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Abstract

Appointing or electing professionals to be public officials is a double-edged sword. Experts can use their rich knowledge to implement reforms, but they can also favor their own profession. In this study, we compare physician-trained state health ministers to ministers of other professions in Germany during 1955-2017. German state health ministers have great power to determine hospital capacities and infrastructure. Our results show that physician-trained health ministers increase hospital capacities, capital, and funding by the statutory health insurance (SHI). This prompts hospitals to hire more physicians, but with little impact on hospital outputs. As a result, total factor productivity (TFP) growth in hospital care slows down substantially under physician-ministers. At the same time, job satisfaction of hospital doctors tends to increase. We conclude that, in particular, the medical profession benefits from medical doctors in office.

JEL code: D72, I11, I18, O47, P16
Keywords: Hospitals, health minister, productivity, TFP, favoritism, profession, technocracy

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"The practicing physician and the patient could not have a better friend in that office than Tom Price."
— Republican Representative Michael C. Burgess on the nomination of the medical doctor Tom Price as Secretary of Health and Human Services by US President Donald J. Trump in 2016

"Even though I'm health minister, I'm a doctor first of all."
— Andrea Kalavská, Slovakian health minister since 2018

1 Introduction

Politicians love to give a little bit extra to their peers. Political leaders are found to privilege their home region (Hodler and Raschky, 2014; Jennes and Persyn, 2015; Fiva and Halse, 2016; Asher and Novosad, 2017; Baskaran and Lopes da Fonseca, 2017; Do et al., 2017; Gehring and Schneider, 2018), ethnic group (De Luca et al., 2018; Dickens, 2018; Marx et al., 2019), social class (Hayo and Neumeier, 2012, 2014), fellow party members (Curto-Grau et al., 2018), relatives (Folke et al., 2017) or simply their own bank accounts (Fisman et al., 2014). Scholars therefore often propose nominating experts or technocrats to combat such favoritism. However, advocates of technocracy too often overlook that alignment with professions can also have ambiguous effects. On the one hand, experts can use their rich knowledge to implement reforms and improve efficiency (see, e.g., Jacqmin and Lefebvre (2016)). On the other hand, they may favor their own profession at taxpayer expense. Against the background of rich evidence on local and social favoritism, very little is currently known about whether experts gratify the professional networks they belonged to before entering political office.[1]

In this paper, we present evidence for favoritism within professions: the medical profession benefits from medical doctors in office. We study the case of physician-trained health ministers in German federal states during 1955–2017 and compare them to non-physician ministers. Medical doctors are among the strongest and best-organized professions often insisting on political influence.[2] Several German state health ministers served as medical doctors in hospitals or surgeries before entering office. Health ministers have great power to affect the hospital market by determining capacities and capital resources, even at the level of individual providers. They decide on the number and location of hospitals, departments, and beds for all public and private hospitals (hospital capacity planning) and allocate funds to individual hospitals (hospital capital spending).

By understanding hospital care as a production process, we link the biographies of German state health ministers to hospital inputs, outputs, and total factor productivity (TFP) growth in German hospital care at the state level. TFP measures how efficiently hospital labor and capital inputs translate into hospital outputs, i.e., treated cases. Figure 1 compares the distribution of hospital sector TFP growth rates under physician-ministers to non-physician ministers. TFP rates are clearly centered at lower values under physician-trained ministers. Difference-in-differences models and event study estimates corroborate that TFP growth in hospital care slows down substantially when a medical doctor becomes a health minister. Previous TFP performance does not

[1] Scholars document that MPs act in line with their profession in parliament (Matter and Stutzer, 2015; Hyytinen et al., 2018).

[2] By *medical doctors*, we refer to physicians of any medical degree (either MD or PhD).

predict the nominations of a doctor as health minister and event studies find no significant difference in TFP trends before a physician enters office.

[Figure 1 about here]

We show that the main mechanism behind the TFP slowdown is an increase in hospital inputs, the number of hospital doctors in particular. Physician-trained state health ministers use fiscal policies to increase hospital capital, capacities, and funding by the statutory health insurance (SHI) which prompts hospitals to hire more physicians. Satisfaction data shows that the job satisfaction of doctors tends to increase. Our results strongly suggest that experts in office have strong incentives to gratify their own profession. Our results are robust to several robustness tests, for example using close election outcomes only, different subsamples and excluding individual ministers.

Our findings corroborate rich anecdotal evidence on the nomination of health ministers in various countries. One example is the nomination of Tom Price – a medical doctor – as health secretary in Donald Trump's cabinet in 2016. In his former position as a Georgia state senator, he was described as "a voice for doctors, often aligned with the positions of the American Medical Association and the Medical Association of Georgia" and well gratified his profession (New York Times, 2016).[3] Other examples are the medical doctors Philipp Rösler, who became German national health minister in 2009, Konstanty Radziwiłł – the former president of the Standing Committee of European Doctors – who entered office as a Polish health minister in 2015, and Andrea Kalavská who has been the Slovakian health minister since 2018. Medical associations were enthusiastic about their nominations.[4] We show that connections with political decision-makers can pay off well for a profession. Appointing professionals does not preclude the impact of interest groups (Olson, 1965), which is inherent to democratic societies.[5]

We contribute to at least five existing strands of literature. First, our results contrast with previous findings showing that technocratic governments outperform partisan politicians.[6] Heads of governments are prone to nominate technocrats because of and according to their professional expertise. For example, almost all ministers of the 2011–2013 technocratic Italian government led by Mario Monti had rich experience in the field of their ministry.[7] Scholars often argue that technocrats can ignore party constraints and therefore implement the "best" available evidence-based policy. Many empirical studies support this view. Former professional

[3] As state senator "[h]e has introduced legislation that would make it easier for doctors to defend themselves against medical malpractice lawsuits and to enter into private contracts with Medicare beneficiaries. Under such contracts, doctors can, in effect, opt out of Medicare and charge more than the amounts normally allowed by the program's rules" (see, "Tom Price, Obamacare Critic, Is Trump's Choice for Health Secretary", http://www.nytimes.com/2016/11/28/us/politics/tom-price-secretary-health-and-human-services.html, last accessed: October 10, 2017).

[4] For example: "Cheers: Liberal doctor becomes health minister" (see, http://www.medical-tribune.de/medizin-und-forschung/artikel/jubel-fdp-arzt-wird-gesundheitsminister/, last accessed: November 23, 2017), or the statement by the Standing Committee of European Doctors with regard to the appointment of Konstanty Radziwiłł as health minister of Poland (see, http://www.cpme.eu/dr-konstanty-radziwill-new-polish-minister-of-health/, last accessed: November 20, 2018).

[5] Our findings are in line with theoretical considerations by Murphy et al. (1993), suspecting rent-seeking to be costly for economic growth.

[6] Technocrats are non-partisans who enjoy a great deal of independence and can rely on considerable professional expertise.

[7] "The appointed ministers have all been chosen according to a stringent criteria of professional excellence for their executive duties" (see, "The Who's Who of the Monti Goverment", http://www.iitaly.org/magazine/focus/facts-stories/article/whos-who-monti-goverment/, last accessed: September 20, 2017).

experience is found to improve the performance of ministers for finance (Jochimsen and Thomasius, 2014), education (Jacqmin and Lefebvre, 2016), development and foreign aid (Fuchs and Richert, 2018), and of central bankers (Göhlmann and Vaubel, 2007; Neuenkirch and Neumeier, 2015).[8] Studies document that the educational and professional backgrounds of the head of government can also matter to reforms (Dreher et al., 2009), growth (Besley et al., 2011; Neumeier, 2018), and public deficits (Hayo and Neumeier, 2016). Only a few studies are less optimistic and present rather mixed findings (Hayo and Neumeier, 2014; Moessinger, 2014; Freier and Thomasius, 2016). Our results, by contrast, suggest that expertise can enable professionals to cater their profession. This aspect of technocracy has not yet been adequately studied.[9]

Second, our results shed new light on the issue of connections between rent-seeking interest groups and top politicians. Closely related to our study, Cooper et al. (2020) use the 2003 Medicare Modernization Act (MMA) to illustrate the tight links between congressional politics, health care spending, and local hospitals in the US. For Germany, Ferguson and Voth (2008) document that stock returns of Nazi-affiliated firms sharply increased after the takeover by Hitler in 1933. Roberts (1990) and Fisman (2001) find that connections to politicians also pay off for US firms in terms of stock prices.[10] Xu (2018) documents patronage effects in the British Empire. We show that good connections to those in political office may not only pay off for individuals but also for well-organized professions.

Third, our setting provides a broader discussion about the mechanisms of favoritism. Previous studies have shown that the professional background of decision-makers matters to political outcomes, but channels often remain opaque.[11] The institutional setting of German hospital policy allows us to examine specific political instruments that can be adopted by health ministers. Health ministers cannot directly hire hospital staff. However, our findings suggest that health ministers use fiscal policies to boost staffing in hospitals indirectly. Capital funding in hospital care has been shown to have substantial and long-lasting effects on hospital market structures (Chung et al., 2017). Medical doctors might be aware of the low elasticities of substitution between input factors in health care (Jensen and Morrisey, 1986; Cawley et al., 2006), and increase capital spending to trigger labor. We also show that physician-trained health ministers tend to raise state-administered prices for SHI reimbursement to establish fiscal capacities for additional hospital staff.

Fourth, we provide evidence for the scope and determinants of TFP in health care services from a long-term perspective. Long-term TFP trends in individual (service) sectors have been rarely examined.[12] Health sector productivity and efficiency studies often stick to cross-sectional snap shots, which make it hard to separate local idiosyncrasies from temporal effects (Hollingsworth, 2008). Cylus and Dickensheets (2007), Blank and Eggink (2014), and Karmann and Roesel (2017) are rare exceptions. These studies compute hospital produc-

[8] There are similar findings for the private sector. For example, bank losses during the financial crisis correlate with the finance competence of supervisory boards (Hau and Thum, 2009).

[9] Clémenceau and Soguel (2017) show that economists serving as finance ministers in Swiss cantons increase "creative accounting".

[10] Fisman et al. (2012), by contrast, do not find evidence that alignments to top politicians pay off for US companies.

[11] For example, Francese et al. (2014) show that Caesarean deliveries increase when the president of an Italian region is a medical doctor.

[12] Bergeaud et al. (2016) compute long-term TFP series for the entire economy of selected countries from 1890 to the present day. On the level of individual industries, the US Bureau of Labor Statistics offers productivity measures from the late 1940s onwards for the US, the EU KLEMS project (O'Mahony and Timmer, 2009) for further countries from 1970 onwards.

tivity over a period of two to three decades. Our study, by contrast, offers productivity figures for the German hospital sector for more than 60 years. Our results show that productivity virtually stagnates over the entire period if quality is not taken into account, supporting the cost disease diagnosis in services sectors by Baumol and Bowen (1966). Once we account for quality improvements in hospital care, however, TFP contributes some 0.3 percentage points to output growth, which accumulates to more than 20 percentage points over a period of 60 years. We conclude that quality, not quantity, is key to productivity improvements in medical services.

Fifth, our results contribute to the recent literature on the effectiveness of "managerial capital" – defined as advanced management practices – on the productivity and performance of firms and industries (Bertrand and Schoar, 2003; Bennedsen et al., 2007; Bloom and Van Reenen, 2007; Bloom et al., 2013, 2019). For instance, Bloom et al. (2015) show that "managerial capital" in private equity firms explains firm-level spreads of TFP within and between countries.[13] Productivity can be affected by management via the channels of workforce selection and pay, i.e., better-managed firms are able to build up a superior stock of employees through selective hiring and attrition (Bender et al., 2018). Superior management quality is also strongly associated with better educational outcomes in schools (Bloom et al., 2015). Similar results are available for the health care sector. Bloom et al. (2015) find that higher competition in UK hospital markets results in higher management quality and improved hospital performance. McConnell et al. (2013), Tsai et al. (2015), McConnell et al. (2016), and Bloom et al. (2019) show that hospitals with more effective management practices – adopted from manufacturing sectors – provide higher-quality care. Furthermore, patients are more likely to choose hospitals with higher management scores (McConnell et al., 2016). Our paper adds new evidence for public decision-makers.

2 Institutional background

2.1 Hospital care in Germany

Large parts of German hospital policies are decentralized to the 16 federal state governments.[14] According to the German constitution, the federal government is only responsible for the financial and legislative framework in hospital care. For example, the federal government is responsible for the statutory health insurance (SHI). All other tasks in hospital care are assigned to the state governments. Capacity planning, hospital capital funding, hospital reimbursement price levels for the SHI, and university hospitals are the main hospital care responsibilities held by the states that are exclusively executed by the state health ministers.

First, state health ministries are responsible for hospital capacity planning. German states autonomously decide on the size, location and specialization of the hospitals and departments, as well as the bed capacities that qualify for reimbursement by the SHI and state capital funding. In some states, health ministers even decide on the exact number of beds in each individual hospital department. Hospital capacity planning equally applies to *all* three types of ownership in Germany: public hospitals, private non-profit hospitals (operated by churches and charity organizations), and private for-profit hospitals.

[13] A theoretical model on this finding is provided by Bloom et al. (2016).

[14] More detailed overviews are provided by Karmann and Roesel (2017) and Pilny (2017).

Second, states must fund hospital capital expenditures, while current expenditures for treating patients are reimbursed by the SHI. This funding rule applies to all hospitals independent of ownership type, i.e., all types of hospital ownership must be treated equally. Therefore, state health ministries directly decide on the scope and location of hospital infrastructure and its capital endowment.

Third, state health ministers may influence reimbursement by the SHI. Local hospital associations and SHI branches negotiate DRG prices (*base rates*) which, however, also needs approval by state authorities. DRG prices are set at the state level since 2005 and apply to all hospitals in the state.[15] Thus, state authorities are able to control hospital reimbursement since 2005.

Finally, states also directly run and fund university hospitals and specialized hospitals such as psychiatric hospitals, and federal state law regulates hospital hygiene and public health services. In conclusion, state health ministers are key players in German hospital care. They decide on regulation and hospital capital allocation. By contrast, hospital management decides on staff, equipment and day-to-day business of hospitals not owned by the state government.

2.2 Ministers in German federal states

German state health ministers are part of the state governments, which depend on majorities in state parliaments. Regular parliamentary elections in German states take place every four (state of Bremen) or five years (all other states). They do not take place simultaneously. Voters elect MPs to state parliaments (proportional representation), who in turn elect the prime minister. The prime minister then appoints the members of her cabinet. In most states, appointments of individual ministers do not require parliamentary approvals. Thus, health ministers are not directly elected by voters or parliaments but depend on the choice of the prime minister.

Appointments of individual ministers are a result of complex political bargaining. First, usually coalitions of two or three parties form parliamentary majorities in German state parliaments. Allocating ministries to the coalition partners is the result of long negotiations on a coalition agreement. Second, German state ministries usually oversee more than one policy field. Each state government designs ministries according to the coalition agreement. For the years 1955 to 2017, only 10% of state health ministries were single-purpose ministries without responsibilities for other policy fields. Usually, health care is part of a broadly-defined ministry that oversees social affairs, labor and/or the environment as well. Therefore, experts on social care or labor markets are at least as likely to become health ministers as experts on health care. However, health is certainly among the most important issues in broader-defined ministries for social care which increases the likelihood of health care experts to become health ministers.

[15] The German DRG system has been introduced in 2003. Before its introduction, hospitals were reimbursed per diem via fixed budgets. In 2003 and 2004, initial base rates were set on individual hospital level, in 2005 state-wide base rates went into effect.

3 Data

We now turn to our data, which we hand-collect from many administrative, official, historical, parliamentary, and other sources. Our new dataset includes information on hospital markets, health ministers, and further control variables at the level of the German federal states. We digitize hardcover reports on the hospital sector published by the German Statistical Office. Detailed information is provided online in Appendix A. Our dataset includes 10 West German federal states between 1955 and 2017 and 5 East German states for the period from 1993 to 2017.[16] Time series start in 1955 and 1993, respectively, when data quality is no longer impaired by post-WWII and post-reunification turbulences. Including East German states for earlier years is not possible because state and health care institutions differed substantially in the former socialist German Democratic Republic, where no democratic elections were held. We also have to exclude the city state of Berlin, which was divided among West and East Germany and experienced a completely different development of its hospital sector.[17] We end up with a balanced panel dataset for the years 1955 (1993) to 2017 for 10 West German (5 East German) states. Because we employ all data in growth rates, our final dataset has 745 observations in total. Table 1 shows the descriptive statistics we now discuss in more detail.

[Table 1 about here]

3.1 Biography data

We hand-collect information on all health ministers and state governments from publications of state parliaments and governments, media archives, ministers' personal websites and search engine hits. In the period from 1955 to 2017, 185 distinct health ministers served in 245 different state cabinets in our 15 German sample states. A detailed overview of all German state health ministers is provided in Table A1 in Appendix C. Health ministers usually change during the year. We follow Jochimsen and Thomasius (2014) and choose February 1st as the cut-off day. We assume that the health minister serving on February 1st determines the hospital outcomes for this particular year. We therefore take into consideration that in many states, elections are held in the final months of the year, and a new government does not enter office before late January or early February. Due to this cut-off day, our set of health ministers in the final sample shrinks from 185 to 178 because in some years and states, certain health ministers were in office for only a few months. Robustness tests later show that our results do not change by using different cut-off days.

