Essays in Empirical Industrial Organization

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Philipp Schmidt-Dengler and Christine Zulehner

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    - We want to answer questions that standard models cannot answer,
      e.g., simulate counterfactuals related to information or dynamics

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3. **Revisiting demand estimation in storable goods markets**

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Chapter 1

Inertia in the market for mobile telephony

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- **Research Questions:**

  - Which market frictions matter most for explaining observed inertia?

  - What is the optimal regulatory response? Should consumers be "forced to make a choice"?

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- Evaluate different policy options in counterfactual scenarios where frictions are removed

Related Literature

- **Demand estimation for telecom services.** Train, McFadden, and Ben-Akiva (1987), Viard (2007), Grubb and Osborne (2015), Bourreau, Sun, and Verboven (2021), Weiergraeber (2022)

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- **Smart defaults and other policies targeting inertia**: Gravert (2024), Handel and Kolstad (2015), CMA, BEREC

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I construct a data set on individual-time-product level by matching two data sources:

- Survey[1]

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    - Plan prices and characteristics 2019Q2-2024Q1 `Full list`

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Screenshot of Survey
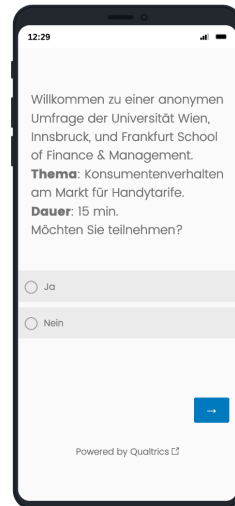
■ I follow Abaluck and Adams (2021): combine conditional logit with consideration sets

Utility $$u_{ijt} = \mathbf{x}'_{jt}\beta + \zeta \cdot Switch_{ijt} + \xi_j + \varepsilon_{ijt} = \delta_{ijt} + \varepsilon_{ijt}$$

Attention $$\mu_{it} = Pr(\text{shop around}) := \Lambda(\mathbf{x}_0, \mathbf{z}_i, \xi_j)$$

Consideration $$\phi_{ijt} = Pr(\text{consider product } j) := \Lambda(\mathbf{x}_{jt}, \mathbf{z}_i, \xi_j)$$

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- where ε_{ijt} is distributed i.i.d. type 1 extreme value, ξ_j is a brand fixed effect, and $\phi_{i0t} = 1$

- Choice probabilities $s_j^\star$ depend on consideration – consumer only chooses from products in consideration set C

$$s_j^\star(\mathbf{x} \mid C) = \begin{cases} \frac{\exp(\delta_j)}{\sum_{k \in C} \exp(\delta_k)} & \text{if } j \in C \\ 0 & \text{otherwise} \end{cases}$$

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- For every consumer and time period, consideration set probabilities π_C sum up to 1

Unconditional choice probabilities

- We need to weight each conditional choice probability $s_j^\star(\mathbf{x}_t \mid C)$ with probability that the consumer chooses from consideration set C, which is π_C

$$s_j(\cdot) = \mu(\cdot) \sum_{C \in \mathbb{P}(j)} \pi_C(\cdot) s_j^\star(\cdot \mid C) \quad \text{for } j \neq 0,$$

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- If a consumer does not shop around, $\mu = 0$, she chooses her previous plan, $s_0 = 1$

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- Given identification of $\frac{\partial s_j}{\partial p_{j'}}, \pi_C, s_j^\star$, identification of mean preferences is standard (how choice shares vary with characteristics)

Estimation

- I estimate the model by maximum likelihood

$$\log \mathcal{L}(y_{it}; X, \theta) = \sum_{i=1}^{N} \sum_{t=1}^{T} \sum_{j \in \mathcal{J}_{it}} \mathbb{1}_{y_{it}=j} \log s_{itj}(\mathbf{x}_t, \mathbf{z}_i; \theta)$$

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- Computational challenge:
  - large number of consideration sets ($2^{\#\text{products}}$)
  - but many fringe firms, largest 5 providers capture ~97% market share

    Another route: aggregation over plans by user types (low, medium, high, power user)

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    - Full consideration: $\phi = 1$
    - Differences in switching rates reveal relative importance of frictions

Chapter 2

Collusion in the Austro-Hungarian Sugar Industry 1889-1914

with Nikolaus Fink, Philipp Schmidt-Dengler, and Christine Zulehner

Motivation

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  - Did storing behaviour reduce the welfare costs of cartelisation?
  - Did integrated cartels obtain higher markups than downstream-only cartels?

