

Exploring Migration Patterns Using Digital Trace Data

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About us



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Laboratory of Migration and Mobility - MPIDR



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- PhD student at Max Planck Institute for Demographic Research, Max Planck Institute for Software Systems and Saarland University, Germany
Laboratory of Migration and Mobility - MPIDR
Group of Social and Information Systems - MPI-SWS



Workshop Exploring Migration Patterns using Digital Trace Data

First edition:

9th African Population Conference
(APC) 2024

Lilongwe, Malawi
21 May 2024

Organized by the IUSSP Panel in Digital and Computational Demography.





Introduction

- Name
- Affiliation
- Research area
- Why this workshop?



Exploring Migration Patterns Using Digital Trace Data



Introduction

Three pillars in population studies:

- **Mortality**
- **Fertility**
- **Migration**

“Messy” in terms of definition and data collection.

Opportunity to use innovative data sources?



Migration

What is your definition of migration or migrant?



Migration

Migration: Moving to a country other than the usual residence for a period of at least a year (12 months), so that the country of destination effectively becomes the new country of usual residence.

(adapted from the definition of “immigrant” by UN DESA)

<https://www.iom.int/key-migration-terms>



Introduction to migration studies

Data sources in migration studies

- Administrative data sources
 - Census data
- Statistical data sources
 - Survey data
- **Innovative data sources**
 - Digital trace data

(i.e., data generated — and collected —
as a by-product of our online activities)



Introduction to migration studies

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- Administrative data sources
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- **Innovative data sources**
 - Digital trace data

(i.e., data generated — and collected — as a by-product of our online activities)



The screenshot shows the homepage of the Max Planck Institute for Demographic Research. The header contains the institute's logo and name. A green arrow points from the 'Innovative data sources' section in the text above to this page. The main content area features a title for the 'Digital and Computational Demography (Zagheni)' department. A sidebar on the right provides links to various research groups and topics.

https://www.demogr.mpg.de/en/research_6120/digital_and_computational_demography_zagheni_11666/



Introduction to digital trace data in migration studies

Why do we use digital trace data?

- Traditional data are often **difficult, time-consuming, and costly** to collect.
- Traditional data sources are limited in hard-to-reach contexts and societies.
- Some populations (e.g., immigrants) are often underrepresented in traditional data sources.
- Even in “good-data” contexts, emigration is harder to register than immigration.



Introduction to digital trace data in migration studies

Advantages

- Detailed and rich information
- Can provide (almost) real-time data
- Less costly than traditional methods of data collection

Disadvantages

- Privacy and ethical concerns
- Biases



Examples of digital trace data that have been used in migration studies



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WIKIPEDIA
The Free Encyclopedia

Google Trends





Examples of digital trace data that have been used in migration studies



The impact of **Hurricane Maria** on **out-migration from Puerto Rico**: evidence from **Facebook** data. Alexander et al. (2019).

Which definition of migration better fits **Facebook ‘expats’**? A response using **Mexican census data**. Varona et al. (2024).

The interplay of **migration** and **cultural similarity** between countries: Evidence from **Facebook** data on food and drink interests. Coimbra Vieira et al. (2022).



The Value of Cultural Similarity for Predicting Migration: Evidence from Food and Drink Interests in Digital Trace Data. Coimbra Vieira et al. (2024).



Examples of digital trace data that have been used in migration studies



Openness to migrate internationally for a job: evidence from LinkedIn data in Europe. Perrotta et al. (2022).

Global gender gaps in the international migration of professionals on LinkedIn. Jacobs et al. (2024).

Using Facebook and LinkedIn data to study international mobility. Coimbra Vieira et al. (2022).



Examples of digital trace data that have been used in migration studies

Desaparecidxs: characterizing the population of **missing children** using **Twitter**. Coimbra Vieira et al. (2022).



Online social **integration of migrants**: evidence from **Twitter**. Kim et al. (2023).

Twitter data for **migration studies**. Kim et al. (2022).



Examples of digital trace data that have been used in migration studies

Miranda-González, A., Aref, S., Theile, T., & Zaghuni, E. (2020).

Scholarly migration within Mexico: Analyzing internal migration among researchers using Scopus longitudinal bibliometric data. *EPJ Data Science*, 9(1), 34.



Scopus®

Sanliturk, E., Zaghuni, E., Dańko, M. J., Theile, T., & Akbaritabar, A. (2023). **Global patterns of migration of scholars with economic development.** *Proceedings of the National Academy of Sciences*, 120(4).



Scholarly Migration Database
Quantifying the Mobility of Scholars

Zhao, X., Akbaritabar, A., Kashyap, R., & Zaghuni, E. (2023). **A gender perspective on the global migration of scholars.** *Proceedings of the National Academy of Sciences*, 120(10).



Examples of digital trace data that have been used in migration studies

Sanliturk, E., & Billari, F. C. (2025). **Search for a New Home: Refugee Stock and Google Search.** *International Migration Review*, 59(1), 61-89.

Böhme, M. H., Gröger, A., & Stöhr, T. (2020). **Searching for a better life: Predicting international migration with online search keywords.** *Journal of Development Economics*, 142.

Wikipedia as a tool for tracking mass migration flows: Insights from the **Russian invasion of Ukraine**. Coimbra Vieira et al. Working paper.



WIKIPEDIA
The Free Encyclopedia

Google Trends





Examples of digital trace data that have been used in migration studies



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GOOGLE TRENDS DATA IN MIGRATION STUDIES





WHAT IS GOOGLE TRENDS?

Google Trends is a tool by Google, that shows the **relative** interest over time and/or by subregion for any selected query, time period and location.

(Trends Help, 2021)

(see: https://support.google.com/trends/answer/4365533?hl=en&ref_topic=6248052)



WHAT DO GOOGLE TRENDS DATA TELL US?

- Interest for a selected query over time

Search interest for a topic as a proportion of all searches on all topics on Google at the specified time and location

- Interest for a selected query by subregions

Search interest for a topic by subregions as a proportion of all searches on all topics on Google in that same place and time.



WHAT DO GOOGLE TRENDS DATA TELL US?

- Google Trends **does not** report the overall search volume for a selected query.
Google Ads – Keyword Planner is meant for insights into monthly and average search volumes, specifically for advertisers to assess the size of the audience
(<https://support.google.com/google-ads/answer/6325025>)
- It gives us a measure of interest for a query normalized for the selected time and location.

(Trends Help, 2021)



GOOGLE TRENDS INDEX

- Google Trends normalizes search data to make comparisons between terms easier. Search results are normalized to the selected time and location of a query as follows;
 - “Each data point is divided by the total searches of the geography and time range it represents to compare relative popularity”
 - This process is necessary to avoid the places with the most search volume to always rank the highest.
 - “The resulting numbers are then scaled on a range of 0 to 100 based on a topic’s proportion to all searches on all topics”



GOOGLE TRENDS INDEX

- Different regions that show the same search interest for a term don't always have the same total search volumes.

- The parameters we enter matter. 100 indicates the maximum search interest for a query, only for the time and location selected. Shortening and extending the selected time period may change the minimum and maximum interest points.

- Time adjustment for non-real time data

GOOGLE TRENDS IN THE LITERATURE





GOOGLE TRENDS DATA IN LITERATURE

□ Epidemiology:

- Online search data to *nowcast* outbreaks (**Flu Trends!**)

(Ginsberg, et al., 2009) (Pelat, Turbelin, Bar-Hen, Flahault, & Valleron, 2009) (Brownstein, Freifeld, & Madoff, 2009)

□ Economics:

- Online search data to forecast unemployment rate, economic activity, inflation rate

(Ettredge, Gerdes, & Karuga, 2005) (Askitas & Zimmermann, 2009) (Choi & Varian, 2009)
(Guzman, 2011)



GOOGLE TRENDS DATA IN DEMOGRAPHY LITERATURE

□ Demography

- Online search data to *forecast* abortions, fertility behaviour, suicides and causes of mortality

(Reis & Brownstein, 2010)

(Billari, D'Amuri & Marcucci, 2016)

(Wilde, Chen & Lohmann, 2020)

(McCarthy, 2010)

(Song, et al., 2014)

(Chang, Kwok, Cheng, Yip, & Chen, 2015)

(Solano, et al., 2016)

(Ricketts & Silva, 2017)



GOOGLE TRENDS DATA IN MIGRATION CONTEXT

□ How do the Google Trends data help us in the migration context?

Main assumptions

Migration

- Online searches show interest in potential destinations
- Interest in a destination may be a proxy for migration intention

Forced migration

- People on the move need information
- We look for significant divergences from regular search patterns



GOOGLE TRENDS DATA IN MIGRATION STUDIES

□ Use in migration research

- Estimating migration flows
- Estimating migration stocks
- Now-casting and forecasting



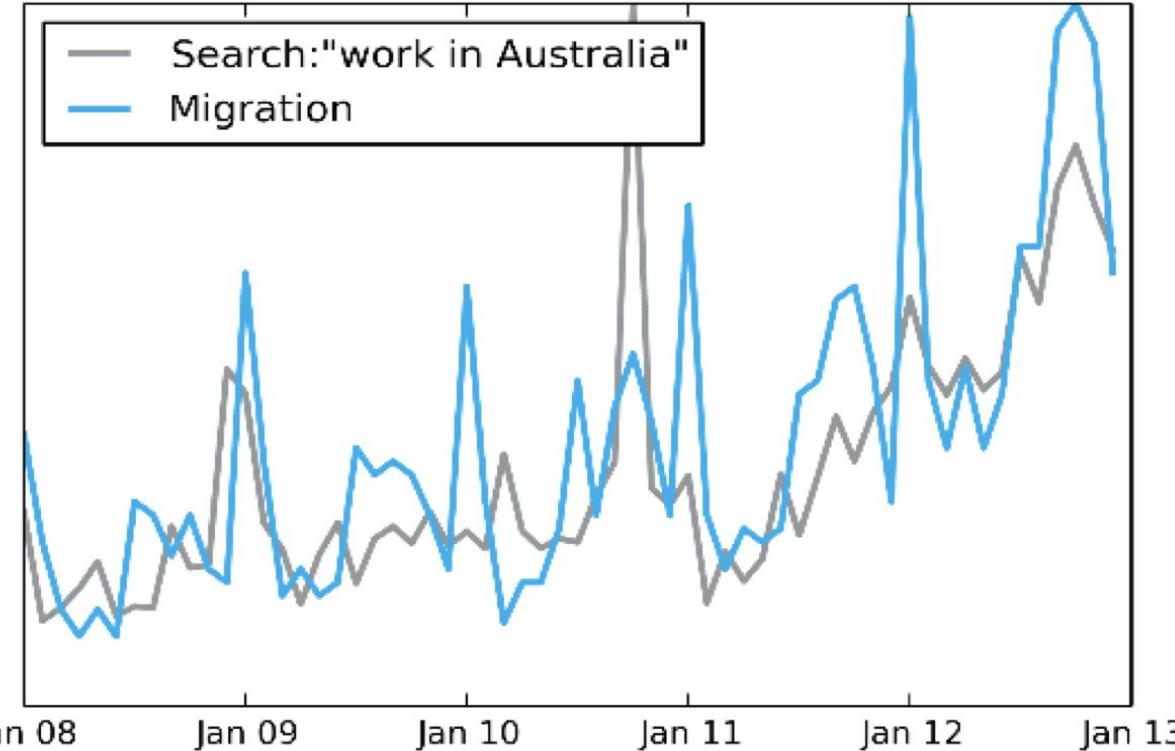
GOOGLE TRENDS DATA IN MIGRATION STUDIES LITERATURE

- Migration from Latin America to Spain & Google search (Wladyka, 2013)
- UN Global Pulse 2014 – Estimating migration flows using online search data
- Internal migration & Bing search (Lin, Cranshaw & Counts, 2019)
- Syrian refugees & Google search (Connor, 2017)
- Predicting international migration with online search keywords (Böhme, Gröger & Stöhr, 2020)
- Now-casting Romanian migration into the United Kingdom by using Google Search engine data (Avramescu & Wiśniowski, 2021).
- Refugees from Ukraine in Lithuania and the Lithuanian labour market: A preliminary assessment (Deimantas & Sanliturk, 2023)



UN Global Pulse
(2014), p.13

- **Online search as proxy for migration statistics:** The results of this study demonstrate the potential for online search volumes to be used as proxy for migration statistics. This implies that people interested in migrating conduct online searches to explore employment just prior to migrating, and thus search data could be used as proxy for intent to migrate.

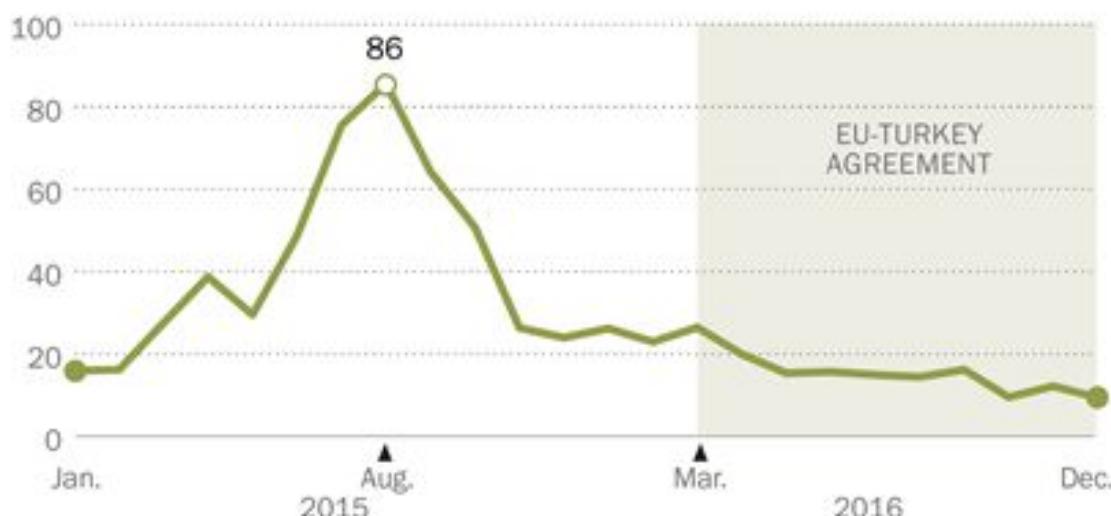


The graph above shows the trend in actual migration from Italy to Australia from January 2008 to December 2013 (blue line) and Google search activity from Italy for the query 'work in Australia' (grey line). The correlation value for migration from Italy to Australia with search query 'work in Australia' is $r=0.74$, $p<0.001$.



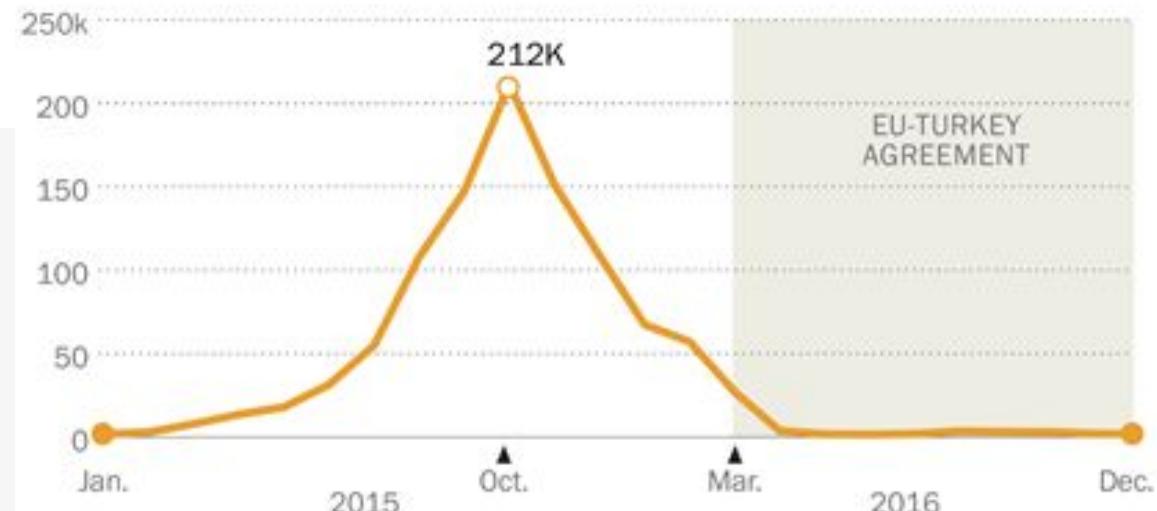
Surge of Arabic searches for ‘Greece’ in Turkey preceded surge in refugees arriving in Greece

Google Trends: Relative volume of Arabic-language Google searches for “Greece” by users in Turkey



Connor. (2017), Pew Research Center

Monthly arrivals (in thousands) of migrants into Greece



Note: Google trends data do not indicate the number of searches but instead are standardized data, displaying the relative change in searches over the time period on a 0 to 100 scale. Google trends are monthly averages based on weekly volume. Search data are for the term “Greece” in Arabic (اليونان). Arrivals into Greece are for all nationalities, not only Arabic speakers. See methodology for more details.

Sources: Pew Research Center analysis of Google Trends (accessed on March 3, 2016, at 1:17 p.m.) and United Nations High Commissioner for Refugees (UNHCR) data, accessed March 13, 2017.

“The Digital Footprint of Europe’s Refugees”

PEW RESEARCH CENTER

Table 1
List of main keywords.



