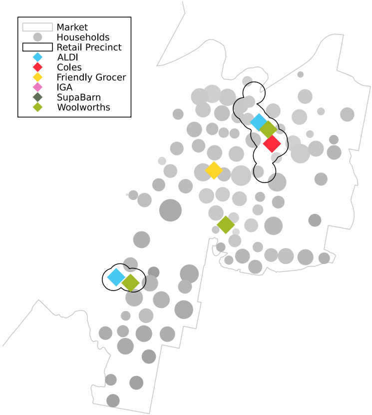


Counterfactuals

Woolworths-IGA Karabar - Woolworths Acquisition - Store Summaries & Welfare

[IGA Woolworths SupaBarn] Karabar

s	p_s	c_s	q_s	π_s
ALDI Jerrabomberra	2.66	1.51	1184	-65
ALDI Queanbeyan	2.49	1.51	1385	-69
Coles Queanbeyan	1.86	0.4	4176	1081
Friendly Grocer Queanbeyan	3.25	1.05	3499	2916
Woolworths Karabar	3.32	0.5	3393	5928
Woolworths Jerrabomberra	3.13	0.5	3707	6088
Woolworths Queanbeyan	1.81	0.5	4083	1699



- Consumer welfare: $\widehat{W}_h = 65,258$
  - $\Delta\widehat{W}_h = -540$
- IGA $\longrightarrow$ Woolworths Karabar:
  - Store price decrease: 3.46 $\longrightarrow$ 3.32
  - Marginal cost decrease: 0.94 $\longrightarrow$ 0.50
  - Market-wide price increases
    - Concentration increase

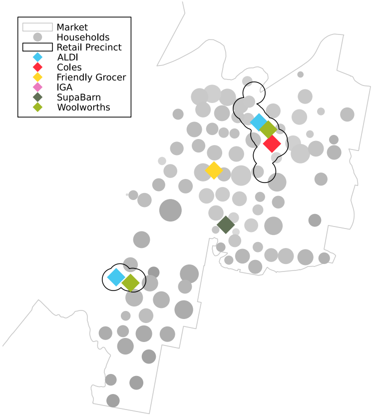
Counterfactuals

Woolworths-IGA Karabar - SupaBarn Acquisition - Store Summaries & Welfare

[IGA Woolworths SupaBarn] Karabar

s	p_s	c_s	q_s	π_s
ALDI Jerrabomberra	2.65	1.51	1115	-157
ALDI Queanbeyan	2.49	1.51	1362	-95
Coles Queanbeyan	1.85	0.4	4071	862
Friendly Grocer Queanbeyan	3.19	1.05	3385	2463
SupaBarn Karabar	3.57	0.83	3982	4456
Woolworths Jerrabomberra	3.06	0.5	3722	5878
Woolworths Queanbeyan	1.8	0.5	4136	1712

- Consumer welfare: $\widehat{W}_h = 67,540$
  - $\Delta\widehat{W}_h = +1,742$
- IGA $\longrightarrow$ SupaBarn Karabar:
  - Marginal cost reduction: 0.9 $\longrightarrow$ 0.83
  - Quality increase: 10.52 $\longrightarrow$ 11.17
  - Price increase: 3.46 $\longrightarrow$ 3.57



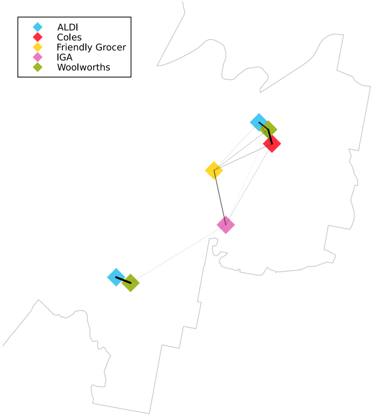
Counterfactuals

Woolworths-IGA Karabar - Pre-Merger - Diversion Ratios - δ Sensitivities

$$\delta = [\text{-4.73} \quad \text{-4.00} \quad \text{-3.00} \quad \text{-2.00} \quad \text{-1.00}]$$

