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Hospital Competition, Service Provision and Quality – Evidence From Maternity Units

Hospital Competition, Service Provision and Quality - Evidence from Maternity Units ♥

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Abstract

Maternity unit closures are increasingly common in areas with low birth rates, resulting in diminished competition between units. We examine how competition affects the quality and amenities of the remaining maternity units in Germany. To address potential endogeneity in the level of competition, we exploit the unpopularity of maternity unit closures and instrument competition with the tightness of past regional elections. Our findings indicate that while low competition does not significantly affect the quality of care, it leads to reduced availability of additional services potentially used to attract patients in the higher competitive market.

Keywords: Maternity unis, hospital competition, healthcare quality, non-price amenities
JEL codes: I11, I18, L13

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1 Introduction

In areas with low birth rates, high reservation costs put financial pressure on maternity units within case-based payment systems. The increasing number of maternity unit closures shows that offsetting high reservation costs from maintaining empty facilities and staff is becoming increasingly difficult. In the US, such closures reduced the number of counties with access to in-county maternity units by nine percent between 2004 and 2014 (Hung et al., 2017). In France, 20% of maternity units closed between 1998 and 2003 (Pilkington et al., 2008). In Germany, out of 747 hospitals that offered obstetrics services in 2014, 85 (11%) were closed by 2019 (Hoffmann et al., 2023). While these closures directly affect access to maternal care, less is known about the effect of the resulting reduced competition on services and quality offered in maternity units.

In this paper, we analyze how competition affects service provision and quality of care. Theoretically, hospitals can only compete through quality of care in markets with fixed prices. In this setup, a decrease in competition from clinic closures would result in a decline in quality (see Gaynor and Town (2011) for an overview of the early literature). However, recent research indicates that the relationship between competition and quality is not always positive (see e.g., Moscelli et al. (2021) and Wani et al. (2018)).

We use hospital-level data on all German maternity units from mandatory quality reporting to analyze the relationship between competition, quality, and service provision. We measure competition as the Herfindahl-Hirschman-Index (HHI) for hospital births in the area surrounding each hospital. Our main variation to the HHI stems from maternity unit closures. Since these closures are potentially endogenous, we leverage the winning margin between the two most successful parties in regional elections as an instrumental variable (IV) since unpopular policies such as maternity unit closures are less likely when elections are tight.

We find that while reduced competition does not affect the quality of care, it leads to fewer additional services offered by maternity units. These special services for parents and families, for example, baby cry units and baby massages could have been used to attract patients in a high-competition environment and are therefore less important to the hospital when competition is low. Maternity units in small hospitals are driving the results. Further, we investigate whether the decrease in additional services is due to a decline in hospital staff. While there is a negative relationship between the absolute number of staff and the HHI, staff per birth does not change. Our results are robust to alternative samples and IV specifications.

With respect to the existing literature, our study adds insights into the relationship between competition and the quality of hospitals in a fixed-price setting. So far, the literature is indecisive on the direction of the relationship. For healthcare systems with regulated prices, there is evidence for improved patient outcomes resulting from competition in the English NHS (Cooper et al., 2011; Gaynor et al., 2013; Moscelli et al., 2018), for Italy (Lisi et al., 2021), the Netherlands (Brekke et al., 2021; Croes et al., 2018), or China (Pan et al., 2015) while there are mixed effects for Australia (Palangkaraya & Yong, 2013), Germany (Bayindir et al., 2024; Strumann et al., 2022), and the US (Colla et al., 2016; Wani et al., 2018). Several studies have also investigated the influence of competition on hospital characteristics that indirectly affect quality. Bloom et al. (2015) show that competition increases managerial quality in English hospitals, whereas is associated with a lower probability of investing in large-scale medical equipment in Germany (Dreger et al., 2022).

While previous research points to quality as the main dimension for hospital differentiation (e.g. Douglas & Ryman, 2003; Goldman et al., 2010), also the role of non-price amenities in the hospital sector is increasingly receiving attention. For instance, Horn et al. (2022) find a positive association of technology adoption with patient volume whereas Beckert (2018) shows that patients tend to focus on hospital amenities rather than referrals from their general practitioners for their hospital choice. Evidence, specifically, on the relationship of non-price amenities in the form of specialized services in a competitive setup is given by Devers et al. (2003), who show that additional services are offered even when there is price competition. Goldman and Romley (2008) find that non-price amenities drive patient demand and Trinh (2020) shows that market competition is negatively associated with duplicating services from competitors. We add the unique setting of maternity units to the literature. Maternity units are a good showcase for the effects of competition on services offered since patients can usually make informed choices between competing providers (Avdic et al., 2019). With the transparency of quality indicators and the patient's freedom to choose hospitals, the German healthcare market provides an ideal setting to analyze changes in hospital behavior in response to changes in competition.

Finally, we also add to the growing literature on maternity unit closures. For the US, Kozhimannil et al. (2018) show that maternity unit closures are positively correlated with the probability of preterm births and Durrance et al. (2024) find overall worse health outcomes for births in regions where maternity units closed. In contrast, Fischer et al. (2024) and Battaglia (2023) find no influence of increased concentration on outcomes. For Sweden, Avdic et al. (2024) document negative effects of maternity unit closures on maternal outcomes. We complement this literature by analyzing hospitals' reactions to the changes in competition.

The remainder of this paper is structured as follows: Section 2 provides a brief overview of healthcare provision in Germany. Afterward, we introduce our data and descriptive statistics (Section 3). In Section 4, we present the estimation strategy used to analyze the relationship between hospital quality and competition. Our main results and additional analyses are presented in Sections 5 and 6, respectively. We then discuss our analysis and conclude in Section 7.

2 Institutional Background

In the German healthcare system, patients are either covered through one of the social health insurances or buy private health insurance. Inpatient services are provided by a mix of public, private, and private non-profit hospitals. Reimbursement to the hospital is the same under private and social insurance and patients are also free to choose their hospital, independent of which type of insurance they have (Bundesministerium für Gesundheit, 2022). We give a short overview of the details of the institutional context in this section.[1]

Hospital Financing and Market Structure

Hospitals in Germany are financed from two sources: Each federal state decides which hospitals are included in the hospital plan, making hospitals eligible for both investment cost funding from the state (lump-sum grants for hospital infrastructure) and case-based reimbursement from the social and private health insurances (according to the German DRG scheme). Patients are free to choose their hospital and about 98% of all births take place in-hospital (see Appendix Table A.1). The fixed reimbursement per case under the DRG scheme provides an incentive for hospitals to compete for patients in order to generate sufficient revenue.[2] To stand out in the competitive maternity care market, hospitals can differentiate by ensuring quality of care or by offering non-price amenities in the form of additional services. The reimbursement for additional services in maternity units can be roughly divided into three categories: First, hospitals can provide additional care services like childbirth preparation courses or breastfeeding counseling. These additional care services are reimbursed by some health insurances or paid for out of pocket. Second, hospitals can provide additional medical services such as prenatal diagnostics or therapy for pregnancy-related illnesses. These additional medical services are reimbursed by all insurances. In addition, patients can choose to pay for extra accommodation services (e.g., single rooms). These services are either paid out-of-pocket

[1] For a detailed overview, see e.g. Blümel et al. (2020).

[2] On average, maternity units need more than 500 births per year to cover their costs (DKG, 2019).

by the patient or covered by private insurance (for patients who are fully insured in the private market or patients with private add-on insurance for such services).

Changes in the hospital market structure occur when hospitals either close down completely, partially (closure of selected units), or merge with another hospital. Such market exits are most commonly the consequence of financial reasons (Preusker et al., 2013) since maternity units suffering from low demand face lower total reimbursement while fixed costs remain unchanged. These demand-side changes are a consequence of an aging population or migration flows (Mennicken et al., 2014).

Politics and Market Structure

In Germany, federal states (NUTS Level 2) play a major role in shaping the market structure for hospitals and, therefore, the market structure for maternity units as states are in charge of maintaining the hospital plan and providing investment financing. However, counties (NUTS Level 3) are ultimately responsible for their infrastructure including among others the availability of inpatient medical care for their population. Some counties also operate hospitals and contribute to their investment financing (DKG, 2021). Given this setup, county policy has a great influence on the design of the hospital landscape.

This influence, however, comes with a trade-off. Running public-owned hospitals or supporting private or private non-profit hospitals can often be costly for the county. Nevertheless, closing a hospital and especially a maternity unit is highly unpopular with residents. Anecdotal evidence shows that politicians were rebuked when they proposed a closure (RAG-Redaktion, 2016; Stäbler, 2022) and local pressure can even reverse an attempt to close a maternity unit (Czerwonn, 2020). As a result, the number of competitors in the market for maternity care tends to be higher than it would be without political influence.

To proxy political willingness to close maternity units, we use the closeness of elections in counties. Politicians are less likely to support unpopular policies, such as maternity unit closures, when small shifts in voting intentions can significantly affect election results. We leverage this variation to instrument for changes in the structure of the maternity care market.

3 Data

Our data on maternity units is from quality report cards of hospitals provided by the Federal Joint Committee (G-BA), an institution where insurances and providers jointly agree on regulations for healthcare provision. The quality report data was first introduced in 2005 and originally collected every other year. Since 2012, the data has been available on an annual basis. Each hospital in the federal state hospital plans is required to report all information requested by the G-BA and the data is made available to the public free of charge to improve transparency for patients and physicians.