English	French	Spanish
applicant	candidat	solicitante
arrival	arrivee	llegada
asylum	asile	asilo
benefit	allocation sociale	beneficio
border control	controle frontiere	control frontera
business	entreprise	negocio
citizenship	citoyennete	ciudadania
compensation	compensation	compensacion
consulate	consulat	consulado
contract	contrat	contrato
customs	douane	aduana
deportation	expulsion	deportacion
diaspora	diaspora	diaspora
discriminate	discriminer	discriminar
earning	revenu	ganancia
economy	economie	economia
embassy	ambassade	embajada
emigrant	emigre	emigrante
emigrate	emigrer	emigrar
emigration	emigration	emigracion
employer	employer	empleador
employment	emploi	empleo
foreigner	etrangeur	extranjero
GDP	PIB	PIB
hiring	embauche	contratacion
illegal	illegal	illegal
immigrant	immigre	inmigrante
immigrate	immigrer	inmigrar
immigration	immigration	inmigracion
income	revenu	ingreso
inflation	inflation	inflacion
internship	stage	pasantia
job	emploi	trabajo
labor	travail	mano de obra
layoff	licenciemment	despido

UNDERSTANDING GOOGLE TRENDS DATA IN MIGRATION CONTEXT





GOOGLE TRENDS – UNDERSTANDING THE DATA

- Google Trends, while a big data source in itself, limits our access to aggregated and normalized data
- Google Trends gives us a proxy for the intended behavior, i.e. in the case of migration studies intention to move
- Google Trends allows us to form variable for intention to move measured at any given location and any given time
 - as known as Search Popularity Index or Google Trends Index



OVERLOOK AT GOOGLE TRENDS DATA

- Data does not show the volume of Google searches but its popularity.
- Calculated and normalized by Google
- Data are anonymized, categorized, and aggregated.
- Sample data



OVERLOOK AT GOOGLE TRENDS DATA

- There are two types of Google Trends data that can be accessed:
- Real-time data covering the last seven days.
 - Time unit: hour
- Non-real time data (a separate sample from real-time data)
 - Between 2004 and up to 36 hours prior



GOOGLE TRENDS – DATA PROCESSING

- Google processes data prior to reporting Google Trends output.
- The data pre-processing includes;
 - filtering irregular activities (some may still remain),
 - sampling,
 - placing thresholds



GOOGLE TRENDS – DATA PROCESSING

- Google Trends data excludes;
- Search terms with low volume that cannot pass the threshold (appear as "0")
- Repeated searches from the same person over a short period of time as irregular activity.
- Queries with apostrophes and other special characters.

(Trends Help, 2021)



REPRESENTATIVENESS

- Google Trends output is calculated based on a representative sample instead of the entire volume of Google searches. This is due to the too big volume of Google searches, exceeding billions of searches per day.
- We don't know the exact sampling methodology used by Google.

- Even if you search for trends using the same parameters, you may get very slightly different results, due to the sample. These are statistically not significant – but can do a robustness check.



REPRESENTATIVENESS

- Beware of the representation bias while using digital trace data
- Google usage is mostly more widespread than use of a certain social media outlet, but is still bound by the same limitations
- In statistical analyses using an adjustment factor is encouraged
 - such as the Google search engine market share or internet penetration rate



NON-REAL TIME DATA – REPORTING

□ Time unit of non-real time data reporting depends on the selected time period

- Up to 7 days hourly data
- **Up to 9 months** daily data
- Up to 5 years weekly data
- + 5 years monthly data

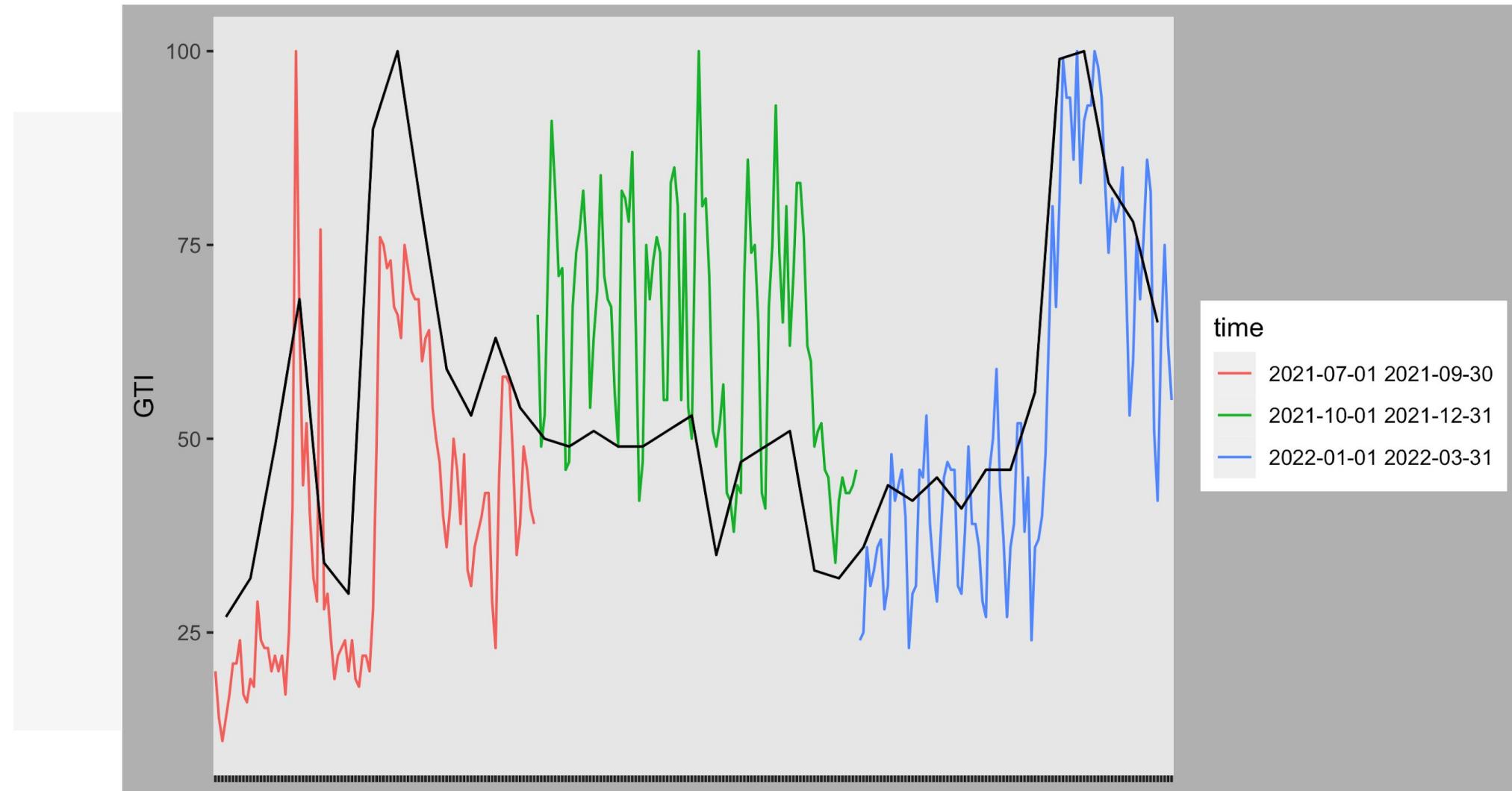


EXTENDING THE TIME PERIOD

- If we need daily data for longer than 9 months or weekly data for longer than 5 years, we need to download them separately.
- Normalization problem
- Google Trends normalizes the data for the given time period. Merging different time periods requires additional adjustments or normalization.



MERGED DAILY DATA



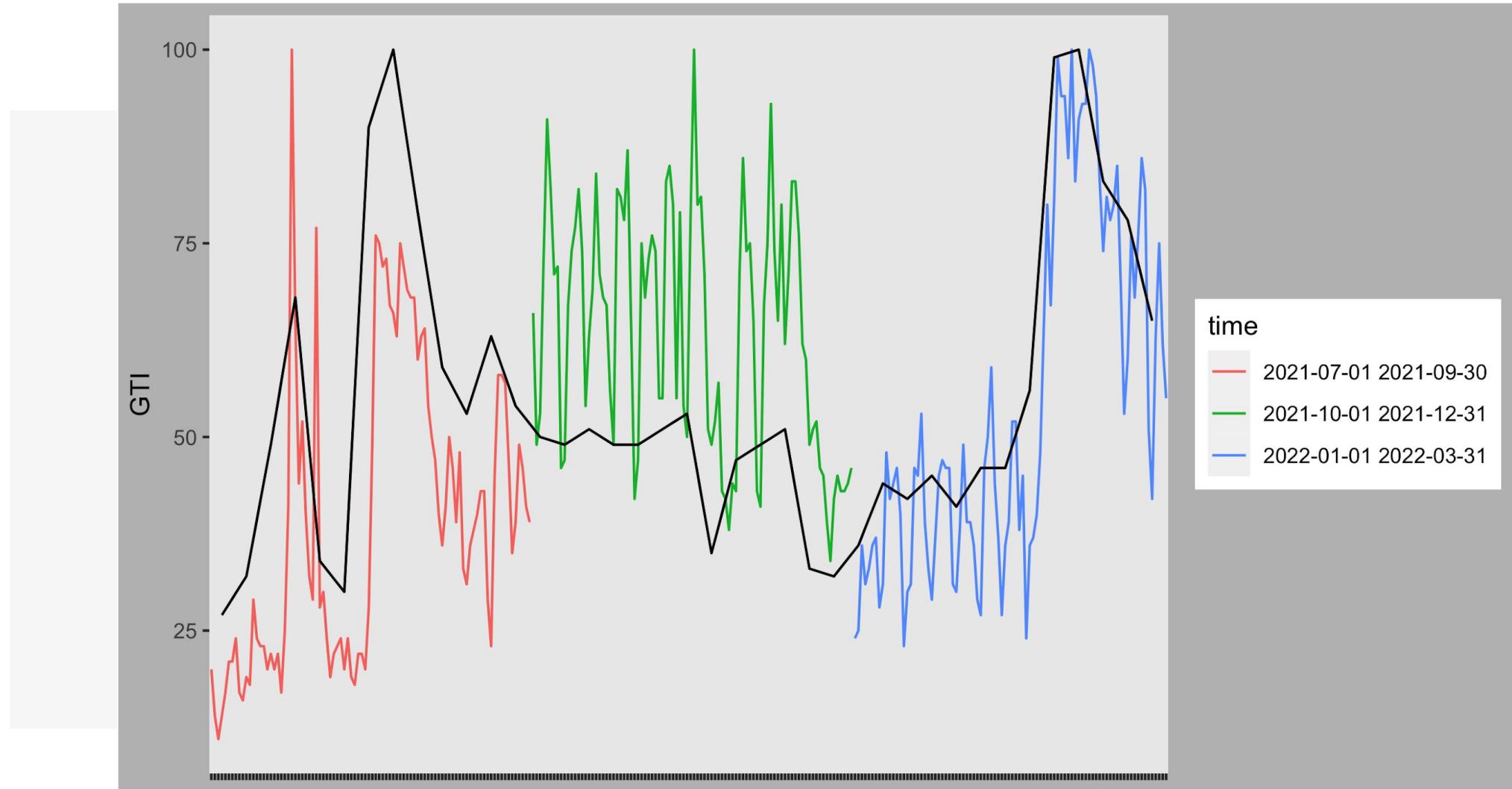


EXTENDING THE TIME PERIOD

- Create an adjustment factor
 - Combine daily (or weekly) data sets
 - Download weekly (or monthly) data set for the same time period
 - Calculate the adjustment factor by the overlapping dates and apply the adjustment to the daily data of the same week (weekly data of the same month)
 - (Johansson, 2014; Risteski & Davcev, 2014)
 - Rescale to 0-100 range

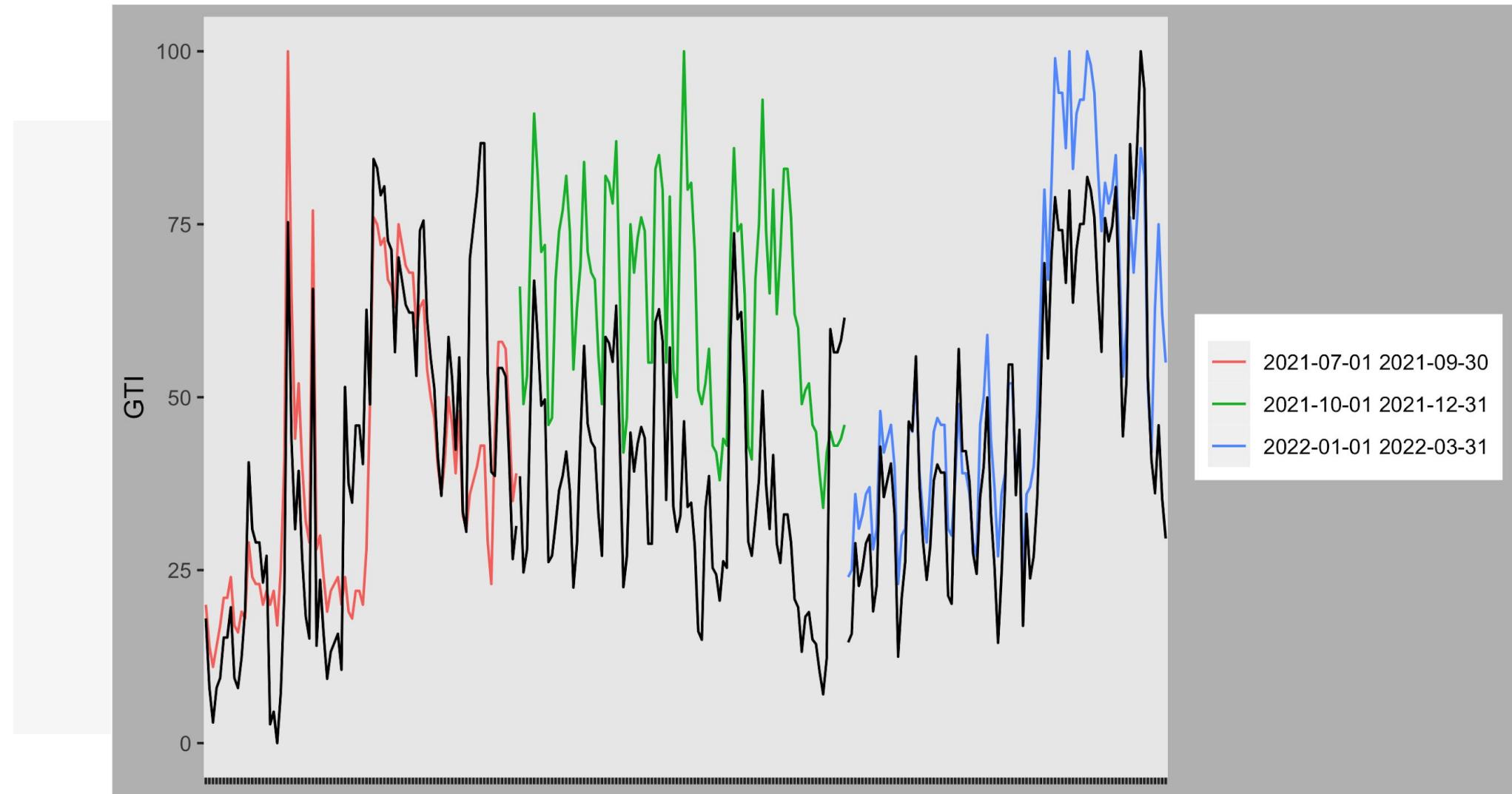


EXTENDING THE TIME PERIOD





EXTENDING THE TIME PERIOD



USING ON GOOGLE TRENDS DATA





HOW TO MAKE A QUERY

Search term	Results
tennis shoes	<p>Results can include searches containing both tennis and shoes in any order. Results can also include searches like "red tennis shoes," "funny shoes for tennis," or "tennis without shoes."</p> <p>No misspellings, spelling variations, synonyms, plural, or singular versions of your terms are included.</p>
"tennis shoes"	<p>Results include the exact phrase inside double quotation marks, possibly with words before or after, like "red tennis shoes."</p>
tennis + squash	<p>Results can include searches containing the words "tennis" OR "squash."</p>
tennis -shoes	<p>Results include searches containing the word "tennis," but exclude searches with the word "shoes."</p>
center + centre + centere	<p>Results include alternative spellings like "centre" or "centere," and common misspellings like "centere." Trends considers each version of a word a different search, including misspellings.</p>

Google. (2022), Trends Help: Search Tips for Trends, https://support.google.com/trends/answer/4359582?hl=en&ref_topic=4365530

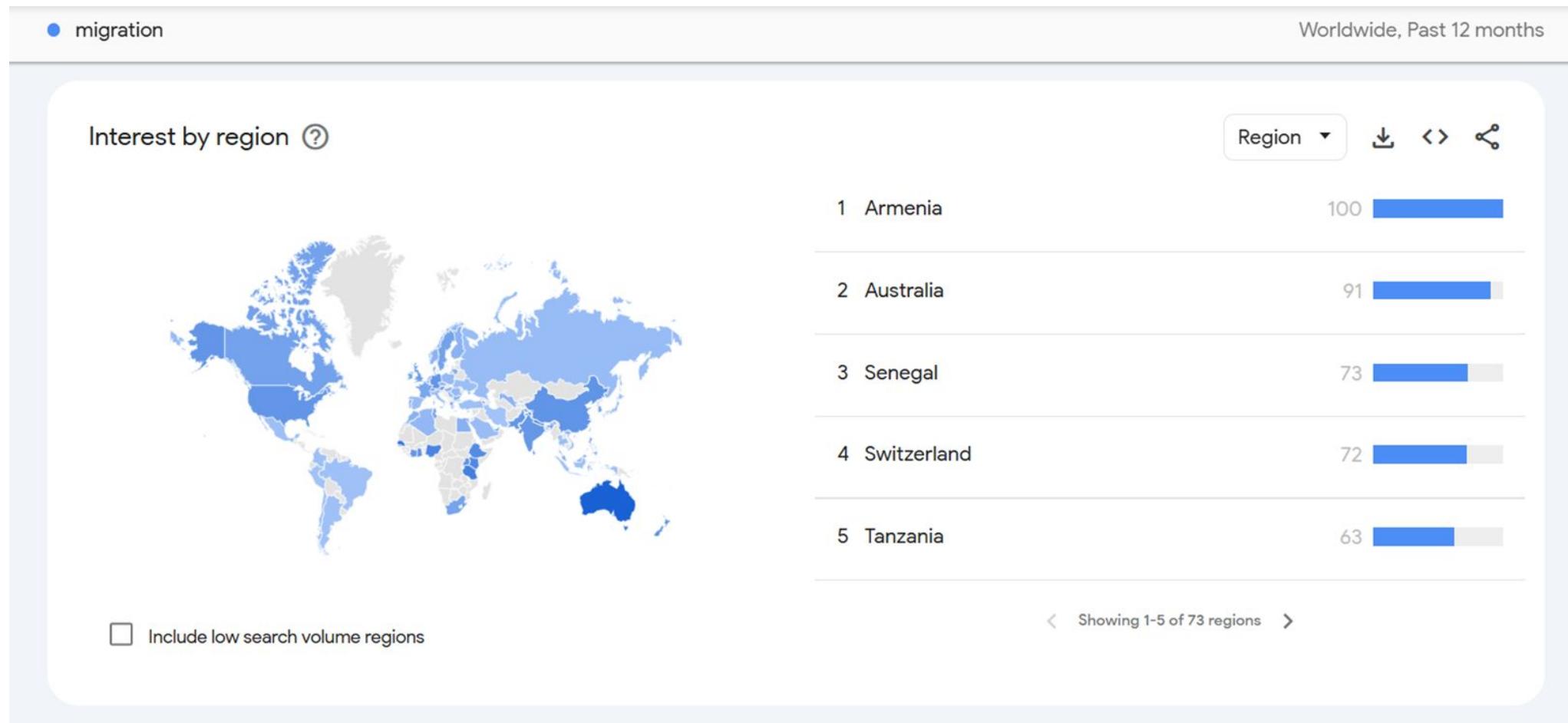


HOW TO MAKE A QUERY

- Being more specific with selected keywords helps narrow down the focus to the matter of interest
- When you determine the parameters, download the data using *gtrendsR* package by Massicotte & Eddelbuettel (or *pytrends* on Python)
 - For further information, see <https://github.com/PMassicotte/gtrendsR>

