Erasmus University Rotterdam
Erasmus School of Economics
Bachelor Thesis International Economics and Business Economics

The Impact of tuition fees on enrollment in Germany: A synthetic control approach

Yunis Griebenow (582348)

Supervisor:	Prof. dr. (Ivo) IJM Arnold
Second assessor:	Prof. dr. Dinand Webbink
Date final version:	4th August 2023

Abstract

This thesis investigates the impact of introducing tuition fees for higher education in certain German states on enrollment behavior. Previous research mainly applied the difference-in-difference methodology to examine effects, whereas this empirical approach is based on the synthetic control methodology. The study separately analyzes the impacts on three outcome variables related to enrollment rates in the four largest treated states. In contrast to most existing studies, the findings do not indicate a significant direct effect on enrollment rates but suggest an impact on student mobility. The results suggest that approximately 1% to 2.5% of prospective students affected by the implementation opt to move to a state without tuition fees. However, other structural changes affect the trajectory of the outcome variables differently for the treated and control units during the post-intervention period, making it challenging to draw definitive conclusions about the impacts.

1 Introduction

The financing of higher education institutions has been the subject of intense political debate. In particular, whether and to what extent students should contribute directly to the financing of their higher education. The lack of consensus around the topic is underscored by the differences in the share of public- and private spending on tertiary education between OECD countries. Countries like the United States and the United Kingdom finance a high share (64.3% and 72.6%) of their tertiary education privately, whereas many others rely heavily on public funding (OECD, 2022). Germany, for example, finances its tertiary education mostly publicly (81,2%), but has also extensively discussed the topic. Particularly an implementation of tuition fees and the corresponding effects.

Nevertheless, a consensus about the effects of tuition fees in Germany is still missing. This is not only reflected in the different responses of federal states but was also a source of disagreement among experts at a public debate in the Committee on Education, Research, and Technology Assessment in January 2012. Where the emergence of numerous conflicting empirical statements further emphasized the need for more comprehensive research on the subject (Müller, 2012).

The aim of my research is to elaborate on the question: *How introduction and abolition of tuition fees at higher education institutions in Germany impact the enrollment behavior of prospective students?* To address this question, I conduct an extensive analysis based on data obtained from official statistics, which contain information on all students in Germany. The tuition fee reforms in Germany represent a unique natural experiment: some federal states introduced tuition fees starting in 2006 and abolished them successively from 2008 to 2014, while other states did not introduce tuition fees at all.

To date, several research papers have been conducted focusing on this specific reform (see, e.g., Hübner, 2012; Dietrich & Gerner, 2012; Bruckmeier & Wigger, 2014; Bietenbeck et al., 2023). Most of the previous studies utilize the difference-in-difference methodology to assess the effects of tuition fee introductions on enrollment. They rely on the same official statistical data but are limited to the period before 2010. This research seeks to contribute to the existing literature by employing an advanced statistical method, extending the investigation period, and addressing additional potential biases. Applying the synthetic control methodology as my primary research approach enables me to closer examine the treatment and comparison units. And therefore fits my intention to bring more transparency to the discourse surrounding tuition fees. To achieve this, I analyse three outcome variables for each treated state separately. Aiming to disentangle and filter out the effects as much as possible. More specifically, I focus on the three outcome variables: 1. Higher education enrollment rates based on the state of the high school; 2. Enrollment rates based on the state of the higher education institution; and 3. The difference between these two rates.

Consequently, my findings diverge from most previous research, as they indicate no significant direct effects of tuition fees on enrollment rates. Nevertheless, the study points out that tuition fees may influence student mobility. After considering potential biases, the results suggest that approximately 1% to 2.5% of high school graduates in states with tuition fees choose to enroll in higher education institutions in other states without fees.

To systematically address my research question, I start with a Literature Review, which presents the key findings of relevant previous studies. Next, contextual information is given in the Institutional Background section. Subsequently, the Data and Methodology parts offer comprehensive details on the empirical approach and the data used. And lastly, the results are interpreted and discussed in the Results and Conclusion sections.

2 Literature Review

Previous studies have already extensively discussed the impact of tuition fees on the demand for higher education. The research branch related to the human capital theory has been highly influenced by Gary S. Becker with his book *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education* (1964). He argued that education should be perceived as an investment in human capital. And at the same time, emphasizes the market failure created by the inability of students to borrow money based on possible future earnings.

Resting upon Becker's human capital theory, a strand of literature relating to the effect of tuition fees and other economic factors on enrollment established itself (see, e.g., Fredriksson, 1997; Huijsman et al., 1986; Kane, 1996; Leslie & Brinkman, 1987). The findings are consistent with economic theory and suggest that economic incentives are positively related to the demand for education. Huijsman et al. (1986), as well as Leslie and Brinkman (1987), conclude that tuition fees decrease enrollment and find the opposite effect for financial aid. Correspondingly, Kane (1996) investigates the interface of these two effects and highlights the impact of borrowing constraints. Fredriksson (1997) extends the research by estimating the influence of other economic variables on the demand for higher education. The findings advise that economic changes affecting the university wage premium should also be considered when exploring changes in the demand for higher education.

More recent papers in the field support the consensus about the negative effects of tuition fees on enrollment (see, e.g., Canton & De Jong, 2005; Dearden et al., 2011; Neill, 2009). The studies contribute to the existing research on the topic by trying to estimate the magnitude of the effect. Nevertheless, Canton and Jong (2005) observe that the elasticity of the demand for higher education with respect to tuition fees is rather insignificant, whereas financial support is suggested to have a significant positive effect. Still aligning with the human capital theory, the paper argues that the results are caused by the comparably small extent of the tuition fee increases. Neill (2009) and Dearden et al. (2011) present some more concrete outcomes. Former finds that a C$1000 increase in tuition fees reduced enrollment by between 2.5% and 5%. Latter estimates a £1,000 raise in fees would decrease enrollment by around 3.9%. Additionally, Dearden et al. (2011) find that a £1,000 increase in grants results in a 2.6% increase in demand for higher education.

Another important literature branch regarding the effects of tuition fees investigates the corresponding inequality concerns. The arguments for- and against free higher education relating to the fairness aspect are conflicting. On the one hand, everyone should have the right to attain education, and cost barriers could make it inaccessible for people from low-income households. On the other hand, private returns to higher education are proven to be high, and middle- and upper-class families continue to benefit disproportionately from higher education (Marcucci & Johnstone, 2007). Relating to the discussion, the effect of tuition fee adjustments on Canadian university attendance among various income levels is examined by Coelli (2009). According to the study, enrollment of low-income students was most significantly impacted by tuition fee increases, while enrollment of other youth was less affected.

Redirecting the focus to the literature concerning the tuition fee reform that is being investigated in this paper. The natural experiment setting created through the policy change in Germany has been exploited by various studies, especially for conducting comparative analyses. Similar to the previously mentioned, most established research about the effects of tuition fees, the studies concerning the German reform mainly examine the impact on enrollment. Most of these papers utilize the difference-in-difference methodology (Hübner, 2012; Dietrich & Gerner, 2012; Bruckmeier & Wigger, 2014; Bietenbeck et al., 2023), but a consensus is missing. Dietrich and Gerner (2012), as well as Hübner (2012), find a negative effect of tuition fees on enrollment behavior, whereas Bruckmeier and Wigger (2014) conclude no significant effect on higher education entry rates. The most recent paper on the reform by Bietenbeck et al. (2023) supports the negative effect.

The internal validity of the difference-in-difference methodology heavily relies on the parallel trends' assumption, which assumes that the difference between the treatment and control groups remains consistent in the absence of treatment. Considering the most cited paper related to the reform (Hübner, 2012), the assumption seems to hold at first sight. Similar to my analysis, the difference-in-difference approach is based on data collected by the German Federal Statistical Office. Hübner (2012) compares the higher education enrollment probabilities for high school graduates of non-fee and fee states for the period between 2002 and 2008. The treatment group is calculated based on the average of all states that have introduced tuition fees. And the variable of interest measures the share of high school graduates in state k that enroll in higher education in the year of high school completion. The results suggest a negative effect of 2.7%.

Bruckmeier and Wigger (2014) further examine the results of Hübner (2012) and offer additional insights. Acknowledging the fact that all the treatment states are in West Germany, whereas most states in the control group are located in East Germany, they searched for structural changes that differed between the treatment and control groups. The findings specifically address one structural difference. Due to a strong decline in birth rates in the former DDR, the number of high school graduates in certain East-German states began to decrease after the reunification in 1989. Conversely, in the other states, the number of high school graduates continued to rise steadily from 2007 onwards. Hübner (2012) investigates the rate of high school graduates that enroll in higher education, which should not be directly affected since it is only measuring the ratio. Nevertheless, since admission to many studies in German higher education is competitive, the likelihood of getting accepted by a higher education institution can be assumed to be negatively influenced by the number of high school graduates. In consideration of this possible bias, Bruckmeier and Wigger (2014) use the number of high school graduates as a control variable, which leads to their finding of no significant results.

Lastly, the study of the German Institute for Economic Research by Bietenbeck et al. (2023) can be considered as particularly relevant due to its recent publication. The difference-in-difference analysis is also based on data collected by the German Federal Statistical Office. But uses another approach to estimate the higher education entry rate of high school students and considers the period between 2001 and 2010. Bietenbeck et al. (2023) estimate the fraction of high school graduates who enroll at a university up to one year after leaving high school. Besides that, their estimation strategy is comparable to the difference-in-difference methodology that Hübner (2012) uses and therefore subject to the previously addressed limitations. As expected, they find a negative effect, but with a higher magnitude (3.9%). This result is proportional to the finding of Hübner (2012), considering the overall higher enrollment rates when including admissions up to one year after high school graduation.

The aim of this research paper is to overcome some of the limitations of previous papers. To achieve this, I employ a new statistical method that allows me to examine each treatment state individually. Described by Athey and Imbens (2017) as "arguably the most important innovation in the policy evaluation literature in the last 15 years" (Athey & Imbens, 2017), the in this paper used synthetic control methodology offers a new way to estimate the counterfactual. This approach expands on the difference-in-differences estimation but has the advantage of consistently better fitting counterfactuals. To attain this, the control units are weighted differently instead of using a single control unit to minimize the pre-intervention gap between the treatment and control groups. Ergo, the method not only increases the probability for the parallel trends' assumption to hold but also allows for further insights into the composition of the counterfactual. This has the benefit that biases caused by, e.g., differences in birth rates, as mentioned by Bruckmeier and Wigger (2014), can be examined closely. Additionally, this paper extends the investigated time and thus considers the complete intervention period.