Our main specification uses the cross-section of units in 2019, the most recent year before the Covid-19 pandemic affected various aspects of inpatient care. The main advantage of using more recent years is the availability of more quality indicators in the data. As an alternative specification, we analyze changes from 2010 to 2019. While this specification allows us to better account for regional characteristics, it contains fewer variables since their inclusion and definition changed considerably over time. We take 2010 as the baseline year for this analysis since this was the first wave with rich quality information. We construct our IV using county election outcomes provided by the statistical offices of the federal states.

Maternity Units

Hospitals in Germany usually consist of multiple specialist departments. We identify maternity units as hospitals with a specialist department related to maternity care (gynecology and obstetrics).[3] Even though some hospitals have more than one such specialist department, we treat them as one observation in our analysis. Next, we restrict our analysis to hospitals that report at least five births per year.[4] This way, we are able to identify 813 hospitals with maternity units in the year 2010 and 659 in the year 2019. We use OpenStreetMap (OSM) to geolocate all maternity units based on addresses.[5]

In our main specification, we use the 659 units available in 2019 to analyze the effect of competition on outcomes. As an additional specification, we restrict our data to the 582 maternity units operating in 2010 and 2019. Figure 1 shows the location of the maternity units in Germany. The blue dots illustrate the geolocation of maternity units available in 2019, whereas the red crosses depict maternity units that closed between 2010 and 2019.[6] Most closures happened in North Rhine-Westphalia and Bavaria (see Appendix Table A.7 for an overview by state).

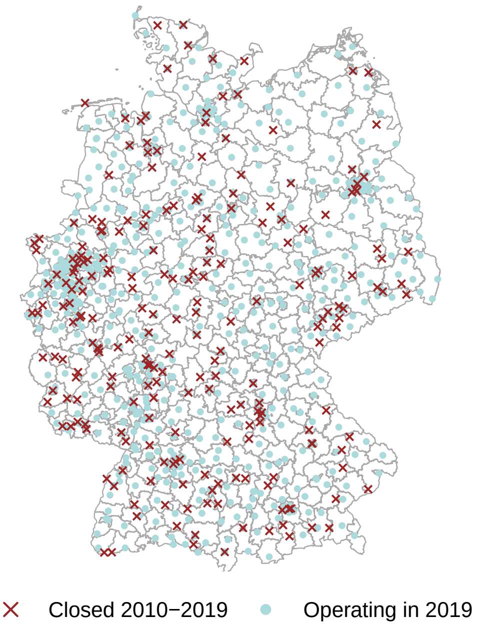
[3] We provide the detailed lists with all unit keys and descriptions used in our definition of maternity units in Appendix Table A.2.

[4] We construct this variable based on OPS-codes. The exact definition can be found in Appendix Table A.3.

[5] We used the address of the specialist department if reported. Otherwise, we assume that the address of the hospital equals the address of the specialist department.

[6] Appendix Table A.6 reports summary statistics for the units we identified as *closed* and *opened* by comparing the geolocation points of 2019 and 2010. We do not distinguish closures and relocations since we are ultimately interested in the (changes) in competition. Appendix 7 provides further details on the identification procedure of units in our data set.

Figure 1: Geographical Distribution of Maternity Units



Notes: This figure depicts the location of maternity units in Germany. The grey border-lines identify counties. The blue dots display the location of maternity units in 2019. The red crosses show the locations of the maternity units that were closed between 2010 and 2019. Appendix Table A.2 list all specialist department key numbers we used to define maternity units.

Quality Data

We employ seven quality indicators used for quality assurance by official institutions, only available in the 2019 data (IQTIG, 2020). We directly use the scores reported for 1) the presence of a pediatrician, 2) antenatal corticosteroid therapy performed for premature births, 3) the time between decision and delivery of emergency Cesarean Section (CS), 4) pre-surgery antibiotic prophylaxis during CS, and 5) a score for the outcomes of critical full-term births. Although these indicators have the advantage of being risk-adjusted, they are only available for a subset of hospitals in 2019 and were measured differently or not at all for the 2010 reports. To ensure comparability across hospitals and over time, we construct two indicators based on reported OPS-codes available in 2010 and 2019. These additional indicators are 6) perineal tear rates, and 7) the rate of C-sections. Appendix Table A.5 provides an overview of the quality indicators, definitions, and interpretations. The OPS-codes used for the reconstruction of perineal tear and CS rates can be found in Appendix Table A.3.

Additional Care and Services

In addition to the medical and care services hospitals need to offer to qualify for running a maternity unit, hospitals may provide additional services for patients. In the quality scorecards, hospitals report whether they offer each of seven additional care services related to maternal care: 1) special offers such as baby swimming, 2) childbirth preparation courses, 3) infant care courses, 4) additional midwife services such as underwater births, 5) breastfeeding counseling, 6) postpartum gymnastics, and 7) additional services for parents and families. Hospitals also report whether they offer one of the following five additional medical services related to maternal care: 1) prenatal diagnostics, 2) assistance for high-risk pregnancies, 3) diagnostics and therapy for diseases during pregnancy, 4) obstetric surgeries, and 5) special consulting hours by gynecologists.

For our analysis, we construct an index by summing the additional care and medical services offered by each hospital. This sum is then standardized to range between 0 (none of the services offered) and 1 (all services offered). Appendix Table A.4 lists all key numbers we used to define each of our service provision measures.

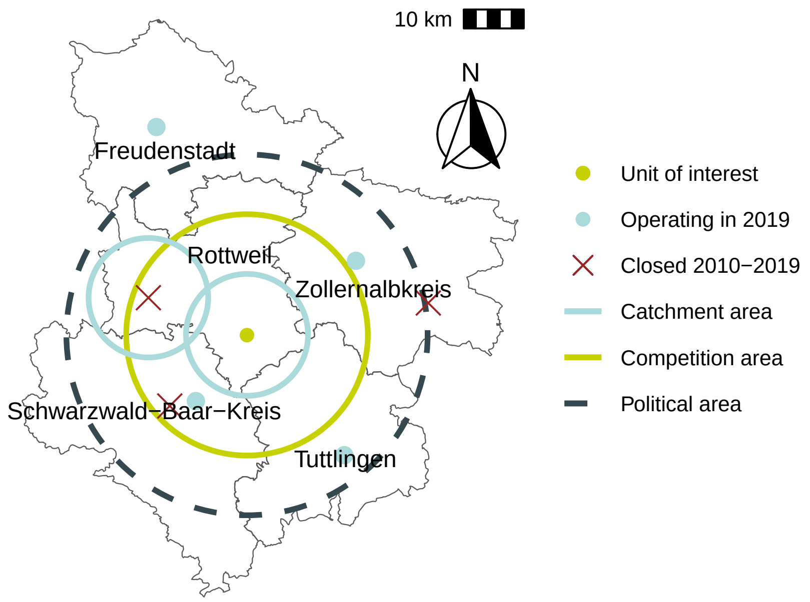
Competition and Political Area

Our definition of the area of competition is inspired by Bloom et al. (2015) and illustrated in Figure 2. We define a hospital's primary catchment area for patients to whom it provides its services as a 10 km radius around the maternity unit (the blue circle surrounding the hospitals represented as dots when they were operating in 2019 or crosses when they closed between 2010 and 2019).[7] The area of competition is therefore in the 20 km radius around each hospital (the green circle), ensuring that the catchment areas of competitors overlap with that of the maternity unit.

We generate the Herfindahl-Hirschman index (HHI) to measure market concentration for maternity units within the 20 km radius. We use the total number of births in each maternity unit in this area as an inflow variable and consider different units from the same hospital operator as one player when we compute market shares. The HHI ranges from 0 (perfect competition) to 10,000 (monopolistic provider, only one maternity unit in the 20 km radius).

[7]This radius is chosen as it roughly corresponds to the distance pregnant women are willing to travel in Germany (see Avdic et al. (2019)).

Figure 2: Illustration of Competition and Policy Influence Area



Notes: Blue dots depict maternity units that are available in 2019. Red crosses illustrate maternity units that closed in the time frame 2010-2019. In this region they represent the following events: 1) the complete closure of a hospital in Rottweil County, 2) the relocation of an entire hospital in the Schwarzwald-Baar-Kreis County, and 3) the relocation of a maternity unit in the Zollernalbkreis County. The blue circle represents the catchment area of two maternity units using a radius of 10 km. The competition area is illustrated as the green circle which has a radius of 20 km for the maternity unit in the middle (green dot). This way, the competition area of the green dot in the middle takes into account the catchment area of a rival that overlaps its own. The black dashed line depicts the geographic area of our political instrument. This area has a radius of 30 km as it takes into account the catchment area of the rivals.

For our political pressure instrument we use county-level voting data from the statistical offices of the federal states. The data includes turnouts of county elections for counties and city elections for cities having the same status as a county.[8] For each election, we have information on the total number of votes, number of votes for each party, total number of eligible voters per electoral district, total number of valid votes per electoral district as well as the year of election.

We again follow Bloom et al. (2015) for defining the geographical area in which the political turnout is relevant for a change in hospital structure. This area is defined as a 30 km radius around each maternity unit since this is the furthest distance from the maternity unit to a location in the catchment area of a competitor. Political decisions in this area hence influence the competitive environment of the unit of interest. A graphical representation of this definition is shown in Figure 2 as the black dashed circle.

County-level elections take place in different years across Germany. We use the most recent election before 2010 for each county in our IV approach since this is reasonably far away from 2019 to affect maternity unit closures (or the lack thereof) and

[8]In German: Kreisfreie Städte.

reactions to changes in competition.[9] For each county, we construct a measure of the tightness of the election as the difference in vote shares between the two parties with the highest and second highest voting shares. We then sum up these differences for all counties in the 30 km radius of the corresponding maternity unit. We use all counties that cover at least ten percent of the 30 km buffer zone. The aggregation is done as a weighted average of voting margins in the individual counties where the weights are based on the share the county has in the buffer of 30 km.