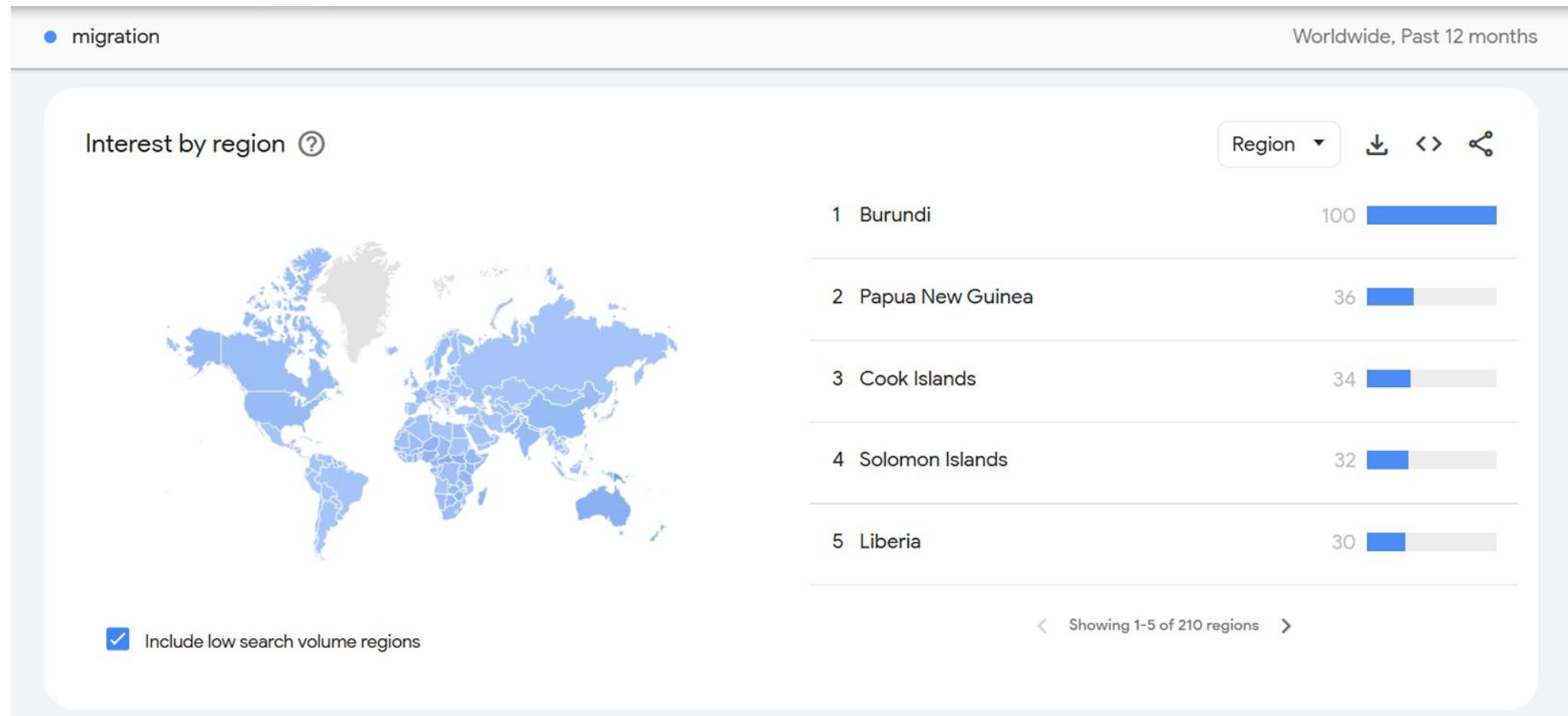


GOOGLE TRENDS VISUALIZATION





GOOGLE TRENDS VISUALIZATION





TOPICS?

Related topics [?](#)

Rising [▼](#)



- | | | | |
|---|--------------------------------|---------|-------------------|
| 1 | Migration - Ecology | +1,600% | ⋮ |
| 2 | Academic certificate - Topic | +400% | ⋮ |
| 3 | Immigration consultant - Topic | +160% | ⋮ |
| 4 | Universal Credit - Topic | +110% | ⋮ |
| 5 | Whale - Animal | +80% | ⋮ |

[◀](#) Showing 1-5 of 9 topics [▶](#)

Related queries [?](#)

Rising [▼](#)



- | | | | |
|---|--------------------------------|----------|-------------------|
| 1 | hummingbird migration 2025 | Breakout | ⋮ |
| 2 | hummingbird migration map 2025 | Breakout | ⋮ |
| 3 | whale migration fisch | Breakout | ⋮ |
| 4 | orca migration fisch | Breakout | ⋮ |
| 5 | sweden great moose migration | Breakout | ⋮ |

[◀](#) Showing 1-5 of 25 queries [▶](#)

ALTERNATIVES?





YANDEX KEYWORD STATISTICS

- Useful for research on Russian-speaking communities
- Used in several countries apart from Russia, but Google is clearly the market leader
- <https://wordstat.yandex.com>



YANDEX KEYWORD STATISTICS

- Monthly data for 2 years, weekly data for 1 year
- Custom date selection is not possible
- Provides absolute numbers of searches as well as relative figures
- Provides a distinction between searches made on all and mobile devices



YANDEX KEYWORD STATISTICS

[Direct](#) [Directory](#) [Metrica](#) [Advertising Network](#) [Market](#) [more](#)

[Logout](#)



migration

By keyword

By region

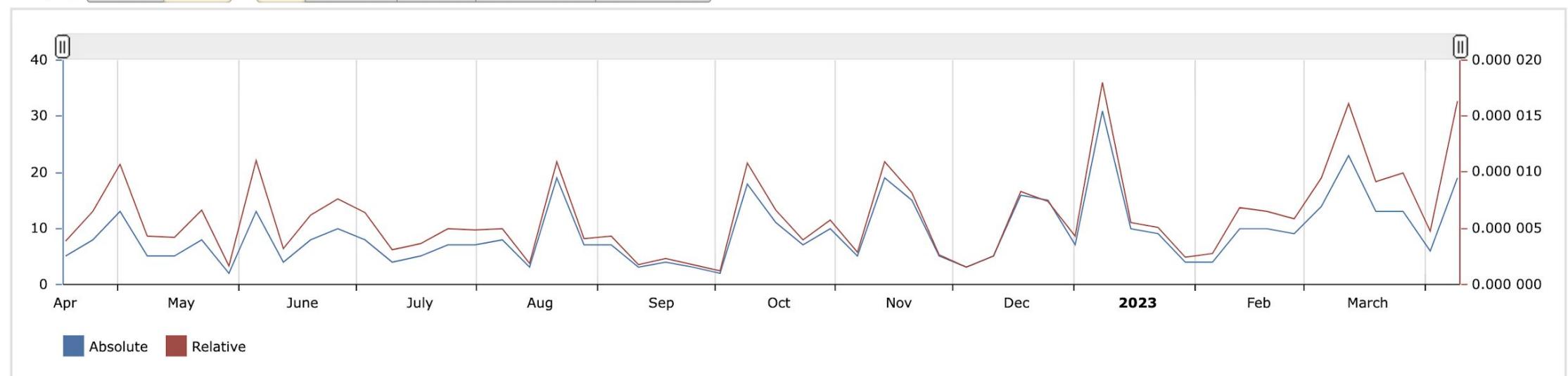
Query history

United Kingdom

[Submit](#)

Impressions history for keyword "migration"

Group by: [month](#) [week](#) [All](#) [Desktop](#) [Mobile](#) [Phones only](#) [Tablets only](#) [?](#)

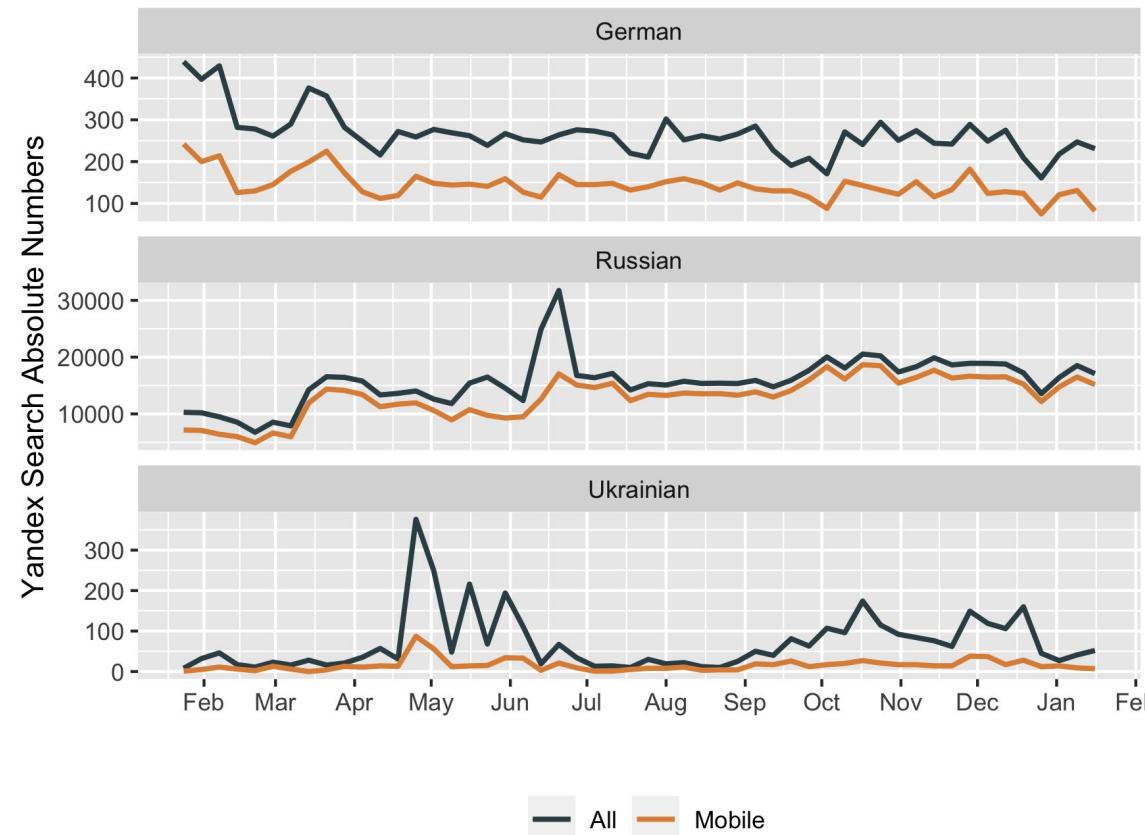


Period	Absolute	Relative	Period	Absolute	Relative
11.04.2022 - 17.04.2022	5	0.000 003 859 177	10.10.2022 - 16.10.2022	11	0.000 006 683 209
18.04.2022 - 24.04.2022	8	0.000 006 478 142	17.10.2022 - 23.10.2022	7	0.000 003 924 607
25.04.2022 - 01.05.2022	13	0.000 010 695 592	24.10.2022 - 30.10.2022	10	0.000 005 731 116
02.05.2022 - 08.05.2022	5	0.000 004 285 441	31.10.2022 - 06.11.2022	5	0.000 002 855 059

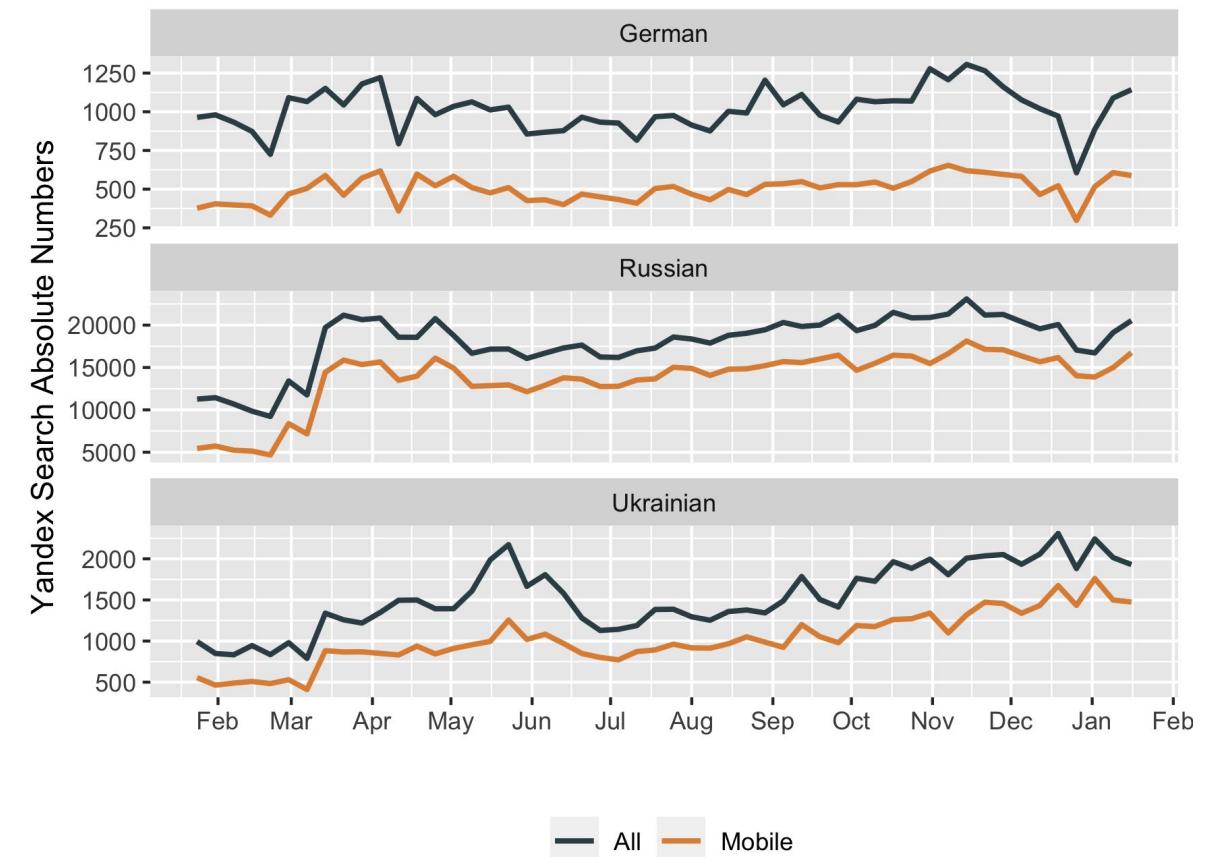


YANDEX KEYWORD STATISTICS

Health-related keywords



Job-related keywords

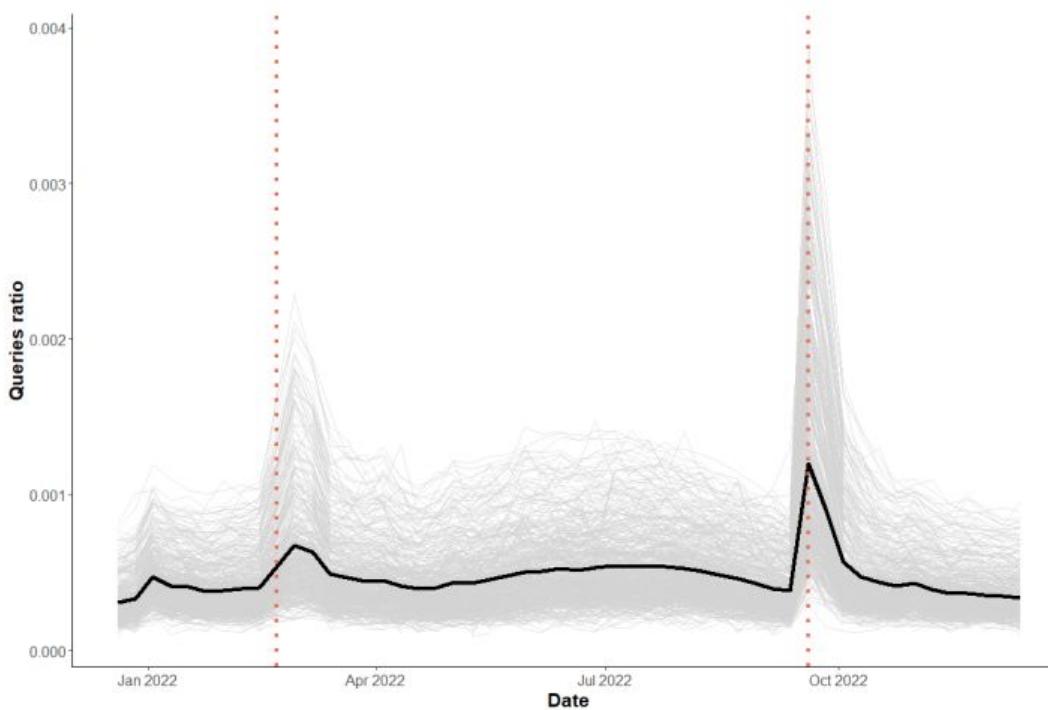




YANDEX KEYWORD STATISTICS

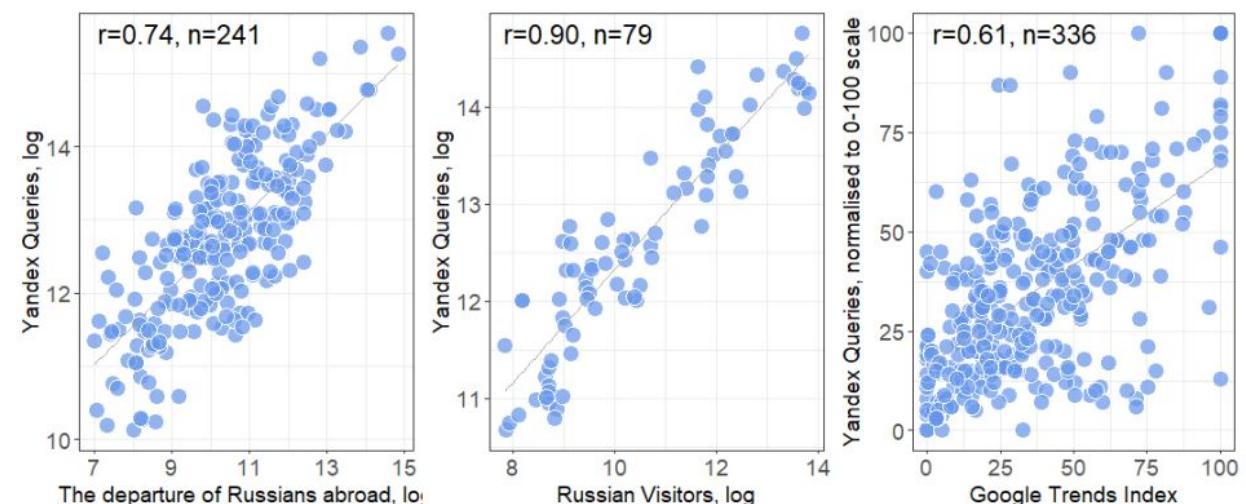
Demographic Research: Volume 50, Article 8

Figure 1: Mobility-related internet searches across Russia



Note: Mobility-related searches (share of total weekly searches) performed at the city level (grey lines) in Russia and their average (black line). Red dots indicate February 24, 2022 (beginning of the full-scale invasion) and September 21 (beginning of mobilization).