Related Literature

- **Estimation of conduct in homogeneous good industries:** Porter (1983)
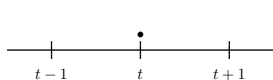
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- **Factors determining cartel success:** Levenstein and Suslow (2006)

  $\rightarrow$ *We estimate conduct taking into account stockpiling dynamics* (monthly data)
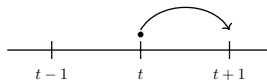
Hints of stockpiling

3rd refinery cartel starts
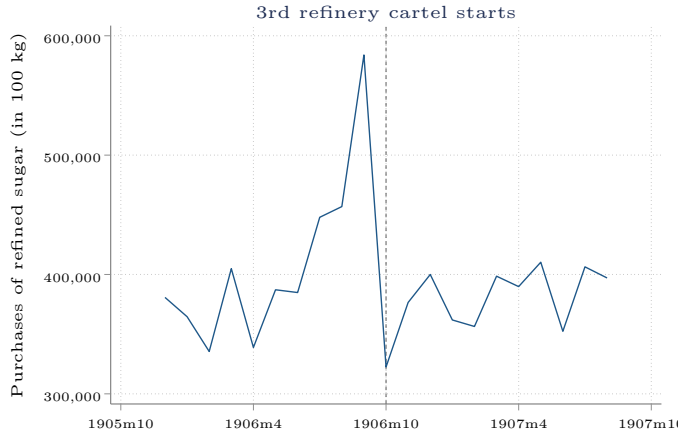
Data source: Centralverein der Rübenzuckerindustrie

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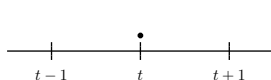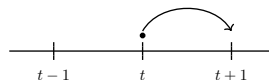
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- 4 states, where state C ("cheap") occurs in period t if $p_t \leq p_{t+1}$ `More on assumptions`

Methodology: Demand

- We adapt the dynamic model from Hendel and Nevo (2013) which allows for storage
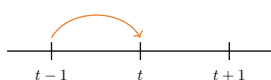- 4 states, where state C ("cheap") occurs in period t if $p_t \leq p_{t+1}$ More on assumptions
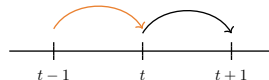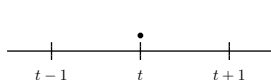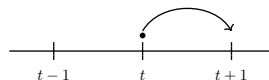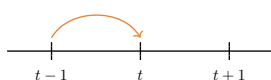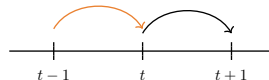

- **Instruments:** price of raw sugar (global market), tax on refined sugar, cartel dates

Methodology: Supply

- Supply: generalisation of static and symmetric Cournot (for now)

$$\text{FOC:} \quad P(Q) + P'(Q) \underbrace{\theta}_{\text{as if } \theta := \frac{dQ}{dq_j}} q_j = MC(W, ST)$$

$$\frac{\theta}{N} = \frac{\frac{P-MC}{P}}{\frac{1}{\eta}}$$

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    - Raw sugar was turned into refined sugar in fixed proportion (1.11:1)
- Conduct parameter θ (elasticity adjusted price-cost markup):

$$\frac{\theta}{N} = \frac{\frac{P-MC}{P}}{\frac{1}{\eta}}$$

Next Steps

- Finish coding up estimator

Next Steps

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- Expand specification for supply side

Next Steps

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- (Digitalise more data)

Next Steps

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    - Price under cournot competition: $\frac{\theta}{N} = \frac{1}{N}$

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- Estimate demand, supply, and conduct

- Simulate counterfactuals
  - Price under cournot competition: $\frac{\theta}{N} = \frac{1}{N}$
  - Collusive price in absence of stockpiling   Elasticity in absence of stockpiling

Chapter 3

Revisiting demand estimation in storable goods markets

- Demand for storable goods can feature stockpiling dynamics

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- The resulting non-linearities can give rise to *non-additively separable* demand shocks