Our main variable of interest is the occupational background of the health minister. The dummy variable *Doctor* takes on the value of one if a state health minister is a medical doctor (physician). In our sample, 12 health ministers are medical doctors (6.8% of the sample, i.e., 51 observations, see Table 1). We also code other medical professions such as nurses or pharmacists for ministers with working experience in the health sector but excluding physicians (18.1% of the sample), and health ministers with a business or economics

[16] We exclude 1990 as the year of reunification when hospital statistics were entirely revised.

[17] Berlin had a massive oversupply in hospital care because both the German Democratic Republic and the Federal Republic of Germany ran a full-sized hospital sector for each part of the city. The Berlin hospital sector was drastically consolidated after 1990. Developments in Berlin are not comparable to any other German state.

background but no health care background (20.8% of the sample). For classification, we focus not only on formal qualifications but also on real-life occupational experience.[18]

We collect further information on our health ministers and use them as control variables. For example, Table 1 shows that 44% of all health ministers are aligned with center right-wing parties and 81% are aligned with the same party as the prime minister.[19] 47% are locals, born in the same federal state they serve as minister. Approximately 40% of all ministers are female. The average age of health ministers is 52 years, with an average tenure in office of around 3 years. More than 40% of all ministers hold a university degree, and 27% hold a PhD. The last two columns in Table 1 compare means for medical doctors and non-doctors. On average, medical doctors are somewhat older (55 years) and more often female (57%) than non-doctors. Furthermore, almost all (94%) medical doctors hold a PhD. Since the PhD (German: *Dr. med.*) is almost the standard graduate degree for students of medicine in Germany, we do not stratify by MD and PhD.[20]

3.2 Government, hospital market and sociodemographic controls

We collect information on governments and the political environment (see, again, Table 1). 24% of all years are election years. On average, 1.8 parties formed a coalition. Minority governments without a majority in the parliament are rare exceptions (3%). We also code whether a ministry was a single-purpose ministry, i.e., responsible for health only (10%). In approximately two out of three cases, the health ministry was also responsible for labor affairs.

Our data on state hospital markets includes the number of beds, the number of hospitals, the average length of stay and information on ownership. A total of 57% of all hospital beds were public and 10% were private for-profit. The remainder are private non-profit beds in hospitals operated by churches and charity organizations that serve as base category (33%).

In our regressions, we also control for demographic and economic variables, such as total population, the population share older than 65 years, and unemployment rates. Sociodemographic characteristics were hand-collected from the annually published Statistical Yearbooks for the Federal Republic of Germany or individual federal states, or are from further official publications by state statistical offices. We use growth rates for all sociodemographic control variables and hospital market variables, with ownership shares being the exception.

3.3 Hospital inputs and outputs

We understand hospital care as a production process which transforms inputs into an output. The main goal of this paper is to test whether this production process differs under physician-trained health ministers. We therefore investigate outputs (hospital cases at a certain quality) and inputs (labor and capital) separately, but also as a combined productivity ratio (total factor productivity, TFP) which we describe in detail below.

[18]For example, one health minister in our sample is formally qualified as a docker. However, he worked in a hospital for years and is therefore categorized into other medical professions.

[19]As right-wing parties we consider CDU, CSU and FDP. See, for example, Mechtel and Potrafke (2013) and Potrafke (2013).

[20]We include the dummy variable for PhD in the regression model (see section 4). However, it does not conflict with the dummy variable for doctors in terms of collinearity, since not all doctors hold a PhD. When changing the reference category for educational attainment with PhD as reference, the main results remain robust.

Figure 2 plots how inputs, outputs and productivity in German hospital care developed between 1955 and 2017. Details on data sources and computation are provided online in Appendix A.

[Figure 2 about here]

First, we turn to the input side. Hospitals use labor and capital goods to produce health outcomes. As labor inputs, we use separate series of total annual working hours by doctors and by nurses. We calculate the number of full-time equivalents, which we multiply by the average number of annual working hours of doctors and nurses typical of this time. As illustrated by Figure 2, the labor volumes of doctors increased almost continuously from 1955 to 2017 and more than tripled during this period. While the labor volumes of doctors steeply increased, the labor volume of nurses declined in the last 15 years. As capital input, we self-compile hospital capital stocks using the perpetual inventory method (Schmalwasser and Schidlowski, 2006; Schreyer, 2009). We collect long-term series on hospital investments between 1900 and 2017, transform investment data to constant 2017 euros,[21] and compute hospital capital stocks as the sum of non-retired investments of prior periods as described in Appendix A. Figure 2 shows that capital stocks increased over the entire period from 1955 to 2017. The kink in the early 1990s is a result of very large growth rates in East German hospital capital stocks, which we include for all years after 1993.[22] We do not consider intermediate goods such as medical materials, services and energy because data are not available before 1990 and productivity measures for the period 1991 to 2017 hardly change when we omit or include intermediate goods as inputs (correlation coefficient $r = 0.94$).[23]

Second, we consider treated cases to be the main output of hospitals. Figure 2 shows that the number of treated cases has increased substantially over the last 60 years. However, not only the quantity but also the quality of hospital treatments has certainly changed significantly in the course of the last century, and should therefore be taken into account. We therefore construct series for hospital cases adjusted for quality improvements. Quality measures such as complication rates, patient-assessed treatment quality or 30-day mortality rates would be preferable, but none of them are available for Germany before 2006, when the publication of quality report cards became mandatory. For the period from 1955 to 2017, the only proxy for treatment quality we can rely on is in-hospital mortality. To derive quality adjusted cases, we compute in-hospital mortality rates, which is in-hospital deceases over total number of hospital discharges.[24] Figure A3 in Appendix C shows average in-hospital mortality rates indexed to 1955. Higher values indicate lower quality, and vice versa. Hospital mortality increases until the early 1970s, but then steadily decreased in the decades afterwards.[25]

[21] We apply the federal price index for capital goods.

[22] After reunification, very large investments were necessary to modernize the out-of-date East German hospital sector. Without East Germany, real-term hospital capital stocks in Germany increased by a factor of 2.5 between 1955 and 2015, which somewhat parallels the number of hospital cases (see Figure A1 in Appendix C).

[23] The upper panel of Figure A2 in Appendix C confirms this expectation.

[24] The number of deceased patients is included in the data on discharges (patients released from hospitals because of death), and not in the case statistics. We use discharges instead of cases to compute consistent mortality rates. Cases and discharges can differ, for example when patients are treated in December but released in January, or because of readmissions. However, discharges and cases are highly correlated ($r = 0.999$).

[25] About 20-30% of hospital capacities were destroyed during WWII. Furthermore, large portions of hospital capacities became outdated in the post-WWII period, e.g., in 1968 more than one third of hospital beds dated from the years before 1920 (Deutscher Bundestag, 1968). In the 1950s and 1960s, much more people were treated in hospitals than in the decades before, and some patients died in hospitals that would have died at home in the decades before.

This well coincides with anecdotal evidence on general improvement of hospital treatment. One key example is infant mortality which has declined to large extent in industrial countries because of the medical progress in hospital diagnosis and treatments. Thus, successful treatments and quality improvements in hospital care should, in the end, also materialize in decreases in hospital mortality (Varabyova and Schreyögg, 2013). A potential shortcoming is that demographic changes may affect mortality rates, which in turn may bias our quality adjustment. Mortality might change for a number of reasons which are exogenous to hospital quality, for example, changes in lifestyle habits. We cannot directly control for such impacts. However, we believe that demography as a long-term trend should not systematically bias our short-term effects. We also provide all empirical analyses for quality-adjusted and quality-unadjusted cases separately. Figure A4 in Appendix C corroborates the validity of our quality measure. In order to assess the validity, we compare in-hospital mortality rates to 18 different clinical quality indicators from hospital quality report cards which are publicly available for recent years. In Germany, hospital quality data has been reported biannually from 2006 to 2012, and after 2013 annually.[26] The scatter plots in Figure A4 (Appendix C) show that clinical quality measures and in-hospital mortality are in large parts highly correlated in German states. We therefore assume that in-hospital mortality captures general improvements of hospital service quality at least at the state level. One limitation is that we cannot conduct this validity analyses for prior decades. However, we will conduct all regression analyses for both unadjusted and quality-adjusted cases. The results show that our findings are not sensitive to quality adjustment at all.

We take into account the quality improvements by dividing the total number of "raw" cases by our mortality rate and obtain quality-adjusted cases. Figure 2 shows that both quality-adjusted and unadjusted cases develop very similar until the 1980s. Quality-adjusted cases grew even slower because in-hospital mortality increased at this time. Afterwards, trends diverged reflecting the substantial decrease in in-hospital mortality. Quality-adjusted cases increased by a factor of four over the period 1955 to 2017. In contrast, the number of unadjusted cases grew by a factor of 2.5 over 60 years.

3.4 Productivity measure (TFP)

We have shown that both hospital inputs and outputs grew substantially over the last 60 years. This raises the question which of both series has grown faster. We rely on the concept of total factor productivity (TFP) to answer this question. TFP growth describes changes in outputs that cannot be traced back to shifts in total inputs.[27] TFP growth in hospital care therefore describes the change in efficiency of hospital sectors to transform inputs into outputs, which we consider as an ideal measure of the performance of health ministers. There are two main concepts in computing productivity changes. Studies that derive TFP from national accounts usually apply the growth accounting framework developed by Solow (1957). This concept assumes a Cobb-Douglas production function, and the production elasticities of inputs must be specified explicitly. TFP growth can then be derived as the residual output growth, which exceeds the sum of production elasticity weighted input

[26] Since the definitions of some quality indicators changed over time and the fact that some quality indicators had been at first published in later years, we have chosen indicators with the highest availability over all years. All indicators were averaged on state level and year for our analysis.

[27] Literature on economic growth refers to TFP growth as the Solow residual (Solow, 1956, 1957), which is equivalent to the *non*-input-based contribution to output growth – often denoted as technological progress.

growth rates. A second popular TFP concept originates from Malmquist (1953) and relies on the benchmarking of multiple decision-making units. The main idea of this concept is that the most efficient decision-making unit defines the efficiency frontier. An explicit specification of a certain production function and elasticities is not required.

The Malmquist approach has been frequently applied by health economists to study hospital efficiency and is perfectly suited to the purposes of our paper. A detailed overview of the conceptual framework and the related algebra is provided online in Appendix B. We have state-level data that allows benchmarking across federal states, but no long series on costs or production elasticities are available. Therefore, we apply the Malmquist concept in the data envelopment analysis (DEA) framework as proposed by Färe et al. (1994). We use our hospital output measure (either qualiy-adjusted or unadjusted cases) and our three inputs (labor volume of doctors, labor volume of nurses, capital stock). However, for the subperiod from 1991 to 2017, when production elasticities are available (Karmann and Roesel, 2017), the Malmquist concept and the Solow growth accounting framework deliver very similar TFP rates (see lower panel of Figure A2 in Appendix C). We conclude that the Malmquist approach yields reliable and meaningful TFP rates.

The DEA procedure provides us with annual hospital TFP growth rates over the period from 1955 to 2017 for all German states. Table 1 summarizes the results. When we do not consider quality improvements, the mean TFP growth rate for German hospital care over six decades is negative (-0.4 percentage points). This negative TFP growth corroborates findings for TFP rates in the social and health care sector in the US. Average TFP in the US health care sector was also -0.4 percentage points between 1970 and 2017, which is similar to the German hospital sector with an average TFP of -0.4 percentage points for the period from 1955 to 2017 and -0.2 percentage points for 1970 to 2017 (without adjustment for service quality) (see Figure A5 in Appendix C). However, the results change drastically when we take quality improvements into account. In this case, TFP contributes 0.36 percentage points to total output growth. Thus, inputs grow faster than the number of cases but slower than quality-adjusted hospital cases. Figure 2 shows how quality-based and unadjusted TFP evolved over time. Because hospital mortality increased in the 1960s and 1970s, quality-adjusted TFP rates declined more than unadjusted TFP until 1975. Afterwards, unadjusted TFP basically stagnates but quality-adjusted TFP starts to increase a great deal because hospital mortality decreased significantly. Including or excluding East Germany hardly changes any result (see Figure A1 in Appendix C). We use all discussed outputs, inputs, and TFP measures in our following regression analyses.

4 Identification strategy

We are interested in the effects of the health ministers' occupational background on hospital policy outcomes. As a major concern, nominating a doctor as health minister and hospital sector performance might be endogenous and bias the OLS results.[28] We therefore follow Xu (2018) among others and estimate a difference-in-differences model that allows us to take pre-treatment trends into account. Our treatment is the inauguration

[28]For example, Gehlbach et al. (2010) show a selection of election candidates in favor of businessmen where transparency is low and institutions are weak. Li et al. (2006) corroborate these findings and show that the probability of entering politics decreases when the institutional quality improves. Brändle and Stutzer (2016) and Hallerberg and Wehner (2018) discuss the selection of public servants and economists into politics.

of a physician-trained health minister. The main identifying assumption is that if a state would not have nominated a medical doctor as a health minister, hospital TFP would have evolved in the way of states that did not have a medical doctor as a health minister. The identifying assumption is credible when we observe parallel trends prior to the inauguration of a medical doctor as health minister. Because states nominate medical doctors as health ministers in different points of time, we cannot provide the conventional difference-in-differences trend plots. We conduct two different exercises instead. First, we test whether we can predict the nomination of medical doctors. Second, estimate event studies.

First, neither previous hospital TFP growth rates nor sociodemographic factors predict the probability of nominating a doctor as health minister. In our sample, we have 178 health ministers being in office from 1955 to 2017. However, for some ministers the inauguration took place in years for which we cannot observe pre-inauguration TFP rates. That applies to 14 ministers who took office prior to 1955 in West Germany or 1993 in East Germany, respectively. Thus, we code the remaining 164 selection decisions between 1955 and 2017 as a dummy variable (Doctor = 1, and 0 otherwise) which we regress on one-, two-, and three-year lagged TFP growth rates in a panel logit estimation. We include state fixed effects and control for potential confounding sociodemographic factors. Table A2 in Appendix C shows no significant correlation between previous productivity performance and the decision to nominate a doctor as health minister. The table presents marginal effects that are close to zero. Given the fact that the probability of nominating a medical doctor as minister is around 7%, the marginal effects have no substantial meaning in terms of the effect size. We can take this finding as evidence for parallel trends prior to the inauguration of a medical doctor as state health minister. Institutions back this finding because the nomination procedure of German state health ministers is quite complex. In only 10% of all cases is there a single-purpose health ministry without responsibilities in other policy fields.[29] As discussed in section 2.2, experts on social care or labor markets are at least as likely to become health ministers as experts on health care, since broadly-defined ministries also oversee other policy fields. Allocating the health ministry to one of up to four different coalition partners can also make a crucial difference. Therefore, predicting a certain candidate to become health minister is virtually impossible, particularly in the case of close political races. We will therefore employ close election outcomes as a robustness test.[30] Further sources of exogeneity are unexpected accidents, early elections, demission for reasons other than health care or changes of positions during the election term.[31]

Second, we estimate event studies as an extension of our difference-in-differences model. Recent studies have shown that conventional difference-in-differences models might lead to misleading summary estimates of treatment effects, when units receive treatment at different times and when the treatment effects vary strongly

[29] This share shrinks to only 5% when we exclude the city state of Hamburg.

[30] A substantial number of coalition governments rely on a single-seat margin in parliament, for example, Schleswig-Holstein (2012, left-wing government), Lower Saxony (2013, left-wing government), Thuringia (2014, left-wing government), North Rhine-Westphalia (2017, right-wing government), and Hesse (2018, Conservatives and Green party), to name only a few. In tight political races, parliamentary majorities arguably depend on exogenous events that drive the voting decision of the pivotal voter (Ferreira and Gyourko, 2009; Freier and Thomasius, 2016). For example, conservative parties benefit from rainfall on election day (Arnold and Freier, 2016) but may suffer from longer opening hours of polling stations (Potrafke and Roesel, 2020). These events are unlikely to correlate with TFP growth in hospital care. The more that majorities in parliaments become quasi-exogenous, the more that governments and certain (health) ministers can be considered randomly chosen as well.

[31] For example, in the state of Hesse, the medical doctor and health minister Horst Schmidt died in a car accident by 1976. He was followed by Armin Clauss, a civil servant.

over time. This can bias many of the timing comparisons (Abraham and Sun, 2018; Goodman-Bacon, 2018).[32] The results show that TFP does not differ among states before a medical doctor has been appointed as health minister, but afterwards. Since prior TFP growth does not predict the nomination of medical doctors as health ministers, we conclude that no substantial differences in pre-inauguration trends exist. Given that the common trend assumption seems to be credible, our difference-in-differences regression model estimated with OLS takes the following form:

$$\Delta ln\, TFP_{it} = \alpha_i + \delta_t + \gamma\, Doctor_{it} + \sum_j \theta_j\, Control_{jit} + \epsilon_{it} \quad (1)$$

$\Delta ln\, TFP_{it}$ denotes annual TFP growth rates in the hospital sector of German state $i = 1, ..., 15$ in year $t = 1955, ..., 2017$. We also use all inputs and outputs used to compute TFP as dependent variables in separate regressions. Our main explanatory variable of interest is $Doctor_{it}$, which takes on the value of one if the state health minister serving on February 1st in year t is a medical doctor and zero otherwise. $Control_{jit}$ represents j control variables, including further biographical attributes of the state health ministers, such as age, gender, educational attainment, and partisanship, as well as government, hospital market, and sociodemographic control variables.[33] However, including or excluding control variables do not change our results (see Table A3 in Appendix C). State fixed effects α_i and year fixed effects δ_t eliminate unobservable time-invariant heterogeneity across states and temporal shocks that affect all states simultaneously. ϵ_{it} is the error term, which is assumed to be normal. We cluster standard errors in all estimations at the level of health ministers.[34]

Later, we will replace the dummy variable $Doctor_{it}$ with a set of dummy variables that measure the first year (-1 year), the second and all other previous years (≤ -2 years) prior to inauguration of a physician-trained health minister, and the first year ($+1$ year), the second year ($+2$ years), the third and all further years ($\geq +3$ years) in the period of tenure of this minister, and a dummy variable for all years after handing over to a new health minister (*After*). The year of inauguration is labeled as +1, the year before inauguration is -1 and serves as base category. We have chosen this time span consciously, because the average tenure of medical doctors as health ministers is 3 years. Thus, for this setting, we will obtain the most precise point estimates compared to larger time spans in the post-inauguration period. This event study design will allow us to shed light on pre-inauguration trends and the timing of political actions after inauguration.[35]

[32]We estimate a model with multiple events per observational unit. Since the discussion on the optimal regression design in the case of multiple events is not yet settled, we follow the conventional approach to allow periods in cases of multiple events to be both pre- and post-treatment periods (see Lafortune et al. (2018)).