Figure 3: Correlations between Yandex web searches and other mobility indicators



Note: Correlations between total mobility-related searches on Yandex and departures of Russians abroad, border crossings into selected destination countries, and respective Google Trends Indices indicate that Yandex web searches are a reasonable proxy for measuring migration intentions, similar to Google Trends. The left plot shows the number of departures of Russians abroad in each quarter from 2020 Q4 to 2022 Q3 for each potential destination country in our sample and the corresponding quarterly number of Yandex searches for those countries.

The middle plot shows the monthly number of Russian visitors to Turkey, Georgia, and Serbia from January 2021 to November 2022 and the corresponding monthly number of Yandex searches for those countries.

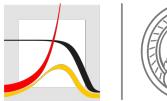
The right plot depicts the monthly value of the Google Trends Index for mobility-related queries in each country in the sample from December 2020 to November 2022 and the corresponding monthly number of Yandex searches for those countries normalized within the country.



BING SEARCH?

- See:
 - Lin, A. Y., Cranshaw, J., & Counts, S. (2019). Forecasting US Domestic Migration Using Internet Search Queries. Proceedings of the 2019 World Wide Web Conference (WWW'19), (pp. 13-17).

WIKIPEDIA DATA FOR MIGRATION STUDIES

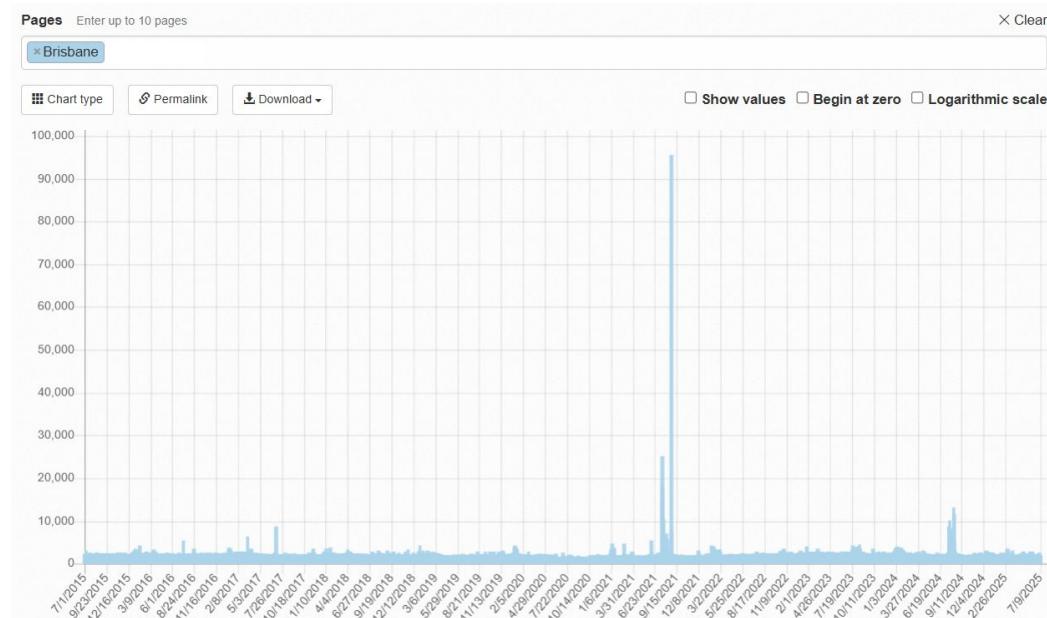




Wikipedia data

Wikipedia Pageviews: <https://pageviews.wmcloud.org/>

Provides **daily view counts** for each **Wikipedia page** of interest across all available languages, starting **from July 2015**.



WIKIPEDIA

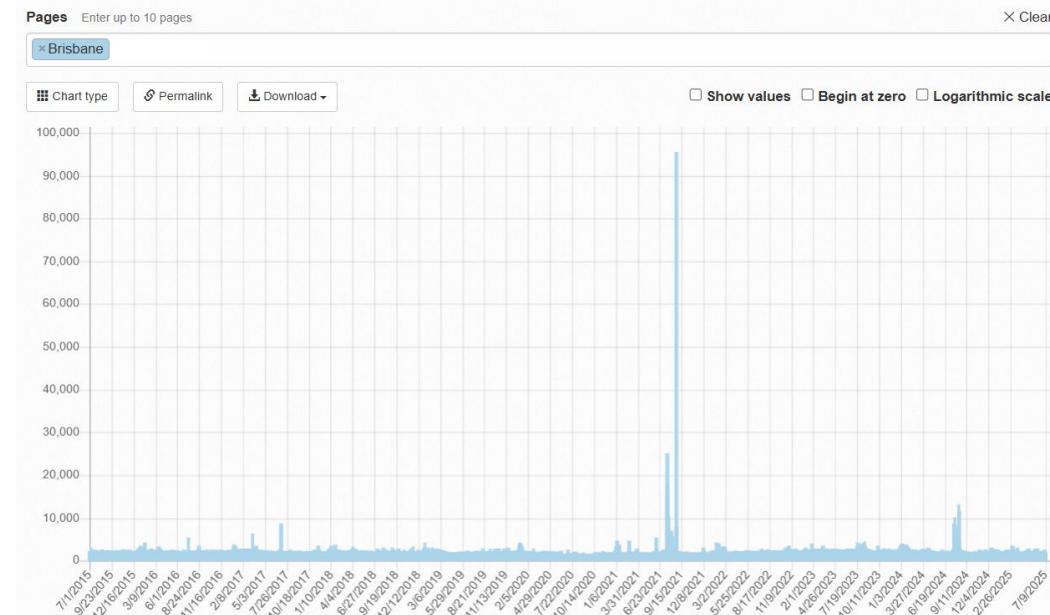


Wikipedia data

Wikipedia Pageviews: <https://pageviews.wmcloud.org/>

Provides **daily view counts** for each **Wikipedia page** of interest across all available **languages**, starting **from July 2015**.

This data do not have the location where the views come from. Language is used as a proxy for origin.



WIKIPEDIA



Langviews Analysis

Pageviews of a page across all languages

Dates	Source project	Platform	Agent
7/1/2015 - 4/14/2025	en.wikipedia.org	All	User
Page			
Star Wars	<input type="button" value="Submit"/>		

Langviews Analysis

Pageviews of a page across all languages

[◀ Do another query](#)

Brisbane 7/1/2015 - 7/9/2025

List

Chart

[🔗 Permalink](#)

[⬇️ Download ▾](#)

#	Language	Page title	Badges	Pageviews ↓ [?]	Daily average
Totals	144 languages	49 unique titles	 × 1,  × 1, × 1	15,177,701	4,145
1	en	Brisbane		8,355,192	2,282
2	de	Brisbane		873,404	239
3	es	Brisbane		720,433	197
4	zh	布里斯班		686,026	187
5	ja	ブリスベン		676,842	185

Langviews Analysis

Pageviews of a page across all languages

◀ Do another query

Brisbane 7/1/2015 - 7/9/2025

🔗 Permalink

⬇️ Download ▾

#	Language	Page title	Pageviews ↓ ^z	Daily average
Totals	144 languages	49 unique titles	15,177,701	4,145
1	en	Brisbane	8,355,192	2,282
2	de	Brisbane	873,404	239
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4	zh	布里斯班	686,026	187
5	ja	ブリスベン	676,842	185

▼ array [144]

▼ 0 {9}

▼ data [3662]

0 : 2086

1 : 2104

2 : 2032

3 : 2056

4 : 2445

5 : 3015

6 : 2370

7 : 2492

Wikipedia page about Brisbane is available in 144 languages

For each language, each data point corresponds to the number of views for the Wikipedia page about Brisbane in language L on the date D.



How could we use Wikipedia data to study migration?



Context

Imagine a situation of **crisis**, such as conflicts or war, resulting in **large-scale migration** of people.



Context

Imagine a situation of **crisis**, such as conflicts or war, resulting in **large-scale migration** of people.

...who **seek for information** quickly and efficiently to **decide where to go**

and receive all the **support** they need at the **destination**.



Context

Imagine a situation of **crisis**, such as conflicts or war, resulting in **large-scale migration** of people.

...who **seek for information** quickly and efficiently **to decide where to go**

and receive all the **support** they need at the **destination**.

There is a growing literature that claims that **online sources of information** are used during their journey and after arriving at the destination, as important sources of information.

(Zimmer and Scheibe, 2020; Merisalo and Jauhainen, 2020)



Hypothesis

While **moving** and right after crossing the border out of their countries, refugees might **search** for places to move in to.



Hypothesis

While **moving** and right after crossing the border out of their countries, refugees might **search** for places to move in to.

In this study, we aim to shed light on the relationship between **refugee flows** and **online sources of information (Wikipedia*)**



* Wikipedia free online encyclopedia and a worldwide well-known source of information.

WIKIPEDIA

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(Top)

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Warsaw

[Article](#) [Talk](#)[Read](#) [Edit](#) [View history](#) [Tools](#) ▾

From Wikipedia, the free encyclopedia

Coordinates: 52°13'48"N 21°00'40"E

*For other uses, see [Warsaw \(disambiguation\)](#).**Several terms redirect here. For other uses, see [Warszawa \(disambiguation\)](#), [Warschau \(disambiguation\)](#), and [City of Warsaw \(disambiguation\)](#).*

Warsaw,^[a] officially the **Capital City of Warsaw**,^{[6][b]} is the **capital** and **largest** city of Poland. The metropolis stands on the [River Vistula](#) in east-central Poland. Its population is officially estimated at 1.86 million residents within a greater metropolitan area of 3.1 million residents, which makes Warsaw the 6th most populous city in the European Union.^[2] The city area measures 517 km² (200 sq mi) and comprises 18 districts, while the metropolitan area covers 6,100 km² (2,355 sq mi).^[7] Warsaw is an alpha global city,^[8] a major cultural, political and economic hub, and the country's seat of government. It is also capital of the [Masovian Voivodeship](#).

Warsaw traces its origins to a small fishing town in [Masovia](#). The city rose to prominence in the late 16th century, when [Sigismund III](#) decided to move the Polish capital and his royal court from [Kraków](#). Warsaw served as the de facto capital of the [Polish–Lithuanian Commonwealth](#) until 1795, and subsequently as the seat of [Napoleon's Duchy of Warsaw](#). The 19th century and its [Industrial Revolution](#) brought a demographic boom which made it one of the largest and most densely populated cities in Europe. Known then for its elegant architecture and boulevards, Warsaw was [bombed](#) and [besieged](#) at the start of [World War II](#) in 1939.^{[9][10][11]} Much of the historic city was destroyed and its diverse population decimated by the [Ghetto Uprising](#) in 1943, the general [Warsaw Uprising](#) in 1944 and systematic razing.

Warsaw is served by two international airports, the busiest being [Warsaw Chopin](#) and the smaller [Warsaw Modlin](#) intended for low-cost carriers. Major public transport services operating in the city include the [Warsaw Metro](#), [buses](#), [commuter rail service](#) and an extensive [tram network](#). The city is a significant centre of research and development, [business process outsourcing](#), and [information technology outsourcing](#). The [Warsaw Stock Exchange](#) is the largest and most important in Central and Eastern Europe.^{[12][13]} [Frontex](#), the European Union agency for external border security, and [ODIHR](#), one of the principal institutions of the Organization for Security and Co-operation in Europe, have their headquarters in Warsaw. As of 2022, Warsaw has one of the highest number of skyscrapers in Europe while [Varso Place](#) is the tallest building in the European Union.

Warsaw
Warszawa (Polish)
Capital city and county
Capital City of Warsaw Polish: <i>miasto stołeczne Warszawa</i>



Warsaw business district

Royal Castle and
Sigismund's ColumnNicolaus Copernicus
Monument

Łazienki Park

Main Market Square



Варшава [ред. | ред. код]

239 мов ▼

Зміст сховати

Вступ

Етимологія

Географія

Історія

Демографія

Уряд

Економіка

Освіта

Культура

Транспорт

Українці у Варшаві

Відомі варшав'яни

Галерея

Міста-побратими

Стаття

Обговорення

Читати

Редактувати

Редактувати код

Переглянути історію

Інструменти ▼

Матеріал з Вікіпедії — вільної енциклопедії.

Варшава (пол. Warszawa), офіційно **столичне місто**

Варшава (пол. miasto stołeczne Warszawa) — столиця

Польщі з 1596 року, порт на річці Вісла,

адміністративний центр Мазовецького воєводства.

Місто є місцем розташування центральних органів

влади Республіки Польща, іноземних місій, штаб-

квартир значної кількості підприємств та громадських

об'єднань, що працюють в Польщі.

Варшава з населенням 1 860 281^[20] жителів є найбільшим містом Польщі й утворює другу найбільшу агломерацію в країні (після Катовицької конурбації).

Розвинені **машинобудування** (автобудування, електротехнічне та ін.), металообробка і металургія,



Зовнішній вигляд

сховати

Текст

Малий

Стандартний

Великий

Ширина

Стандартний

Широкий

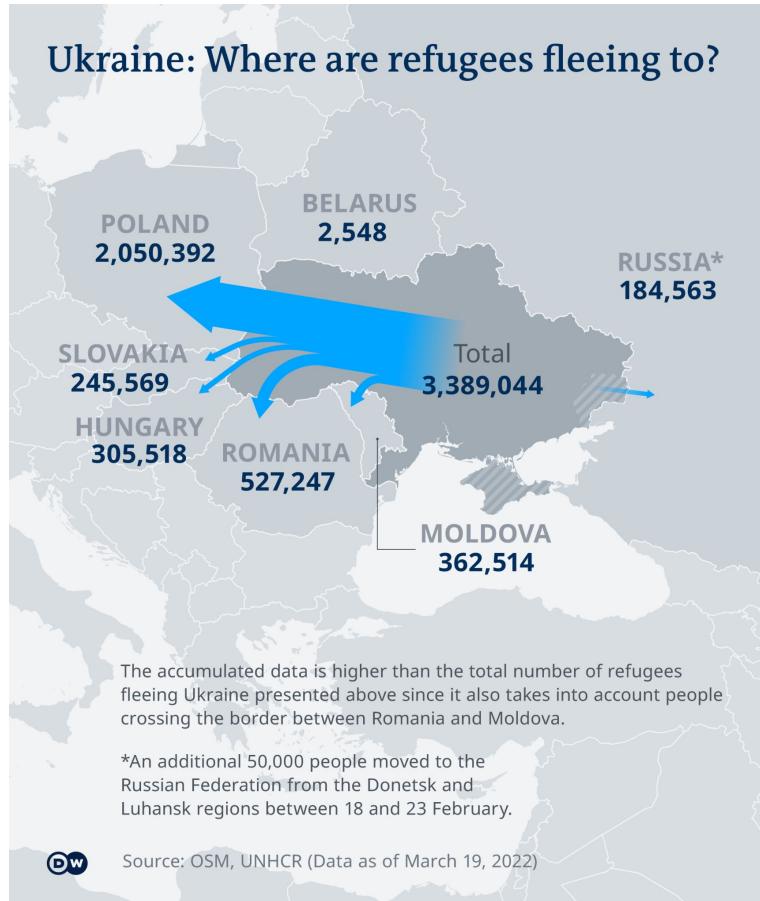
Кольорова тема (бета)

Автоматична

Світла

Темна

Case study:



The Ukrainian refugee crisis in 2022

~ 6.5 million Ukrainian refugees recorded globally.
Poland has welcomed the greatest number (~ 60%) of Ukrainian refugees.

Research questions:

RQ1: How has the Ukrainian refugee crisis affected the information-seeking behavior on Wikipedia?

RQ2: What is the temporal relationship between the information-seeking behavior on Wikipedia and Ukrainian refugee flows?

