Socio-Economic Aspects of Urban Development

Unit 2: City Size and City Growth

Prof. Melanie Krause, Ph.D.

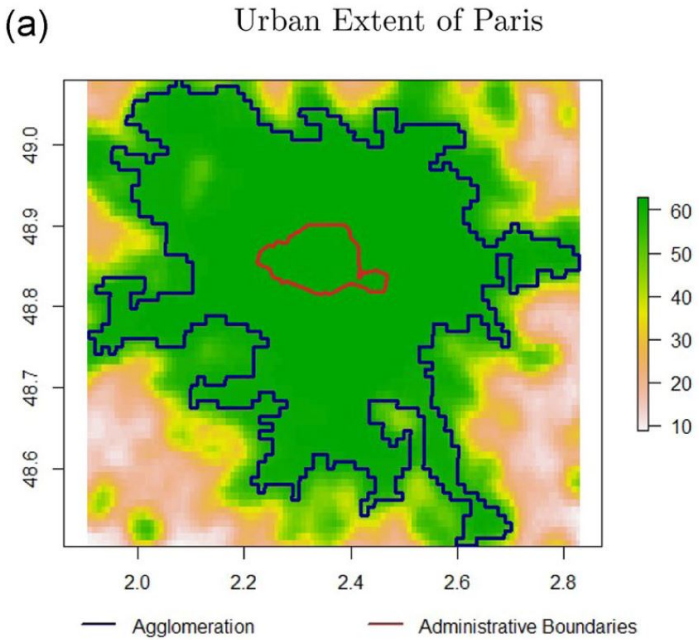
Winter Semester 26/27

Overview of Unit 2

- What is a city and where are its boundaries?
- City size
  - How many big and small cities does a country typically have?
  - The importance of primary cities
- City growth
  - How can cities grow in terms of area?
  - How can cities grow in terms of population?

Where are the City Boundaries?

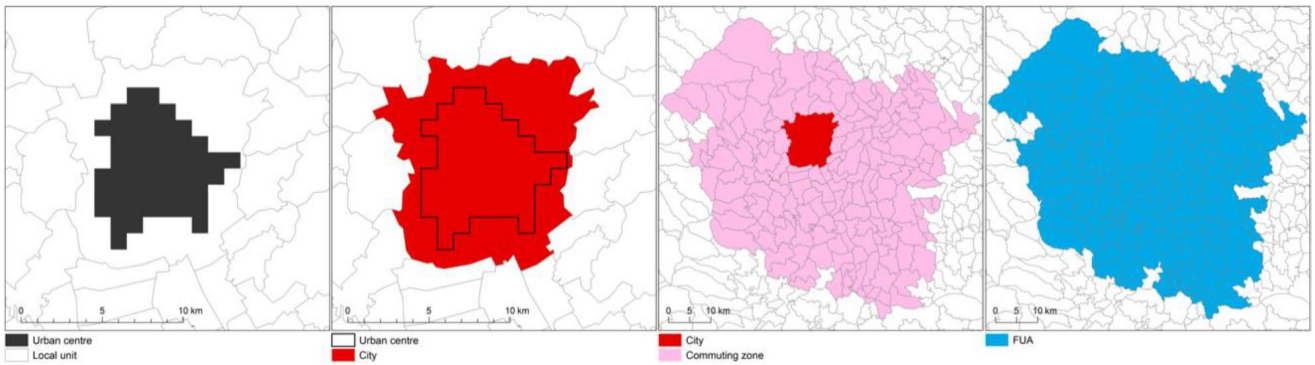
- In order to analyze who is living in the city, we need to know where its boundaries are.
- Statement for discussion: *"The largest German city is actually the Ruhrgebiet."*
- Or consider Paris: Administrative borders (red) vs built-up area (blue) and nighttime light intensity (background), Source: Düben and Krause (2021)



Functional Urban Area

- Lewis Dijkstra, Hugo Poelman and Paolo Veneri use yet another definition of cities in their 2019 paper: **Functional Urban Areas**
- A Functional Urban Area (FUA) is composed of a city (in the administrative sense) and its surrounding areas that are part of the city's labor market (its commuting zone)
  - The commuting zone consists of those suburbs and villages where at least 15% of residents work in the city
- FAUs are particularly useful in for an analysis of a city's labor market, firms and workers. Example: Graz (Austria) from Dijkstra et al (2019)

Figure 1. Urban centre, city, commuting zone and functional urban area of Graz, Austria



Which City Definition is Best?

