

Using Online Prices for Measuring Real Consumption Across Countries. The Russian Federation and the United Kingdom case.

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Irina Ermolenko , Sara Razazi

Supervisor: Prof. Dr. Günter W. Beck

Let's go!





Introduction

Data Collection

Methodology

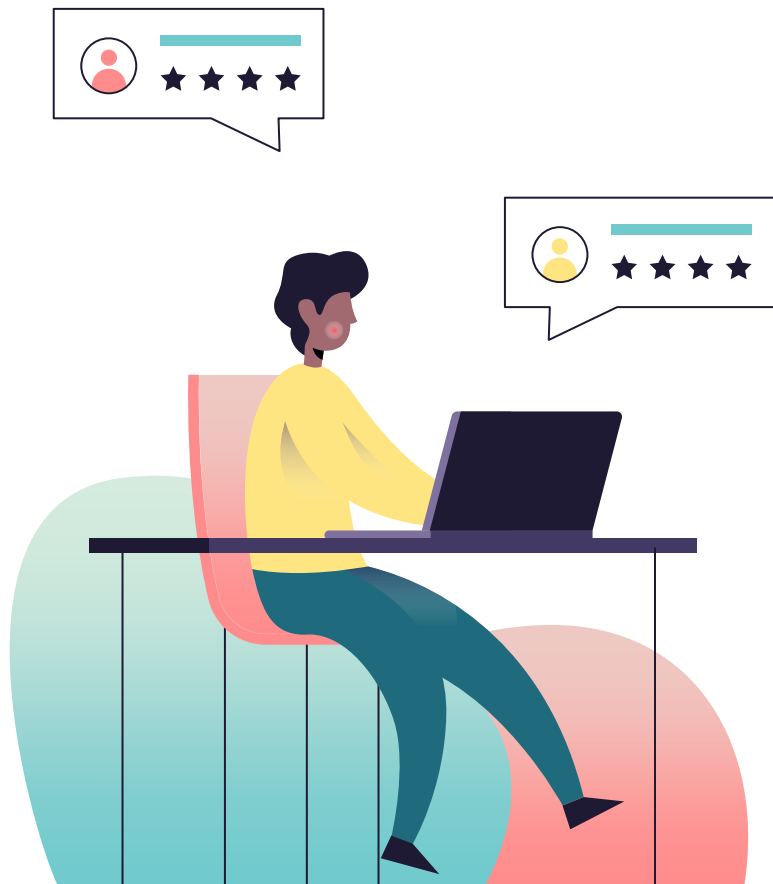
Data Investigation

Data Analysis

Limitations

Conclusions

01

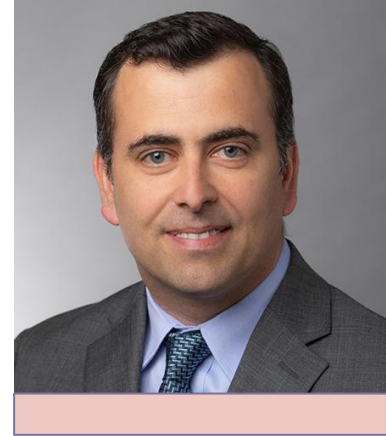


Introduction

Professor Cavallo's research focuses on the behavior of prices and its implications for macroeconomic measurement and policies.

He pioneered the use of online data to measure inflation and conduct research on high-frequency pricing dynamics.

He also created Inflacion Verdadera to measure the real inflation rate in Argentina and Venezuela and co-founded The Billion Prices Project, an academic initiative at Harvard and MIT, as well as PriceStats, the leading private source of inflation and PPP statistics in over 20 countries.



**Prof. Alberto F.
Cavallo**

EDGERLEY FAMILY
ASSOCIATE PROFESSOR OF
BUSINESS ADMINISTRATION

Introduction

Power Purchasing Parity (PPP) is a measurement of prices in different countries that uses the prices of specific goods to compare the purchasing power of the countries' currencies.

PPP is for comparison of prices of goods in different countries to finally evaluate countries' currencies according to its purchasing power.

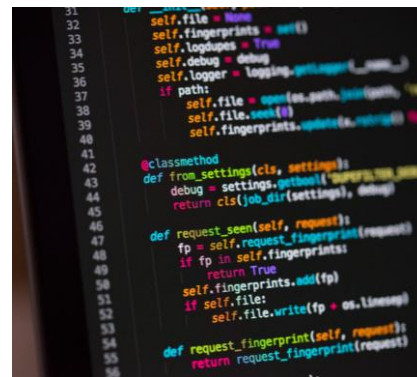




Paper



Data



Code

THE BILLION PRICES PROJECT

AN ACADEMIC INITIATIVE TO IMPROVE MACROECONOMIC MEASUREMENT

[RESEARCH PAPERS](#)

[DOWNLOAD DATA](#)

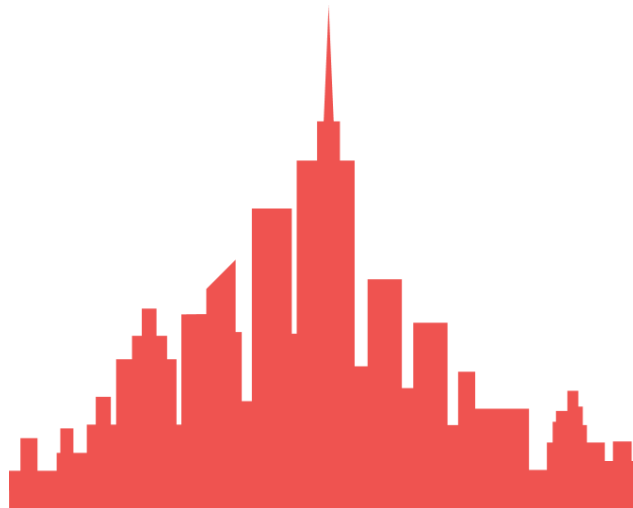
Introduction

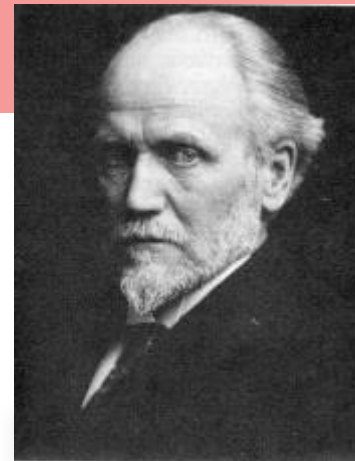
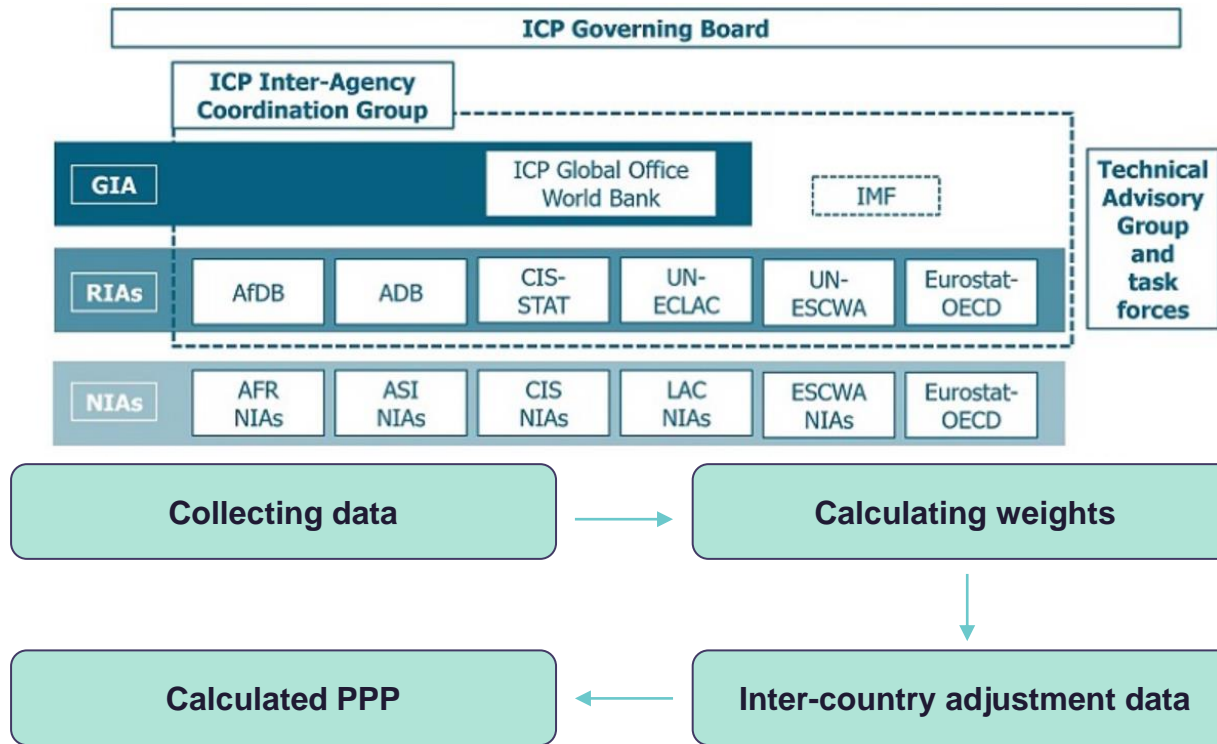
What exactly is PPP?

How exactly should PPP be calculated?

Project of the Century

$$X^T X = \begin{bmatrix} 1 & 0 & 0 & \partial_2^1 s_2^1 & \partial_2^i s_2^i & \partial_2^{Np} s_2^{Np} \\ 0 & 1 & 0 & \partial_j^1 s_j^1 & \partial_j^i s_j^i & \partial_j^{Np} s_j^{Np} \\ 0 & 0 & 1 & \partial_{Nc}^1 s_{Nc}^1 & \partial_{Nc}^i s_{Nc}^i & \partial_{Nc}^{Np} s_{Nc}^{Np} \\ \partial_2^1 s_2^1 & \partial_j^1 s_j^1 & \partial_{Nc}^1 s_{Nc}^1 & \sum_{\psi_s \in S(p_1)} S_s & 0 & 0 \\ \partial_2^i s_2^i & \partial_j^i s_j^i & \partial_{Nc}^i s_{Nc}^i & 0 & \sum_{\psi_s \in S(p_i)} S_s & 0 \\ \partial_2^{Np} s_2^{Np} & \partial_j^{Np} s_j^{Np} & \partial_{Nc}^{Np} s_{Nc}^{Np} & 0 & 0 & \sum_{\psi_s \in S(p_{Np})} S_s \end{bmatrix}$$

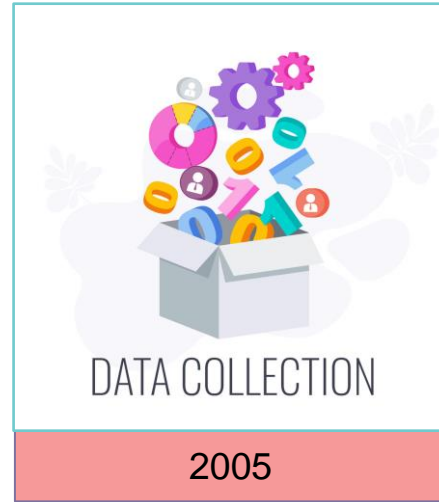




Gustav
Cassel

The problem with the traditional method is the difficulty of collecting data, and even for a huge international institution like the World Bank the calculation of PPP is an expensive and time-consuming project.

This long implementation time span affects the timeliness of PPP data.



