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Who will be the mediator? Local politics and hospital closures in Germany

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Ieva Sriubaite

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and Hospital Closures in Germany**

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Ieva Sriubaite¹

Who will be the Mediator? Local Politics and Hospital Closures in Germany

Abstract

This paper analyses the effects of hospital closures in Germany in the context of emergency medical care for patients with acute myocardial infarction or hemorrhagic stroke. Using a comprehensive inpatient care data, I evaluate the extent of the impact of hospital closures between 2006 and 2012 on geographical healthcare access and several patient clinical outcomes. To minimize bias from the potential endogeneity between the hospital quality and market structure, I employ an instrumental variable strategy and build a strong and highly relevant instrument in the context of municipal politics. Using collected data on the turnout of each local election in Germany, I compute a measure of concentration in political power that is estimated by the winning margin of the largest centre-right political party in Germany against the opposition. My findings suggest that: first, while patients living in closure-affected areas face worse healthcare access, this does not result in lower survival for acute medical cases; second, that a hospital closure mainly affects the access for rural residents and stimulates the efficiency of hospitals located in the more densely populated areas; and political power in the area plays an important role in shaping hospital's future in the local market.

JEL-Code: I11, I15, I18, I19

Keywords: Hospital closure; quality of care; municipality election; instrumental variable

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1 Introduction

Pledges of greater efficiency, better coordinated healthcare and lower costs have led many healthcare systems to experience strong consolidation tendencies over the last two decades in the form of hospital closures, mergers and acquisitions¹ and privatizations² (Town *et al.*, 2006; Harrison, 2007). Driven by rapidly rising healthcare costs such policies resulted in multiple benefits to the efficiency in healthcare, in particular related to the coordination and the management of healthcare (Lindrooth *et al.*, 2003; Deily *et al.*, 2000; Ciliberto and Lindrooth, 2007). Yet public concerns with respect to both the equity of healthcare access and the quality of care still remain at the forefront of the political arena.³ Competition-driven market concentration and the shift of medical resources from remote to metropolitan areas lead to the establishment of large hospital complexes in urban areas at the expense of smaller units in rural areas for which populations are often too small to financially support resource-intensive medical centers. This pattern causes geographical imbalances in catering to the demand for and access to emergency healthcare for urban and rural populations. For instance, the German Federal Statistical Office states that only 64% of rural residents are able to reach the closest hospital offering basic healthcare within 15 minutes, while the corresponding figure is over 90% for the urban population.⁴ In addition to the deteriorated geographical access, researchers found that the concentration of healthcare markets inhibit provider competition that consequently lead to increases in costs of care (Gaynor, 2011) and further promote the migration of medical professionals away from under-served areas (Benham *et al.*, 1968; Kuhn and Ochsen, 2019; Vogt, 2016; Zuckerman *et al.*, 1990).

This study contributes to the literature on the effects of healthcare con-

¹For an overview of the hospital merger literature see: Dor and Friedman (1994); Dranove and Shanley (1995); Dranove (1998); Ho and Hamilton (2000); Cuellar and Gertler (2003); Sloan *et al.* (2003); Hansmann *et al.* (2007); Dranove and Lindrooth (2003); Krishnan *et al.* (2004); Huckman (2006); Coenen *et al.* (2012); Pilny (2014); Schmid and Varkevisser (2016); Schmitt (2017).

²A common policy to increase healthcare savings and improve the efficiency in the provision of healthcare is privatization of healthcare providers. See i.e., Mark (1999); Shen (2003); Cutler and Horwitz (2007).

³See, i.e., Bindman *et al.* (1990); Buchmueller *et al.* (2006); Harrison (2007); Capps *et al.* (2010); Hsia *et al.* (2012); Countouris *et al.* (2014); Avdic (2016); Burkey *et al.* (2017)

⁴Based on the *Hospital Atlas (Krankenhausatlass)* 2016 published by DESTATIS - the Federal Statistical office of Germany. More statistics about the German healthcare sector can be found at www.destatis.de.

solidation policies. I study a case of hospital market exits in Germany to empirically assess the causal impact of hospital closure on geographical access to healthcare and multiple clinical patient outcomes in the context of acute myocardial infarction (*AMI*) or hemorrhagic stroke. Cardiovascular diseases, for which *AMI* and stroke are the two most common manifestations, are the leading cause of death globally causing nearly 18 million deaths worldwide each year ([World Health Organization, 2011](#)) and are the number one reason for all medical emergencies ([Linden, 2006](#)). Timely access to healthcare is essential for patients with these conditions, thus deteriorating access, as i.e. due to healthcare consolidation, might impinge the chances of survival as well as medical complications during the recovery.⁵

A number of studies has investigated the effects of healthcare consolidation trends on the geographical healthcare access. For instance, a study by [Burkey *et al.* \(2017\)](#) analysed the closure of several hospitals in the South-eastern U.S. and did not find any significant impact on healthcare access. Similarly, [Hentschker and Mennicken \(2014\)](#) estimated only a marginal increase in the travelling distance for patients with a hip fracture or abdominal aortic aneurysm after hospital closures in Germany. However, these findings rely on a strong assumption that all hospitals provide universal care and patients could receive similar care in any given hospital. As hospitals often differ in both the services they provide and in the quality of their care, the empirical setting used in these studies potentially biases the true effect of travel distance downwards. To address this limitation, [Mennicken *et al.* \(2014\)](#) studied the centralisation of hospital services in gynaecology and obstetrics and, similar to previous studies, found that patients did not travel further after hospital closures. However, while aligned with the discussed literature, the study raises concerns about potential patient sorting caused by differences in the quality of care that are particularly important when studying planned procedures such as maternal care ([Avdic *et al.*, 2019](#)). To address this empirical drawback, several studies investigated the effect of hospital closures on patient outcomes. If inferior access to healthcare is affected by trending healthcare consolidation policies, it is likely to result in worse health outcomes, in particular for patient who require immediate medical attention. Studying hospital closures

⁵According to the report published by American Heart Association every minute without treatment for a patient with an *AMI* reduces survival chances by 7 to 10 percent ([American Heart Association, 2003](#)).

in Los Angeles County, [Buchmueller *et al.* \(2006\)](#) found that an increase in travel distance results in higher mortality rates from heart attacks and unintentional injuries. In line with this evidence, [Avdic \(2016\)](#) concluded that after closures of emergency departments in Sweden, patients had lower chances of surviving an acute myocardial infarction. Together, these and other studies⁶ suggest that healthcare efficiency gains from consolidating services are likely to be accompanied with a deterioration in patient care for the most sensitive groups. In a similar manner to previously discussed research designs, this study also analyses patients requiring emergency care. However, instead of focusing on policy-induced variation in distance, I study the direct effects of hospital closures using an instrumental variable approach to overcome the empirical challenges arising from the endogeneity between the hospital quality and market structure.

My empirical analysis entails the use of a nationally representative sample of hospital discharge records provided by a large German health insurer. I identify the sample of interest using comprehensive clinical information about the diagnosis assigned at the time of admission. This sample is further augmented by the addition of two auxiliary data sources ([Preusker *et al.*, 2014](#)). First, I obtain information about all hospital closures in Germany that occurred in the years 2006 - 2012 from a report published by the Federal Joint Committee of German physicians. Detailed information about each hospital closure provided in this report allows me to identify all particularities of hospital market exits such as details about the process and execution, primary reasons and the exact time of closure that is particularly important in this empirical analysis. I use a linear regression to estimate the effect of the treatment on patient outcomes while controlling for a number of observed confounding factors such as patient demographics, medical condition, hospital- and market-related characteristics. There may be several reasons for a hospital to close; however, in most of the cases, hospitals close when they are not able to cater to the demand due to remoteness, poor quality of care or financial performance. In order to adjust for such unobserved factors that might influence both hospital closures and patient outcomes, I employ an instrumental variable strategy. I collect data on political party composition of the local councils in German municipalities from the German Federal Statistical Offices

⁶For more research findings that draw similar conclusions, see i.e., [Blondel *et al.* \(2011\)](#); [Ravelli *et al.* \(2011\)](#); [Grzybowski *et al.* \(2011\)](#); [Engjom *et al.* \(2014\)](#).

and estimate the political party's voting shares. This measure represents the political dynamics and the distribution of political powers in each council and serve as an instrument for a decision regarding hospital closure.

Political decisions play a substantial role in shaping the German healthcare market. In the last decade federal policy-makers have adopted several major policies to encourage market efficiency. First, the 1993 Healthcare Structure Act introduced a number of changes in the hospital payment system that substantially limited hospital expenditure. Additional financial pressure from the introduction of a prospective payment system based on the Diagnosis-related groups was introduced in 2004 (Augurzky and Schmitz, 2010; Schulten, 2006). These reforms placed all healthcare providers under significant financial pressure, that, combined with high competition, resulted in a reduction of hospitals and hospital beds over the last two decades. The German healthcare market in 2020 was expected to be approximately 20% smaller than that of the early 1990s (Schulten, 2006). The most significant factors for this phenomenon are the size of a hospital (Pilny, 2014; Augurzky and Schmitz, 2010), the variety of services a hospital provides, the ownership type of a hospital as well as the financial status (Williams *et al.*, 1992; Succi *et al.*, 1997; Ciliberto and Lindrooth, 2007; Pilny, 2014). Even though the financial status is mainly the responsibility of the federal state, maintenance of a hospital falls on the political decision-making bodies in the municipality. Closing hospitals is a very unpopular politically, especially for local politicians, who often worry about their political decisions losing them votes in the next election. When the electoral margin is small, it is more likely that the politicians currently in office will be very cautious about implementing an unpopular hospital closure policy. Thus, hospitals are more likely close when the ruling political party received a significant majority of votes in the previous election. Originally applied by Bloom *et al.* (2015) to instrument for the competition in the healthcare markets, I follow a similar strategy to construct a highly relevant instrument for hospital closure based on political pressure in the local governmental area.

The main findings of this paper provide evidence of the benefits of health-care consolidation policies. Even though I find that a hospital closure causes a significant increase in travel distance of, on average, 4 kilometres (or 3 minutes of travel time) for patients residing in closure-affected areas, the reduced access to emergency services does not lead to worse patient outcomes. The results also suggest that both the likelihood for death in-hospital and within

30 days decrease in closure-affected areas after the closure; however, the effect is not statistically significant. I also explore several other treatment-related outcomes that relate to the efficiency of healthcare provision. I find that, likely due to an increased number of patients attending neighbouring hospitals, hospital closures lead to a more efficient provision, reducing length of stay of emergency admissions by approximately 2.5 days without impacting on readmission rates.

