Who Cares?
Four Essays on Elderly Care Markets

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With the title **"Who cares?"**, I dedicate a special place to the many caregivers who carry out their valuable work every day and care for the most vulnerable individuals in our society.

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Abstract

German:

Diese Doktorarbeit befasst sich mit den wichtigsten Herausforderungen in der Altenpflege und konzentriert sich dabei auf den Bedarf und den Zugang zur Pflege, die Qualität der Pflege und das Pflegepersonal. Die Dissertation besteht aus vier Kapiteln, die sich jeweils mit verschiedenen Aspekten der Komplexität Altenpflege befassen.

Im ersten Kapitel untersuchen wir die Auswirkungen der Anbieterdichte ambulanter häuslicher Altenpflege auf die Pflegequalität. Unsere Ergebnisse deuten darauf hin, dass eine höhere Anbieterdichte mit einer geringeren Pflegequalität einhergeht. Wir unterstreichen damit die entscheidende Rolle des Pflegepersonals bei der Versorgungsqualität.

In Kapitel zwei wird der Umgang des Managements in Pflegeheimen vor dem Hintergrund des akuten Personalmangels untersucht. Durch unsere Analyse decken wir einen Eskalationsprozess auf, der mit der Veröffentlichung von Stellenangeboten beginnt, sich zu einer erhöhten Arbeitsbelastung des Personals ausweitet und schließlich in einem verringerten Zugang gipfelt. Daraus resultieren erhebliche Herausforderung für die Bereitstellung von Pflegeleistungen.

Im dritten Kapitel werden die treibenden Faktoren von regionalen Unterschieden in der Nachfrage nach deutscher Pflegeheimpflege untersucht. Unsere Untersuchungen geben Aufschluss darüber, warum sich Menschen für die stationäre Pflegeheimversorgung entscheiden. Dabei wird die eingeschränkte Verfügbarkeit informeller häuslicher Betreuungsmöglichkeiten als ein wichtiger Faktor für die Nachfragedynamik identifiziert.

Im letzten Kapitel untersuchen wir die Auswirkungen höherer Einzelzimmerstandards in Pflegeheimen auf den Zugang für Personen mit schwerem Pflegebedarf. Darüber hinaus bewerten wir die Auswirkungen auf den Markt für informelle häusliche Pflege, wenn der Zugang zur Pflegeheimpflege eingeschränkt wird. Unsere Ergebnisse sind ein wertvoller Beitrag zum laufenden Diskurs über die Optimierung der Altenpflegesysteme, um den sich wandelnden Bedürfnissen der alternden Bevölkerung gerecht zu werden.

Schlagworte:
Langzeitpflege, Wettbewerb, Qualität, Einzelzimmer, Pflegepersonal, Pflegepersonal, Personalmangel

English:

This doctoral thesis addresses key challenges in elderly care, focusing on care demand and access, care quality, and nursing personnel. The study comprises four chapters, each delving into distinct aspects of the complex landscape of elderly care.

In the first chapter, we investigate the impact of provider density in the ambulatory home health care market on care quality. Surprisingly, our findings reveal an inverse relationship, suggesting that higher provider density correlates with lower quality of care. We underscore the crucial role of the nursing workforce in shaping care outcomes.

Chapter two scrutinizes management metrics of nursing homes amidst an urgent personnel shortage. Through our analysis, we uncover a concerning escalation process, beginning with the publication of job vacancies, escalating to heightened personnel workload, and culminating in diminished access and capacity, posing significant challenges to care provision.

The third chapter examines the driving factors behind regional variations in demand for German nursing home care. Our research sheds light on why individuals opt for stationary nursing home care, highlighting the constrained availability of informal home care options as a significant factor influencing demand dynamics.

In the final chapter, we explore the implications of higher single room standards in nursing homes on access for individuals with severe care needs. Additionally, we assess the ripple effects on the informal home care market when access to nursing home care becomes restricted. Our findings contribute valuable insights to the ongoing discourse on optimizing elderly care systems to meet the evolving needs of aging populations.