2011



While you are Waiting



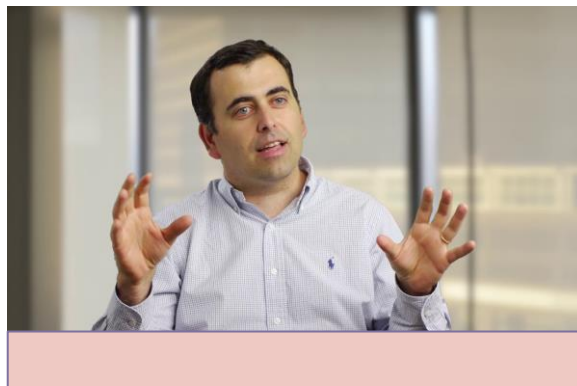
Collecting internet data



Comparison with official PPP



Extremely high goodness of fit

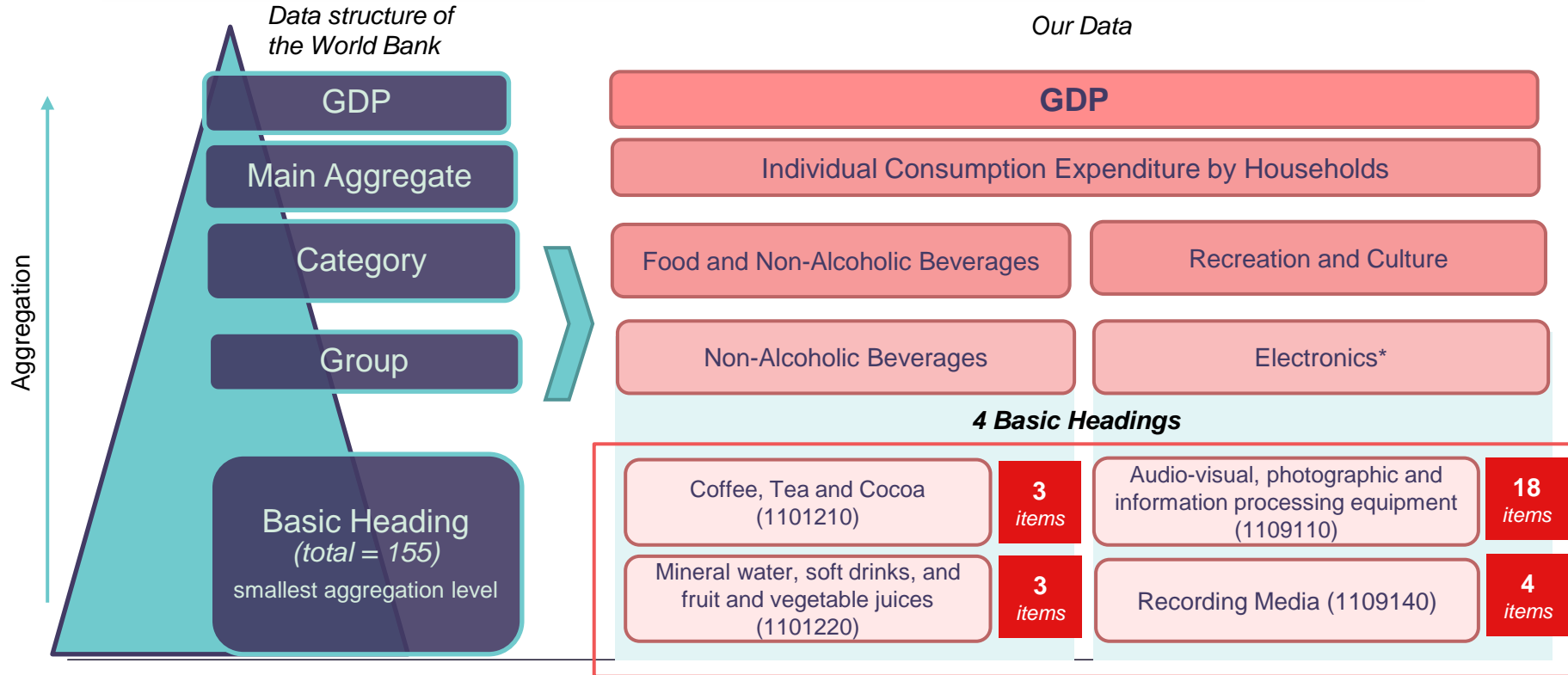


02



Data collection

Data Structure



* Here and further the term "Electronics" is used for simplicity following Alberto Cavallo (2018). The full name of Group is "Audio-visual, photographic and information processing equipment" according to the World Bank

Items for price collection

Non-Alcoholic Beverages

Coffee, Tea and Cocoa

3
items



Coffee *all kinds*



Tea *in bags or pyramids*



Cocoa *all kinds*

Mineral water, soft drinks, fruit and vegetable juices

3
items



Mineral water
All kinds



Soft drinks
All kinds



Juices
All kinds

Electronics

Audio-visual, photographic and information processing equipment

18
items



39-43"



55-60"

Smart TVs



13-13.9"
256 GB



13-13.9"
512 GB



15-15.9 "
256 GB



15-15.9 "
512 GB

Laptops Win 10



24-26"



27-29"

PC monitors



Smart Speaker
portable wireless



Loudspeaker
portable wireless



CCTV
for home usage



Handy Android



iPhone
iOS



Ear Buds



Smart Watch



Action Camera



Tablet
Android



iPad
iOS

Recording Media

4
items



SSD 1 Tb
External, portable



SSD 2 Tb
External, portable



HDD 1 Tb
External, portable



HDD 2 Tb
External, portable

Web Scrapping

Москва

Магазины Покупателям Юридическим лицам Клуб DNS

8-800-77-07-999 (с 03:00 до 22:00)

DNS

Каталог

Поиск по сайту



Сравнить

Избранное

Корзина



Войти

Каталог > Комплектующие, компьютеры и ноутбуки > Периферия и аксессуары > Внешние накопители данных > Внешние SSD накопители

Внешние SSD накопители 16 товаров

2048Гб

4096Гб

480-512Гб

240-256Гб

120-128Гб

C Type C

C Wi-Fi

C Thunderbolt

C защитой от воды

Показать еще

Сортировка: сначала популярные

Группировка: отсутствует

Сбросить фильтры

Объем накопителя (Гб): 1000 Гб

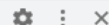
Поиск по категориям



% СКИДКИ



11 90



ID	Start URL
cl-display-24-26	https://www.citilink.ru/catalog/monitor/?f=discount.any%2Crating.any%2C2771_162&pf=discount.any%2Crating.any ...
cl-display-27-29	https://www.citilink.ru/catalog/monitor/?f=discount.any%2Crating.any%2C2767_162&pf=discount.any%2Crating.any ...

Items for price collection

Observed retailers
Electronics



OZON

DNS

ЦИФРОВАЯ И
БЫТОВАЯ ТЕХНИКА

СИТИЛИНК



Online

Online

Offline

Online

Offline

Online

Online

Offline

Online

Offline



amazon

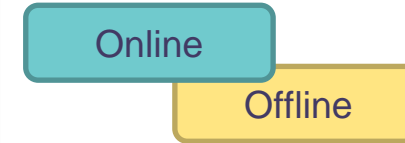
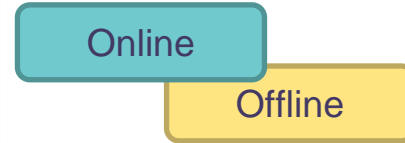
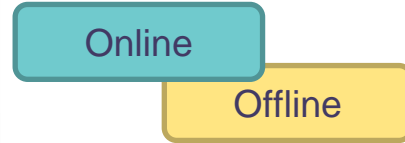
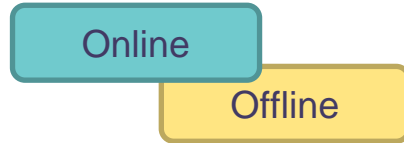
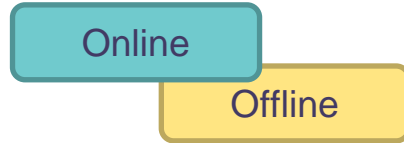
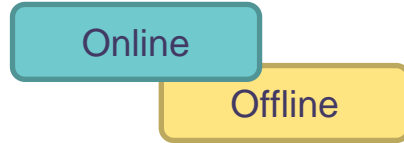


Argos

Currys PC World

Items for price collection

Observed retailers
Non-Alcoholic Beverages



03



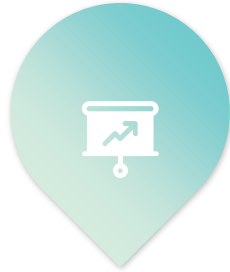
Data Investigation



“Input quality data, output quality performance.”

—Christian Baloga

PILLARS of qualitative trustworthy results



DATA CLEARING and CONSOLIDATION

Guarantees relevance of
information



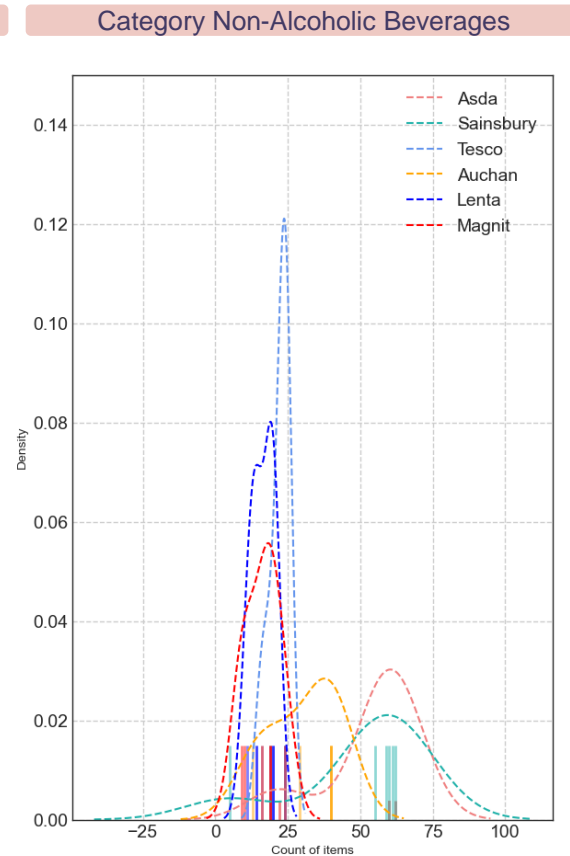
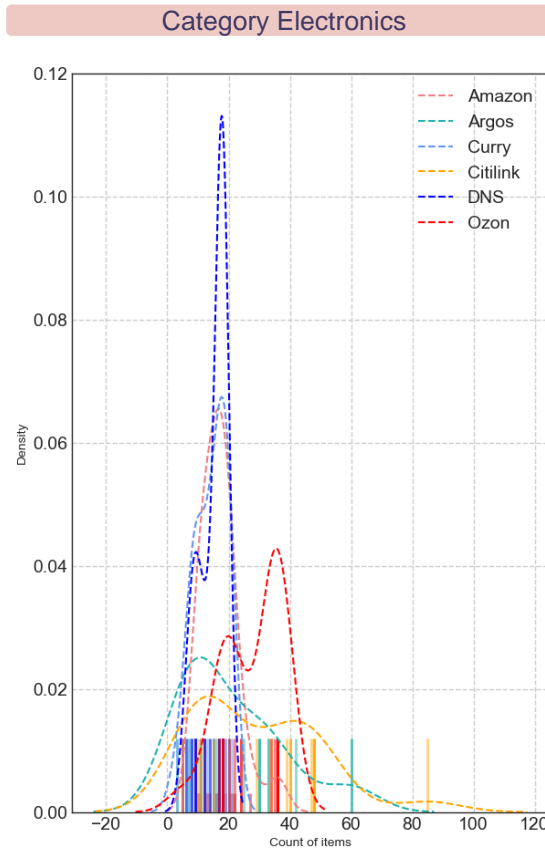
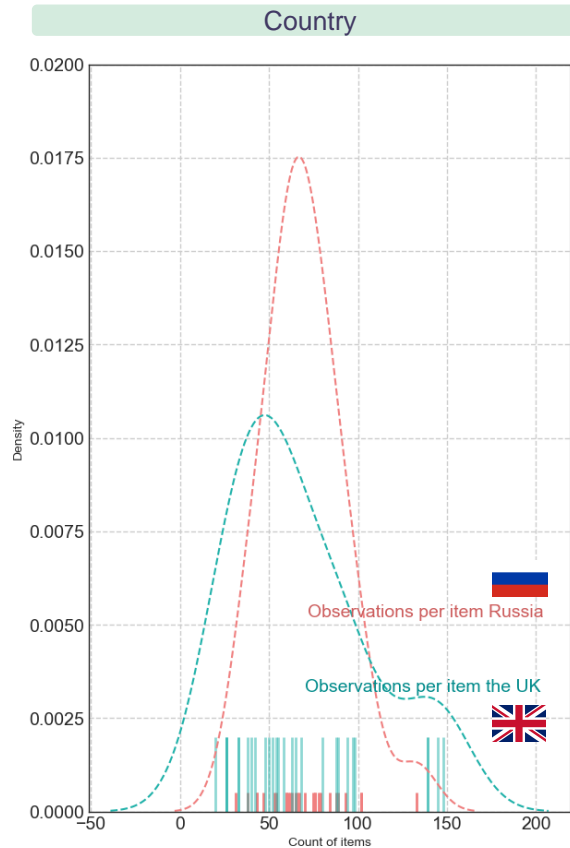
DATA INVESTIGATION

Reveals potential issues with data
and gives insights for results
interpretation

DATA CLEARING

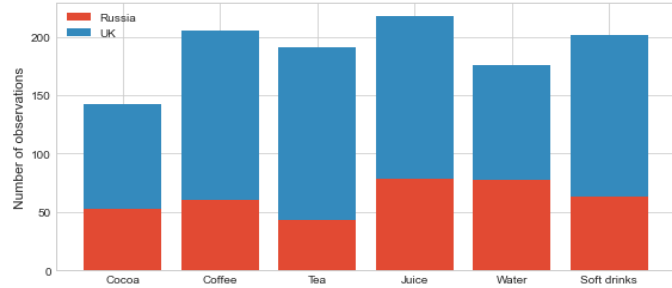
- Precise filters for web-scraping on retailers' websites
 - Investigation of every item position
 - Do all web-scraped data correspond to the indicated criteria?
 - Are there any obvious outliers?
 - Data consolidation using Python
 - Removal of implausible values (null, negatives)
 - If suspicious results are obtained → deeper data investigation for potential problems
-