This study contributes to the growing research literature analysing healthcare consolidation in several ways. First, I explore potential mechanisms affecting hospital financing through politics in the German healthcare setting. By exploiting this mechanism, I minimize potential endogeneity bias arising from the hospital quality and market structure, a common manifestation when studying healthcare market exits in empirical settings. I employ electoral turnout data on all German municipalities to construct a strong and highly relevant instrument and provide evidence for geographical access, patient outcomes and the efficiency of healthcare provision. Studying emergency patients addresses concerns related to patient sorting to hospital that was rarely addressed in the previous literature. Information about each hospital closure from official reports provides further evidence for the validity of the results. They are also supported by a comprehensive administrative data with a rich set of explanatory variables to control for variation in outcomes and to reduce further endogeneity issues that arise from unobserved heterogeneity.

This paper is structured as follows. The next section (Section 2) presents a detailed overview of the provision of the healthcare in Germany, in particular how hospitals are financed and the main causes of market exits. The remainder of this article introduces the data and sampling in Section 4, the econometric framework and the definition of the instrument in Section 5 and Section 6 respectively. Section 7 summarizes the main results and Section 8 presents a number of robustness checks. Finally, Section 9 concludes.

2 Institutional Context

Health Care in Germany

The German healthcare system has universal health insurance coverage that is based on a multi-payer insurer system. A mandatory membership in either the

public statutory health insurance (SHI) and/or the private health insurance (PHI) ensures healthcare for all citizens and permanent residents. Whether an insuree belongs to SHI or PHI is distinguished by the gross wage earnings⁷ and the nature of work itself. For instance, the self-employed and civil servants can voluntarily choose PHI (Bünnings *et al.*, 2019). Currently around 90 percent of the German population is covered by SHI.⁸

Regardless of the type of insurance the healthcare provision is similar; both PHI and SHI offer a full range of healthcare services for all types and levels of care. The major difference between these insurance policies is the selection of health insurance plans as PHI allows for an individual to choose a tailored plan (e.g. cost-sharing, better accommodation at the hospital such as private wards), while SHI offers only one standardised health insurance plan. Due to the additional benefits, PHI insurees may face different tariffs and prices since PHI companies do not have to contract with healthcare providers; however, the maximum fee that providers may charge is regulated by the German Federal Ministry of Health to ensure fair pricing and impartiality among different insurees (Wasem *et al.*, 2004). Despite the type of insurance an insuree has, everyone is entitled to choose their healthcare provider, which fosters competition in the healthcare market (Avdic *et al.*, 2019).

The German healthcare system provides high quality, attentive care and professional services; however, increasing public expenditures on healthcare raise serious concerns and is often debated by policy makers. Healthcare expenditure as a share of GDP has risen from 9.4% in 1992 to 11.7% in 2018. Despite some stability in recent years, expenditure per inhabitant rose from 3,771€ in 2012 to 4,712€ in 2018 due to demographic changes.⁹ Higher healthcare expenditures do not necessarily mirror in better quality of care or patient health outcomes (Garber and Skinner, 2008), highlighting both equity and efficiency concerns.

⁷In 2018 employees earning more than 59K€/73K per year qualified for receiving the PHI.

⁸A detailed overview about German SHI is given in Pilny *et al.* (2017).

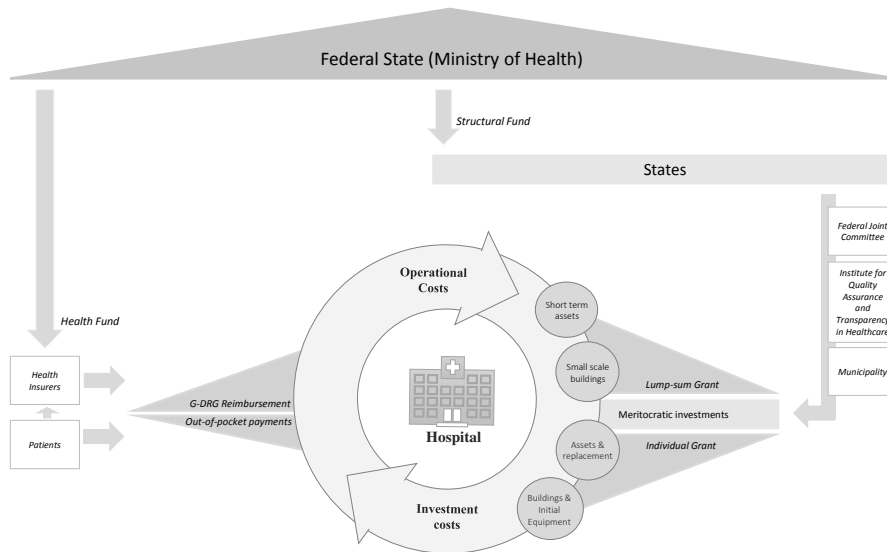
⁹The statistical figures of healthcare expenditures are provided by Federal Statistical Office Destatis.

How are hospitals financed?

The *Hospital Financing Act 1972* (Krankenhausfinanzierungsgesetz, KHG) set up a dual-financing framework for hospitals (See [Figure 1](#)). This concept distinguishes operational costs, such as expenditure for patient care and medical supply, from investment costs, such as new buildings and equipment. While operational costs are mainly reimbursed by statutory and private health insurers,¹⁰ investments in capital are secured by the federal state; thus the concept lays basis for several independent decision-makers in the financing of a hospital. Here *the National Association of Health Insurers (GKV-Spitzenverband)* acts as a consulting party with respect to hospital financing, whereas the federal state designs the investment plan and makes decisions about the type and the size of funding hospitals receive ([Pilny, 2017](#); [Preusker et al., 2014](#); [Karmann and Roesel, 2017](#)). Such conditions are described in the *State Hospital Plans* (Landkrankenhausplan). The *State Hospital Plans* set region-specific aims that follow the main national goals to ensure efficient, high quality and, in the future, economically independent hospitals. All hospitals included in the *State Hospital Plans* are entitled to receive individual grants, chiefly for long-term investments in new capital, and lump-sum grants, that cover the short-term assets and small scale buildings. In 2009, the *Hospital Financing Reform Act* (KHRG) complemented the existing funding model with additional financial aid on merit basis with the federal government deciding whether and how to distribute the additional investment ([Busse and Blümel, 2014](#)).

¹⁰Since 2004 hospital reimbursement system for inpatient care is based on patient classification system German Diagnosis-related groups (G-DRG).

FIGURE 1.
Hospital financing



Note.— Figure presents the financial structure of hospitals in Germany.

Hospitals that become dependent on the federal benefits are highly restricted by German Healthcare Law.¹¹ They have an interest in providing high quality of services to attract more patients in order to maintain the financial support from the state. Making the provision of healthcare effective and efficient ensures market stability and profitability. The quality of hospitals is controlled by the Federal Joint Committee (Gemeinsamer Bundesausschuss, G-BA)¹² which was founded in 2004 through *Health Modernization Act*. The G-BA defines the hospital performance quality criteria that are relevant for hospital planning and which form the basis for each *State Hospital Plan*. Hospitals are obliged to submit quarterly quality information to the *Institute for Quality Assurance and Transparency in Healthcare* (Institut für Qualitätssicherung und Transparenz im Gesundheitswesen, IQTIG), which is evaluated and published online biannually. Using this information, the G-BA formulates the assessment criteria for hospital performance, that federal states ought to incorporate into their hospital plans. Hospitals that do not comply with this criteria are excluded from the plan and, in most cases, close (Preusker *et al.*, 2014; Busse and Blümel, 2014).

¹¹The German healthcare Law is summarized in Greifeneder (2019) and outlined in <https://www.bundesgesundheitsministerium.de/service/gesetze-und-verordnungen.html>.

¹²G-BA is the highest decision-making body of the joint self-government of physicians, dentists, hospitals and health insurance funds in Germany.

To promote healthy competition in the market, the KHG regulates with respect to the variety of hospital ownership types in the state territories (Karmann and Roesel, 2017). The German hospital market has a multi-ownership structure, that includes three different types of ownership: private for-profit, private non-profit and public. In 2012, Germany had approximately 2000 hospitals with total of 500,000 beds of which 48% were public, 34% private non-profit and 18% private for-profit (Busse and Blümel, 2014). Management of the hospital differs by ownership type; however, according to the law, all hospitals are entitled to receive subsidies from the federal state regardless of their ownership type, ensuring the equality in the granting process (Deutsche Krankenhausgesellschaft DKG, 2014). Evidence from Pilny (2017) shows that private for-profit hospitals receive the least financial support as profitable hospitals can often rely on their own profits and do not need to receive benefits from the federal state. Meanwhile, public and non-profit hospitals do often rely on these subsidies and are mainly funded by the federal state and health insurance generated funds (Tiemann *et al.*, 2011; Pilny, 2017). Public hospitals are owned by public entities such as local or regional governments (Tiemann *et al.*, 2011), thus are highly dependent on various politics at both federal and municipal level. Even though the federal state decides on the number of hospitals and hospital beds, municipal decision-bodies are responsible for ensuring the stationary medical supply in their territory. The city or county councils are usually the owners of public hospitals with mayors and county commissioners leading or participating in hospital supervisory boards. They also oversee existing hospital finances and, even though major investments come from the state, they often need to cover monetary losses in case of financial insufficiency. Thus, municipal politics play an important role in the management of hospitals; however, their power and authority differs from state to state (Busse and Blümel, 2014; Deutsche Krankenhausgesellschaft DKG, 2018). Non-profit hospitals are in most cases owned by the church or other welfare institutions. Even though they are less directly dependent on local politicians, they are still exposed to local policy changes due to close cooperation with the municipality leaders. As hospitals of these ownership types are highly dependent on the federal state funding (Pilny, 2017), I will focus on public and non-profit hospitals in this paper.

Municipal Politics and the Media

In Germany, the federal system is comprised of three tiers of governments. The cornerstone of the German political system is federal assembly (*Bundestag*) that has the widest political powers and is responsible for the enactment of all legislations. The interest of all 16 federal states in Germany is represented by the federal council (*Bundesrat*). The lowest tier of administration is local governments in each municipality that account for approximately 12,500 municipal governments. Municipal governments are responsible for all administrative tasks on local matters and the execution of any legislative assignments made by the federal and state governments. Municipal political bodies have little influence in federal or state level legislation, they are responsible for executing given tasks and often only have discretion on how to complete them (Krause, 2019; Freier and Thomasius, 2016).

Local municipal governments are typically elected every 5 years.¹³ The election cycle varies from state to state and is not controlled by individual municipality. During an election a local council is chosen to represent the interests of the municipality. Local councils share a joint responsibility for all municipal affairs with the mayor or the executive who is sometimes elected at a separate election as an individual candidate. While the mayoral elections follow a majoritarian electoral system, the local council elections are conducted as a plurality voting system and the council is elected according to a proportional representation system (Krause, 2019; Freier and Thomasius, 2016).