Control Variables

In our estimations, we account for three hospital characteristics reported in the quality scorecards. First, we use the total number of beds for the overall hospital to proxy hospital size. Second, we control for ownership type using a categorical variable that indicates whether the hospital is in private, public, or non-profit ownership. Third, we include a dummy variable indicating whether a hospital reports being a teaching hospital, training medical students.

Descriptives

Table 1 shows the descriptive statistics for the 659 maternity units observed in 2019. On average, these units faced 3.8 competitors, with an average HHI of approximately 5000. The variance of the HHI is high, reflecting the presence of units without competitors (HHI = 10,000) as well as units in highly competitive regions (min HHI = 654). About half of the maternity units are in public ownership, and around 70 percent report being part of a teaching hospital. There is large heterogeneity in hospital size (between 13 and 3011 beds) and in the number of births (between 32 and 8076). In 31 percent of births, CS were performed and 61 percent of births involved perineal tears. Our indicators for additional services are high on average: the average score for additional care services is 0.85, and the average score for additional medical services is 0.87, even though some units offer no additional services. On average, seven counties lie within a 30 km radius of a maternity unit. The weighted difference for the voting shares between the two leading parties is 17 percentage points on average.

[9] See Appendix Table C.1 for an overview of the county election years for each federal state and Figure C.2 for a graphical representation of the distribution of winning parties.

Table 1: Descriptive Statistics 2019

	Mean	Std. Dev.	Median	Min.	Max.	N
Competition Measures						
# competitors 2019 (in 20 km radius)	3.76	4.38	2.00	0.00	19.00	659
HH-index (in 20 km radius)	5,030.50	3,410.51	3,961.79	653.56	10,000.00	659
Quality Measures						
C-section rate	0.31	0.10	0.30	0.00	1.00	659
Perineal tear rate	0.61	0.19	0.61	0.01	1.00	587
Antenatal corticosteroid therapy (+)	97.04	6.11	100.00	51.35	100.00	199
Presence pediatrician (+)	97.40	3.97	99.32	71.43	100.00	264
E-E-time C-section (-)	0.13	1.98	0.00	0.00	36.36	430
Critical outcome full-term (-)	99.05	1.30	99.53	87.96	100.00	554
Grade IV perineal tears (-)	0.77	1.18	0.00	0.00	7.45	612
Ratio C-section (-)	1.01	0.20	1.02	0.33	1.92	656
Service Provision Measures						
Composite Msr: Additional care	0.85	0.21	0.86	0.00	1.00	659
Special offers for infants/small children	0.72	0.45	1.00	0.00	1.00	659
Childbirth prep. courses	0.94	0.23	1.00	0.00	1.00	659
Infant care courses	0.73	0.44	1.00	0.00	1.00	659
Midwife services	0.89	0.31	1.00	0.00	1.00	659
Breastfeeding counseling	0.97	0.17	1.00	0.00	1.00	659
Postpartum gymnastics	0.93	0.26	1.00	0.00	1.00	659
Special offers for parents/families	0.75	0.44	1.00	0.00	1.00	659
Composite Msr: Additional medical	0.87	0.20	1.00	0.00	1.00	659
Prenatal diagnosis	0.72	0.45	1.00	0.00	1.00	659
Assistance high-risk pregnancies	0.84	0.37	1.00	0.00	1.00	659
Diagnostics/Therapy of diseases	0.97	0.16	1.00	0.00	1.00	659
Obstetrical surgeries	0.97	0.18	1.00	0.00	1.00	659
Special counseling hours by gynecologists	0.83	0.37	1.00	0.00	1.00	659
Hospital Characteristics						
# of births	1,159.89	834.57	883.00	32.00	8,076.00	659
# beds	435.54	338.59	338.00	13.00	3,011.00	659
Private	0.17	0.38	0.00	0.00	1.00	659
Public	0.45	0.50	0.00	0.00	1.00	659
Non-profit	0.37	0.48	0.00	0.00	1.00	659
Teaching hospital	0.72	0.45	1.00	0.00	1.00	659
Hospital Staff						
# doctors	13.13	8.41	11.20	0.00	73.20	659
# attending doctors	0.14	0.63	0.00	0.00	8.00	659
# head physicians	1.33	0.74	1.00	0.00	6.00	659
# specialists	6.84	4.61	5.88	0.00	39.01	659
# midwives	11.32	8.25	10.10	0.00	69.00	659
# nurses	21.45	15.36	18.10	0.00	119.80	659
# health assistants	1.29	2.13	0.60	0.00	20.89	659
Political Variables						
Election win margin (in 30 km radius)	17.20	8.43	14.94	1.49	52.29	659
Weighted election win margin (in 30 km radius)	16.60	8.53	13.86	1.56	52.04	659
Number of counties (in 30 km radius)	7.28	3.49	6.00	1.00	20.00	659

Notes: Sample based on maternity units that are available in 2019. See Appendix Table A.2 for the keys used to identify maternity units within hospitals. HHI is calculated based on the catchment area radius of 20 km. C-section rate, perineal tear rate and number of births are calculated based on OPS-codes (see Appendix Table A.3). Appendix Table A.5 provides details on the official quality indicators. Election win margins are calculated as the difference in voting shares between the two leading parties and dividing that sum by the weighted number of counties within a 30 km radius of the unit.

4 Empirical Analysis

Our interest is to examine the relationship between competition and quality and amenities in a maternity unit. The estimation equation for modeling this relationship is defined as follows:

$$Outcome_{aj} = \beta Competition_{aj} + \mathbf{Z}_{aj} + \gamma_a + \varepsilon_{aj} \tag{1}$$

Here, $Outcome_{aj}$ is either a quality measure or a score for the additional services provided by maternity unit j in federal state a. $Competition_{aj}$ is the HHI for maternity unit j.[10] The vector of controls, Z_{aj}, includes a dummy for teaching hospitals, a categorical variable for a hospital's ownership type and the number of beds on the hospital level. In addition, we include federal state fixed effects, γ_a. We cluster our standard errors at the county level.

Estimation Equation 1 gives a first insight into the relationship between competition and our outcome measures. We are, however, ultimately interested in the causal relationship between them. The variation in competition can be endogenous as, for instance, a reduction in quality could reduce competition when fewer patients choose the low-quality hospital. Therefore, we use an instrumental variable approach, first proposed by Bloom et al. (2015), which measures the degree of political marginality as an exogenous driver of competition. The underlying idea behind this political instrument is that parties avoid unpopular policies when they anticipate the upcoming election to be close. We instrument for the endogenous variable $Competition_{aj}$ from Equation 1 with $ElectionWinMargin_{aj}$, which is the difference in vote share between the first and the second most popular party in the counties surrounding the hospital, weighted by each county's share in the 30 km radius around the hospital. The resulting first-stage estimation equation takes the following form:

$$Competition_{aj} = \rho\, ElectionWinMargin_j + \mathbf{Z}_{aj} + \gamma_a + \varepsilon_{aj} \tag{2}$$

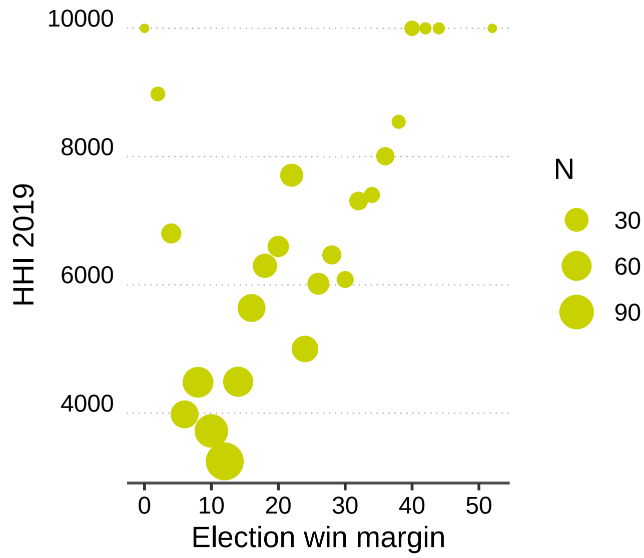
The remainder of Equation 2 is defined as in Equation 1. In both equations we use clustered standard errors at the county level.

To ensure the validity of our instrument, we need to justify the following conditions: First, the political marginality should influence the variation in the HHI (instrument relevance). Second, the instrument must not directly affect quality of service provision of a maternity unit, except through the variation it induces in the HHI (exclusion restriction).

[10] A detailed description of the competition measure can be found in Section 3.

Our hypothesis suggests that the relationship between political marginality and the variation in the HHI is positive. In other words, a higher difference in the vote shares between the first and second most popular party (less tight political races) should be associated with an increased likelihood of maternity unit closures and, hence, a higher HHI (less competition) for the remaining units. To evaluate whether our hypothesis holds, we first investigate the relationship between the two variables descriptively. Figure 3 suggests a positive relationship between the mean HHI (y-axis) and the factored version of the average election win margin (x-axis). To formally test relevance, Table 2 shows the first stage estimates. Depending on the sample and the inclusion of control variables, the F-statistic is between 83 and 93, supporting the relevance of our instrument. The relationship between the difference in vote shares of the two most popular parties and the HHI is positive and statistically significant, consistent with our with our hypothesis about the mechanism of the instrument. In order to interpret our results as a local average treatment effect (LATE), we further check the monotonicity of our instrument. For this, we vary the radius of the catchment area, which in turn leads to changes in the radius chosen for the competition area and area of the political instrument. In our main specification, we used a catchment area of 10 km and, for the analysis of monotonicity, extended the specification to 15 km and 20 km, respectively. Table 3 suggests that our instrument is robust to the alternative specifications. The estimates remain positive and statistically significant, although their sizes decrease with larger radii. From these results, we conclude that the monotonicity assumption is valid. While the exclusion restriction cannot be tested, we are not aware of any channel through which the election win margin could influence quality or service provision of maternity units other than competition.