- Advantages of working with administrative city boundaries
  - Good official data from municipal authorities, e.g. census data and socio-economic data
  - Clear and unambiguous boundaries (compared to boundaries of an agglomeration)
  - Direct accountability of local politicians to residents, important for implementing policies
- Disadvantages of working with administrative city boundaries
  - Environmental issues such as pollution do not stop at administrative boundaries $\Longrightarrow$ Agglomeration
  - People often cross administrative boundaries on their way to work $\Longrightarrow$ FAU
- In the end, it depends on data availability as well as on the precise application. When reading papers and conducting your own research on cities, ask yourself how the city is defined: Administrative area? Agglomeration based on built-up area? FAU?

City Size Distribution

- How many big and small cities are there within a country?
- **Zipf's Law** is a regularity about the city size distribution that holds in many countries
  - In general: The size distribution of cities in terms of population follows a **Pareto distribution**

$$N_y = A_{max} \cdot y^{-\alpha} \tag{1}$$

    with N_y as the number of cities larger than population size y and shape parameter α. A_{max} equals the size of the largest city.
  - The special case of $\alpha = 1$ is number as Zipf's Law:

$$N_y = \frac{A_{max}}{y} \tag{2}$$

  - Example: If the largest city has 10 million inhabitants, how many cities have more than (a) 1 million inhabitants? (b) 5 million inhabitants?

City Size Distribution

- The higher population size you look at, the fewer cities with this population. If Zipf's Law holds, it tells you how many!
  - 'The frequency of an event is inversely proportional to its position in the distribution.'
- Working with ranks (the most populous city, the second most populous city and so on), Zipf's Law implies:

$$y_i = \frac{A_{max}}{rank_i} \tag{3}$$

- The population of city i is given as the population of the largest city divided by the rank of city i (i.e. 1, 2, 3...)
- **The second-largest city has one half of the population of the largest city, the third-largest city has one third of the population of the largest city, and so on.**
- Think about some countries. Where does Zipf's Law hold (approximately)? Which countries have a different size distribution?

City Size Distribution

Look at Sweden

	Name	Adm.	Population Estimate (E) 2023-12-31
1	Stockholm	STO	988,943
2	Göteborg	VGÖ	604,616
3	Malmö	SKA	362,133
4	Uppsala	UPP	245,329
5	Linköping	ÖST	167,404
6	Västerås	VML	159,662
7	Örebro	ÖRE	159,348
8	Helsingborg	SKA	151,306
9	Jönköping	JÖN	146,161
10	Norrköping	ÖST	145,163

City Size Distribution

- Taking logs of the rank-size equation leads to an equation that is often used to test for Zipf's Law