The composition of politics at the local level is mainly shaped by six major political parties that are currently active in Germany. These are the two largest political parties: the Christian Democratic Union (*CDU*) that follows a centre-right political ideology and the Social Democratic Party (*SPD*) that has a centre-left political interest. In the recent elections of the *Bundestag* the populist party, the Alternative for Germany (*AfD*), that follows a right-wing to far-right political ideology joined these major political parties and became the third largest political party at the federal election. The other active political parties are: the Free Democratic Party (*FDP*) on the centre to centre-right, the Greens (*Gruene*) on the centre left and the Die Linke

¹³In the state of Bavaria the election is held each 6 years.

(LINKE), on the left wing.¹⁴

The closure of a hospital is often followed by critical feedback from local residents who are frightened to lose their access to healthcare. To attract attention, local and regional press often emphasise closures and do not discuss other perspectives, which magnifies the dissatisfaction of the local population. As a consequence, distance to the healthcare provider deceptively plays a bigger role than hospital quality and creates very strong public concern just before a hospital closure (WAZ, 2011; Westdeutsche Zeitung, 2013; Frankfurter Allgemeine, 2013; Thüringer Allgemeine, 2014; WDR, 2015). Staff members of the closing hospital often join the local criticism as the closure becomes not only a loss in healthcare access but a loss in the job market as well. However, since information about the potential closure is released early, staff members take action to search for other job opportunities, which will accelerate the closure process. The owner of the hospital has the strong incentive to initiate the market exit as maintaining an inefficient hospital leads to monetary losses. The exit strategy process usually starts with the internal restructuring, the reduction of employees and, in some cases, transforms into a merger or acquisition (Preusker *et al.*, 2014).

3 Why do hospitals close?

Severe economic difficulties, particularly related to low occupancy rates, lead hospitals to partially or fully exit the market, but this fundamental decision is usually the last alternative. It is a structural as well as strategic decision made by hospital owners and supervisory board members (Preusker *et al.*, 2014) that is often related to financial insufficiencies, that, for example, regional and small hospitals experience due to a growing market concentration in the healthcare sector (Augurzky and Schmitz, 2010).

One of the main risk factors for market exit is the financial status of a hospital (Williams *et al.*, 1992). According to the findings of Succi *et al.* (1997) and Pilny (2014), hospitals that operate with higher cash flows are less likely to close or merge with other entities. This is closely linked to the size of the hospital, another significant factor when describing market exits. Hospitals with smaller capacities, especially located in rural and remote areas, suffer from

¹⁴More detailed information about each political party in Germany can be found at the official website of Bundestag: <https://www.bundestag.de/parlament/fraktionen>.

financial distress more often as they offer fewer services. They usually provide only basic healthcare services including emergency care that, as a result, leads to weakly designed inpatient/outpatient care programs without access to sophisticated and high-tech services (Williams *et al.*, 1992; Succi *et al.*, 1997; Ciliberto and Lindrooth, 2007; Pilny, 2014). In addition to the hospital's size, the ownership status plays an important role. Based on evidence from the U.S. healthcare market, for-profit as well as public healthcare providers are more likely to exit the market than non-profit hospitals (Williams *et al.*, 1992; Succi *et al.*, 1997; Ciliberto and Lindrooth, 2007); however in the German healthcare market public hospitals together with non-profit organisations are more likely to experience mergers and acquisitions due to a high protection of the federal state (Pilny, 2014).

Regardless of size, the variety of services offered and ownership status, a hospital must ensure the efficient provision of services in order to remain in the market. The literature often discusses hospital efficiency both as a reason for as well as a consequence of the closure. Using a measure of hospital relative efficiency calculated via a frontier cost function, Deily *et al.* (2000) suggest that inefficient hospitals are more likely to close regardless of their ownership status. A similar conclusion is drawn by Ciliberto and Lindrooth (2007) who measure the efficiency by hospital fixed effects previously suggested by Skinner (1994). On a related note, when a less efficient hospital closes, it places pressure on the remaining hospitals in the market. Therefore, this stimulates local healthcare providers and leads to a more efficient delivery of services. Based on the evidence from the urban hospital closures in the U.S., Lindrooth *et al.* (2003) found that the closure of a less efficient hospital leads to lower costs for their competitors due to an increased number of inpatient as well as emergency admissions at neighbouring hospitals. Consequently, it promotes a small but statistically significant improvement in the efficiency of the local healthcare market.

In fact, efficiency is often at the forefront of the German political arena. In general, German hospitals provide a very high quality of healthcare, but the efficiency of the provision is disputable. Germany has the highest number of hospital beds per capita in the European Union. In 2017¹⁵ there were approximately 800 hospital beds available per 100,000 inhabitants, signifi-

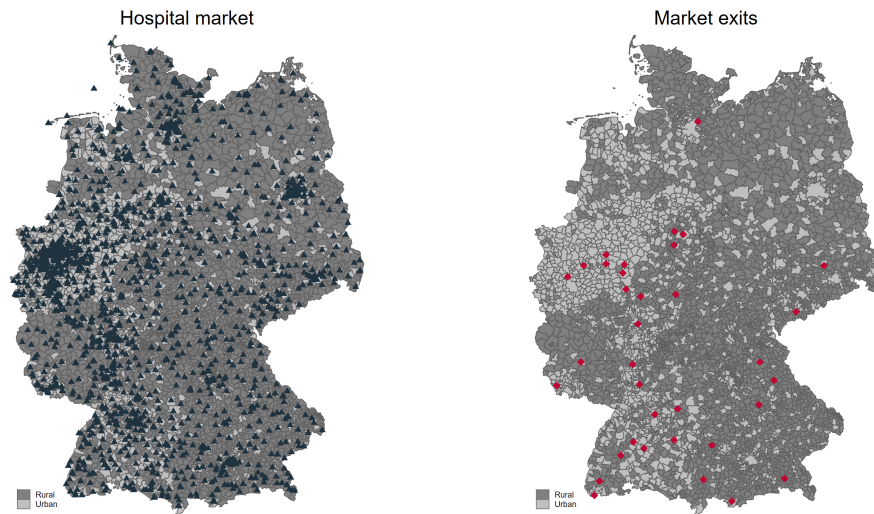
¹⁵Statistics provided by Eurostat, accessed on 04.05.20 at <https://ec.europa.eu/eurostat/databrowser/view/tps00046/default/table?lang=en>.

cantly above the average of 541 beds in the European Union. Partly, as a consequence healthcare in Germany account for nearly 12 % of GDP in 2018 compared to approximately 8% in the United Kingdom (OECD, 2019). High healthcare costs led to the political pressure to reduce public spending on hospitals, particularly on those identified as less efficient. Hospital consolidation and closures was a policy response and, as a result, the German healthcare market has shrunk by nearly 20 % since the 1990s.¹⁶

Preusker *et al.* (2014) suggest that the most common reasons for both full as well as partial market exits in the German healthcare market are similar to those described in the wider literature. The majority of hospitals closed due to economic insolvency that accounts for approximately 68% of all closures from 2006 – 2012. Failure to meet regulatory quality requirements outlined in the *Hospital Plans* imposed by each federal state resulted in around 12 % of hospital exits. The introduction of prospective funding system on the DRGs (2004) penalized comparatively inefficient hospitals and forced around 3% of hospitals to close. Some public hospitals were in practice only small clinics offering several inpatient care beds and closed due to high competition with their larger competitor. However, these and other similar reasons describe more exceptional cases, which occurred less frequently (Preusker *et al.*, 2014). The overview of the German healthcare market and market exits by the municipality are presented in Figure 2. The left panel shows the spatial distribution of hospitals offering emergency services to patients with *AMI* or *Stroke* in 2006. Market density is high with about 1,500 hospitals, of which around 67% are located in urban areas. The densest areas are in the state of North Rhine-Westphalia, the most populous state in Germany located in the West, as well as around cities such as Berlin, Stuttgart, München and Hamburg. The right panel presents diamond shaped indicators showing the locations of all hospital closures during the study period. A large share of hospitals that closed are in rural areas; however, the majority of closures (57 %) appeared in urban areas.

¹⁶In 1991 2,411 hospitals operated in Germany and in 2017 this number reduced to 1,942. Statistics accessed on the official website of the Federal Statistical Office (Destatis) at <https://www.destatis.de/EN/Themes/Society-Environment/Health/Hospitals/Tables/gd-hospitals-years.html>.

FIGURE 2.
Overview of hospital market in Germany



Note.— The figures present an overview of hospital market and market exits in German municipalities. The right panel presents the spatial distribution of all hospitals in the sample that cater emergency care services to patients with *AMI* or *Stroke* conditions; whereas the right panel indicates hospitals that closed during the study period. Each municipality is categorised as urban or rural.

4 Data and Sampling

The empirical analysis employs a nationally representative sample of patient-level data provided by a large German health insurance company. Data is collected from hospital discharge records based on diagnosis-related group (DRG) reimbursement claims and provides detailed information about patients hospitalised between 2006 and 2012. It includes a wide range of patient characteristics such as age, gender, dates of admission and discharge, place of residence and also includes comprehensive clinical information that was administrated during the hospital spell.

The sample of interest include all patients diagnosed with either an Acute Myocardial Infarction (*AMI*) or ischaemic or haemorrhagic stroke (*Stroke*). To identify these patients I exploit the information about patient's medical diagnosis classified according to the *World Health Organization's International Statistical Classification of Diseases and Related Health Problems (ICD-10)*.¹⁷

¹⁷Specifically, to identify patients diagnosed with *AMI* I extract ICD-10 codes: O21 (Acute myocardial infarction), I22 (Subsequent myocardial infarction) and to draw out *Stroke* patients I used codes: I61 (Intracerebral haemorrhage); I63 (Cerebral infarctions); I64 (Stroke, not specified as haemorrhage or infarction); a number of G45 (Transient cerebral ischaemic attacks and related syndromes) group codes: G45.0-; G45.1-; G45.2-; G45.3-; G45.8-; G45.9-. (Note, that for latter codes the international ICD coding has a slight difference from the German specification). In addition, I rely on a following set of secondary diagnosis codes to revise *Stroke* cases. I exclude patients that have one of those secondary

Due to the life-threatening nature of both *AMI* and *Stroke*, patients require immediate medical attention, preferably in units, that have access to a specialised equipment needed for diagnosis and treatment. Thus, travel time to a hospital is particularly important for patients with these conditions. When the hospital market experiences any structural changes such as a reduction in capacity or a hospital closure, emergency patients such as *AMI* or *Stroke*, are among the most sensitive and impaired access to healthcare is likely to reduce their chances for survival and successful recovery ([American Heart Association, 2003](#)). Due to these reasons, this group of patients provides close to an ideal base for the empirical setting to study the effects of hospital closures.