Datasets

Wikipedia Pageviews data: daily number of views on Wikipedia pages about European capitals and the most populous cities in Poland

United Nations High Commissioner for Refugees (UNHCR) data:
Europe: total number of Ukrainian refugees in European countries as of October 2023

Poland:

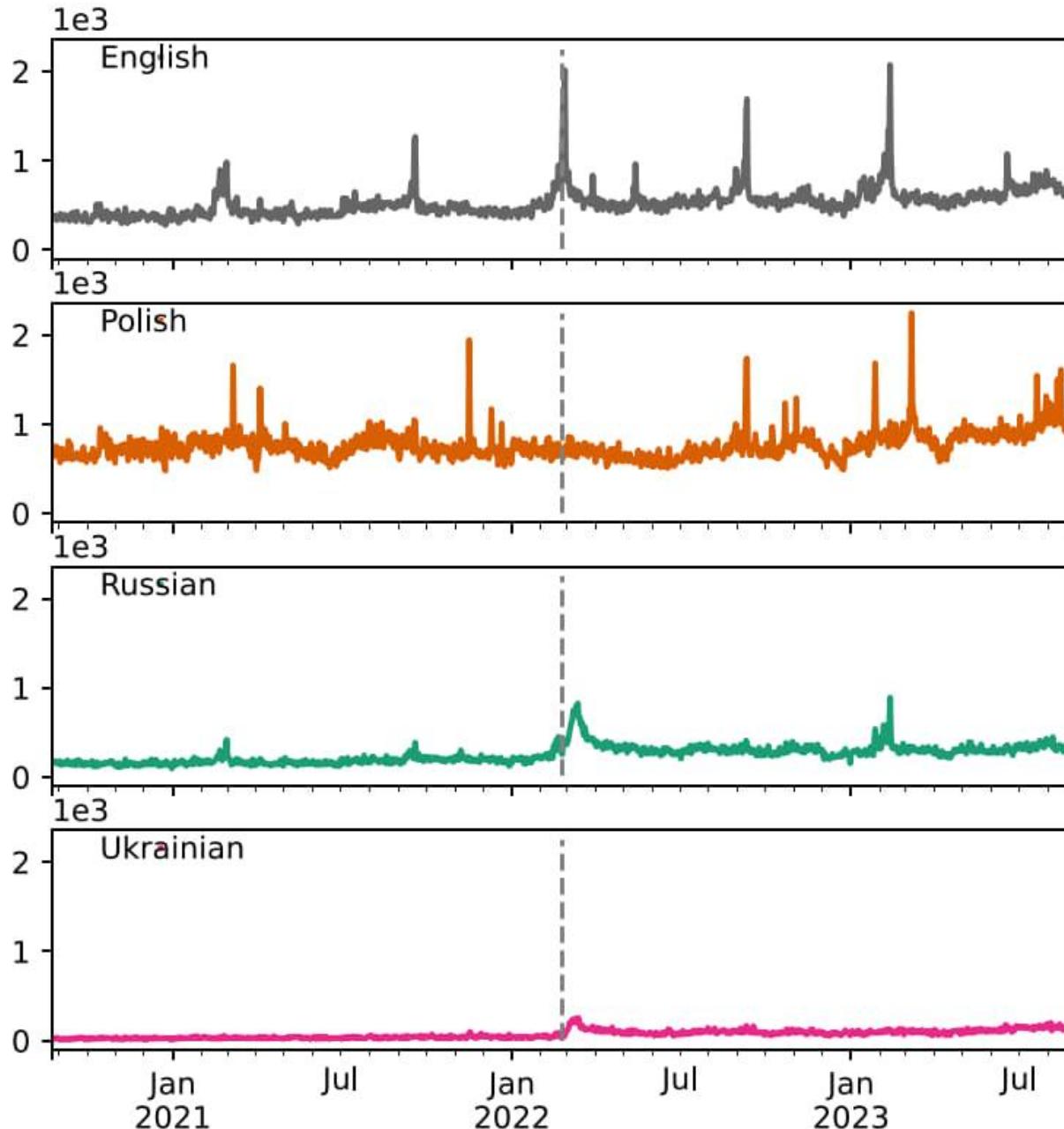
daily number of Ukrainian refugees crossing the border to Poland
since February 24th, 2022

(weekly) number of Ukrainian refugees who have been assigned a PESEL residence registration number in Polish cities since April 2022

Data: Wikipedia Pageviews

Daily number of views on
Wikipedia pages about:

- European capitals and
- the 19 most populous cities in Poland



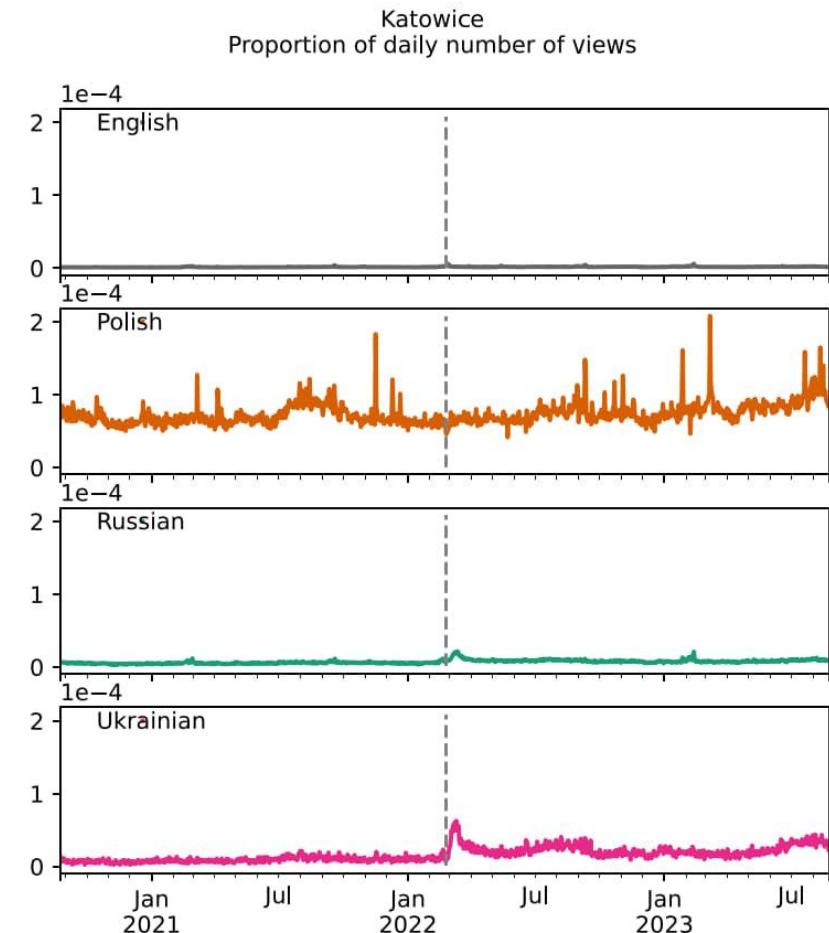
Data: Wikipedia Pageviews

Daily number of **views on Wikipedia pages about European capitals and the 19 most populous cities in Poland.**

Normalization process:

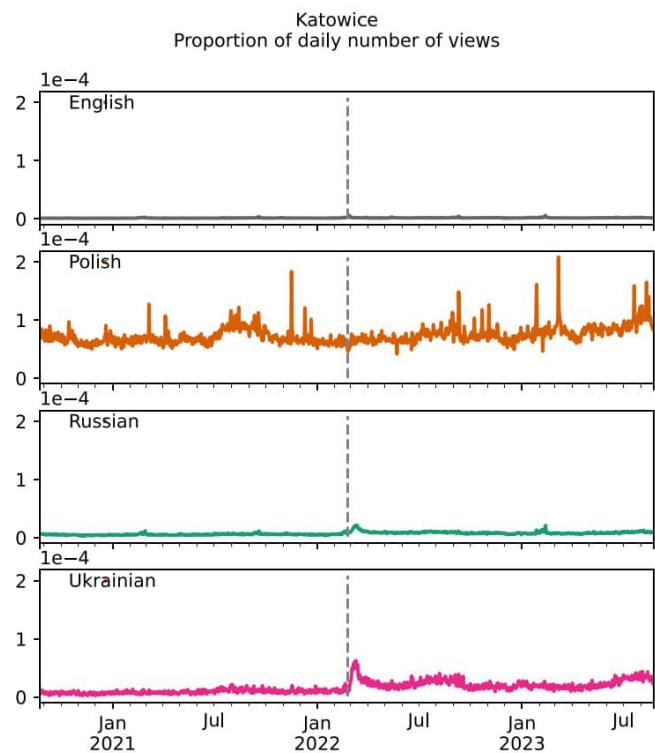
$$\frac{\text{\# daily views (page P, language L)}}{\text{\# daily views (language L)}}$$

Proportion of the daily number of views on Wikipedia pages across different languages.



Relative change Wikipedia Pageviews

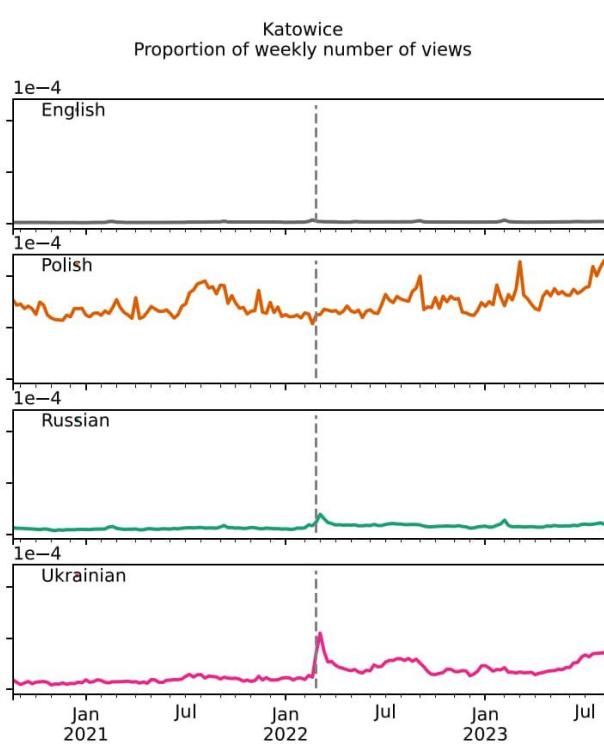
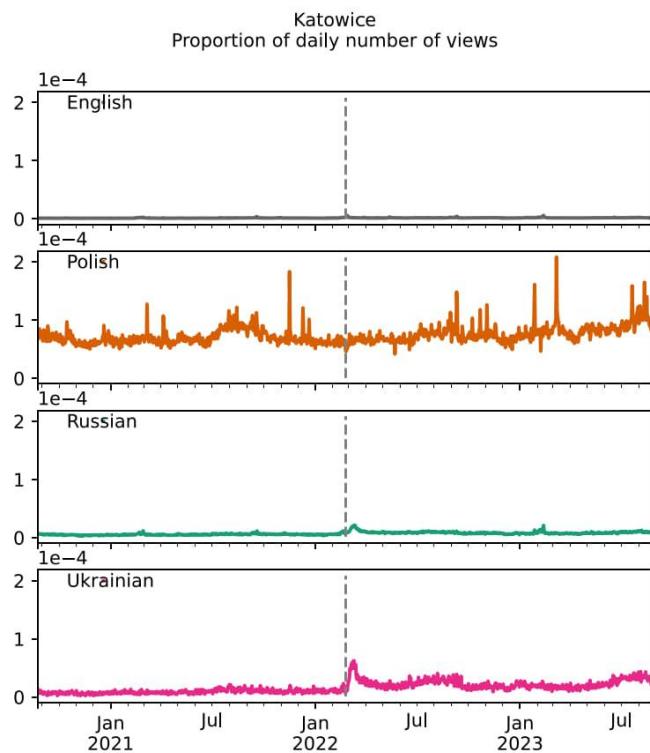
Daily data



Relative change Wikipedia Pageviews

Daily data

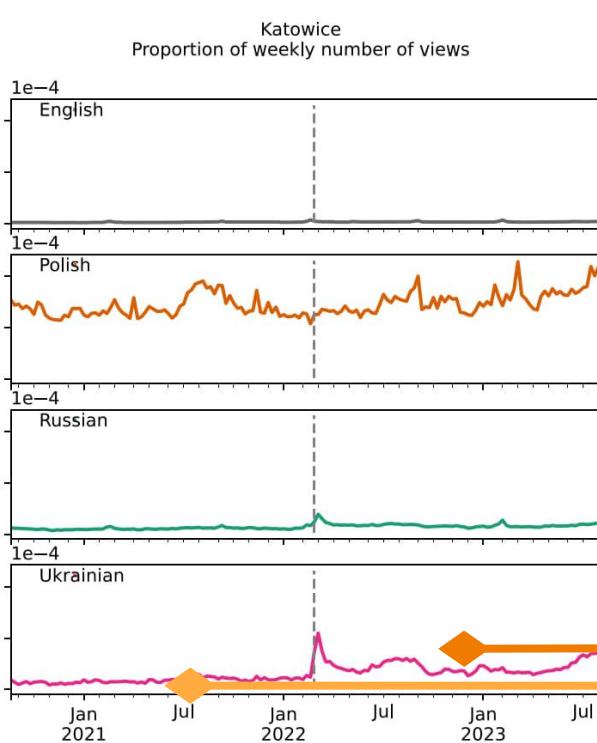
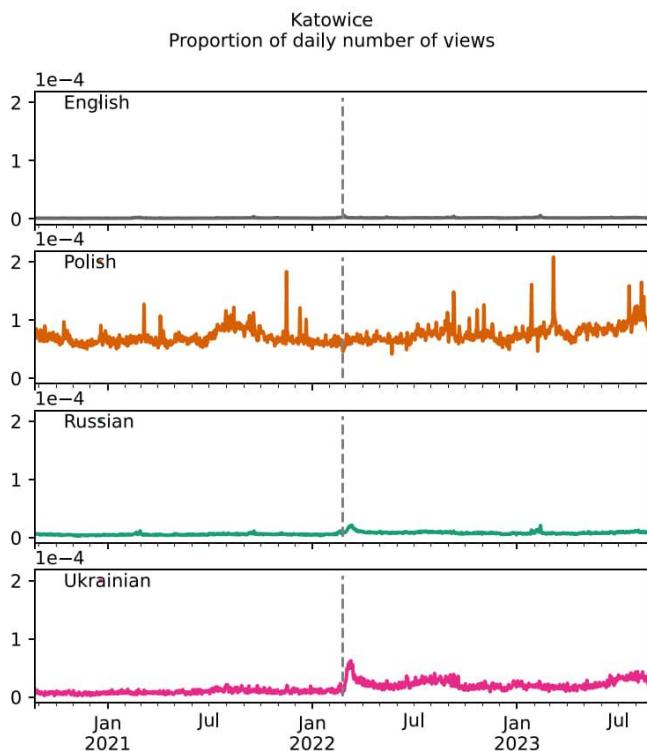
Weekly data



Relative change Wikipedia Pageviews

Daily data

Weekly data



Increase in the number of views:
median post-war - median pre-war



Ranking European capitals according to the increase in Wikipedia Pageviews in Ukrainian

The increase in the number of views on
Ukrainian Wikipedia pages dedicated
to **European capitals** after February
24th, 2022

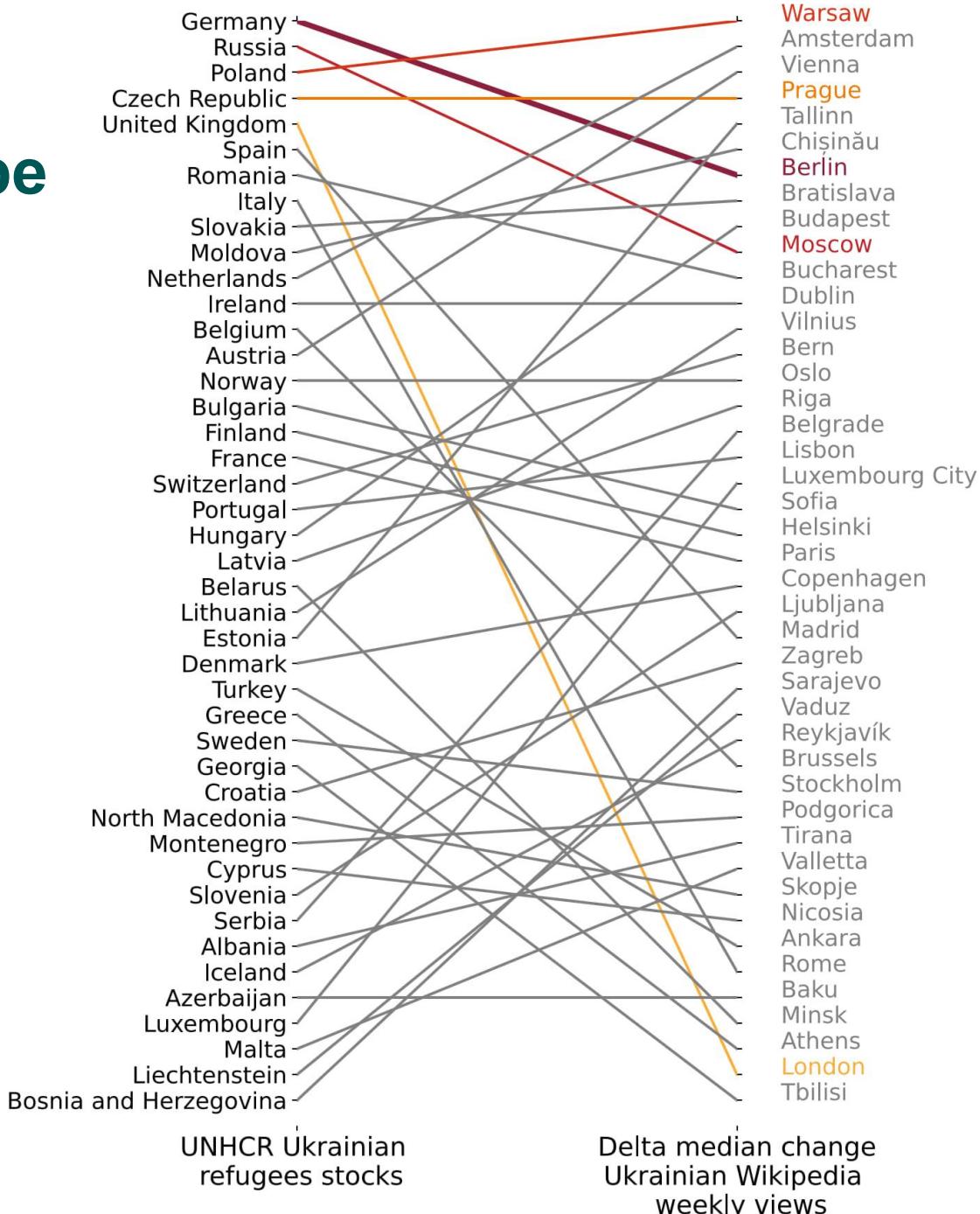


Warsaw
Amsterdam
Vienna
Prague
Tallinn
Chisinau
Berlin
Bratislava
Budapest
Moscow
Bucharest
Dublin
Vilnius
Bern
Oslo
Riga
Belgrade
Lisbon
Luxembourg City
Sofia
Helsinki
Paris
Copenhagen
Ljubljana
Madrid
Zagreb
Sarajevo
Vaduz
Reykjavík
Brussels
Stockholm
Podgorica
Tirana
Valletta
Skopje
Nicosia
Ankara
Baku
Minsk
Rome
Athens
London
Tbilisi

Findings I: Rank correlation Europe

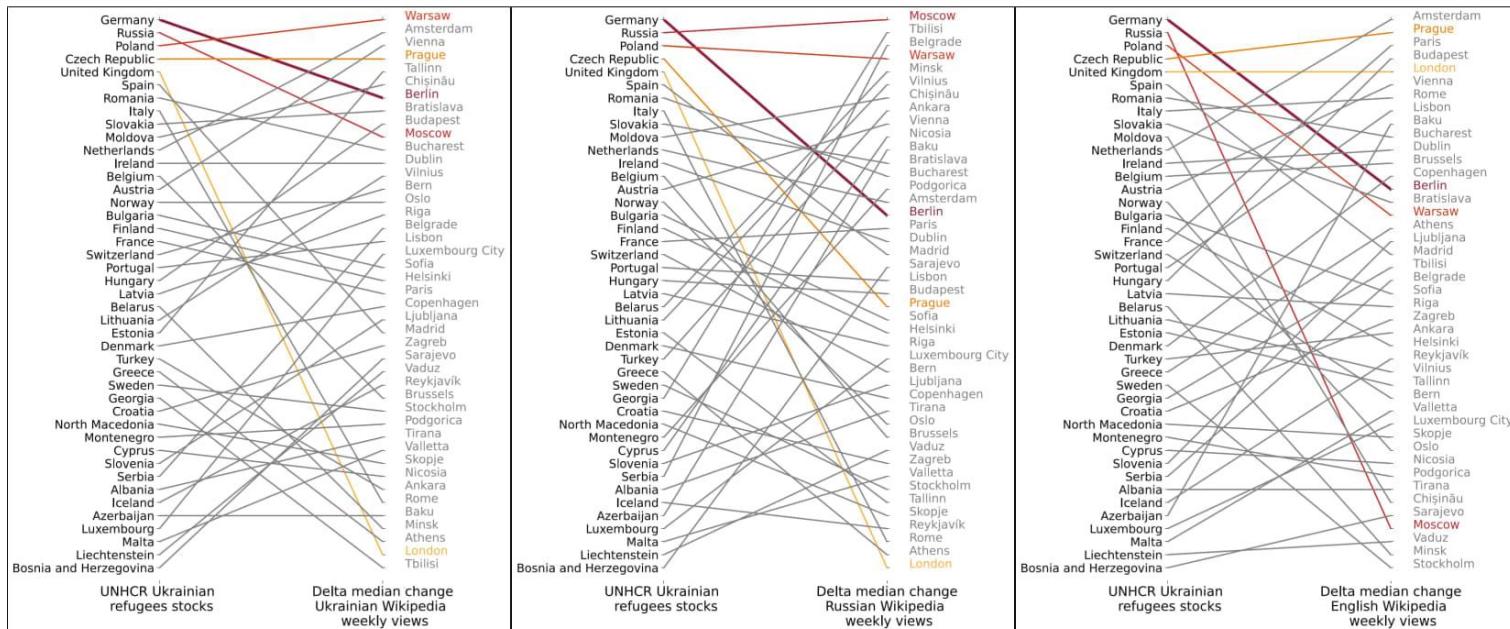
The increase in the number of views on **Ukrainian Wikipedia** pages dedicated to **European capitals** after February 24th, 2022 is highly correlated with the current **number of Ukrainian refugees in European countries**.