From \ To	AJ	AQ	CQ	FGQ	IK	WJ	WQ
ALDI Jerrabomberra	-1.0	0.0	0.0	0.01	0.02	0.78	0.0
ALDI Queanbeyan	0.0	-1.0	0.23	0.07	0.0	0.0	0.6
Coles Queanbeyan	0.0	0.11	-1.0	0.12	0.06	0.0	0.6
Friendly Grocer Queanbeyan	0.01	0.06	0.21	-1.0	0.26	0.01	0.18
IGA Karabar	0.02	0.0	0.13	0.3	-1.0	0.06	0.04
Woolworths Jerrabomberra	0.53	0.0	0.0	0.01	0.06	-1.0	0.0
Woolworths Queanbeyan	0.0	0.26	0.53	0.09	0.02	0.0	-1.0

- Diversion ratios: $D_{ij} = \left(\frac{\partial q_j}{\partial p_i}\right) / \left(\left|\frac{\partial q_i}{\partial p_i}\right|\right)$
  - Proportion of customers who leave *i* that switch to *j*
- ACCC analysis consistent with smaller disutility of distance, δ
  - Increased IGA Karabar diversion to/from Queanbeyan/Jerrabomberra stores
  - Denser diversion network

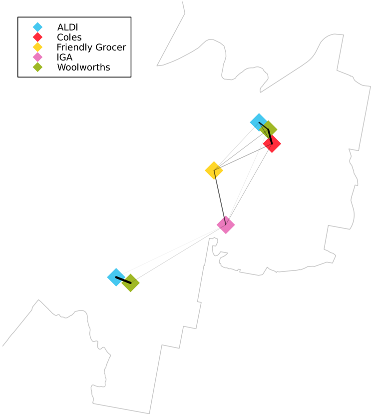


Counterfactuals

Woolworths-IGA Karabar - Pre-Merger - Diversion Ratios - δ Sensitivities

$$\delta = [-4.73 \quad -4.00 \quad -3.00 \quad -2.00 \quad -1.00]$$

From \ To	AJ	AQ	CQ	FGQ	IK	WJ	WQ
ALDI Jerrabomberra	-1.0	0.0	0.0	0.03	0.03	0.8	0.0
ALDI Queanbeyan	0.0	-1.0	0.29	0.09	0.01	0.0	0.58
Coles Queanbeyan	0.0	0.12	-1.0	0.13	0.09	0.0	0.59
Friendly Grocer Queanbeyan	0.02	0.07	0.25	-1.0	0.28	0.02	0.21
IGA Karabar	0.03	0.01	0.19	0.33	-1.0	0.09	0.06
Woolworths Jerrabomberra	0.62	0.0	0.0	0.03	0.09	-1.0	0.0
Woolworths Queanbeyan	0.0	0.23	0.57	0.11	0.03	0.0	-1.0



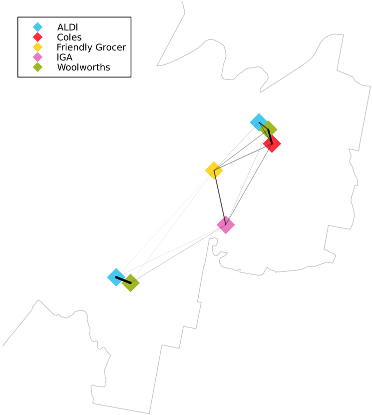
- Diversion ratios: $D_{ij} = \left(\frac{\partial q_j}{\partial p_i}\right) / \left(\left|\frac{\partial q_i}{\partial p_i}\right|\right)$
  - Proportion of customers who leave i that switch to j
- ACCC analysis consistent with smaller disutility of distance, δ
  - Increased IGA Karabar diversion to/from Queanbeyan/Jerrabomberra stores
  - Denser diversion network

Counterfactuals

Woolworths-IGA Karabar - Pre-Merger - Diversion Ratios - δ Sensitivities

$$\delta = \begin{bmatrix} -4.73 & -4.00 & -3.00 & -2.00 & -1.00 \end{bmatrix}$$

From \ To	AJ	AQ	CQ	FGQ	IK	WJ	WQ
ALDI Jerrabomberra	-1.0	0.0	0.0	0.04	0.06	0.83	0.0
ALDI Queanbeyan	0.0	-1.0	0.34	0.12	0.02	0.0	0.51
Coles Queanbeyan	0.0	0.11	-1.0	0.16	0.13	0.0	0.57
Friendly Grocer Queanbeyan	0.03	0.07	0.29	-1.0	0.3	0.04	0.25
IGA Karabar	0.04	0.02	0.28	0.36	-1.0	0.11	0.12
Woolworths Jerrabomberra	0.7	0.0	0.0	0.05	0.13	-1.0	0.0
Woolworths Queanbeyan	0.0	0.18	0.6	0.14	0.06	0.0	-1.0