Distribution of the observations by Country and Retailers

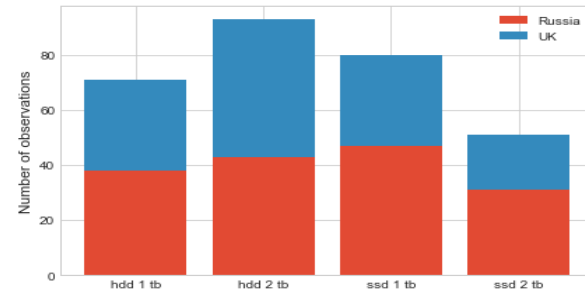


Distribution of the observations by Country

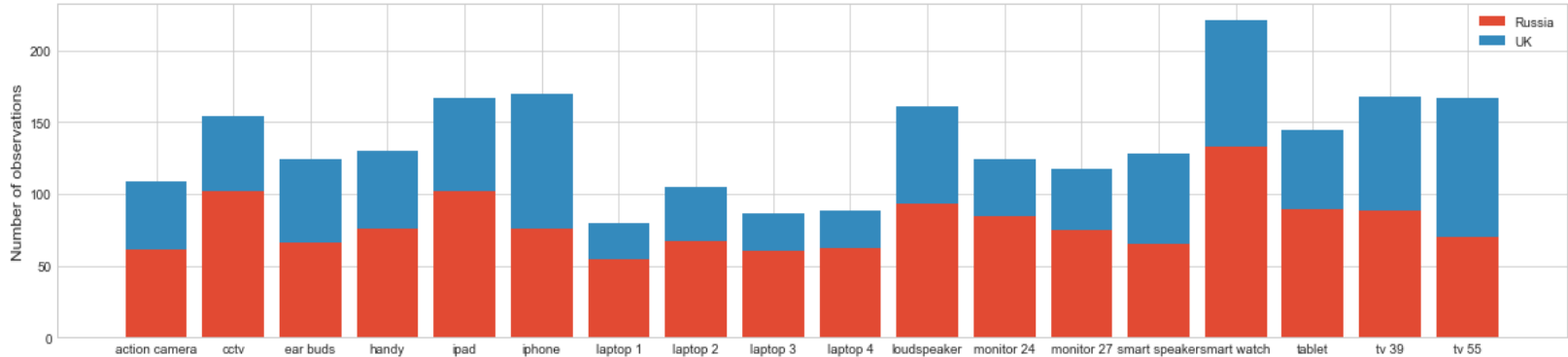
Non-Alcoholic Beverages



Recording Media

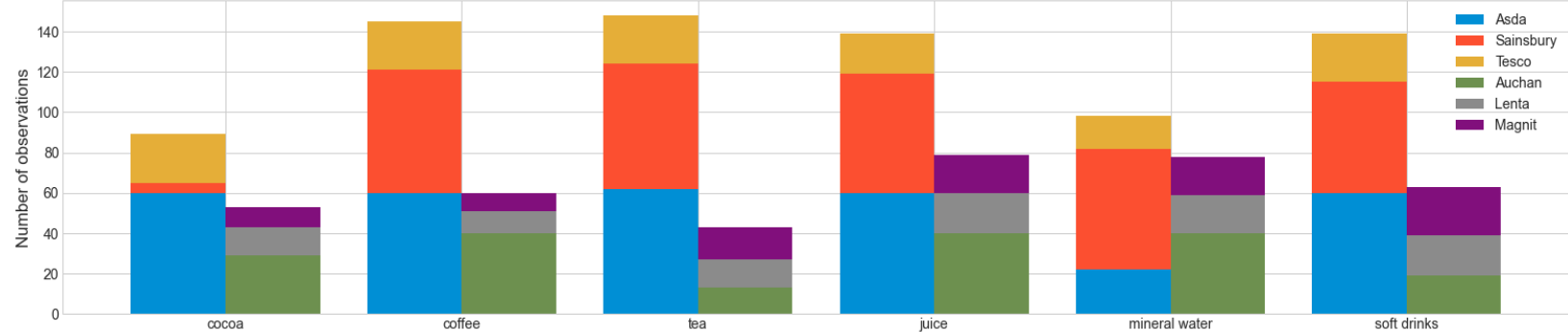


Audio-visual, photographic and information processing equipment

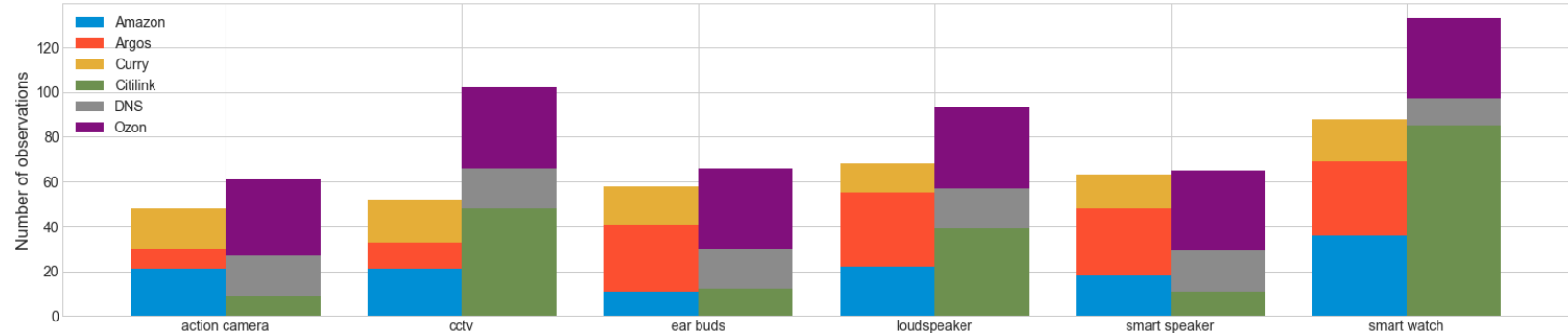


Distribution of the observations by Retailers (1)

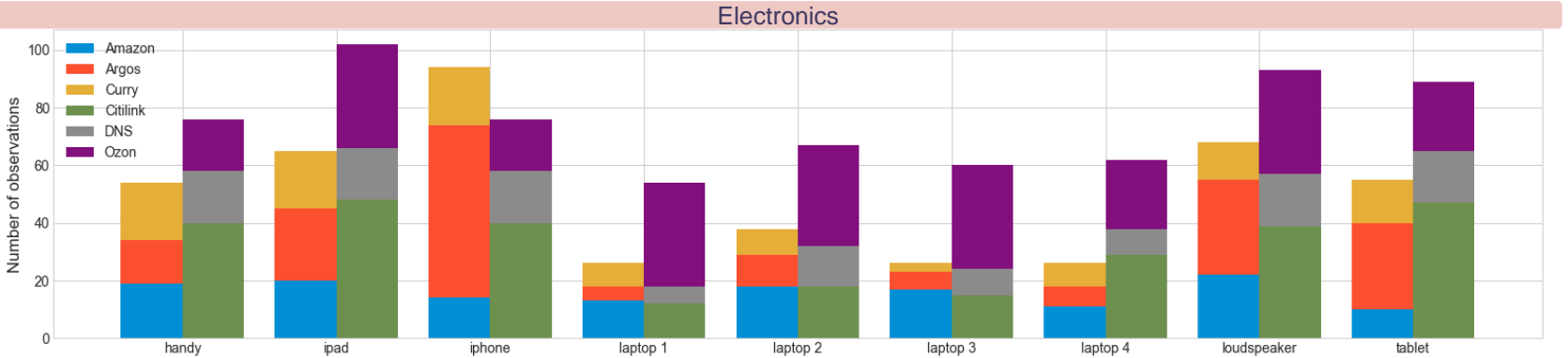
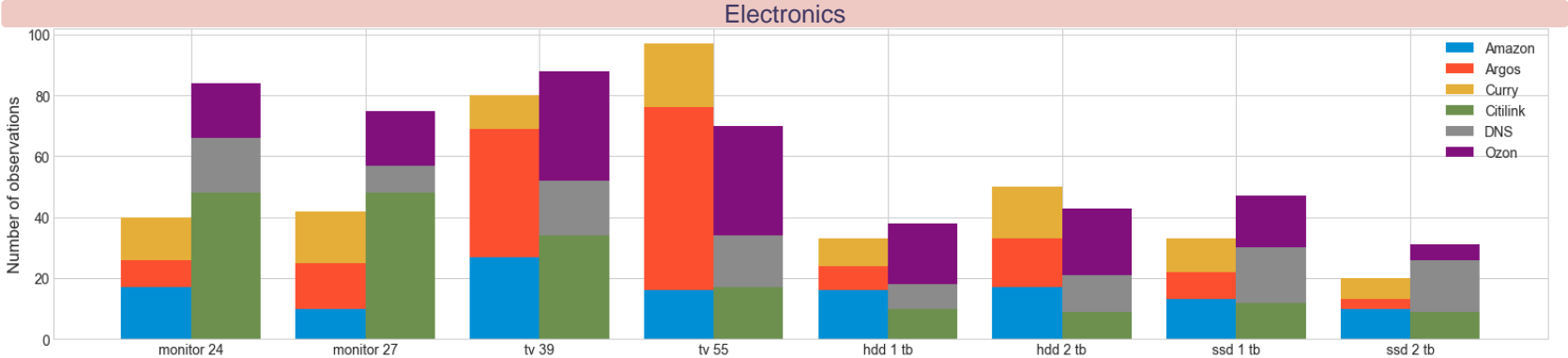
Non-Alcoholic Beverages



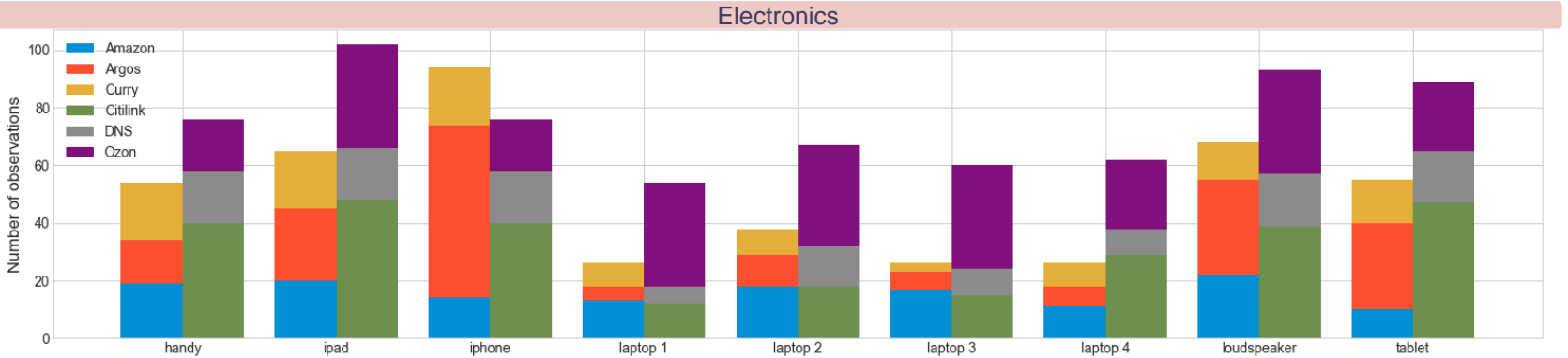
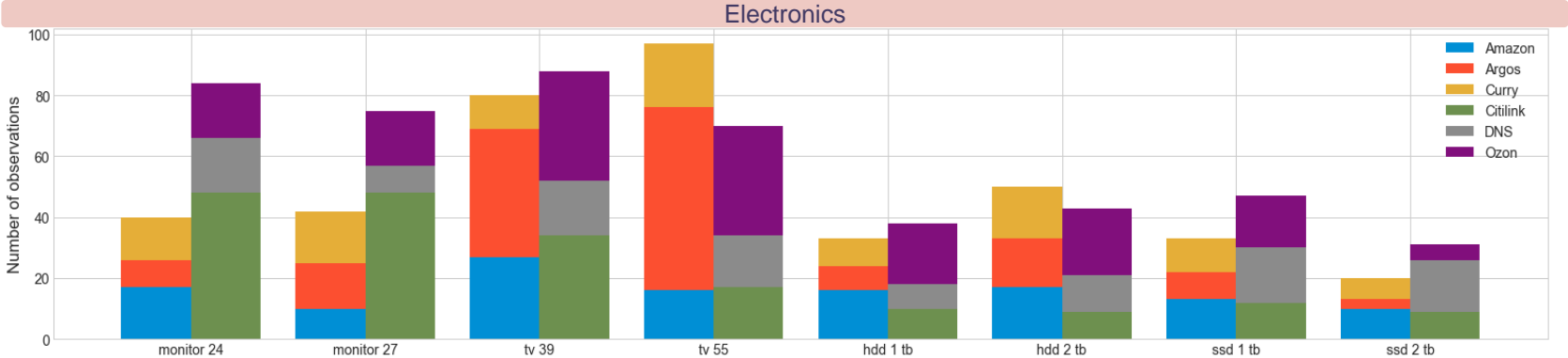
Electronics



Distribution of the observations by Retailers (2)



Distribution of the observations by Retailers (2)