3 Institutional Background

Over the past few decades, German higher education has undergone substantial policy changes in terms of financing. In 1976, during the governance of the Social Democratic Party of Germany (SPD), the federal university law (Hochschulrahmengesetz) was introduced, which legally prohibited tuition fees at the federal level (*Hochschulrahmengesetz*, 2019). Since then, an ongoing debate on tuition fees has persisted between the two major political parties in Germany, namely the SPD and its conservative opposition, the CDU. The ban endured until six federal states[1], at this time all governed by the CDU, won their case in front of the Federal Constitutional Court in 2005. They argued that the federal university law interferes with the autonomy of the states in determining their education system. Seven federal states reacted to the decision by introducing tuition fees, none of which were governed by the SPD or part of East Germany.

Treatment state	Legislation passed	Introduced	Abolished	Average fees
Baden-Württemberg	15/12/2005	Spring 2007	Spring 2012	€500
Bavaria	23/05/2006	Spring 2007	Fall 2013	€450
Hesse	05/10/2006	Fall 2007	Fall 2008	€500
Hamburg	28/06/2006	Spring 2007	Fall 2012	€500
Lower-Saxony	21/11/2006	Fall 2006	Fall 2014	€500
North Rhine-Westphalia	16/03/2006	Fall 2006	Fall 2011	€450
Saarland	12/07/2006	Fall 2007	Spring 2010	€500

Source: Hübner (2012) and Bietenbeck et al. (2021)

Table 1: Introdcution and abolishment of tuition fees in federal states

Table 1 presents a comprehensive overview of the fee levels as well as implementation dates in the affected states. The tuition fees were mostly uniformly distributed, all affected states except two introduced tuition fees of €500 per semester (€1000 annually). Only Bavaria and North Rhine-Westphalia forwarded the decision to the university level, which were allowed to charge between €300 and €500 per semester. Nevertheless, merely a few universities decided to charge less than €500 leading to an average of approximately €450 in these two states (Hübner, 2012).

Moreover, to examine possible anticipation effects, it is important to consider the

[1]Baden-Württemberg, Bavaria, Hamburg, Saarland, Saxony, and Saxony-Anhalt.

salience of the decision. Dwenger (2012) addresses the public debate around tuition fees in his paper. He emphasizes that the implementation has been highly discussed in the media since the ruling on January 26th, in 2005. Table 2 presents the estimates of tuition fee implementations by states according to three nationwide newspapers and magazines. A possible anticipation effect should be considered since the fees affected already- and newly-enrolled students similarly.

Treatment State	FAS (January 2005)	StudiInfo (March 2005)	UniSpiegel (May 2005)
Baden-Württemberg	X	X	X
Bavaria	X	X	X
Hesse	?	X	?
Hamburg	X	X	X
Lower-Saxony	X	X	X
North Rhine-Westphalia	-	-	X
Saarland	X	X	X

Source: Dwenger (2012)

Table 2: Newspaper estimates of a possible implementation of tuition fees

Besides that, the discrepancy between federal states regarding secondary and high school educational structures should be taken into consideration. In this context, especially one reform, allowing states to make a transition from the 9-year (G9) to the 8-year (G8) gymnasium, has been the subject of intense political debate (BPB, 2018). The transition from G9 to G8 implies a short-term increase in the number of high school graduates, which allows for further insights into the effect of higher competition on entry rates, as discussed by Bruckmeier and Wigger (2014). Table 3 provides an overview of the first G8 grade levels in each state.

State	First-year of G8 graduates	State	First-year of G8 graduates
Baden-Württemberg	2011	Mecklenburg-Vorpommern	2007
Bavaria	2010	Rheinland-Palatine	-
Lower-Saxony	2010	Saxony	-
North Rhine-Westphalia	2012	Saxony-Anhalt	2006
Berlin	2011	Schleswig-Holstein	2015
Brandenburg	2011	Thuringia	-
Bremen	2011		

Source: Helbig et al. (2015)

Table 3: First-year of G8 graduates by state

However, the inconsistency of the reform is not only prevalent between states but also within states. For instance, in several states that transitioned from G9 to G8, this change was only implemented for gymnasiums. Therefore, Figure 1 illustrates the trends in the number of high school graduates. The observable spikes seem overall consistent with the information provided in Table 3. But the different magnitudes of the short-term increases indicate the variation in the impact of reform within states. Apart from that, Figure 1 provides valuable insights into the declining birth rates in the East German states. As mentioned by Bruckmeier and Wigger (2014), it is observable that the number of high school graduates declines in certain states from 2007 onwards. The implications of these disparities in the trends will be further examined in the results section.

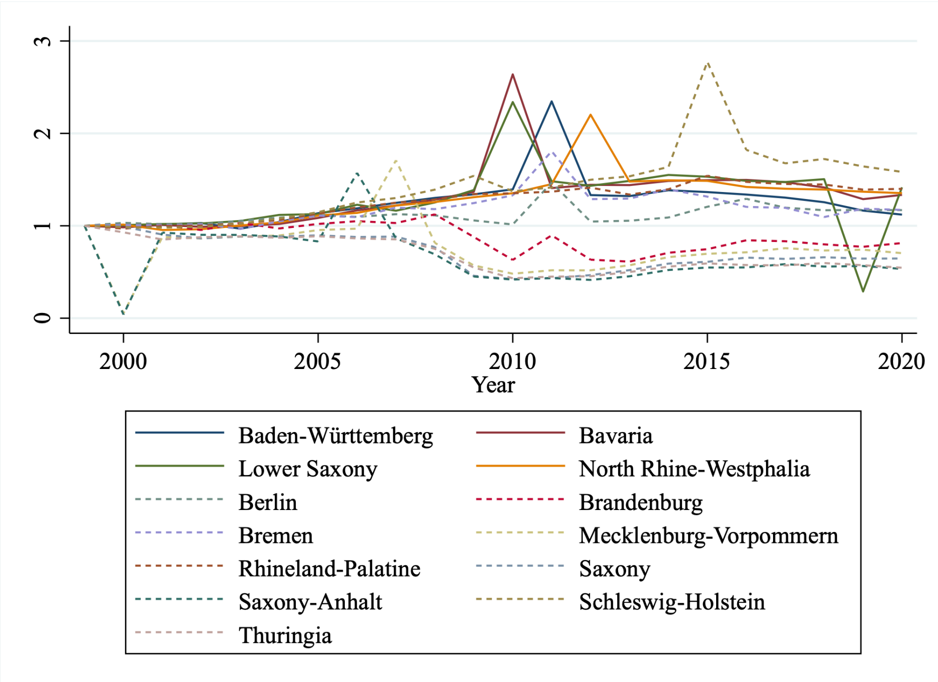

Figure 1: Index (base-year 1999) of number of high school graduates by state

4 Data

The empirical approach relies on administrative data collected by the German Federal Statistical Office (2023). The state-level panel data is available for the period from 2000 to 2021 but will be limited to the years before 2019 to avoid possible biases caused by the COVID-19 pandemic. The data provides aggregated information on all students in Germany attending higher education institutions, the number of which has increased from approximately two to nearly three million over the past two decades. The control group includes all the states that chose not to introduce tuition fees[2]. Conversely, the treatment group contains the states that implemented fees (see Table 1). But, because of the differences in the time of the introduction and abolishment of the fees, this analysis will consider each treatment unit separately. This allows to not only investigate the effect at the time of the intervention but also when the abolishment takes place. Moreover, I choose to concentrate on the four treatment states with the largest number of students. The reason is that Hesse implemented tuition fees for only one year, and Saarland and Hamburg have significantly fewer students, which makes them more vulnerable to biases. The empirical analysis will investigate the effect on the following three outcome variables:

$$Enrollment_{jt}^{S} = \sum_{b=1}^{N} \frac{enrollments_{bjt}}{population_{bjt}} \tag{1}$$

$$Enrollment_{jt}^{H} = \sum_{b=1}^{N} \frac{enrollments_{bt}^{H(j)}}{population_{bjt}} \tag{2}$$

$$\Delta Enrollment_{jt} = Enrollment_{jt}^{S} - Enrollment_{jt}^{H} \tag{3}$$

$Enrollment_{jt}^{S}$ denotes the proportion of students enrolling in a higher education program compared to the population of the corresponding birth year (by the state where the higher education institution is located), in year t and state j. The rates are determined for each birth cohort b individually and then added together (so-called 'sum-of-rates procedure'). Whereas $Enrollment_{jt}^{H}$ measures the same proportion but according to the state where the students obtained their higher education entrance qualification, denoted by $H(j)$. Consequently, $\Delta Enrollment_{jt}$ estimates the in- or decrease of first-year students in the corresponding state with respect to the high school graduates who choose to follow higher education. Furthermore, I include two predictor variables, namely the gross domestic product per capita GDP_{jt} and the yearly available income of private households $Income_{jt}$. These predictors allow to better align the characteristics of the treatment unit and its synthetic counterfactual. And are relevant because the financial situation of a state and its population can be expected to have an influence on the decision to pursue

[2] Namely, Berlin, Brandenburg, Bremen, Mecklenburg-Vorpommern, Rheinland-Palatine, Saxony, Saxony-Anhalt, Schleswig-Holstein, and Thuringia.

tertiary education. Additionally, inspired by Bruckmeier and Wigger's (2014) research, I use the index of the number of high school graduate I_{jt}^{hg} (see Figure 1) as a control variable.

Table 4 presents the descriptive statistics of the variables. Considering the period between 2000 and 2018, I obtain 304 observations for each variable. It is noticeable that the enrollment by state is lower than the enrollment probability by high school; this discrepancy is caused by the differences in the absolute number of high school graduates per state. Thus, city-states like Berlin are weighted the same as larger states, but because they are popular among students, they experience enrollment rates by state of up to 100%. On the other hand, the enrollment rate, depending on the state of high school graduation, is less affected by the popularity of a city since high school students are typically restricted by the place of residence of their parents.