Spearman's rank correlation: 0.52



Findings I: Rank correlation Europe

Spearman's rank correlation on the increase in the number of views on **Wikipedia** pages dedicated to **European capitals** after February 24th, 2022 and the **number of Ukrainian refugees** in European countries.



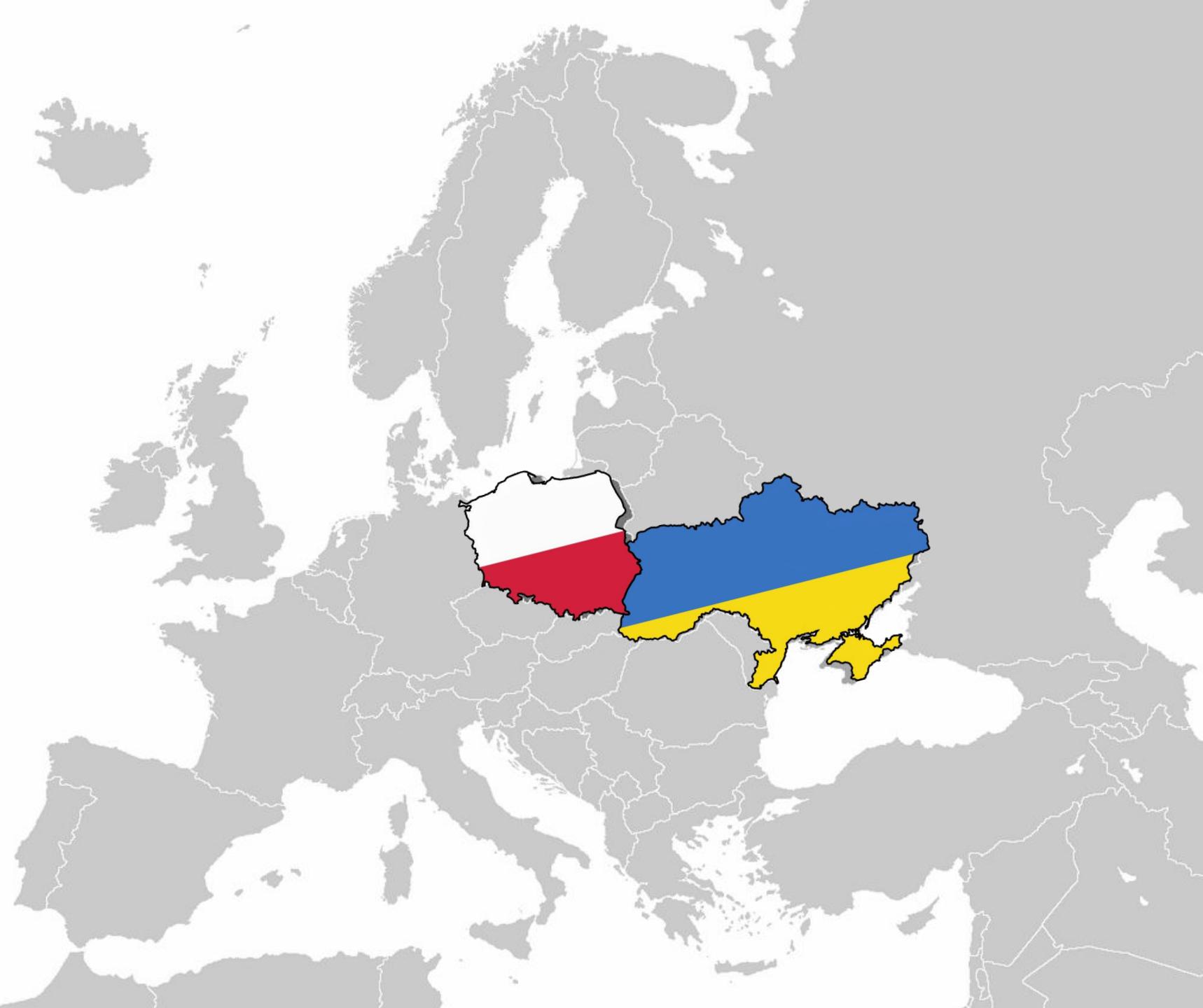
Ukrainian Wikipedia: 0.52

Russian Wikipedia: 0.22

English Wikipedia: 0.47

From Europe to Poland

Warsaw
Kraków
Wrocław
Gdańsk
Rzeszów
Katowice
Lublin
Poznań
Łódź
Szczecin
Bydgoszcz
Częstochowa
Gdynia
Toruń
Białystok
Kielce
Gliwice
Radom
Sosnowiec



Ranking Polish cities according to the increase in Wikipedia Pageviews in Ukrainian

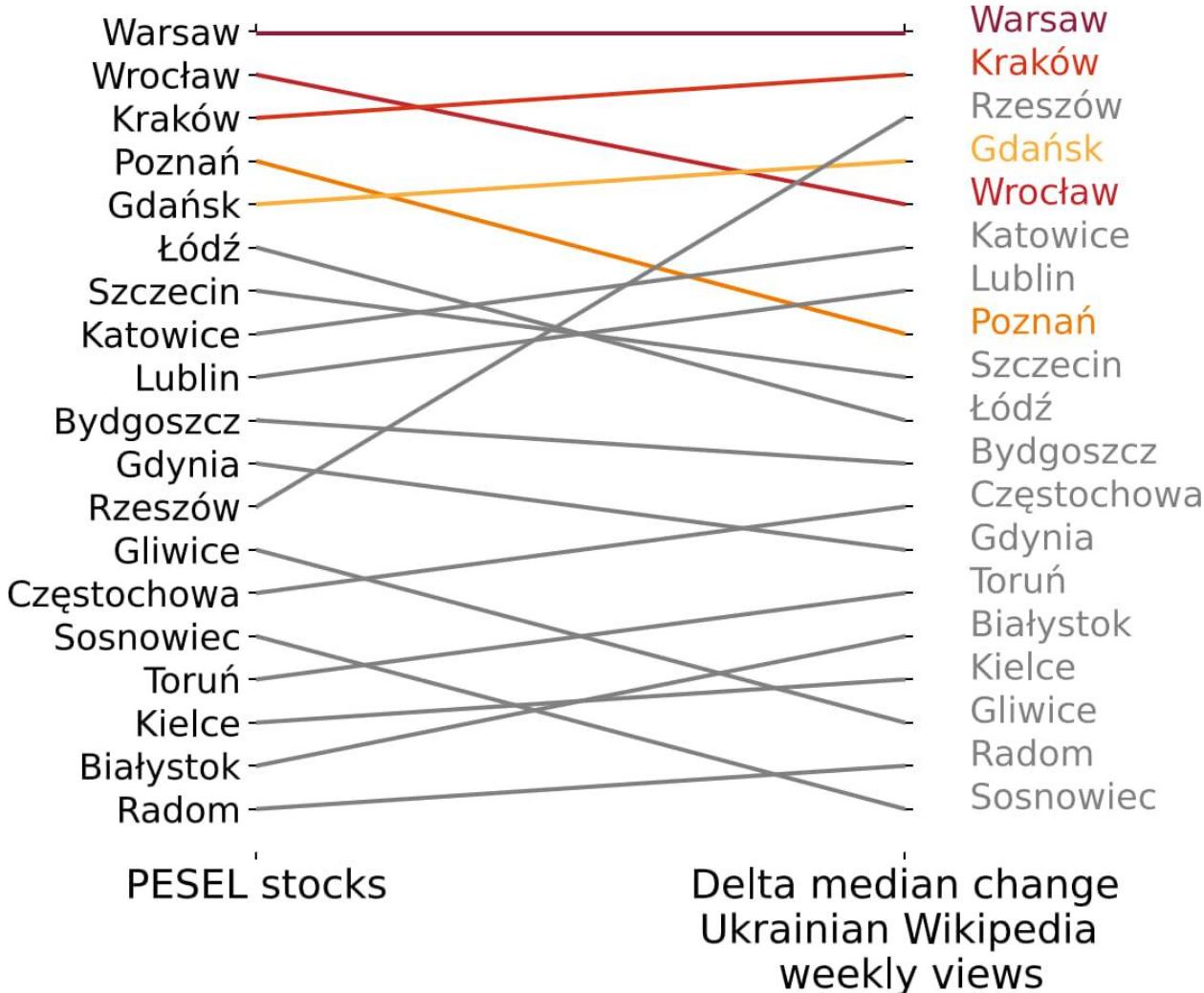
The increase in the number of views on
Ukrainian Wikipedia pages dedicated
to the 19 most populous **cities in**
Poland after February 24th, 2022

Warsaw
Kraków
Wrocław
Gdańsk
Rzeszów
Katowice
Lublin
Poznań
Łódź
Szczecin
Bydgoszcz
Częstochowa
Gdynia
Toruń
Białystok
Kielce
Gliwice
Radom
Sosnowiec

Findings I: Rank correlation Poland PESEL

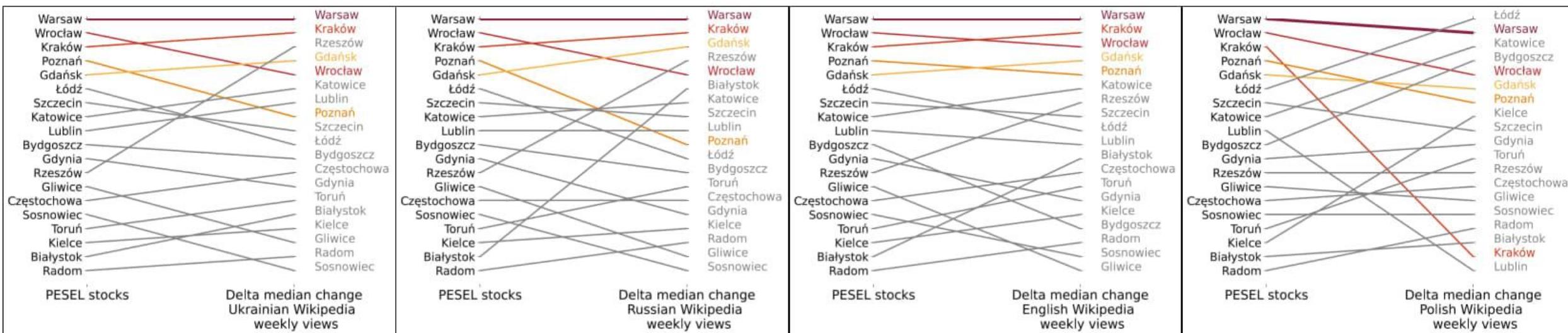
The increase in the number of views on **Ukrainian Wikipedia pages** dedicated to the 19 most populous **cities in Poland** after February 24th, 2022 is **correlated** with the total number of **Ukrainian refugees** who have been assigned a **PESEL residence registration number** in **Polish cities**

Spearman's rank correlation: 0.83



Findings I: Rank correlation Poland PESEL

Spearman's rank correlation on the increase in the number of views on **Wikipedia** pages dedicated to the **19 most populous cities in Poland** after February 24th, 2022 and the **number of Ukrainian refugees who have been assigned a PESEL number** in Polish cities



Ukrainian Wikipedia: 0.83

Russian Wikipedia: 0.68

English Wikipedia: 0.82

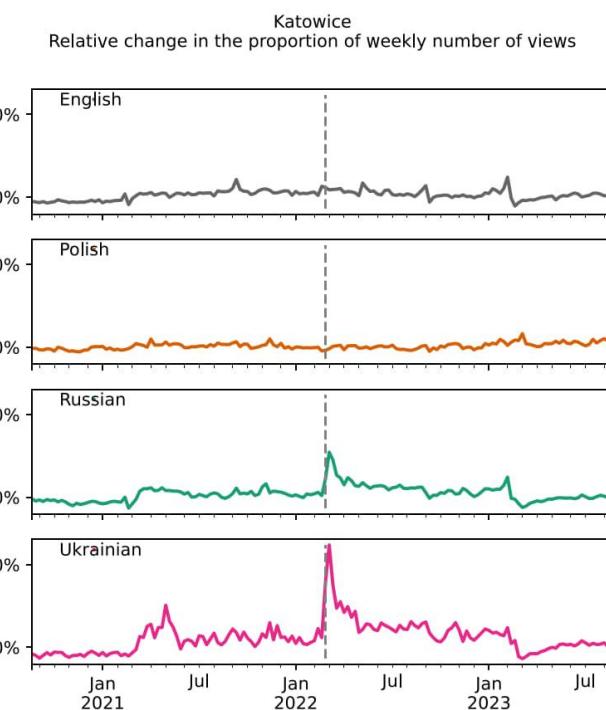
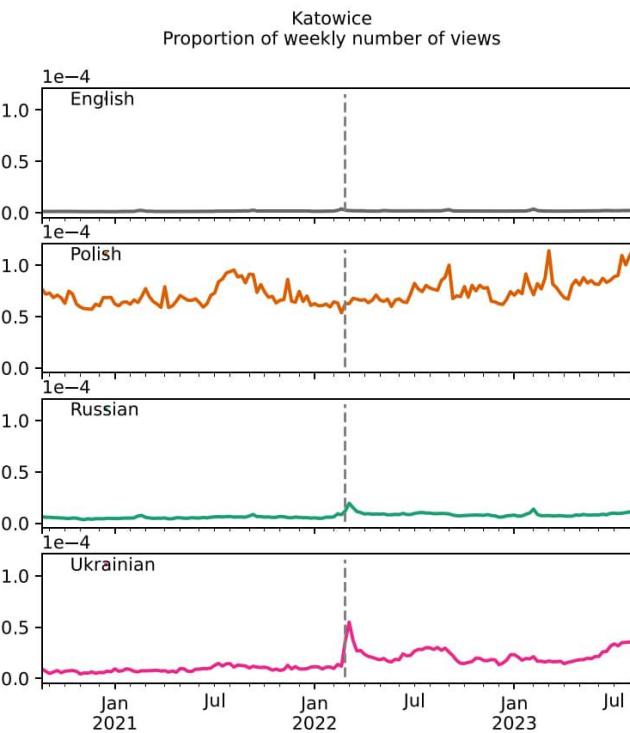
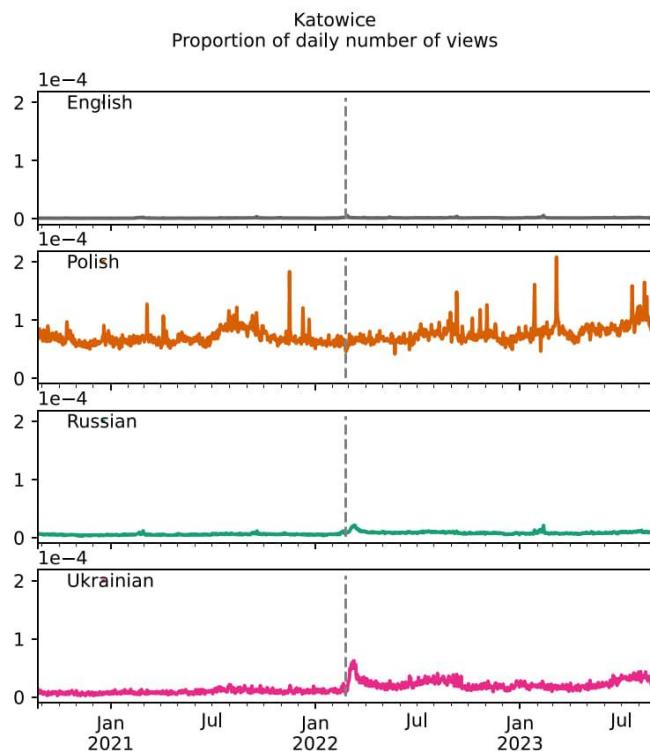
Polish Wikipedia: 0.51