I identify and extract the sample of interest that includes all *AMI* and *Stroke* patients admitted to hospitals providing emergency services over the years 2006 – 2012. To distinctly describe patients’ medical condition prior to the medical emergency, a set of secondary diagnoses¹⁸ was coded for each patient. This allows the analysis to account for patient case-mix by computing the Elixhauser index ([Elixhauser *et al.*, 1998](#)).¹⁹ I further restrict the sample to patients’ aged > 18 to exclude all younger individuals, particularly newborns, that might have had congenital heart conditions. As one of the objectives of this study is to evaluate access to healthcare I am interested in the first contact the patient receives after the medical emergency only. Therefore I exclude subsequent medical information about transfers to other hospitals.

I complement the sample with several auxiliary datasets. First, to measure the geographical distance to a hospital I use a 5-digit postal code of patient’s registered residence and the postal address of each hospital, both of which are available in the hospital discharge data²⁰. Using these I estimate both the

diagnoses: C70.0; C70.9; C72.8; C72.9; C79.3; C71.-; S06.-; S07.-; S08.-; S09.-

¹⁸According to the German Medical Coding guidelines ("Deutsche Kodierrichtlinien") the main diagnosis is made after the evaluation of patient’s condition mainly responsible for the inpatient or outpatient care, while the secondary diagnosis refers to diseases and/or complaints that either already existed before the evaluation, i.e. diabetes, or was developed after.

¹⁹The Elixhauser Comorbidity Index (ECI) distinguishes 31 different comorbidities and is often used as a risk-adjustment tool to predict hospital resource use and in-hospital mortality. For a list of comorbidities I include in the analysis, see [Table A.1](#) in [Appendix A](#).

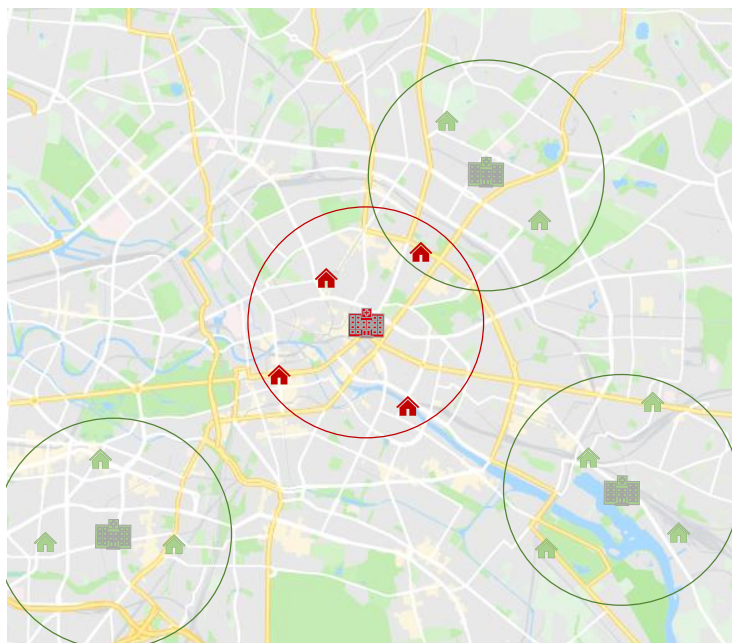
²⁰This approach follows, e.g., [Hentschker and Mennicken \(2014, 2018\)](#); [Mennicken *et al.* \(2014\)](#) and implicitly assumes that patients travel from the geographic centroid of each 5-digit postal code area corresponding to its geographic center. There are about 8,200 5-digit postal code in Germany with a median size of 27 km² and the vast majority below 100 km². When interpreting the results from estimation, it is worth noting that there are

travel distance and the travel time for each patient-hospital combination using geocoding API software from Google[®] and Open Source Routing Machine (OSRM)²¹. Some patients in this sample travelled unreasonably far from their residence to receive emergency care, that may not have been a regular event. For instance, a medical emergency might have occurred when an individual was travelling for business or holidays. Thus, I rely on the distribution of the distance travelled and exclude patients who are above the 95th percentile (in this case travelled more than 47.7km), that is approximately 5 % of the sample. Secondly, I augment the study dataset with information from standardised public hospital quality report cards that all hospitals are required by law to publish. The quality report cards include detailed information on numbers of cases and procedures performed for each hospital department, which are particularly important when assessing differences between hospitals. I exploit several quality indicators provided in these quality report cards in the supplementary analysis to provide further evidence for the exclusion restriction. Thirdly, I systematise the reported information about the German hospital market exits in [Preusker *et al.* \(2014\)](#) to identify hospitals that closed over the period of the study. In the robustness analysis I use the categorised reasons for closure to construct an alternative instrument for closure. Finally, I collect publicly available information on the political party composition of local councils in German municipalities published by the German Federal Statistical Offices. Using this information I estimate political party voting shares to construct the instrument for the instrumental variable design explained in [Section 5](#).

no obvious reasons why any measurement errors arising from this simplification would be systematically related to the chosen instrument in the empirical strategy.

²¹For a documentation of the latter resource, see <http://project-osrm.org/> and [Huber and Rust \(2016\)](#). We exclude a few cases where measuring the distance to a hospital was not possible, such as patients living on an island without a road connection to a hospital or the provided residential postal coded was inaccurate. In total it account for approx. 1% of the sample.

FIGURE 3.
Definition of the hospital emergency market



Note.— Figure illustrates how the hospital emergency market is defined in this study. A red color indicates the closure-affected area, whereas a green color - the non-affected area. The map raffle is irrelevant and chosen only for illustrative purposes.

Using the information from the calculated patient-hospital distance matrix, I allocate patients to their potential hospital emergency market which is defined by a 15 km radius around the hospital.²² Figure 3 illustrates the market definition. Here a circle represents a hospital market that either closed (highlighted in red) or had no structural changes during the study period (highlighted in green). Patients living in the market with a hospital closure are considered to be treated in this empirical setting.²³ Using a pool of remaining non-treated markets in the sample I perform a Propensity Score Matching technique to achieve a balanced distribution of confounders across treatment groups.²⁴

²²Robustness analysis for different specifications of hospital market in terms of the radius was performed and presented in Section 8.

²³If hospital spatial markets overlap and patient's residence falls into two or more markets, the closest hospital was chosen as the primary one. For descriptive purposes Figure 3 illustrates very densely located hospitals, which is a rare case in this set up. Therefore, a very small amount of patients fell into several markets.

²⁴I employ the Nearest Neighbour technique to match for a given treated market with an untreated market that is closest in its propensity score. The matching covariates include a number of hospital market-related characteristics (rural, if hospital in the market has a cardiology or angiology department, if teaching, # of hospital beds, # of doctors, # of nurses) and a number of (averaged) patient-related characteristics to control for patient

[Table 1](#) presents the descriptive statistics of the matched sample. The final sample comprises of 11,492 patients of which 22 % are defined as treated individuals. On average patients travelled around 5 km to their primary hospital and their travel time was approximately 6 minutes. The risk-adjusted and rescaled in-hospital as well as 30 day mortality was similar. Patients stayed about 10 days in the hospital and only 10% were readmitted due to similar health conditions. The average patient in the sample is a 72 year old male and, based on the Elixhauser Comorbidity index, had about three medical conditions prior to the medical emergency considered in this study. Several indicators related to hospital capacities and specific characteristics provided by the quality report cards are included in the set of controls to account for potential heterogeneity between hospitals. In addition, I consider a set of indicators specific to hospital emergency market. More detailed statistics on the matched and treated hospital markets are provided in [Table A.2](#) in [Appendix A](#).

case-mix in the market (share of male patients, patient's age, shares of each Elixhauser comorbidity). The optimal calliper width is 0.1. The balancing test for sampling is presented in [Figure A.7](#) in [Appendix A](#).

TABLE 1.
Descriptive Statistics of matched sample

	Mean	SD	Min	Max
— <i>Outcomes</i> —				
Distance to the nearest, km	4.64	3.30	0.03	14.95
Time to the nearest, min	5.84	3.42	0.07	19.82
Death (RA, rescaled)	0.47	0.14	0.02	1.00
Death 30 days (RA, rescaled)	0.48	0.16	0.02	1.00
Length of stay	9.17	8.04	1.00	205.00
Readmission	0.11	0.32	0.00	1.00
— <i>Treatment & Instrument</i> —				
Treated	0.22	0.41	0.00	1.00
CDU winning margin	-0.08	0.16	-0.30	0.67
Reason: Economic	0.82	0.39	0.00	1.00
Reason: Hospital plans	0.10	0.30	0.00	1.00
Reason: DRG implementation	0.04	0.19	0.00	1.00
— <i>Covariates</i> —				
Age	71.53	13.52	19.00	103.00
If male	0.57	0.49	0.00	1.00
If rural	0.11	0.31	0.00	1.00
EL score	2.70	1.82	0.00	13.00
Beds	655.68	516.57	20.00	2910.00
If university	0.13	0.34	0.00	1.00
If teaching	0.45	0.50	0.00	1.00
If public	0.56	0.50	0.00	1.00
If non-profit	0.37	0.48	0.00	1.00
Cases/doctor	114.20	147.42	0.00	1525.74
Cases/nurse	47.28	32.28	0.00	186.17
Market: Small hospital size	0.35	0.48	0.00	1.00
Market: Middle hospital size	0.33	0.47	0.00	1.00
Market: Large hospital size	0.33	0.47	0.00	1.00
Market: if teaching	0.18	0.39	0.00	1.00
Market: if rural	0.19	0.39	0.00	1.00
Market: average age	71.81	2.25	48.00	84.13
Market: average EL score	2.74	0.34	0.67	6.00
Market: average gender ratio	0.57	0.07	0.00	1.00
Observations	11492			

Note.— Table presents descriptive statistics of the matched sample. Here RA abbreviates risk-adjusted, CDU - Christian Democratic Union, DRG - diagnosis related groups, and EL - Elixhauser comorbidity.

5 Econometric framework

Several issues arise when estimating the effect of hospital closures on patient outcomes. First, estimates might suffer from the estimation bias due to patients' sorting into different residential areas. It is likely that patients with worse health conditions might deliberately choose to live closer to a hospital²⁵ and failure to control for this spatial sorting might result in a downward bias

²⁵See e.g., Currie and Reagan (2003); Grzybowski *et al.* (2011); Chou *et al.* (2014).

in the estimate of hospital closure. To minimize this bias, I employ a large set of detailed patient- and location-specific characteristics and additionally control for patient case-mix using a set of averaged patient characteristics in the market. A particular advantage of this comprehensive data is a possibility to follow patients over time, that allows to identify hospital transfers and any readmissions after the initial hospital presentation. I explore this feature of the data and estimate the effect of hospital closure on readmission rates. In addition, to account for potential changes and variation over time and I include time fixed effects in the estimation.

