

# Availability of Abitur and Non-Abitur Upper Secondary Schools and Housing Prices in NRW

Project Outline - Hedonic Housing Models and School Quality

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# Table of contents I

- 1 Introduction
- 2 Theoretical Framework
- 3 Insights from relevant empirical literature
- 4 Empirical Design
- 5 Results
- 6 Policy Implications and further research
- 7 Appendix

## Section 1

### Introduction

# 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 3km 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 and other specialised or private schools

## Motivation

- School availability and quality plays an important role in housing decisions.
  - Previous studies have shown capitalization of school quality into housing prices, but evidence on differences across upper secondary school tracks is limited.
  - Especially the capitalization effects of upper secondary school availability as an implicit measure of school quality
  - However, the **magnitude of the effect may differ by school track** and most studies suffer from the endogeneity problem of hedonic price regressions.
  - Germany's multi-track secondary school system provides a unique setting to study differential capitalization effects across educational tracks.

# Institutional Context and Literature Insight

- In NRW, parents enjoy considerable freedom in choosing schools — especially at the secondary level since the reform in 2008/09
- Although this weakens formal ties between residence and school assignment, it may **increase behavioral selection** into high-quality school areas.

## Section 2

### Theoretical Framework

# Tiebout sorting

- The decision-making process of residents include the availability and quality of provided public goods and services within a municipality
- Under the assumption of perfect mobility, residents pick that community that exactly satisfies their preferences (Tiebout [10], p. 421)
- If such a community or municipality is not feasible, a perfect substitute (if existent) is to be chosen

# What do parents value?

- Educational quality is an important part of the set of considered public goods, because quality schooling is often decisive in later life-outcomes (e.g. labor market opportunities, gained income, health etc.)
- Shape the way in which parents sort into the housing market directly influencing the level of residential segregation (Bayer et al. 2007)
- Ongoing debate, which dimension of education is valued by parents (outputs or learning environments containing sociodemographic composition) - Machin 2011
- We want to test whether the availability of upper secondary schools is such a dimension

# Capitalization mechanism

- Households sort across boundaries generating differences related to neighborhood quality - in this case: Education
- Parents are willing to pay a premium for housing units nearby top-tier school networks (Jaynatha 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:

- Education is one of the most important public services (Zhang 2020) and it is therefore reasonable to test the channel
- Educational opportunities play a role in parents' housing decisions
- Parents value the opportunity to achieve higher educational outcomes for their children (z.B. Hörnig & Schäfer 2025) because of their decisiveness for later life outcomes
- Parents are therefore willing to pay a premium for houses near a secondary school offering the opportunity to obtain an *Abitur*

## Formal Hypothesis

$$\tau_{\text{school}} \text{ (Estimated treatment effect): } H_1 : \beta_1 > 0$$

## Section 3

Insights from relevant empirical literature

## Literature Insights (excerpt)

- Generally speaking, the empirical literature mainly focused on the capitalization effects of school quality
- UK: Strong capitalization of **primary school** performance into housing prices. [5]
- US: Stronger price effects from **middle and high school** quality than from elementary schools.[9]
- France: Secondary school quality capitalized more strongly in areas without **private school alternatives**. [4]

### 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.

## Section 4

### Empirical Design

# Basic Identification Assumptions

## Theoretical Assumptions:

- Households/parents derive utility from the perceived quality of schooling [2] available to their child
- Parents consider the availability of Abitur and non-Abitur upper secondary schools in their housing decisions.

## Empirical Assumptions:

- The parents preferences regarding their children's education are reflected by hedonic price regressions
- Conditional on the controlling for both housing and neighborhood characteristics, the treatment assignment can be considered to be random.
- Within the treatment area and the control area, the capitalization effect is constant.

