Socio-Economic Aspects of Urban Development

Unit 9: Determinants of the Spatial Distribution of Rich and Poor Within a City

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Why is Central Paris Rich and Downtown Detroit Poor?

This is the title of an article by Brueckner, Thisse, and Zenou (1999)
- and the question we are going to answer today!





Overview of Unit 9

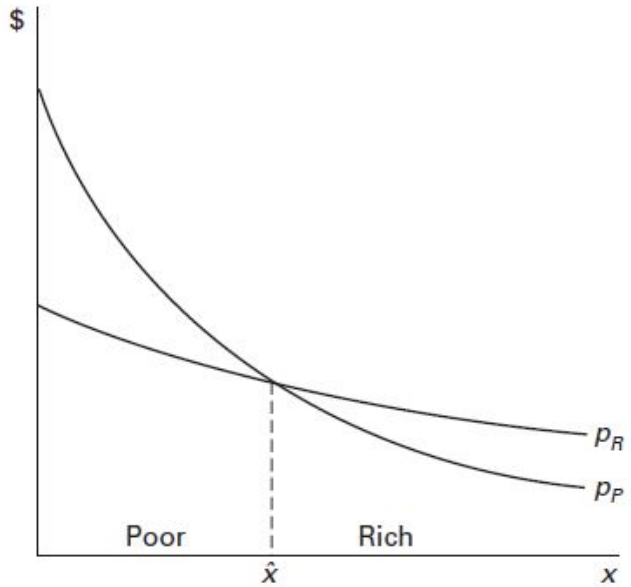
- Residential sorting: Where in the city do the rich and the poor live - and why is this the case?
  - The city center vs. the outskirts
    - ★ Economic mechanisms: Adding income heterogeneity to the Alonso-Muth-Mills model
  - The impact of natural amenities
  - The East-West divide within a city
  - Urban revival and neighborhood change

Income Differentiation in the Alonso-Muth-Mills Model

- The standard version of the Alonso-Muth-Mills of rental prices, apartment size and population density (Unit 3) does not differentiate between different income groups. All residents are identical.
- In the textbook by Brueckner (2011), a straightforward model extension is discussed: Two different income groups.
- The other assumptions remain the same:
  - Monocentric city, with jobs located at the city center
  - Commuting to the city center comes with travel costs τ times x, the distance to the city center
  - Residents spend their income (net of transport costs) on housing and one consumption good
  - Preference for larger apartments if possible
  - No preference for specific city locations for other reasons

Income Differentiation in the Alonso-Muth-Mills Model

- **Two income groups**: The poor have an income of y_p, the rich of y_r. Each income group has its own bidding curve for the rent it is willing to pay that gives it the same utility anywhere in the city. The curve of the rich is flatter (slope $-\tau/q$) because they demand more housing q at each rent p. The highest bidder gets the apartment. The curves must intersect for all individuals to find housing.



Income Differentiation in the Alonso-Muth-Mills Model

- Mathematically, the relative slopes of the two bid-price curves at their intersection $\hat{x}$ determine who outbids whom inside $\hat{x}$. The steeper curve comes from above when reaching the intersection and thus indicates which group lives inside $\hat{x}$.
- In the standard model, the rental price depends negatively on distance to the city center to compensate residents for their higher commuting costs: $\frac{\partial p(x)}{\partial x} = -\frac{\tau}{q(x)} < 0$
- Here, we have two price bid curves because the two groups have different $q(x)$. The rich demand more square meters of living space, being able to afford large apartments at each rental rate: $q_R(x) > q_P(x)$.
- At the intersection $\hat{x}$, the poor's bid-price curve is steeper (more negatively sloped). Look at the difference in slopes between the poor's and the rich's curves, which is negative for the steeper one $(-1/4 - (-1/10) < 0)$

$$\Delta = \frac{\partial p_P(x)}{\partial x} - \frac{\partial p_R(x)}{\partial x} = -\frac{\tau}{q_P(x)} - \left(-\frac{\tau}{q_R(x)}\right) < 0 \qquad (1)$$