Keywords:
long-term care, competition, quality, single room, nursing staff, nursing staff, staff shortage

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List of Abbreviations

AOK	**A**llgemeine **O**rts**k**rankenkasse (German)
BER	**Ber**lin (German federal state)
BKG	**B**undesamt für **K**artographie und **G**eodäsie (German)
BKK	**B**etriebs**k**ranken**k**asse (German)
BW	**B**aden **W**uerttemberg (German federal state)
BY	**B**avaria (German federal state)
CMM	**C**apacity **M**anagement **M**etrics
FDZ	**F**orschungs**d**aten**z**entrum (Research data center)
FTE	**F**ull-**T**ime **E**quivalent
FE	**F**ixed **E**effects
IAB	**I**nstitut für **A**rbeitsmarkt und **B**erufsforschungs (German)
BR	**B**remen (German federal state)
HE	**He**sse (German federal state)
HH	**H**ansecity **H**amburg (German federal state)
HHC	**H**ome **H**ealth **C**are
INKAR	**In**dikatoren und **Ka**rten zur **R**aum- und Stadtentwicklung (German)
IHC	**I**nformal **H**ome **C**are
IV	**I**nstrumental **V**ariable
LTC	**L**ong-**T**erm **C**are
MRB	**M**edical **R**eview **B**oard
NA	**N**urse **A**ssistant (e.g., untrained or rarely trained nurse)
NH care	**N**ursing **H**ome care
NP	**N**ursing **P**ersonnel
NRW	**N**orth-**R**hine **W**estphalia (German federal state)
OLS	**O**rdinary **L**east **S**quares
RN	**R**egistered **N**urse (e.g., a trained nurse)
SGB	**S**ozial **G**esetz**b**uch (German)
SH	**S**chleswig-**H**olstein (German federal state)
VIF	**V**ariance **I**nflation **F**actor

Chapter 1

Introduction

The responsibility for care work rested within the family when Florence Nightingale introduced the idea of formal elderly care 200 years ago (Pfettscher, 2021). With the disruption of traditional family structures, families began to outsource elderly care towards professional providers. While many individuals in need of care still rely on informal family assistance, nowadays, elderly care has evolved into an economic market.

In Germany, the elderly care market has a market volume of more than 60 billion Euros p.a.. It is therefore the second-largest market in healthcare after the hospital sector and before medical practices (Heger et al., 2021). Three types of care with informal home care on the one hand and the formal care providers that include ambulatory home health care, and stationary nursing home care on the other hand represent the elderly care market. Individuals in need of care tend to choose between these options primarily based on their required level of care assistance (Charles and Sevak, 2005). Those with minor care needs typically obtain assistance from semi-professional family members or friends without any specific training. It is still common that the spouse, and women in particular, carry out the care provision for their spouses (Jong et al., 2023). In 2023, almost 2.6 million Germans obtain informal home care (Statistisches Bundesamt, 2020).

If individuals' care needs significantly impair daily life or if medical assistance is needed, formal ambulatory home health care is usually the preferred choice. Home health care predominantly takes place in the dwellings of care recipients, where nurses provide medical care and hygiene assistance. In Germany, the number of home health care providers has increased from 10,500 in the early 2000s to 14,700 in 2021, with around 400,000 employees care for nearly 1,000,000 care recipients (Heger et al., 2021).

Once care needs become more severe and people cannot live in their own homes anymore, they move into nursing homes. This generally makes the nursing home a last resort for many elderly people. Stationary nursing home

care offers inpatient care in a residence environment that is adapted to the requirements of the care recipients. It offers both short- and long-term stays. Next to a new place of living, nursing home care delivers care procedures that are conducted by trained nurses. Around 15,400 nursing homes serve approximately 960,000 individuals in need of care while employing over 790,000 people (Heger et al., 2021). Overall, people with care needs prefer to stay in their own homes as long as possible before moving to a nursing home (Karsch-Völk et al., 2012; Plöthner et al., 2019). The reasons are manifold and include privacy concerns and the fear of moving to a last resort. Nonetheless, the cost for nursing home care remain a notable factor influencing the decision to move into formal care (Bakx et al., 2020).

All three care types offer care work as the same differentiated good. However, it is clear that they are no perfect substitutes as they are used to serve consumer groups with different needs.

To quantify the care needs, the Medical Review Board, an independent institution for health care quality evaluation in Germany, classifies individuals in need of care into five levels of care dependency. The higher the level, the more extensive the care needs. In 2022, around five million Germans were in need of care (Statistisches Bundesamt, 2020). More than half of these people, 2.7 million, are classified in the lower care level one and two. The other half are assigned to a higher level, and thus more likely to demand formal care, i.e. as ambulatory home health care services or stationary nursing home care (Heger et al., 2021).

