

Empirical estimation of demand of spatially heterogeneous consumers on retail

Dmitrii Tereshchenko

HSE University

dtereshchenko@hse.ru

The 13th meetings of the Armenian Economic Association
Gyumri, June 24, 2023

- ▶ **We aim to estimate a demand model on the level of grocery categories and stores in a space of a big city, namely St. Petersburg.**
- ▶ Such research on Russia is almost absent because of the relative "youth" of Russian retailing and the lack of widely available detailed data.
- ▶ Perhaps for the first time in Russia, we have a rich spatial data on purchases of grocery categories, location of stores and consumer demographics.
- ▶ If we get adequate estimates of demand parameters, we can use them ...
 - ▶ ...to evaluate substitution patterns between product categories and store formats,
 - ▶ ...to measure the intensity of spatial competition between retailers, including for the assessment of mergers and acquisitions.

Overview

- ▶ **We aim to estimate a demand model on the level of grocery categories and stores in a space of a big city, namely St. Petersburg.**
- ▶ Our work is still in progress, so at this point we have not yet estimated the model.
- ▶ I plan to devote most of today's talk to describing the data we have and the key problems we have faced at this point.

Spatial demand

Dmitrii
Tereshchenko

Introduction

Industry context

No model

Data

No results

References

Related literature

- ▶ The preliminary concept of our project is described in Gaivoronskaia et al. (2021), while a detailed description of the data is given in Tereshchenko (2022).
- ▶ In estimating demand, we follow the approach developed in Ellickson et al. (2020).

Spatial demand

Dmitrii
Tereshchenko

Introduction

Industry context

No model

Data

No results

References

Grocery retail market in St. Petersburg

- ▶ The grocery retail market in St. Petersburg is considered to be the most consolidated and competitive market in Russia.
- ▶ The Top-5 retailers in St. Petersburg include X5 Group, Lenta, O'KEY, Dixy and Magnit. They account for more than 70% of the industry's turnover in St. Petersburg.



Spatial demand

Dmitrii
Tereshchenko

Introduction

Industry context

No model

Data

No results

References

Market regulation

- ▶ The grocery retail sector has been subjected to regular and noticeable control by the government. "Law on Commerce", among other things, limits the allowed market share of a chain retailer to 25 percent within the boundaries of a municipal district or region.
- ▶ St. Petersburg is recognized as a city of federal importance, which means that its status is equal to that of a region. Therefore, in accordance with the "Law on Commerce", it is treated as a single market with a limit of 25% of the share of each chain retailer. At the same time, St. Petersburg consists of 111 municipalities, each of which is also considered a single market in accordance with this law.
- ▶ Note that the law does not apply to a specific chain, but to the owner company. For example, the market share of X5 Group company in St. Petersburg exceeded 25% in 2018, 2019 and 2020. As a result, the company has long been the subject of intense interest from the Federal Antimonopoly Service.
- ▶ In 2021 Magnit bought Dixy. This acquisition was approved by the Federal Antimonopoly Service.

Brief description of the model

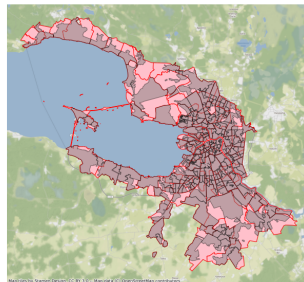
- ▶ We aim to model the utility of a representative consumer within a city from distributing expenditure shares over a universe of stores and product categories.
- ▶ Following Holmes (2011) and Ellickson et al. (2020) we allow stores to serve overlapping markets, i.e. we treat each consumer location as a separate market with their own distance to each store within a city.
- ▶ Unlike Ellickson et al. (2020), which had data on revenue in each store, we only have sales or shares aggregated at the local market level, but for different product categories.

Data sources

- ▶ We obtained geocoded data about the grocery retail industry in St. Petersburg from Geointellect, one of the leading geoanalytics platforms in Russia.
- ▶ Three main blocks of data were collected:
 - ▶ socioeconomic characteristics of local markets,
 - ▶ store location data,
 - ▶ sales data.
- ▶ Sales data are the most unique and important for us, but they are also the most problematic.

Local market definition

	Municipalities	Postcodes
n	111	247
mean	13.06	4.00
std	17.82	5.84
min	1.07	0.00
max	106.27	39.70
sum	1450.11	988.45