Figure 3: Competition between Maternity Units and Tightness of Elections



Notes: This scatterplot illustrates the relationship between the mean in HHI 2019 (y-axis) and the factored version of the average election win margin (x-axis). The size of the green bubbles relfects the number of observations for each factor of the election win margin instrument. The scatterplot suggests that the mean in HHI and the average election win margin are positively correlated.

Table 2: IV First Stage - HHI in 2019

	HHI 2019			
	Full Sample		Tear Rate Sample	
	I	II	III	IV
Election win margin	165.523***	158.845***	167.183***	162.296***
	(25.008)	(21.531)	(25.160)	(22.124)
State FE	X	X	X	X
Additional Controls		X		X
IV F-Stat	93.01	90.78	83.16	83.26
N	659	659	587	587
R^2	0.37	0.42	0.39	0.44

Notes: This table shows the results for the first stage estimation as defined in Equation 2. Each column depicts the results for a separate regression varying whether the estimation included the vector of controls Z_{aj}. The instrument is defined as the average weighted difference in voting shares of the first two parties that got the majority of votes for all counties that lie within 30 km of the corresponding maternity unit. The sample is restricted to maternity units experiencing more than five births in 2019. Standard errors are clustered at the county level and are shown in parentheses. ***, **, * indicate significance at the 1%, 5% level, and 10% level, respectively.

Table 3: IV First Stage by Radius - HHI in 2019

	HHI		
	I	II	III
Election win margin	158.845***	116.802***	70.030***
	(21.531)	(19.061)	(12.424)
Catchment area radius	10 km	15 km	20 km
Competition radius	20 km	30 km	40 km
Instrument radius	30 km	45 km	60 km
IV F-Stat	90.78	61.81	50.82
N	659	659	659
R^2	0.42	0.36	0.43

Notes: This table shows the results for the first stage estimation as defined in Equation 2. The instrument is defined as the average weighted difference in voting shares of the first two parties that got the majority of votes for all counties. The columns depict the results for different assumptions on the radius chosen for the catchment area of a maternity unit. Starting off with column (I), main specification, with 10 km as catchment area and increasing by 5 km until column (III). The sample is restricted to maternity units experiencing more than five births in 2019. Standard errors are clustered at the county level and are shown in parentheses. ***, **, * indicate significance at the 1%, 5% level, and 10% level, respectively.

5 Results

Impact on Quality and Service Provision

First, we examine the relationship between market concentration and key quality outcomes, alongside indicators of additional service provision. OLS estimation results based on Equation 1 are reported in Table 4. We find a negative and statistically significant association between the HHI on the number of births, indicating that more concentrated markets are associated with fewer births. This pattern shows that regions with fewer hospitals (lower competition) also have fewer births per hospital. In terms of quality, there is no correlation between the HHI and CS rates but a small negative correlation between HHI and perineal tear rates. This correlation would mean equal outcomes (CS rates) or better outcomes (tear rates) in less competitive regions. With respect to additional services, fewer competition is negatively correlated with additional care services but positively correlated with additional medical services. Qualitatively, all estimates are robust to the inclusion of control variables. For additional medical services, the coefficient is only significantly different from zero when control variables are included.

Since the OLS estimations can be biased due to the endogenous competition, we now turn to our IV estimates shown in Table 5. The first four columns show results for the IV estimations on the quality outcomes CS rate and perineal tear rate. The coefficients for CS remain insignificant and the coefficients for perineal tear rates turn insignificant in the IV estimations. These results indicate that competition does not significantly affect the quality of care as measured by CS and perineal tear rates when the endogeneity of competition is taken into accountt. IV results for additional services are presented in the last four columns. The negative effect of reduced competition on additional care services is quantitatively larger compared to the OLS estimates and again significantly different from zero. In the IV estimations, the effect of HHI on additional medical services is insignificant in the specification with and without additional control variables. These results suggests that hospitals reduce non-price amenities in the form of additional care offers when competition is low but do not change additional medical services.

In addition to the CS and tear rates which we use as our main quality indicators, we can also look at a larger set of quality indicators that are reported by a subset of hospitals. Table 6 shows the IV results for these risk-adjusted indicators. The signs in the column headers indicate the desired direction for each quality indicator. None of the estimates are statistically significant, confirming that competition does not affect quality of care in maternity units.

Table 4: OLS Results 2019 - HHI on Outcomes

	Number Births		Share CS		Tear Rate		Additional Care		Additional Medical	
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(IX)	(X)
HHI 2019	-0.07066***	-0.03077***	0.00000	0.00000	-0.00001***	-0.00001***	-0.00001***	-0.00001**	0.00000	0.00000*
	(0.01107)	(0.00929)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Additional Controls		X		X		X		X		X
N	659	659	659	659	587	587	659	659	659	659
R^2	0.21	0.51	0.07	0.10	0.12	0.16	0.07	0.13	0.03	0.12

Notes: This table shows the results for the estimation as defined in Equation 1. Each column depicts the results for a separate regression using the outcome shown in the column headers varying whether the estimation included the vector of controls Z_{aj}. Standard errors are clustered at the county level and are shown in parentheses. ***, **, * indicate significance at the 1%, 5% level, and 10% level, respectively.

Table 5: IV Results 2019 - HHI on Outcomes

	Share CS		Tear Rate		Additional Care		Additional Medical	
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
HHI 2019	0.00000	0.00000	-0.00001	-0.00001	-0.00002**	-0.00002**	0.00000	0.00000
	(0.00000)	(0.00000)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Additional Controls		X		X		X		X
N	659	659	587	587	659	659	659	659

Notes: This table shows the results for the estimation as defined in Equation 1. Each column depicts the results for a separate regression using the outcome shown in the column headers varying whether the estimation included the vector of controls Z_{aj}. The instrument is defined as the average weighted difference in vote shares of the first two parties that got the majority of votes for all counties that lie within 30 km of the corresponding maternity unit. The sample is restricted to maternity units experiencing more than five births in 2019. Standard errors are clustered at the county level and are shown in parentheses. ***, **, * indicate significance at the 1%, 5% level, and 10% level, respectively.

Table 6: IV Results 2019 - HHI on Quality Indicators

	ACS Therapy (+)		Presence Pediatrician (+)		E-E-time C-section (-)		Perioperative Antibiotic (+)		Critical Outcome Full-Term (-)		Grade IV Perineal Tears (-)		Ratio C-section (-)	
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(IX)	(X)	(XI)	(XII)	(XIII)	(XIV)
HHI 2019	-0.00049	-0.00053	-0.00011	-0.00013	-0.00007	-0.00008	0.00002	0.00003	0.00002	0.00004	0.00002	0.00003	0.00000	0.00000
	(0.00052)	(0.00063)	(0.00032)	(0.00041)	(0.00006)	(0.00007)	(0.00006)	(0.00006)	(0.00003)	(0.00003)	(0.00005)	(0.00005)	(0.00001)	(0.00001)
Additional Controls		X		X		X		X		X		X		X
N	199	199	264	264	430	430	554	554	555	555	612	612	656	656

Notes: This table shows the results for the second stage estimation as defined in Equation 1. Each column depicts the results for a separate regression using the outcome shown in the column headers varying whether the estimation included the vector of controls Z_{aj}. The sign in the header indicates in which direction the movement of the measurement is desired by the Federal Joint Committee. The instrument is defined as the average difference in vote shares of the first two parties that got the majority of votes for all counties that lie within 30 km of the corresponding maternity unit. The sample is restricted to maternity units experiencing more than five births in 2019. Varying sample size in specifications is due to units e.g., that are not obliged to report the mentioned quality indicator. Standard errors are clustered at the county level and are shown in parentheses. ***, **, * indicate significance at the 1%, 5% level, and 10% level, respectively.

We can also analyze the effect of competition on each of the individual service measures used for our composite measures. For this, we repeat our IV regressions, but instead of using the composite measures, we employ indicator variables for each service as outcomes. Table 7 presents the results for the different care offers. While all coefficients on HHI are negative, only the one on *Special offers: parents/families* (Column (VII)) is significantly different from zero. In contrast, the coefficients for additional medical offers are all positive but small in magnitude and not statistically significant (Table 8).

The results suggest that the reduction in the composite measure of additional care offers is driven by the reduction in special services for parents and families. Services in this category include offering a crying clinic (where parents can find help and support for infants with excessive crying), baby sling courses, baby massage courses, a parent café, and parenting advice.

Table 7: IV Results 2019 - HHI on Specific Care Services

	Special Offers: Infants/Small Children	Childbirth Prep. Courses	Infant Care Courses	Midwife Services	Breastfeeding Counseling	Postpartum Gymnastics	Special Offers: Parents/Families
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
HHI 2019	-0.00002	-0.00001	-0.00002	-0.00001	-0.00001	-0.00001	-0.00005**
	(0.00002)	(0.00001)	(0.00002)	(0.00001)	(0.00001)	(0.00001)	(0.00002)
N	659	659	659	659	659	659	659

Notes: This table shows the results for the second stage estimation as defined in Equation 1. Each column depicts the results for a separate regression using the outcome shown in the column headers. The instrument is defined as the average weighted difference in voting shares of the first two parties that got the majority of votes for all counties that lie within 30 km of the corresponding maternity unit. The sample is restricted to maternity units experiencing more than five births in 2019. Standard errors are clustered at the county level and are shown in parentheses. ***, **, * indicate significance at the 1%, 5% level, and 10% level, respectively.