In spite of being able to control for a detailed and rich set of observable influences on patient outcomes that might be correlated with a hospital closure, there remains a possibility of unobserved common influences on patient outcomes and the likelihood of hospital closure. For instance, one of the most common reasons for closure is financial instability as a consequence of low patient volume due to poor quality of care, such as, for example, high mortality rates. Estimating the effect of hospital closure on patient outcomes will result in the correlation between the variable of interest and the error term, and a potentially bias and inconsistent estimator. To address this endogeneity problem caused by reverse causality, I adopt two empirical strategies. First, I use the Propensity Score Matching technique explained in the previous section to find a suitable control market that stands as a benchmark to measure differences between treated and non-treated individuals. Second, I employ the Instrumental Variable (IV) empirical strategy to estimate the effect of hospital closure. With a novel instrument in hand, that well predicts the endogenous treatment variable, this approach grants precise and unbiased estimators. The construction of the instrument as well as the validation for the underlying assumptions is explained in detail in Section 6.

Let i be a patient admitted to hospital h at time t . The patient is treated ($\mathbb{1}_{i \in M_j^1}$) if s/he resides in the hospital market M_j that experienced a closure (indicated by M_j^1). Then the effect of hospital closure on outcome Y can be estimated with the following model:

$$Y_{iht} = \rho_0 + \rho_1 \widehat{\mathbb{1}}_{i \in M_j^1} + X_i' \gamma + H_{ht}' \pi + \lambda_t + \mu_d + \epsilon_{iht} \quad (1)$$

with the corresponding first stage:

$$\mathbb{1}_{i \in M_j^1} = \phi_0 + \phi_1 Z_{ht}^{CDU} + X_i' \gamma_0 + H_{ht}' \pi_0 + \lambda_t + \mu_d + \epsilon_{iht} \quad (2)$$

where $\hat{\mathbb{1}}_{i \in M_j^1}$ in (1) is the predicted treatment from the first stage estimation and ρ_1 is the estimate of the interest. Herein, I focus on several outcomes Y . First, I consider the effect on geographical healthcare access measured by the shortest distance and travel time to a hospital. Second, to describe the quality aspects, I look at various patient outcomes such as death in-hospital and within 30 days of discharge.²⁶ Finally, I investigate the efficiency of hospitals by looking at length of stay in days and the readmission rate with a condition that the patient was readmitted within 30 days of discharge and had a similar diagnosis.

The model specification further controls for a vector of patient-specific characteristics X_i such as age, gender, rural status, and a number of Elixhauser comorbidities as well as a vector of hospital-specific characteristics H_{ht} including number of beds; university and teaching status, ownership type and number of cases per doctor and per nurse. I also control for year fixed effects λ_t and admission-day-of-the-week²⁷ fixed effects μ_d . Let ϵ be uncorrelated random error term. Due to the sampling design that is based on hospital markets, the standard errors will be clustered at the hospital level.

6 Construction of the Instrument

The empirical model employs instrumental variable to take into account concerns related to potential endogeneity of hospital closure. Recall that the closure might have influence on the quality of care in the area, but the quality itself may also be a reason for closure. To overcome this limitation, I follow a similar approach as outlined in [Bloom *et al.* \(2015\)](#) and construct

²⁶The outcomes on mortality rates were first risk-adjusted using a logistic regression. The risk adjusters considered in the regression include several patient characteristics such as patient's age, Elixhauser comorbidities, gender, state and urbanity of patient's residence; various hospital-related characteristics such as ownership type, if teaching, if university and several capacity-related measures (number of beds, number of cases per doctor, doctor's specialization level, a number of cases per nurse); and several treatment related characteristics particularly important in the case of a stroke.

²⁷To control for average differences in days of the week, I include the admission-day-of-the-week fixed effect into the model. It determines a day of the week, identified as d , i.e. Monday, Tuesday etc., when a patient was admitted to the hospital.

an instrument based on the degree of political pressure. The authors argue that politicians loath to deliver policies not popular with the voters (such as the hospital closure), especially in the areas where the political vote winning margin is small. On the other hand, in the areas where one party has a noticeable political advantage against the remaining parties these policies are more likely to be enacted. Using this particular phenomenon, authors adopt the constituency election winning margin as an instrument to instrument the level of hospital competition in the area and evaluate it's effect on management quality.

Following this novel technique, I construct an instrument in a similar way to account for potential endogeneity between hospital quality and market structure. Using the German local municipal government elections results, I calculate shares of votes for major political parties. Policies such as shut-downs of the institutions (that might as well be a major employer in the area) are more likely to happen when the governing party follows market-oriented policy perspective rather than more socialist political ideology. For this reason, I chose to reference the calculation of the winning margin on the condition that the largest centre-right political party in Germany - Christian Democratic Union (CDU) - has a political advantage in the municipality.²⁸ The winning margin is then constructed as a difference between voting shares of the CDU and the opposition parties, expressing interest in more left orientated political views such as Social Democratic Party (SPD), The Left Party (LINKE) and The Greens (GRUENE). When the winning margin is positive, the governing party is the CDU and the higher the margin is, more political power the party enjoys in the municipality. To support the relevance assumption for this instrument, I first explore the associations between the defined treatment and the instrument. Similarly as in the UK setting described in [Bloom et al. \(2015\)](#) I observe „political punishment” patterns. [Table 2](#) shows that treatment is significantly associated with the share of votes both for the CDU (Column (1)) as well as the opposition parties (Column (2)). If an individual resides in the treated market, the share of the CDU votes are significantly and approximately 6 percentage points smaller than among those, who reside in a non-treated market. The difference appears to be even larger for the opposition parties. This provides evidence that a substantive policy such as hospital

²⁸The reference chosen to calculate the winning margin does not alter the main results and only affects the interpretation of the first stage coefficients.

closure raises public awareness especially related to the political decisions in the municipality.

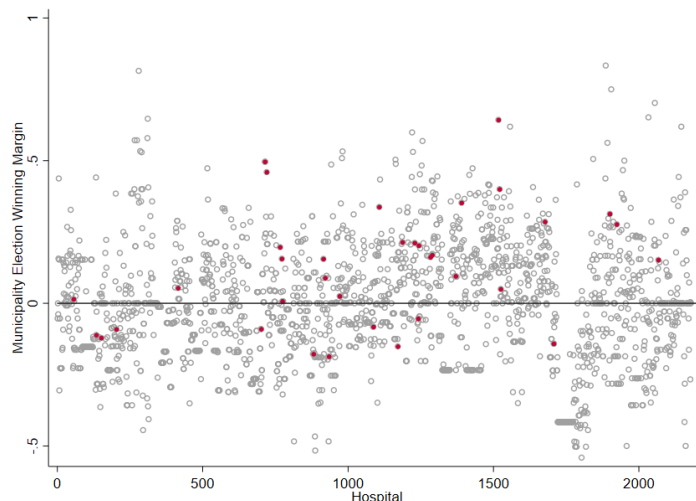
TABLE 2.
The relevance of the instrument I: Political punishment

	(1)	(2)
	Share CDU	Share Opposition
$\mathbb{1}_{i \in M^1}$	-0.0581** (-2.02)	-0.296*** (-20.83)
Observations	11492	11492

Note.— Table presents the estimation results of a linear regression measuring the association between treatment and shares of political votes. The models also control for a set of patient characteristics - age, if male, if rural; Elixhauser commorbidities; hospital characteristics - # of beds, if university, if teaching, if public, if non-profit, # of cases per doctor, # of cases per nurse; as well as year fixed effects.

Further evidence for the relevance of the instrument is presented in [Figure 4](#). Figure reports the variation of winning margins across all hospitals in the sample over the study period (numeration of hospitals is random). The solid horizontal line represents political stalemate, when the CDU and the opposition parties evenly divide the votes with no party enjoying a political margin. Yet, this is a particularly rare situation, therefore most of hospitals fluctuate above or below the solid line. All points above the line indicate hospitals in municipalities where the CDU party enjoys the political majority and the opposite below the line. The closer to the line the mark is located, the less political power the party has. Additionally, red points in the figure highlight hospitals that closed during the study period. As suspected, the majority of closures appear in the CDU winning municipalities. A larger portion of those were located in areas where the winning margin is relatively high, highlighting weaker political competition when these substantive policies were implemented.

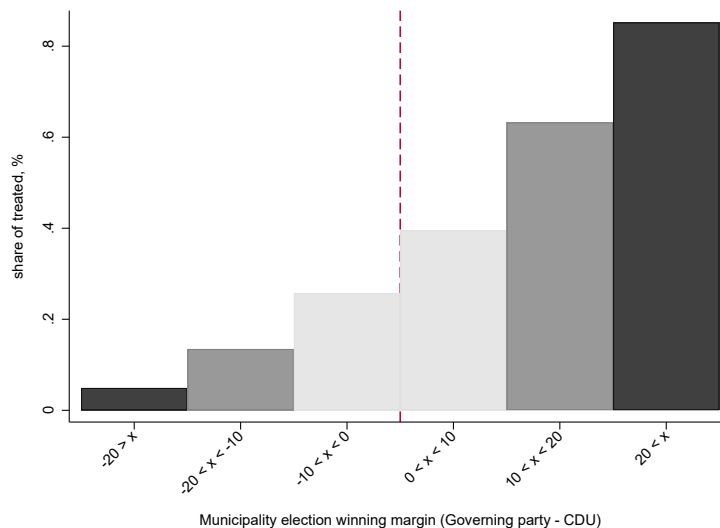
FIGURE 4.
The relevance of the instrument II: Political winning margin in the location of a hospital



Note.— Figure presents the variation in municipality election winning margin for all hospitals that operated in years 2006 – 2012. The numeration of hospital is random. Red coloured circles highlight hospitals that closed during this period.

To further explore the significance of political competition, [Figure 5](#) presents the relationship between the winning margin and the treatment. Each column presents a share of individuals by the winning margin divided into intensity of political pressure intervals. The brighter the column, the higher political pressure is observed in the municipality. Columns located to the right of the dashed red line indicate occasions when the CDU had a political advantage against the opposition, whereas columns to the left show the contrary occasions when the CDU had a political disadvantage. It is apparent from this figure that the share of treated individuals is higher when the CDU has a majority of votes and, as a result, the histogram is skewed right. Besides, the scarcity of individuals on the left side of the dashed line shows that the share of treated is smaller when the left-leaning party is in lead.

FIGURE 5.
Governing party's (CDU) winning margin and the
share of treated individuals



Note.— Figure presents the share of treated individuals by different winning margin intervals.