Total Positions

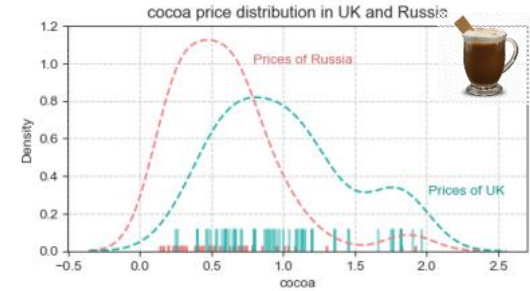
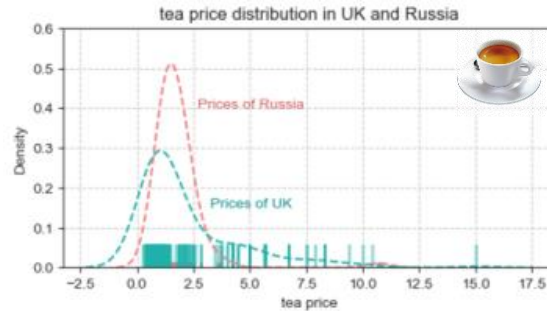
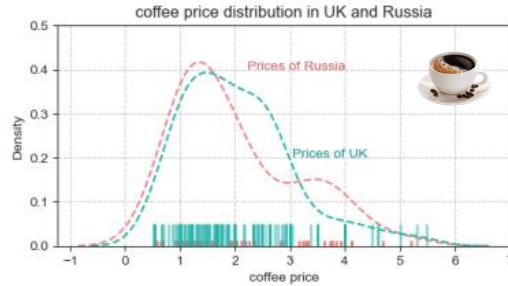
26 - 148 positions per item

56 observations per item on average

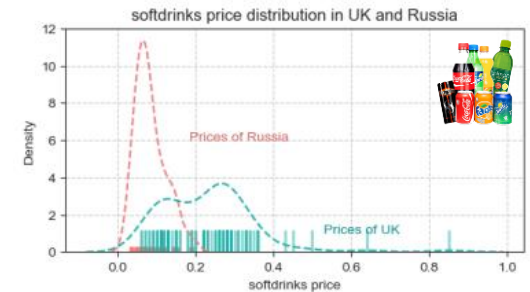
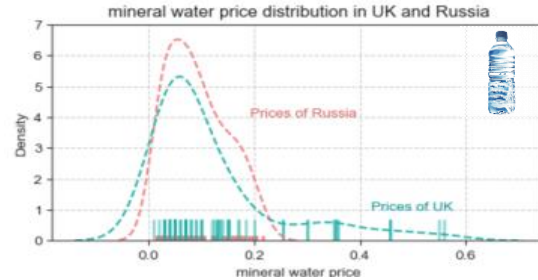
3 892 total number of collected data

Distribution of the prices | Non-Alcoholic Beverages

Coffee, Tea and Cocoa

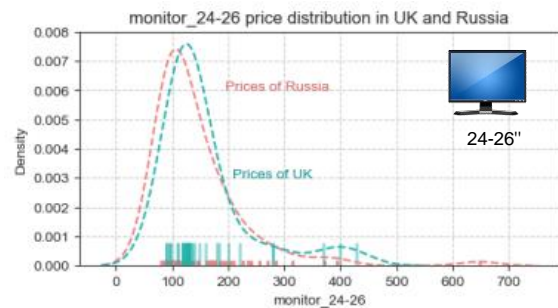
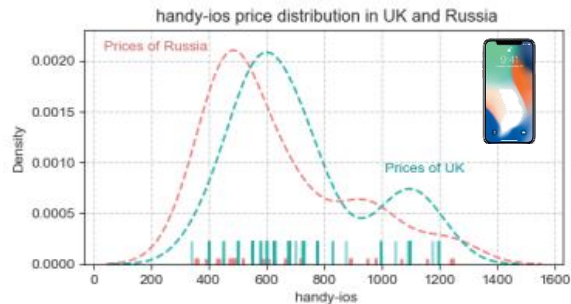
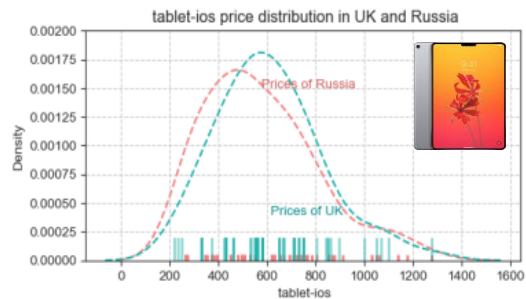


Mineral water, soft drinks, fruit and vegetable juices



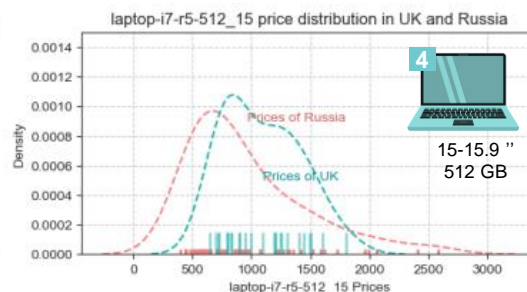
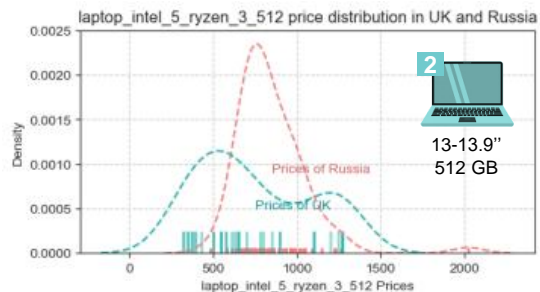
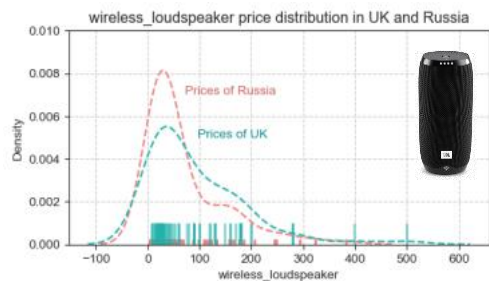
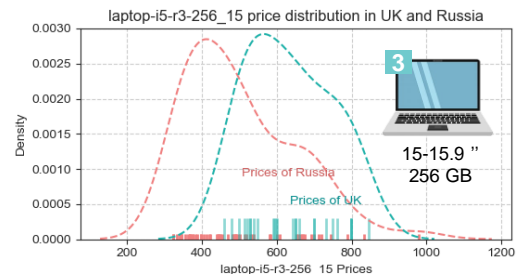
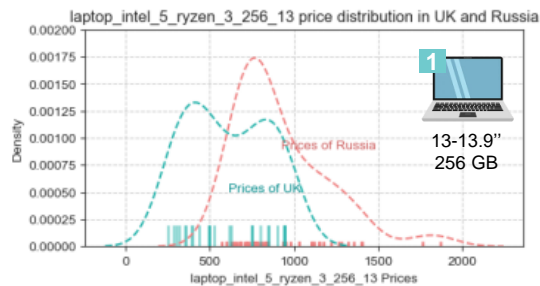
Distribution of the prices | Electronics

Audio-visual, photographic and information processing equipment



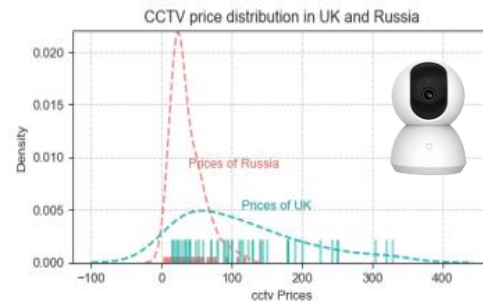
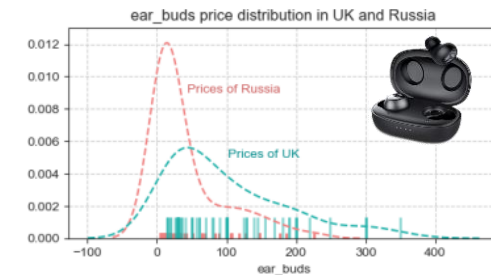
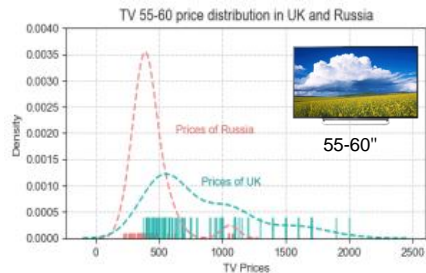
Distribution of the prices | Electronics

Audio-visual, photographic and information processing equipment



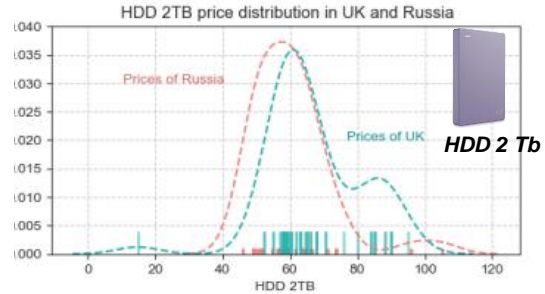
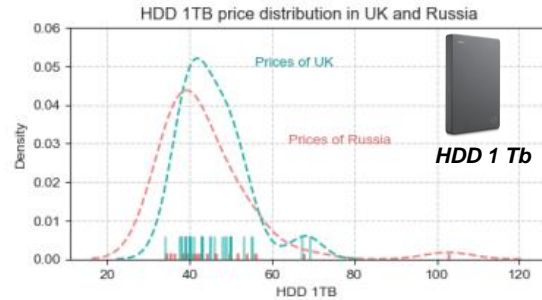
Distribution of the prices | Electronics

Audio-visual, photographic and information processing equipment



Distribution of the prices | Electronics

Recording Media

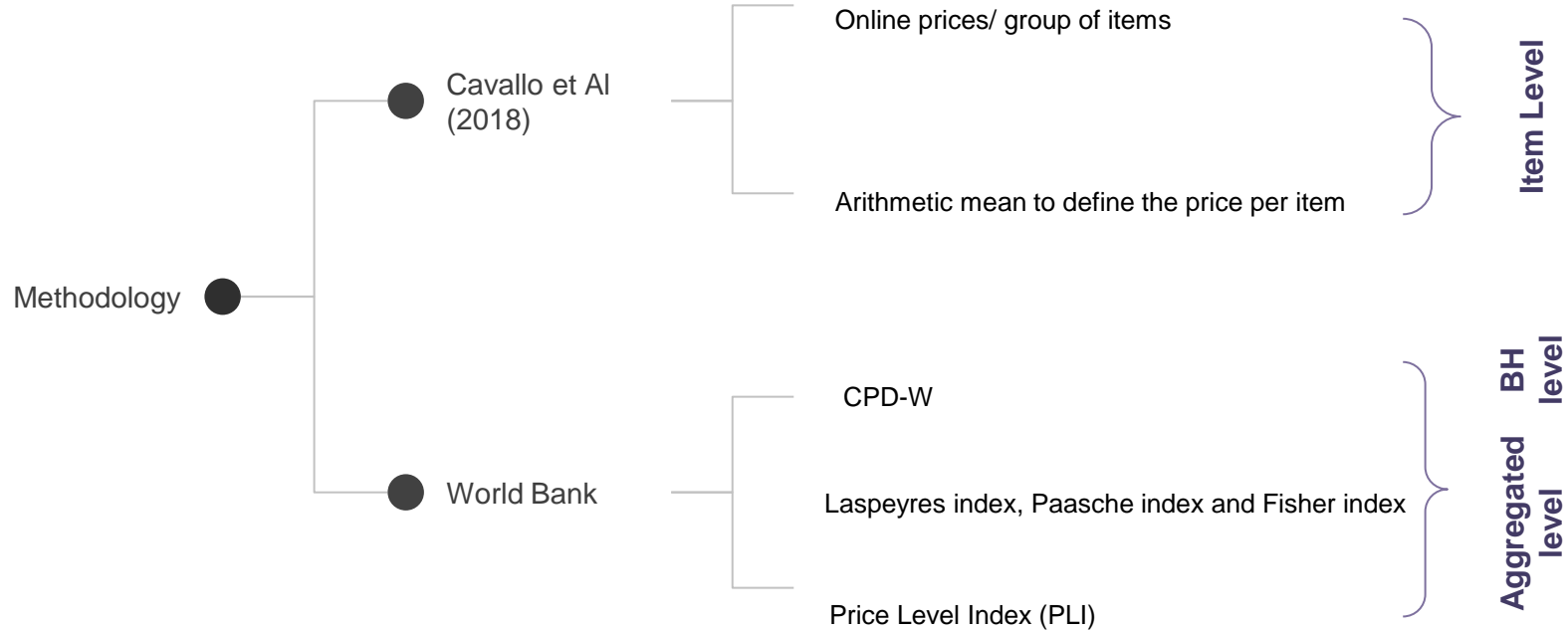


04



Methodology

Methodology



Methodology

Price Relative (Ratio)

Arithmetic mean by item :

$$P_{RF1}^A = (P_{RF1}^1 + \dots + P_{RF1}^n) / n$$

Price relatives

$$P_{RF} / P_{UK}$$

Country Product Dummy- W

To consider the differences between items inside one “basic heading” a Country Product Dummy (CPD) regression is used for every basic heading k.

$$\log p_{ij}^k = \eta_i^k + \eta_j^k + \epsilon_{ij}^k$$

The exponent of each country dummy is the estimated PPP for a particular basic heading:

$$P_{kj} = \exp(\eta_j^k).$$

Laspeyres index, Paasche index and Fisher index

PPPs calculation is weighted according to the economy of the base country (Laspeyres index), then weighted according to the economy of the other country (Paasche index), to calculate the geometric mean (GM) of the both PPPs (Fisher index).