[33]To avoid any concerns regarding instationarity, we include all variables in growth rates; dummy variables are the exception. Table 1 shows descriptive statistics for all control variables. First, we control for government and political characteristics. A dummy for election years accounts for electoral cycles. The number of parties in office and a dummy for minority governments cover political fragmentation. We control for whether a ministry is a single-purpose health ministry or if the ministry also oversees labor affairs. Second, we account for changes in the hospital market. We include the growth rates of the number of beds per capita, hospitals per capita, and the length of stay. Furthermore, we control for the market shares of public and for-profit private hospitals (non-profit private hospitals operated by churches and charity organizations are the base category). Finally, we include sociodemographic controls that may predict hospital care: the growth rate of the total population, number unemployed per capita and population older than 65 years.

[34]Inferences do not change when we use robust standard errors (see section 5.2).

[35]A similar event study approach to explore the validity of the identifying assumption has been used by Liu and Mao (2019).

5 Results

5.1 Baseline

Table 2 presents our baseline difference-in-differences specification where we regress hospital input, output and TFP growth rates on a dummy variable for physician-trained health ministers (*Doctor*) and the full set of control variables.[36] We first start with input measures. Our estimates indicate that all labor and capital inputs increase under medical doctors serving as health minister. The largest point estimate is found for capital which health ministers can directly influence via capital spending. All effects for the inputs are statistically significant at the 5% level. Hospital outputs also tend to increase under physician-trained health ministers with very similar point estimates for quality-adjusted and unadjusted cases, but the effects are not statistically significant at any conventional level. Thus, effects of medical doctors in office are limited to the input side. Finally, we investigate total factor productivity. Our results in columns (6) and (7) show that hospital TFP growth rates decrease by 1.6 to 1.7 percentage points when a medical doctor takes the office of the health minister. The estimated decline in TPF growth is a relative decline compared to non-physician ministers. The results are statistically significant at the 1% level and hardly differ between quality-adjusted and unadjusted TFP rates. The effect amounts to approximately one third to one half of a standard deviation in TFP rates (see Table 1), which is economically substantial.

[Table 2 about here]

Event studies allow us to investigate the timing around the inauguration of a medical doctor as health minister in more detail. As described in section 4, we replace the dummy variable for doctors by a set of dummy variables for the years before and after inauguration. Because the inauguration year can already be characterized by political action, we choose the year before a doctor enters office as the reference year. We plot the resulting coefficients for TFP measures in Figure 3, event study plots for inputs and outputs are available online in Appendix C (see Figure A6). We find that years before entering office are slightly negative, but do not differ significantly from the reference year. Together with the findings of the exercise in Table A2 in Appendix C , i.e., predicting the nomination of a medical doctors with prior TFP rates, we conclude that this indicates no substantial differences in pre-inauguration trends. After a medical doctor enters office as health minister, TFP immediately slows down compared to the year before inauguration. We find also negative effects for the second as well as for the third and all other remaining tenure years of a physician-trained health minister. After handing over to a new health minister (*After*), TFP rates return to their initial levels observed two and more years ahead of the medical doctor in office (≤ -2). The only exception for statistically significant effects at the 10% level is the second year after inauguration when considering quality-adjusted TFP rates (lower panel of Figure 3). Effects are not precisely estimated for this coefficient. Figure A6 in Appendix C shows the corresponding event study plots for inputs and outputs. The main findings from the difference-indifferences point estimates in Table 2 coincide with the results in event studies. Labor volume of doctors and the capital stock increase after the inauguration of a physician-minister. A detailed discussion about the mechanisms will follow in section 6. Difference-in-differences as well as event study estimates consistently indicate that TFP growth

[36] In the interest of readability, we do not show all control variables here. Table A4 (Appendix C) reports full regression outputs.

slows down under physician-trained ministers. The effects become apparent in the first full year after inauguration and fade out afterwards. We observe no effects in the years after resignation. This lets us conclude that hospital productivity is adversely affected by medical doctors serving as health ministers, because during the tenure of office of physician-ministers, hospital inputs grow faster than outputs.

[Figure 3 about here]

5.2 Robustness

We submit our main results to several robustness tests which we present in Table 3. We use close election outcomes, take election term averages, limit the dataset to different subperiods and subsamples, control for other occupations than medical doctors, use different standard errors and different cut-off days. However, the main results are robust and inferences do not change. Including or excluding control variables also does not change any main results. We discuss all robustness tests in detail below.

[Table 3 about here]

First, we improve the counterfactual to physician-trained health ministers by using close election outcomes. As outlined in section 4, we use narrow left-wing and right-wing electoral victories. In these cases, parliamentary majorities are more or less a result of random events on the election day, for example, rainfall. When majorities are quasi-exogenous, the selection of a certain health minister can also be assumed to be quasi-random. Panels A, B, and C in Table 3 report the regression results when we use the same specification as in Table 2 but restrict our dataset to clear and narrow left-wing and right-wing majorities with a seat margin in parliament of bandwidths of $\pm$5.0, $\pm$7.5, and $\pm$10.0 percentage points around the 50% majority cut-off in parliamentary seats. The number of observations shrinks to approximately 35-55% of the full sample, but inferences do not change (except for capital); point estimates become even larger as we reduce the bandwidth.

Second, we experiment with subperiods. We average variables over health ministers, resulting in a sample with 178 observations. Panel D shows that the effects on TFP barely change when we use health minister averages: we find statistically significant increases in hospital inputs, reductions in TFP rates, and no statistically significant effect for outputs. Thus, using yearly data in the baseline specification does not inflate our results toward statistical significance. Third, we consider the subperiod from 1972 to 2017 and exclude the years 1955 to 1971. Since 1972 federal law explicitly defines the hospital care responsibilities (capacity planning and capital funding) of German state governments. When we estimate the model for the subperiod 1972 to 2017, we find robust profession effects for doctors (Panel E).

Third, we also limit our sample to different sets of German states. In Panel F, we include West German states only. The effects are now limited to labor inputs and productivity. This is well in line with the historical background. After the German reunification, East German health ministers were able to leverage hospital performance via expanded capital spending. In West Germany, by contrast, investment spending was lower and health ministers were limited to capacity planning and organization. In Panel G, we include states where at least one medical doctor served as health minister between 1955 and 2017. Thus, we exclude states without any within-state variation with regard to doctors as health ministers. This subsampling does also not change our baseline findings.

Fourth, we include further profession control variables for all medical occupations other than physicians (for example, nurses or pharmacists) which we label *Other health care* and a dummy for health ministers which might be "productivity-minded" from their business administration or economics studies (*Business/economics*). Panel H shows the results. Again, we find statistically significant effects for medical doctors.

Fifth, we vary some more technical properties of our estimations. In our main empirical specification, we cluster standard errors at the level of health ministers. The statistical inference of our main results for medical doctors does not change when we use Huber-White robust standard errors, except for capital (Panel I). We also modify the cut-off days for the selection of health ministers. Because health ministers usually change during the year, we choose February 1st as the cut-off day in our main specification. We assume that the health minister serving around this day is able to determine hospital policies for that particular year. The main results do not alter when January 1st (Panel J) or March 1st (Panel K) are used as cut-off days.

Finally, to rule out the possibility that a single minister drives the results, we exclude individual doctors from the dataset. Our panel comprises twelve different doctors serving as health ministers. We estimate our regression model for twelve different sets of doctors, each including only eleven ministers and excluding one doctor from the data set. The point estimates of *Doctor* for this robustness check are shown in Figure A7 (Appendix C). The profession effect of doctors on TFP growth rates remains statistically significant and stable. Thus, we can reason that the results are not driven by individual doctors. Including or excluding control variables does also not change any main result (see Table A3 in Appendix C).

Altogether, we challenge our main specification in multiple ways, but inferences regarding the effect of a medical doctor barely change. When we consider narrow electoral races where the nomination of a certain health minister is even more likely to be exogenous, we find larger effects than in our baseline model. We therefore postulate that our baseline results might be, if at all, downward biased and, consequently, represent the lower bound of the impact of medical doctors.

6 Mechanisms

We now turn to the underlying mechanisms of our findings to uncover how doctors use their powers as health ministers to influence hospital markets. The institutional setting of German hospital policy allows us to examine specific political instruments that can be adopted by health ministers. Health ministers cannot directly hire hospital staff. However, our findings on capital stocks suggest that health ministers use capacities to boost staffing in hospitals indirectly. Capital funding has substantial and long-lasting effects on hospital market structures (Chung et al., 2017). Medical doctors might be aware of the low elasticities of substitution between input factors in health care (Jensen and Morrisey, 1986; Cawley et al., 2006), and may use bed capacities and capital spending to trigger labor. We have already shown that physician-trained health ministers increase capital stocks significantly. Capital spending is the fastest and most direct way for governments to influence hospital markets in Germany. Accordingly, Figure A6 in Appendix C shows that capital increases immediately and to a statistically significant extent in the first full year after the inauguration of a medical doctor as health minister. Medical associations often take hospital capital expansion as a justification to pursue an increase in the number of employed doctors. In the summer of 2017, for example, the doctors and nurses of one of the oldest and largest hospitals in Europe, the *Charité* in Germany's capital of Berlin, were striking because a newly built operating facility did not come with increases in hospital staff.[37] The striking doctors and nurses expected the management to hire new employees. Thus, if health ministers would like to increase hospital staff in their state, they can increase capital spending, introduce new medical equipment and buildings, which in turn facilitate employment to increase.

Another way to expand capacities is to increase the number of hospital beds or to shift bed capacities toward labor-intensive hospital departments. We therefore investigate whether medical doctors serving as health ministers influence the bed capacities, extent, location and specialization of hospitals. We use growth rates of hospital beds in our difference-in-differences setting and plot point estimates of the *Doctor* coefficient in Figure 4.[38] We do not find notable evidence for a general expansion of hospital beds nor for increases in state-run university hospitals and any shift towards labor-intensive departments. Thus, the key trigger for more hospital staff is an increase in capital spending, which is a faster tool than capacity planning. Hospital capacity planning usually takes more time to be implemented and often requires some negotiations with the SHI and regional hospital associations. In contrast, capital funding can be changed rapidly. An example for a sudden increase in hospital capital spending is the state of North Rhine-Westphalia. In 2017, the health ministry of North Rhine-Westphalia increased the volume of hospital capital funds by around 50% from 530 to 780 million euro, compared to the scheduled amount in the state budget plan for that year. Hence, budgets are more flexible than hospital planning to change policies in the very short run.

[Figure 4 about here]

Any fast increase in capital capacities requires new fiscal scope for hospitals to hire additional hospital staff. Figure 4 shows that physician-trained health ministers seem to increase SHI funding as well. German state health ministers do not directly decide on current hospital spending but may affect state-administered prices for SHI reimbursement. Figure 4 shows that DRG prices tend to increase under physician-trained health ministers. Ministers might approve higher price levels negotiated by local hospital associations and SHI branches. Thus, physician-trained ministers allow fiscal capacities of hospitals to rise, which is also for the benefit of the hospital staff. In conclusion, medical doctors mainly use fiscal policies to increase hospital employment indirectly. First, they increase spending on hospital capital. Second, state-administered prices for SHI reimbursement tend to grow under physician-trained ministers which enables hospitals to hire more doctors and nurses.

We collect data on registered medical doctors employed in the inpatient sector (hospitals, rehab hospitals and nursing homes) and in the outpatient sector (medical practices, surgeries). Further disaggregation is not possible. The employment of doctors in the full inpatient sector increases under medical doctors as health

[37]"Nursing staff and doctors criticize the new operating facility as hazardous to health" (see, http://www.rbb24.de/politik/beitrag/2017/08/charite-streik-op-trakt-kritik.html, last accessed: January 9, 2017).

[38]Data is not available for the 1950s, 1960s, and early 1970s. We exclude hospitals controls from these models, since we use hospital inputs (beds, departments) as dependent variables.

ministers; the coefficient marginally lacks statistical significance. By contrast, the total number of doctors and of outpatient doctors do not change. The results well resemble the institutional setting in German health care. Although state health ministers have a strong impact on hospital policy, they do not have any influence on the outpatient sector.[39] Interestingly, the number of retired or inactive doctors decreases significantly. A conservative interpretation would be that avoiding early retirement could also play a role in the increase in hospital staff. This may also explain why we observe immediate effects already in the first full year after inauguration of a physician-trained health minister.

7 Patient and staff satisfaction

We have shown that medical doctors use fiscal policies to increase capital and labor inputs in hospital care, which reduces TFP growth. However, patients and hospital staff may well perceive additional resources as something good if hospital capital and labor had been at inefficiently low levels before. In order to illustrate potential effects of physician-trained health ministers on patients and hospital staff, we provide the following empirical exercise. The results do not necessarily have a causal interpretation but will give suggestive evidence on potential influences of these ministers on satisfaction measures. We are not able to provide objective optimal levels of staffing and capital. For the purpose of this paper, we are limited to revealed preferences such as patient and staff satisfaction that is available for the 2000s. We regress growth rates of patient satisfaction and three proxies for hospital staff satisfaction on the *Doctor* dummy variable and on TFP growth, respectively.[40] Table 4 shows the results. First, we use a state-level patient satisfaction score that results from a large and nationwide patient survey in Germany (Techniker Krankenkasse, 2010).[41] In column (1), we regress changes in patient satisfaction on the *Doctor* variable (Panel A) and TFP growth rates (Panel B). The point estimate in Panel B is close to zero, and standard errors are large. Thus, changes in TFP growth do not come with changes in patient satisfaction. When we regress changes in patient satisfaction on the *Doctor* dummy variable in Panel A, the effect is positive and clearly increases in size. However, this point estimate is also not statistically significant.

[Table 4 about here]

Second, we use data on hospital staff fluctuation, stratified by total hospital staff, and subsamples for doctors and nurses. Staff fluctuation describes the average of job entries and exits in the state hospital sector relative to the stock of hospital employees. We assume that fluctuation appropriately reflects job quality, workload, and satisfaction. Boyle et al. (1999), for example, show that, among nurses, job satisfaction predicts the intent to remain in a position. Therefore, states with a high level of stress in the hospital sector may exhibit higher fluctuation and retirement rates. If medical doctors enter office as health ministers and indirectly increase hospital employment, workloads may relax, and satisfaction among staff may increase. Patients may benefit from higher doctor-case ratios and more individual care and treatments. In columns (2) to (4) in Panel A, we estimate the effects of medical doctors as ministers on hospital staff fluctuation. Due to the limited sample size

[39] The organization and distribution of medical practices and surgeries in the German outpatient sector is incumbent on 17 different Regional Associations of Statutory Health Insurance Physicians.

[40] We further include year fixed effects and our sociodemographic control variables.

[41] More details on the patient satisfaction score are provided online in Appendix A.

and the fact, that we only have five physician-ministers in the 2000s, the point estimates are not significant in a statistical sense but are quite large in economic terms. Job fluctuations seem to reduce in years when a medical doctor is in office. In Panel B, we estimate the effects of TFP growth on hospital staff fluctuation. The point estimates in columns (2) to (4) are all positive. Averaging over nurses and doctors in column (2) however may hide significant differences across occupations. Fluctuation of nursing staff does not change significantly with changing TFP growth rates (column (4)). By contrast, job fluctuation of doctors is significantly associated with changes in TFP growth (column (3)): when TFP rates slow down as it is the case under physician-trained health ministers, job fluctuation of doctors decreases. This may indicate a higher job satisfaction. This result coincides with our finding in Figure 4 that more doctors seem to become active and/or delay early retirement, signaling higher job satisfaction. In particular, doctors seem to benefit from increasing hospital inputs under physician-trained health ministers.

8 Conclusion

We have shown that medical doctors serving as health ministers in German states differ from ministers of other professions. Physician-trained health ministers use their political power to increase hospital capacities and capital spending, which prompts hospitals to hire additional hospital staff, doctors in particular. As a result, productivity in the hospital sector slows down, because growth rates of hospital inputs, i.e., labor and capital, increase more than the output, i.e., treated cases. Comprehensive analyses of mechanisms that can be adopted by ministers clearly show that medical doctors serving as health ministers use fiscal policies to improve the financial situation of hospitals. This finding can be interpreted as a correction of an underfunding of German hospitals that is still at political debate. When non-physician ministers neglect a sufficient funding level of hospitals, physician-ministers can use their political competences for an increase in capital endowments. Another interpretation is that medical doctors may simply try to improve the working situation of medical and nursing professionals when they become health ministers. Even though the results can be interpreted this way or the other, we conclude that mainly the medical professions benefit from medical doctors in office.