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Difference in entry-rates	304	10.30	12.44	-11.90	48.00
Enrollment by high school	304	37.88	8.40	20.90	57.70
Enrollment by state	304	48.18	17.79	21.10	100.70
GDP per capita	304	60175.07	11497.21	36592.00	93368.00
Income household	304	18277.92	2745.38	12362.00	25588.00
Index high school graduates	304	1.11	0.39	0.04	2.78

Table 4: Descriptive statistics of variables

5 Methodology

5.1 Estimation strategy

To answer the research questions, I utilize the synthetic control methodology (Abadie, 2021; Abadie et al., 2010; Abadie & Gardeazabal, 2003). As an empirical strategy to estimate counterfactuals and the treatment impacts of policy interventions, synthetic control methodologies have gained a lot of popularity in the social sciences. The method allows one to predict the trajectory of the outcome variable in the absence of treatment by creating a "synthetic control", which is a weighted average of comparable untreated units.

Following Abadie et al. (2010) the methodology assumes data containing $J + 1$ units, denoted as $j = 1, 2, \ldots, J+1$. In this case, the first unit ($j = 1$) is supposed to be the treated unit, hence one of the states in which a tuition fee was implemented. The remaining units, $j = 2, \ldots, J+1$, form the donor pool, comprising all states which were not subject to an introduction of tuition fees. Furthermore, there are T periods, with the initial T_o periods occurring before the intervention takes place. Hence, before 2006 or 2007, depending on the treatment state. Besides that, the methodology requires a sufficient pre- and post-intervention period. The data contains the outcome variable of interest Y_{jt}, for each state j and time t. Additionally, I include a set of k predictors, $X_{1j}, \ldots, X_{kj}$. These variables are independent of the treatment and may contain Y_{jt} values from pre-intervention periods. The predictors for units $j = 1, 2, \ldots, J+1$ are collected in $k * 1$ vectors denoted as $X_1, \ldots, X_{J+1}$ and the $k * j$ matrix, $X_0 = [X_2 \ldots X_{J+1}]$, gathers these vectors for the control units.

Y_{jt}^N is defined as the possible trajectory in the absence of an intervention for each state, j, and year, t (Abadie, 2021). Moreover, Y_{1t}^I denotes the potential response under the intervention for the state impacted by the tuition fee implementation, $j = 1$, in the post-intervention period, $t > T_0$. Thus, the effect of the intervention on the state, $j = 1$ is defined as:

$$\tau_{1t} = Y_{1t}^I - Y_{jt}^N \tag{4}$$

The main challenge of a policy assessment is to estimate Y_{jt}^N, hence the trajectory of the outcome variable, for the period $t > T_0$, without the treatment. The difference-in-difference methodology does this by using one, or an average, of the unaffected units with similar characteristics. Nevertheless, since the data for this analysis provides a donor pool of several unaffected states, the synthetic control mythology can be applied to create a better fitting counterfactual (Abadie, 2021). More precisely, the synthetic control consists of a $J * 1$ vector with the weights, $W = (\omega_2, \ldots, \omega_{J+1})$ and is formally expressed as:

$$Y_{jt}^N = \sum_{j=2}^{J+1} \omega_j Y_{jt} \tag{5}$$

According, to Abadie et al. (2010) the weights are required be non-negative and sum to one to avoid extrapolation. Furthermore, the aim is to find the synthetic counterfactual that minimizes the root mean squared prediction error (RMSPE) for the pre-intervention period:

$$RMSPE^{pre-intervention} = \left(\frac{1}{T_0} \sum_{t=t_0+1}^{T_0} \left(Y_{1t}^I - \sum_{j=2}^{J+1} \omega_j Y_{jt} \right)^2 \right)^{1/2} \tag{6}$$

5.2 Inference

Within the synthetic control framework, Abadie, Diamond, and Hainmueller (2010) offer an inference approach that makes use of permutation methods. This so-called “in-space” placebo test uses the estimation strategy mentioned above with a single treatment unit to evaluate the impact of an intervention separately for each unit in the sample. A permutation distribution is produced by repeatedly reassigning the treatment to units in the donor pool and calculating ”placebo effects” in each iteration. This distribution combines the estimated placebo effects for the units in the donor pool with the estimated treatment effects for the treated unit (Abadie, 2021). By contrasting its size with the extremes of the permutation distribution, one may estimate the importance of the treatment's impact on the unit subject to the intervention. Therefore, the test considers the ratio of the pre- and post-intervention RMSPE values. A high post-intervention value can be regarded as less significant if the synthetic control is not able to closely fit the course of the outcome variable for the treated unit before the intervention. The ratio for state j is defined as:

$$r_j = \frac{RMSPE_j^{post-intervention}}{RMSPE_j^{pre-intervention}} \tag{7}$$

Based on that, a p-value can be calculated by considering the magnitude of the RMSPE ratio of the treated state relative to the permutation distribution:

$$p = \frac{1}{J+1} \sum_{j=1}^{J+1} I_+(r_j - r_1) \tag{8}$$

Thereby, $I_+(.)$ represents an indicator function with a value of one for non-negative arguments and else a zero (Abadie, 2021). Since there are nine states in the donor pool $J+1$ will be ten. And, because the indicator function takes at least for $j = 1$ a value of one, the lowest possible p-value is 0.1. In consideration of this analysis, a p-value of 0.1 indicates that the magnitude of the effect in the treatment state was higher than for all ”in-space” placebo tests. Moreover, a p-value of 0.2 implies the treated unit has a more significant effect than 89% of the placebo tests for the donor pool units.

To conduct these tests, I will use the *allsynth* STATA module provided by Wiltshire (2022). This extension automates the application of many modifications to the conventional strategy while preserving the synth's syntax. More specifically, it allows me to generate the results presented in the Appendix (Table B10-B21), measuring the gap, RMSPE ratio, RMSPE rank, and p-value. The gap measures the effect τ_{1t} for year t. Hence, taking the average over the treatment period allows one to draw conclusions about the average effect of the intervention.

5.3 Contextual Requirements

As stated by Abadie (2021), reliable estimates from the synthetic control methodology depend on certain essential requirements. These prerequisites apply not only to the synthetic control but also to the difference-in-difference approach. One of the main requirements is the need for a well-suited comparison group. This entails ensuring that none of the units in the donor pool have been impacted by a similar intervention and that these control units have similar characteristics to the treatment group (Abadie, 2021). To ensure this for my analysis, the comparison units are chosen based on two essential criteria. Firstly, their outcome variables should follow similar trends to the treatment group in the pre-intervention period. Secondly, the approach takes into account the previously mentioned predictor variables. By doing so, the analysis aims to produce more reliable and valid estimates. Moreover, it is important to ensure that there is no anticipation of the intervention. If students are aware of the upcoming implementation of tuition fees before the actual intervention, it could introduce anticipation effects, potentially influencing the results (Abadie, 2021). In the Institutional Background section, as well as during the interpretation of the results, I discuss a possible bias arising from anticipation effects. Nonetheless, I am unable to completely eliminate the potential bias. Additionally, Abadie (2021) addresses the requirement of no interference. Meaning that the outcomes of individual units are unaffected by the treatments applied to other units. However, in some cases, interventions may produce spillover effects on non-targeted units. Considering the setting of this analysis, the assumption is unlikely to hold. Introducing tuition fees in different states will always cause spillover effects that are difficult to estimate. Therefore, this approach recognizes this possible bias in the results but is not capable of estimating its magnitude.

6 Results

To interpret the results, I begin by examining the graphical representations of the synthetic control outcomes generated through STATA, alongside the corresponding tables. The interpretation contains three parts: first, an analysis of the basic synthetic control results; second, a comparison to the synthetic control tests that control for the index of high school graduates; and finally, an elaboration on the inference of the results.

Figure 2 illustrates the trends of the difference in enrollment rates for the four largest treatment states and their synthetic counterfactual. At first glance, it seems like the difference in enrollment rates in all four states is negatively affected by the introduction of tuition fees. To evaluate the significance of the effect, it is desirable to obtain similar trends between the state and its synthetic counterpart in the pre-intervention period. This seems to hold particularly for North Rhine-Westphalia and Baden-Württemberg, where the trends align closely. In contrast, in Lower Saxony and Bavaria, the trends move in similar directions but differ in minor ways. Besides that, a small negative effect in the year before the intervention is noticeable for all states except North Rhine-Westphalia. This observation is consistent with the information provided in the institutional background section, which highlights the salience of the implementation. Specifically, it indicates that in 2005, the implementation of tuition fees remained uncertain solely in North Rhine-Westphalia. Moreover, in the case of Lower Saxony and Baden-Württemberg, a slight increase in the difference between the rates is observable, compared to the counterfactual, in the year following the intervention.