$$\text{The Laspeyres index : } P_{RF UK}^L = \sum_k s_{kUK} P_{kRF} / P_{kUK}$$

$$\text{The Paasche index: } P_{RF UK}^P = (\sum_k s_{kRF} P_{kUK} / P_{kRF})^{-1}$$

The Fisher index as the geometric mean :

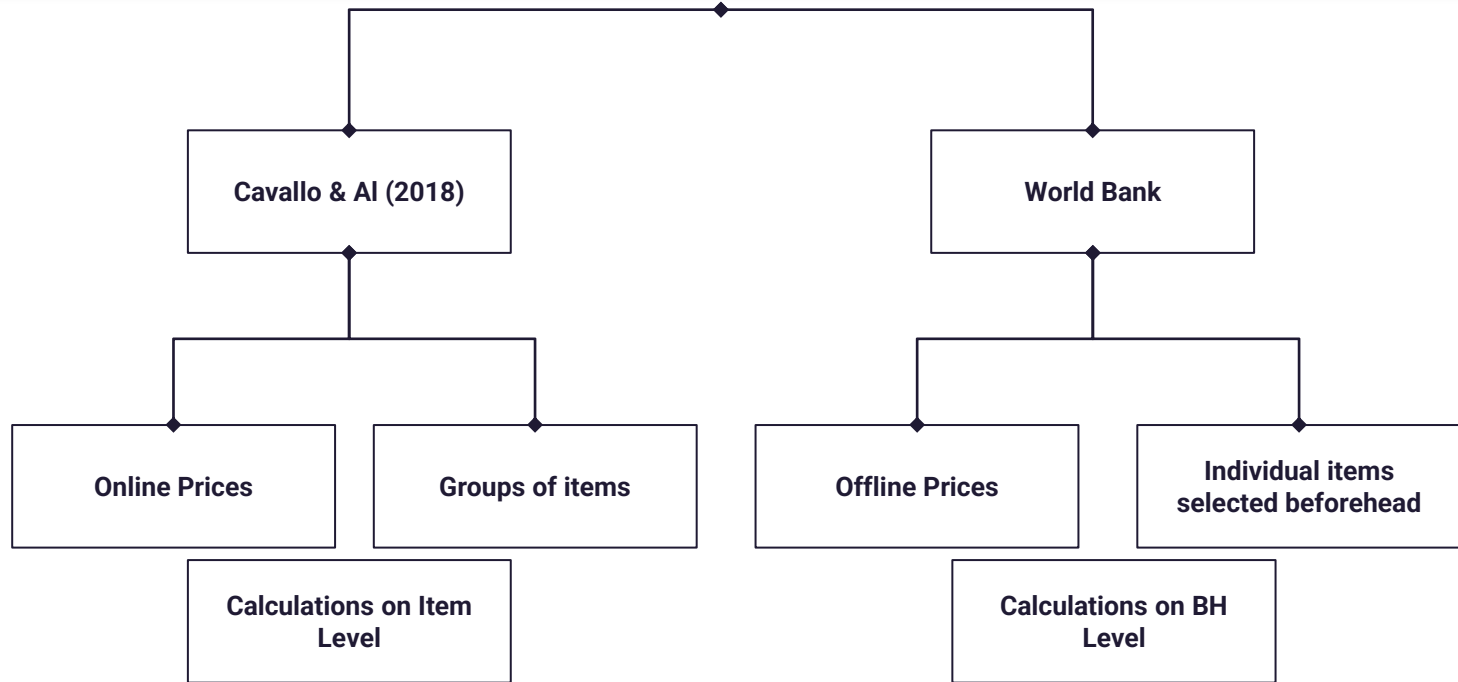
$$P_{RF UK}^F = (P_{RF UK}^L \times P_{RF UK}^P)^{1/2}$$

Price Level Index (PLI)

PLIs per country is calculated by dividing every country's PPP by the exchange rate of the pound sterling.

Relative to the base country, prices can be interpreted as high if PLI is more than 1 (> 1), and low if the PLI is less than 1 (< 1).

Methodology Key Differences



Cavallo's initial list of Electronics items was modified to reflect modern trends and technological advancement

Cavallo's list of items (for ICP 2011)

Television, screen size 32" (1 piece)
Television, screen size 42" (1 piece)
DVD player (1 piece)
DVD recorder with hard disc, 160-250 GB (1 piece)
DVD recorder with hard disc, 200-300 GB (1 piece)
Blu-ray disc player (1 piece)
Portable MP3 player, 4 GB (1 piece)
Portable MP3 player, 16 GB (1 piece)
Compact digital camera, 12 Mpx (1 piece)
Camcorder, HDD (1 piece)
Laptop, Hard Disc 320 GB, RAM 4 GB (1 piece)
Laptop, Hard Disc 640 GB, RAM 4 GB (1 piece)
Laptop, Hard Disc 750 GB, RAM 8 GB (1 piece)
Laptop, Hard Disc 750 GB - 1 TB, RAM 8 GB (1 piece)
Monitor, Full HD (1 piece)
Music CD - Pop Chart (1 piece)
Movie DVD (1 piece)
Blank compact disc (CD-R) (1 piece)
~~Blank compact disc (CD-R) (10 pieces)~~
Blank DVDs (R), slim cases (10 pieces)

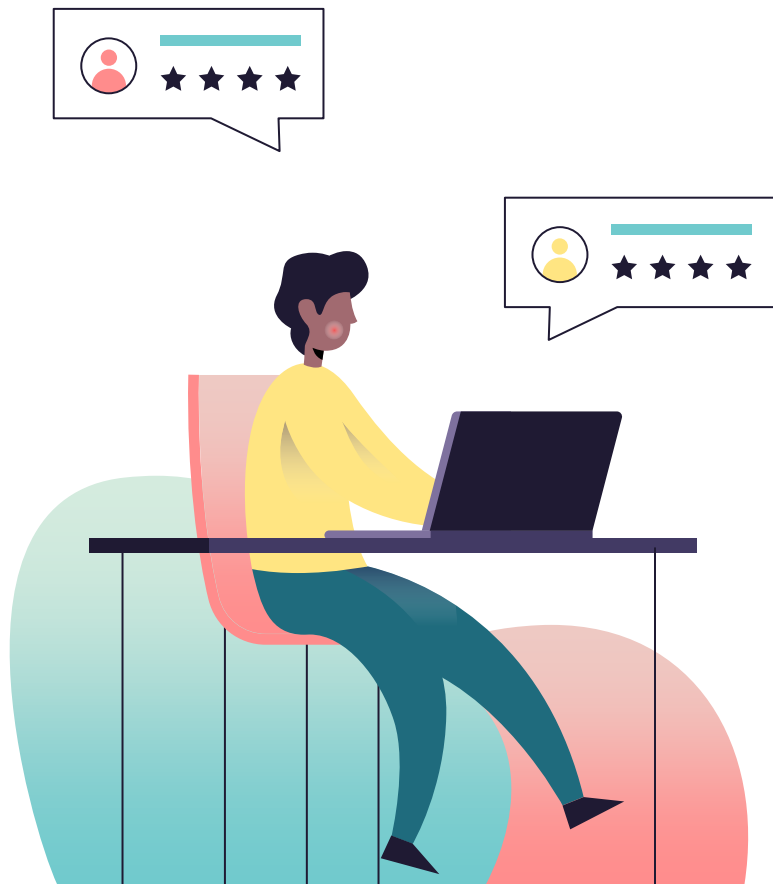


Modified list of items

Smart TV, screen size 39-43" (1 piece)
Smart TV, screen size 55-60" (1 piece)
Tablet Android (1 piece)
Tablet iOS (1 piece)
Handy Android (1 piece)
Handy iOS (1 piece)
Ear Buds (1 piece)
Wireless Loudspeaker (1 piece)
Action Camera FHD (1 piece)
CCTV (1 piece)
Laptop Intel 5 / Ryzen 3 256 GB 13-13.9", Windows 10
Laptop Intel 5 / Ryzen 3 512 GB 13-13.9", Windows 10
Laptop Intel 5 / Ryzen 3 256 GB 15-15.9", Windows 10
Laptop Intel 7 / Ryzen 5 512 GB 15-15.9", Windows 10
PC Monitor, screen size 24-26" (1 piece)
PC Monitor, screen size 27-29" (1 piece)
Smart Speaker (1 piece)
Smart Watch (1 piece)
External portable Solid State Drive (SSD) 1 Tb (1 piece)
External portable Solid State Drive (SSD) 2 Tb (1 piece)
External portable Hard Disk Drive (HDD) 1 Tb (1 piece)
External portable Hard Disk Drive (HDD) 2 Tb (1 piece)

05

Results Analysis



Using methodology, data collected and Python the following results were obtained

1

PPPs and PLIs on
Item level

When explaining results....

Focus on categories differences and
microeconomic factors

Type of PPP

**RATIO of ARITHMETIC MEAN
PRICE between countries**

Using methodology, data collected and Python the following results were obtained

1

PPPs and PLIs on
Item level

Focus on categories differences and
microeconomic factors

2

PPPs and PLIs on
Basic Heading level

When explaining results....

Focus on macroeconomic factors

Type of PPP

**RATIO of ARITHMETIC MEAN
PRICE between countries**

**EXPONENTIATED COEFFICIENTS OF
RUSSIA DUMMY obtained in CPD-W
within each BH**

Using methodology, data collected and Python the following results were obtained

1

PPPs and PLIs on
Item level

Focus on categories differences and
microeconomic factors

2

PPPs and PLIs on
Basic Heading level

When explaining results....

Focus on macroeconomic factors

3

PPPs and PLIs
Aggregated

Combining all the factors and making
general conclusion

Type of PPP

**RATIO of ARITHMETIC MEAN
PRICE between countries**

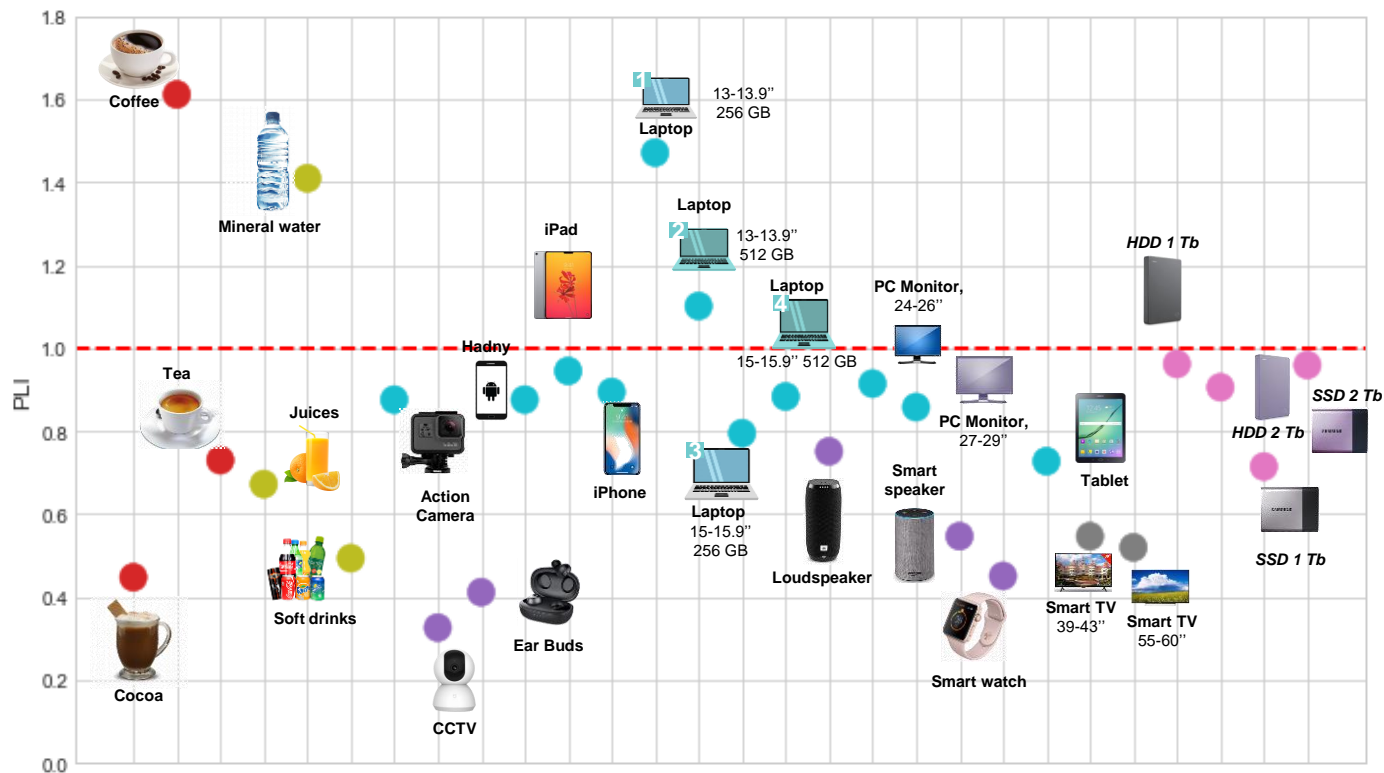
**EXPONENTIATED COEFFICIENTS OF
RUSSIA DUMMY obtained in CPD-W
within each BH**