Income Differentiation in the Alonso-Muth-Mills Model

- Hence, in this simple model extension, the poor's pid-price curve has a steeper slope than the rich's and lies above the rich's inside of $\hat{x}$. This means that poor outbid the rich inside $\hat{x}$, and the rich outside. The reason is q, the square meters of living space demanded for a given rental rate.
  - Idea: The rich move to the outskirts of the city because of the larger apartments with more q. The poor bear the high rents p in the inner city area, but can do so because their apartments are small.
- $\Longrightarrow$ Conclusion of this simple model extension: **The poor live downtown, the rich live on the outskirts**.
  - Note the mechanism: If income y increases, residents move from the inner city to the outskirts in search of larger homes
- But reality is often more complex. If we change other assumptions of the model, the result "poor in the inner city, rich on the outskirts" might no longer hold. Which further assumptions can we weaken?

Income-Dependent Travel Costs

- (i) **Income-dependent travel costs:** In addition to the monetary amount, commuting costs include lost time, which the wealthy value more. This will make suburban housing less attractive.
  - We can model this by assuming the rich have commuting costs that exceed those of the poor: $\tau_R > \tau_P$
  - In the slope of the bid-rent function $\frac{\partial p_i(x)}{\partial x} = -\frac{\tau_i}{q_i(x)}$ (with $i = R, P$), not only the denominator q differs between groups, but also the numerator τ. Which curve is steeper, who will be living in the center?

$$\Delta = \frac{\partial p_P(x)}{\partial x} - \frac{\partial p_R(x)}{\partial x} = -\frac{\tau_P}{q_P(x)} - \left(-\frac{\tau_R}{q_R(x)}\right) \lessgtr 0 \qquad (2)$$

  - The poor's curve could be steeper - or the rich's! It depends on the magnitude of numerator and denominator, this means the strength of the two effects:
    - ★ $q_R > q_P$: The rich demand larger apartments. $\Longrightarrow$ Outskirts
    - ★ $\tau_R > \tau_P$: The rich have higher (perceived) travel costs. $\Longrightarrow$ City center

The Impact of Amenities on the Rich and Poor in the City

- (ii) Another important factor that matters a lot in practice: The **Amenities** of a neighborhood. In the (standard) model, all locations within the city are per se equally attractive. In reality there are:
  - **Exogenous/geographic amenities**: Ocean view, proximity to beach/river, proximity to forests/parks, sunny side, clean air, etc.
  - **Endogenous/cultural amenities**: Restaurants, theaters and bars nearby, historical city center (cultural amenities), but also e.g. good schools
- In their paper, *'Why is Central Paris Rich and Downtown Detroit Poor'*, Brueckner, Thisse, and Zenou (1999) extend the Alonso-Muth-Mills model to include amenities. The location of amenities may vary across the city.
- Key assumption: The rich value amenities more than the poor, which means they have a higher willingness to pay for them. v^a, the marginal valuation of amenities, depends positively on available income $y - \tau \cdot x$ and the amenity itself $a(x)$:

$$v^a(y - \tau \cdot x, a(x)) \tag{3}$$

The Impact of Amenities on the Rich and Poor in the City

- In the amenity-based extension of Brueckner, Thisse, and Zenou (1999), there is an adjusted bid rent curve $\frac{\partial p(x)}{\partial x}$, which has an additional component that depends on amenities:

$$\frac{\partial p(x)}{\partial x} = -\frac{\tau}{q(x)} + \frac{v^a}{q(x)} \cdot \frac{\partial a(x)}{\partial x} \lessgtr 0 \tag{4}$$

  - The second component depends on v^a, the marginal valuation of amenities (assumed to be positive), and $\frac{\partial a(x)}{\partial x}$, whether amenities decrease or increase with distance to the city center.
  - The first result of the simple Alonso-Muth-Mills Model - rental prices decrease with distance to the city center - might no longer hold.
  - $\frac{\partial a(x)}{\partial x} < 0$: Amenities decrease with distance to the city center $\Longrightarrow$ Both components reinforce each other. Rental prices are cheaper on the outskirts to compensate for both travel and worse amenities!
  - $\frac{\partial a(x)}{\partial x} > 0$: Amenities increase with distance to the city center $\Longrightarrow$ If amenities on the outskirts are sufficiently attractive to outweigh the travel costs (first component), rents might rise with distance to the city center!