$$y_i = \frac{A_{max}}{rank_i} \tag{4}$$

$$log(y_i) = log(A_{max}) - log(rank_i) \tag{5}$$

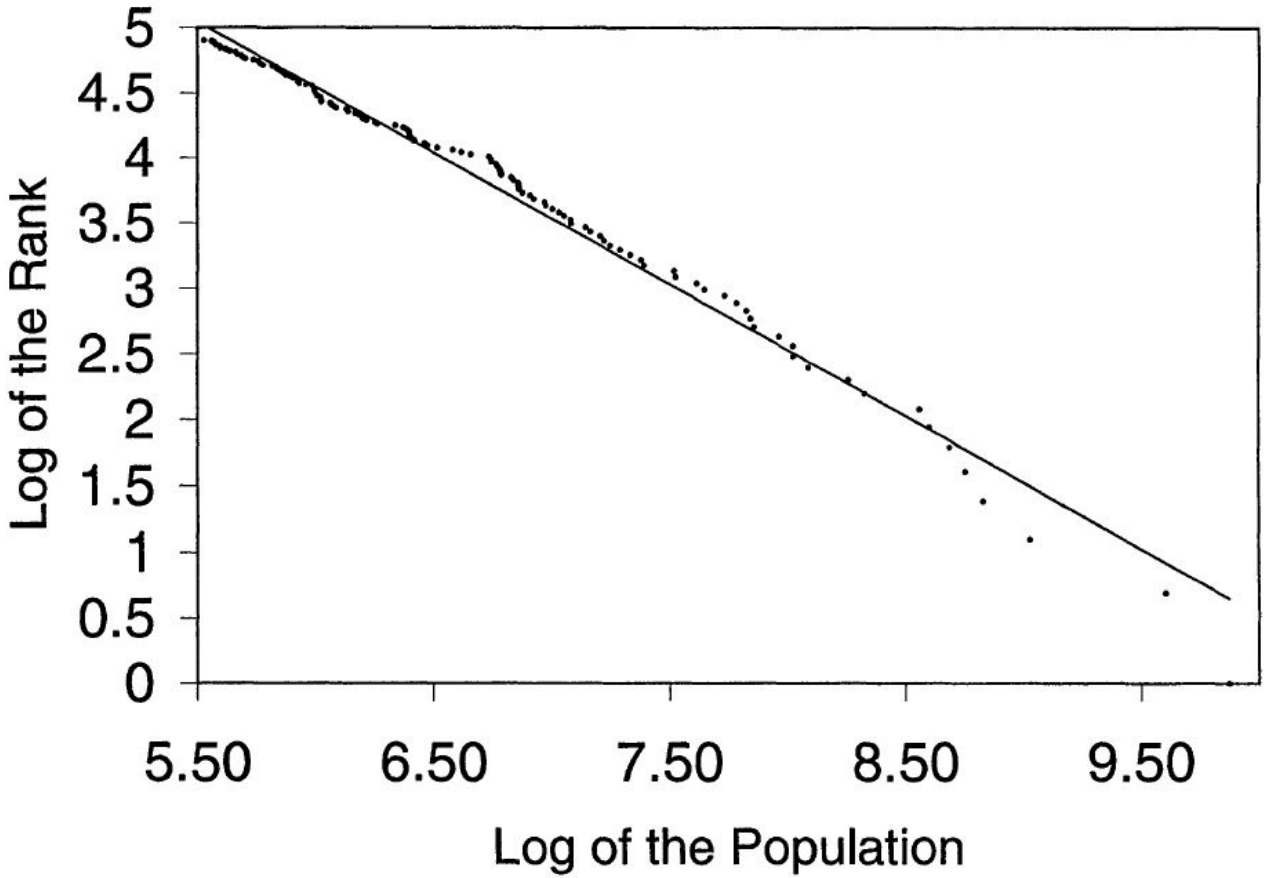
- Regress log city size on its rank and expect to find a downward sloping straight line with a slope of -1
- Example: Gabaix (1999) in his often-cited study shows that the U.S. size distribution of cities (Metropolitan Statistical Areas) follows Zipf's Law surprisingly well:

$$log(y_i) = log(A_{max}) - \alpha \cdot log(rank_i) + \epsilon_i \tag{6}$$

with an estimated α of 1.005 (standard error of 0.10) and an R^2 of 98.6%. Also, Los Angeles has half of the population of New York and Chicago has about one third of the population of New York.