**FISHER-TYPE PPP as geometric
mean of Laspeyres – and Paasche
index**

1

PPPs and PLIs on Item level

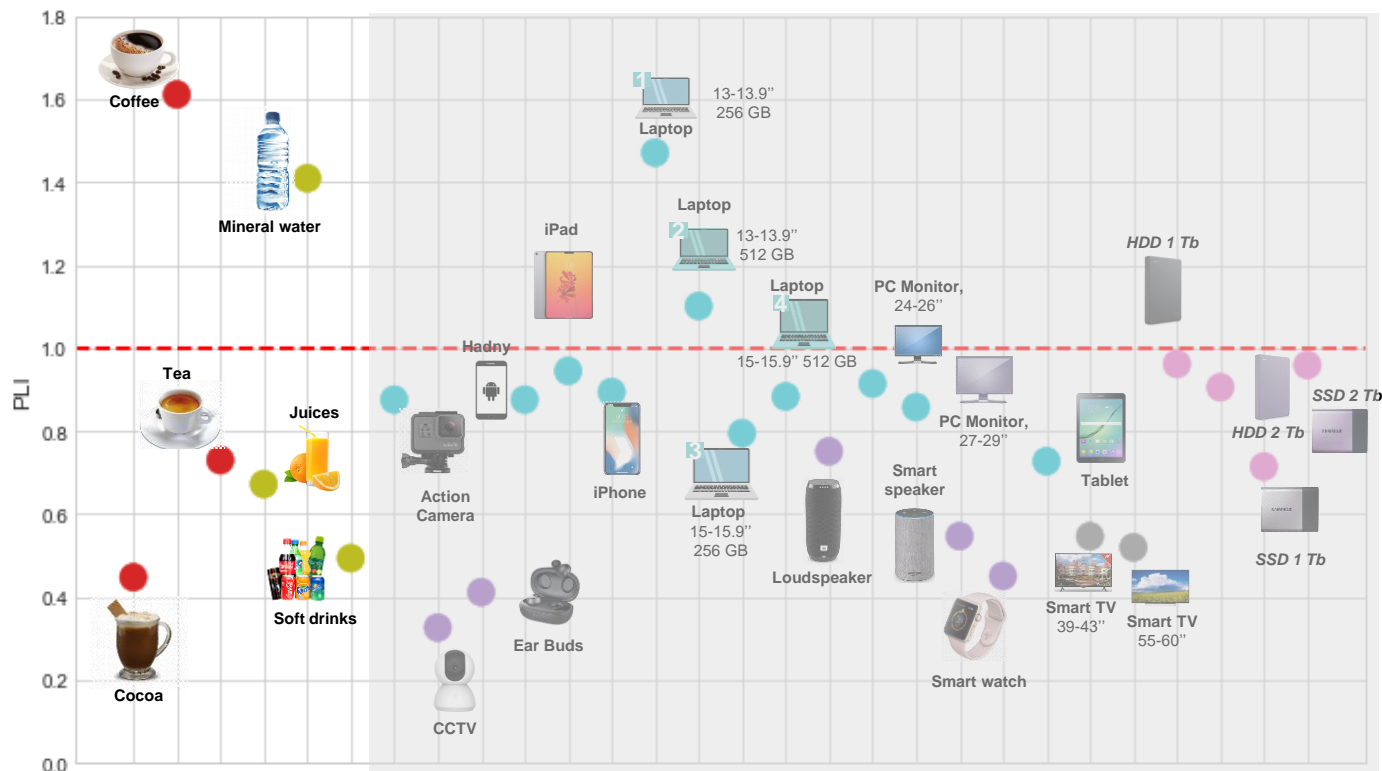
PLI by items, base country UK, exchange rate = 101.96 Rub/GBP



* For "Non-Alcoholic Beverages" amount is always 100 gram or ml. For "Electronics" amount is always 1 piece

1 PPPs and PLIs on Item level | Group “Non-Alcoholic Beverages”

PLI by items, base country UK, exchange rate = 101.96 Rub/GBP



Summary table

Basic Heading	Type of item	PPP	PLI
Coffee, tea and cocoa	cocoa	45.66	0.45
	coffee	164.30	1.61
	tea	74.44	0.73
Mineral waters, soft drinks, fruit and vegetable juices	juice	68.55	0.67
	mineral water	143.70	1.41
	soft drinks	50.34	0.49

How to read Summary table (example):

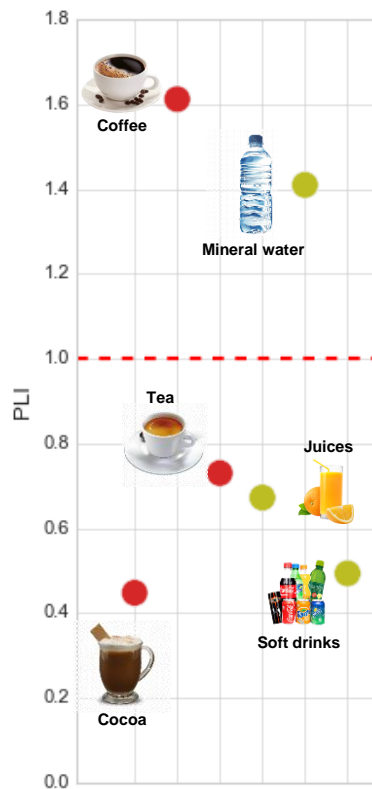
PPP 45.662 for “cocoa” means that 45.662 Rub is the cost of an amount of “cocoa” in Russia that would cost in the United Kingdom £1.0.*

PLI <1 indicates that it is relatively cheaper to buy coca in Russia than in the UK

* For “Non-Alcoholic Beverages” amount is always 100 gram or ml. For “Electronics” amount is always 1 piece

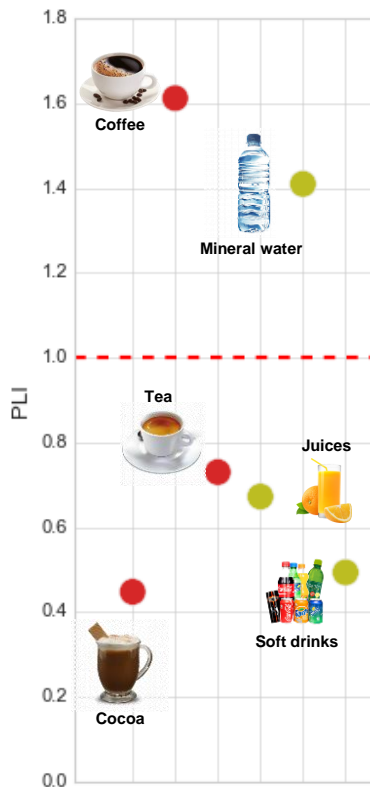
1 PPPs and PLIs on Item level | Group “Non-Alcoholic Beverages”

PLI by items



1 PPPs and PLIs on Item level | Group “Non-Alcoholic Beverages”

PLI by items



Explanation of results

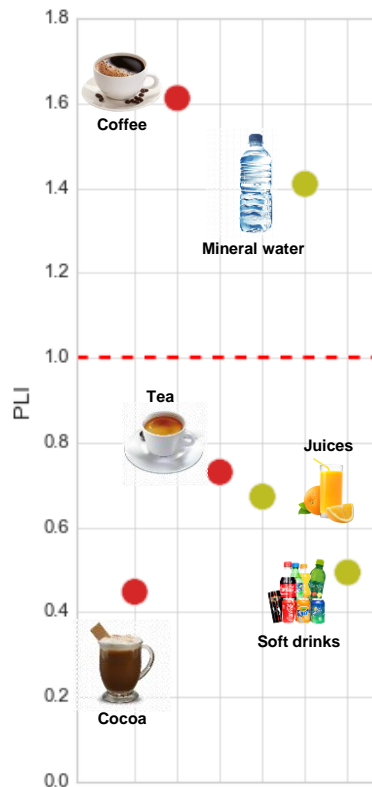
The Major drivers of relative expensiveness of Coffee and Mineral water in Russia are:

- focus of UK's retailers on selling its own brands ("Tesco", "Asda", "Sainsbury's")
- presence of the strong local player "Kenco"

	Type of brand	count of brand			mean price in pounds		
		Internati onal	Loca l	Own brand	Internati onal	Loca l	Own brand
coffee	Russia	52	8		3.54	2.70	
	UK	93	21	31	2.40	2.17	1.28
mineral water	Russia	35	43		0.14	0.06	
	UK	65		33	0.08		0.05

1 PPPs and PLIs on Item level | Group “Non-Alcoholic Beverages”

PLI by items



Explanation of results

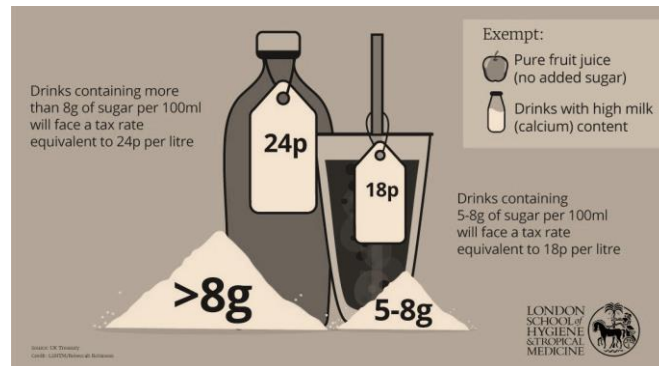
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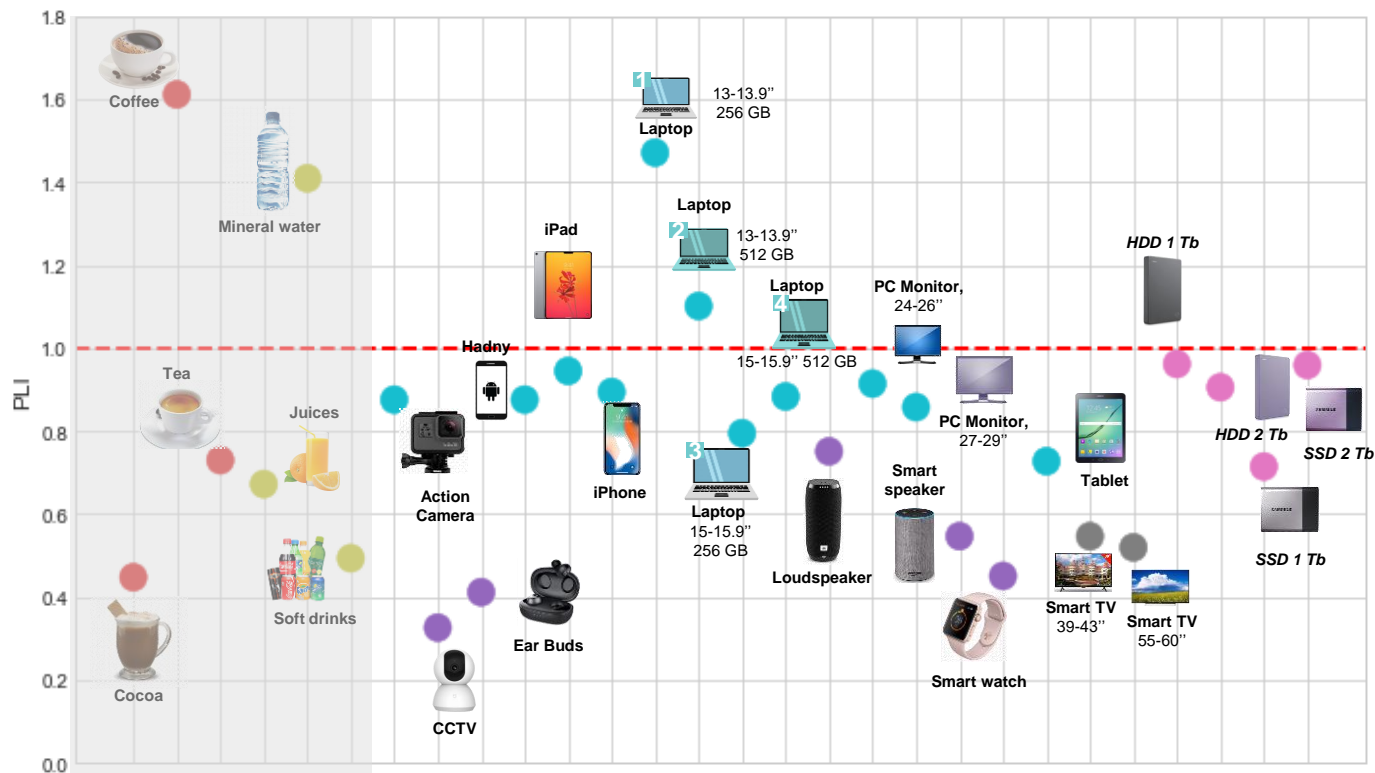
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	UK	65		33	0.08		0.05

Soft drinks, cocoa and juices in Russia are much cheaper than in the UK presumably because of :

- “Soft Drinks Industry Levy” (SDIL) law introduced in the UK in 2018 → drinks with high sugar content are taxed higher
- Presence of many local brands of juices in Russian market