Table 8: IV Results 2019 - HHI on Specific Medical Services

	Prenatal Diagnosis	Assistance High-risk Pregnancies	Diagnostics/Therapy of Diseases	Obstetrical Surgeries	Special Counseling Hours by Gynecologists
	(I)	(II)	(III)	(IV)	(V)
HHI 2019	0.00000	0.00001	0.00001	0.00000	0.00000
	(0.00002)	(0.00002)	(0.00000)	(0.00001)	(0.00002)
N	659	659	659	659	659

Notes: This table shows the results for the second stage estimation as defined in Equation 1. Each column depicts the results for a separate regression using the outcome shown in the column headers. The instrument is defined as the average weighted difference in voting shares of the first two parties that got the majority of votes for all counties that lie within 30 km of the corresponding maternity unit. The sample is restricted to maternity units experiencing more than five births in 2019. Standard errors are clustered at the county level and are shown in parentheses. ***, **, * indicate significance at the 1%, 5% level, and 10% level, respectively.

6 Extensions and Robustness

Change over Time

The main advantage of our analysis using cross-sectional data of maternity units in 2019 is the data availability of multiple quality indicators. However, even though we use exogenous changes in competition in our IV approach, the results might still be driven by time-constant unobservable differences between maternity units. To rule out biases from such factors, we repeat our analysis for the subsample of hospitals which provided maternal care in 2010 and 2019. For these maternity units, we can implicitly control for maternity unit fixed-effects by analyzing the effect of changes in competition on changes in outcomes. We employ the same methodology outlined in Section 4, but instead of the levels in 2019, we use the difference between values in 2019 and 2010. The definition of the instrument as well the control variables are equivalent to the main specification.

However, as noted in Section 3, there are two caveats when including data from 2010: First, the official quality indicators cannot serve as outcomes due to changes in their definitions from 2010 to 2019. Second, the data does not cover units that started operating after 2010 and units that were no longer operational by 2019.

Table 10 presents the results of the OLS specification for the analysis of changes. In this specification, there is a negative and statistically significant coefficient for change in HHI on the change in number of births. Here, an increase in concentration indicates that competitors exited the market and there are hence more births in the remaining units. This pattern describes a different variation from the cross section where the negative correlation between competition and number of births describes markets with different levels of competition. The correlations between the change in HHI with the other outcomes are not significantly different from zero.

The results for the first stage are shown in Table 9. Here, the variation in HHI changes is smaller than the levels of HHI in 2019 and the first-stage coefficients are also smaller. Nevertheless, there is a significant correlation between the closeness of elections and change in HHI. The larger the difference in vote shares between the first and the second most popular party, the larger the increase in HHI. This result confirms the hypothesis that tight elections make maternity unit closures less likely.

Qualitatively, the IV results from this change-specification are the same as in the cross-section IV results above. The estimates in Table 11 are negative for the two quality indicators (changes in C-section rates and changes in perineal tear rates), they are not significantly different from zero. There is also no change in additional medical services offered when competition changes. However, similar to the results from the cross-section IV, there is a statistically significant negative effect of increased concentration on additional care services offered.

Table 9: IV First Stage - Change in HHI 2010-2019

	Change in HHI			
	Full Sample		Tear Rate Sample	
	(I)	(II)	(II)	(IV)
Election win margin	47.051***	46.671***	46.240***	46.581***
	(10.796)	(10.920)	(11.869)	(12.105)
State FE	X	X	X	X
Additional Controls		X		X
IV F-Stat	23.26	22.52	20.09	19.90
N	583	583	544	544
R^2	0.09	0.10	0.09	0.10

Notes: This table shows the results for the OLS first stage as defined in Equation 2. Each column depicts the results for a separate regression using the outcome shown in the column headers varying whether the estimation included the vector of controls Z_{aj}. All outcomes are measured as the changes which is the difference of that variable between 2019 and 2010. Standard errors are clustered at the county level and are shown in parentheses. ***, **, * indicate significance at the 1%, 5% level, and 10% level, respectively.

Table 10: OLS Results - Change in HHI 2010-2019 on Outcomes

	Number Births		Share CS		Tear Rate		Additional Care		Additional Medical	
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(IX)	(X)
Change in HHI	0.02051*	0.02483**	0.00000	0.00000	0.00000	0.00000	-0.00001	-0.00001	0.00000	0.00001
	(0.01199)	(0.01160)	(0.00000)	(0.00000)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
State FE	X	X	X	X	X	X	X	X	X	X
Additional Controls		X		X		X		X		X
N	583	583	583	583	544	544	583	583	583	583
R^2	0.09	0.26	0.03	0.04	0.02	0.03	0.02	0.05	0.03	0.03

Notes: This table shows the results for the OLS estimation as defined in Equation 1. Each column depicts the results for a separate regression using the outcome shown in the column headers varying whether the estimation included the vector of controls Z_{aj}. All outcomes are measured as the changes which is the difference of that variable between 2019 and 2010. Standard errors are clustered at the county level and are shown in parentheses. ***, **, * indicate significance at the 1%, 5% level, and 10% level, respectively.

Table 11: IV Results - Change in HHI 2010-2019 on Outcomes

	Share CS		Tear Rate		Additional Care		Additional Medical	
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Change in HHI	-0.00003	-0.00002	-0.00004	-0.00004	-0.00010*	-0.00009*	0.00000	0.00000
	(0.00002)	(0.00002)	(0.00004)	(0.00004)	(0.00006)	(0.00005)	(0.00004)	(0.00004)
State FE	X	X	X	X	X	X	X	X
Additional Controls		X		X		X		X
N	583	583	544	544	583	583	583	583

Notes: This table shows the results for the second stage estimation as defined in Equation 1. Each column depicts the results for a separate regression varying whether the estimation included the vector of controls Z_{aj}. The change in HHI is defined as the difference between HHI in 2019 and HHI in 2010. The instrument is defined as the average weighted difference in vote shares of the first two parties that got the majority of votes for all counties that lie within 30 km of the corresponding maternity unit. The sample is restricted to units that existed throughout the time frame of 2010 until 2019 and experienced more than five births. Standard errors are clustered at the county level and are shown in parentheses. ***, **, * indicate significance at the 1%, 5% level, and 10% level, respectively.

Heterogeneity across Units

To analyze the heterogeneity of our main results, we first divide our sample into high and low-urbanized regions and test whether the effect on service provision remains.[11] Further, we determine the role of hospital size by dividing the 2019 sample into small and large hospitals using the median number of beds as the cutoff. We then estimate the IV regression with each subsample, using additional care services as the outcome.

Table 12 depicts the first and second stages for the degree of urbanization subsample analysis. The first stage for both samples remains positive and statistically significant. However, while the second-stage estimates remain negative, they are no longer statistically significant. Therefore, we cannot determine whether the effect of HHI may differ based on the degree of urbanization.

In contrast, our results based on hospital size suggest that the effect might be driven by smaller hospitals (Table 13). Comparable to the degree of urbanization samples, the first-stage estimates remain statistically significant and positive. The second-stage coefficients are quantitatively similar between the two samples, while the coefficient is only significantly different from zero for the sample of smaller hospitals.

Table 12: IV Results 2019 - HHI on Outcomes - By Urbanity

	Low		High	
	First Stage HHI 2019	IV Service Provision	First Stage HHI 2019	IV Service Provision
Election win margin	73.67441***		233.93353***	
	(23.60167)		(41.04387)	
HHI 2019		-0.00002		-0.00001
		(0.00002)		(0.00002)
IV F-Stat	10.75	10.75	61.10	61.10
N	327	327	332	332
R^2	0.15	0.15	0.43	0.12

Notes: This table shows the results for the first and second stage estimation as defined in Equation 2 and 1, respectively. The outcome for each second stage estimation is additional care services. The sample is based on the universe of maternity units in 2019 which is divided into low and high urbanization subsample. The division occurs at the median of the average urbanization levels of the municipalities within the county where the units are located. Standard errors are clustered at the county level and are shown in parentheses. ***, **, * indicate significance at the 1%, 5% level, and 10% level, respectively.

[11] Data on the urbanization degree at the municipal level is provided by the Federal Statistical Office to generate an average urbanization measure for each county where a unit is located.

Table 13: IV Results 2019 - HHI on Outcomes - By Hospital Size

	Small		Large	
	First Stage HHI 2019	IV Service Provision	First Stage HHI 2019	IV Service Provision
Election win margin	157.70707***		162.57748***	
	(22.19346)		(33.83298)	
HHI 2019		-0.00002*		-0.00002
		(0.00001)		(0.00001)
IV F-Stat	49.23	49.23	38.93	38.93
N	330	330	329	329
R^2	0.39	0.10	0.46	0.03

Notes: This table shows the results for the first and second stage estimation as defined in Equation 2 and 1, respectively. The sample is based on the universe of maternity units in 2019 which is divided into small and big hospital subsample. The division is made at the median of the number of beds in the whole sample. Standard errors are clustered at the county level and are shown in parentheses. ***, **, * indicate significance at the 1%, 5% level, and 10% level, respectively.