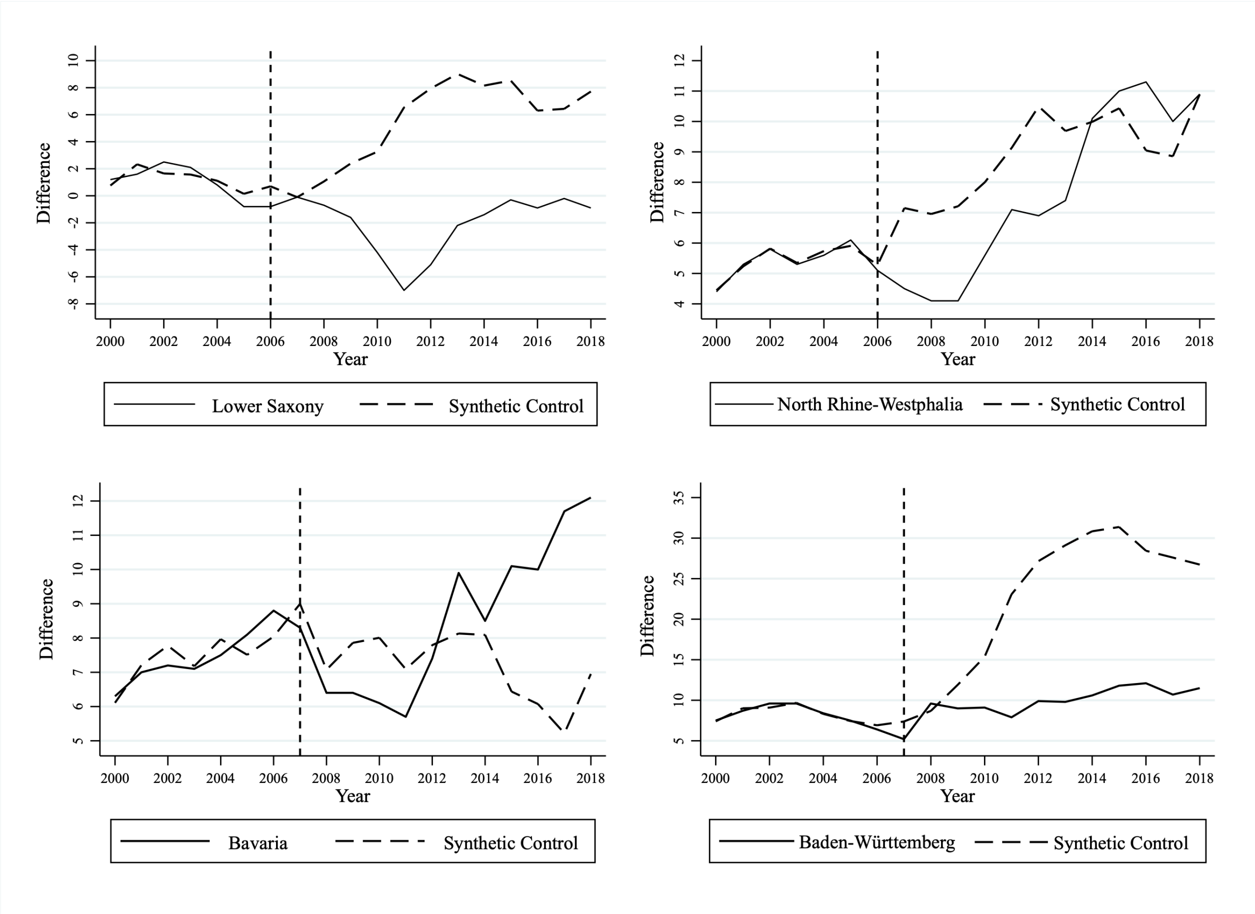

Figure 2: Synthetic control analysis for difference in entry-rates

Overall, based on Figure 2, the implementation of tuition fees seems to have a mostly negative effect on the difference in entry rates compared to the control unit. In other words, the enrollment rates for higher education institutions in these states decline in comparison to the ratio of high school graduates from these states who enroll in higher education in any state. This observation could be attributed to two main effects related to tuition fees. It is possible that fewer high school graduates from other states opt to enroll in one of the treatment states after the implementation of tuition fees, or that more high school graduates in the treatment states choose to avoid the tuition fees and enroll for higher education in another state.

Control states:	Lower Saxony	North Rhine-Westphalia	Bavaria	Baden-Württemberg
Berlin	0.114	0.132	0	0.254
Brandenburg	0.119	0.009	0	0
Bremen	0	0.144	0	0.003
Mecklenburg-Vorpommern	0	0	0	0
Rhineland-Palatine	0	0	0.959	0
Saxony	0	0	0	0.461
Saxony-Anhalt	0.333	0	0	0.283
Schleswig-Holstein	0.434	0.544	0	0
Thuringia	0	0.171	0.041	0

Table 5: Synthetic control weights for difference in entry-rates

Table 5 provides insight into the different weights assigned to the control states, allowing for enhanced transparency and a more thorough examination of potential biases. As depicted in Figure 1, the control states, including Thuringia, Saxony, Saxony-Anhalt, Brandenburg, and Mecklenburg-Vorpommern, experienced a substantial decrease in the number of high school graduates. Considering the different weights of the control states, it is noticeable that each synthetic counterfactual for this comparative analysis is at least half composed of the previously mentioned states. To address this potential selection bias, a similar synthetic control analysis is conducted for all four states. However, this time, the index of high school graduates for each state between 2007 and 2018 is included as a predictor variable (see Figure A1). As a consequence, none of the five mentioned states, which experienced a decrease in high school graduates after 2007, are assigned any weight in the synthetic control (see Table B1). Additionally, this adjustment aligns the predictors for the index of high school graduates, suggesting a potential elimination of bias (see Table B7). The graphical representation (see Figure A1) presents a weaker pre-intervention fit and slightly fewer negative effects, particularly for Baden-Württemberg. However, it does not necessarily imply that controlling for the index of high school graduates results in non-significant effects.

State:	Average treatment effect	Average p-value
Lower Saxony	-3.78%	0.24
North Rhine-Westphalia	-1.44%	0.22
Bavaria	-0.90%	0.55
Baden-Württemberg	-1.74%	0.24

Table 6: Average treatment effects and p-values for the controlled analysis of the differences in enrollment rates

Table 6 presents the average treatment effect and corresponding p-values for each state during the relevant intervention period (derived from Table B10, B13, B16, and B19). The results indicate an overall negative effect, with varying magnitudes across states. Notably, Lower Saxony experiences a stronger negative effect (-3.78%) as the other states. Analyzing the graphical representation (Figure A1), a clear drop in the rate is observable in 2011, potentially linked to the change from G9 to G8 in Lower Saxony in 2010. To address this, calculating the average effects for Lower Saxony until 2010 yields an average treatment effect of -2.49% and an average p-value of 0.28, which may provide a more representative result (see Table B22). Additionally, the average p-values indicate the need for a careful interpretation regarding the significance of the results. The effect of Bavaria appears to be relatively insignificant, while p-values between 0.22 to 0.24 for the other treatment states could support the finding of significant negative effects. At least, they indicate that the average effect in each of these three treatment states is more significant than for around 85% of the corresponding ”in-space” placebo tests.

Figure 3: Synthetic control analysis for entry-rate by state of high school graduation

To further test the findings, additional synthetic control analyses are conducted separately, using the two enrollment rates as outcome variables. Figure 3 displays the trends for the outcome variable $Enrollment^{H}_{jt}$. The graphs present a good fit between the treatment and control groups in the pre-intervention period, but the effects are contradicting, Whereas the comparison of the trends suggests a small negative effect for Lower Saxony, North Rhine-Westphalia, and Bavaria, it seems to be positive for Baden-Württemberg. Additionally, all four trends of the treatment states are marked by positive shocks. These one-year spikes are consistent with high school graduate increases caused by the change from G9 to G8, and always appear one year after the corresponding state has its first year of G8 graduates.

Table 7 offers an overview of the weights assigned to the synthetic counterfactuals. The synthetic counterparts for Lower Saxony and North Rhine-Westphalia only slightly incorporate control states affected by the decrease in high school graduates. In contrast, the synthetic controls for Bavaria and Baden-Württemberg depend substantially on these states. Therefore, I again conduct additional tests to control for the number of high school graduates. Although this leads to marginally worse pre-intervention fits and slightly less significant spikes around the G9 to G8 change (see Figure A2), none of the four states that experienced the most significant decrease in high school graduates after 2007 receive weights anymore (see Table B2).

Control states:	Lower Saxony	North Rhine-Westphalia	Bavaria	Baden-Württemberg
Berlin	0	0.596	0	0.582
Brandenburg	0.316	0	0.257	0
Bremen	0.25	0.155	0	0
Mecklenburg-Vorpommern	0	0	0.196	0
Rhineland-Palatine	0	0.25	0	0.058
Saxony	0.025	0	0.112	0
Saxony-Anhalt	0	0	0	0.057
Schleswig-Holstein	0.33	0	0.103	0
Thuringia	0.079	0	0.332	0.303

Table 7: Synthetic control weights for entry-rates by state of high school graduation

To draw conclusions about the inference of the results, Table 8 provides valuable insights, presenting the average treatment effects and p-values (derived from Table B11, B14, B17, and B20). Lower Saxony and North Rhine-Westphalia experience nearly no effects, while Bavaria and Baden-Württemberg suggest clearly positive impacts. However, these results are associated with high corresponding p-values and could be influenced by the change from G9 to G8. Considering this, it is beneficial to examine the average effect before 2010 to control for the potential bias resulting from the G9 to G8 change (see Table B23). The average p-values remain high, but the average treatment effects tend to center around zero. This suggests an overall non-significant effect of tuition fees on enrollment rates, depending on the state of high school graduation.

State:	Average treatment effect	Average p-value
Lower Saxony	0.33%	0.23
North Rhine-Westphalia	0.08%	0.9
Bavaria	3.96%	0.53
Baden-Württemberg	2.70%	0.42

Table 8: Average treatment effects and p-values for the controlled analysis of the enrollment rates by location of high school

Continuing the analysis of enrollment rates based on the state of the higher education institution, I begin by interpreting the trends presented in Figure 4. Once again, the pre-intervention trends appear to align, suggesting that the parallel trends' assumption holds. With the exception of Baden-Württemberg, the disparity in trends between the treatment state and its counterfactual indicates a negative effect of the intervention. The shocks, consistent with the changes from G9 to G8, are also observable here but exhibit a smaller magnitude. This could explain the corresponding negative shock in the trend of the difference (Figure 2). Hence, the short-term increase in high school graduates seems to have a bigger effect on higher education enrollment probabilities by the state of high school graduation than by the state of the higher education institution.

Table 9 displays the weights for the corresponding synthetic control units in Figure 4. Once more, the states that experience a decreasing trend in higher education graduates after 2007 significantly contribute to the composition of the synthetic counterfactual. This is controlled for in Figure A3.

Control states:	Lower Saxony	North Rhine-Westphalia	Bavaria	Baden-Württemberg
Berlin	0.267	0.104	0	0.245
Brandenburg	0.517	0	0	0
Bremen	0.009	0.157	0.074	0.032
Mecklenburg-Vorpommern	0	0	0	0
Rhineland-Palatine	0	0.236	0.394	0.128
Saxony	0	0	0	0.546
Saxony-Anhalt	0.207	0	0	0.049
Schleswig-Holstein	0	0.212	0	0
Thuringia	0	0.29	0.532	0

Table 9: Synthetic control weights for entry-rates by state of higher education institution

Figure 4: Synthetic control analysis for entry-rate by state of higher education institution

Employing the index of high school graduates as a predictor for the post-intervention periods results in the four states with decreasing rates not receiving any weights (see Table B3). However, the graphical representation of the synthetic control analysis (see Figure A3) remains largely unchanged compared to Figure 3. The average treatment effects and p-values presented in Table 10 (derived from Table B12, B15, B18, and B21) present contradictory results. Lower Saxony and North Rhine-Westphalia show negative effects, whereas Bavaria and Baden-Württemberg display positive impacts.

