Effect of school quality on housing prices in NRW

Project Outline - Hedonic Housing Models and School Quality

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Research Question

Main question

To what extent does the local availability of upper secondary schools that offer an Abitur pathway, compared to other secondary schools, affect housing prices in North Rhine-Westphalia (NRW)?

- Goal: Estimating heterogeneity in the capitalization of secondary schools that offer the possibility to achieve higher educational outcomes.
- We assume that parents are willing to pay a premium for their homes, if a school lies within 2km at which their children can make an Abitur (Gymnasium or Gesamtschule)
- Therefore, we restrict our analysis on differen types of secondary schools and exclude elementary schools

Motivation

- School quality is a major location factor in housing decisions.
- Previous studies have shown that better schools are capitalized into higher housing prices.
- However, the **magnitude of the effect may differ by school level or track** and most studies suffer from the endogeneity problem of hedonic price regressions
- Germany's multi-track secondary school system is particularly suited to explore these differences.

Theoretical Framework

- **Tiebout Sorting:** Households "vote with their feet" by moving into districts with desirable public goods – such as schools.
- **Human Capital Channel:** Secondary schools (especially Gymnasien) impact long-run outcomes like university access, thus potentially commanding higher price premiums.

Institutional Context and Literature Insight

- In Germany, parents enjoy considerable freedom in choosing schools — especially at the secondary level.
- Although this weakens formal ties between residence and school assignment, it may **increase behavioral selection** into high-quality school areas.

Key Insight:

When school choice is flexible, households with strong school preferences are more likely to relocate to access better schools — reinforcing the link between school quality and housing prices. [1]

- *Implication:* School choice flexibility does not reduce capitalization — it may even **enhance** it through self-selection.

Literature Insights (excerpt)

- UK: Strong capitalization of **primary school** performance into housing prices. [4]
- US: Stronger price effects from **middle and high school** quality than from elementary schools.[8]
- France: Secondary school quality capitalized more strongly in areas without **private school alternatives**. [3]

School type matters for the strength of the housing price effect.#

Data and Variables

Housing Data:

- Geo-referenced listings of sales properties (e.g., ImmoScout).
- Variables: living space, number of rooms, year built, condition, etc.

School Data:

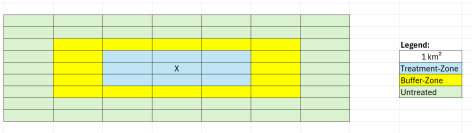
- Locations and types of schools (primary, Gymnasium, Gesamtschule, etc.)
- School quality measured by the **School Social Index (SSI)** — lower values indicate better schools.

Regional Data:

- Includes information on neighborhood characteristics (e.g. income levels, migration rates etc.)

Empirical Strategy

We define spatial treatment zones to estimate the causal effect of upper secondary schools on housing prices using grid-cells:



- **Treatment-Zone** Grid-cells **within ca. 2 km** radius
- **Buffer zone:** within **1 km** are excluded to prevent spillover contamination
- **Untreated zone:** Grid-cells **more than 3 km** from any school
- Houses that are exposed to different kinds of secondary schools at the same time (double-treated) are also excluded from the sample

Identification Strategy

Potential Outcome Model (POM): following [7]

$$\ln(P_{ijt}) = \begin{cases} \ln(P_{1ijt}) & \text{if } D_i = 1, \\ \ln(P_{0ijt}) & \text{if } D_i = 0. \end{cases}$$

where:

$\ln(P_{1ijt})$: Price of the house, when it lies in the treatment-zone near to a Gymnasium or Gesamtschule.

$\ln(P_{0ijt})$: Price of the house, when it would not have been 'exposed' to a school (counterfactual).

Note

Since the counterfactual is not observed, we use the most similar house lying in the non-treated zone as a proxy for the counterfactual.

Matching Strategy

Identification Assumption (CIA):

$$\ln(P_{0ijt}), \ln(P_{1ijt}) \perp D \,|X_i$$

Estimation method: We use **matching** on observable covariates to compare treated and untreated buildings:

- Building characteristics (e.g., floor area, construction year, amenities)
- Neighborhood characteristics (e.g., income, urbanity, regional fixed effects)

After successful matching, the treatment effect is estimated through the following equation [2]:

$$\begin{aligned}\tau_{\text{school}} &= \mathbb{E}\big[\ln(P_{1ijt}) - \ln(P_{0ijt}) \,\big|\, X_i\big] \\ &= \mathbb{E}\big[\ln(P_{1ijt}) \,\big|\, X_i, D=1\big] - \mathbb{E}\big[\ln(P_{0ijt}) \,\big|\, X_i, D=0\big]\end{aligned}$$

Econometric Model (OLS Specification)