The Impact of Amenities on the Rich and Poor in the City

- Now let's compute the difference in rental bid curves of the poor and the rich in this amenity-based extension and see who lives in the city center:

$$\Delta = \frac{\partial p_P(x)}{\partial x} - \frac{\partial p_R(x)}{\partial x} \tag{5}$$

$$= \underbrace{-\frac{\tau_P}{q_P(x)} - \left(-\frac{\tau_R}{q_R(x)}\right)}_{\lessgtr 0} + \frac{\partial a(x)}{\partial x} \cdot \underbrace{\left[\frac{v_P^a}{q_P(x)} - \frac{v_R^a}{q_R(x)}\right]}_{<0} \lessgtr 0 \tag{6}$$

- The difference of the $\frac{\tau}{q}$ is indeterminate, probably close to zero. The bracket $\left[\frac{v_P^a}{q_P(x)} - \frac{v_R^a}{q_R(x)}\right]$ can be assumed to be negative: The richs' valuation of amenities is much higher than the poors'. Then it depends on $\frac{\partial a(x)}{\partial x}$:
- If $\frac{\partial a(x)}{\partial x} < 0$, so amenities are highest in the center (Paris!), Δ is the product of two negative factors and hence positive. $\Longrightarrow$ The rich's curve is steeper than the poor's (e.g. -1/10 - (-1/4) > 0) $\Longrightarrow$ Rich live in the center.

Summary of the Economic Mechanism of Residential Sorting

- The different extensions of the simple Alonso-Muth-Mills model have shown that whether rich inhabitants live in the city center or on the outskirts depends on various factors and their relative magnitude:
  - **Demand for larger apartments** q: Rich households can afford larger apartments at given rental prices and demand them. $\Longrightarrow$ Tendency for outskirts
  - **Income-dependent travel costs** τ: Rich households might value travel time more highly (opportunity costs). $\Longrightarrow$ Tendency for city center
  - **Amenities**: Both exogenous/geographical and endogenous/cultural amenities are valued more highly by rich households, who are willing to pay for them. $\Longrightarrow$ Tendency for wherever these amenities are located (Paris: in the city center, Detroit: no particular amenities according to Brueckner, Thisse, and Zenou, 1999)
- Let us now look at some empirical evidence for amenities - and at further patterns in the spatial distribution of rich and poor households

Geographical Amenities and the Spatial Income Distribution

- Can one show that desirable natural amenities attract high-income households to certain neighborhoods - and anchor them there persistently?
- Lin and Lee (2018) work with geographical features as well as income data from American cities:
  - 60,000 neighbourhoods across 308 metropolitan areas (beyond administrative borders, Long Beach as part of L.A.'s metro area) and 12 census years from 1880 to 2010
  - Empirical challenge: The amenity value of geographical factors is difficult to observe directly. Is an (industrial?) river an amenity or disamenity?
  - $\Longrightarrow$ Focus on geographical features with obvious benefits, such as coastal proximity

Geographical Amenities and the Spatial Income Distribution

$$\Delta r_{i,t} = \beta_0 + \beta_1 \mathbf{1}(a_i) + \beta_2 r_{i,t} + \delta_{m,t} + \epsilon_{i,t},$$

- Regress the forward change in neighborhood i's income percentile rank within metropolitan area m between t and $t+1$ on...
  - a dummy variable for superior natural amenity a_i
  - initial income rank of the neighborhood $r_{i,t}$
  - metropolitan area - year fixed effects $\delta_{m,t}$
  - other control variables: distance to city center, population density and average building age, to capture the historical structure of the city
- The baseline regression defines superior natural amenity as coastal proximity (within 500m of an ocean, the Gulf of Mexico or a Great Lake). Other regressions use elevation (on top of a hill!) or an aggregate natural amenity index in which also lakes, rivers, temperate climate and flood risk enter.