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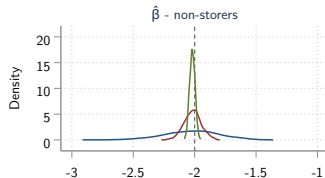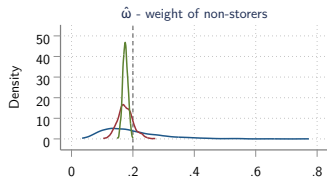
- Research questions (data):

Outline

- Demand for storable goods can feature stockpiling dynamics

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- Research questions (data):

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- Research questions (data):
  - What is the cost of abstracting from non-additively separable shocks if they are present? (simulated data) Simulation Setup
  - Should we include them in our model in the first place? (scanner data)

Preliminary Monte Carlo Results

Large Sample

$\hat{\omega}$ - weight of non-storers

$\hat{\beta}$ - non-storers

$\hat{\beta}$ - storers

Repetitions = 1000
Sample Sizes: 500, 5000, 50000

Parameters

- ω measures the weight of non-storers

- β^n measures the price sensitivity of non-storers

- β^s measures the price sensitivity of storers

- Disregard demand shocks ε_t, ε_{t+1} Estimating Equation

Preliminary Monte Carlo Results

universität
wien

Huge Sample

ŵ - multiplier of non-storers

β̂ - non-storers

β̂ - storers

Discussion

- Distributions center to the left of true values

- $\widehat{\beta}^s$ performs worse than $\widehat{\beta}^n$

- In sum, estimator that disregards shocks is inconsistent
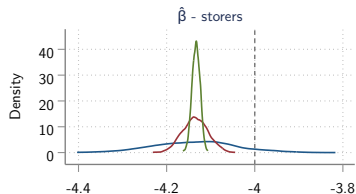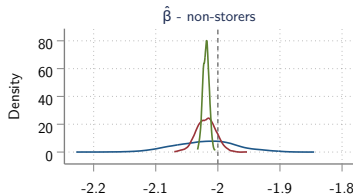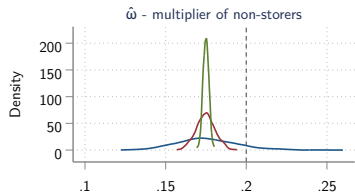
Repetitions = 1000
Sample Sizes: 10000, 100000, 1000000

Next Steps

- Code up the full original estimator (panel setting)

Next Steps

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    - Store dimension

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  - Three differentiated products (Pepsi, Coca-Cola, store brand)

Next Steps

- Code up the full original estimator (panel setting)

  - Store dimension

  - Three differentiated products (Pepsi, Coca-Cola, store brand)

- Estimate model with and without non-separable shocks on observational data

1 **Inertia in the market for mobile telephony** Appendix

1. **Inertia in the market for mobile telephony** (Appendix)

2. **Collusion in the Austro-Hungarian Sugar Industry 1889-1914** (Appendix)

   with Nikolaus Fink, Philipp Schmidt-Dengler, and Christine Zulehner

Research Proposal

1 **Inertia in the market for mobile telephony** (Appendix)

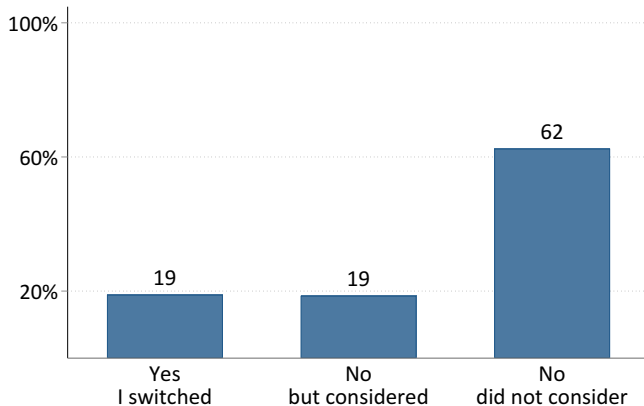2 **Collusion in the Austro-Hungarian Sugar Industry 1889-1914** (Appendix)

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3 **Revisiting demand estimation in storable goods markets** (Appendix)

Appendix 1

Data source: RTR (2021) (Back)

Aus welchen Gründen haben Sie sich für Ihren aktuellen Mobilfunkanbieter entschieden?