Although previously presented evidence supports the relevance of the instrument, it is important to test the exclusion restriction. Recall that in Germany *State Hospital Plans* highly regulate healthcare resources as well as the quality of care. Thus, political parties in the municipality do not have any powers to expand the number of healthcare providers in the area that could affect the geographical healthcare access. Similarly, they do not have any influence neither on hospital capacity nor on the variety of services a hospital provides, both of which could potentially improve the quality of care in the area. As political bodies often sit on the supervisory board of the hospital, the only channel through which politicians could potentially affect the quality of care is the management of the hospital. [Table 3](#) provides supportive evidence that this channel is not significant and that the violation of the exclusion restriction is unlikely. Table presents regression estimation results on the multiple quality indicators reported in the hospital quality report cards that are relevant to the patient group of interest. Columns (1) - (3) include quality-related outcomes such as specialist doctors, the proficiency level in surgeries and the proficiency in the diagnostic-related treatments, respectively. The former outcome denotes a share of specialist doctors operating in the hospital, while the proficiency outcomes indicate the number of different services a hospital provides and act as a score from 0, being the lowest, and

7, being the highest possible proficiency.²⁹ Results show that the instrument does not have any significant effect on any of the quality indicators related to the management of the hospital and provide further support to the assumption that political power does not alter the quality of the services provided in the area.

TABLE 3.
Exclusion restriction: Politicians' influence on the quality

	(1) Specialist Doctors	(2) Proficiency in Surgeries	(3) Proficiency in Diagnostics
Winning Margin (CDU)	0.0406 (0.03)	-2.827 (-0.26)	0.0406 (0.03)
Mean	0.53	0.63	0.92
SD	0.18	1.30	1.57
Observations	2014	2014	2014

Note.— Table presents the estimation results of a linear regression measuring the relationship between the instrument and quality indicators of the hospital such as share of specialist doctors operating in the hospital, number of surgeries and invasive procedures available at the hospital and number of diagnostic procedure performed at the hospital. Each proficiency indicator is a score from 0, being the lowest, and 7, being the highest possible proficiency. Each model additionally accounts for hospital characteristics such as if public, if university, if teaching and hospital fixed effects.

The distribution of the constructed instrumental variable is illustrated in [Figure A.8](#) in [Appendix A](#).

7 Results

I first demonstrate that geographical distance to hospital is in fact important for patients with *AMI* or *Stroke* and that worse healthcare access due to a hospital closure could lead to adverse clinical outcomes. [Table 4](#) reports estimation results based on the linear regression model that evaluates the associations between the distance patient travelled to the hospital and several patient outcomes. In addition, I allow for potentially non-linear relationships in this setting and express the distance as a second order polynomial

²⁹The score of hospital's proficiency in surgery includes a possibility to perform a major coronary surgery including a surgery following any complications of the coronary heart disease, a heart valve surgery, both pacemaker and defibrillator interventions and, lastly, a heart transplantation. The score of hospital's proficiency in diagnostics include a possibility to perform angiography, pulmonary embolectomy, an intervention on the pericard, treatment of health injuries, and other diagnostic and therapeutic treatments for ischemic, pulmonary and other heart diseases. These quality measures indicate that the hospital has the capacity and the capability including specialised angiographers/cardiologists/surgeons and equipment to perform any of diagnostic procedures or surgeries listed.

by including the quadratic curve. Columns (1) - (4) present the estimation results on in-hospital death, death within 30-days of discharge, length of stay and readmission within 30 days of the initial discharge. Reported parameter estimates are then interpreted as the average percentage change in the probability of death if distance travelled increases by one kilometre. Thus, if the patient travels one additional kilometre, the probability of in-hospital death is approximately 0.0014 percentage points higher. Although this result looks small at first glance, recall that a patient on average travels about 5 km to the nearest hospital, if this hospital closed and the distance increased by 5 to 10 kilometre, the patient would face an increased probability of in-hospital death by 0.5 to 1 percentage points. The estimate is even higher in the case of death within 30-days of discharge, signalling that additional complications might arise due to delayed treatment. Distance to the hospital does not seem to play an important role on other patient outcomes such as length of stay and readmission.

TABLE 4.
Distance effect on patient outcomes

	(1) <i>Death</i>	(2) <i>Death (30-days)</i>	(3) <i>Length of stay</i>	(4) <i>Readmission</i>
Distance, km	0.00138** (2.62)	0.00174** (2.94)	0.00204 (0.06)	-0.00144 (-0.67)
(Distance, km) ²	-0.00003* (-2.10)	-0.00003* (-2.11)	0.00043 (0.35)	0.00007 (1.17)
<i>N</i>	11336	11336	11492	11492

Note.— Table presents the linear regression model estimating the relationship between distance travelled and patient outcomes. All models also control for a set of patient characteristics: age, if male, if rural, Elixhauser commorbidities; hospital-related characteristics: # of beds, if university, if teaching, if public, # of cases per doctor, # of cases per nurse; as well as year and weekday fixed effects. Outcomes (1) and (2) are risk-adjusted measures and due to additional estimations made beforehand analysis sample is slightly smaller, however this should not affect the main findings. Standard errors are clustered at the hospital level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Following this evidence, I estimate the effects of hospital closures on the geographical healthcare access and patient outcomes. Considering the setting of this study, that focuses on the closure of the nearest medical facility, I anticipate that patient's proximity to the nearest medical care will in fact increase after hospital closure. However, it is essential to examine the extent of this increase and its effects on patient outcomes. Panel B of [Table 5](#) reports results from the estimation of the IV model as defined in (1) and (2) and, for comparative reasons, panel A presents the estimation results of the second stage

using the Least Squares. The estimate of the first stage regression reported in Column (1) suggests a significant positive relationship between the selected instrument and the treatment. This result supports the previous discussion in Section 6. The point estimate can be interpreted as one percentage point change in the CDU winning margin, or simply the CDU political power, and is interpreted as 1.3 percentage point change in the likelihood of residing in a closure-affected area. Hence, if the CDU governing party gains more political power against the opposition, it is more likely that the party will adopt a substantive policy such as closing a hospital in the municipality. The first stage coefficient is highly significant with an F -statistic value of around 47, providing further evidence that the instrument is a strong predictor of treatment and supporting the validity of the second stage estimations.³⁰

TABLE 5.
IV estimation. Effect on healthcare access and patient outcomes

	Health care access			Health outcomes			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	<i>I stage</i>	<i>Distance</i>	<i>Travel time</i>	<i>Death</i>	<i>Death (30-days)</i>	<i>Length of stay</i>	<i>Readmission</i>
<i>A. OLS Estimation</i>							
$\mathbb{1}_{i \in M^1}$		1.547*** (4.15)	1.451*** (4.21)	-0.006 (-1.01)	-0.001 (-0.21)	-0.695* (-1.80)	0.027* (1.91)
<i>B. IV Estimation</i>							
Z^{CDU} $\widehat{\mathbb{1}}_{i \in M^1}$	1.345***	3.704*** (5.22)	2.603*** (4.32)	-0.008 (-0.98)	-0.004 (-0.39)	-2.310*** (-3.18)	-0.021 (-1.37)
Observations	11492	11492	11492	11336	11336	11492	11492
F	47.30						

Note.— Table presents the estimated effect on healthcare access and patient outcomes using Least Squares (panel A) and IV model (panel B). Here the instrument is the CDU winning margin in the municipality elections against the opposition. All models also control for a set of patient characteristics: age, if male, if rural, Elixhauser commorbidities; hospital-related characteristics: # of beds, if university, if teaching, if public, # of cases per doctor, # of cases per nurse; as well as year and weekday fixed effects. Outcomes (4) and (5) are risk-adjusted measures and due to additional estimations made beforehand analysis sample is slightly smaller, however this should not affect the main findings. Standard errors are clustered at the hospital level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Columns (2) to (3) and (4) to (7) show the results of the second stage estimation on healthcare access and patient outcomes, respectively. As anticipated, patients, living in the area where the hospital closed, face worse healthcare access in terms of the distance and travel time to the hospital. For both outcomes considered the coefficient of $\widehat{\mathbb{1}}_{i \in M^1}$ is highly significant at a significance level of 0.1%. This estimate suggests that residents of closure-affected area travel on average nearly 4 kilometres further (or 3 minutes longer)

³⁰I rely on the evidence by [Staiger and Stock \(1997\)](#), stating that for a strong instrument inference, the F -statistic greater than 10 is required.

to the nearest hospital offering emergency care. The estimate of Least Squares is also highly significant, albeit much smaller in magnitude. Hence, not accounting for the potentially endogenous market structure would give induced a downward bias and, consequently, the true effect of hospital closure would have been underestimated. Although the results on the healthcare access confirm that the hospital closure reduces patients' chances of receiving prompt medical care in case of emergency, it may not necessarily result in either worse survival or other health outcomes following the medical event. The estimates reported in Column (4) and (5) indicate that, even though an increase in travel distance is associated with higher mortality rates as shown in [Table 4](#), an increase in travel distance due to closure is in fact not critical for these emergency cases. The coefficients signal somewhat lower odds of dying both in-hospital as well as after discharge; however, the estimated effects are not statistically significant. Interestingly, as reported in Column (6), patients residing in closure-affected areas has on average shorter length of stay. The estimate suggests that treated individual's hospital stay is more than 2 days shorter than their untreated counterparts. One possible reason for this finding is that, when a hospital closes, the number of patients at the neighbouring hospital increases and, as a result, stimulates more efficient delivery of services in the remaining market. This finding is supported by previous literature showing that the economic pressure arising from competitor closing down leads to gains in efficiency for the remaining healthcare market ([Lindrooth *et al.*, 2003](#)). However, these gains in efficiency do not appear to result in any medical complications that would require a readmission, supporting the finding that they do not come at the expense of the quality of care (Column (7)).