Geographical Amenities and the Spatial Income Distribution

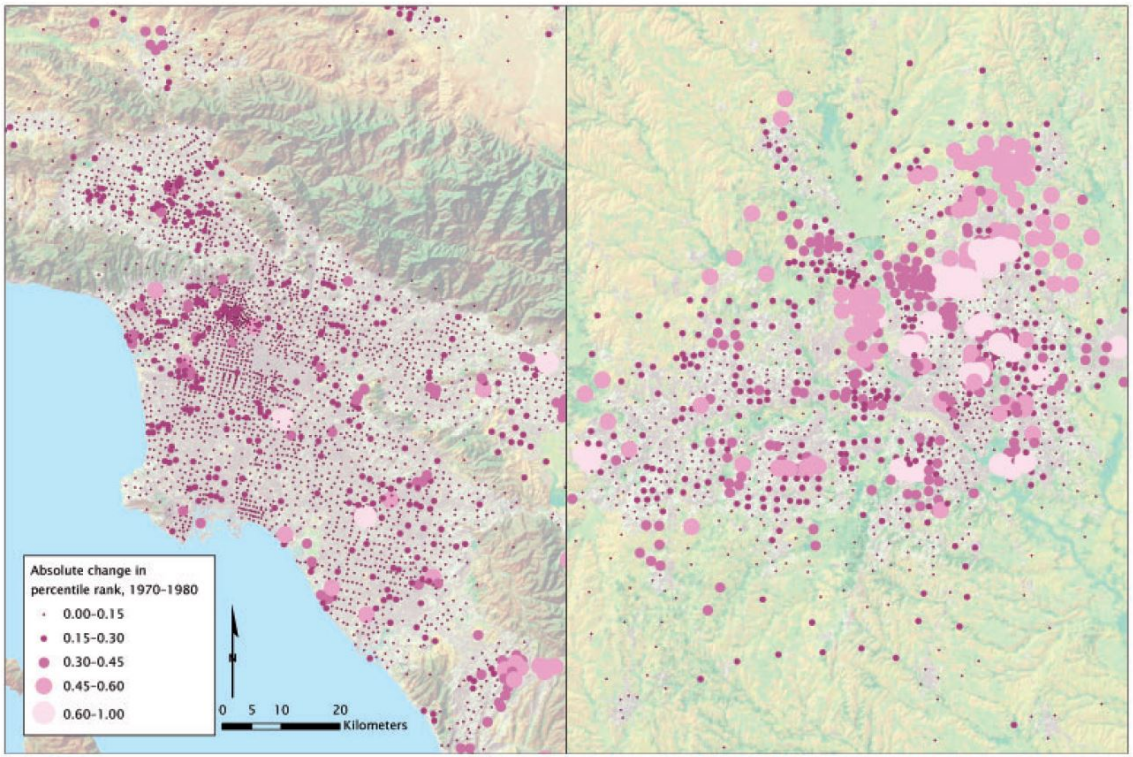
TABLE 2
Coastal proximity anchors neighbourhoods to high incomes

	μ [σ]	(1)	(2)	(3)	(4)
1(Coast)[a,b,c]	0.05	−0.004	0.013***	0.007*	0.014***
	[0.22]	(0.004)	(0.004)	(0.004)	(0.003)
Initial Percentile rank	0.50	−0.161***	−0.169***	−0.184***	−0.202***
by income ($r_{i,t}$)	[0.29]	(0.007)	(0.007)	(0.008)	(0.008)
Log distance to	5.02		0.028***		−0.004
nearest seaport[d]	[4.83]		(0.004)		(0.002)
Log distance to	7.51			0.035***	−0.008***
city centre	[1.95]			(0.003)	(0.002)
Log population	9.74				−0.036***
density	[1.04]				(0.001)
Log average	3.00				−0.019***
house age	[0.53]				(0.004)
Metro–year f.e.		✓	✓	✓	✓
R^2		0.081	0.090	0.116	0.202
Neighbourhoods		298,776	298,776	297,518	281,321
Metro–years		1,357	1,357	1,313	1,263

Conditioned on initial income, the income rank of coastal neighborhoods tends to increase 1.4 percentile points more every 10 years than interior neighborhoods