PLI by items, base country UK, exchange rate = 101.96 Rub/GBP



Summary table

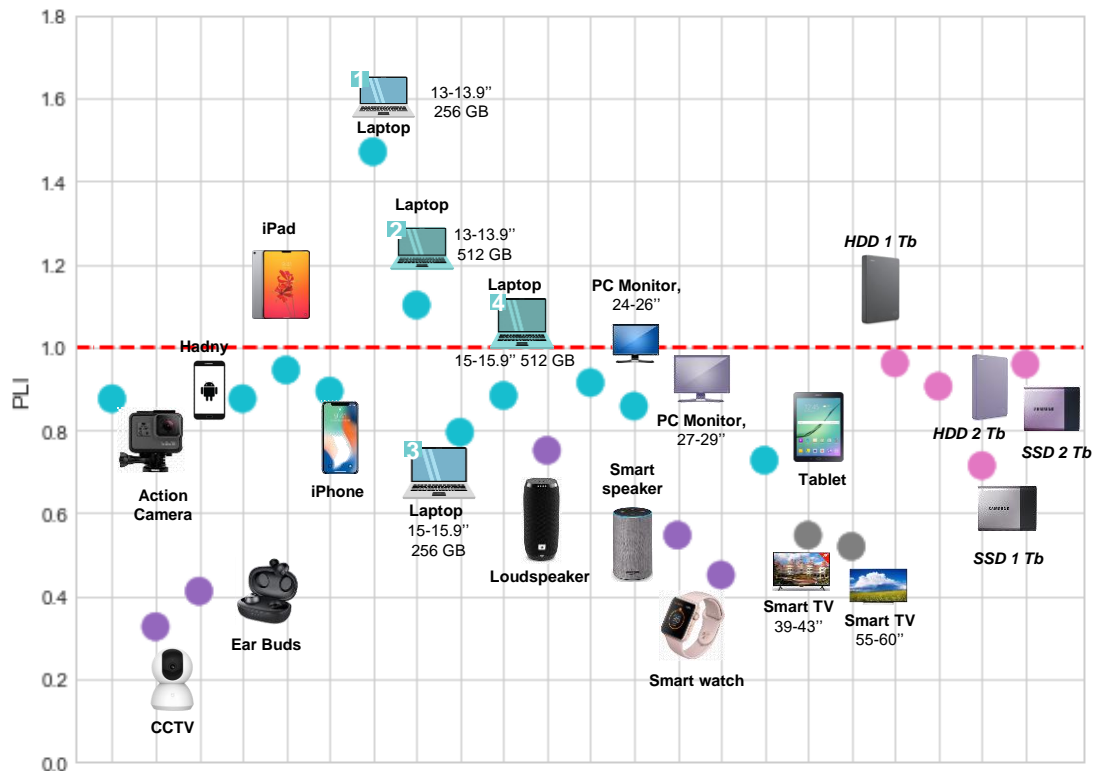
BH	Type of item	PPP	PLI
Audio-visual, photographic and information processing equipment	action camera	89.300	0.876
	cctv	33.285	0.326
	ear buds	41.998	0.412
	handy	89.309	0.876
	ipad	96.349	0.945
	iphone	91.186	0.894
	laptop 1	149.998	1.471
	laptop 2	112.308	1.101
	laptop 3	81.064	0.795
	laptop 4	90.072	0.883
	loudspeaker	76.596	0.751
	monitor 24	93.243	0.915
	monitor 27	87.469	0.858
	smart speaker	55.753	0.547
	smart watch	45.977	0.451
Recording Media	tablet	74.170	0.727
	tv 39	55.737	0.547
	tv 55	53.010	0.520
	hdd 1 tb	98.072	0.962
	hdd 2 tb	92.349	0.906
	ssd 1 tb	72.879	0.715
	ssd 2 tb	113.744	1.116

* For “Non-Alcoholic Beverages” amount is always 100 gram or ml. For “Electronics” amount is always 1 piece

1

PPPs and PLIs on Item level | Group “Electronics”

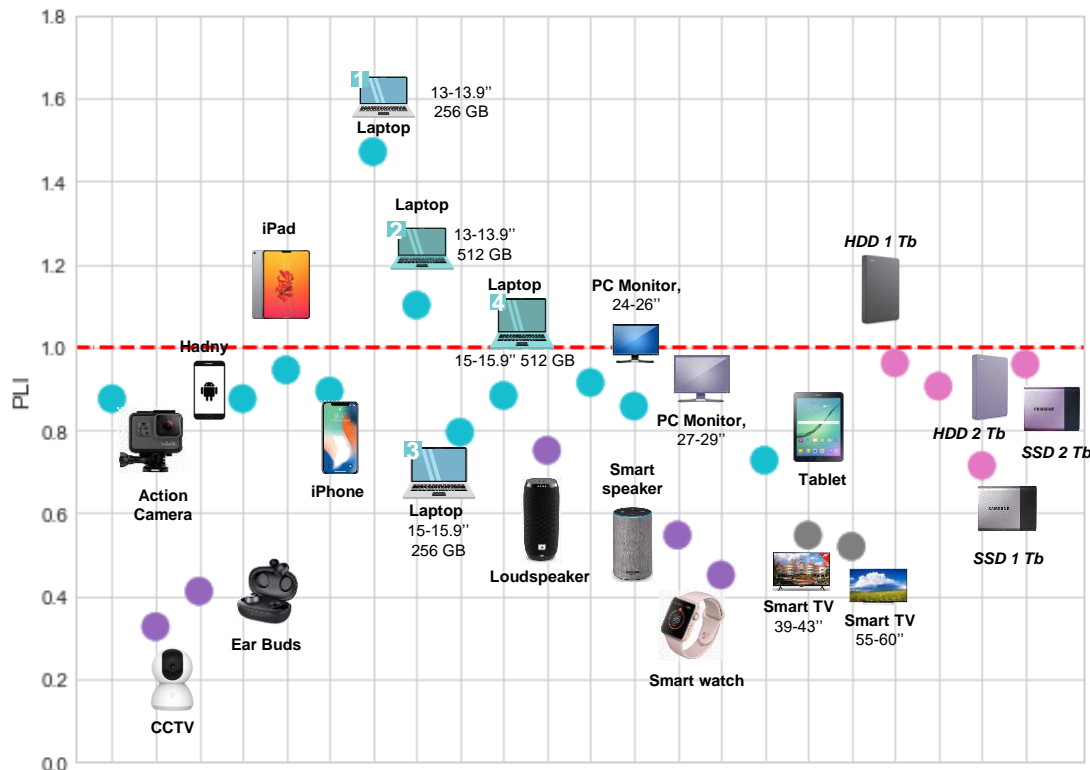
PLI by items



1

PPPs and PLIs on Item level | Group “Electronics”

PLI by items



Electronics-specific factors affecting price

Items are globally supplied (*mainly from Asia*)



Prices for the same brands are expected to be globally comparable

Russia shares common border with China



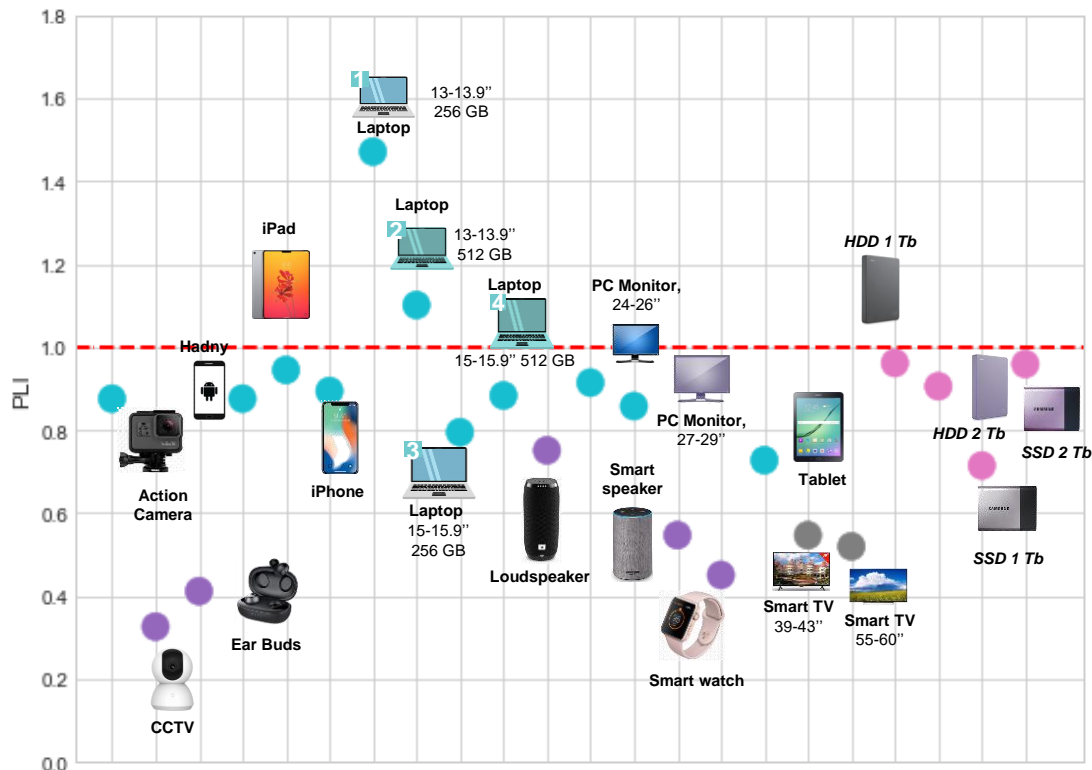
Lower logistics costs → expectation of lower price

Stock depletion speed



Expectation of bigger diversity of Chinese brands for Russia
Due to the countries differences price can be largely affected

PLI by items



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Groups of items to be differentiated