Gründe für die Wahl des aktuellen Mobilfunkanbieters in Österreich 2021

Anteil der Befragten

Preis- / Leistungsverhältnis des Tarifs	41,6%
Attraktives Tarifangebot	29%
Gute Netzabdeckung	26,8%
Großes Datenvolumen inkludiert	19,8%
Einfache / leicht verständliche Tarifmodelle	16,3%
Schnelles Internet	15,7%
Großes Paket an Freiminuten / SMS / Nachrichten	12,5%
Wurde mir empfohlen (Freunde, Familie, Berater)	11,2%
Qualität des Kundenservice	10,7%
Qualität des Netzes im Ausland	10,4%

18 Beschreibung: Bei einer Meinungsumfrage in Österreich aus dem Jahr 2021 über die Gründe bei der Wahl des Mobilfunkanbieters, gaben 41,6 Prozent der Befragten an, sich vor allem wegen des Preis-Leistungsverhältnisses des Tarifs für einen bestimmten Anbieter entschieden zu haben. 26,8 Prozent der befragten Teilnehmer gaben eine gute Netzabdeckung als Grund an. Empfehlungen durch Freunde, Familie oder Berater waren nur für 11,2 Prozent der Befragten entscheidend. Mehr
Hinweis(e): Österreich; 6. Mai 2020 bis 6. Mai 2021; 39791 Befragte; ab 14 Jahre; Repräsentativ für die österreichische Bevölkerung; Top 10
Quelle(n): Marketagent

statista

Wenn 5G zehnfach schnelleres Internet bereitstellt, wie viel sind Sie bereit, mehr zu zahlen?

Zahlungsbereitschaft für 5G in Österreich 2021

Anteil der Befragten

2021 2020

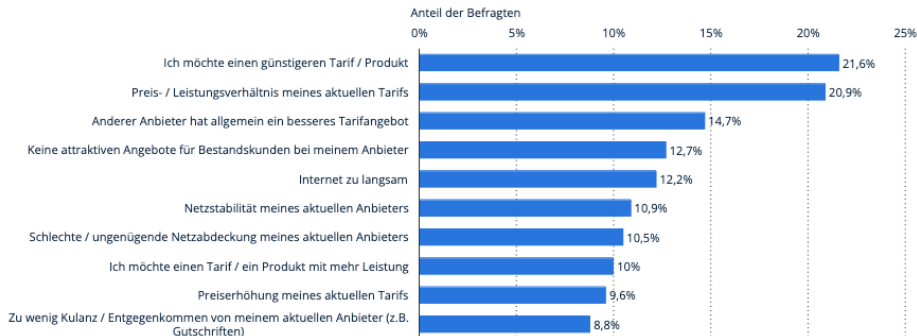|	2021	2020
Bis zu 5 Euro	21%	20%
6 - 10 Euro	12%	10%
11 - 15 Euro	6%	5%
16 - 20 Euro	5%	4%
Mehr als 20 Euro	5%	2%
Ich bin nicht bereit, für 5G mehr zu zahlen	46%	53%
Weiß nicht	6%	7%
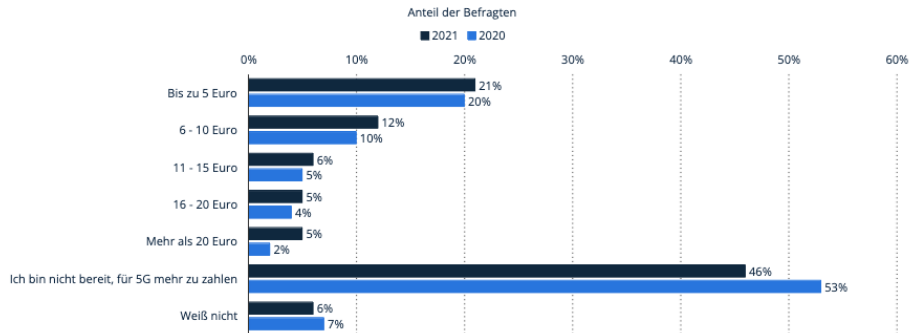
Beschreibung: Laut einer Umfrage von Deloitte im Jahr 2021 waren 46 Prozent der Befragten in Österreich nicht bereit, für eine 5G-Verfügbarkeit, die ein zehnfach schnelleres Internet bereitstellt, mehr Geld zu zahlen. Im Jahr 2020 waren es mit 53 Prozent noch etwas mehr. Mehr
Hinweis(e): Österreich; Sommer 2021; 1000 Befragte
Quelle(n): Deloitte

statista

Aus welchen Gründen haben Sie vor Ihren aktuellen Mobilfunkanbieter zu wechseln?