Hospital Staff as a Mediator

One possible explanation for the negative relationship between HHI and additional services is that hospitals might reduce the number of midwives, nurses, and doctors needed to offer additional services when competition is low. To investigate this channel, we estimate the effect of HHI on the staffing levels across different occupations. The results of the IV estimations in Table 14 and Table 16 show that while the total number of personnel decreases when competition decreases, there is no significant effect on the ratio of staff per birth (see Table 15 and Table 17). These results suggest that it is easier for hospitals to offer additional services when the total number of births is higher. We can however not disentangle whether the lower total number of staff drives the decision to offer fewer additional services or whether the decision to offer fewer additional services allows for fewer staff.

Table 14: IV Results 2019 - HHI on Number of Staff

	# Physicians	# Specialists	# Nurse Assistants	# Nurses	# Midwives
	(I)	(II)	(III)	(IV)	(V)
HHI 2019	-0.00072***	-0.00023**	-0.00013	-0.00076**	-0.00047**
	(0.00019)	(0.00011)	(0.00009)	(0.00036)	(0.00024)
N	659	659	659	659	659

Notes: This table shows the results for the second stage estimation as defined in Equation 1. Each column depicts the results for a separate regression using the outcome shown in the column headers. The instrument is defined as the average difference in voting shares of the first two parties that got the majority of votes for all counties that lie within 30 km of the corresponding maternity unit. The sample is based on the universe of maternity units in 2019. Standard errors are clustered at the county level and are shown in parentheses. ***, **, * indicate significance at the 1%, 5% level, and 10% level, respectively.

Table 15: IV Results 2019 - HHI on Number of Staff per 100 Births

	# Physicians	# Specialists	# Nurse Assistants	# Nurses	# Midwives
	(I)	(II)	(III)	(IV)	(V)
HHI 2019	-0.00002	0.00000	0.00000	0.00002	0.00000
	(0.00002)	(0.00001)	(0.00001)	(0.00005)	(0.00003)
N	659	659	659	659	659

Notes: This table shows the results for the second stage estimation as defined in Equation 1. Each column depicts the results for a separate regression using the outcome shown in the column headers. The instrument is defined as the average difference in voting shares of the first two parties that got the majority of votes for all counties that lie within 30 km of the corresponding maternity unit. The sample is based on the universe of maternity units in 2019. Standard errors are clustered at the county level and are shown in parentheses. ***, **, * indicate significance at the 1%, 5% level, and 10% level, respectively.

Table 16: IV Results - HHI Change 2010-2019 on Number of Staff

	# Physicians	# Specialists	# Nurse Assistants	# Nurses	# Midwives
	(I)	(II)	(III)	(IV)	(V)
Change in HHI	-0.00271***	-0.00095**	-0.00018	-0.00246	-0.00211**
	(0.00092)	(0.00044)	(0.00026)	(0.00150)	(0.00098)
N	583	583	583	583	583

Notes: This table shows the results for the second stage estimation as defined in Equation 1. Each column depicts the results for a separate regression using the outcome shown in the column headers. The outcome is measured as the number of personnel in the year of 2019. The instrument is defined as the average difference in voting shares of the first two parties that got the majority of votes for all counties that lie within 30 km of the corresponding obstetric unit. The sample is restricted to units that existed throughout the time frame of 2010 until 2019 and experienced more than five births. Standard errors are clustered at the county level and are shown in parentheses. ***, **, * indicate significance at the 1%, 5% level, and 10% level, respectively.

Table 17: IV Results - HHI Change 2010-2019 on Number of Staff per 100 Births

	# Physicians	# Specialists	# Nurse Assistants	# Nurses	# Midwives
	(I)	(II)	(III)	(IV)	(V)
Change in HHI	-0.00009	-0.00001	0.00001	0.00000	-0.00005
	(0.00008)	(0.00005)	(0.00003)	(0.00017)	(0.00009)
N	583	583	583	583	583

Notes: This table shows the results for the second stage estimation as defined in Equation 1. Each column depicts the results for a separate regression using the outcome shown in the column headers. The instrument is defined as the average difference in voting shares of the first two parties that got the majority of votes for all counties that lie within 30 km of the corresponding maternity unit. The sample is based on the universe of maternity units in 2019. Standard errors are clustered at the county level and are shown in parentheses. ***, **, * indicate significance at the 1%, 5% level, and 10% level, respectively.

7 Discussion and Conclusion

Our analysis of German maternity units shows that competition between units does not significantly affect the quality of care but decreases the availability of additional services offered in maternity units. Offering such services might be important amenities to attract patients in a highly competitive market but not necessary when competition is low. While our analysis contributes yet another data point to the still inconclusive discussion on the effects of competition on quality, our analysis of the additional services offered provides a new angle to the literature.

Two aspects of our approach do however need to be taken into account when interpreting the results. First, the information stored in the quality reports of the Federal Joint Committee is collected through self-reporting by hospitals. The quality of this self-reported data is likely to be correlated with overall management quality in a hospital. While the IV strategy accounts for endogeneity in our competition variable, we cannot account for potential measurement error in the outcome variables. We therefore cannot rule out that we observe changes in reporting quality instead of changes in additional services. It is however unlikely that changes in reporting are the only source of our estimated effects. For this to be true, changes in reporting may have only affected some additional services while leaving some quality measures unchanged, which seems unlikely. Second, the nature of the IV approach restricts our interpretation to the LATE meaning that we are only able to estimate the effect of competition on the outcomes for those hospitals where the variation in competition can be attributed to the instrument. In particular, the LATE estimates are based on units that were artificially kept open, and might therefore not be relevant competitors for other maternity units. The variation in competition from those hospitals can therefore be seen as a lower bound to the true ATE.

More research is needed to understand the welfare effects of reductions in the provision of additional services. On the one hand, these services might have provided high utility to parents and newborns at low costs and therefore the reduction in these services reduces welfare. On the other hand, alternative providers e.g. in the ambulatory sector could substitute the provision in hospitals. Given the scarcity of nurses and midwives in hospitals, such a shift might be an efficient reallocation of resources. While it is reassuring that reduced competition does not affect quality of care in German maternity units, the lack of data to understand welfare effects of changes in additional services is certainly detrimental to evidence-based health policymaking.

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Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT to support writing code as well as ChatGPT and Grammarly in order to improve grammar and spelling of the text. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

Appendix A: Additional Tables

Table A.1: Number of Births In- and Outside of Hospitals

Year	Children born in Germany	Children born outside of the hospital and documented at QUAG	Childern born outside as a share of all children born in Germany (%)
2001	737,360	8,266	1.12
2002	721,950	8,238	1.14
2003	709,420	8,586	1.21
2004	708,350	8,715	1.23
2005	688,282	8,640	1.26
2006	675,144	8,351	1.24
2007	687,233	8,221	1.2
2008	684,926	8,327	1.22
2009	667,464	8,769	1.31
2010	680,413	9,045	1.33
2011	665,072	8,828	1.33
2012	675,944	9,090	1.34
2013	684,625	8,943	1.31
2014	717,524	9,431	1.31
2015	740,362	9,366	1.27
2016	795,041	10,365	1.3
2017	787,884	10,630	1.35
2018	790,553	11,956	1.51
2019	781,270	12,242	1.57
2020	776,306	13,969	1.8
2021	798,912	15,125	1.89
2022	742,066	14,401	1.94
2023	695,996	13,799	1.98

Notes: This table based on information provided by *Qualität in der außerklinischen Geburtshilfe - QUAG* (Quality for out-of-hospital obstetric care). Full information on data collection can be found here: https://www.quag.de/quag/geburtenzahlen.htm

Table A.2: Overview of Specialist Department Key Numbers

Key Number	Official Name	Translation
2400	Frauenheilkunde und Geburtshilfe	gynecology and obstetrics
2425	Frauenheilkunde	gynecology
2490	Frauenheilkunde und Geburtshilfe	gynecology and obstetrics
2491	Frauenheilkunde und Geburtshilfe	gynecology and obstetrics
2492	Frauenheilkunde und Geburtshilfe	gynecology and obstetrics
2500	Geburtshilfe	obstetrics
2590	Geburtshilfe	obstetrics
2591	Geburtshilfe	obstetrics
2592	Geburtshilfe	obstetrics

Notes: This table list all specialist department key numbers we used to define obstetric units. The specialist departments are part of a hospital. We used gynecology as well as obstetrics key numbers, as the differentiation between these specialist departments is not sharp. A full list of key numbers for all possible specialist departments can be found here: https://www.gkv-datenaustausch.de/media/dokumente/leistungserbringer_1/krankenhaeuser/archiv/technische_anlage_2/2_anl2-110.pdf

Table A.3: OPS-Codes used for C-section, Perineal Tear Rate and Number of Births

OPS-Code	Name	C-section	Delivery	Perineal tear	Perineal Tear Denominator
9-260*	monitoring and management of a normal delivery		x		x
9-261*	monitoring and management of a risk delivery		x		x
9-268*	monitoring and management of a normal delivery, unspecified		x		x
8-515*	partus with manual help		x		x
5-720*	forceps delivery		x		x
5-724*	rotation of the child's head with forceps				x
5-725	extraction of breech presentation		x		
	5-725.1 instrumented				x
	5-725.2 combined instrumented/manual				x
5-727*	spontaneous and vaginal operative delivery in breech presentation		x		
	5-727.2 Assisted delivery with instrument assistance				x
	5-727.3 Combined delivery with special handles and instrument help				x
5-728*	vacuum delivery		x		x
5-729*	other instrumental delivery				x
5-731*	Other surgical induction of labor		x		x
5-732	inner and combined turn without and with extraction only using codes with extraction (5-732.2, 5-732.3, 5-732.4)		x		
5-733*	Unsuccessful vaginal operative delivery		x		x
5-734*	Surgical measures on the fetus to facilitate birth		x		
5-739*	Other surgeries to assist childbirth		x		
	5-739.0 Incision of the cervix uteri				x
	5-739.1 Symphysiotomy				x
5-740*	classic caesarean section	x	x		
5-741*	section caesarea, supracervical and corporeal	x	x		
5-742*	sectiono caesarea extraperitonealis	x	x		
5-745*	sectio caesarea combined with other gynecological procedures		x		
5-749	other sectio caesarea excluding 5-749-0	x	x		
5-758*	reconstruction of female genital organs after rupture, post partum [perineal tear]			x	

Notes: This table depicts the OPS-codes used to define number of births, number of C-sections, number of perineal tears and the official denominator for the perineal tear rate. C-section rate is defined as the number of C-sections divided by the overall number of deliveries. The denominator for perineal tear rate is defined as the number of spontaneous births plus the number of instrumented vaginal births. All definitions closely follow the official OPS-codes definition for these rates set by the IQTIG. The asterisk at the OPS-codes stands for the overall category including all subcategories of that OPS-code.