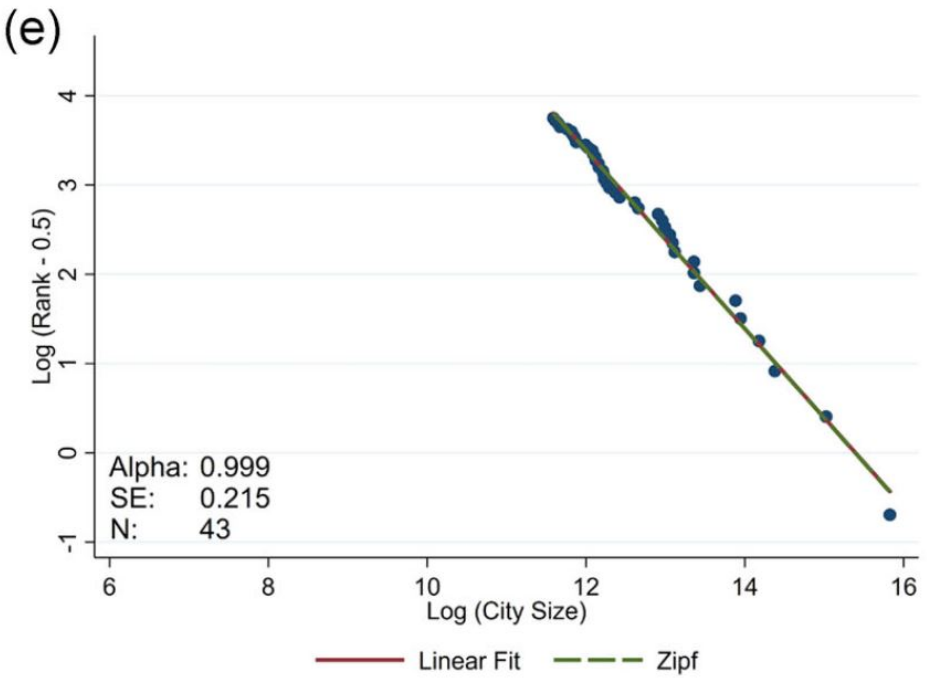
City Size Distribution

Gabaix's (1999) Zipf plot for the U.S.



City Size Distribution

Düben and Krause (2021) find strong evidence of Zipf's law for Germany



Population: Germany

Also note that Hamburg has approximately one half of Berlin's population, Munich has one third of Berlin's population, Cologne has one fourth...

Zipf's Law: The Pattern and the Deviations

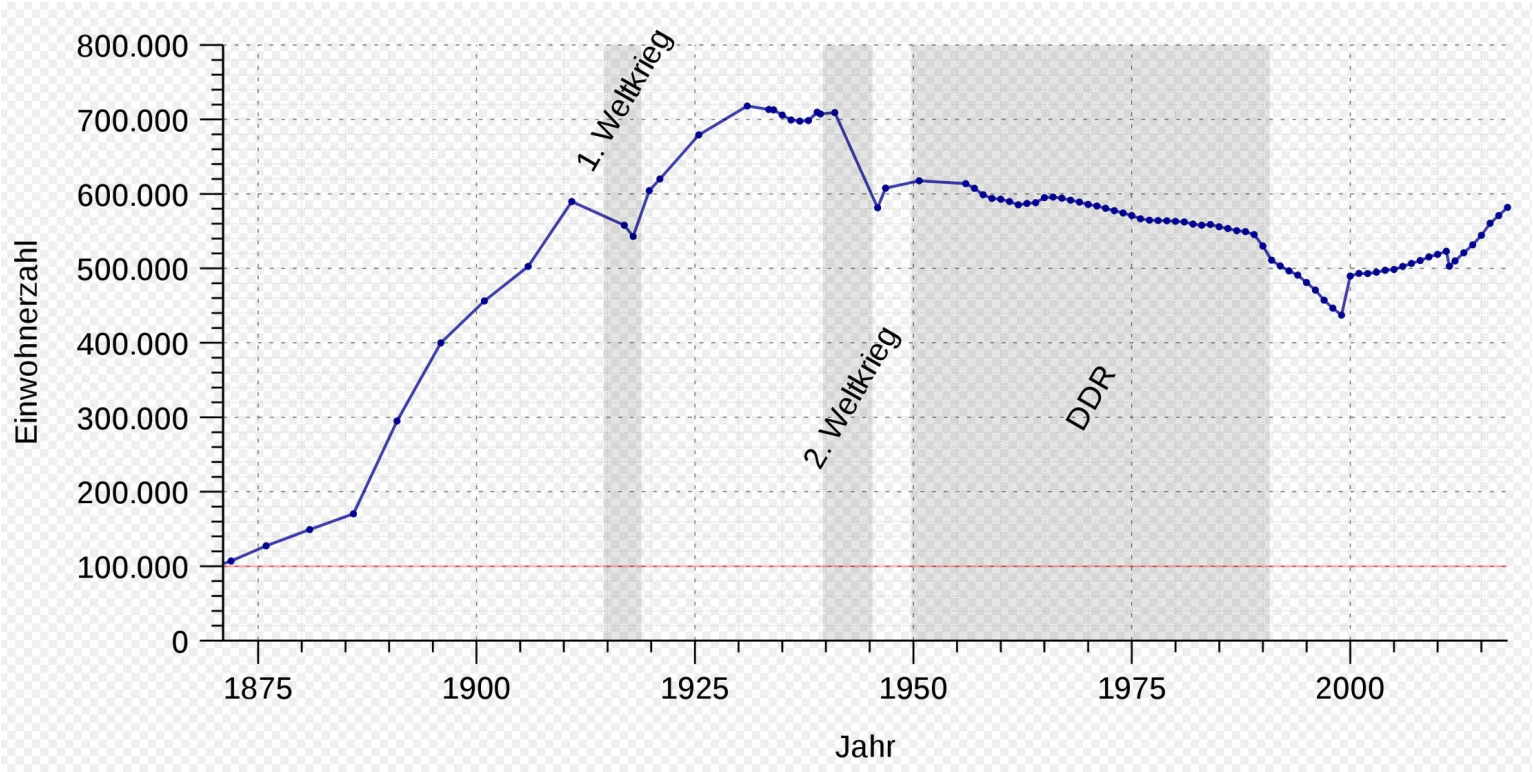
- Looking at the size distributions of city (in terms of agglomerations) around the world, Düben and Krause (2021) find that *many* countries have estimated α coefficients of 1, so that Zipf's Law holds. But far from all!
  - The size of a city is typically measured in terms of population. When instead it is measured in terms of emitted nighttime lights, Zipf's law is less likely to hold (Düben and Krause, 2021). The largest cities are disproportionally brighter than the smaller ones in many countries.
  - City size distributions are remarkably stable over time.
  - Mathematical reason behind Zipf's Law (see Gabaix 1999): Similar growth rates of cities, combined with an upper bound on city size as well as shocks to their growth process