Geographical Amenities and the Spatial Income Distribution

- Cities with a variation of geographical amenities exhibit less of an up-and-down process with decline and gentrification
  - Los Angeles with its hills, beaches and valleys has persistently rich areas, compared to Dallas, which is more featureless and flat, and has a spatial income distribution that is subject to more changes over time



Geographical Amenities: Sunshine

- Let us look at another amenity which varies across a city: Sunshine!
- In particular, in temperate climate zones, households might be willing to pay for a sunny location. Why might direct insolation vary across the city?
  - Topographical considerations, such as being built in a valley or on the side of a mountain
  - Obstruction of the view by man-made objects, such as other buildings
- Fleming et al. (2018) work with data from New Zealand:
  - With geographical information on properties across New Zealand's cities, they calculate average daily sunshine hours by taking into account the topography, man-made features, zenith angles and elevation. Daily sunshine hours across the sample vary a lot: From a minimum of 3.7 daily hours (across the year) to more than 11 hours, with a mean value of 8.3 hours.
- $\Longrightarrow$ Residents are clearly willing to pay for sunshine, with 1 extra hour of daily sunshine increasing house prices by 2.4%, contributing towards a composition of high-income earners in the neighborhood.

Why is the Eastern part in many European cities poorer than the Western part?

- In strikingly many European cities, the Eastern part is poorer than the Western part.
  - Think about some examples!
- What can explain this East-West divide?
  - Sometimes, it might be particular historical conditions as in Berlin. But what about the other cities?
  - In London, the East is the location of the docks, because the Thames flows eastwards.
    - ★ Housing for the dock workers. In addition, the Thames took waste and smell eastwards.
  - But in Paris, the Seine flows westwards and still, the East is poorer than the West. And this holds for many cities without a river.
- Heblich, Trew and Zylberberg (2021) suggest a different explanation in their paper *'East Side Story'*.

Heblich et al. (2021): East Side Story



- Argumentation by Heblich et al. (2021): Air pollution in the period of industrialization

Heblich et al. (2021): East Side Story

- Chain of arguments:
  - In the middle latitudes (where most European cities are located), the wind mainly blows from West to East.
  - In the period of industrialization, this meant that the wind took air pollution from the chimneys eastwards.
  - Neighborhood sorting: Wealthy residents preferred to settle in the locations with clean air (the West), leaving poor workers in the East end.
  - Historical persistence: Quality of schools, cultural amenities, infrastructure, inheritance patterns, reputation... $\Longrightarrow$ East-west divide persisting after the closure of industrial factories
- Heblich et al. (2021) collect modern and historical income data, as well as data on the location of 5000 industrial chimneys in British cities in 1880. They use an atmospheric model to predict wind directions and pollution from these chimneys.

Heblich et al. (2021): East Side Story

- Differences in air quality in 1881 - between the 10th and 90th percentile of air quality in British cities - were associated with a 15 percentage point variation in the share of low-skilled workers in the neighborhood at that time.
- Comparison with pre-Industrialization: No excess poverty/ deprivation along this downwind axis before use the use of industrial coal.
- Persistence over time: The Clean Air Act from 1968 stopped pollution from coal burning in Britain. But historical air pollution still explains around 20% variation of high-skilled and low-skilled workers across neighborhoods in 2011. And it even explains 40% of the variation in house prices across neighborhoods.
- Hence, while historical air pollution is certainly not the only determinant of the spatial distribution of income along an East-/West axis of a city, it does contribute - and it shows the importance and persistence of history.
- Is history destiny? The data show some evidence of mean-reversion for neighborhoods of medium historical pollution (history loses influence), while the most polluted and least polluted areas remain relatively poor or rich.