State:	Average treatment effect	Average p-value
Lower Saxony	-4.52%	0.28
North Rhine-Westphalia	-2.05%	0.13
Bavaria	3.05%	0.67
Baden-Württemberg	3.95%	0.18

Table 10: Average treatment effects and p-values for the controlled analysis of the enrollment rates by location of higher education institution

Restricting the average treatment effects to the years before 2010 results in Bavaria showing no effects, and the magnitude of the impact for Baden-Württemberg decreases to 2.21%. The impacts of the other two treatment states remain relatively unchanged (see Table B24). In conclusion, concerning this outcome variable, Lower Saxony and North Rhine-Westphalia appear to experience negative effects of tuition fees, Bavaria shows no significant effects, and, in contrast, Baden-Württemberg encounters positive effects.

7 Conclusion

This research has attempted to shed new light on the discussion about the effects of tuition fees on the enrollment behavior of students at German higher education institutions. It has been the first approach to investigate the effects of the German tuition fee reform by applying the synthetic control methodology. Although the findings may not be as conclusive as those from prior research on the subject, this paper contributes to the discourse by enhancing transparency in the discussion. The approach of individually examining each affected state and carefully considering the composition of the control units allows for a more thorough analysis, effectively addressing potential biases introduced by structural changes. By taking these extra steps, this study aims to enhance the reliability and validity of the results.

Consequently, in contrast to most of the existing research but in accordance with the findings of Bruckmeier and Wigger (2014), I find overall non-significant effects of tuition fees on enrollment rates. Nevertheless, the findings suggest that tuition fees have an effect on the mobility of students. Controlled for possible biases, the results estimate that around 1% to 2.5% of the high school graduates in a state that charges tuition fees choose to enroll in higher education in another state without fees. Hence, the findings indicate that introducing tuition fees in only a few states within a country does not necessarily result in a decrease in the overall number of individuals pursuing higher education. However, it does lead to a reduction in the relative enrollment rate in the treated states.

As the paper has shown, enrollment rates can be influenced by many structural differences. Taking into account the non-randomized introduction of fees and Germany's regional demographic discrepancies, filtering out effects becomes complex. Therefore, these results, as well as the results of related research, have to be considered carefully. It is essential to acknowledge and thoroughly consider the possible implications of spillover and anticipation effects as limitations of this analysis. A suggestion for future research could be to focus on investigating the magnitude or direction of bias caused by spillover effects in relation to this topic.

Formulating concrete policy implications based on the findings appears to be challenging. The research should rather be considered as an effort to emphasize the complexity of such impact evaluations. And therefore, as an attempt to enhance critical awareness concerning the interpretation of possible impacts of such policy changes.

References

Abadie, A. (2021, June). Using Synthetic Controls: Feasibility, Data Requirements, and Methodological Aspects. *Journal of Economic Literature*, *59*(2), 391–425. Retrieved 2023-06-16, from https://pubs.aeaweb.org/doi/10.1257/jel.20191450 doi: 10.1257/jel.20191450

Abadie, A., Diamond, A. & Hainmueller, J. (2010, June). Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program. *Journal of the American Statistical Association*, *105*(490), 493–505. Retrieved 2023-06-16, from http://www.tandfonline.com/doi/abs/10.1198/jasa.2009.ap08746 doi: 10.1198/jasa.2009.ap08746

Abadie, A. & Gardeazabal, J. (2003, March). The Economic Costs of Conflict: A Case Study of the Basque Country. *American Economic Review*, *93*(1), 113–132. Retrieved 2023-06-29, from https://www.aeaweb.org/articles/pdf/doi/10.1257/000282803321455188 doi: 10.1257/000282803321455188

Athey, S. & Imbens, G. W. (2017, May). The State of Applied Econometrics: Causality and Policy Evaluation. *Journal of Economic Perspectives*, *31*(2), 3–32. Retrieved 2023-06-27, from https://www.aeaweb.org/articles?id=10.1257/jep.31.2.3 doi: 10.1257/jep.31.2.3

Becker, G. S. (1964). *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education, First Edition* (No. beck-5). National Bureau of Economic Research, Inc. Retrieved from https://ideas.repec.org/b/nbr/nberbk/beck-5.html

Bietenbeck, J., Leibing, A., Marcus, J. & Weinhardt, F. (2023, May). Tuition fees and educational attainment. *European Economic Review*, *154*, 104431. Retrieved 2023-06-16, from https://www.sciencedirect.com/science/article/pii/S0014292123000600 doi: 10.1016/j.euroecorev.2023.104431

Bietenberck, J., Marcus, J. & Weinhardt, F. (2021). Temporäre Erhebung allgemeiner Studiengebühren: Mehr Studierende schlossen ihr Studium ab, aber weniger schrieben sich neu ein. *DIW Wochenbericht*. Retrieved 2023-06-16, from http://www.diw.de/sixcms/detail.php?id=diw_01.c.815790.de (Publisher: DIW - Deutsches Institut für Wirtschaftsforschung Version Number: 2.0) doi: 10.18723/DIW_WB:2021-15-1

BPB. (2018, April). *Abitur: G8 oder G9?* Retrieved 2023-07-19, from https://www.bpb.de/themen/medien-journalismus/netzdebatte/268182/abitur-g8-oder-g9/

Bruckmeier, K. & Wigger, B. U. (2014, August). The effects of tuition fees on transition from high school to university in Germany. *Economics of Education Review*, *41*, 14–23. Retrieved 2023-06-16, from https://linkinghub.elsevier.com/retrieve/pii/S0272775714000399 doi: 10.1016/j.econedurev.2014.03.009

Canton, E. & De Jong, F. (2005, December). The demand for higher education in The Netherlands, 1950–1999. *Economics of Education Review*, *24*(6), 651–663. Retrieved 2023-06-16, from https://linkinghub.elsevier.com/retrieve/pii/S027277570400130X doi: 10.1016/j.econedurev.2004.09.006

Coelli, M. B. (2009, August). Tuition fees and equality of university enrolment. *Canadian Journal of Economics/Revue canadienne d'économique*, *42*(3), 1072–1099. Retrieved 2023-06-16, from https://onlinelibrary.wiley.com/doi/10.1111/j.1540-5982.2009.01539.x doi: 10.1111/j.1540-5982.2009.01539.x

Dearden, L., Fitzsimons, E. & Wyness, G. (2011, September). *The impact of tuition fees and support on university participation in the UK* (Working Paper Series). Retrieved 2023-06-16, from http://www.ifs.org.uk/wps/wp1117.pdf (Series: Working Paper Series) doi: 10.1920/wp.ifs.2011.1117

Dietrich, H. & Gerner, H.-D. (2012). The effects of tuition fees on the decision for higher education: Evidence from a German policy experiment.

Dwenger, N., Storck, J. & Wrohlich, K. (2012, February). Do tuition fees affect the mobility of university applicants? Evidence from a natural experiment. *Economics of Education Review*, *31*(1), 155–167. Retrieved 2023-06-16, from https://linkinghub.elsevier.com/retrieve/pii/S0272775711001713 doi: 10.1016/j.econedurev.2011.10.004

Fredriksson, P. (1997, March). Economic Incentives and the Demand for Higher Education. *The Scandinavian Journal of Economics*, *99*(1), 129–142. Retrieved 2023-06-16, from https://onlinelibrary.wiley.com/doi/10.1111/1467-9442.00052 doi: 10.1111/1467-9442.00052

Helbig, M. & Nikolai, R. (2015). Die Unvergleichbaren. Der Wandel der Schulsysteme in den deutschen Bundesländern seit 1949. , 380 pages. Retrieved 2023-07-19, from https://www.pedocs.de/frontdoor.php?source_opus=11095 (Artwork Size: 380 pages Publisher: Klinkhardt : Bad Heilbrunn) doi: 10.25656/01:11095

Hochschulrahmengesetz. (2019). Bundesgesetzblatt. Retrieved from https://www.gesetze-im-internet.de/hrg_2019/index.html

Huijsman, R., Kloek, T., Kodde, D. A. & Ritzen, J. M. M. (1986, June). An empirical analysis of college enrollment in The Netherlands. *De Economist*, *134*(2), 181–190. Retrieved 2023-06-16, from http://link.springer.com/10.1007/BF01706288 doi: 10.1007/BF01706288

Hübner, M. (2012, December). Do tuition fees affect enrollment behavior? Evidence from a 'natural experiment' in Germany. *Economics of Education Review*, *31*(6), 949–960. Retrieved 2023-06-16, from https://www.sciencedirect.com/science/article/pii/S027277571200074X doi: 10.1016/j.econedurev.2012.06.006

Kane, T. J. (1996). College Cost, Borrowing Constraints and the Timing of College Entry. *Eastern Economic Journal*, *22*(2), 181–194. Retrieved 2023-06-16, from https://www.jstor.org/stable/40325703 (Publisher: Palgrave Macmillan Journals)

Leslie, L. L. & Brinkman, P. T. (1987, March). Student Price Response in Higher Education: The Student Demand Studies. *The Journal of Higher Education*, *58*(2), 181. Retrieved 2023-06-16, from http://www.jstor.org/stable/1981241?origin=crossref doi: 10.2307/1981241

Marcucci, P. N. & Johnstone, D. B. (2007, March). Tuition fee policies in a comparative perspective: Theoretical and political rationales. *Journal of Higher Education Policy and Management*, *29*(1), 25–40. Retrieved 2023-06-16, from http://www.tandfonline.com/doi/abs/10.1080/13600800600980015 doi: 10.1080/13600800600980015

Müller, V. (2012). *Deutscher Bundestag - Auswirkungen von Studiengebühren umstritten.* Retrieved 2023-06-16, from https://www.bundestag.de/webarchiv/textarchiv/2012/37344519_kw04_pa_bildung_forschung-207368

Neill, C. (2009, October). Tuition fees and the demand for university places. *Economics of Education Review*, *28*(5), 561–570. Retrieved 2023-06-16, from https://linkinghub.elsevier.com/retrieve/pii/S0272775709000211 doi: 10.1016/j.econedurev.2009.01.002

OECD. (2022). *Education at a Glance 2022: OECD Indicators*. OECD. Retrieved 2023-06-16, from https://www.oecd-ilibrary.org/education/education-at-a-glance-2022_3197152b-en doi: 10.1787/3197152b-en

Statistisches Bundesamt Deutschland - GENESIS-Online [Text]. (2023, July). Retrieved 2023-07-19, from https://www-genesis.destatis.de/genesis/online?operation=statistic&levelindex=0&levelid=1689756935112&code=21381#abreadcrumb

Wiltshire, J. C. (2022). allsynth: (Stacked) Synthetic Control Bias-Correction Utilities for Stata.