Zipf's Law: The Pattern and the Deviations

- Countries whose city size distribution strongly deviates from Zipf's law often have **disproportionally large primary cities**:
  - In some countries a large share of the population is concentrated in the largest city. 35% of the Argentinian population live in Buenos Aires but only 4% of Germans live in Berlin.
- Ades and Glaeser (1995): Concentration of population as well as economic and political power in one city often goes in line with...
  - Bad infrastructure within the country
  - Typically lower level of GDP per capita
    - ★ The relative size of the primary city is larger in many African and Latin American countries than in Europe
  - Autocracy rather than democracy
    - ★ Centralization is purportedly conducive to maintaining control and remaining in power

City Growth over Time

- Looking at an individual city, one can chart its population growth over time in a time graph.
- Example of Leipzig: The evolution can be linked to specific events, such as the 1st and 2nd World War or the GDR period



City Growth

- Year of 1999: How did Leipzig's population increase by 50000 inhabitants - more than 10% - in one year? By incorporating a number of suburbs and villages



City Growth: Area

- There are two possibilities for a city to grow in terms of area over time
  1. **Land development**
     - ★ Building on new land outside the city boundaries
     - ★ Note that this only increases the city in an administrative sense, if administrative boundaries move along
     - ★ Where is the building land taken from? Agricultural land, fields and forests, barren land?
  2. **Incorporation of suburbs**
     - ★ Historically, this can explain a lot of jumps in the growth of cities
     - ★ Note: This is mainly an administrative act. If the incorporated suburbs are sufficiently close by, they might already have been part of the Functional Urban Area or the city delimited by built-up area or lights.

City Growth: Population

- Keeping the area fixed, there are only two factors behind population growth of a city, split into two more subfactors:
  1. **Natural population growth** as births minus deaths
     - ★ What influences the number of **births**?
     - ★ What influences the number of **deaths**?
  2. **Net migration** as the number of people moving to the city minus those moving away
     - ★ What influences the number of **new arrivals** to the city?
     - ★ What influences the number of people **departing**?

City Growth in Developing Countries

- Jedwab et al. (2017) compare rapid city growth in developing countries with the urbanization process during the industrialization period in Europe
  - Birth and death rates from 35 developing countries, 1960-2010
  - Birth and death rates from 7 countries from Industrial Europe, 1700-1950
- Decomposition of urban growth rates into the natural increase (urban births minus deaths) and residual/net migration from the countryside
  - The natural increase and migration reinforce in each other - in fact, the natural increase seems to be a larger driver than migration
  - This was different during the industrialization period in Europe: The natural increase was often negative, with urban deaths exceeding urban births. Why?