Gründe für einen Anbieterwechsel in Österreich im Jahr 2021

Anteil der Befragten

	Anteil
Ich möchte einen günstigeren Tarif / Produkt	21,6%
Preis- / Leistungsverhältnis meines aktuellen Tarifs	20,9%
Anderer Anbieter hat allgemein ein besseres Tarifangebot	14,7%
Keine attraktiven Angebote für Bestandskunden bei meinem Anbieter	12,7%
Internet zu langsam	12,2%
Netzstabilität meines aktuellen Anbieters	10,9%
Schlechte / ungenügende Netzabdeckung meines aktuellen Anbieters	10,5%
Ich möchte einen Tarif / ein Produkt mit mehr Leistung	10%
Preiserhöhung meines aktuellen Tarifs	9,6%
Zu wenig Kulanz / Entgegenkommen von meinem aktuellen Anbieter (z.B. Gutschriften)	8,8%

Beschreibung: Bei einer Meinungsumfrage in Österreich aus dem Jahr 2021 zu den Gründen für einen gewünschten Mobilfunkanbieterwechsel gaben mit 21,6 Prozent die meisten der Befragten an, einen günstigeren Tarif haben zu wollen. 20,9 Prozent der befragten Österreicher nannten als Grund dafür, warum sie (eher) den Anbieter wechseln würden, das Preis- / Leistungsverhältnis ihres aktuellen Tarifs. Mehr
Hinweis(e): Österreich; 5. Mai 2020 bis 5. Mai 2021; 7.928 Befragte*; ab 14 Jahre; Repräsentativ für die österreichische Bevölkerung; Top 10 ; * Basis: Entscheidungsträger bzgl. der Wahl eines Mobilfunkanbieters würden (eher) den Mobilfunk-Anbieter [...] Mehr
Quelle(n): Marketagent

statista

The survey filters for consumers that fulfil the following criteria:

- At least 18 years old in 2022

Criteria must be fulfilled for both current and previous plan Back

The survey filters for consumers that fulfil the following criteria:

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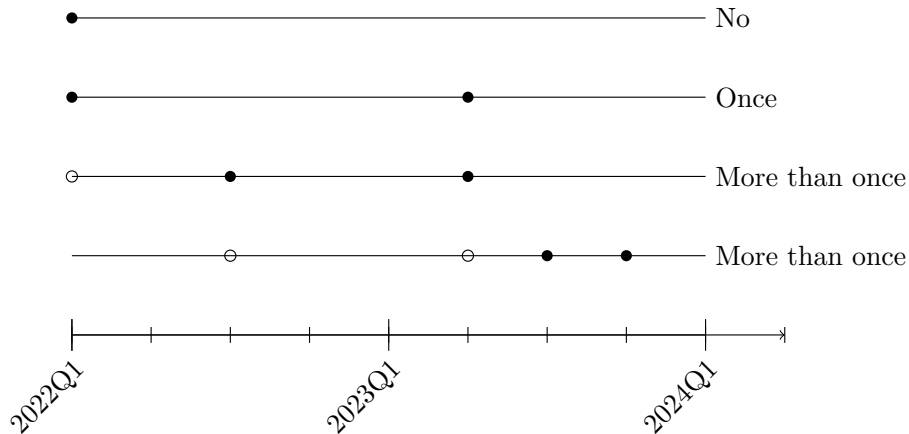
The survey filters for consumers that fulfil the following criteria:

- At least 18 years old in 2022
- They have and know about their Austrian (domestic) plan
- The plan is for retail customers
- They pay for the plan themselves
- They chose the plan