## Assumptions (part 2)

- Buildings inside and outside of the treatment zones share the same average housing and neighborhood characteristics.
- Sale prices are time-independently exceeding offer prices at a constant rate.
- Property prices can be interpreted as the willingness to pay for amenities because they are determined by relevant characteristics
- The School Social Index (SSI) provides a reasonable proxy for neighborhood socio-economic composition, as it reflects the socio-economic background of students.

# Data and Variables

## Housing Data:

- Geo-referenced listings of sales properties (e.g., ImmoScout).
- Variables: living area, site area, number of rooms, number of bathrooms, year of construction, cellar

## School Data:

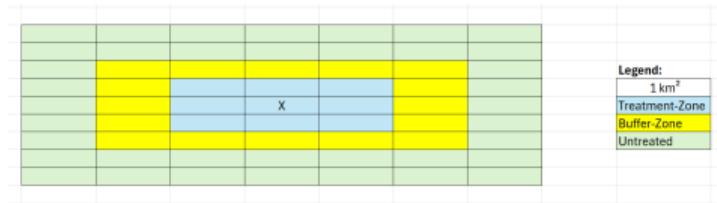
- Locations and types of schools (primary, Gymnasium, Gesamtschule, etc.)
- School quality measured by the **School Social Index (SSI)** — lower values indicate better schools.

## Regional Data:

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

# Quasi-experimental approach

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. 3 km** radius
- **Untreated zone:** Grid-cells **3-4 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

## Robustness check

As a robustness check, we define the treatment zone within a 2 km radius and exclude a **Buffer zone** of 1km around it to prevent spillover contamination

# Identification Framework

**Potential Outcome Model (POM):** following [8]

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

**where:**

$\ln(P_{1ij})$  : Price of the house, when it lies in the treatment-zone  
near to a secondary school.

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

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

**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 [3]:

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

## Econometric Model (OLS Specification) - First model

We estimate the following log-linear autoregressive hedonic regression for elementary and secondary schools each [7]:

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

Where:

- $\log(P_i)$ : price of a building per  $m^2$
- $D_i$ : Is within treatment distance to a secondary school ( $=1$ ) or not ( $=0$ )
- $\mathbf{X}_i$ : set of building characteristics
- $\mathbf{N}_i$ : set 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

## Multiple treatment regime - Second model

We are especially interested in the price premium of an available school that offers academic track compared to other secondary schools (treatment heterogeneity).

The basic specification is extended referring to a multiple treatment regime:

$$\log(P_i) = \alpha + \beta_1 D_i + \beta_2(D_i \times A_i) + \mathbf{X}'_i \gamma + \mathbf{N}'_i \delta + \text{FE}_{r(i)} + \varepsilon_i$$

**Where:**

- $A_i$ : Nearest school offers academic track (=1), otherwise (=0)
- All other variables are the same as for the main specification

## 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 [4]
- **Assumptions:** It may be unrealistic that the capitalization effects of upper secondary schools are uniform across the whole space [11]
- **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 [6] 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.
- **Data:** Incomplete sets of observed building ( $X_i$ ) and neighborhood ( $N_i$ ) characteristics

## Section 5

### Results

## Section 6

Policy Implications and further research

## Section 7

## Appendix

# Control Variables

## **Structural/House Characteristics**

number of bedrooms, full and half baths (full baths, half baths), the number of fireplaces, the age of the structure in linear and quadratic form (house age, age squared), the lot size on which the structure is located, and size of the structure measured in square feet. (clark2002)

## **Neighborhood characteristics**

# Controls

Table 1: Control variables and categories

Variable	Description	Category
<b>Property characteristics</b>		
living_area	Living area of the dwelling (m <sup>2</sup> )	Property character
rooms_n	Number of rooms	Property character
age_building	Age of the building (years)	Property character
<b>Neighborhood characteristics</b>		
immigrants_percents	Share of immigrants in the 1 km grid (%)	Neighborhood cha
average_age	Average age of residents in the neighborhood	Neighborhood cha

# Literature I

- [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).
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- [7] 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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