Appendix

A Figures

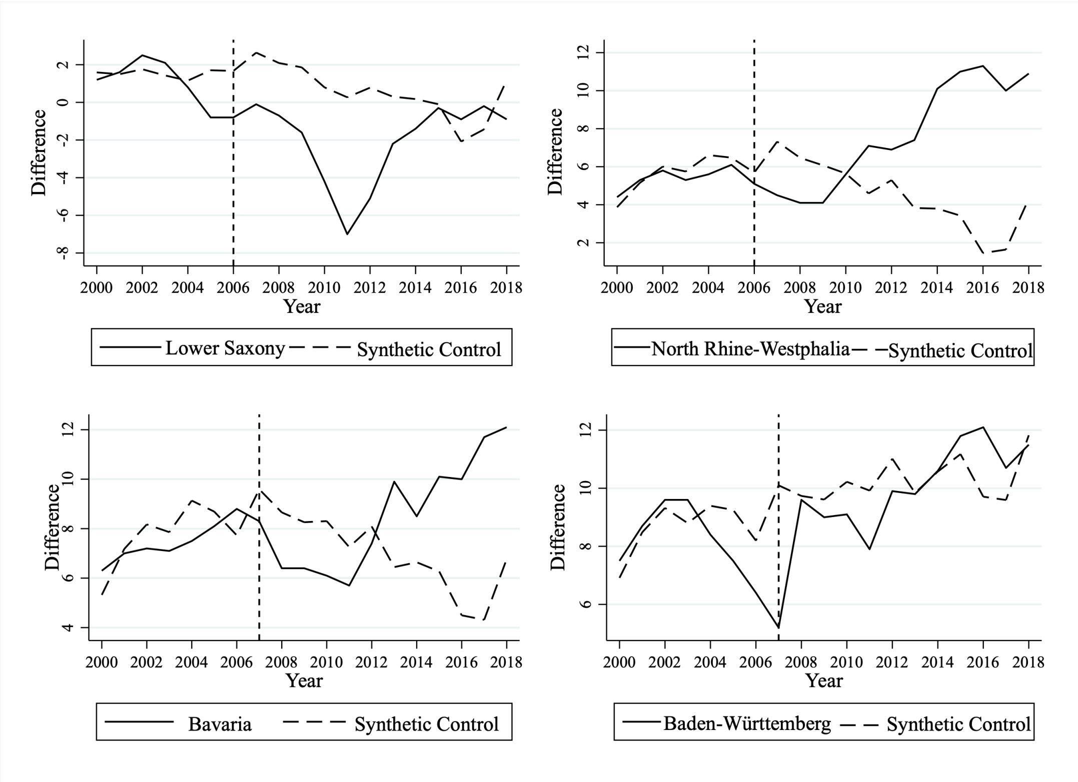

Figure A1: Synthetic control analysis for difference between entry-rates (controlled

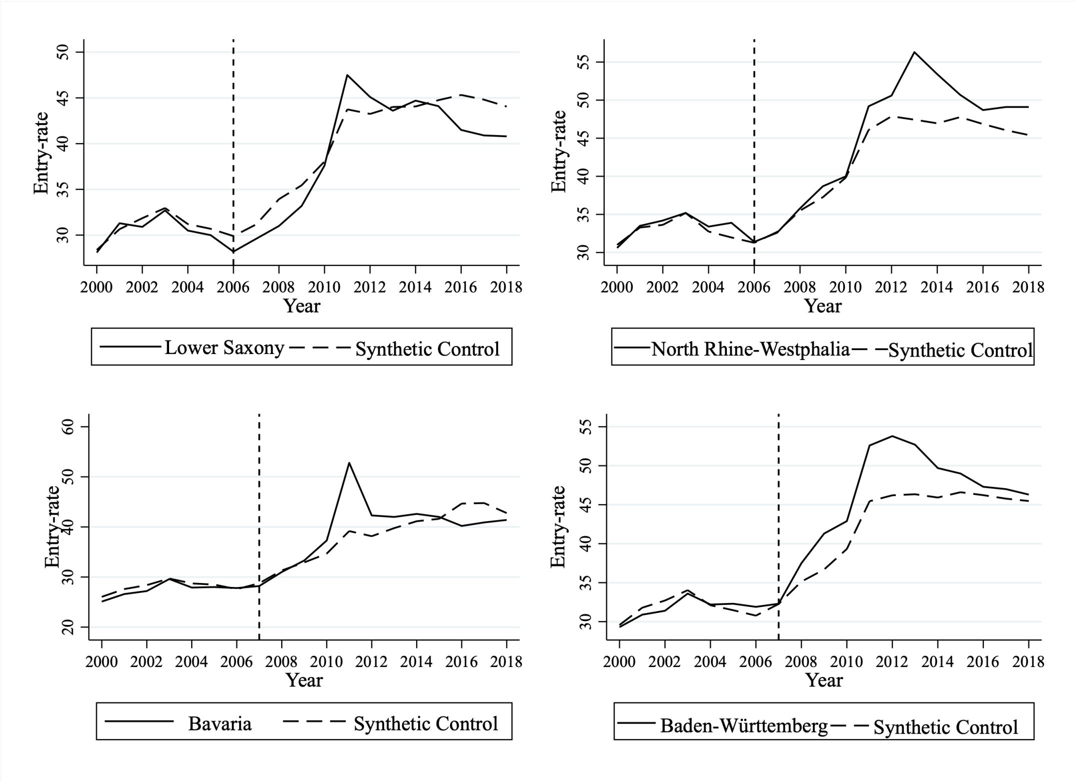

Figure A2: Synthetic control analysis for entry-rate by state of high school graduation

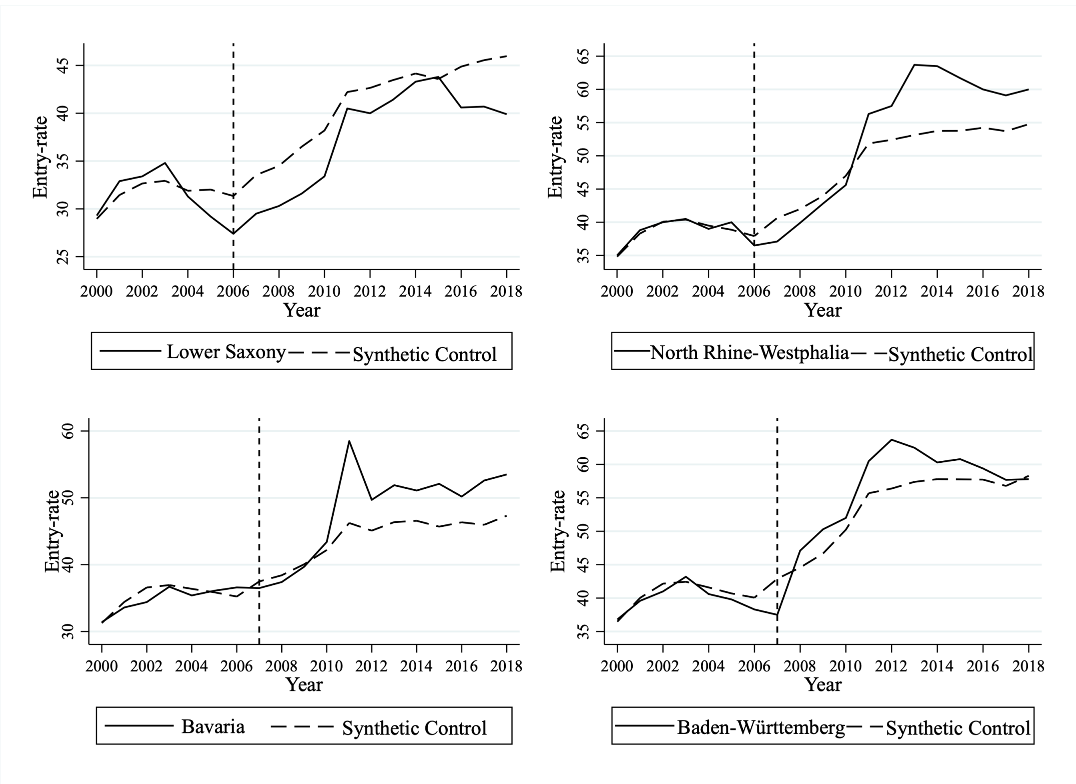

Figure A3: Synthetic control analysis for entry-rate by state of higher education institution

B Tables

Control states:	Lower Saxony	North Rhine-Westphalia	Bavaria	Baden-Württemberg
Berlin	0	0.148	0	0.146
Brandenburg	0.024	0	0	0
Bremen	0.152	0.302	0	0.18
Mecklenburg-Vorpommern	0	0	0.175	0
Rhineland-Palatine	0.659	0.549	0.18	0.673
Saxony	0	0	0	0
Saxony-Anhalt	0	0	0	0
Schleswig-Holstein	0.164	0	0.646	0
Thuringia	0	0	0	0

Table B1: Synthetic control weights for difference in entry-rates (controlled)

Control states:	Lower Saxony	North Rhine-Westphalia	Bavaria	Baden-Württemberg
Berlin	0.074	0.108	0	0.126
Brandenburg	0.077	0	0	0.023
Bremen	0	0.067	0.028	0.047
Mecklenburg-Vorpommern	0	0	0	0
Rhineland-Palatine	0.306	0.581	0.669	0.803
Saxony	0	0	0	0
Saxony-Anhalt	0	0	0	0
Schleswig-Holstein	0.543	0.244	0.303	0
Thuringia	0	0	0	0

Table B2: Synthetic control weights for entry-rates by state of high school graduation (controlled)