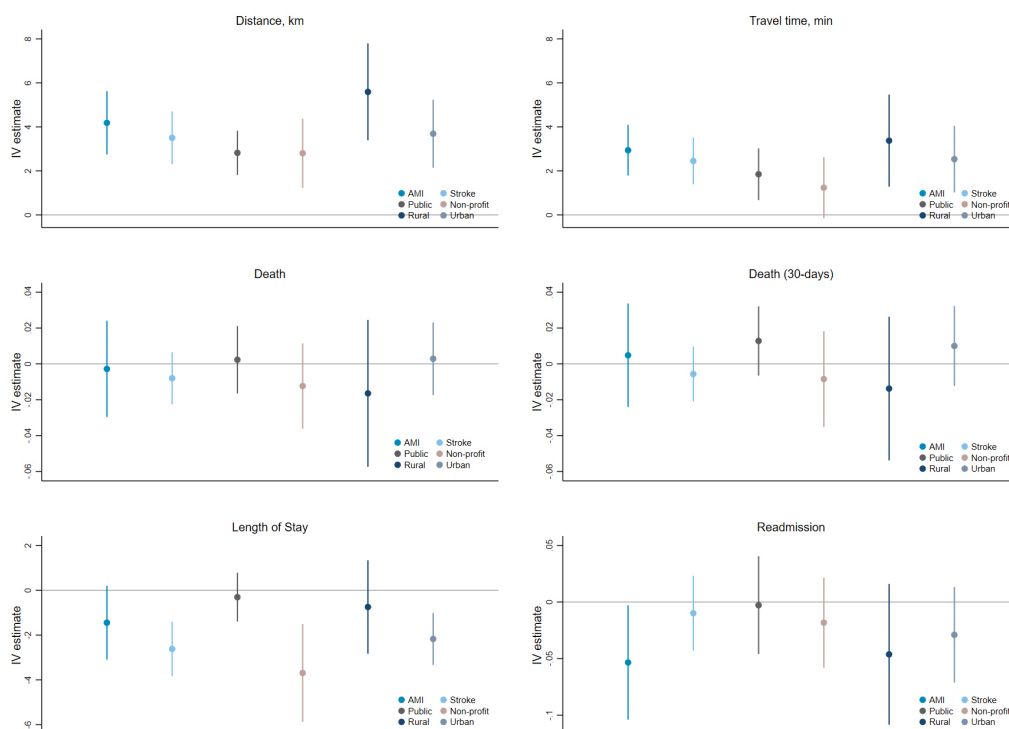
8 Heterogeneity and Robustness Analysis

Finally, I report estimation results from a set of extensions to the main analysis to gauge the robustness of my findings and further assess whether the effects are heterogeneous across specific subgroups of the study sample. I first study heterogeneity with respect to patient's medical condition, the type of hospital and residence location. The findings are illustrated in [Figure 6](#), of which each panel shows the estimation results on a set of outcomes considered in the main analysis. Each dot in the figure refers to an estimated parameter ρ_1 ,

that is the point estimate of the second stage of the IV model outlined in (1). The solid horizontal line in each panel stands as a reference line indicating the occasion when the effect is zero and insignificant. The analysis sample is split into two sub-samples by each heterogeneous group and indicated by different colors: first, by the medical condition, *AMI* or *Stroke*; second, by admitted hospital ownership status, public or non-profit; and, lastly, by the type of residential location, urban or rural. The estimated effect on healthcare access appears to be insensitive to patient’s medical condition: both *AMI* and *Stroke* patients experience longer travel to the nearest hospital by about 4 km (3 min) with slightly larger effect noted for *AMI* patients. However, this significant change in travel time does not result in higher odds of dying for either of these conditions. On the other hand, efficiency gains with respect to the length of stay appear to be mainly driven by the treatment of *Stroke* patients, suggesting that patients with this medical condition could be and are treated quicker in neighbouring hospitals when pressure on the capacity rises. Interestingly, *Stroke* patients are no more likely to be readmitted, confirming that shorter length of stay does not result in any subsequent complications. However, a quality improvement is noted for patients with *AMI*, who are significantly less likely to be readmitted when they receive treatment at the neighbouring rather than at the nearest hospital.

With respect to the ownership type of the hospital, I note no significant differences in healthcare access, odds of dying and readmission results. However, the effect on length of stay appears to be driven by non-profit hospitals, that treat patients residing in closure-affected areas on average 4 days quicker than patients residing in unaffected areas. Non-profit hospitals often have smaller capacities with respect to the number of beds and staff as well as treat a smaller share of patients in the market. Thus, closing a neighbouring hospital seems to place a higher pressure on these hospitals that respond by providing medical services more efficiently and, relying on the results on other outcomes, effectively. With regards to the type of residential location, the effect on healthcare access is as expected larger for patients living in rural areas; however, not surprisingly, the efficiency gains are driven only by urban areas, where larger hospital complexes are often located.

FIGURE 6.
Heterogeneity analysis by different subgroups



Note.— Figure presents the IV estimation results on a set of sub-samples. Each dot denotes a point estimate (and its 95% confidence interval) of the second stage of the IV model. The instrument is the CDU winning margin in the municipality elections against the opposition. All models also control for a set of patient characteristics: age, if male, if rural, Elixhauser commorbidities; hospital-related characteristics: # of beds, if university, if teaching, if public, # of cases per doctor, # of cases per nurse; as well as year and weekday fixed effects. Standard errors are clustered at the hospital level.

Next, to provide additional evidence for the reliability of the instrument I perform several robustness analyses. First, one possible issue with the construction of the instrument could arise from the fact that the instrument is constructed at the market level, whereas the analysis of treatment effects is at the patient level. To provide the support that this does not cause any problems, I estimate the same IV model defined in (1) and (2) aggregated at the market level. Herein, each outcome denotes the average outcome in the hospital market and models also control for patient case-mix in the area determined by averaged patient characteristics. Results are presented in Table 6. Despite the aggregated sample, results on the first stage reported in Column (1) again support the relevance of the instrument with an F -statistic value of 56. The estimated coefficient on other patient outcomes are similar in terms of both statistical significance and effect size. In contrast to the results from the main analysis, the effect size is smaller and insignificant for length

of stay. This is not unexpected and is likely a result of removing some of the variation in the outcomes, and should not be interpreted as contradicting the main finding.

TABLE 6.
Robustness analysis I. Aggregated analysis

	<i>Health care access</i>			<i>Health outcomes</i>			
	(1) <i>I stage</i>	(2) <i>Distance</i>	(3) <i>Travel time</i>	(4) <i>Death</i>	(5) <i>Death (30-days)</i>	(6) <i>Length of stay</i>	(7) <i>Readmission</i>
Z^{CDU}	1.015*** (7.52)						
$\widehat{\mathbb{1}}_{i \in M^1}$		3.988*** (4.90)	2.158*** (2.89)	-0.000 (-0.01)	0.015 (0.95)	0.548 (0.62)	-0.002 (-0.06)
Observations	179	179	179	171	171	179	179
<i>F</i>	56.62						

Note.— Table presents IV estimation results on the aggregated to hospital market level sample. The instrument is the CDU winning margin in the municipality elections against the opposition. All models also control for a set of averaged patient characteristics at the market level: age, if male, if rural, dummies for Elixhauser comorbidities; and hospital characteristics - # of beds, if university, if teaching, if public, # of cases per doctor, # of cases per nurse; as well as year and weekday fixed effects. Outcomes (4) and (5) are risk-adjusted measures and due to additional estimations made beforehand analysis sample is slightly smaller, however this should not affect the findings. Standard errors are robust. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Second, another potential problem with the constructed instrument might be related to the main rationale of the significance of political pressure on hospital closure decisions. It is likely that, if a hospital experiences financial difficulties, politicians might be under pressure to act to reduce current and any future monetary losses. I employ the information provided in the report by Preusker *et al.* (2014) about the reason for hospital closure and augment the instrument used in the main analysis by interacting with a dummy indicator variable for whether the main reason for closure was financial. This allows me to identify those areas where the political pressure in the market is only driven by economic incentives. The instrument is then defined as the following

$$\ddot{Z}_{ht}^{CDU} = Z_{ht}^{CDU} \times \mathbb{1}_{economic} \quad (3)$$

where $\mathbb{1}_{economic}$ is a dummy variable indicating whether a hospital closed due to economic insolvency or other similar reasons. This specification replaces the instrument employed in the first stage (2) and the corresponding estimation results are shown in Table 7. Based on the first stage *F-statistic*, the alternative specification of the instrument is again highly relevant when predicting the treatment. The estimated coefficients from the second stage are in

line with the main results discussed in Section 7 and are only slightly higher for healthcare access. This finding gives additional credibility to the selected instrument if one suspects that political pressure could be driven by economics only.

TABLE 7.
Robustness analysis III. Alternative specification of the instrument

	<i>Health care access</i>			<i>Health outcomes</i>			
	(1) <i>I stage</i>	(2) <i>Distance</i>	(3) <i>Travel time</i>	(4) <i>Death</i>	(5) <i>Death (30-days)</i>	(6) <i>Length of stay</i>	(7) <i>Readmission</i>
$\hat{\beta}^{CDU}$	1.187*** (5.99)						
$\widehat{\mathbb{1}}_{i \in M^1}$		4.714*** (5.68)	3.377*** (4.98)	-0.007 (-0.67)	-0.002 (-0.15)	-2.334*** (-2.67)	-0.0230 (-1.20)
Observations	11492	11492	11492	11336	11336	11492	11492
<i>F</i>	35.89						

Note.— Table presents IV estimation results using an alternative specification of the instrument. The instrument here is the interaction between the CDU winning margin against the opposition and the dummy variable indicating if the reason for closure is related to economic insolvency. All models also control for a set of patient characteristics: age, if male, if rural, Elixhauser commorbidities; hospital-related characteristics: # of beds, if university, if teaching, if public, # of cases per doctor, # of cases per nurse; as well as year and weekday fixed effects. Outcomes (4) and (5) are risk-adjusted measures and due to additional estimations made beforehand analysis sample is slightly smaller, however this should not affect the findings. Standard errors are clustered at the hospital level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Finally, I study whether the main estimation results are sensitive to the definition of the hospital emergency market. In the main specification, I assumed that patients residing within a 15 km radius of a hospital are referred to that hospital. While this is likely the case in more populated areas, it might not necessarily reflect reality in less populous areas where small hospitals do not have the capacity to treat patients with severe medical conditions such as *AMI* or *Stroke*. To investigate whether the definition of the hospital emergency market alters the main findings, I estimate the IV model specified in (1) and (2) using 25 km and 50 km radiuses. Table 6 presents estimated coefficients using both definitions in Panel A and B, respectively. Note, that changing the definition of the market enlarges the geographical area in the study, thus the number of patients considered in each model increases with increasing hospital market catchment areas. I find that the relevance of the instrument is insensitive to the definition of the market and the political pressure still plays an important role. However, the estimated coefficients, albeit significant, are slightly smaller in size which is expected result when the market expands.