Whether policies implemented by physician-trained health ministers increase or decrease general economic welfare is a question we have to leave for further research. Additional staff is costly but may help to lift pressure on hospital employees and reduce burn-out rates. Additional resources provided by physician-trained ministers may also reduce underfunding and can enhance global efficiency in the long run. Thus, we document clear improvements for the medical profession, but also the public may benefit. Conventional productivity measures need some refinement and future studies may incorporate stakeholder interests more explicitly to avoid that short-term productivity gains in health care may come at the expense of the health of employees and patients in the long run.

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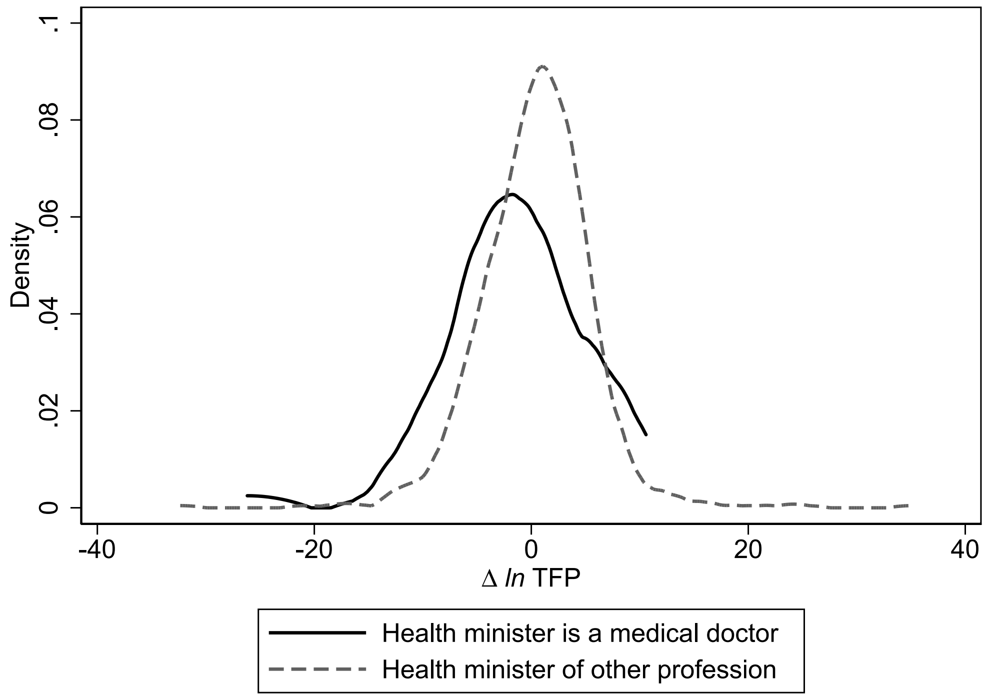
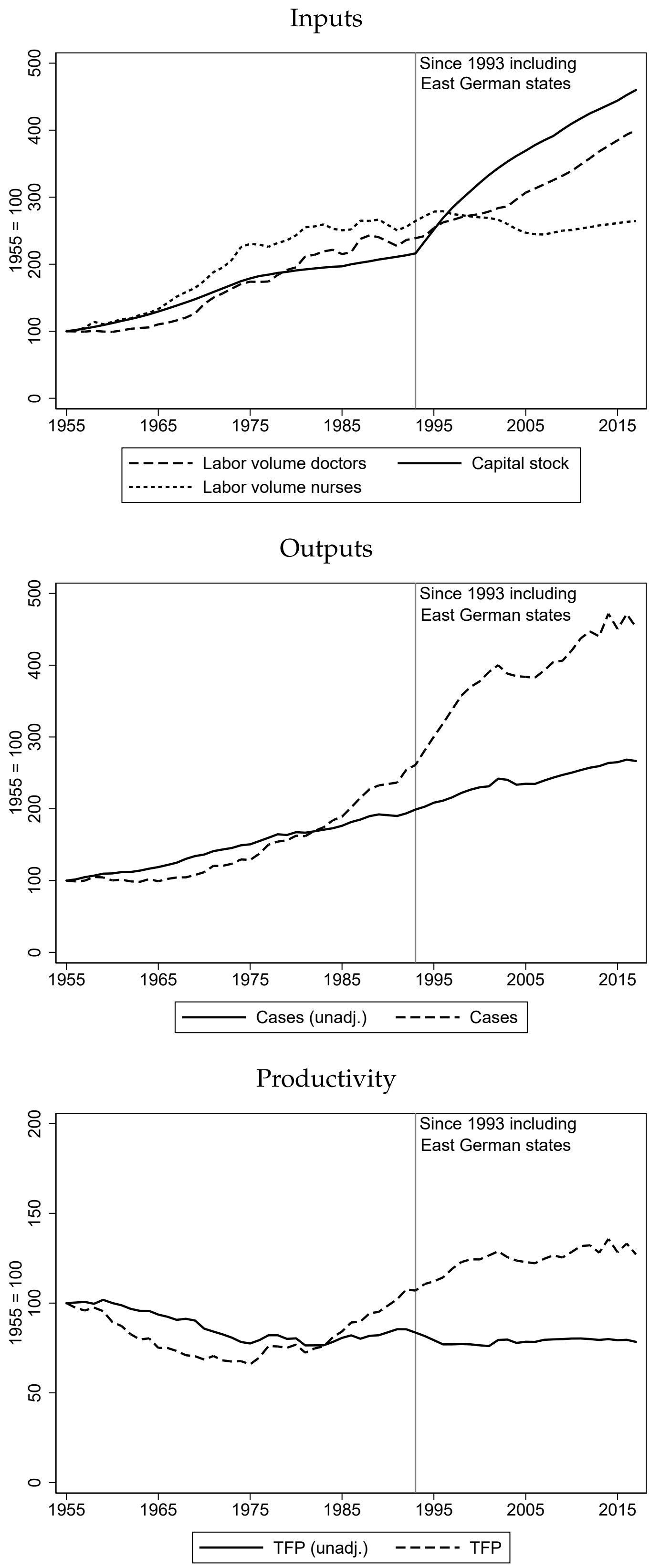
Figure 1: Hospital TFP growth rates under physician-trained health ministers



Notes: The figure shows the Kernel density of hospital sector TFP growth rates by the profession of the state health minister. The units of observation are 10 West German states over the period 1955 to 2017 and 5 East German states over the period 1993 to 2017.

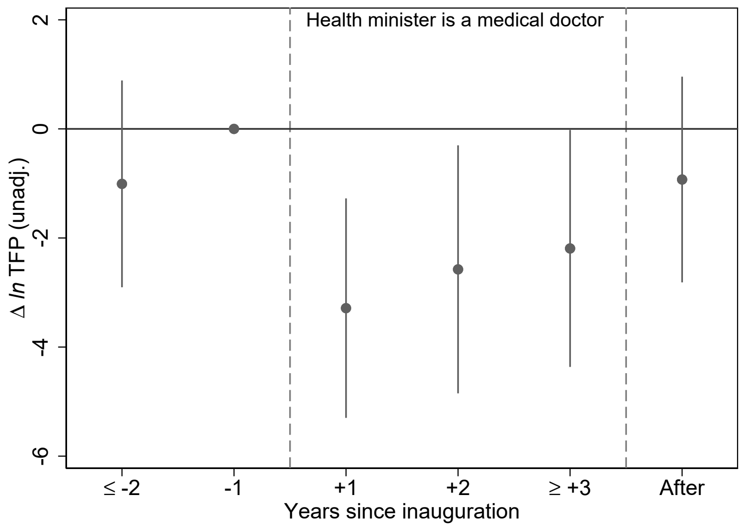
Figure 2: Productivity in German hospital care



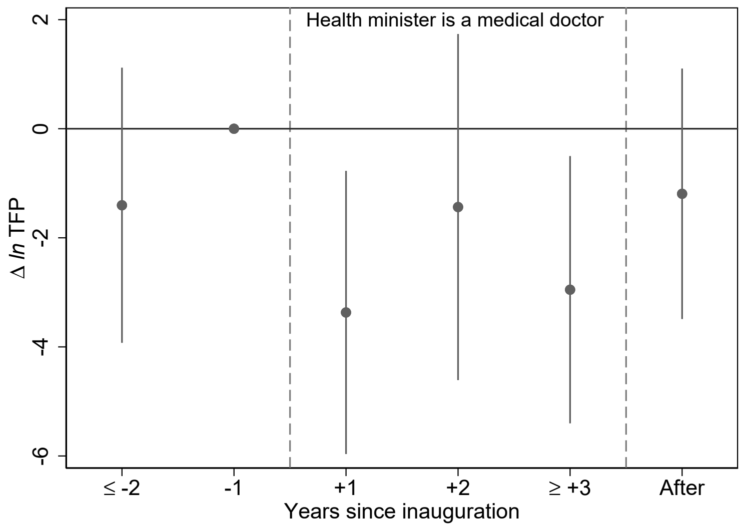
Notes: The figures show hospital inputs, outputs, and TFP growth in German hospital care. 1955 is set to 100; indices increase with average growth rates. The units of observation are 10 West German states over the period 1955 to 2017 and 5 East German states over the period 1993 to 2017. The vertical dashed line represents the year 1993 when data for East Germany are available. Labor volume in annual total working hours. Capital stock in 2017 euros. Cases account for quality improvements proxied with in-hospital mortality. Figure A1 in Appendix C shows graphs for West German states only.

Figure 3: Event studies

TFP (unadj.)

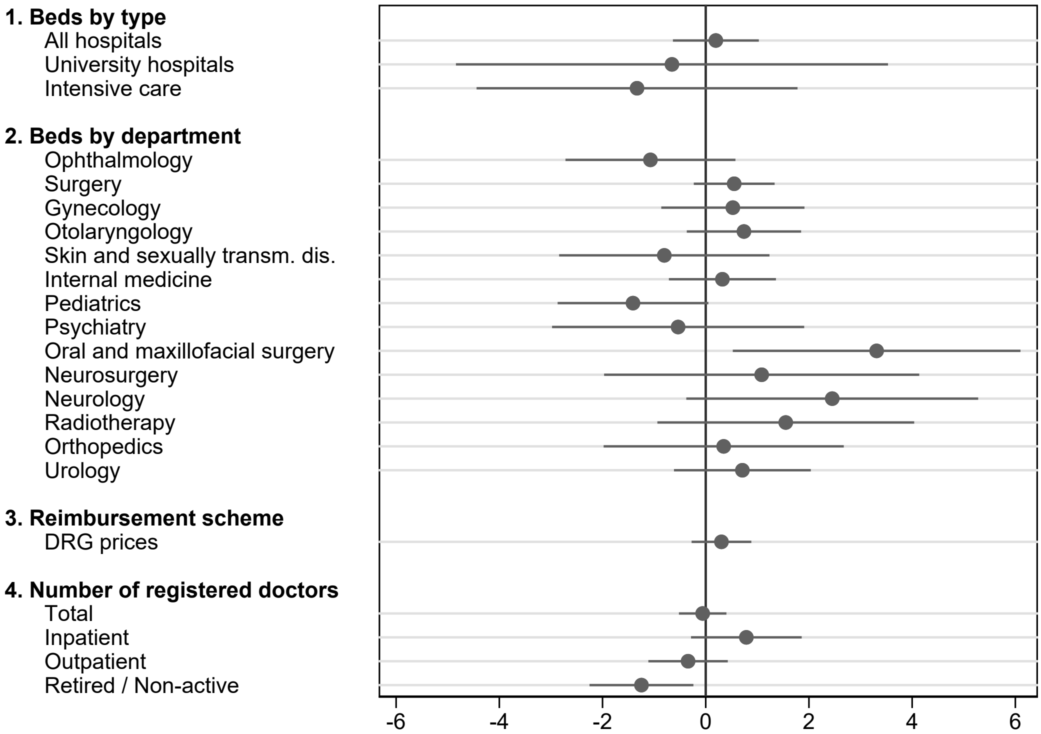


TFP



Notes: Event studies show TFP growth effects for the years before and after the inauguration of a medical doctors as health minister. The year of inauguration is labeled as +1, the year before inauguration is -1 and serves as base category. Solid vertical lines represent the 90% confidence interval. Dashed vertical lines bracket the years of a physician-trained health minister. Standard errors are clustered at the health minister level.

Figure 4: Other mechanisms



Notes: The figure plots the effects of an medical doctor serving as health minister on bed capacities, the number of registered doctors, and DRG prices for the SHI (each in growth rates). Point estimates are from separate regressions. Specifications correspond with the baseline model in Table 2, and include year and state fixed effects, minister controls, government controls and sociodemographic controls. The samples include the years 1975 to 2017 (panels 1 and 2), 2005 to 2017 (panel 3), and 1980 to 2017 (panel 4) for which data are available. Horizontal lines represent confidence the 90% confidence interval. Standard errors are clustered at the health minister level.

Table 1: Descriptive statistics

	Full sample				Doctor = 1	Doctor = 0
	Mean (1)	**SD (2)**	**Min (3)**	**Max (4)**	**Mean (5)**	**Mean (6)**
Inputs						
Δln Volume of doctors	2.197	4.462	-35.917	45.374	2.820	2.151
Δln Volume of nurses	1.459	4.496	-28.039	31.940	1.823	1.432
Δln Capital stock	2.809	4.502	-2.912	39.405	5.155	2.637
Outputs						
Δln Cases (unadj.)	1.570	1.762	-8.607	9.829	1.302	1.590
Δln Cases	2.420	4.477	-15.209	21.559	1.949	2.454
Productivity						
Δln TFP (unadj.)	-0.401	3.358	-23.297	23.125	-1.916	-0.290
Δln TFP	0.363	5.343	-32.357	35.195	-1.392	0.492
Minister controls						
Doctor	0.068	0.253	0	1	1	0
Right-wing	0.443	0.497	0	1	0.804	0.416
Local	0.467	0.499	0	1	0.314	0.478
Female	0.393	0.489	0	1	0.569	0.380
Age	51.919	7.536	33.389	70.293	54.986	51.693
Tenure	3.203	2.779	0.003	17.167	3.030	3.215
Vocational degree	0.286	0.452	0	1	0	0.307
University degree	0.413	0.493	0	1	0.059	0.439
PhD	0.268	0.443	0	1	0.941	0.219
PM party affiliation	0.807	0.395	0	1	0.745	0.811
Government controls						
Election year	0.236	0.425	0	1	0.255	0.235
Parties in government	1.772	0.669	1	4	1.980	1.756
Minority government	0.027	0.162	0	1	0	0.029
Ministry for health only	0.102	0.303	0	1	0.137	0.099
Ministry of labor	0.647	0.478	0	1	0.686	0.644
Hospital market controls						
Δln Beds per capita	-0.559	2.334	-19.126	14.989	-1.350	-0.501
Δln Hospitals per capita	-0.914	2.703	-10.713	24.827	-1.301	-0.886
Δln Length of stay	-2.088	2.064	-12.113	12.745	-2.416	-2.064
Public hospital beds (in %)	0.573	0.155	0.097	0.879	0.619	0.570
For-profit hospital beds (in %)	0.100	0.113	0.000	0.565	0.114	0.099
Sociodemographic controls						
Δln Population	0.182	0.828	-3.896	3.219	0.047	0.192
Δln Unemployed per capita	-0.018	27.161	-112.577	130.851	2.677	-0.216
Δln Population aged 65+	1.395	1.398	-2.579	5.425	1.218	1.408
Observations	745				51	694

Notes: The table shows the descriptive statistics of our data set. We observe 10 West German states over the period 1955 to 2017, and 5 East German states over the period 1993 to 2017. The year 1990 is excluded because hospital statistics were entirely revised in the course of reunification. For details on data sources and computation, see Appendix A.