Table A.4: Definition of Service Provision Variables

Key Number	Name
Extra Care Offers	
MP05	Special offers for the care of infants and small children, e.g. baby swimming
MP19	Childbirth preparation courses
MP36	Infant care courses
MP41	Midwife services such as underwater births and special courses
MP43	Breastfeeding counseling
MP50	Postpartum gymnastics
MP65	Special range of services for parents and families
Extra Medical Offers	
VG9	Prenatal diagnosis
VG10	Assistance for high-risk pregnancies
VG11	Diagnostics and therapy of diseases during pregnancy, childbirth and the puerperium
VG12	Obstetrical surgeries
VG15	Special consulting hours by gynecologists

Notes: This table lists all keys used to define service provision variables used in our analysis. Additional care offers are encoded as MP keys. Additional medical offers for obstetrics and gynecology are encoded as VG keys. The associated definition of these services is shown in column 'Name'. The full list of MP keys can be found in the codebooks of the Federal Joint Committee: https://www.g-ba.de/richtlinien/39/

Table A.5: Overview Official Quality Indicators 2019

Key Number	Description (German and Translation)	Interpretation
ID 318	Anwesenheit eines Pädiaters bei Frühgeburten Presence of a pediatrician for premature births	The higher the better. Measured in %. *
ID 330	Antenatale Kortikosteroidtherapie bei Frühgeburten mit einem präpartalen stationären Aufenthalt von mindestens zwei Kalendertagen Antenatal corticosteroid therapy in premature births with a prepartum hospital stay of at least two calendar days	The higher the better. Measured in %.*
ID 1058	E-E-Zeit bei Notfallkaiserschnitt über 20 Minuten E-E time for emergency cesarean section over 20 minutes	The lower the better. Measured in rates. *
ID 50045	Perioperative Antibiotikaprophylaxe bei Kaiserschnittentbindung Perioperative antibiotic prophylaxis during cesarean section	The higher the better. Measured in %.*
ID 51803	Qualitätsindex zum kritischen Outcome bei Reifgeborenen Quality index for critical outcome in full-term infants	The lower the better. Measured as logistic regression of observed to expected rates.
ID 181800	Qualitätsindex zu Dammrissen Grad IV bei Einlingsgeburten Quality index for grade IV perineal tears in singleton births	The lower the better. Measured as logistic regression of observed to expected rates.
ID 52249	Verhältnis der beobachteten zur erwarteten Rate (O / E) an Kaiserschnittgeburten Ratio of observed to expected rate (O/E) of cesarean deliveries	The lower the better. Measured as logistic regression of observed to expected rates.

Notes: This table lists official quality indicators used for the 2019 cross-section specification. The first five quality indicators are used by official institutions for quality assurance. The last two indicators are the official quality indicators which we rebuilt with OPS codes for the changes specification.

Table A.6: Descriptive Statistics - Closed vs. Opened

	Change Data Set				Closed				Opened			
Variable	Mean 0	Median 0	SD 0	N 0	Mean 1	Median 1	SD 1	N 1	Mean 2	Median 2	SD 2	N 2
Competition Measures												
# competitors (in 20 km radius)	4.80	2.00	5.58	589.00	4.36	2.00	4.89	228.00	3.08	2.00	3.33	74.00
HH-index (in 20 km radius)	4456.02	3503.91	3190.63	589.00	4142.54	3631.06	2714.50	228.00	5133.40	4253.61	3298.28	74.00
Quality Measures												
# C-section	275.18	220.00	189.83	589.00	194.99	128.00	200.29	228.00	417.85	336.50	300.75	74.00
# perineal tear	328.94	248.00	266.53	589.00	219.19	127.00	266.03	228.00	633.86	492.00	471.90	74.00
# of births	846.70	682.00	560.20	589.00	596.18	385.00	625.95	228.00	1347.88	1079.50	907.50	74.00
Service Provision Measures												
Add. care offers	0.79	0.86	0.21	589.00	0.74	0.86	0.26	228.00	0.84	0.86	0.20	74.00
Add. medical offers	0.83	1.00	0.24	589.00	0.71	0.80	0.30	228.00	0.84	0.86	0.20	74.00
Covariates												
Teaching hospital	0.61	1.00	0.49	589.00	0.38	0.00	0.49	228.00	0.68	1.00	0.47	74.00
# beds	440.10	361.00	322.26	589.00	401.80	220.00	475.16	228.00	625.76	442.50	471.83	74.00

Notes: Change data sample based on obstetric units that are available in the time frame of 2010 until 2019. *Closed* sample includes all units in 2010 that we could not match via geolocation in the units sample of 2019 and vice versa for the *Opened* sample. See Appendix Table A.2 for the keys used to identify obstetric units within hospitals. The HHI (Herfindahl-Hirschmann index) is calculated as the difference between HHI in 2019 and HHI in 2010 based on the catchment area radius of 20 km. Number of C-sections, perineal tear as well as number of births are calculated based on OPS-codes (see Appendix Table A.3). Additional care offers as well as the additional medical offers are defined for each sample year.

Table A.7: Maternity Units per Federal State

	Federal state	Wards per 100.000 Pop. 2010	Wards per 100.000 Pop. 2019
01	Schleswig-Holstein	0.917	0.758
02	Hamburg	0.672	0.595
03	Niedersachsen	1.086	0.876
04	Bremen	1.059	0.734
05	Nordrhein-Westfalen	0.992	0.813
06	Hessen	1.055	0.763
07	Rheinland-Pfalz	1.224	0.782
08	Baden-Württemberg	0.874	0.712
09	Bayern	0.989	0.754
10	Saarland	1.081	0.811
11	Berlin	0.636	0.491
12	Brandenburg	1.079	0.991
13	Mecklenburg-Vorpommern	1.096	0.995
14	Sachsen	1.181	0.958
15	Sachsen-Anhalt	1.156	1.002
16	Thüringen	1.074	1.125

Notes: Number of wards per 100.000 population in Germany per federal state based on cross-section of wards in 2010 and 2019. Population data is retrieved from Federal Statistical Office (Destatis).

Table A.8: Closed and Opened Maternity Units per Federal State

	Federal state	'Closed' wards (2010-2019)	'Opened' wards in (2010-2019)
01	Schleswig-Holstein	8	4
02	Hamburg	2	1
03	Niedersachsen	24	7
04	Bremen	3	1
05	Nordrhein-Westfalen	42	11
06	Hessen	21	5
07	Rheinland-Pfalz	20	3
08	Baden-Württemberg	26	11
09	Bayern	40	15
10	Saarland	4	1
11	Berlin	5	1
12	Brandenburg	6	4
13	Mecklenburg-Vorpommern	3	1
14	Sachsen	15	5
15	Sachsen-Anhalt	7	2
16	Thüringen	2	2

Notes: Number of wards in Germany per federal state that *closed*/*opened* during the time frame of 2010 until 2019. Appendix 7 provides further details on the identification procedure of wards in our data set.

Appendix B: Defining obstetric units and closures

Obstetric units sample 2010

The quality data of the Federal Joint Committee contains different xml files. Each xml file contains information on a hospital that is obliged to report its quality data to the Federal Joint Committee. Each hospital has an "institution key number" (Institutionskennzeichen) that is assigned uniquely to a hospital in that year. However, the institution number can change over the year or within years. The additional site number should indicate whether the xml file contains information summarized from all sites of that institution (site number "00") or if it only contains information from one site (e.g., site number "01"). A hospital site can consist of more than one building including different specialist departments. Yet, in the data set of 2010, the site numbers are not consistently assigned. The challenge with this data set is to identify hospitals uniquely. This means, first, to identify duplicates (same institution but changed institution key number and site number over the years). Second, to extract institutions that are uniquely defined as hospitals. Third, to identify obstetric unit sites.

To solve the abovementioned challenges, we proceed in the following way: First, we extract information on all institutions that have an institution key number starting with "26" which indicates "hospitals and hospital pharmacies" (ARGE-IK, 2020).

Afterwards, we select institutions that report specialist department key numbers belonging to the category of gynecology and obstetrics.[12] As we are interested in maternity unit sites rather than hospital sites, we further extract information on the address of the maternity unit. If an institution reports to have more than one obstetric unit, we check whether the maternity units reported are located at the same spot using the address string. The same spot obstetric units are merged into one "site". Different locations of obstetric units from the same institution count as two observations in our data set. Exact duplicates due to changing institution key numbers are removed. For obstetric units with no address information, we use the address of the institution instead.