Control states:	Lower Saxony	North Rhine-Westphalia	Bavaria	Baden-Württemberg
Berlin	0.117	0.023	0	0.153
Brandenburg	0.066	0	0	0
Bremen	0.038	0.157	0.192	0.184
Mecklenburg-Vorpommern	0	0	0	0
Rhineland-Palatine	0	0.215	0.363	0.16
Saxony	0	0	0	0
Saxony-Anhalt	0	0	0	0
Schleswig-Holstein	0.778	0.605	0.445	0.503
Thuringia	0	0	0	0

Table B3: Synthetic control weights for entry-rates by state of higher education institution (controlled)

	Lower Saxony		North Rhine Westphalia		Bavaria		Baden-Württemberg	
Predictors:	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic
GDP	53035	48393	56767	51326	59579	53073	59694	46063
Income household	15768	15138	16856	16003	18440	16748	18359	14462
Difference (2000)	1.2	0.8	4.4	4.5	6.3	6.1	7.5	7.4
Difference (2001)	1.6	2.3	5.3	5.2	7	7.2	8.7	9
Difference (2002)	2.5	1.7	5.8	5.8	7.2	7.8	9.6	9.1
Difference (2003)	2.1	1.6	5.3	5.4	7.1	7.2	9.6	9.7
Difference (2004)	0.8	1.1	5.6	5.7	7.5	8	8.4	8.3
Difference (2005)	-0.8	0.2	6.1	5.9	8.1	7.5	7.5	7.4
Difference (2006)					8.8	8.0	6.4	6.9

Table B4: Predictor balances for differences in entry-rates

	Lower Saxony		North Rhine Westphalia		Bavaria		Baden-Württemberg	
Predictors:	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic
GDP	53035	50493	56767	55200	59579	43282	59694	49914
Income household	15768	15592	16856	16021	18440	14290	18359	15093
Difference (2000)	28.1	28.5	4.4	31.5	25.1	25.3	29.3	29.6
Difference (2001)	31.3	30.9	5.3	33.8	26.6	26.4	30.9	31.5
Difference (2002)	30.9	31	5.8	33.5	27.2	27.3	31.4	31.4
Difference (2003)	32.7	32.6	5.3	35	29.6	29.6	33.6	33.3
Difference (2004)	30.5	30.5	5.6	33.2	27.9	28.4	32.2	32.1
Difference (2005)	30	30	6.1	32.6	28	28.2	32.3	31.8
Difference (2006)					27.8	27.3	31.9	31

Table B5: Predictor balances for entry-rates by state of high school graduation

	Lower Saxony		North Rhine Westphalia		Bavaria		Baden-Württemberg	
Predictors:	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic
GDP	53035	47126	56767	50309	59579	47259	59694	47549
Income household	15768	14397	16856	15688	18440	15289	18359	15034
Difference (2000)	29.3	30.4	35	35.2	31.4	31.3	36.8	36.9
Difference (2001)	32.9	32.5	38.8	38.8	33.6	33.9	39.6	39.6
Difference (2002)	33.4	31.8	40	39.8	34.4	35.4	41	40.9
Difference (2003)	34.8	33.7	40.5	40.6	36.7	36.3	43.2	43
Difference (2004)	31.3	32	39	339.6	35.4	35.8	40.6	40.7
Difference (2005)	29.2	30.8	40	39.2	36.1	35.6	39.8	40
Difference (2006)					36.6	35.2	38.3	38.2

Table B6: Predictor balances for entry-rates by state of higher education institution

	Lower Saxony		North Rhine Westphalia		Bavaria		Baden-Württemberg	
Predictors:	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic
Index high school graduates(2007)	1.16	1.26	1.22	1.23	1.22	1.25	1.25	1.24
Index high school graduates(2009)	1.39	1.42	1.31	1.36	1.37	1.36	1.34	1.37
Index high school graduates(2011)	1.48	1.39	1.45	1.43	1.41	1.39	2.35	1.49
GDP	53035	51804	56767	52668	59579	53708	59694	54320
Income household	15768	16349	16856	16259	18440	16843	18359	16525
Difference (2000)	1.2	1.76	4.4	4.39	6.3	6.07	7.5	7.44
Difference (2001)	1.6	1.36	5.3	5.33	7	7.28	8.7	8.54
Difference (2002)	2.5	1.51	5.8	5.78	7.2	7.92	9.6	9.2
Difference (2003)	2.1	1.11	5.3	5.32	7.1	7.38	9.6	8.53
Difference (2004)	0.8	0.5	5.6	5.6	7.5	8.15	8.4	8.48
Difference (2005)	-0.8	1.2	6.1	5.75	8.1	7.74	7.5	8.66
Difference (2006)					8.8	7.96	6.4	7.7

Table B7: Predictor balances for differences in entry-rates (controlled)

	Lower Saxony		North Rhine Westphalia		Bavaria		Baden-Württemberg	
Predictors:	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic
Index high school graduates(2007)	1.16	1.22	1.22	1.21	1.22	1.39	1.25	1.18
Index high school graduates(2009)	1.39	1.32	1.31	1.25	1.37	1.31	1.34	1.19
Index high school graduates(2011)	1.48	1.39	1.45	1.52	1.41	1.2	2.35	1.42
GDP	53035	52315	56767	55648	59579	49640	59694	54359
Income household	15768	16152	16856	16405	18440	16045	18359	16224
Difference (2000)	28.1	28.49	30.6	31.38	25.1	25.83	29.3	29.49
Difference (2001)	31.3	30.97	33.5	33.67	26.6	27.09	30.9	31.69
Difference (2002)	30.9	31.15	34.2	33.79	27.2	27.63	31.4	32.2
Difference (2003)	32.7	32.36	35.2	35.39	29.6	29.18	33.6	33.42
Difference (2004)	30.5	30.46	33.4	32.97	27.9	28.22	32.2	32.22
Difference (2005)	30	29.99	33.9	32.2	28	28	32.3	31.07
Difference (2006)					27.8	27.07	31.9	7.7

Table B8: Predictor balances for entry-rates by state of high school graduation (controlled)

	Lower Saxony		North Rhine Westphalia		Bavaria		Baden-Württemberg	
Predictors:	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic
Index high school graduates(2007)	1.16	1.24	1.22	1.25	1.22	1.27	1.25	1.25
Index high school graduates(2009)	1.39	1.39	1.31	1.37	1.37	1.46	1.34	1.4
Index high school graduates(2011)	1.48	1.39	1.45	1.45	1.41	1.47	2.35	1.5
GDP	53035	51937	56767	53633	59579	53944	59694	54656
Income household	15768	16262	16856	16540	18440	16834	18359	16734
Difference (2000)	29.3	30.13	35	35.02	31.4	31.64	36.8	35.77
Difference (2001)	32.9	32.74	38.8	38.81	33.6	35.48	39.6	40.16
Difference (2002)	33.4	33.15	40	40.31	34.4	36.71	41	41.17
Difference (2003)	34.8	33.46	40.5	40.75	36.7	37.33	43.2	41.82
Difference (2004)	31.3	32.03	39	39.85	35.4	36.66	40.6	40.93
Difference (2005)	29.2	32.35	40	39.19	36.1	36.19	39.8	40.17
Difference (2006)					36.6	34.35	38.3	37.97

Table B9: Predictor balances for entry-rates by state of higher education institution (controlled)

Year	Gap	RMSPE ratio	RMSPE ranking	p-value	N
2000	-.5584	.	.	.	10
2001	.2427	.	.	.	10
2002	.9894	.	.	.	10
2003	.9891	.	.	.	10
2004	.3018	.	.	.	10
2005	-1.997	.	.	.	10
2006	-2.1711	4.414217	2	.2	10
2007	-2.2607	4.600148	3	.3	10
2008	-2.3004	4.718649	4	.4	10
2009	-3.2069	5.9467	2	.2	10
2010	-4.7365	8.959196	2	.2	10
2011	-7.1155	15.3683	2	.2	10
2012	-5.7156	17.54321	2	.2	10
2013	-2.7606	16.2424	2	.2	10
2014	-1.8538	14.79528	3	.3	10
2015	-.5239	13.34145	4	.4	10
2016	.6437	12.16387	4	.4	10
2017	.6609	11.1843	4	.4	10
2018	-2.5974	10.80996	4	.4	10

Table B10: Allsynth output for the difference in entry-rates for Lower Saxony (controlled)

Year	Gap	RMSPE ratio	RMSPE ranking	p-value	N
2000	-.3888	.	.	.	10
2001	.328	.	.	.	10
2002	-.2494	.	.	.	10
2003	.34	.	.	.	10
2004	.0369	.	.	.	10
2005	.0081	.	.	.	10
2006	-.7264	7.228557	1	.1	10
2007	-.6058	6.128065	3	.3	10
2008	-1.1272	9.887416	2	.2	10
2009	-1.6639	16.89744	2	.2	10
2010	.3927	13.94048	4	.4	10
2011	5.6009	83.24202	1	.1	10
2012	.8474	72.75563	2	.2	10
2013	-.0803	63.67222	3	.3	10
2014	.4954	56.9711	4	.4	10
2015	-.5397	51.67302	4	.4	10
2016	-4.7641	75.24177	2	.2	10
2017	-5.2857	100.8667	1	.1	10
2018	-3.0395	102.8433	1	.1	10

Table B11: Allsynth output for the entry-rates by state of high school graduation for Lower Saxony (controlled)

Year	Gap	RMSPE ratio	RMSPE ranking	p-value	N
2000	-.8255	.	.	.	10
2001	.1622	.	.	.	10
2002	.2471	.	.	.	10
2003	1.3436	.	.	.	10
2004	-.7341	.	.	.	10
2005	-3.1524	.	.	.	10
2006	-3.764	6.51358	2	.2	10
2007	-4.1983	7.308491	2	.2	10
2008	-4.5365	8.026178	2	.2	10
2009	-5.4755	9.465576	2	.2	10
2010	-5.6479	10.50555	3	.3	10
2011	-2.8626	9.382522	3	.3	10
2012	-5.5891	10.09383	4	.4	10
2013	-4.0553	9.777194	4	.4	10
2014	-3.4625	9.303271	6	.6	10
2015	-3.2182	8.849097	6	.6	10
2016	-7.8909	10.64707	5	.5	10
2017	-8.8253	12.74381	4	.4	10
2018	-9.2543	14.79228	4	.4	10

Table B12: Allsynth output for the entry-rates by state of higher education institution for Lower Saxony (controlled)