Table 2: Baseline results

	Δln **Doctors**	Δln **Nurses**	Δln **Capital**	Δln **Cases (unadj.)**	Δln **Cases**	Δln **TFP (unadj.)**	Δln **TFP**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Doctor	1.412**	0.876**	2.157**	0.120	0.170	-1.718***	-1.582***
	(0.693)	(0.409)	(1.067)	(0.217)	(0.446)	(0.503)	(0.599)
Observations	745	745	745	745	745	745	745
R^2 (within)	0.307	0.460	0.441	0.663	0.629	0.410	0.505
Mean dependent variable	2.197	1.459	2.809	1.570	2.420	-0.401	0.363
Minister controls	×	×	×	×	×	×	×
Government controls	×	×	×	×	×	×	×
Hospital market controls	×	×	×	×	×	×	×
Sociodemographic controls	×	×	×	×	×	×	×
State fixed effects	×	×	×	×	×	×	×
Year fixed effects	×	×	×	×	×	×	×

Notes: The table shows the results of panel regressions using different hospital input, output, and productivity measures in growth rates as dependent variables. The units of observation are 10 West German states over the period 1955 to 2017 and 5 East German states over the period 1993 to 2017. Estimations include a full set of control variables (not reported here, see Table A4 in Appendix C). Standard errors in parentheses are clustered at the health minister level. * p<0.1, ** p<0.05, *** p<0.01

Table 3: Robustness

	Δln **Doctors**	Δln **Nurses**	Δln **Capital**	Δln **Cases (unadj.)**	Δln **Cases**	Δln **TFP (unadj.)**	Δln **TFP**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Panel A: Narrow parliamentary majority with ±5.0 percentage point window							
Doctor	10.633**	6.770**	0.887	0.665	0.685	-6.053***	-7.989***
	(4.093)	(2.993)	(0.588)	(0.467)	(0.966)	(1.901)	(2.867)
Observations	263	263	263	263	263	263	263
R^2 (within)	0.438	0.501	0.678	0.792	0.751	0.545	0.563
Mean dependent variable	2.213	1.172	1.615	1.404	2.487	-0.043	0.966
Panel B: Narrow parliamentary majority with ±7.5 percentage point window							
Doctor	3.925**	2.485**	1.216	0.067	-0.124	-2.666***	-3.079***
	(1.639)	(1.062)	(0.741)	(0.283)	(0.607)	(0.779)	(1.142)
Observations	337	337	337	337	337	337	337
R^2 (within)	0.379	0.461	0.584	0.745	0.693	0.481	0.515
Mean dependent variable	2.272	1.184	1.770	1.442	2.420	-0.009	0.878
Panel C: Narrow parliamentary majority with ±10.0 percentage point window							
Doctor	2.932**	1.591**	1.464	0.181	0.541	-2.002***	-1.662*
	(1.150)	(0.765)	(0.927)	(0.241)	(0.589)	(0.600)	(0.971)
Observations	413	413	413	413	413	413	413
R^2 (within)	0.368	0.458	0.328	0.714	0.682	0.463	0.528
Mean dependent variable	2.312	1.213	2.275	1.478	2.560	-0.181	0.843
Panel D: Health minister averages							
Doctor	1.960**	1.738**	3.997***	0.306	0.227	-2.589***	-2.244**
	(0.915)	(0.815)	(1.466)	(0.385)	(0.864)	(0.815)	(1.021)
Observations	178	178	178	178	178	178	178
R^2 (within)	0.349	0.489	0.665	0.529	0.597	0.477	0.522
Mean dependent variable	1.845	1.166	2.909	1.516	2.411	-0.267	0.550
Panel E: Years 1972-2017							
Doctor	1.673**	0.833*	2.768**	0.263	0.301	-1.807***	-1.661**
	(0.679)	(0.452)	(1.129)	(0.206)	(0.484)	(0.525)	(0.664)
Observations	575	575	575	575	575	575	575
R^2 (within)	0.262	0.370	0.479	0.731	0.685	0.421	0.503
Mean dependent variable	2.150	0.586	2.800	1.389	2.845	-0.197	1.169
Panel F: West German states only							
Doctor	1.670**	1.083**	0.043	-0.084	-0.140	-1.206**	-1.339**
	(0.781)	(0.471)	(0.368)	(0.174)	(0.401)	(0.469)	(0.610)
Observations	620	620	620	620	620	620	620
R^2 (within)	0.310	0.470	0.564	0.676	0.617	0.427	0.515
Mean dependent variable	2.227	1.761	1.707	1.639	2.349	-0.094	0.490
Panel G: Excluding states that never had a medical doctors as health minister							
Doctor	1.865*	1.216*	3.795***	0.270	-0.076	-2.240***	-2.390***
	(0.992)	(0.687)	(1.164)	(0.264)	(0.606)	(0.690)	(0.791)
Observations	447	447	447	447	447	447	447
R^2 (within)	0.357	0.454	0.500	0.665	0.617	0.458	0.505
Mean dependent variable	2.178	1.340	2.960	1.509	2.369	-0.467	0.214

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... Table 3 continued

	Δln **Doctors**	Δln **Nurses**	Δln **Capital**	Δln **Cases (unadj.)**	Δln **Cases**	Δln **TFP (unadj.)**	Δln **TFP**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Panel H: With other occupations							
Doctor	1.315*	0.789**	1.994*	0.067	0.026	-1.618***	-1.558**
	(0.670)	(0.394)	(1.100)	(0.219)	(0.440)	(0.507)	(0.603)
Others health care	0.136	-0.190	-0.054	-0.193	-0.471*	0.057	-0.125
	(0.355)	(0.278)	(0.820)	(0.131)	(0.277)	(0.338)	(0.347)
Business/Economics	-0.549*	-0.283	-0.738	-0.124	-0.370	0.435	0.193
	(0.330)	(0.298)	(0.507)	(0.117)	(0.240)	(0.279)	(0.357)
Observations	745	745	745	745	745	745	745
R^2 (within)	0.309	0.461	0.445	0.664	0.630	0.412	0.505
Mean dependent variable	2.197	1.459	2.809	1.570	2.420	-0.401	0.363
Panel I: Robust standard errors (Huber-White)							
Doctor	1.412*	0.876**	2.157	0.120	0.170	-1.718***	-1.582**
	(0.778)	(0.372)	(1.232)	(0.171)	(0.385)	(0.492)	(0.642)
Observations	745	745	745	745	745	745	745
R^2 (within)	0.307	0.460	0.441	0.663	0.629	0.410	0.505
Mean dependent variable	2.197	1.459	2.809	1.570	2.420	-0.401	0.363
Panel J: January 1st as cut-off day							
Doctor	1.404**	0.915**	2.145**	0.128	0.223	-1.736***	-1.535**
	(0.703)	(0.427)	(1.072)	(0.212)	(0.442)	(0.508)	(0.597)
Observations	745	745	745	745	745	745	745
R^2 (within)	0.305	0.461	0.441	0.663	0.628	0.410	0.503
Mean dependent variable	2.197	1.459	2.809	1.570	2.420	-0.401	0.363
Panel K: March 1st as cut-off day							
Doctor	1.523**	0.867**	2.197**	0.132	0.234	-1.712***	-1.551***
	(0.705)	(0.407)	(1.051)	(0.213)	(0.441)	(0.504)	(0.592)
Observations	745	745	745	745	745	745	745
R^2 (within)	0.309	0.460	0.444	0.663	0.629	0.411	0.505
Mean dependent variable	2.197	1.459	2.809	1.570	2.420	-0.401	0.363
Additional control variables in all panels							
Minister controls	×	×	×	×	×	×	×
Government controls	×	×	×	×	×	×	×
Hospital market controls	×	×	×	×	×	×	×
Sociodemographic controls	×	×	×	×	×	×	×
State fixed effects	×	×	×	×	×	×	×
Year fixed effects	×	×	×	×	×	×	×

Notes: The table shows the results of panel regressions using different hospital input, output, and productivity measures in growth rates as dependent variables. The units of observation are 10 West German states over the period 1955 to 2017 and 5 East German states over the period 1993 to 2017 if not defined otherwise. Panels A to C refer to close political races, with each model estimated for a defined bandwidth near the 50% threshold of a left-wing majority in state parliaments. In Panel D, we estimate the model with averages of all variables over health ministers. In Panel E, we restrict the sample to years after 1972 when the federal hospital financing act explicitly defines responsibilities of the federal states in hospital care. In Panel F, we include West German states only. In Panel G, we exclude federal states that never had a medical doctor as health minister. In Panel H, we include further professions in the regression model. In Panel I, we use Huber-White robust standard errors. In Panels J and K, we use other cut-off days than February 1st. Estimations in all panels include a full set of control variables (see, for example, Table A4 in Appendix C); only in Panel D, the model is estimated without year dummies. Standard errors in parentheses are clustered at the health minister level, except in Panel I. * p<0.1, ** p<0.05, *** p<0.01

Table 4: Patient and staff satisfaction

	Δln **Patient satisfaction**	Δln **Job fluctuation of hospital staff** **General staff**	**Doctors**	**Nurses**
	(1)	**(2)**	**(3)**	**(4)**
Panel A				
Doctor	0.158	-5.697	-2.767	-4.408
	(0.284)	(6.852)	(4.440)	(7.586)
Observations	133	225	225	225
States	15	15	15	15
R^2 (within)	0.198	0.126	0.139	0.110
Mean dependent variable	0.283	-1.704	-0.766	-0.891
Sociodemographic controls	×	×	×	×
Year fixed effects	×	×	×	×
Panel B				
Δln TFP	0.004	0.179	0.476*	0.059
	(0.072)	(0.310)	(0.249)	(0.363)
Observations	133	225	225	225
States	15	15	15	15
R^2 (within)	0.197	0.123	0.142	0.108
Mean dependent variable	0.283	-1.704	-0.766	-0.891
Sociodemographic controls	×	×	×	×
Year fixed effects	×	×	×	×

Notes: The table reports the results of panel estimations where measures for patient and staff satisfaction (job fluctuation) in growth rates serve as dependent variables. The units of observation are 10 West German states and 5 East German states. The sample is restricted to the years 2007 to 2015 (patient satisfaction) and 2003 to 2017 (job satisfaction), respectively, due to data availability. Total hospital staff fluctuation describes the average of job entries and exits in the state hospital sector relative to the stock of hospital employees (column (2)). The same holds for the fluctuation of doctors and nurses (columns (3) and (4)). Standard errors in parentheses are clustered at health minister level. * p<0.1, ** p<0.05, *** p<0.01

Appendix A: Data computation

We have digitized numerous hardcover copies of German hospital statistics and annual yearbooks and have computed our data as follows.

Output

The output y_t in period t is the number of inpatient cases which is the "raw" output volume d_t. In order to adjust this numbers by quality improvements, we divide the "raw" number of inpatient cases by a quality index q_t. The quality index is the in-hospital mortality, given by the ratio of decease in hospitals over total hospital discharges. Hence, $y_t = q_t d_t^{-1}$. In-hospital mortality comes from German Federal Statistical Office (1960, 1976, 1991, 2018a).

Labor

Numbers of full-time equivalents (FTE) and employees by occupational group are obtained from German Federal Statistical Office (1960, 1976, 1991, 2018a). FTEs are translated into the volume of annual working hours. A FTE in 2017 is not comparable with a FTE in the 1950s, since standard weekly hours of work changed significantly during six decades and differed between groups of employees. Doctors employed in hospitals had to work 60 hours per week in 1953, 46 hours in 1970 and about 40 hours in 2017, while other employee groups had to work less in prior decades (1950s:$\sim$ 50 hours/week; 2017:$\sim$40 hours/week). We calculate the labor volume measured as the sum of annual working hours separately for employed doctors and nurses, by multiplying the number of FTEs with the average annual working hours in the corresponding year (Berié, 1999; Jorzig and Uphoff, 2010; Simon, 2013; Marburger Bund, 2015; Institut Arbeit und Qualifikation der Universität Duisburg-Essen, 2016).

Capital

We use a simplified version of the Perpetual Inventory Method for measuring capital (Schreyer, 2009; Schmalwasser and Schidlowski, 2006). We calculate the capital stock K_t as the sum of the survived investments (in real terms) of all prior periods $\tau < t$. Hence, K_t can be expressed as

$$K_t = \sum_{\tau=1}^{t-1} I_\tau \times (1 - F(\tau)). \tag{1}$$

Based on several studies examining German hospitals, we assume an average service life of 20 years of the overall "hospital capital good mix". Recent studies show that the mean of the annual depreciation rate of the "hospital capital good mix" is slightly above 5% (Augurzky et al., 2016, 2017). This number is confirmed another study that reveals a linear depreciation rate of approximately 5% (Krankenhausgesellschaft and Senatsverwaltung für Gesundheit, 2011). We define:

$$F(\tau) = \begin{cases} \int f(\tau) \\ 0 \text{ if } \int f(\tau) < 0.05 \end{cases} \tag{2}$$

with

$$f(t) = 9^9 (8!)^{-1} 20^{-9} t^8 e^{(-\frac{9t}{20})}. \tag{3}$$

The mortality function of capital goods of an average life of 20 years is given by the term $f(t)$. The integral of the mortality function yields the share of retired goods of a cohort. We define a break condition if the share of survived goods falls below 1%.

We compute long-term investment series (1900-2017) for all German states. Total investment consists of the following four sources: (i) capital funds for hospitals that are included in a state's hospital plan and therefore eligible for funds, (ii) investment spending of university hospitals and (iii) own-funded hospital investment spending. For West (East) German states, we have information on capital funds after 1972 (1993) (Arbeitsgemeinschaft der Obersten Landesgesundheitsbehörden, 2018; Deutsche Krankenhausgesellschaft, 2017). For prior data on hospital capital expenditures, pubic health care funding and subsidies we resort to historic and parliamentarian publications: Andic and Veverka (1963), Deutscher Bundestag (1969), Rothenbacher (1982), Leineweber (1988), Ritschl and Spoerer (1997). For East German states historical data on hospital capital stocks and capital funding in the former socialist German Democratic Republic were obtained in Arnold and Schirmer (1990), Institut für angewandte Wirtschaftsforschung (1990) and Schwarzer (1999).

Based on this rich set of information, we calculate a publicly financed capital stock of German hospitals. Additionally, we have to take into account a share of own-funded investments by hospitals due to a decreasing level of state-financed subsidies for capital expenditures (due to binding budget constraints). Thus, we assume own-funded investments to be zero up to 1985 with a rising level up to 2017, achieving the level of the own-funded capital expenditures measured by Augurzky et al. (2017).

We express all monetary values in 2017 euros using the official German price index for capital goods (German Federal Statistical Office, 2018b).

Minister and government controls

Biographies of ministers and information on governments are obtained from publicly available sources such as government and parliament websites and handbooks.

Hospital markets

Data on hospital markets are from digitized hard-cover copies of official publications (German Federal Statistical Office, 1960, 1976, 1991, 2018a).

Sociodemographics

Sociodemographic state characteristics were obtained from the annually published Statistical Yearbooks of the Federal Republic of Germany (German Federal Statistical Office, 2018c) and Statistical Yearbooks of some federal states (Statistisches Amt des Saarlandes, 1958).

DRG prices

DRG prices (base rates) at state level for 2005 to 2017 are obtained from Verband der Ersatzkassen e. V. (vdek) (2019).

Registered doctors

We obtained the number of registered medical doctors for the years 1979 to 2017 from German Medical Association (2018). The data cover information on doctors employed in the inpatient sector (hospitals, rehab hospitals and nursing homes), the outpatient sector (medical practices, surgeries), and those who are retired or inactive (e.g. in parental leave).

Patient satisfaction

Starting from 2006, a large public German health insurer, *Techniker Krankenkasse* (TK), has (bi-)annually surveyed its enrollees about their experiences with the care they received during their last hospital visit (Techniker Krankenkasse, 2010). Techniker Krankenkasse, founded in 1884, is one of Germany's largest social health insurance funds with a market share of about 14%, or 10 million enrollees (as of 2018). The questionnaires are sent to a random sample of enrollees, with exceptions for individuals older than 80 years or in need of long-term care. For each hospital between 150 and 1,000 patients were asked to participate in the survey. The response rates were quite high.[1] For our analysis we average patient satisfaction scores at state level.

Job fluctuation

Federal Employment Agency (2018b) provides data on the stock of hospital employees at state level for the years 2003 to 2017. Hospital staff fluctuation, i.e. job entries and exits, in the state hospital sector were obtained from Federal Employment Agency (2018a). All data are stratified by general hospital staff, doctors and nurses.

[1]For example, in 2010 more than 61% of surveyed patients responded (Pilny and Mennicken, 2014). However, the results were only reported when at least 60 questionnaires were fully completed. In 2015, 1,138 hospitals were able to comply with the requirements.

Quality indicators

We use clinical quality indicators from publicly available quality report cards, which all hospitals are by law required to provide. Since 2006, hospitals that are included in a state hospital plan are legally obliged to publish standardized quality report cards. Hospitals not included in a state hospital plan are allowed to contract with the social health insurance (SHI), in which case they are also legally obliged to publish quality report cards. Together these hospitals comprise about 90 percent of all hospitals and 99 percent of all bed capacities in the German hospital market. Quality report cards are obtained from Federal Joint Committee (2017).

The quality report cards include detailed information on procedures performed for each hospital. One important aspect of the quality data is that it is reported biannually from 2006 to 2012, and after 2013 annually. Since the definitions of some quality indicators changed over time and the fact that some quality indicators had been published at first in later years, we have chosen the following indicators with the highest availability over all years. All indicators were averaged on state level and year for our analysis. For consistency and ease of interpretation, these quality indicators in our empirical analysis are defined that a more positive value of the indicator always corresponds to worse quality. This interpretation coincides with our quality-adjustment measure used in the main analysis, i.e. hospital mortality.

List of clinical quality indicators:

(1) Reinterventions due to complications during knee endoprostheses (first implantation)

(2) Reinterventions due to complications during knee endoprostheses (change of endoprostheses or components)

(3) Reinterventions due to complications during hip endoprostheses (first implantation)

(4) Reinterventions due to complications during hip endoprostheses (change of endoprostheses or components)

(5) Postoperative wound infections after hip endoprostheses

(6) Dislocation of endoprostheses

(7) Perioperative complications after pacemaker implantation

(8) Reinterventions due to complications after laparoscopic surgery

(9) Hospital mortality rate of patients with a percutaneous coronary intervention

(10) Reinterventions due to complications after femoral fracture

(11) Postoperative wound infections after femoral fracture

(12) Hospital mortality rate of femoral fracture patients (ASA risk classification 1 or 2)

(13) Hospital mortality rate of femoral fracture patients (ASA risk classification 3)

(14) Hospital mortality rate of femoral fracture patients after endoprosthetic treatment

(15) Hospital mortality rate of femoral fracture patients after osteosynthetic treatment

(16) Hospital mortality rate of patients with community-acquired pneumonia (risk classification 1)

(17) Hospital mortality rate of patients with community-acquired pneumonia (risk classification 2)

(18) Hospital mortality rate of patients with community-acquired pneumonia (risk classification 3)

Appendix B: Computing TFP growth rates

In order to compute long-term TFP growth, we rely on the Malmquist approach. To validate the robustness of our TFP measures, we also calculate TFP growth with the Törnqvist approach which is equivalent to the growth decomposition framework developed by Solow (1956, 1957).