City Growth in Developing Countries

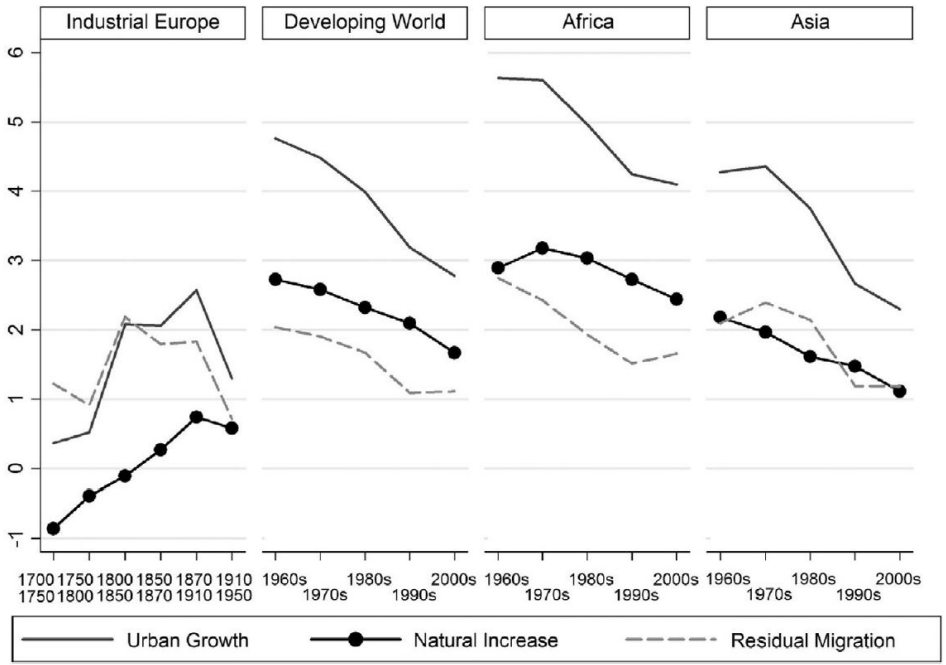


Fig. 4. Decomposition of urban growth for the developing world. *Notes:* This figure plots the decomposition of annual urban growth rate (%) into annual urban natural increase (%) and annual residual migration (%) for Industrial Europe in 1700–1950 and the developing world as a whole, Africa and Asia in 1960–2010. See the Web Appendix for data sources.

- High mortality rates ('mushroom cities') in Europe during industrialization made cities rely on new migrants for growth. Sanitary conditions and health provision in cities in developing countries are much better than in Europe at the same urbanization stage, making cities grow from natural increase as well. Future challenges due to congested cities?