Spatial demand

Dmitrii
Tereshchenko

Introduction

Industry context

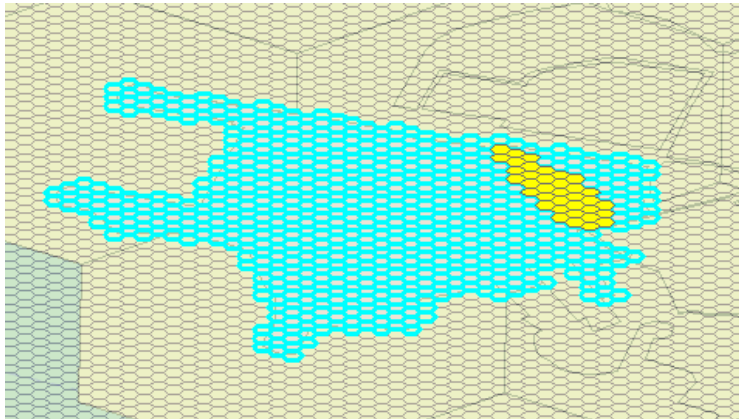
No model

Data

No results

References

Local market definition



Spatial demand

Dmitrii
Tereshchenko

Introduction

Industry context

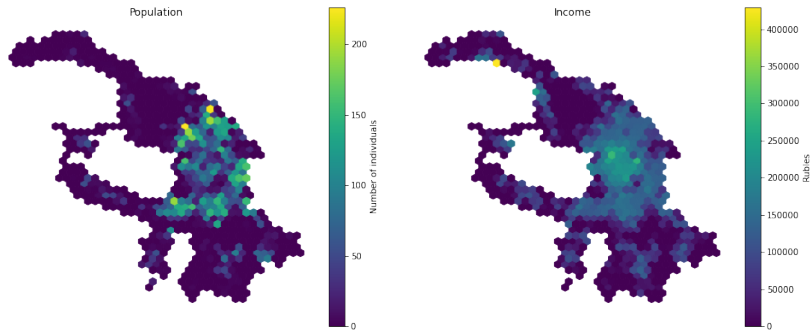
No model

Data

No results

References

Population and income in St. Petersburg with hexagonal binning, 2022



Spatial demand

Dmitrii
Tereshchenko

Introduction

Industry context

No model

Data

No results

References

Descriptive statistics of local markets' socioeconomic characteristics at hex level

	Population	Income	Commercial rent	Mass congestion
count	225,672.0	225,672.0	225,672.0	225,672.0
mean	28.2	63,037.7	1,197.7	0.7
std	158.7	79,874.4	10,232.7	2.1
min	0.0	0.0	0.0	0.0
25%	0.0	0.0	0.0	0.0
50%	0.0	0.0	0.0	0.0
75%	0.0	132,776.4	920.5	0.1
max	11,797.5	762,477.9	625,000.0	100.0

Spatial demand

Dmitrii
Tereshchenko

Introduction

Industry context

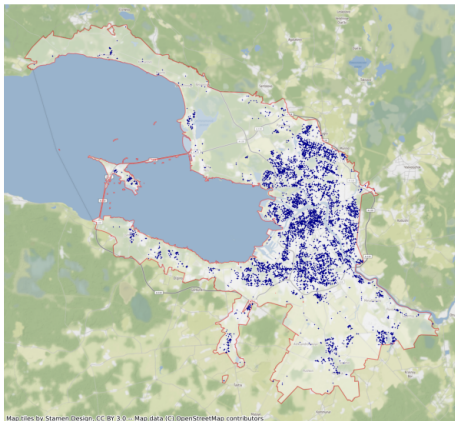
No model

Data

No results

References

Store locations data example



Spatial demand

Dmitrii
Tereshchenko

Introduction

Industry context

No model

Data

No results

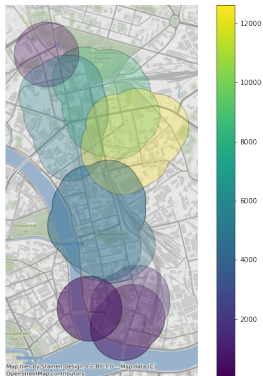
References

Overlapping stores' competitive areas illustration

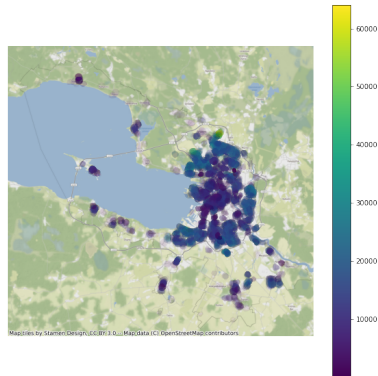
Spatial demand

Dmitrii
Tereshchenko

Sample of ten stores' competition areas



Stores' competition areas in St. Petersburg



Introduction

Industry context

No model

Data

No results

References

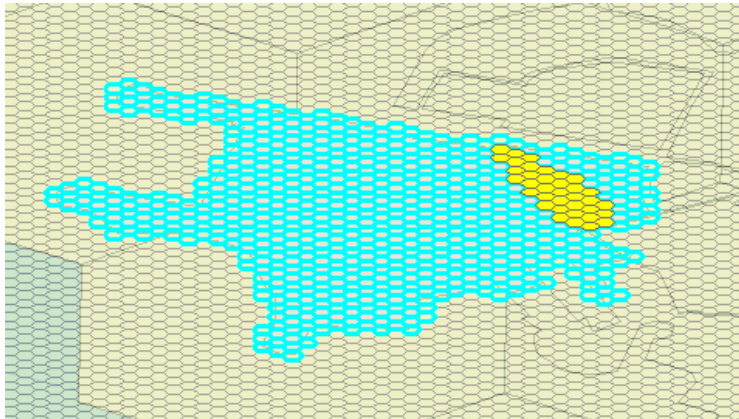
Sales data description

- ▶ Sales data was originally obtained by the operators of fiscal data (hereafter in the paper – OFD). The operator of fiscal data is a legal entity established specifically to receive, process, store and transmit fiscal data to the Federal Tax Service.
- ▶ The unit of observation in this dataset is a combination of local market, store format and product category.
- ▶ The store format variable can take three values, including (i) supermarkets, (ii) hypermarkets, and (iii) discounters and convenience stores.
- ▶ The product category variable can take 15 values relating to the primary categories.
- ▶ For each unit of observation, i.e., for each combination of local market, store format, and product category, the data contain two key measures of retail store sales. These measures are the average number of checks per month (hereafter and the average amount per check in a given month.