Malmquist

Following Färe et al. (1994), we employ the Malmquist approach as follows. Let S_t be a production technology transforming inputs x_t into outputs y_t at a certain point of time t. A distance function D for the production technology in t and the input-output combination (x_t, y_t) is given as follows:

$$D_t(x_t, y_t) = \inf\left\{\theta : \left(x_t, \frac{y_t}{\theta}\right) \in S_t\right\} \tag{4}$$

The output-oriented Malmquist index M in period t can be defined as the ratio of two distance functions measuring the maximal proportional change of the input-output combination of the previous period (x_{t-1}, y_{t-1}) (denominator) and of the current period (x_t, y_t) (numerator), holding the production technology of a certain point of time, here t, constant:

$$M_t(x_t, y_t, x_{t-1}, y_{t-1}) = \frac{D_t(x_t, y_t)}{D_t(x_{t-1}, y_{t-1})} \tag{5}$$

The Malmquist TFP (MQ_t) is the geometric mean of two separately calculated Malmquist indices for the production technology in period $t-1$ and t:

$$MQ_t(x_t, y_t, x_{t-1}, y_{t-1}) = \left[\left(\frac{D_{t-1}(x_t, y_t)}{D_{t-1}(x_{t-1}, y_{t-1})}\right)\left(\frac{D_t(x_t, y_t)}{D_t(x_{t-1}, y_{t-1})}\right)\right]^{0.5} \tag{6}$$

Törnqvist

The non-frontier index concept of Törnqvist (1936) can be derived as a special case of the Malmquist index (Färe et al., 1994) and is roughly equivalent to the growth-accounting framework of Solow (1957). Following again (Färe et al., 1994), we assume a production function of the Cobb-Douglas type:

$$y_t = A_t \prod_{n=1}^{N} (x_{n,t})^{\alpha_{n,t}} \tag{7}$$

with $a_n > 0$, $\sum_{n=1}^{N} \alpha_{n,t} = 1$, and where y_t gives the output and $x_{n,t}$ input n in period t. $\alpha_{n,t}$ defines the production elasticity of input n and equals its marginal product under strict neoclassical assumptions. A_t is the efficiency parameter of the technology. Substituting y_t in equation 4 by equation 7 yields the distance function:

$$D_t(x_t, y_t) = \inf\left\{\theta : \left(\frac{y_t}{\theta}\right) \leq A_t \prod_{n=1}^{N} (x_{n,t})^{\alpha_{n,t}}\right\} = \frac{y_t}{A_t \prod_{n=1}^{N} (x_{n,t})^{\alpha_{n,t}}} \tag{8}$$

which gives (insert Equation 7 into 6):

$$TQ_t(x_t, y_t, x_{t-1}, y_{t-1}) = \left(\frac{y_t}{\prod_{n=1}^{N} (x_{n,t})^{\alpha_{n,t}}}\right)\left(\frac{\prod_{n=1}^{N} (x_{n,t-1})^{\alpha_{n,t-1}}}{y_{t-1}}\right) = \frac{A_t}{A_{t-1}} \tag{9}$$

Now, the Törnqvist TFP can also be computed by logarithmic transformation. Following the growth decomposition framework of Solow (1957), we write the Törnqvist TFP as the difference of (logarithmic computed) output growth rates and cost share-weighted input growth rates. The result is identical to the time derivation of equation 7:

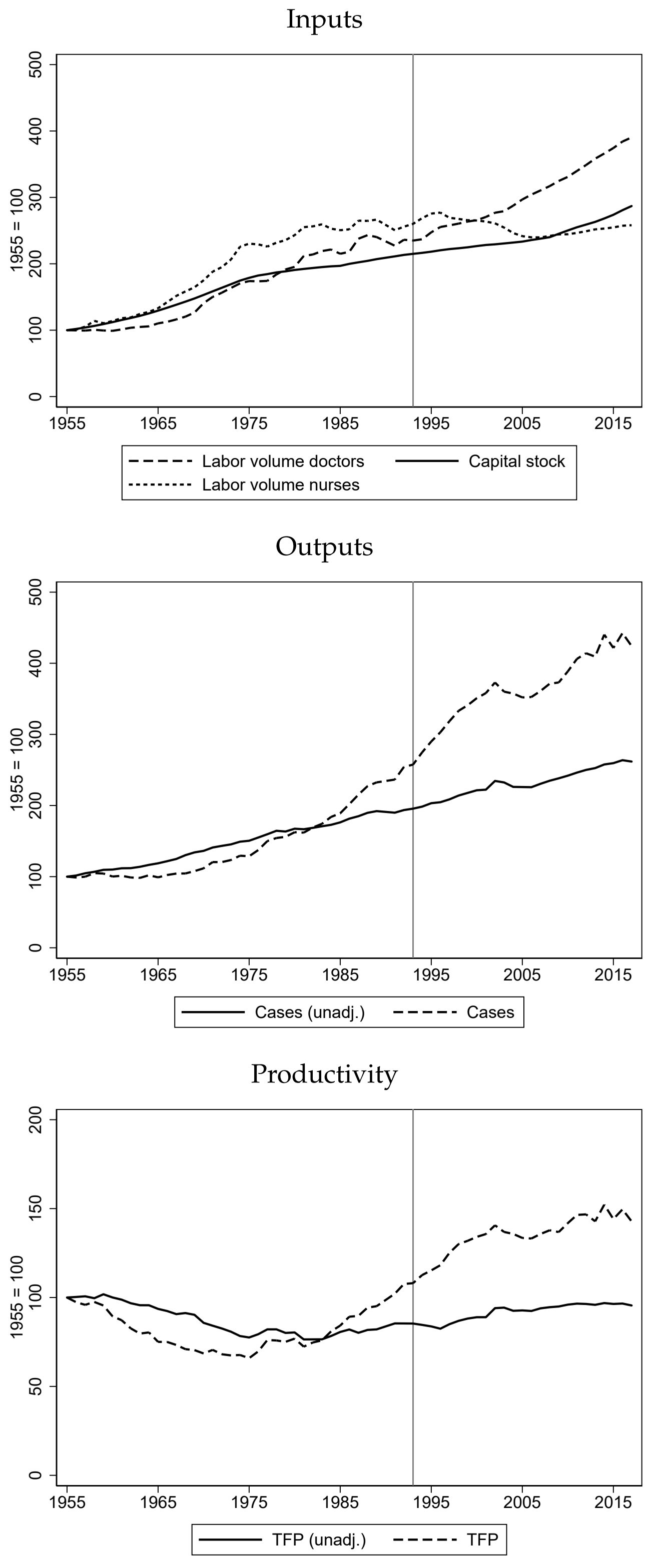
$$TFP_t^{TQ} = ln\left(\frac{A_t}{A_{t-1}}\right) = ln\left(\frac{y_t}{y_{t-1}}\right) - \sum_{n=1}^{N} \alpha_{n,t} ln\left(\frac{X_{n,t}}{x_{n,t-1}}\right) \tag{10}$$

The weights $\alpha_{n,t}$ in period t are given by the costs of input n ($w_{n,t}$) in relation to total costs w_t. As common in productivity analysis, we calculate the mean of the current period t and the previous period $t-1$:

$$\alpha_{n,t} = \frac{1}{2}\left(\frac{w_{n,t}}{w_t} + \frac{w_{n,t-1}}{w_{t-1}}\right) \tag{11}$$

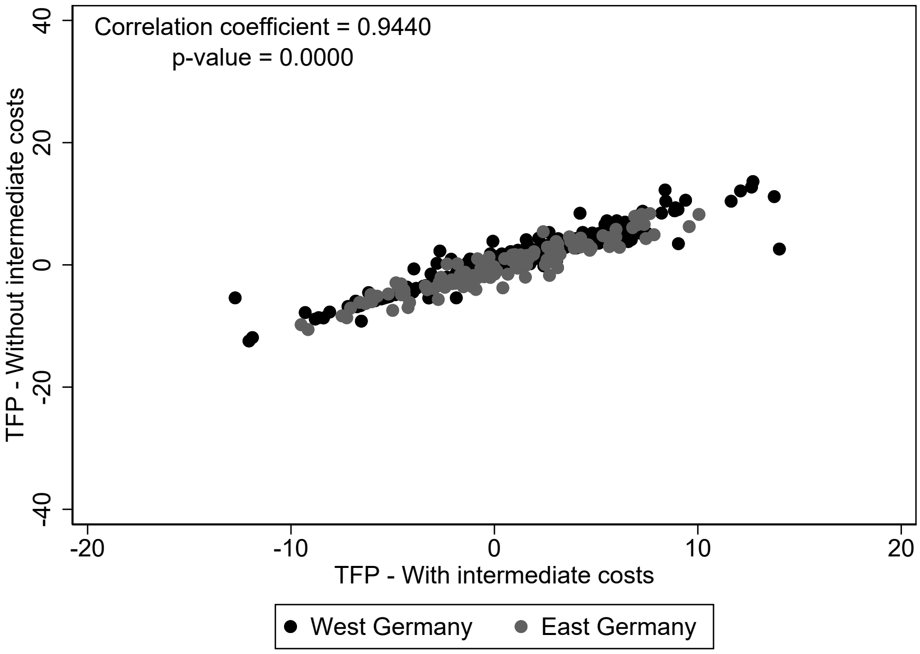
Appendix C: Supplementary figures and tables

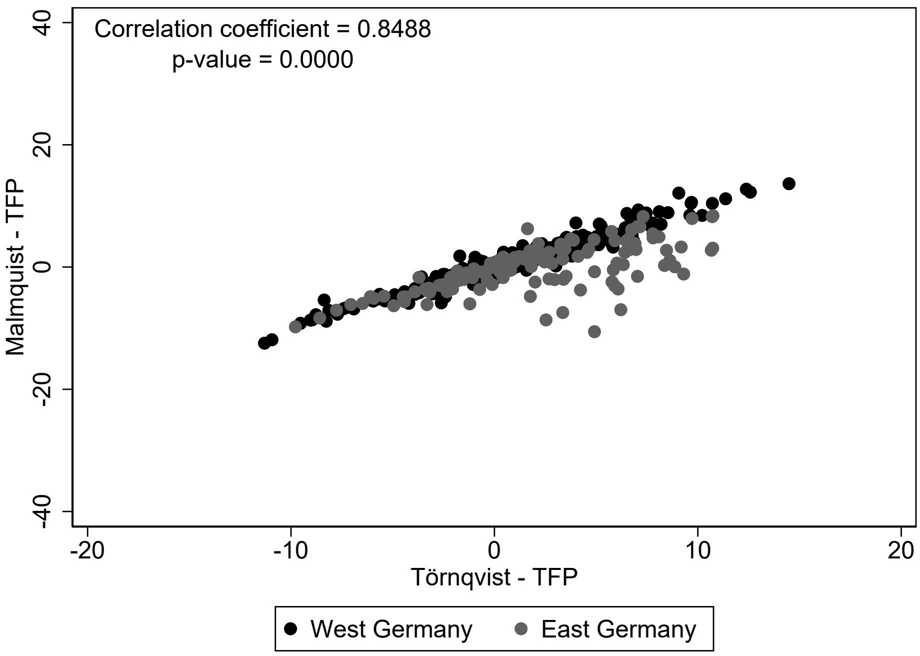
Figure A1: Productivity in German hospital care (West Germany only)



Notes: The figures show hospital inputs, outputs, and TFP growth in West German hospital care. 1955 is set to 100; indices increase with average growth rates. The units of observation are 10 West German states over the period 1955 to 2017. Labor volume in annual total working hours. Capital stock in 2017 euros. Cases account for quality improvements proxied with in-hospital mortality. The corresponding graphs for West and East Germany are provided in Figure 2 in the main article.

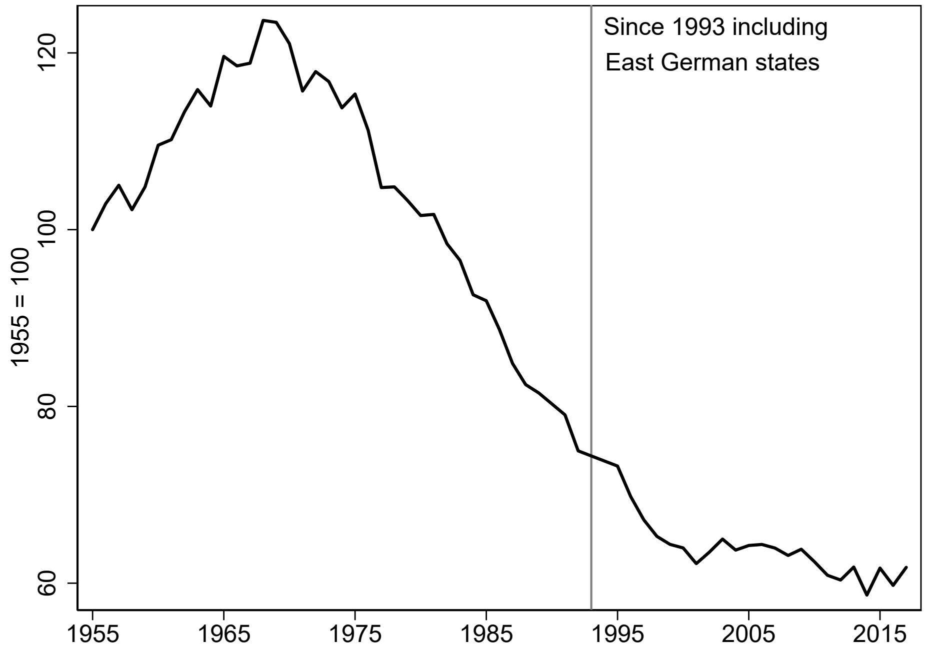
Figure A2: Validity of TFP calculations





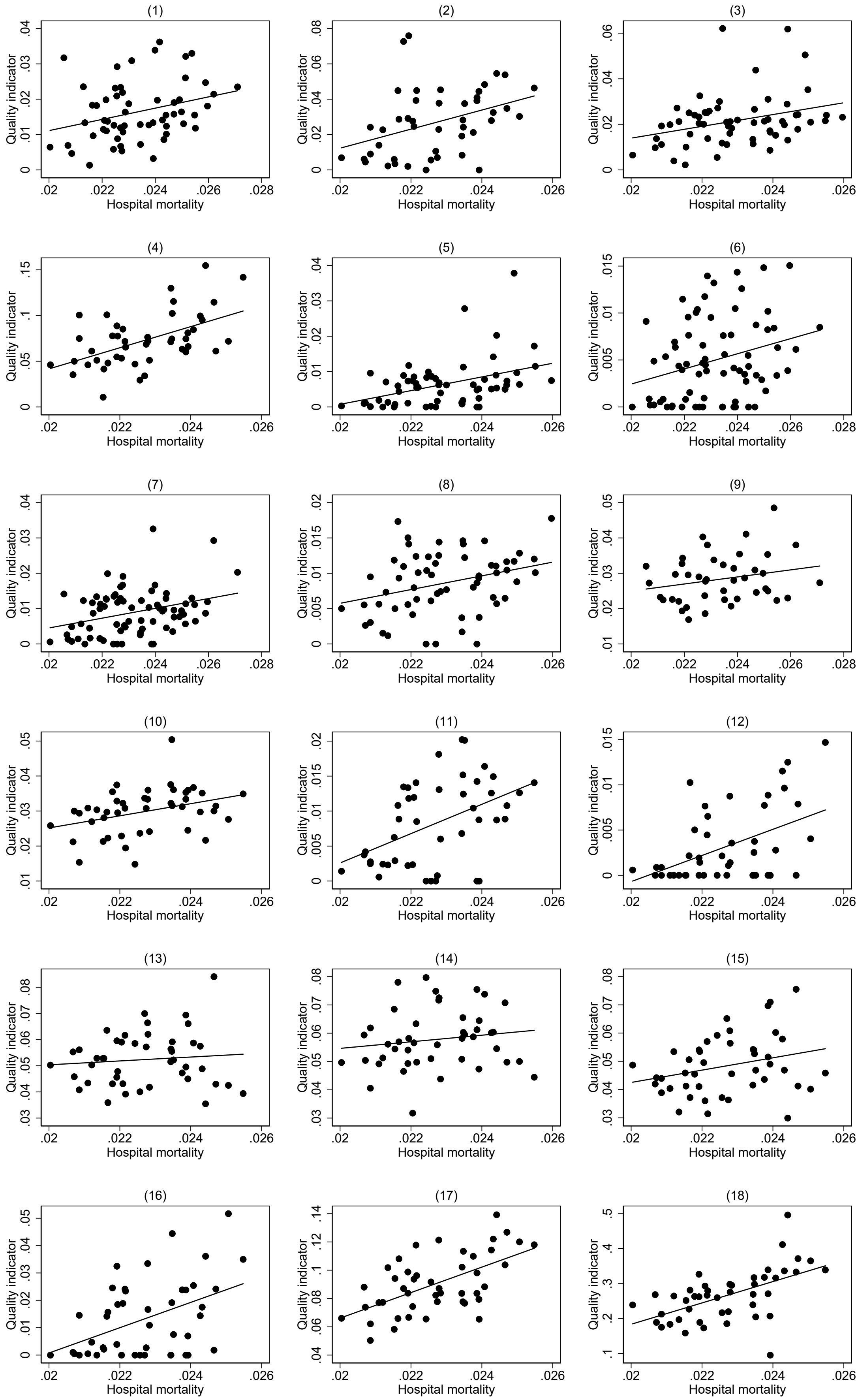
Notes: We plot adjusted measures for TFP growth (x-axis) against our baseline measures for productivity (y-axis). In the upper panel, we compare our baseline TFP growth rates to TFP growth rates where we use intermediate goods and hospital staff other than nurses and doctors as input factors. In the lower panel, we compare our Malmquist based TFP growth rates to TFP growth rates based on the Törnqvist index. Both adjustments base on hospital expenditure data which only available between 1991 and 2017.