We estimate the following log-linear autoregressive hedonic regression for elementary and secondary schools each [6]:

$$\log(\mathsf{P}_i) = \alpha + \beta_1 D_i + \mathbf{X}_i'\gamma + \mathbf{N}_i'\delta + \mathsf{FE}_{r(i)} + \varepsilon_i$$

Where:

- $\log(P_i)$: price of a building per m^2
- $\beta_1 D_i$: Captures the effect of the treatment of the nearest upper secondary school
- $\mathbf{X}_i$: vector of building characteristics
- $\mathbf{N}_i$: vector of neighborhood characteristics, includes the SSI for a proxy of the social composition
- $\mathsf{FE}_{r(i)}$: Regional fixed effects to account for spatial effects at the grid-cell level
- ε_i: error term

Assumptions - Part 1

- The School Social Index (SSI) serves as an indirect proxy for school quality since it captures the socio-economic composition of the student body and allocation of compensatory resources to schools
- Parents consider the SSI in their housing decision
- Within the treatment area and the control area, the effect is constant
- Buildings inside and outside of the treatment zones share the same average housing and neighborhood chararcteristics

Assumptions - Part 2

- Conditional on the controlling for both housing and neighborhood characteristics, the treatment assignment can considered to be random
- Including the autoregressive term into the regression, we account for **unobservable regional differences and dependencies**
- Sale prices are time-independently exceeding offer prices at a constant rat

Empirical Challenges and Limitations

- **Endogeneity:** better schools tend to be located in affluent neighborhoods and students endowed with those priviledged backgrounds generally achieve higher educational outcomes [3]
- **Measurement:** SSI is an aggregate proxy and may not fully capture educational quality.
- **School access rules:** In some regions, school choice or private alternatives may weaken capitalization effects.
- **Interpretation:** It is arguably that property prices can be interpreted as the willingness to pay for amenities [5] and therefore the difference between the groups as a premium for educational opportunities
- **Price validity:** Property prices from ImmoScout are *asking prices* — not actual transaction prices. This has implications on the interpretations of the results and has to be taken into account.

[1] Patrick Bayer, Fernando Ferreira, and Robert McMillan. "A Unified Framework for Measuring Preferences for Schools and Neighborhoods". In: *Journal of Political Economy* 115.4 (2007), pp. 588–638. ISSN: 00223808, 1537534X. URL: http://www.jstor.org/stable/10.1086/522381 (visited on 12/02/2025).

[2] Firmin Doko Tchatoka and Vanessa Varvaris. "Neighbourhood, school zoning and the housing market: Evidence from New South Wales". In: *Journal of Housing Economics* 54.C (2021). DOI: 10.1016/j.jhe.2021.101790. URL: https://ideas.repec.org/a/eee/jhouse/v54y2021ics1051137721000401.html.

[3] Gabrielle Fack and Julien Grenet. "When do better schools raise housing prices? Evidence from Paris public and private schools". In: *Journal of Public Economics* 94.1 (2010), pp. 59–77. ISSN: 0047-2727. DOI: https://doi.org/10.1016/j.jpubeco.2009.10.009. URL: https://www.sciencedirect.com/science/article/pii/S0047272709001388.

[4] Steve Gibbons and Stephen Machin. "Valuing English primary schools". In: *Journal of Urban Economics* 53.2 (2003), pp. 197–219. ISSN: 0094-1190. DOI: https://doi.org/10.1016/S0094-1190(02)00516-8. URL: https://www.sciencedirect.com/science/article/pii/S0094119002005168.

[5] Wadu Mesthrige Jayantha and Siu Oi Lam. "Capitalization of secondary school education into property values: A case study in Hong Kong". In: *Habitat International* 50 (2015), pp. 12–22.

[6] Yi Lu, Vivien Shi, and Christopher Pettit. "The Impacts of Public Schools on Housing Prices of Residential Properties: A Case Study of Greater Sydney, Australia". In: *ISPRS International Journal of Geo-Information* 12 (July 2023), p. 298. DOI: 10.3390/ijgi12070298.

[7] Donald B. Rubin. "Estimating causal effects of treatments in randomized and nonrandomized studies.". In: *Journal of Educational Psychology* 66 (1974), pp. 688–701. URL: https://api.semanticscholar.org/CorpusID:52832751.

[8] Norman H. Sedgley, Nancy A. Williams, and Frederick W. Derrick. "The effect of educational test scores on house prices in a model with spatial dependence". In: *Journal of Housing Economics* 17.2 (2008), pp. 191–200. ISSN: 1051-1377. DOI: https://doi.org/10.1016/j.jhe.2007.12.003. URL: https://www.sciencedirect.com/science/article/pii/S1051137708000090.