Relative change Wikipedia Pageviews

Daily data

Weekly data

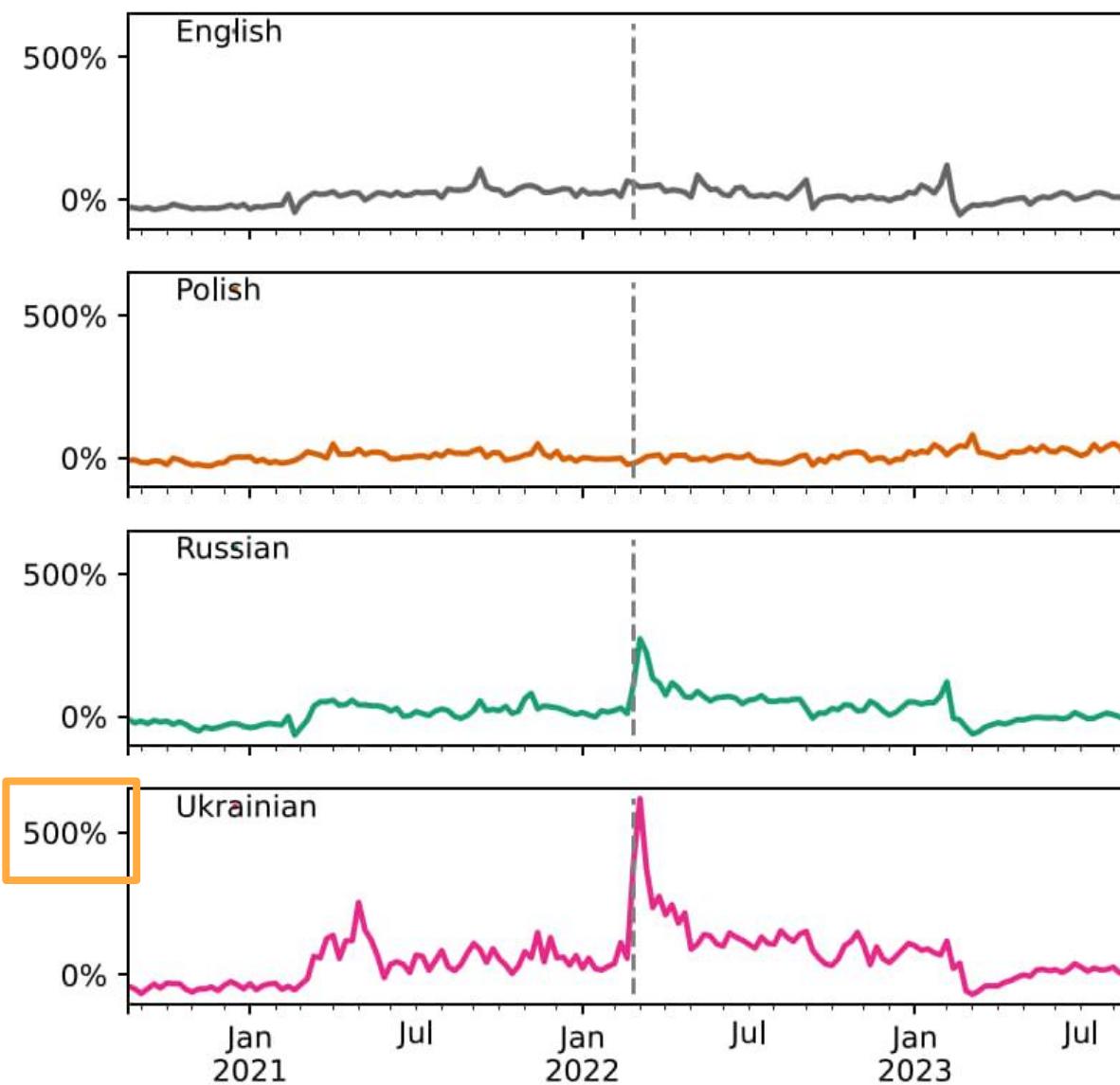
Relative change
*to the same week one year before



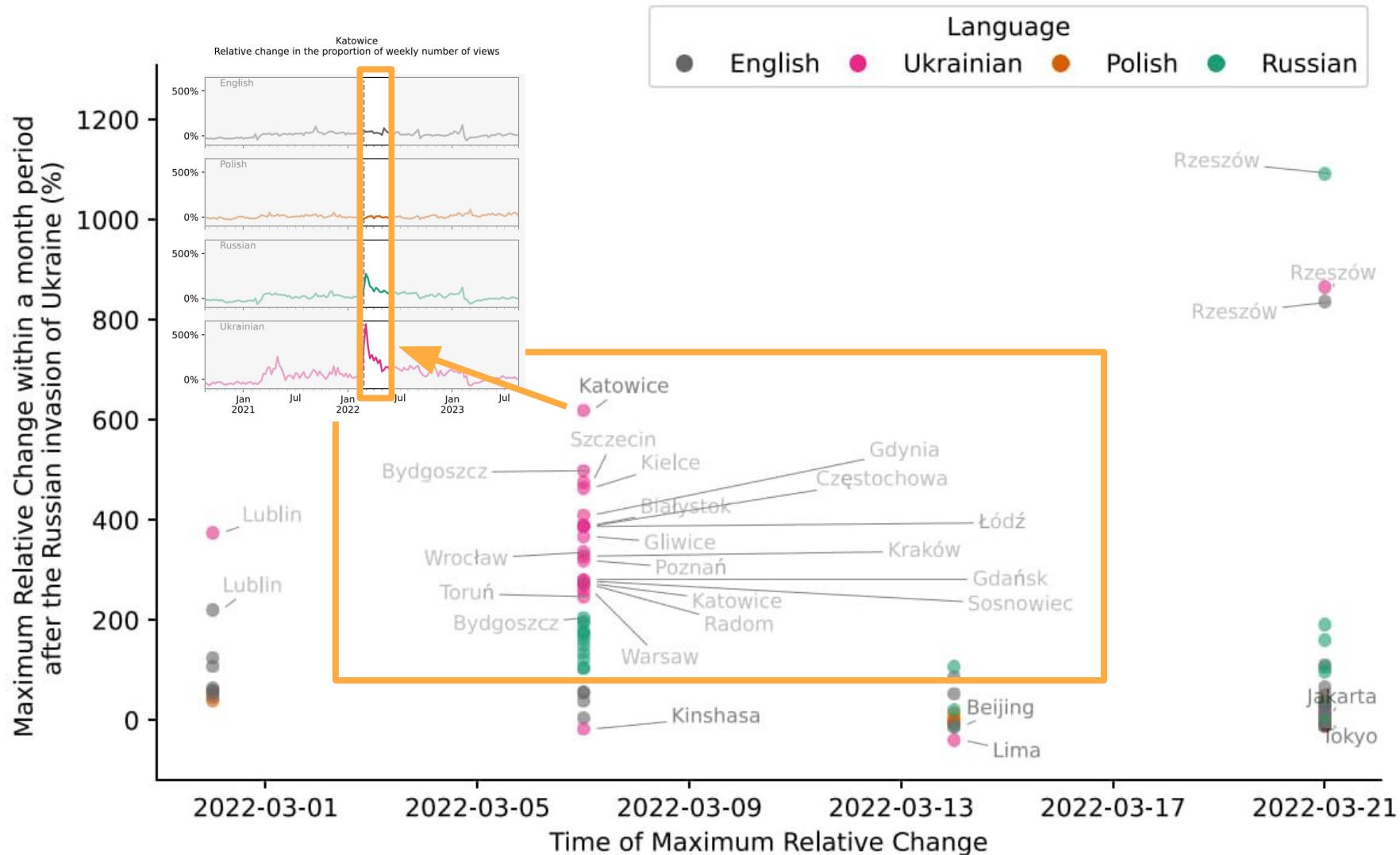
Findings II: Relative change

The Wikipedia page about 18 of the 19 most populous cities in Poland experienced an **increase of at least 200%** in weekly number of views after the Russian invasion of Ukraine, compared to the baseline period from February 24th to August 24th, 2020.

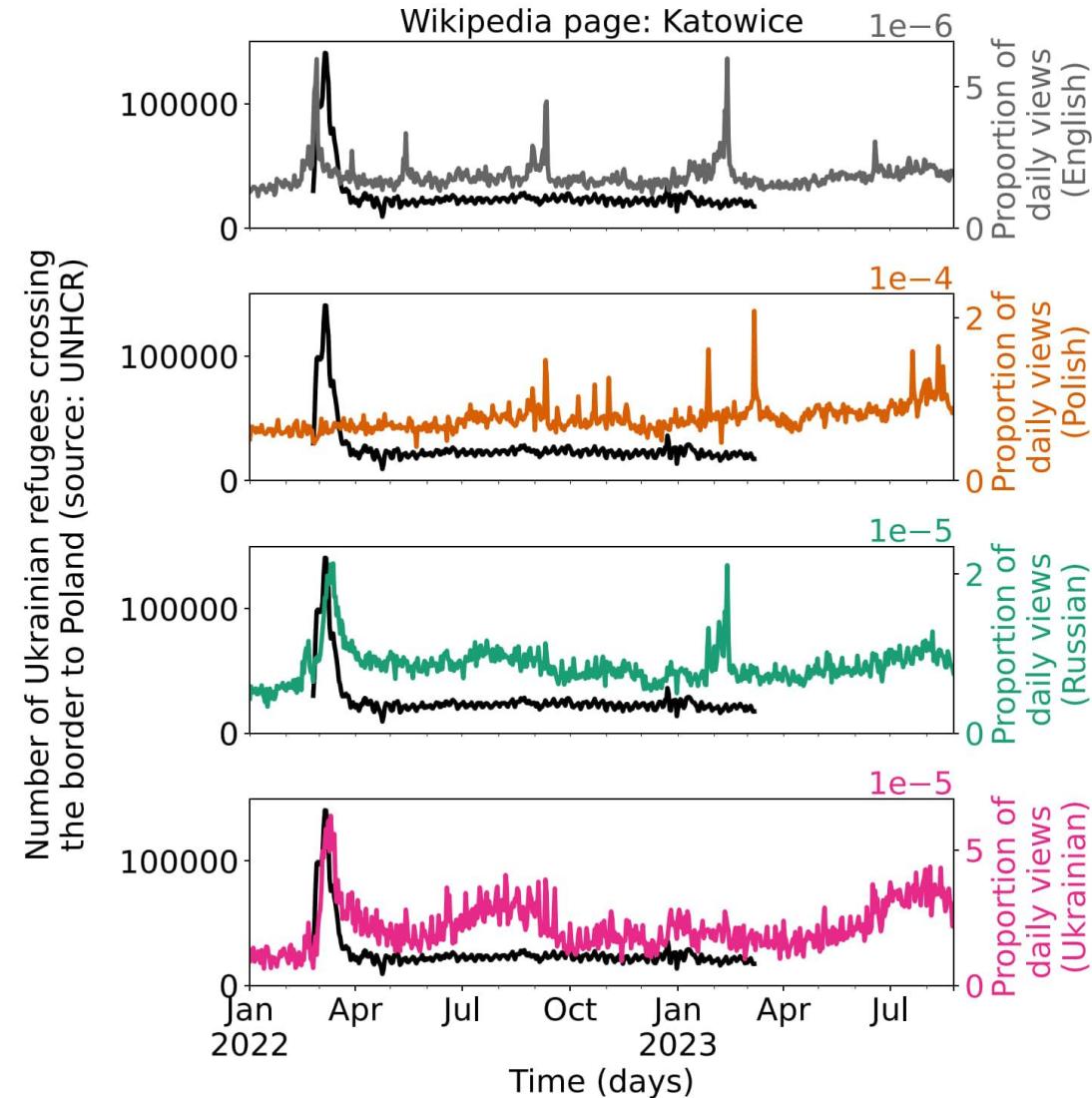
Katowice
Relative change in the proportion of weekly number of views



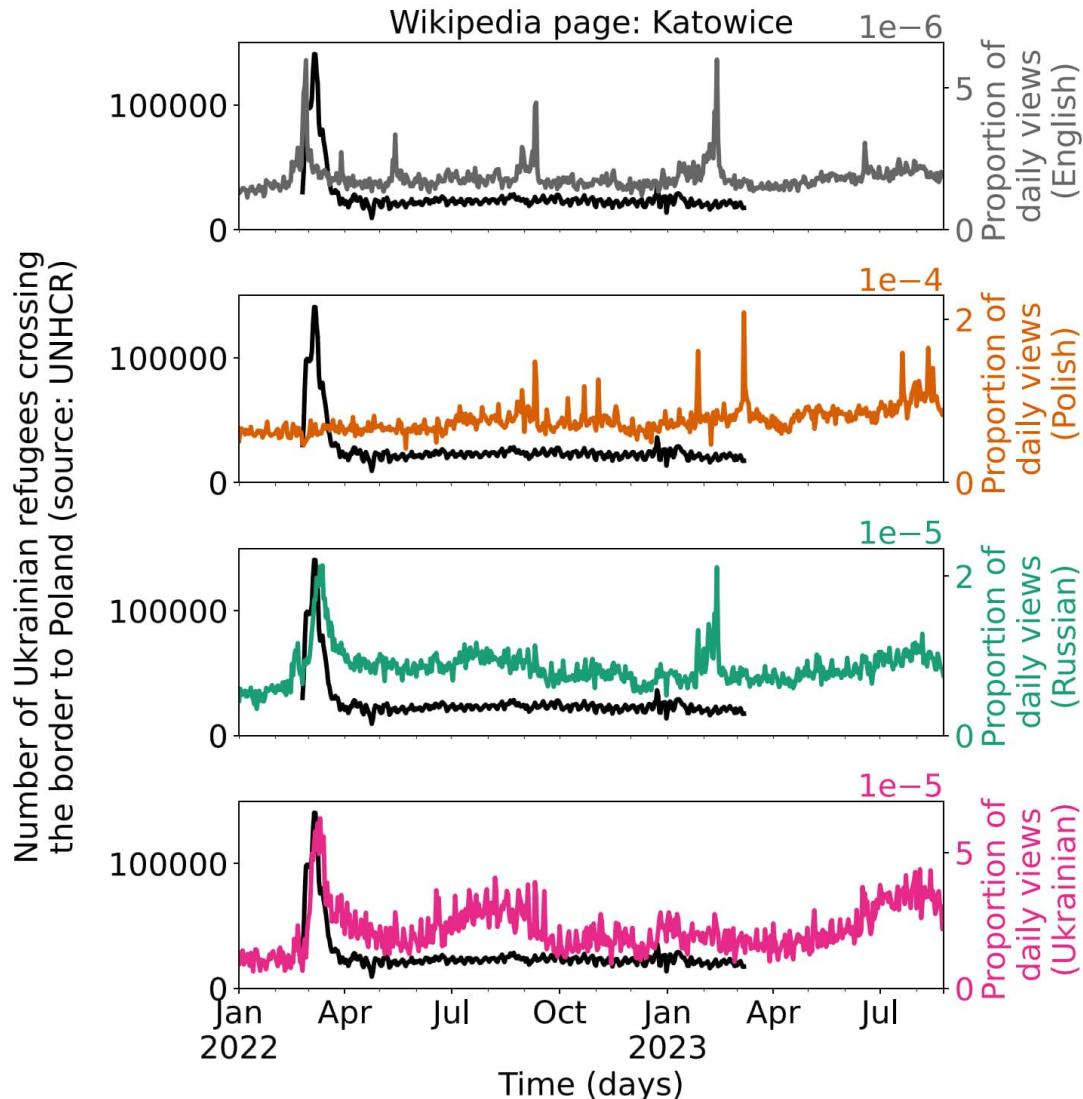
Findings II: Relative change



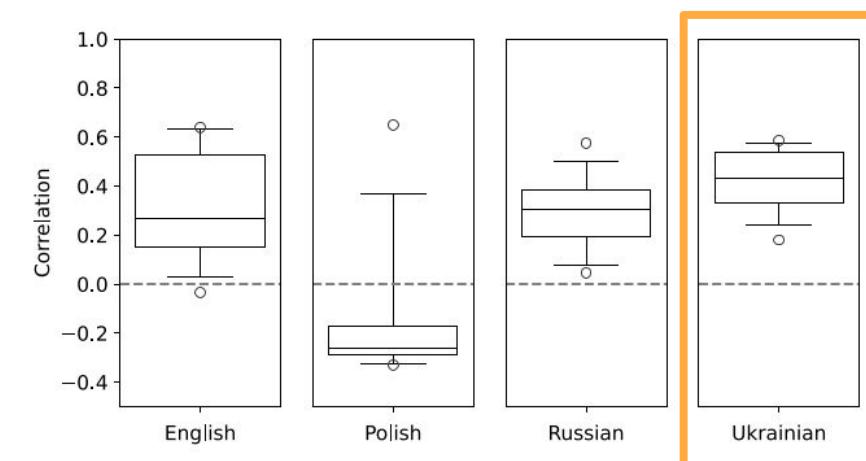
Wikipedia Pageviews and UNHCR border crossing



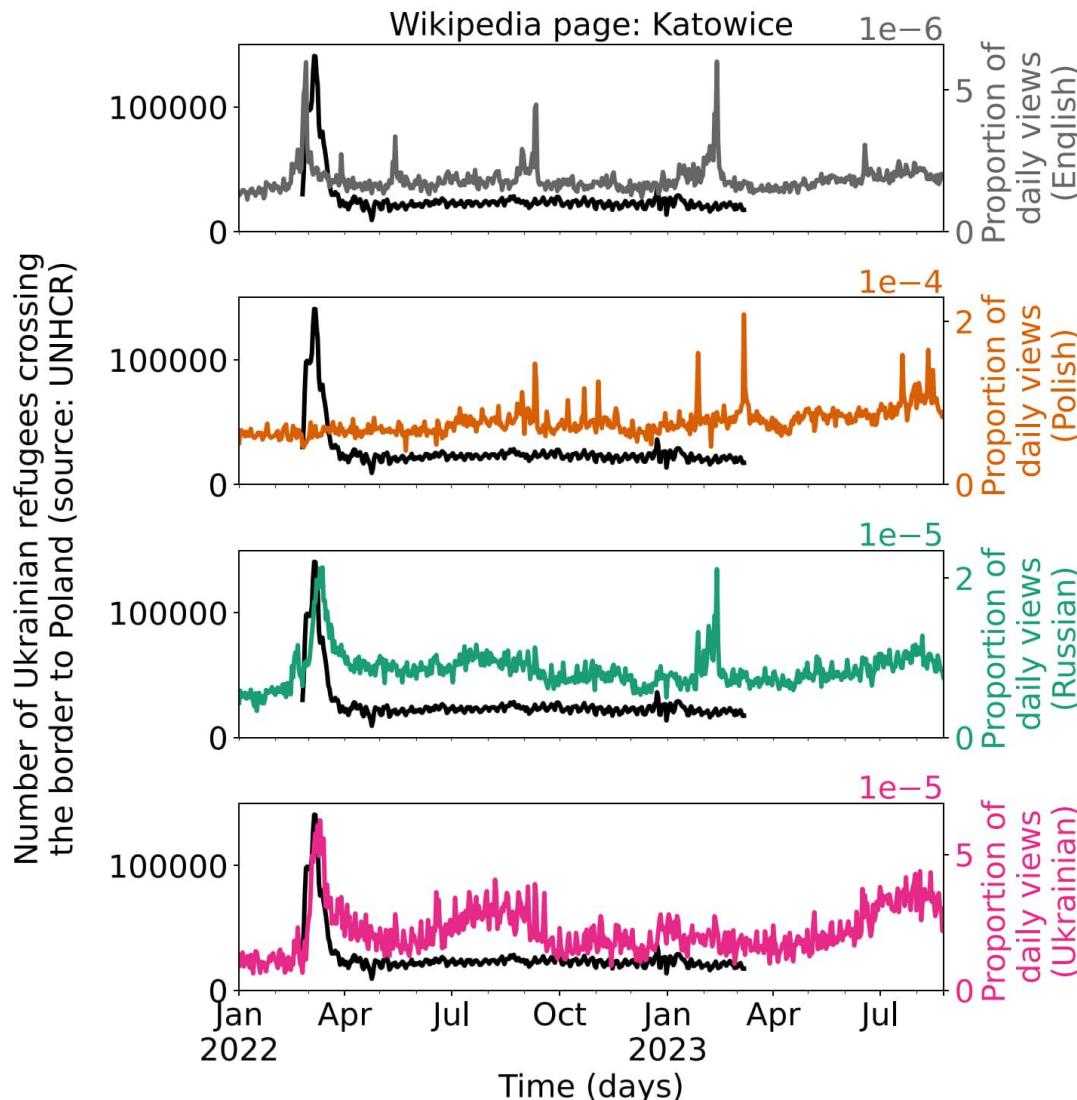
Findings III: Correlation



The **number of views on Ukrainian Wikipedia pages** dedicated to the 19 most populous cities in Poland is **always positively correlated** with the **number of Ukrainian refugees who crossed the border to Poland**



Findings IV: Granger causality



Statistical hypothesis test for determining whether one time series is useful in forecasting another.

