

# 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 different 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.

## Tiebout sorting

- The decision-making process of residents includes the availability and quality of provided public goods and services within a municipality
- Under the assumption of perfect mobility, residents pick the community that exactly satisfies their preferences
- If such a community or municipality is not feasible, a perfect substitute (if existent) is chosen

# Theory

- Educational quality is an important part of the set of considered public goods, because quality schooling is often decisive for later life outcomes (e.g. labor market opportunities, income, health)
- Shapes the way parents sort into the housing market, directly influencing the level of residential segregation (Bayer et al. 2007)
- Ongoing debate about which dimension of education is valued by parents (outputs vs. learning environments and sociodemographic composition; Machin 2011)

## Theory 2

- Households sort across boundaries, generating differences in neighborhood quality — here: education
- Parents are willing to pay a premium for housing units near top-tier schooling networks (Jayantha 2015)

This capitalizes into the housing market via two mechanisms (La 2015):

- Wealthier households that care about school quality bid up prices within the walking zone of a school
- This may generate spillovers through changes in neighborhood composition

# Hypothesis

Based on the theoretical background, we expect the following results:

- Parents value the opportunity to achieve higher educational outcomes for their children (z.B. Hörnig & Schäfer 2025)
- Educational opportunities play a role in parents' housing decisions
- Parents are therefore willing to pay a premium for houses near a secondary school offering the opportunity to obtain an *Abitur*

## Formal Hypothesis

[  $\_1 \{ \text{school} \}$  &= Estimated treatment effect  $H\_1$  &:  $\_1 > 0$  ]

## 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:

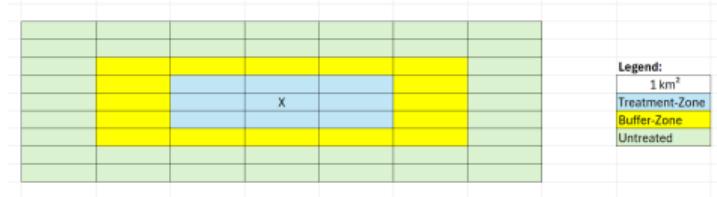
- Locations and types of schools (primary, Gymnasium, Gesamtschule, etc.)
- School quality measured by the **School Social Index (SSI)** — lower values indicate better schools.

## 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]:

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

## Econometric Model (OLS Specification)

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

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

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
- $\text{FE}_{r(i)}$ : Regional fixed effects to account for spatial effects at the grid-cell level
- $\varepsilon_i$ : 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 characteristics

## Assumptions - Part 2

- Conditional on the controlling for both housing and neighborhood characteristics, the treatment assignment can be 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 rate

## Empirical Challenges and Limitations

- **Endogeneity:** better schools tend to be located in affluent neighborhoods and students endowed with those privileged 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>.
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- [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.
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- [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>.