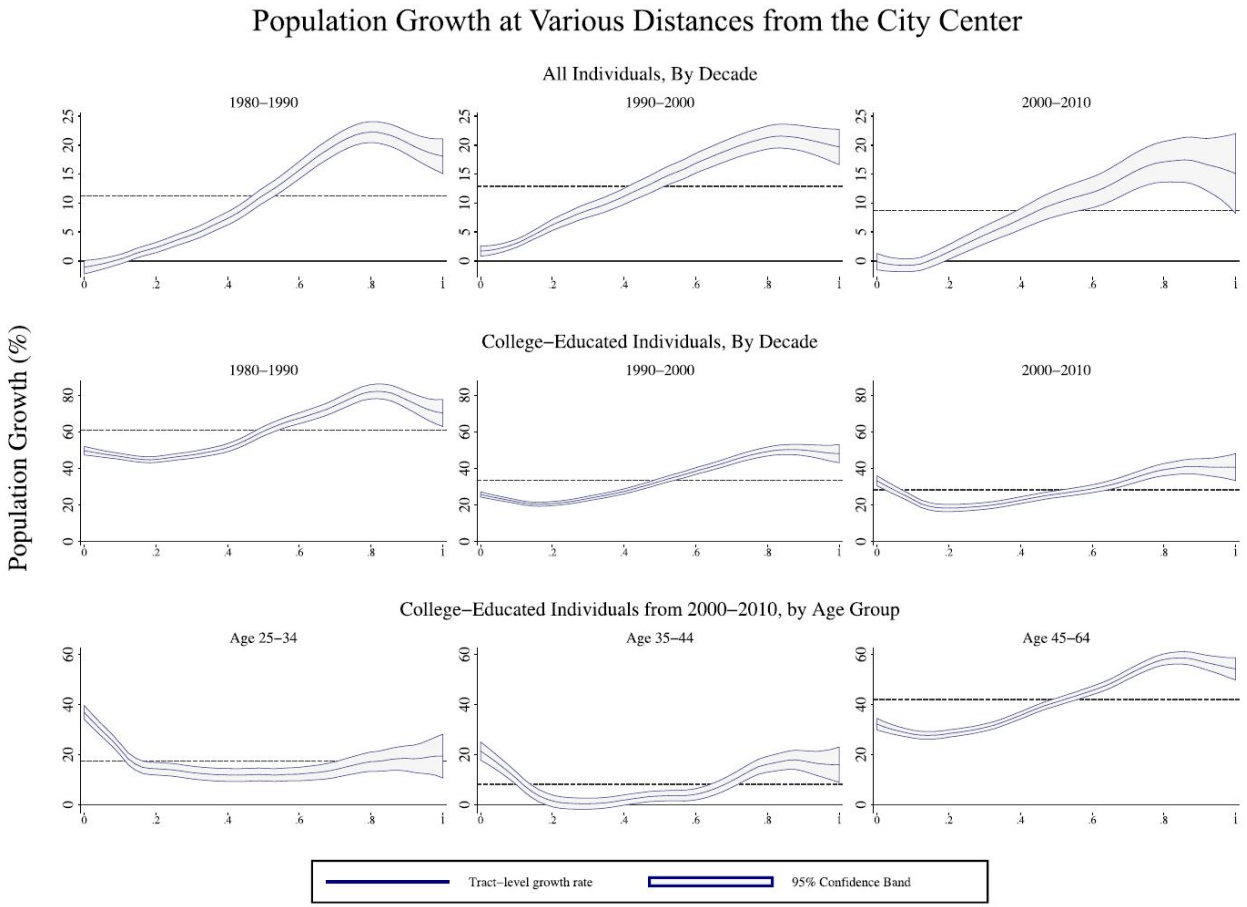
Tracing this 'Path of Pollution' in Germany

- Does the channel of historical pollution -> settlement patterns -> modern inequality also hold beyond English cities?
- Germany: **Has World War II destruction and reconstruction mitigated the rich-poor patterns induced by industrialization-era air pollution?**
  - Hanitzsch, Krause and Seidel (2026, Work in Progress) work with historical maps of the 40 largest German cities
  - Geo-coding of industrialization-era (1880-1910) factory locations. Input these locations into a meteorological model to obtain historical air pollution, as a predictor of rich-poor settlement patterns. Combine this with geo-coded war damage from post-war historical maps.
  - Regress modern-day income per 1 km^2 gridcell on historical air pollution: Negative sign! Also regress it on an interaction term of historical air pollution with war destruction: Positive sign! In more strongly destructed urban areas after WWII, industrialization-era pollution predicts modern incomes less strongly. Different magnitudes in East and West German cities to be analyzed.