Criteria must be fulfilled for both current and previous plan Back

Did you switch mobile telephony plan in 2022/2023/2024? Back

Attention
$$\mu_{it} = \frac{\exp(\mathbf{x}'_{0_i t}\lambda + \mathbf{z}'_i\kappa + \xi^{in}_{\psi(0_i)})}{1 + \exp(\mathbf{x}'_{0_i t}\lambda + \mathbf{z}'_i\kappa + \xi^{in}_{\psi(0_i)})}$$

Consideration
$$\phi_{ijt} = \frac{\exp(\mathbf{x}'_{jt}\gamma + \mathbf{z}'_i\rho + \xi^{c}_{\psi(j)})}{1 + \exp(\mathbf{x}'_{jt}\gamma + \mathbf{z}'_i\rho + \xi^{c}_{\psi(j)})}$$

Choice
$$u_{ijt} = \mathbf{x}'_{jt}\beta + \zeta_1 \cdot \mathbb{1}_{y_{it} \neq y_{it-1}} + \zeta_2 \cdot \mathbb{1}_{\psi(y_{it}) \neq \psi(y_{it-1})} + \xi^{u}_{\psi(j)} + \epsilon_{ijt}$$
$$= \delta_{ijt} + \epsilon_{ijt}$$

Sociodemographics	Plan Characteristics
Gender `Back`	Monthly fee
Age	Annual fee
Region	SMS
Income Bracket	Minutes
Education	Gigabyte
Marital Status	5G
Household Size	Download Speed
Children	Commitment period
Employment Status	EU Roaming
User Type	Non-EU Roaming
Has searched in price comparison websites	Bundle (plan+wifi, plan+fixed line)
Has searched in local shops	Family rebate

- provider specific

- provider specific
  - brick and mortar shops by region

- provider specific
    - brick and mortar shops by region
    - network quality by region

- provider specific
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Potential further variables

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    - ad exposure
    - proxy for ad exposure like media exposure

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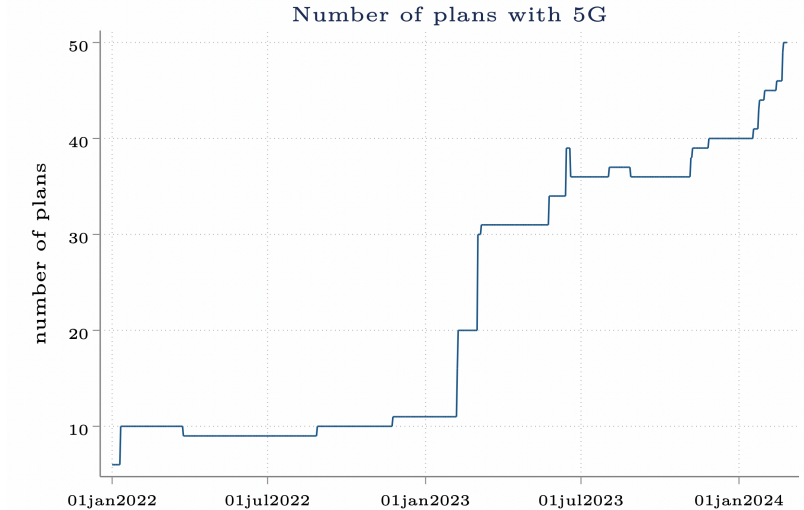 - price comparison websites offer reminders

- Prices
  - Reme, Røhr, and Sæthre (2022) finds increased churn rater after price changes, even after price *de*creases
  - price comparison websites offer reminders
  - can include potential savings (with come caveats) rather than price

Number of plans with 5G

- Can reduce number of plans by grouping them into four categories: low (prepaid), mid, high, power

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- RTR definitions for usage (gigabyte etc) available

Unobserved product characteristics

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3. Does customer service vary over time? Maybe, but how much in 2-3 years? (Investment data from RTR shows no trend 2018-2022, except for covid drop in 2021)
4. Sample period has rather stable market conditions
5. Even if customer service varies over time, prices do not vary much –> would customer service then be correlated with price?

- wholesale electricity prices? $->$ moved around a lot, while telecom prices did not move much or often

These are cost components, but more fixed cost rather than marginal cost.

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Hausman instruments?