TABLE 8.
Robustness analysis II. Different definitions of a hospital market

	<i>Health care access</i>			<i>Health outcomes</i>			
	(1) <i>I stage</i>	(2) <i>Distance</i>	(3) <i>Travel time</i>	(4) <i>Death</i>	(5) <i>Death (30-days)</i>	(6) <i>Length of stay</i>	(7) <i>Readmission</i>
	<i>A. 25 km radius</i>						
Z^{CDU}	0.819*** (5.00)						
$\mathbb{1}_{i \in M^1}$		2.519*** (2.74)	2.098** (2.38)	-0.006 (-0.81)	-0.007 (-0.89)	-1.392* (-1.75)	-0.046* (-1.71)
Observations	23354	23354	23354	23250	23250	23354	23354
F	25.04						
	<i>B. 50 km radius</i>						
Z^{CDU}	0.982*** (10.11)						
$\mathbb{1}_{i \in M^1}$		1.357** (2.16)	1.200* (1.94)	-0.004 (-0.93)	-0.002 (-0.32)	-1.368** (-2.26)	-0.012 (-1.20)
Observations	67371	67371	67371	67141	67141	67371	67371
F	102.30						

Note.— Table presents IV estimation results using different definitions of hospital market. The instrument is the CDU winning margin in the municipality elections against the opposition. All models also control for a set of patient characteristics: age, if male, if rural, Elixhauser comorbidities; hospital-related characteristics: # of beds, if university, if teaching, if public, # of cases per doctor, # of cases per nurse; as well as year and weekday fixed effects. Outcomes (4) and (5) are risk-adjusted measures and due to additional estimations made beforehand analysis sample is slightly smaller, however this should not affect the findings. Standard errors are clustered at the hospital level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

9 Summary and concluding remarks

In this paper I study the effects of hospital closures on geographical healthcare access and clinical patient outcomes. I employ comprehensive administrative hospital discharge data that provide detailed information about patients, their medical condition, and treatment received at the hospital. This data is supplemented with several auxiliary datasets. First, I link the data with public hospital quality report cards and employ a large set of various hospital-related characteristics to account for potentially unobserved heterogeneous effects between different hospitals. I also collect and systematize information about all hospital market exits during the study period and identify them in the data. To construct an instrumental variable that corrects for potentially endogenous market structure when studying the effects of hospital closures on various health outcomes, I collect publicly available data on political party composition of local councils in the German municipalities. Local politicians who undertake substantive policies such as hospital closure are often „punished” by voters. I exploit this feature and estimate a measure of concentration in political power in the market. I condition on the largest centre to centre-right

political party winning and estimate the voting margin to instrument for the treatment defined as individuals residing in a closure-affected areas. I exploit this comprehensive linked dataset and I apply the Instrumental Variable approach to study the effects of hospital closures on geographical healthcare access expressed in distance and travel time to the hospital and several patient clinical outcomes such as death, length of stay and readmission. I find that political power in the local area plays a substantial role in determining the future of hospitals and, although this did not have any effect on clinical quality and the variety of services provided in the area, it is a significant predictor of hospital closures. Patients living in closure-affected areas on average travel further to access care, but this does not result in reduced survival for severe acute conditions such as acute myocardial infarction or stroke. It is important to note that the effects on the mortality could be impinged by the lack of information on out-of-hospital mortality, which I leave for future research. However, the results on other clinical outcomes provide compelling evidence that longer travel times due to closure do not result in additional readmissions due to any medical complications following hospital treatment. To the contrary, closing a hospital stimulates efficiency gains as patients are treated more rapidly at neighbouring hospitals which does not come at the expense of the quality of care.

My findings contribute to the existing literature on healthcare consolidation policies. In line with previous findings I provide empirical evidence that the hospital closure has a negative effect on geographical healthcare access. However, most of previous literature relied on the strong assumption that hospitals provide universal care and concentrated on various patient groups whose choice of hospital might have relied on their personal preferences (Burkey *et al.*, 2017; Hentschker and Mennicken, 2014; Mennicken *et al.*, 2014). Thus, the findings could have underestimated the effects of hospital closure policies. To complement the existing literature, I consider the most vulnerable group of patients – those with *AMI* and *Stroke*, who due to their critical medical condition requiring emergency care, will not choose their preferred hospital. I additionally select only those hospitals that are equipped with specialised equipment for treating these emergency patients. Using very detailed information about market exits I am able to identify all hospital closures over the study period and exploit the effects on patient outcomes rather than exploiting policy-induced variation in distance due to closures that a large body of

literature lies at the heart of (Buchmueller *et al.*, 2006; Avdic, 2016; Blondel *et al.*, 2011; Ravelli *et al.*, 2011). While this measure is relevant for more concentrated markets such as the U.S. or Sweden, it is less informative in a market with high hospital density. Thus, in this paper I employ an alternative empirical approach and using a measure of concentration of political power I provide compelling evidence for the importance of political decisions in hospital markets.

In conclusion, these findings reveal that, in times of great consolidation of health systems, local politics is an important channel that could mediate potentially adverse effects on social welfare. This channel offers a broad scope for communication to reduce public concerns when a hospital forfeit of its future. As my results suggest, even during one of the strongest periods of healthcare consolidation in Germany, this phenomenon did not result in any adverse clinical outcomes and policy-makers should only be considered with closing hospitals in less densely populated areas.

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Appendix A Additional Tables and Figures

TABLE A.1.
Classification of Elixhauser Comorbidities

Variable	Comorbidity
el1	Congestive heart failure
el2	Cardiac arrhythmias
el3	Vascular disease
el4	Pulmonary circulation disorders
el5	Peripheral vascular disorders
el6	Hypertension, uncomplicated
el7	Hypertension, complicated
el8	Paralysis
el9	Other neurological disorders
el10	Chronic pulmonary disease
el11	Diabetes, uncomplicated
el12	Diabetes, complicated
el13	Hypothyroidism
el14	Renal failure
el15	Liver disease
el16	Peptic ulcer disease (excluding bleeding)
el17	AIDS/HIV
el18	Lymphoma
el19	Metastatic cancer
el20	Solid tumor without metastasis
el21	Rheumatoid arthritis/collagen vascular diseases
el22	Coagulopathy
el23	Obesity
el24	Weight loss
el25	Fluid and electrolyte disorders
el26	Blood loss anemia
el27	Deficiency anemia
el28	Alcohol abuse
el29	Drug abuse
el30	Psychoses
el31	Depression

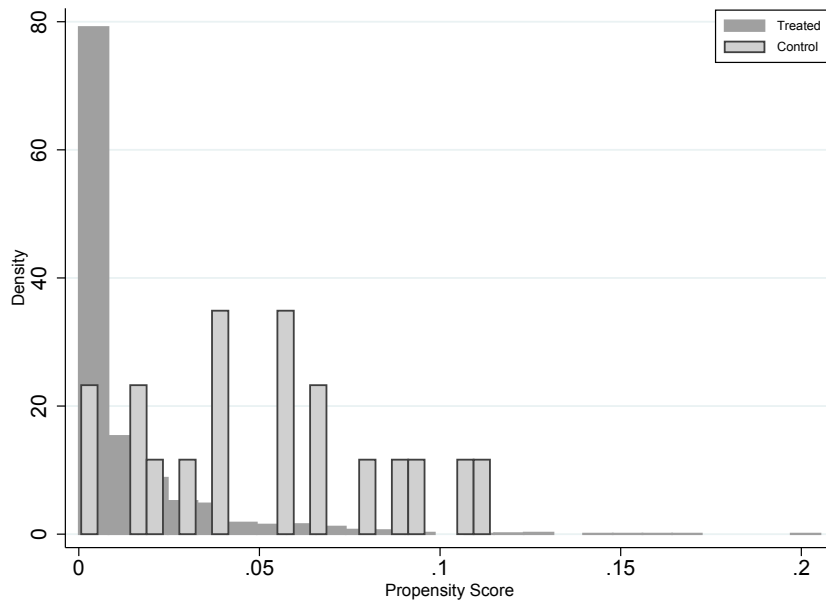
Note.— Table presents all Elixhauser comorbidities. Detailed classification of Elixhauser Comorbidities with respective ICD-9 and ICD-10 codes can be found in [Quan et al. \(2005\)](#).

TABLE A.2.
Descriptive Statistics of treated and control samples

	Treated		Control		Difference	
	mean	sd	mean	sd	b	t
Market: age	70.79	4.97	70.61	5.38	-0.18	(-0.24)
Market: male	0.60	0.15	0.59	0.17	-0.01	(-0.54)
Market: if rural	0.65	0.48	0.49	0.50	-0.16*	(-2.13)
Market: Elixhauser	2.52	0.76	2.73	0.68	0.21	(1.96)
Market: # beds	113.58	102.96	116.41	91.86	2.83	(0.19)
Market: Small hospital size	0.30	0.46	0.20	0.40	-0.10	(-1.60)
Market: Middle hospital size	0.32	0.47	0.41	0.49	0.08	(1.17)
Market: Large hospital size	0.38	0.49	0.40	0.49	0.02	(0.26)
Market: If university	0.00	0.00	0.00	0.00	0.00	(.)
Market: If teaching	0.20	0.41	0.16	0.37	-0.04	(-0.71)
Market: If public	0.42	0.50	0.59	0.49	0.17*	(2.34)
Market: If non-profit	0.11	0.31	0.00	0.00	-0.11**	(-3.20)
Market: Cases/doctor	235.84	72.06	369.10	437.44	133.25*	(2.44)
Market: Doctor's specialization level	0.53	0.20	0.55	0.20	0.02	(0.65)
Market: Cases/nurse	69.16	18.01	69.50	28.69	0.34	(0.09)
Observations	93		86		179	

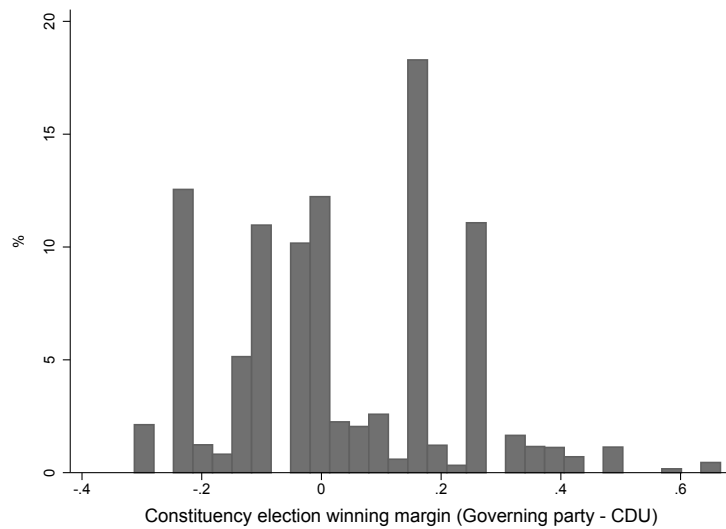
Note.— Table presents the descriptive statistics of hospital markets by treated and control groups. All statistics are aggregated to mean values in the study period and present an average patient as well as hospital in the market.

FIGURE A.7.
Propensity Score Matching. Group balancing test



Note.— Figure presents the balancing test for samples of treated and control groups for Propensity Score Matching technique.

FIGURE A.8.
The distribution of the instrument



Note.— Figure presents the distribution of the instrument that is the CDU winning margin in the municipality elections against the opposition.