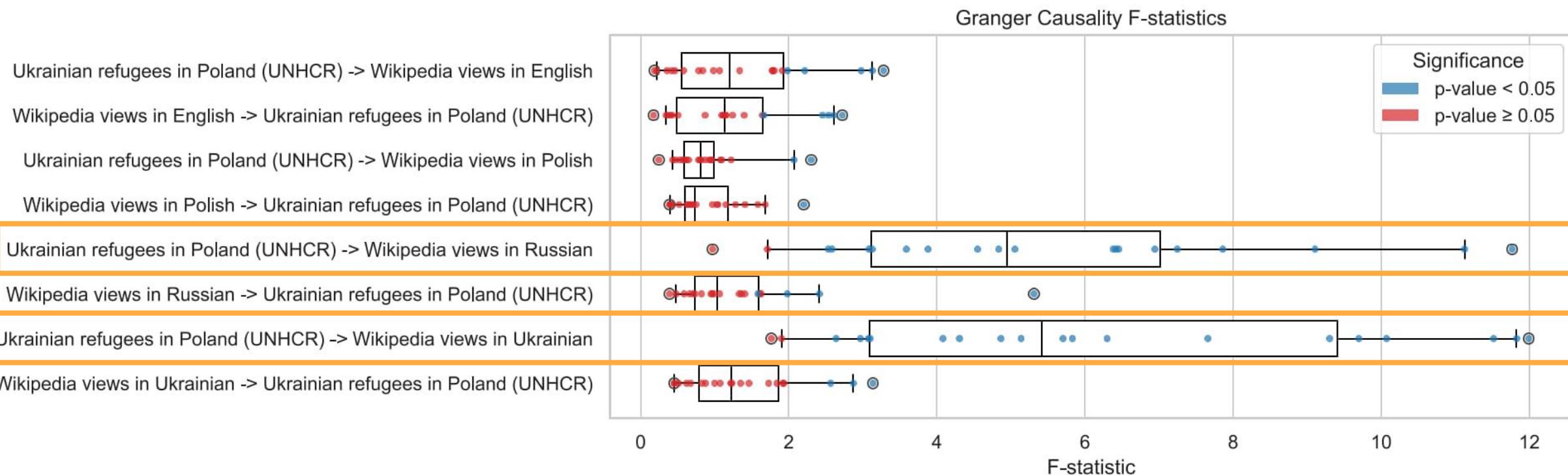
Number of Ukrainian refugees who crossed the border to Poland

|
(optimal lag of 8 days)
↓

Number of views on Ukrainian Wikipedia pages dedicated to the 19 most populous cities in Poland.

Findings IV: Granger causality

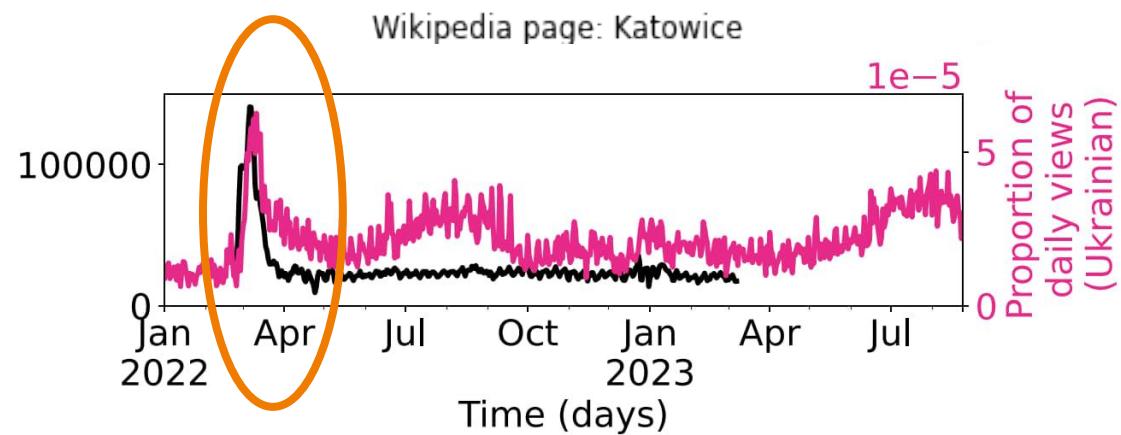
Relationship



Findings IV: Granger causality

There is a “delay” in the increase of the **number of views on Ukrainian Wikipedia pages** dedicated to the 19 most populous cities in Poland compared to the increase in the **number of Ukrainian refugees who crossed the border to Poland**

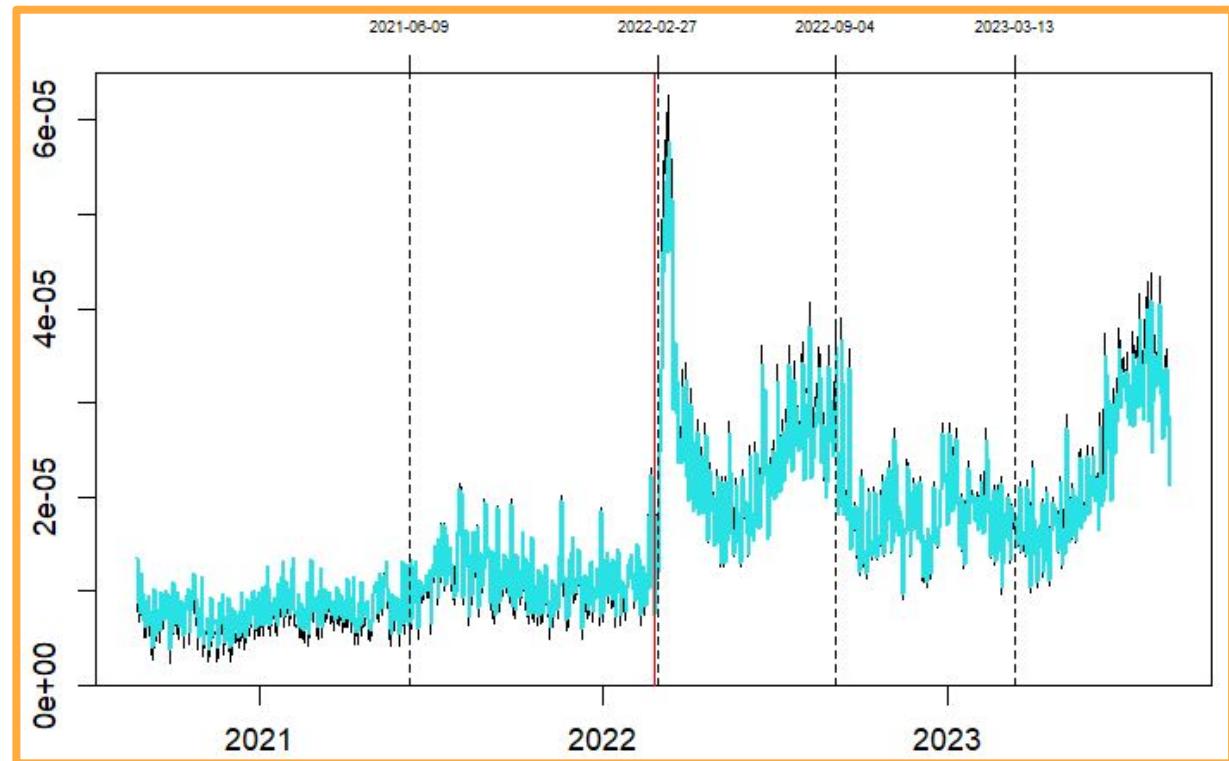
Our hypothesis is that people **crossed the border first, then searched for the city to move to...**



Findings V: Structural breaks

Of the 19 most populous cities in Poland, 12 show a **break within one week** following the start of the war.

Sensitivity check: Tokyo, Seoul, Mexico City and Jakarta. We do not observe break points around the time of the Russian invasion of Ukraine.



Break points for Katowice:

2021-06-09

2022-02-27 (3 days after the Russian invasion of Ukraine)

2022-09-04

2023-03-13

Conclusion

The **Wikipedia** pages views **reflect real-world migration patterns**.

Regarding the temporal dynamics, we identify a lag of approximately 8 days between the onset of mass migration to Poland and the peak in Wikipedia views, confirming that spikes in **information-seeking behavior tend to follow refugee arrivals**.

Our results reveal opportunities to use **Wikipedia views** as a tool for monitoring population movements, understanding the **decision-making processes** and **space distribution** of refugees. Hopefully improving humanitarian responses in a situation of crises.

Limitations and Considerations

The use of **language** as a proxy for the country of origin.

Generalizability of this methodology to other contexts.

Internet penetration rate and **biases** in the use of Wikipedia.

Privacy and **ethical** implications of using digital traces to track refugees or vulnerable groups who may be in precarious situations.

DISCUSSION





Discussion

- Can you think of any cases for potential research that would benefit from using Google Trends and/or Wikipedia data?
- How can we ensure that digital trace data are used in a responsible and ethical manner?
- In what ways can digital trace data sources help us identify and respond to emerging migration challenges, such as forced displacement due to conflict or environmental disasters?
- How can we improve data on online search patterns for research purposes?



Exploring Migration Patterns Using Digital Trace Data



Carolina Coimbra Vieira

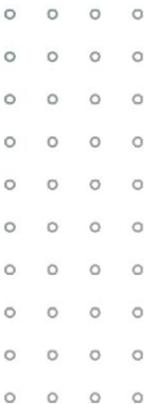
@carol_coimbra2 X

coimbravieira@demogr.mpg.de

Ebru ŞanlıTÜRK

@EbruSanliturk X

sanlituerk@demogr.mpg.de



HANDS-ON





Hands-on

Google Trends:

<https://trends.google.com/trends/>

Wikipedia Pageviews:

<https://pageviews.wmcloud.org/>



<https://github.com/carolcoimbra/workshop-exploring-migration>

USING GTRENDSR TO RETRIEVE DATA



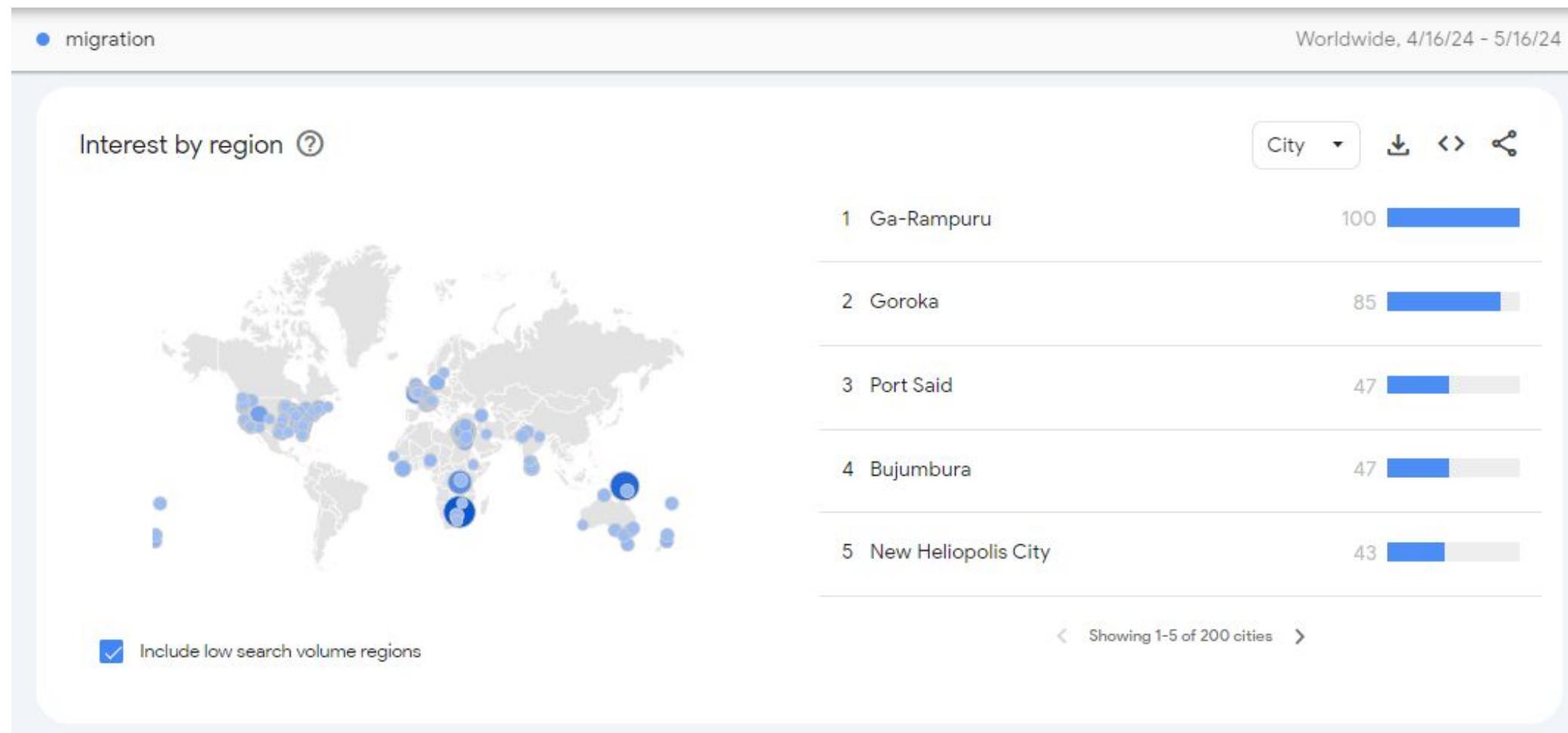


HOW TO MAKE A QUERY

- Determine the keyword(s)
- <https://trends.google.com/> can be helpful in the brainstorming phase
- See which keywords produce a meaningful result
- Check visualizations



GOOGLE TRENDS VISUALIZATION





HINTS

- Consider alternative spellings for search queries
- Consider the use of accented characters
- Google may aggregate results for a query with and without accented characters for local language
 - Same filter / aggregation may not apply in other locations, make a few trials
- Consider regional dialects that may apply
- Be careful when using phrases as search queries
- Consider the justification of query selection



GTRENSR

- `gtrends(keyword = "", geo = "", time = "", gprop = "", hl = "", low_search_volume = TRUE, compared_breakdown = FALSE)`
- time – default is last 5 years
 - “now 7-d” (last seven days), “today 1-m” (past 30 days), “today 3-m” (past 90 days), “today 12-m” (past 12 months), “Y-m-d Y-m-d”
- `compared_breakdown` can only be used to compare multiple keywords in a single location.



GTRENSR OUTPUT

□ Interest over time

- use “onlyInterest = TRUE”

□ Interest by country (or region)

□ Interest by dma (designated market area)

□ Interest by city

□ Related topics

□ Related queries



GTRENSDR OUTPUT: KEYWORD VS. TOPIC

- Search for keyword = Brisbane
- Search for topic = Brisbane (capital city of Queensland, Australia)
- Uses Freebase ID (can be found on Wikidata)
- `gtrends(keyword = "/m/01b8jj", time = "2024-01-01 2024-03-31", low_search_volume = TRUE)`
- Also: Check “categories” included in the package



GTRENSDR – COMMON ERRORS

- Error in get_widget(... : widget\$status_code == 200 is not TRUE

- Make sure you use geo identifiers as given in the *countries* data
- Try downloading the developer version
 - `devtools::install_github("PMassicotte/gtrendsR")`
- It's possible that you have exceeded a limit with Google Trends, try dividing the sets included in your code (keywords, locations etc.)
- It's possible that you have exceeded a limit with Google Trends, try again a some time later.



GTRENSDR – COMMON ERRORS

- `gtrends(keyword = "asylum", time = "2025-01-01 2025-06-30",
gprop = "web", hl = "en", low_search_volume = TRUE,
onlyInterest = TRUE)`

- Unless specified, geo is considered worldwide
- hl – language, important for related queries, related topics and location names



GTRENSDR

```
keys = c("migration", "residence permit", "asylum")
time = "2025-01-01 2025-06-30"

for (i in keys) {
  trendsoutput = gtrends(keyword=i, gprop ="web", geo="US", time = time,
  onlyInterest = TRUE, low_search_volume = FALSE)
  Sys.sleep(5)
  results [[i]] = trendsoutput$interest_over_time
}
```

Exploring Migration Patterns Using Digital Trace Data

THANK YOU!



<https://github.com/carolcoimbra/workshop-exploring-migration>



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