Year	Gap	RMSPE ratio	RMSPE ranking	p-value	N
2000	.0054	.	.	.	10
2001	-.0294	.	.	.	10
2002	.0197	.	.	.	10
2003	-.0196	.	.	.	10
2004	.0004	.	.	.	10
2005	.3498	.	.	.	10
2006	.0542	.1421141	7	.7	10
2007	-2.1836	115.4044	1	.1	10
2008	-2.5043	178.0686	1	.1	10
2009	-2.009	182.3648	1	.1	10
2010	-.5702	149.0376	1	.1	10
2011	.9237	131.0774	1	.1	10
2012	-.2229	112.6954	3	.3	10
2013	1.3616	109.8196	3	.3	10
2014	3.4138	160.2603	2	.2	10
2015	3.8015	214.1458	2	.2	10
2016	6.0036	353.1927	2	.2	10
2017	4.543	406.9637	1	.1	10
2018	3.2467	414.8853	2	.2	10

Table B13: Allsynth output for the difference in entry-rates for North Rhine-Westphalia (controlled)

Year	Gap	RMSPE ratio	RMSPE ranking	p-value	N
2000	-.7753	.	.	.	10
2001	-.1699	.	.	.	10
2002	.414	.	.	.	10
2003	-.1882	.	.	.	10
2004	.4254	.	.	.	10
2005	1.7039	.	.	.	10
2006	-.0961	.0141319	9	.9	10
2007	-.4447	.1583724	9	.9	10
2008	.0824	.1090448	9	.9	10
2009	1.0831	.5305603	9	.9	10
2010	-.2155	.4386609	9	.9	10
2011	2.7123	2.241743	8	.8	10
2012	1.5255	2.430215	8	.8	10
2013	7.9953	14.3538	4	.4	10
2014	5.653	18.19229	4	.4	10
2015	2.2138	17.12301	4	.4	10
2016	1.1497	15.75025	4	.4	10
2017	2.1717	15.03914	4	.4	10
2018	2.8573	14.84328	4	.4	10

Table B14: Allsynth output for the entry-rates by state of high school graduation for North Rhine-Westphalia (controlled)

Year	Gap	RMSPE ratio	RMSPE ranking	p-value	N
2000	-.0214	.	.	.	10
2001	-.0119	.	.	.	10
2002	-.3079	.	.	.	10
2003	-.2486	.	.	.	10
2004	-.8474	.	.	.	10
2005	.8086	.	.	.	10
2006	-1.2953	6.583383	2	.2	10
2007	-3.6035	28.76747	1	.1	10
2008	-2.1634	25.29985	1	.1	10
2009	-1.124	20.2142	1	.1	10
2010	-1.3246	17.54828	1	.1	10
2011	4.6162	28.55919	1	.1	10
2012	4.7342	37.0426	1	.1	10
2013	10.969	91.42591	1	.1	10
2014	9.8971	123.9728	1	.1	10
2015	7.7448	135.1113	1	.1	10
2016	5.7013	134.4233	1	.1	10
2017	5.2974	132.3973	1	.1	10
2018	5.5144	131.3912	1	.1	10

Table B15: Allsynth output for the entry-rates by state of higher education institution for North Rhine-Westphalia (controlled)

Year	Gap	RMSPE ratio	RMSPE ranking	p-value	N
2000	.2332	.	.	.	10
2001	-.2808	.	.	.	10
2002	-.7249	.	.	.	10
2003	-.2754	.	.	.	10
2004	-.6452	.	.	.	10
2005	.3647	.	.	.	10
2006	.8449	.	.		10
2007	-.7179	1.805907	5	.5	10
2008	-.9004	2.323346	7	.7	10
2009	-1.3982	3.832312	5	.5	10
2010	-1.6753	5.332861	4	.4	10
2011	-.8908	4.822395	5	.5	10
2012	.1621	4.034009	7	.7	10
2013	2.6925	7.08667	5	.5	10
2014	1.2445	6.879208	5	.5	10
2015	4.1864	12.93834	5	.5	10
2016	4.7768	19.63993	3	.3	10
2017	7.0818	33.83026	3	.3	10
2018	5.529	39.93754	2	.2	10

Table B16: Allsynth output for the difference in entry-rates for Bavaria (controlled)

Year	Gap	RMSPE ratio	RMSPE ranking	p-value	N
2000	-.7255	.	.	.	10
2001	-.4927	.	.	.	10
2002	-.4338	.	.	.	10
2003	.4214	.	.	.	10
2004	-.3224	.	.	.	10
2005	.0043	.	.	.	10
2006	.7268	.	.		10
2007	-.0316	.0039557	9	.9	10
2008	.1764	.0636108	9	.9	10
2009	.7964	.8799122	9	.9	10
2010	3.3654	11.87649	3	.3	10
2011	14.603	178.452	1	.1	10
2012	4.8688	164.3609	1	.1	10
2013	2.9666	145.8612	1	.1	10
2014	1.9557	129.5224	1	.1	10
2015	.8798	115.4718	1	.1	10
2016	-4.1982	110.9065	1	.1	10
2017	-3.6382	105.5909	1	.1	10
2018	-.8871	97.0514	1	.1	10

Table B17: Allsynth output for the entry-rates by state of high school graduation for Bavaria (controlled)

Year	Gap	RMSPE ratio	RMSPE ranking	p-value	N
2000	-.2374	.	.	.	10
2001	-1.8801	.	.	.	10
2002	-2.3066	.	.	.	10
2003	-.6326	.	.	.	10
2004	-1.2579	.	.	.	10
2005	-.0916	.	.	.	10
2006	2.2515	.	.		10
2007	-.591	.1530814	9	.9	10
2008	-.6187	.1604245	9	.9	10
2009	.2584	.1167043	10	1	10
2010	1.9497	.5040361	8	.8	10
2011	13.3052	15.92068	2	.2	10
2012	4.0045	14.4386	2	.2	10
2013	6.9252	15.37866	2	.2	10
2014	5.1393	14.90332	2	.2	10
2015	6.0172	15.01056	2	.2	10
2016	3.5378	14.05805	2	.2	10
2017	6.035	14.23119	4	.4	10
2018	6.7496	14.70914	3	.3	10

Table B18: Allsynth output for the entry-rates by state of higher education institution for Bavaria (controlled)

Year	Gap	RMSPE ratio	RMSPE ranking	p-value	N
2000	.0562	.	.	.	10
2001	.157	.	.	.	10
2002	.405	.	.	.	10
2003	1.0658	.	.	.	10
2004	-.0768	.	.	.	10
2005	-1.1638	.	.	.	10
2006	-1.3025	.	.		10
2007	-4.2804	29.25075	1	.1	10
2008	.1392	14.64084	1	.1	10
2009	-.594	9.94833	2	.2	10
2010	-1.2821	8.117321	3	.3	10
2011	-2.6636	8.759212	5	.5	10
2012	-1.8673	8.227124	6	.6	10
2013	-1.2967	7.435306	7	.7	10
2014	-1.4913	6.949715	8	.8	10
2015	-1.4578	6.554507	9	.9	10
2016	.0943	5.900476	9	.9	10
2017	-1.3469	5.627367	9	.9	10
2018	-2.6728	6.108849	9	.9	10

Table B19: Allsynth output for the difference in entry-rates for Baden-Württemberg (controlled)

Year	Gap	RMSPE ratio	RMSPE ranking	p-value	N
2000	-.1852	.	.	.	10
2001	-.7948	.	.	.	10
2002	-.796	.	.	.	10
2003	.1752	.	.	.	10
2004	-.0248	.	.	.	10
2005	.53	.	.	.	10
2006	.83	.	.		10
2007	-.9372	2.67237	5	.5	10
2008	1.8848	6.740399	5	.5	10
2009	3.7532	18.77971	3	.3	10
2010	2.5436	19.00597	5	.5	10
2011	6.234	38.85284	3	.3	10
2012	4.154	41.12748	6	.6	10
2013	3.7556	41.38258	6	.6	10
2014	1.4488	37.00805	7	.7	10
2015	.5872	33.0126	7	.7	10
2016	-1.2292	30.17105	7	.7	10
2017	-2.4252	29.05502	7	.7	10
2018	-2.9868	28.89562	7	.7	10

Table B20: Allsynth output for the entry-rates by state of high school graduation for Baden-Württemberg (controlled)

Year	Gap	RMSPE ratio	RMSPE ranking	p-value	N
2000	1.0297	.	.	.	10
2001	-.5575	.	.	.	10
2002	-.1686	.	.	.	10
2003	1.3824	.	.	.	10
2004	-.3264	.	.	.	10
2005	-.3681	.	.	.	10
2006	.332	.	.		10
2007	-3.7493	26.86488	1	.1	10
2008	4.4186	32.08867	2	.2	10
2009	5.9673	44.07641	2	.2	10
2010	4.621	43.25957	2	.2	10
2011	8.4803	62.09526	2	.2	10
2012	9.5904	81.04194	2	.2	10
2013	9.7896	95.62926	2	.2	10
2014	6.2611	93.04034	2	.2	10
2015	5.7652	89.76035	2	.2	10
2016	4.2772	84.28057	2	.2	10
2017	3.0922	78.27992	3	.3	10
2018	3.1469	73.33373	3	.3	10

Table B21: Allsynth output for the entry-rates by state of higher education institution for Baden-Württemberg (controlled)

State:	Average treatment effect	Average p-value
Lower Saxony	-2.49%	0.28
North Rhine-Westphalia	-1.66%	0.25
Bavaria	-1.01%	0.57
Baden-Württemberg	-1.58%	0.13

Table B22: Average treatment effects and p-values for the controlled analysis of the differences in enrollment rates

State:	Average treatment effect	Average p-value
Lower Saxony	-1.03%	0.20
North Rhine-Westphalia	0.156%	0.9
Bavaria	0.31%	0.9
Baden-Württemberg	1.57%	0.43

Table B23: Average treatment effects and p-values for the controlled analysis of the enrollment rates by location of high school

State:	Average treatment effect	Average p-value
Lower Saxony	-4.49%	0.20
North Rhine-Westphalia	-2.05%	0.13
Bavaria	-0.32%	0.9
Baden-Württemberg	2.21%	0.17

Table B24: Average treatment effects and p-values for the controlled analysis of the enrollment rates by location of higher education institution