Figure A3: Hospital mortality rates



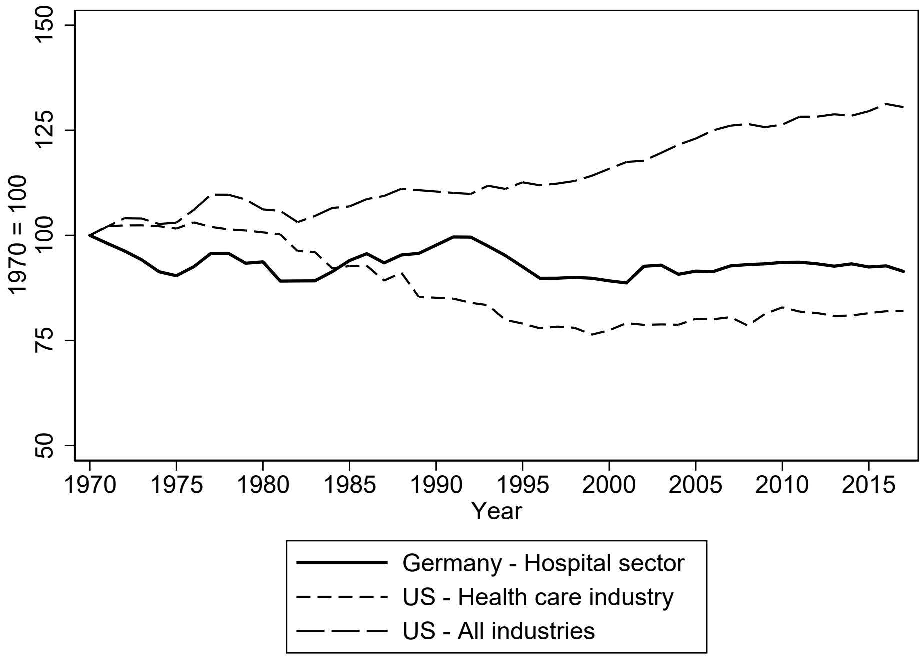
Notes: The figure shows average hospital mortality rates (deceases in hospitals over total hospital discharges) in Germany which we use as a proxy for hospital quality. The years 1993 and 1994 were interpolated for this figure due to statistical revisions after the inclusion of East German states. 1955 is set to 100.

Figure A4: Validity of quality adjustment



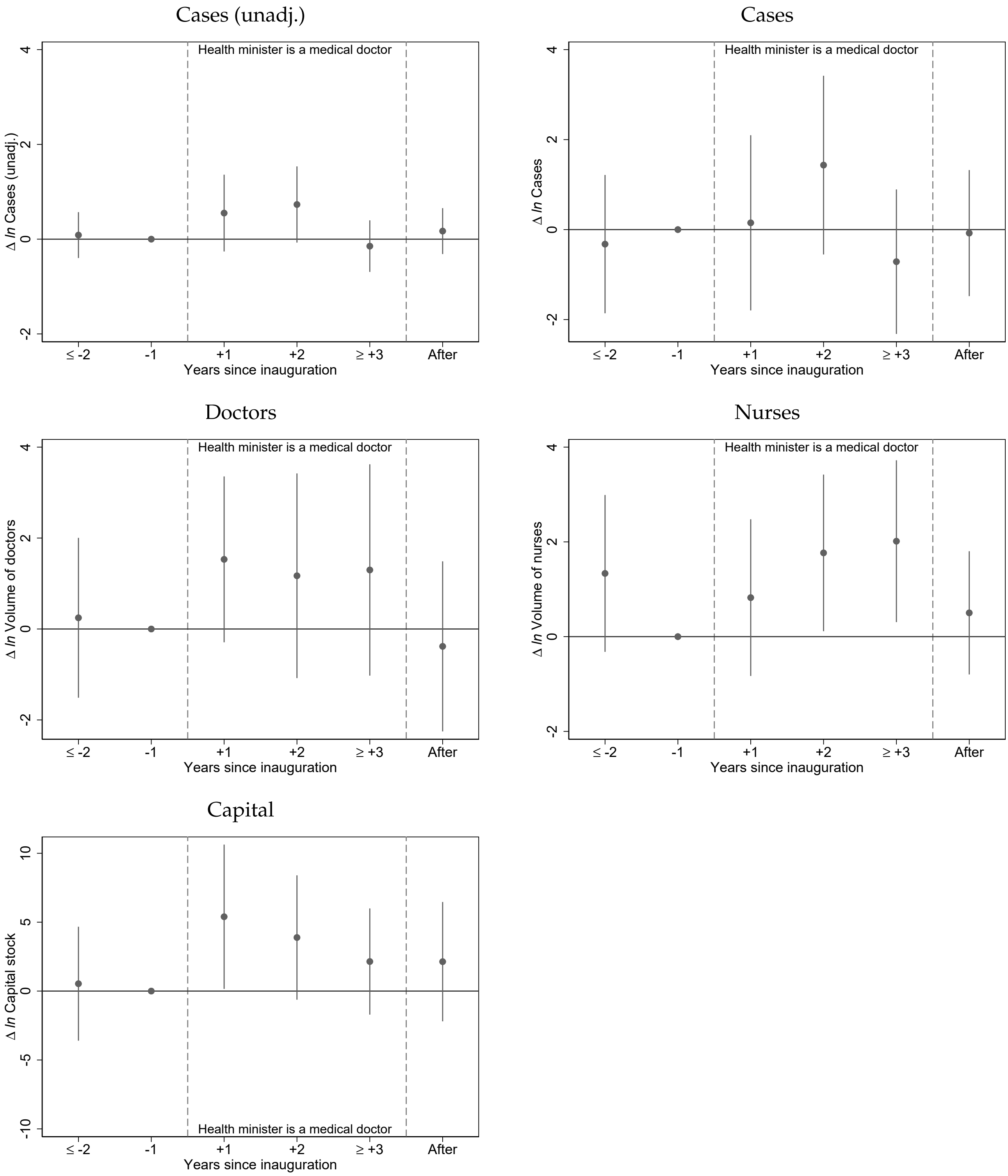
Notes: The figure shows correlations between hospital mortality and 18 clinical quality indicators from quality report cards, mainly complication rates. Quality indicators therefore read as follows: 0 means best quality, 1 worst quality. Detailed definitions of clinical quality indicators according to the numbers are provided in Appendix A in this document.

Figure A5: TFP growth in the US health care sector and in German hospitals



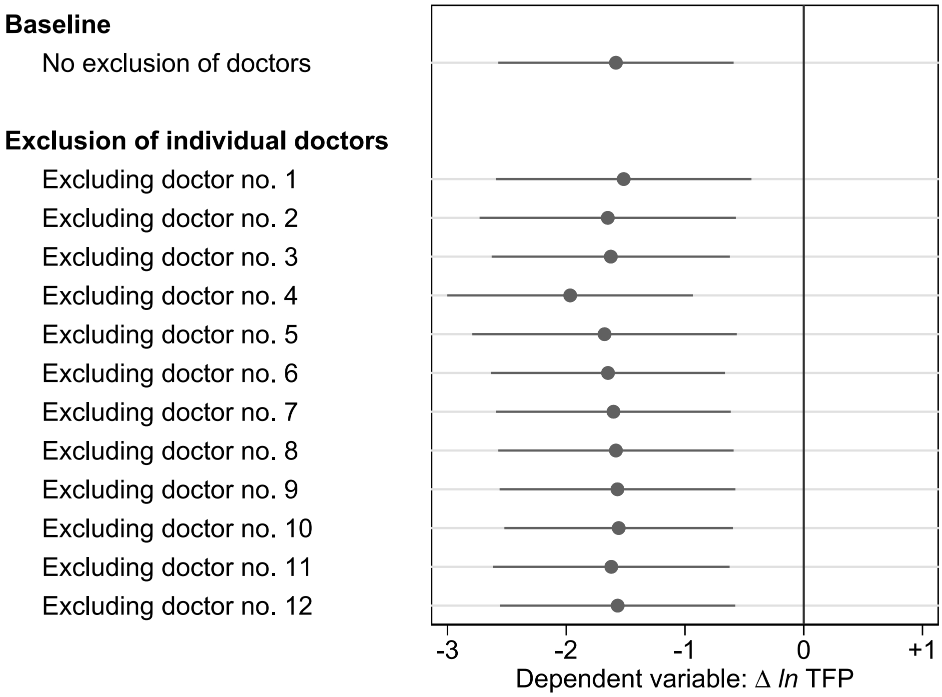
Notes: The figure plots our computed TFP growth for the German hospital sector (based on unadjusted cases) as the solid line and TFP growth rates of the US social and health care industry and the entire US economy over the period 1970 to 2017. Data for German are self-compiled, US data are from the 2019 release of the EU KLEMS project, available at https://euklems.eu/download/.

Figure A6: Event studies (hospital inputs and outputs)



Notes: Event studies show TFP growth effects for the years before and after the inauguration of a medical doctors as health minister. The year of inauguration is labeled as +1, the year before inauguration is -1 and serves as base category. Solid vertical lines represent confidence the 90% confidence interval. Dashed vertical lines bracket the years of a physician-trained health minister. Standard errors are clustered at the health minister level.

Figure A7: Excluding individual health ministers



Notes: The figure plots the effects of an medical doctor serving as health minister on TFP growth. Point estimates are from separate regressions where we exclude individual health ministers. Specifications correspond with the baseline model in Table 2 in the main article and include year and state fixed effects, health minister controls, government controls and sociodemographic controls. Solid vertical gray lines represent confidence the 90% confidence interval. Standard errors are clustered at the health minister level.

Table A1: German state health ministers 1955–2017

ID	Inauguration	Name	Party	Occupation
Baden-Württemberg				
1	25.04.1952	Ermin Hohlwegler	SPD	Industrial worker
2	23.06.1960	Josef Schüttler	CDU	Industrial worker
3	12.06.1968	Walter Hirrlinger	SPD	Commercial clerk
4	08.06.1972	Annemarie Griesinger	CDU	Social worker
5	04.06.1980	Dietmar Schlee	CDU	Lawyer
6	06.06.1984	Barbara Schäfer	CDU	Teacher
7	11.06.1992	Helga Solinger	SPD	Social worker
8	11.06.1996	Erwin Vetter	CDU	Civil servant
9	11.11.1998	Friedhelm Repnik	CDU	Pharmacist
10	14.07.2004	Tanja Gönner	CDU	Lawyer
11	29.04.2005	Andreas Renner	CDU	Civil servant
12	01.02.2006	Monika Stolz	CDU	Medical doctor
13	12.05.2011	Katrin Altpeter	SPD	Nurse
14	04.08.2016	Manfred Lucha	Bündnis90/Die Grünen	Social worker
Bavaria				
15	14.12.1954	Walter Stain	GB/BHE	Commercial clerk
16	11.12.1962	Paul Strenkert	CSU	Miner
17	24.06.1964	Hans Schütz	CSU	Carpenter
18	05.12.1966	Fritz Pirkl	CSU	Psychologist
19	17.07.1984	Franz Neubauer	CSU	Civil servant
20	30.10.1986	Karl Hillermeier	CSU	Civil servant
21	14.06.1988	Gebhard Glück	CSU	Teacher
22	27.10.1994	Barbara Stamm	CSU	Kindergarten teacher
23	30.01.2001	Eberhard Sinner	CSU	Forester
24	14.10.2003	Werner Schnappauf	CSU	Civil servant
25	16.10.2007	Otmar Bernhard	CSU	Civil servant
26	30.10.2008	Markus Söder	CSU	Lawyer
27	04.11.2011	Marcel Huber	CSU	Veterinarian
28	10.10.2013	Melanie Huml	CSU	Medical doctor
Bremen				
29	29.11.1951	Johannes Degener	CDU	Commercial clerk
30	08.10.1958	Karl Krammig	CDU	Customs officer
31	21.12.1959	Karl Weßling	SPD	Electrician
32	16.10.1968	Karl-Heinz Jantzen	SPD	Toolmaker
33	15.12.1971	Albert Müller	SPD	Bricklayer
34	03.11.1975	Herbert Brückner	SPD	Deacon
35	01.02.1987	Henning Scherf	SPD	Lawyer
36	26.01.1988	Vera Rüdiger	SPD	Political scientist
37	12.10.1991	Claus Grobecker	SPD	Book printer
38	11.12.1991	Sabine Uhl	SPD	Teacher
39	25.03.1992	Irmgard Gaertner	SPD	Economist
40	01.03.1994	Sabine Uhl	SPD	Teacher
41	16.03.1994	Irmgard Gaertner	SPD	Economist
42	04.07.1995	Christine Wischer	SPD	Sociologist
43	07.07.1999	Hilde Adolf	SPD	Lawyer
44	22.01.2002	Christine Wischer	SPD	Sociologist
45	20.03.2003	Karin Röpke	SPD	Civil servant
46	11.10.2006	Willi Lemke	SPD	Teacher
47	02.11.2006	Ingelore Rosenkötter	SPD	Bank clerk
48	30.06.2011	Renate Jürgens-Pieper	SPD	Teacher
49	13.12.2012	Hermann Schulte-Sasse	No party	Medical doctor
50	15.07.2015	Eva Quante-Brandt	SPD	Teacher
Hamburg				
51	02.12.1953	Ewald Samsche	CDU	Commercial clerk
52	01.01.1956	Erwin Jacobi	DP	Lawyer
53	21.12.1957	Walter Schmedemann	SPD	Docker
54	11.01.1967	Hans-Joachim Seeler	SPD	Civil servant
55	01.01.1973	Ilse Elsner	SPD	Economist
56	30.04.1974	Wilhelm Nölling	SPD	Economist
57	28.04.1976	Helga Elstner	SPD	Economist

Continued on next page...

... Table A1 continued

ID	Inauguration	Name	Party	Occupation
58	13.06.1984	Christine Maring	SPD	Economist
59	08.06.1988	Ortwin Runde	SPD	Sociologist
60	15.12.1993	Helgrit Fischer-Menzel	SPD	Sociologist
61	01.04.1998	Karin Roth	SPD	Social worker
62	31.10.2001	Peter Rehaag	PRO	Lawyer
63	17.03.2004	Jörg Dräger	No party	Physicist
64	01.05.2006	Birgit Schnieber-Jastram	CDU	Journalist
65	07.05.2008	Dietrich Wersich	CDU	Medical doctor
66	23.03.2011	Cornelia Prüfer-Storcks	SPD	Journalist
Hesse				
67	19.01.1955	Gotthard Franke	GB/BHE	Commercial clerk
68	29.01.1959	Heinrich Hemsath	SPD	Machine fitter
69	23.10.1969	Horst Schmidt	SPD	Medical doctor
70	20.10.1976	Armin Clauss	SPD	Civil servant
71	24.04.1987	Karl-Heinrich Trageser	CDU	Electrician
72	05.04.1991	Iris Blaul	Bündnis90/Die Grünen	Teacher
73	10.10.1995	Margarethe Nimsch	Bündnis90/Die Grünen	Lawyer
74	24.03.1998	Priska Hinz	Bündnis90/Die Grünen	Teacher
75	07.04.1999	Marlies Mosiek-Urbahn	CDU	Judge
76	21.08.2001	Silke Lautenschläger	CDU	Lawyer
77	05.02.2009	Jürgen Banzer	CDU	Lawyer
78	31.08.2010	Stefan Grüttner	CDU	Economist
Lower Saxony				
79	18.09.1950	Heinrich Albertz	SPD	Priest
80	26.05.1955	Heinz Rudolph	CDU	Farmer
81	19.11.1957	Georg Diederichs	SPD	Pharmacist, Economist
82	29.12.1961	Kurt Partzsch	SPD	Civil engineer
83	10.07.1974	Helmut Greulich	SPD	Tool mechanic
84	06.02.1976	Hermann Schnipkoweit	CDU	Miner
85	21.06.1990	Walter Hiller	SPD	Commercial clerk
86	15.10.1996	Wolf Weber	SPD	Judge
87	30.03.1998	Heidrun Merk	SPD	Civil servant
88	13.12.2000	Gitta Trauernicht	SPD	Sociologist
89	04.03.2003	Ursula von der Leyen	CDU	Medical doctor
90	07.12.2005	Mechthild Ross-Luttmann	CDU	Civil servant
91	27.04.2010	Aygül Özkan	CDU	Lawyer
92	19.02.2013	Cornelia Rundt	SPD	Economist
North Rhine-Westphalia				
93	27.07.1954	Johann Platte	CDU	Miner
94	28.02.1956	Heinrich Hemsath	SPD	Machine fitter
95	24.07.1958	Johann Ernst	CDU	Miner
96	12.10.1959	Konrad Grundmann	CDU	Textile worker
97	08.12.1966	Werner Figgen	SPD	Lathe operator
98	04.06.1975	Friedhelm Farthmann	SPD	Lawyer
99	05.06.1985	Hermann Heinemann	SPD	Bank clerk
100	18.12.1992	Franz Müntefering	SPD	Commercial clerk
101	27.11.1995	Axel Horstmann	SPD	Economist
102	09.06.1998	Birgit Fischer	SPD	Teacher
103	24.06.2005	Karl-Josef Laumann	CDU	Machine fitter
104	15.07.2010	Barbara Steffens	Bündnis90/Die Grünen	Technical assistant in biology
Rhineland-Palatinate				
105	13.06.1951	Alois Zimmer	CDU	Civil servant
106	15.10.1957	Otto van Volxem	CDU	Winemaker
107	19.05.1959	August Wolters	CDU	Civil servant
108	18.05.1967	Heiner Geißler	CDU	Civil servant
109	23.06.1977	Georg Gölter	CDU	Teacher
110	12.06.1981	Rudi Geil	CDU	Teacher
111	23.05.1985	Klaus Töpfer	CDU	Economist
112	23.06.1987	Hans-Otto Wilhelm	CDU	Civil servant
113	08.12.1988	Alfred Beth	CDU	Civil servant
114	21.05.1991	Ullrich Galle	SPD	Civil servant
115	26.10.1994	Florian Gerster	SPD	Economist
116	15.03.2002	Malu Dreyer	SPD	Judge

Continued on next page...