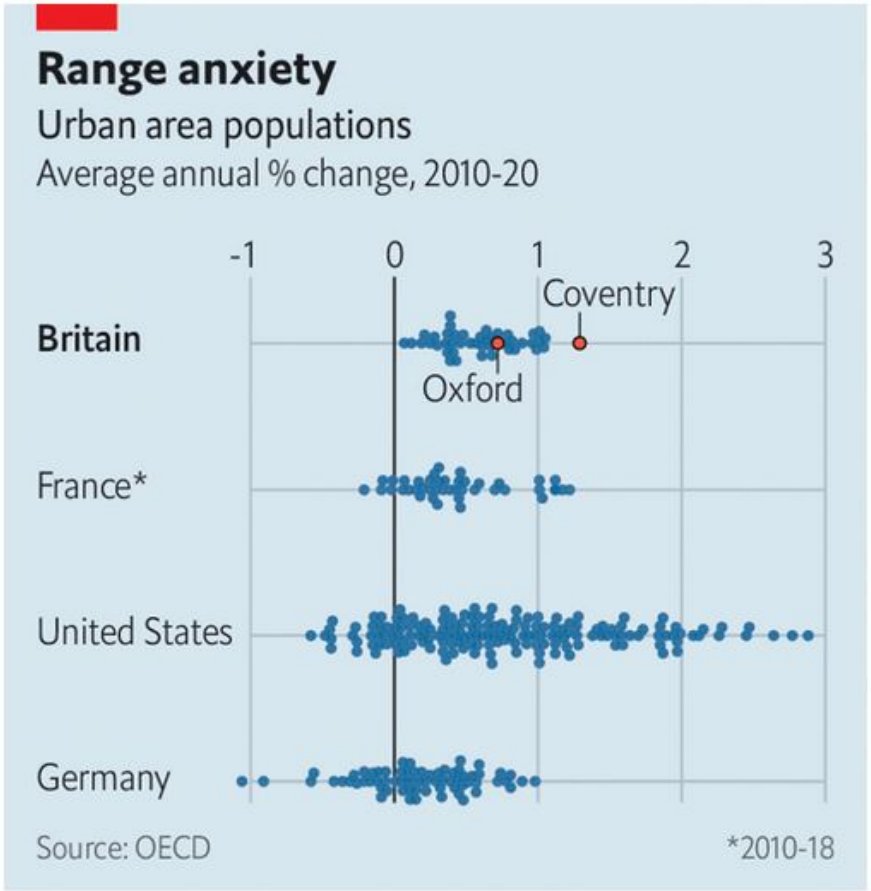
City Growth in Europe Nowadays

- In rich countries, natural population growth is nowadays strongly determined by the demographic distribution of the city as well as cohort sizes
  - The number of people of childbearing age vs. the elderly
- City migration is driven by a number of factors
  - Availability of (high-skilled and high-wage?) jobs
  - Universities - but do graduates stay in the city after their education?
  - Availability of housing (rental prices, affordable living?)
  - The overall quality of life in the city compared to others

Which Cities gain Population and which don't?

- In their 15th June 2022 edition, *The Economist* was *concerned* that British cities were all growing at the same speed
  - Britain: Average population growth rates of 0-1% per year between 2010-2020, no city growing faster, no city shrinking
  - This is unusual compared to other countries.
  - Germany: Some cities shrink (former Industrial midsize cities in Eastern Germany as well as in the West), other grow (Leipzig! as well as the largest metropolises). Growth rates range between -1 and 1% per year.
  - In the U.S., there is even more heterogeneity in population growth between cities, from -1% (Mahoning, Ohio) up to 3% (Austin, Texas).
  - Why not in Britain? And why does *The Economist* think this is a problem?

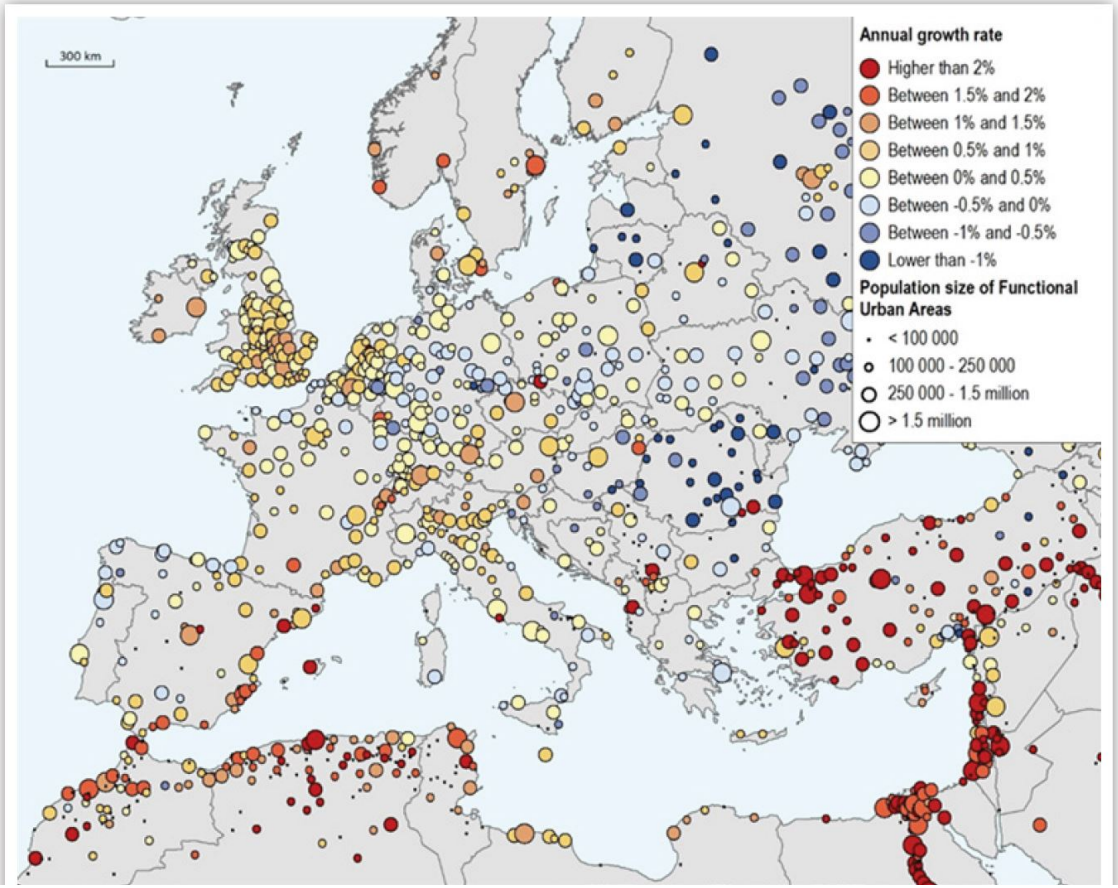
Which Cities gain Population and which don't?