- Diversion ratios: $D_{ij} = \left(\frac{\partial q_j}{\partial p_i}\right) / \left(\left|\frac{\partial q_i}{\partial p_i}\right|\right)$
  - Proportion of customers who leave i that switch to j
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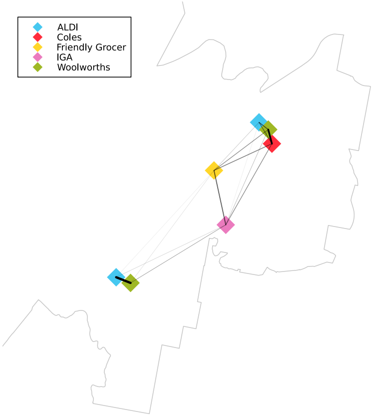
  - Denser diversion network

Counterfactuals

Woolworths-IGA Karabar - Pre-Merger - Diversion Ratios - δ Sensitivities

$$\delta = \begin{bmatrix} -4.73 & -4.00 & -3.00 & -2.00 & -1.00 \end{bmatrix}$$

From \ To	AJ	AQ	CQ	FGQ	IK	WJ	WQ
ALDI Jerrabomberra	-1.0	0.0	0.01	0.05	0.1	0.82	0.0
ALDI Queanbeyan	0.0	-1.0	0.37	0.14	0.05	0.0	0.43
Coles Queanbeyan	0.0	0.1	-1.0	0.19	0.16	0.01	0.53
Friendly Grocer Queanbeyan	0.02	0.06	0.31	-1.0	0.29	0.04	0.26
IGA Karabar	0.06	0.02	0.29	0.32	-1.0	0.14	0.16
Woolworths Jerrabomberra	0.67	0.0	0.02	0.07	0.21	-1.0	0.0
Woolworths Queanbeyan	0.0	0.13	0.59	0.18	0.1	0.0	-1.0



- Diversion ratios: $D_{ij} = \left(\frac{\partial q_j}{\partial p_i}\right) / \left(\left|\frac{\partial q_i}{\partial p_i}\right|\right)$
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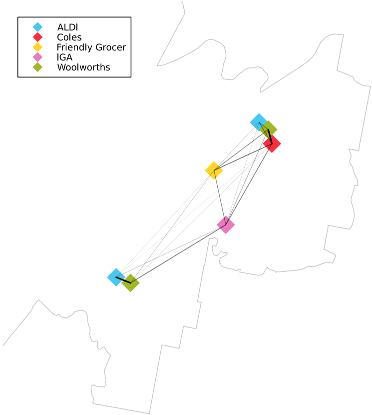
Counterfactuals

Woolworths-IGA Karabar - Pre-Merger - Diversion Ratios - δ Sensitivities

$$\delta = [-4.73 \quad -4.00 \quad -3.00 \quad -2.00 \quad -1.00]$$

From \ To	AJ	AQ	CQ	FGQ	IK	WJ	WQ
ALDI Jerrabomberra	-1.0	0.0	0.07	0.09	0.2	0.63	0.01
ALDI Queanbeyan	0.0	-1.0	0.38	0.15	0.11	0.0	0.36
Coles Queanbeyan	0.01	0.08	-1.0	0.21	0.2	0.04	0.46
Friendly Grocer Queanbeyan	0.03	0.05	0.33	-1.0	0.23	0.08	0.27
IGA Karabar	0.06	0.04	0.3	0.22	-1.0	0.17	0.21
Woolworths Jerrabomberra	0.37	0.0	0.11	0.16	0.35	-1.0	0.01
Woolworths Queanbeyan	0.0	0.09	0.54	0.2	0.16	0.0	-1.0



- Diversion ratios: $D_{ij} = \left(\frac{\partial q_j}{\partial p_i}\right) / \left(\left|\frac{\partial q_i}{\partial p_i}\right|\right)$
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