Sales data issues

- ▶ The key problem is that individual data for each store cannot be provided for commercial confidentiality concerns.
- ▶ For this reason, variables were computed according to the following algorithm:
 - ▶ The entire territory of St. Petersburg was divided into cells using a hexagonal grid (the radius of each cell is about 100 metres).
 - ▶ A buffer with a radius of 1000 metres was then placed around the centroid of each cell.
 - ▶ If the buffer received 3 or more stores with the given format and selling a particular product category, then the sales data were calculated based on information about all stores with the given format and selling a particular product category that were put in the buffer. If 0, 1 or 2 sales outlets of a given format selling a certain category of goods fell within the radius, then a zero value was taken for the corresponding cell.
- ▶ Another problem is that the data was provided by three of the OFDs covers 60% of the market and is available for December 2019. Unfortunately, this data does not include a considerable block of data on chain retailers, because some major chain retailers work with their own OFD, which does not disclose this information.

Sales data example



Spatial demand

Dmitrii
Tereshchenko

Introduction

Industry context

No model

Data

No results

References

Descriptive statistics for sales data in discounters and convenience stores (Saint Petersburg, December 2019)

	Avg. check	Avg. traffic
count	225,672.0	225,672.0
mean	618.0	797.7
std	1,068.0	1,087.9
min	0.0	0.0
25%	0.0	0.0
50%	347.0	162.5
75%	910.7	1,458.7
max	20,230.3	13,403.2

Spatial demand

Dmitrii
Tereshchenko

Introduction

Industry context

No model

Data

No results

References

Avg. check value vs. avg. monthly number of checks for discounters and convenience stores

Spatial demand

Dmitrii
Tereshchenko

Introduction

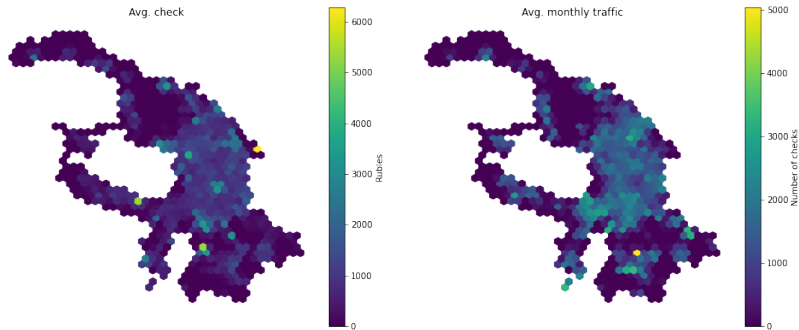
Industry context

No model

Data

No results

References



Discussion

- ▶ The main doubt about the current study is the quality of the sales data, which can make demand estimates meaningless.
- ▶ Unfortunately, alternative sources of data on sales shares like scanner data are expensive and not detailed enough in Russia.
- ▶ Fox et al. (2011) proposed estimator for aggregate data and measurement error in shares, but it seem that errors in our data are too big.
- ▶ Another potential problem is that the assumption of uniform pricing may not be satisfied in Russian retail, even within the same city.
- ▶ Although perhaps we can use spatial variation in prices to impute the shares, as shown in Antoniadou et al. (2022)
- ▶ **Any help and ideas would be greatly appreciated!**

References

- Gaivoronskaia, E., Iskhakov, F., Karmeliuk, M., Kokovin, S., Ozhegov, E., Ozhegova, A., & Tereshchenko, D. (2021). Competition among Russian grocery stores: Facts and hypotheses to explore. *Available at SSRN 3957743*.
- Tereshchenko, D. (2022). *Competition among russian grocery stores: Database on st. petersburg, 2017–2021* (tech. rep.). National Research University Higher School of Economics.
- Ellickson, P. B., Grieco, P. L., & Khvastunov, O. (2020). Measuring competition in spatial retail. *The RAND Journal of Economics*, 51(1), 189–232.
- Holmes, T. J. (2011). The diffusion of wal-mart and economies of density. *Econometrica*, 79(1), 253–302.
- Fox, J. T., Kim, K. I., Ryan, S. P., & Bajari, P. (2011). A simple estimator for the distribution of random coefficients. *Quantitative Economics*, 2(3), 381–418.
- Antoniades, A., Feenstra, R. C., & Xu, M. (2022). Using the retail distribution of sellers to impute expenditure shares. *American Economic Review*, 112(7), 2213–2236.