Expensive durable gadgets



Small gadgets

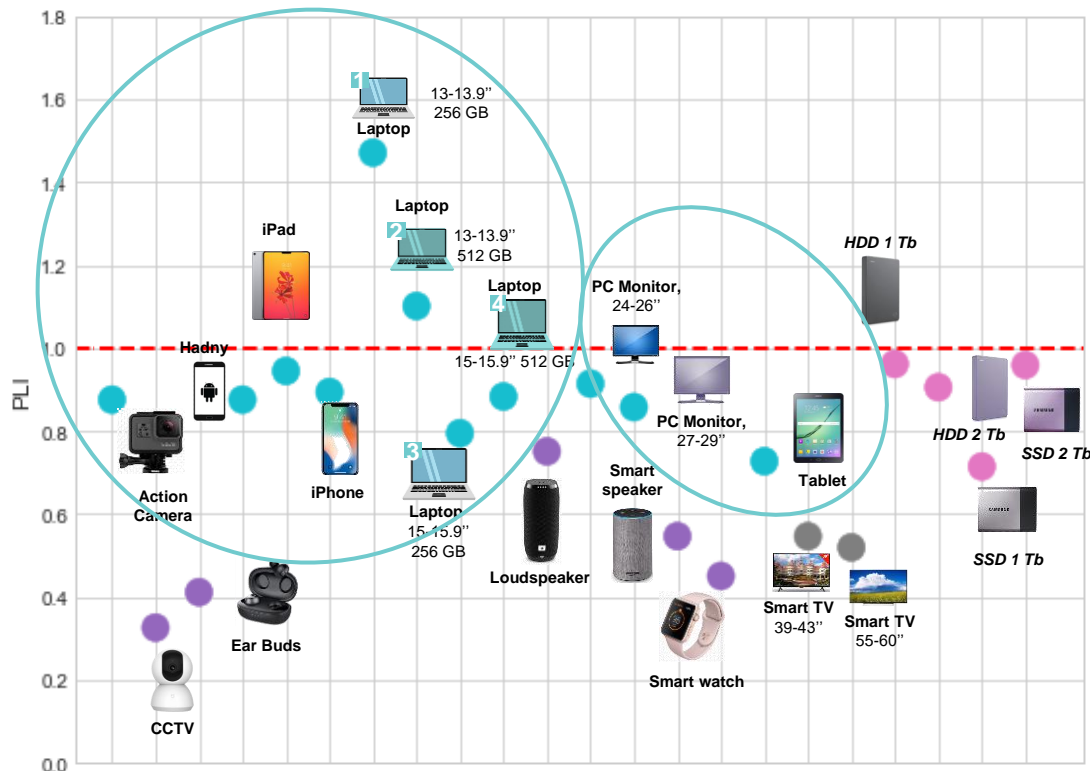


Smart TV



Information storage equipment

PLI by items

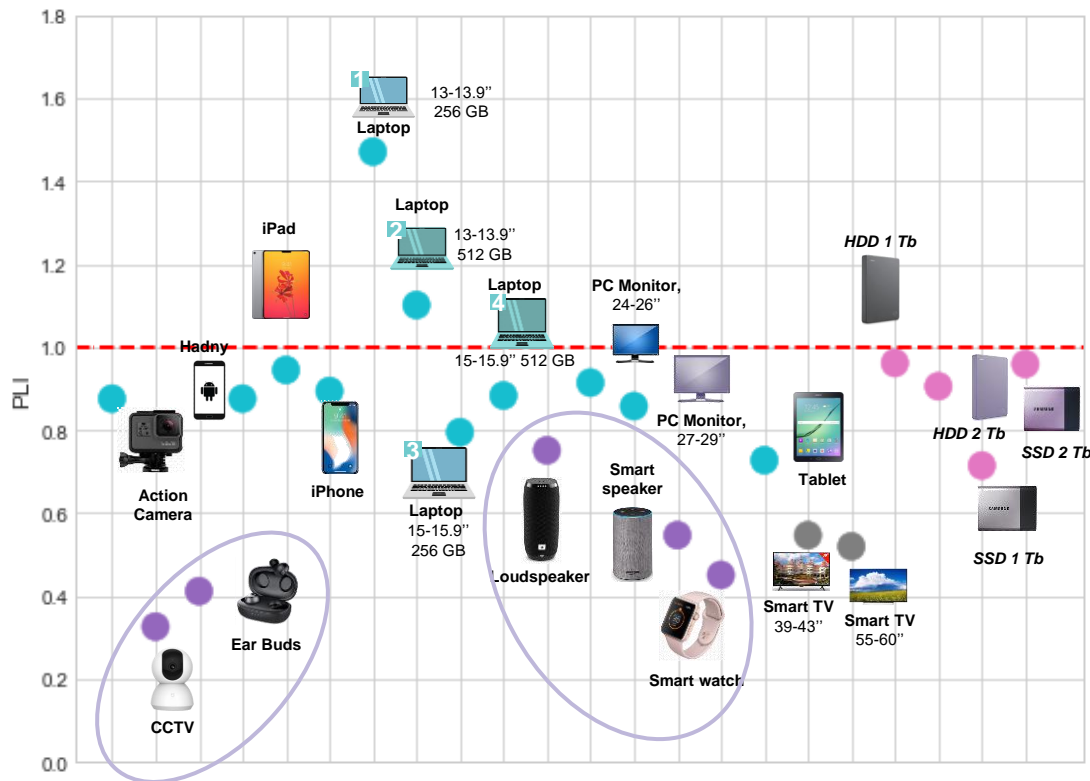


Explanation of results

Expensive durable gadgets

- thoroughly chosen by consumers due to high price and frequency of use
- Considered as a part of lifestyle so readiness to pay is higher
- Dominance of world manufacturers of Electronics (*Samsung, Apple, HP, Acer etc.*)
- Demand shock due to the COVID-19

PLI by items



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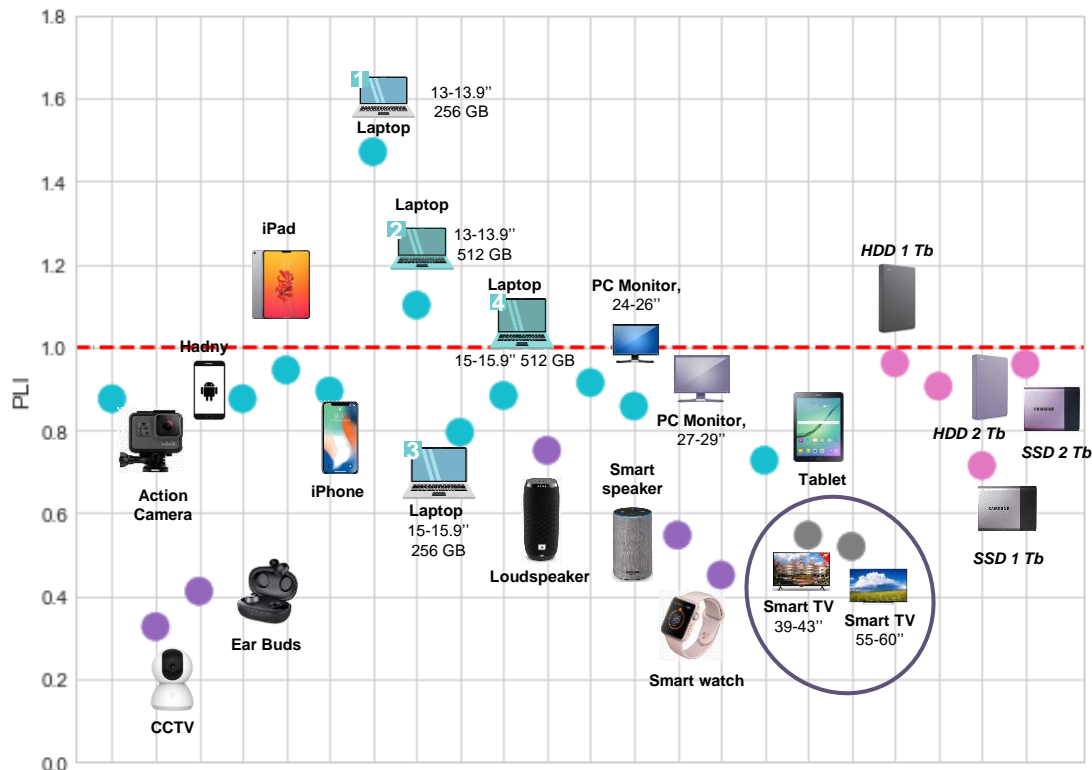
Small gadgets

- less conscious purchase, often as a gift
- skewedness of distribution towards cheaper brands and bigger variety of manufacturers

1

PPPs and PLIs on Item level | Group “Electronics”

PLI by items

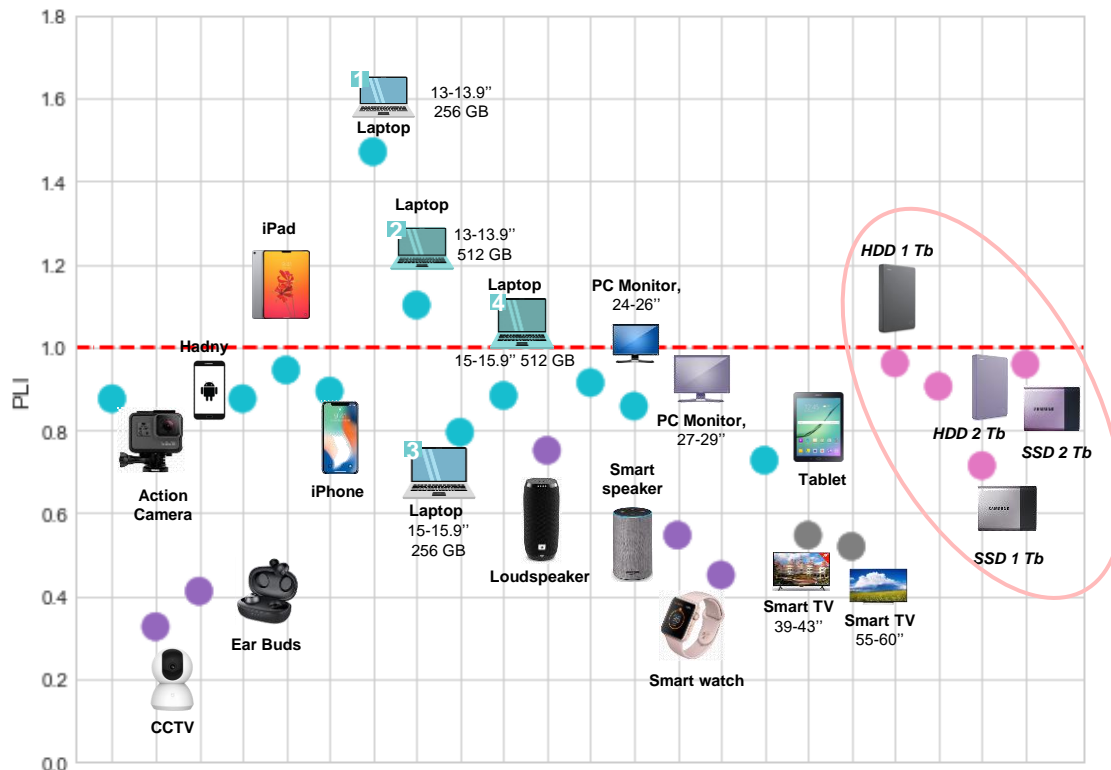


Explanation of results

Smart TV

- bought as a replacement, no sudden demand shocks
- the number of cheaper unknown brands in Russian sample is more than in the UK
- The mean price on the same international brands is lower in Russia than in the UK

PLI by items



Explanation of results

Smart TV

- bought as a replacement, no sudden demand shocks
- the number of cheaper unknown brands in Russian sample is more than in the UK
- The mean price on the same international brands is lower in Russia than in the UK

Information storage equipment

- data are closely comparable
- presumably different stock depletion rates in Russia and the UK of SSD 1 Tb

Results and Interpretation

- On average purchase of the item within all Basic Headings is relatively cheaper in Russia than in the UK

Category	Basic Heading	PPP	PLI
RECREATION AND CULTURE	Audio-visual, photographic and information processing equipment	73.811	0.724
	Recording Media	93.084	0.913
NON- ALCOHOLIC BEVERAGES	Coffee, tea and cocoa	82.349	0.808
	Mineral waters, soft drinks, fruit and vegetable juices	79.1522	0.776

base country – the UK, Exchange rate = 101.96 Rub/GBP

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Explanation of results



The UK GDP per capita is **4x** larger than Russia's → willingness to pay, higher cost of labor



For Electronics:

- Higher shipping costs of items produced in Asia to the UK
- Availability of cheaper Chinese brands for Russia



Higher taxes on **Beverages** with high sugar content in the UK

Results

	PPP	PLI
Laspeyres-type PPP	77.006	0.7550
Paasche-type PPP	78.538	0.7700
Fisher-type PPP	77.768	0.7630

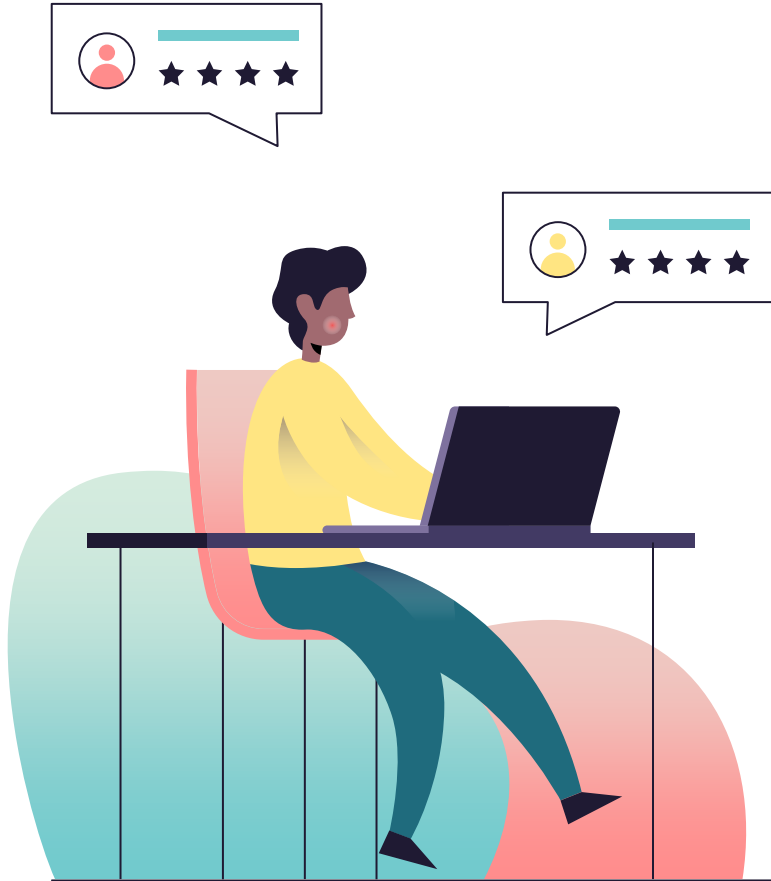
base country – the UK, Exchange rate = 101.96 Rub/GBP

Interpretation

- On aggregated level similar items are **23.7%** cheaper in Russia than in the UK
- PLI indicated the gap between countries' exchange rates
- Relative lower prices do not compensate the GDP per capita gap between countries → Russia is still relatively poorer in comparison to the UK

06

Advantages and Limitations



Advantages

Real-time estimation of consumption vs. estimation once in 6 years

Low cost

More items are included into analysis → no missing values and extrapolations biases

Combination of both online and offline retailers

Limitations

Data **mainly** from large retailers who have online presence



online and offline prices differences?

Online retailers set a single price for all locations within a country

Limited number of categories

No Time-series in the model

Which matched individual products are more representative of actual consumption

07



Conclusions

Conclusions

- In this study there was shown how PPP can be calculated based on the combination of Cavallo et al. (2018) and World Bank methodology and using online web-scraped data for Electronics and Non-Alcoholic Beverages in the UK and Russia.
- On average it can be claimed, that the similar items can be purchased in Russia at lower price than in the UK. Plausibility of results is confirmed by similar PPPs for similar items.
- When interpreting results , we discovered the major micro- and macroeconomic factors affecting price differences in both countries and reflecting different purchasing patterns of consumers, such as different taxes for the same items in Beverages, lower shipping cost and low purchasing power of Russian population.
- Notable is that there are no major differences in prices for Expensive Durable Gadgets and information storage equipment explained by the dominance of global manufacturers
- Although there are a lot of advantages of this method in terms of speed and the research cost in comparison to the World Bank, it has a lot of limitations and can't be used for the whole economy estimation due to the lack of online prices for particular categories.

THANK YOU!