- prices of same provider in different market which shares common cost shocks, but unrelated omitted product characteristics
- time period is market: lagged/future prices?
- broadband prices? (not all firms offer broadband too, are the omitted product characteristics different)

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    - no consumer learning (time invariant preferences)

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  - no consumer learning (time invariant preferences)
- Thought experiment: two products have same characteristics today, one was upgraded to 5G earlier than the other, which attracted consumers, if choice shares are different today then that can only because of switching cost
- (Churn data can also help)

Intuition:

- All cross-derivative asymmetries are due to imperfect consideration

Conditions

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Conditions

- partial derivative of latent choice probability wrt to all other goods prices (compounded) exists, is non-negative and continuous
- cross-price derivatives of latent choice probabilities are symmetric
- no nominal illusion (latent choice probabilities are invariant to price shifts across the board)

Latest Policies against inertia

- EU: directive 2018/1972 "European Electronic Communications Code"

Latest Policies against inertia

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- AUT: Telekommunikationsgesetz Oct 2021 "TKG 2021"

Latest Policies against inertia

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    - 1 month cancellation period (maximum)

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- If consumers have full consideration these policies have no effect

Latest Policies against inertia

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    - 1 month cancellation period (maximum)
    - 24 months commitment (maximum)
    - Provider has to notify consumer when commitment is about to end
    - 1/year provider has to highlight cheapest plan to consumer based on usage
- If consumers have full consideration these policies have no effect
- Empirical question if they work if consumers have limited consideration

§ 135 (7)

Anbieter nach Abs. 1 haben Endnutzern, in den Fällen einer automatischen Verlängerung nach einer Befristung, zumindest einmal jährlich, jedenfalls aber zum Zeitpunkt einer Information nach Abs. 6, über den anhand ihres Nutzungsverhaltens im vergangenen Jahr bestmöglichen Tarif in Bezug auf ihre Dienste zu informieren.

Article 105(3)

Where a contract or national law provides for automatic prolongation of a fixed duration contract for electronic communications services other than number-independent interpersonal communications services and other than transmission services used for the provision of machine-to-machine services, Member States shall ensure that, after such prolongation, end-users are entitled to terminate the contract at any time with a maximum one-month notice period, as determined by Member States, and without incurring any costs except the charges for receiving the service during the notice period. Before the contract is automatically prolonged, providers shall inform end-users, in a prominent and timely manner and on a durable medium, of the end of the contractual commitment and of the means by which to terminate the contract. In addition, and at the same time, providers shall give end-users best tariff advice relating to their services. Providers shall provide end-users with best tariff information at least annually.

Appendix 2
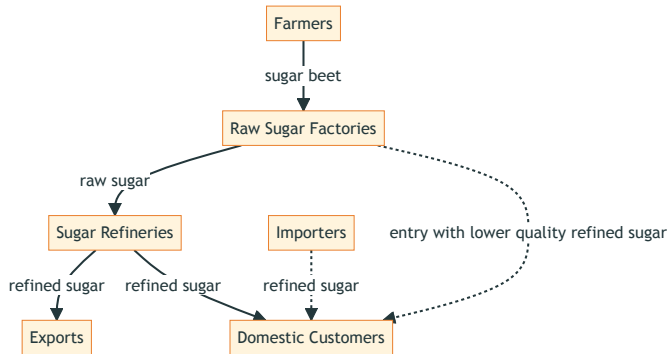
Cartel	Duration	Reason for Breakdown
1st refinery cartel	1891m10-1894m9	Entry from new refineries
2nd refinery cartel	1895m11-1897m10	Start of 1st integrated cartel
1st integrated cartel	1897m11-1903m8	International trade agreement
3rd refinery cartel	1906m10- 1911m9	Start of 2nd integrated cartel
2nd integrated cartel	1911m10 -1914m8	World War I

- There are two types of consumers: storers and non-storers

These assumptions can be relaxed to some extent Back

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Assumptions for dynamic model of demand

- There are two types of consumers: storers and non-storers

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- Storage is free for one month, but infinitely costly afterwards, no discounting

These assumptions can be relaxed to some extent (Back)

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- Consumers have perfect foresight of prices in next month