... *Table A1 continued*

ID	Inauguration	Name	Party	Occupation
117	16.01.2013	Alexander Schweitzer	SPD	Lawyer
118	12.11.2014	Sabine Bätzing-Lichtenthäler	SPD	Civil servant
Saarland				
119	17.07.1954	Johann Klein	CDU	Miner
120	29.10.1955	Heinrich Welsch	No party	Laywer
121	10.01.1956	Kurt Conrad	SPD	Mechanic
122	14.02.1958	Hermann Trittelvitz	SPD	Economist
123	17.01.1961	Paul Simonis	FDP	Civil servant
124	13.07.1970	Rainer Wicklmayr	CDU	Lawyer
125	23.01.1974	Rita Waschbüsch	CDU	Housewife
126	01.03.1977	Rosemarie Scheurlen	FDP	Medical doctor
127	09.04.1985	Brunhilde Peter	SPD	Theologian
128	21.02.1990	Christiane Krajewski	SPD	Economist
129	23.11.1994	Marianne Granz	SPD	Teacher
130	18.09.1996	Barbara Wackernagel-Jacobs	SPD	Social scientist
131	29.09.1999	Regina Görner	CDU	Historian
132	06.10.2004	Josef Hecken	CDU	Civil servant
133	14.05.2008	Gerhard Vigener	CDU	Lawyer
134	10.11.2009	Georg Weisweiler	FDP	Lawyer
135	18.01.2012	Monika Bachmann	CDU	Actuary
136	09.05.2012	Andreas Storm	CDU	Economist
137	12.11.2014	Monika Bachmann	CDU	Actuary
Schleswig-Holstein				
138	27.07.1951	Hans-Adolf Asbach	BHE	Lawyer
139	21.10.1957	Lena Ohnesorge	CDU	Medical doctor
140	03.05.1967	Otto Eisenmann	FDP	Actuary
141	16.11.1969	Hans-Hellmuth Qualen	FDP	Lawyer
142	24.05.1971	Karl Eduard Claussen	CDU	Lawyer
143	29.05.1979	Walter Braun	CDU	Commercial clerk
144	13.04.1983	Ursula Gräfin von Brockdorff	CDU	Housewife
145	31.05.1988	Günther Jansen	SPD	Civil servant
146	24.03.1993	Claus Möller	SPD	Civil servant
147	19.05.1993	Heide Moser	SPD	Teacher
148	26.05.2004	Gitta Trauernicht	SPD	Sociologist
149	21.07.2009	Christian von Boetticher	CDU	Lawyer
150	27.10.2009	Heiner Garg	FDP	Economist
151	06.05.2012	Kristin Alheit	SPD	Lawyer
Brandenburg (East Germany)				
152	01.11.1990	Regine Hildebrandt	SPD	Biologist
153	13.10.1999	Alwin Ziel	SPD	Teacher
154	26.06.2002	Günter Baaske	SPD	Teacher
155	13.10.2004	Dagmar Ziegler	SPD	Economist
156	06.11.2009	Günter Baaske	SPD	Teacher
157	28.08.2013	Anita Tack	Linke	Engineer
158	05.11.2014	Diana Golze	Linke	Social worker
Mecklenburg-West Pomerania (East Germany)				
159	28.10.1990	Klaus Gollert	FDP	Medical doctor
160	08.12.1994	Hinrich Kuessner	SPD	Theologian
161	03.11.1998	Martina Bunge	Linke	Economist
162	06.11.2002	Marianne Linke	Linke	Farmer
163	07.11.2006	Erwin Sellering	SPD	Judge
164	06.10.2008	Manuela Schwesig	SPD	Civil servant
165	14.01.2014	Birgit Hesse	SPD	Lawyer
166	01.11.2016	Harry Glawe	CDU	Nurse
Saxony (East Germany)				
167	08.11.1990	Hans Geisler	CDU	Chemist
168	02.05.2002	Christine Weber	CDU	Dental assistant
169	10.07.2003	Helma Orosz	CDU	Kindergarten teacher
170	08.08.2008	Christine Clauß	CDU	Nurse
171	13.11.2014	Barbara Klepsch	CDU	Civil servant

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... Table A1 continued

ID	Inauguration	Name	Party	Occupation
Saxony-Anhalt (East Germany)				
172	02.11.1990	Werner Schreiber	CDU	Social worker
173	15.12.1993	Wolfgang Böhmer	CDU	Medical doctor
174	21.07.1994	Gerlinde Kuppe	SPD	Chemist
175	16.05.2002	Gerry Kley	FDP	Biologist
176	24.04.2006	Gerlinde Kuppe	SPD	Chemist
177	30.12.2009	Norbert Bischoff	SPD	Theologian
178	25.04.2016	Petra Grimm-Benne	SPD	Lawyer
Thuringia (East Germany)				
179	17.09.1992	Frank-Michael Pietzsch	CDU	Medical doctor
180	30.11.1994	Irene Ellenberger	SPD	Engineer
181	01.10.1999	Frank-Michael Pietzsch	CDU	Medical doctor
182	05.06.2003	Klaus Zeh	CDU	Engineer
183	08.05.2008	Christine Lieberknecht	CDU	Theologian
184	04.11.2009	Heike Taubert	SPD	Engineer
185	05.12.2014	Heike Werner	Linke	Student

Notes: The table reports all health ministers serving in German states between 1955 and 2017.

Table A2: Predicting the nomination of medical doctors as health ministers

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Δln TFP$_{t-1}$ (unadj.)	0.010			0.006				
	(0.008)			(0.008)				
Δln TFP$_{t-2}$ (unadj.)		0.002		-0.001				
		(0.006)		(0.007)				
Δln TFP$_{t-3}$ (unadj.)			-0.007	-0.006				
			(0.008)	(0.008)				
Δln TFP$_{t-1}$					0.001			0.001
					(0.004)			(0.005)
Δln TFP$_{t-2}$						0.004		0.004
						(0.006)		(0.006)
Δln TFP$_{t-3}$							-0.009	-0.008
							(0.006)	(0.006)
Observations	164	161	157	157	164	161	157	157
Sociodemographics	×	×	×	×	×	×	×	×
State fixed effects	×	×	×	×	×	×	×	×

Notes: The table shows the average marginal effects of eight panel logit estimations. The units of observation are 10 West German states over the period 1955 to 2017 and 5 East German states over the period 1993 to 2017. The dependent variable is a dummy that equals 1 if a medical doctor is nominated as health minister in a German federal state, and zero otherwise. Different lags of hospital TFP growth rates are the main explanatory variables; we also include state fixed effects and sociodemographic control variables. Out of our 178 health ministers in our main sample, we have pre-inauguration data on TFP growth only for 164 ministers. This number decreases with more pre-inauguration lags. Cluster-robust standard errors in parentheses. * $p<0.1$, ** $p<0.05$, *** $p<0.01$

Table A3: Baseline results (including and excluding control variables)

	(1)	(2)	(3)	(4)
Panel A – Dependent variable: Δln Doctors				
Doctor	1.280*	1.165*	1.200*	1.412**
	(0.752)	(0.677)	(0.712)	(0.693)
Observations	745	745	745	745
R^2 (within)	0.289	0.297	0.290	0.307
Mean dependent variable	2.197	2.197	2.197	2.197
Panel B – Dependent variable: Δln Nurses				
Doctor	0.805*	0.784**	0.771*	0.876**
	(0.456)	(0.396)	(0.413)	(0.409)
Observations	745	745	745	745
R^2 (within)	0.432	0.457	0.432	0.460
Mean dependent variable	1.459	1.459	1.459	1.459
Panel C – Dependent variable: Δln Capital				
Doctor	1.884**	2.038*	1.968**	2.157**
	(0.946)	(1.090)	(0.979)	(1.067)
Observations	745	745	745	745
R^2 (within)	0.390	0.420	0.363	0.441
Mean dependent variable	2.809	2.809	2.809	2.809
Panel D – Dependent variable: Δln Cases (unadj.)				
Doctor	0.144	0.109	0.237	0.120
	(0.261)	(0.204)	(0.245)	(0.217)
Observations	745	745	745	745
R^2 (within)	0.520	0.646	0.523	0.663
Mean dependent variable	1.570	1.570	1.570	1.570
Panel E – Dependent variable: Δln Cases				
Doctor	0.137	0.089	0.294	0.170
	(0.496)	(0.410)	(0.444)	(0.446)
Observations	745	745	745	745
R^2 (within)	0.543	0.621	0.541	0.629
Mean dependent variable	2.420	2.420	2.420	2.420
Panel F – Dependent variable: Δln TFP (unadj.)				
Doctor	-1.533***	-1.653***	-1.471***	-1.718***
	(0.522)	(0.493)	(0.521)	(0.503)
Observations	745	745	745	745
R^2 (within)	0.359	0.396	0.354	0.410
Mean dependent variable	-0.401	-0.401	-0.401	-0.401
Panel G – Dependent variable: Δln TFP				
Doctor	-1.467**	-1.528***	-1.274**	-1.582***
	(0.643)	(0.565)	(0.594)	(0.599)
Observations	745	745	745	745
R^2 (within)	0.442	0.498	0.441	0.505
Mean dependent variable	0.363	0.363	0.363	0.363
Minister controls	×	×	×	×
Government controls	×			×
Hospital market controls		×		×
Sociodemographic controls			×	×
State fixed effects	×	×	×	×
Year fixed effects	×	×	×	×

Notes: The table shows the results of panel regressions using different hospital input, output and productivity measures as dependent variables. The units of observation are 10 West German states over the period 1955 to 2017 and 5 East German states over the period 1993 to 2017. Control variables are added stepwise (not reported, see Table A4 for full regression tables for column (4))). Standard errors in parentheses are clustered at health minister level. * p<0.1, ** p<0.05, *** p<0.01

Table A4: Baseline results (full report of control variables)

	Δln **Doctors**	Δln **Nurses**	Δln **Capital**	Δln **Cases (unadj.)**	Δln **Cases**	Δln **TFP (unadj.)**	Δln **TFP**
Minister							
Doctor	1.412**	0.876**	2.157**	0.120	0.170	-1.718***	-1.582***
	(0.693)	(0.409)	(1.067)	(0.217)	(0.446)	(0.503)	(0.599)
Right-wing	0.108	0.191	1.555***	0.218*	0.454*	-0.376	-0.201
	(0.312)	(0.298)	(0.526)	(0.120)	(0.274)	(0.288)	(0.369)
Local	0.247	-0.141	-0.785	-0.146	-0.485**	0.077	-0.500*
	(0.280)	(0.227)	(0.477)	(0.103)	(0.226)	(0.255)	(0.287)
Female	0.455*	0.163	-0.927	-0.215**	-0.670***	0.208	-0.361
	(0.271)	(0.221)	(0.572)	(0.107)	(0.222)	(0.298)	(0.310)
Age	0.406**	0.028	0.855***	0.016	-0.231*	-0.182	-0.512**
	(0.187)	(0.155)	(0.304)	(0.056)	(0.138)	(0.153)	(0.200)
Age squared	-0.004**	-0.000	-0.008***	-0.000	0.002*	0.002	0.005**
	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.002)
Tenure	0.141	-0.057	0.015	0.035	0.088	0.015	0.037
	(0.100)	(0.095)	(0.125)	(0.038)	(0.086)	(0.078)	(0.103)
Tenure squared	-0.007	0.006	0.005	-0.004	-0.010	-0.006	-0.008
	(0.008)	(0.008)	(0.010)	(0.003)	(0.007)	(0.006)	(0.008)
Vocational degree	0.054	-0.383	-3.086**	-0.002	-0.022	1.578**	1.518*
	(0.790)	(0.562)	(1.530)	(0.243)	(0.527)	(0.659)	(0.855)
University degree	0.048	-0.179	-2.818*	-0.025	0.110	1.383**	1.414*
	(0.786)	(0.502)	(1.562)	(0.221)	(0.472)	(0.622)	(0.817)
PhD	-0.580	-0.958	-2.859*	-0.179	-0.231	1.898***	1.672*
	(0.925)	(0.624)	(1.587)	(0.236)	(0.501)	(0.728)	(0.912)
PM party affiliation	-0.849**	-0.485	-0.601	-0.174	-0.481*	0.718**	0.573
	(0.373)	(0.303)	(0.707)	(0.118)	(0.258)	(0.344)	(0.398)
Government							
Election year	0.542	0.296	-0.134	-0.119	-0.071	-0.393	-0.463
	(0.372)	(0.291)	(0.190)	(0.101)	(0.278)	(0.242)	(0.380)
Parties in government	-0.264	-0.175	-0.211	0.079	-0.089	0.397	0.368
	(0.263)	(0.266)	(0.456)	(0.098)	(0.208)	(0.241)	(0.306)
Minority government	1.243	0.253	2.625**	0.556**	0.873*	0.240	1.102
	(1.606)	(1.655)	(1.187)	(0.235)	(0.455)	(1.226)	(1.218)
Ministry for health only	0.112	0.284	-0.673	0.174	0.412	-0.176	0.117
	(0.552)	(0.488)	(0.992)	(0.173)	(0.391)	(0.517)	(0.557)
Ministry of labor	0.172	0.404	0.842	0.179	0.648**	-0.732**	-0.123
	(0.363)	(0.259)	(0.760)	(0.115)	(0.281)	(0.349)	(0.407)
Hospital market							
Δln Beds per capita	0.117*	0.154**	-0.118	0.283***	0.479***	0.189***	0.385***
	(0.067)	(0.076)	(0.100)	(0.060)	(0.127)	(0.068)	(0.123)
Δln Hospitals per capita	0.120**	0.090*	-0.078	0.014	0.088*	-0.021	0.047
	(0.054)	(0.047)	(0.047)	(0.018)	(0.049)	(0.039)	(0.057)
Δln Length of stay	-0.027	0.296***	-0.187**	-0.443***	-0.919***	-0.495***	-0.973***
	(0.122)	(0.112)	(0.094)	(0.084)	(0.176)	(0.123)	(0.224)
Public hospital beds (in %)	3.402	-4.516	14.917**	-0.558	6.221**	-4.537	2.847
	(3.828)	(4.104)	(7.187)	(1.604)	(3.144)	(3.769)	(4.511)
For-profit hospital beds (in %)	7.265*	-0.778	3.963	0.801	5.345*	-0.349	3.846
	(3.941)	(4.052)	(7.008)	(1.521)	(3.146)	(3.952)	(4.627)
Sociodemographics							
Δln Population	-0.148	0.311	0.219	0.551***	0.846***	0.535	0.907
	(0.981)	(0.724)	(0.371)	(0.109)	(0.256)	(0.446)	(0.800)
Δln Unemployed per capita	-0.011	0.006	-0.006	-0.000	-0.004	-0.003	0.001
	(0.014)	(0.016)	(0.008)	(0.003)	(0.015)	(0.011)	(0.017)
Δln Population aged 65+	0.458*	0.183	0.200	0.114	0.306*	-0.122	0.053
	(0.241)	(0.196)	(0.281)	(0.069)	(0.179)	(0.168)	(0.227)

Continued on next page...

... Table A4 continued

	Δln **Doctors**	Δln **Nurses**	Δln **Capital**	Δln **Cases (unadj.)**	Δln **Cases**	Δln **TFP (unadj.)**	Δln **TFP**
Constant	-14.374***	14.074***	-27.069***	1.670	-2.900	3.597	1.680
	(5.412)	(4.982)	(9.214)	(1.650)	(4.392)	(4.679)	(5.732)
Observations	745	745	745	745	745	745	745
States	15	15	15	15	15	15	15
R^2 (within)	0.307	0.460	0.441	0.663	0.629	0.410	0.505
Mean dependent variable	2.197	1.459	2.809	1.570	2.420	-0.401	0.363
State fixed effects	×	×	×	×	×	×	×
Year fixed effects	×	×	×	×	×	×	×

Notes: The table shows the results of panel regressions using different hospital input, output and productivity measures as dependent variables, reporting all control variables omitted in Table 2 in the main article. The units of observation are 10 West German states over the period 1955 to 2017 and 5 East German states over the period 1993 to 2017. Estimations include a full set of control variables. Standard errors in parentheses are clustered at the health minister level. * p<0.1, ** p<0.05, *** p<0.01

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