The address information of the obstetric units is geocoded using *tidygeocoder* based on the OSM database. We again check for duplicates as the address string is sensitive to spelling differences. Another feature of the 2010 data set is that additional care service offers belonging to the MP category are reported on two layers, the institution layer and the unit layer. As the MP keys in 2019 are reported on the institution layer, we add up the information on MP keys in 2010 on the institution layer to ensure consistency.

[12]We also use key numbers belonging to gynecology as the differentiation between obstetrics and gynecology is not sharp. Appendix A.2 lists all the key numbers we use in our analysis. A full list of key numbers for specialist departments can be found online: https://www.gkv-datenaustausch.de/media/dokumente/leistungserbringer_1/krankenhaeuser/archiv/technische_anlage_2/2_anl2-110.pdf

Obstetric units sample 2019

In the same manner as the quality data of 2010, the 2019 data set contains xml files that correspond to an institution with an institution key number. In 2019 main hospital sites can be identified via the site number "99". These xml files summarize information about a hospital that has more than one site. We exclude these files and use the subdivided xml files instead that only incorporate information on the site. This has the advantage that we can consistently get the information on each site with unique address information for the unit and the hospital site itself. Similar to 2010, we keep hospital sites that report to specialist department keys belonging to *gynecology and obstetrics*'* and sites that report to have more than one specialist department merged into one observation. We find no duplicates in terms of address string entries or geocoding.

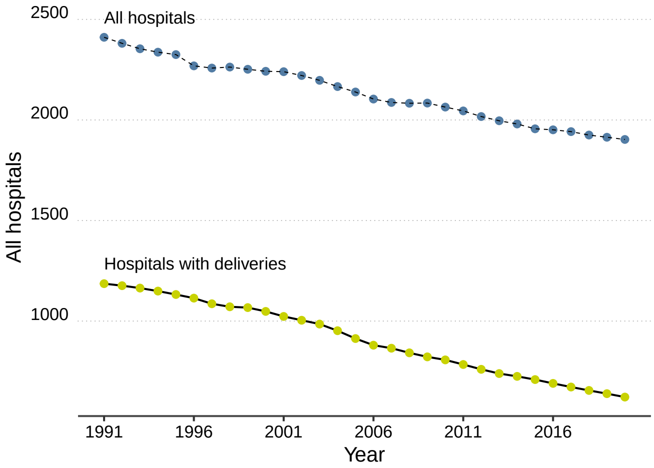
Maternity unit closures

There is no official data set that documents the closures of hospitals or their corresponding units (Preusker et al., 2013). To proxy for unit closures in our setting, we follow a common procedure in the literature that checks whether an obstetric unit is still available at the same location using the geolocation information (Fischer et al., 2024). We proceed in the following way: We use the generated geolocation point of units in 2010 and generate a buffer of 200 meters. Then, we check if geolocation points of units in 2019 fall within the buffers of 2010. The buffer method is less sensitive to small changes in the street number assignment to a unit that occurred in the period between 2010 and 2019. Further, it accounts for units that report to have more than one street number for which the geolocation point is chosen as the centroid of these street numbers.

This way, we end up with 589 units that are available from 2010 until 2019. 228 units *closed* from 2010 (Total sample 817) and 2019 (Total sample 664). Further, we identified 74 *opened* units in 2019. These unit sites could represent both relocations or openings. Appendix Figure C.1 shows the number of hospitals that recorded a birth according to the data set of Federal Health Monitoring (Gesundheitsberichterstattung des Bundes). The drop in hospitals that record a birth is similar to the one in our sample.[13] Appendix Table A.6 reports the summary statistics for the 583 units that were available in 2010 and 2019 as well as the units we termed as *closed* and *opened*.

[13]Note that the sample size is slightly higher since we count units rather than hospitals.

Figure B.1: Number of Hospitals in Germany



Notes: Number of hospitals in Germany are depicted by the black dashed line with blue dots. Number of hospitals with deliveries are shown by the black solid line with green dots.

Appendix C: Details on the Instrumental Variable

As explained in Section 3, we use voting data on the county level provided by the 16 Federal States of Germany to define our political pressure instrument. County-level elections are usually held every five years with a few exceptions. Appendix Table C.1 shows the years of county elections for each of the 16 federal states in Germany right before 2010 and right after 2010.

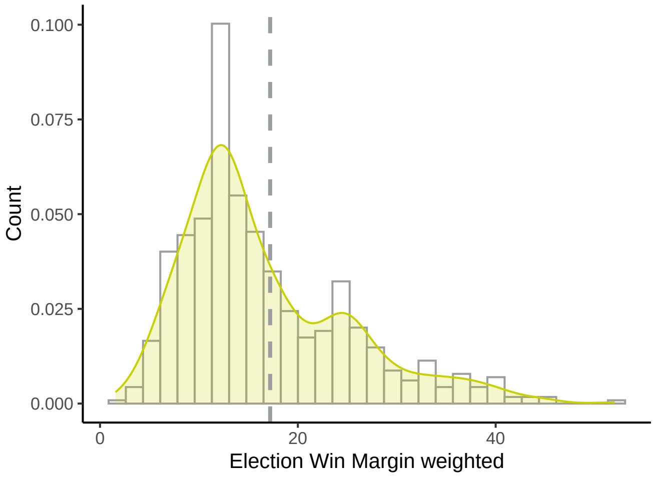
We use election turnouts on the county level. The total number of votes is calculated using the five big parties in Germany: Christian Democratic Union (CDU), Social Democrat Party (SPD), Green Party (GRÜNE), Free Democratic Party (FDP) and Left Party (LINKE). For each county, we calculate the difference in voting shares from the first two parties that got the most votes. Figure C.2 illustrates the variation based on counties. The darker the color of the county the higher the difference in shares. The color of each county shows the party that won the most votes in that county. In order to incorporate the instrument into the catchment area approach, we aggregate the difference in voting shares for each county that falls within the radius of 30 km (see Figure 2 in Section 3). If the 30 km buffer covers less than 10 percent of the area of a county, we do not consider them for the aggregation procedure. The sum of shares over the counties within the 30 km radius is then divided by the number of counties contributing to that sum. We additionally weigh by the percentage a county is covered by the political area radius. This way, the instrument measures the weighted average variation in the vote share difference. Appendix Figure C.1 depicts the distribution of the instrument. The mean of the distribution is approximately 16 p.p., representing the average weighted difference in vote shares for a county. Most counties show a vote share difference below the mean, with none having a zero difference in vote shares.

Table C.1: Overview Election Years

Federal State	Right before 2010	Right after 2010
BW	2009	2014
BY	2008	2014
BER	2006	2011
BB	2008	2014
BRM	2007	2011
HA	2008	2011
HE	2006	2011
MP	2009	2014
NI	2006	2011
NW	2009	2014
RLP	2009	2014
SR	2009	2014
SA	2009	2014
SAA	2009	2014
SH	2008	2013
TH	2009	2014

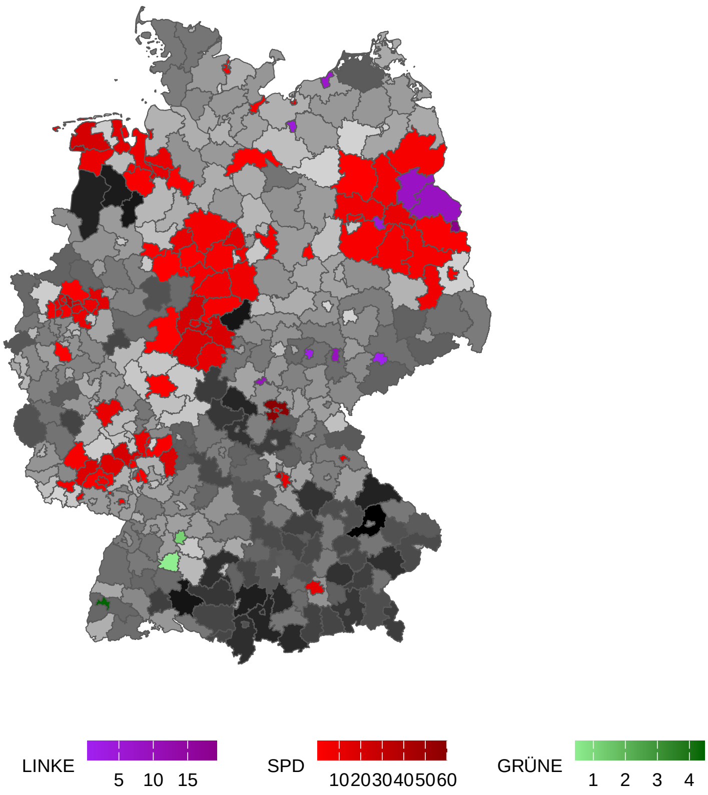
Notes: This table depicts the different years in which each federal state held county elections.

Figure C.1: Density in Instrument



Notes: This figure illustrates the distribution of the instrument "election win margin" which is weighted by the percentage a county is covered by the political area radius. The density is depicted as a solid the green line, the histogram is depicted by the gray colored barplots and the median of the distribution is shown as the gray dashed line.

Figure C.2: Variation IV - Map



Notes: Map of Germany in which county borders are depicted by the gray line. The color of the county represents the party who got the most votes in the county. The intensity of the colors shows the difference this party had in terms of voting shares to the party that got the second most votes. The total of voting shares consist of votes that are given to the 5 biggest parties in Germany: CDU, SPD, GRÜNE, LINKE, and FDP. FDP did not have the most votes in the elections prior to 2010 and, therefore, does not appear on the map. The variation used for the estimation is based on the catchment area radius whereas the map displays the variation based on county borders.

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