- If prices today are the same as tomorrow, storers purchase today

These assumptions can be relaxed to some extent Back

$$\eta := \frac{\partial Q}{\partial P}\frac{P}{Q} = \frac{\frac{\partial}{\partial P}[\omega e^{\alpha+\beta^n P} + (1-\omega)e^{\alpha+\beta^s P}]}{Q}P$$

$$= \frac{\beta^n \omega e^{\alpha+\beta^n P} + \beta^s(1-\omega)e^{\alpha+\beta^s P}}{\omega e^{\alpha+\beta^n P} + (1-\omega)e^{\alpha+\beta^s P}}P$$

$$= [\beta^n \frac{\omega e^{\alpha+\beta^n P}}{\omega e^{\alpha+\beta^n P} + (1-\omega)e^{\alpha+\beta^s P}} + \beta^s \frac{(1-\omega)e^{\alpha+\beta^s P}}{\omega e^{\alpha+\beta^n P} + (1-\omega)e^{\alpha+\beta^s P}}]P$$

$$= [\beta^n Qshare^n + \beta^s Qshare^s]P$$

Back

Appendix 3

- We initialise the NLLS estimation routine with the true parameter vector

Back

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- Similar mean and sd of price, quantity, sales periods and sales definition

Back

Simulation Setup

- We initialise the NLLS estimation routine with the true parameter vector
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- Similar mean and sd of price, quantity, sales periods and sales definition
- Set true parameters approx. equal to their estimates
- $P_t \overset{\text{iid}}{\sim}$

Back

Aggregate purchases X_t are given by

$$\begin{aligned}
X_t &= x_t^n + x_t^s \\
&= q_t^n + (\mathbb{1}_{\text{buy for t}}\, q_t^s + \mathbb{1}_{\text{buy for t+1}}\, q_{t+1}^s) \\
&= \omega e^{\alpha + \beta^n p_t + \varepsilon_t} + (1-\omega)(\mathbb{1}_{\text{buy for t}}\, e^{\alpha + \beta^s p_t + \varepsilon_t} + \mathbb{1}_{\text{buy for t+1}}\, e^{\alpha + \beta^s p_t + \varepsilon_{t+1}})
\end{aligned}$$

- Estimating Equation

$$\log X_t = \alpha + \log \tilde{X}_t + u_t$$
$$\text{where} \quad \tilde{X}_t = \omega e^{\beta^n p_t + \varepsilon_t} + (1-\omega)(\mathbb{1}_{\text{buy for t}}\, e^{\beta^s p_t + \varepsilon_t} + \mathbb{1}_{\text{buy for t+1}}\, e^{\beta^s p_t + \varepsilon_{t+1}})$$

Aggregate purchases X_t are given by

$$\begin{aligned}
X_t &= x_t^n + x_t^s \\
&= q_t^n + (\mathbb{1}_{\text{buy for t}} \, q_t^s + \mathbb{1}_{\text{buy for t+1}} \, q_{t+1}^s) \\
&= \omega e^{\alpha + \beta^n p_t + \varepsilon_t} + (1 - \omega)(\mathbb{1}_{\text{buy for t}} \, e^{\alpha + \beta^s p_t + \varepsilon_t} + \mathbb{1}_{\text{buy for t+1}} \, e^{\alpha + \beta^s p_t + \varepsilon_{t+1}})
\end{aligned}$$

■ Estimating Equation

$$\log X_t = \alpha + \log \tilde{X}_t + u_t$$
$$\text{where} \quad \tilde{X}_t = \omega e^{\beta^n p_t + \varepsilon_t} + (1 - \omega)(\mathbb{1}_{\text{buy for t}} \, e^{\beta^s p_t + \varepsilon_t} + \mathbb{1}_{\text{buy for t+1}} \, e^{\beta^s p_t + \varepsilon_{t+1}})$$

■ Estimation by NLLS if shocks are ignored or if shocks $\varepsilon_t, \varepsilon_{t+1}$ are included by MSM

Aggregate purchases X_t are given by

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$$\log X_t = \alpha + \log \tilde{X}_t + u_t$$

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- Estimation by NLLS if shocks are ignored or if shocks $\varepsilon_t, \varepsilon_{t+1}$ are included by MSM
- MSM is needed because without simulation of $\varepsilon_t, \varepsilon_{t+1}$, we cannot (analytically) evaluate the sample analog of the moment condition $E(u_t p_t) = 0$ (Back)

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