The Economist

Which Cities gain Population and which don't?

Population growth and size in functional urban areas, 2000-15



Which urban areas are growing particularly strongly? Look at the color pattern within a country to see the heterogeneity of city growth and compare Germany to Britain.

Which Cities gain Population and which don't?

- Cities with negative population growth can turn into 'lost places' with derelict buildings, closing firms and shrinking opportunities, accelerating their decline.
- But *The Economist* argues it is not good if all cities tick along at similar population growth rates: Thriving cities should be able to attract residents from elsewhere and grow faster, leading to decline and potentially renewal in other cities? A question for debate
- Would a number of residents rather move away from their close-to-decline city but would struggle to find housing in London or Oxford?
- Christian Hilber (London School of Economics) says stringent planning regulations keep thriving British cities from growing faster:
  - *"Green belts prevent cities from growing horizontally, height restrictions prevent them from growing vertically, and preservation rules prevent them from renewing themselves."*

City Growth in Leipzig: Figures from 2025

- Turning back to Leipzig, its population grew in 2025 from 632,562 to 633,858 inhabitants, that is by $\frac{633{,}858-632{,}562}{632{,}562} = 0.20\%$.
- Natural growth vs migration - what is this growth due to?
  - 4476 births and 6918 deaths - so there was negative natural growth in 2024. This has been the case since 2020, but natural growth had been positive in the years before.
  - 37,059 people moved to Leipzig and 33,321 people moved away.
  - $\Longrightarrow$ In 2025, population growth in Leipzig was driven by migration. From 2014 to 2019, both factors contributed.

City Growth in Leipzig: Long-Run Population Dynamics

- At the fall of the Berlin Wall in 1989, Leipzig had around 530,000 inhabitants.
- How many of these inhabitants were still living in Leipzig in 2025? Around 170,000, so approx. one third.
  - What happened to the rest? Death (it has been 36 years!) and out-migration
- This means that out of the 630,000 inhabitants of Leipzig nowadays, 460,000 (or 73%) did not live here at the fall of the Wall.
  - The importance of births - but even more so in-migration from smaller towns and other big cities
- Looking beyond these figures to understand urban development as well as the analyze the socio-economic issues a city faces will be the goal for the next weeks.

Wrap-Up of Unit 2 on City Size and Growth

- While most official data of cities refer to administrative **boundaries**, sometimes the consideration of larger agglomerations or Functional Urban Areas that include commuter zones makes sense.
- In many - but not all countries in the world - **Zipf's Law** provides a good description of the size distribution of cities. In some countries that deviate from it, primary cities tend to have an outsized importance, often for political reasons.
- When analyzing a city's population growth over time, it is important to look for sudden **growth in the city area**, in particular by incorporating suburbs and villages.
- Keeping the boundaries constant, a city can grow by **natural increase** (the surplus of births over deaths) or by **migration**.

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