Change in the Spatial Income Distribution

- While exogenous amenities anchor the rich persistently to certain parts of the city and historical pollution patterns still matter today...
- ... change in the spatial income distribution is occurring. Under certain circumstances, formerly poor neighborhoods can attract wealthier residents.
  - Certain neighborhoods in London's East End are becoming cool, hip, more expensive - and gentrified. They are benefiting from London's overall attractiveness; it does not necessarily hold for the Eastern parts of other British cities.
  - The city centers of many American cities traditionally had rather poor residents ('Poor Downtown Detroit'), with richer Americans living in suburbs on the outskirts. Yet, cultural, endogenous amenities are... endogenous. More restaurants, bars, galleries are attracting new residents with relatively high income to the city center. See Couture and Handbury (2020), *'Urban Revival in America'*.

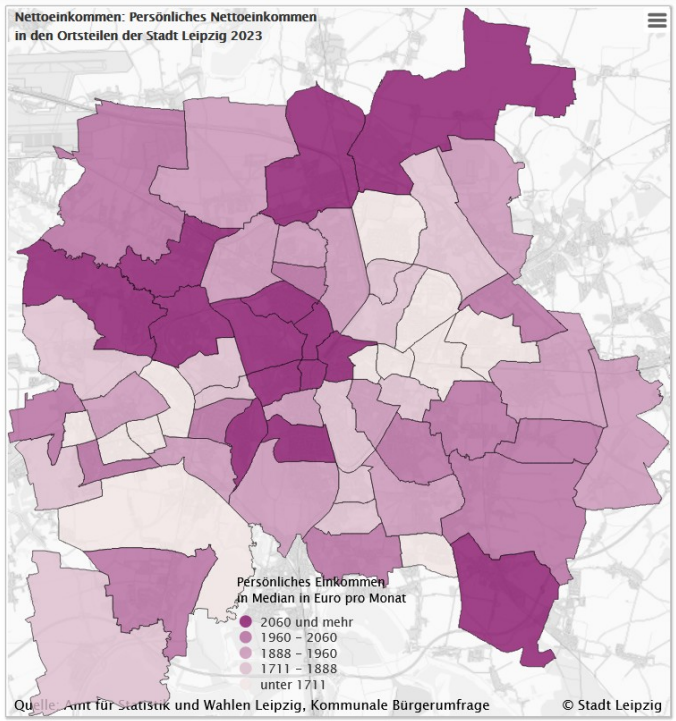
Couture and Handbury (2020), Urban Revival in America



It is the young (25-34, 35-44 years) and highly-educated (and therefore rather high earners) that have in recent years been moving to American city centers. Will these new patterns be long lasting?

Finally: A Look at the Spatial Income Distribution of Leipzig

Median net income per capita (not per household) in each city district of Leipzig in 2023



Which of the factors discussed might contribute to the highest mean income in...

- the city center / Zentrum Nord(west) / Waldstraßenviertel / Gohlis?
- the West (Altlindenau, Böhlitz-Ehrenberg, Burghausen-Rückmarsdorf)?
- the very North East (Seehausen, Plaußig-Portitz)?

Wrap-Up of Unit 9

- **Extensions of the Alonso-Muth-Mills model** can shed light on the underlying economic mechanisms why rich residents live in the city center or on the outskirts. Important factors are demand for larger apartments, income-dependent travel costs, and the location of amenities.
- **Amenities** can be exogenous/ geographical (ocean or river view, more sunshine) or endogenous/ cultural (historical buildings, museums, restaurants, nightlife).
- **Geographical amenities** have been shown to anchor the rich persistently to certain neighborhoods of a city.
- Historical features can still influence the spatial income distribution in cities nowadays, as illustrated by the contribution of **Industrialization-era air pollution** to spatial income differences in English and German cities.
- **Endogenous/ cultural amenities** can under certain conditions accelerate neighborhood change by attracting wealthier residents to formerly poor parts of the city.

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