Transferring the family care work to formal care providers increases the financial burdens for families significantly. To alleviate care recipients, Germany introduced the long-term care insurance in 1995. The long-term care insurance has been integrated into the social coverage framework in Germany and is closely related to the statutory health insurance. It is mandatory for all German taxpayers to contribute a percentage ranging from 1.7 to 2.3 of their gross income to the long-term care insurance (see §72 SGB XI).

The German long-term care insurance provides partial coverage, offering a fixed amount of money to individuals in need of care to help covering essential expenses. The exact sum varies according to the needs and type of care required.[1] Those relying on informal home care receive a monthly sum of up to 900 Euros to address fundamental caregiving expenses. In cases of home health care provision or nursing home care, the long-term care insurance covers services with up to 2,100 Euros per month. Any remaining expenses are carried by the care recipients themselves.

[1] Table C.1 provides an overview of the financial support by the long-term care insurance.

An insurance that covers basic caregiving costs is a fundamental market intervention. There are several market failures that can justify intervening in the market in such a way. These include lacking transparency with respect to the provided quality and prices, excess demand due to demographic trends, and the workforce shortage. Over the last decade, German regulators introduced multiple reforms to address these market failures.[2]

Information asymmetry among providers and individuals in need of care is a significant challenge in the elderly care market. Care recipients and their families frequently lack comprehensive information with respect to available providers, care quality, and costs, resulting in less optimal decisions. To address this concern, German regulators have introduced several minimum standards, as e.g., staff qualification requirements, and deployed insurance entities as gatekeepers. Insurances are responsible for granting supplier contracts to those who meet minimum requirements for personnel qualifications and building standards (§72 SGB XI).

To enhance transparency regarding the supply, quality, and costs of care, Germany introduced quality report cards in 2008. long-term care insurances disclose the results of the quality assessments of formal care providers that are performed by the Medical Review Board on publicly available comparison engines. Since the report cards enhance transparency concerning quality and pricing, they enable individuals in need of care and their family members to select appropriate providers within their vicinity.

We observe a demographic trend towards an aging and increasingly frail population on the one hand and a substantial workforce shortage on the other hand. This impacts the long-term care market in Germany in particular as demand for elderly care increases while formal care providers are struggling to find enough qualified personnel. One driver of the demographic trend is the increase in average life expectancy due to higher living standards and better medical treatments. Therefore, more individuals require care treatment for a longer period of time. Second, German fertility rates experienced a sharp break after introducing the birth control pill. Thus, the average population age increases and therefore, also the demand for nursing services. The demographic trends are closely related to the personnel shortage as Germany is substantially lacking professional workforce. To solve the personnel shortage in care professions, German regulators take action in reforming the educational training for nurses. The "Generalistische Pflegeausbildung" covers all nursing professions, including elderly care, hospital care, and pediatric care. This program provides a broad foundation in nursing skills, allowing

[2]For the latest reforms compare the long-term care strengthening acts (Pflegestärkungsgesetz I (2015), II (2016) and III (2017), Konzertierte Aktion Pflege (2020) and Gesundheitsversorgungsweiterentwicklungsgesetz (2021)).

nurses to choose their specialization after completing their training (Naumer and Höpfner, 2020). Furthermore, German nursing facilities have started to accept nurse degrees from other countries and to recruit foreign nurses (Reiff et al., 2020).

The regulatory interventions also go along with new challenges for the elderly care market. For example, the elderly care market lacks free market entry due to the long-term care insurance as a gate-keeping authority. Moreover, facilities cannot set prices freely, and might therefore lack financial flexibility to increase investments into nursing personnel to increase capacities and to provide better quality of care. Price regulations aim at keeping elderly care affordable. Facilities negotiate prices with the insurances, communities, and social funds. While the negotiations are confidential, they are fundamentally guided by the average costs of other providers (Mennicken et al., 2013; Augurzky et al., 2008; Rothgang, 2005). The social funds offer assistance by covering the care costs if care recipients and their family members are unable to afford the care provision. Hence, social funds are interested in keeping prices low.

In this doctoral thesis, I analyze four main challenges of the elderly care market in four chapters as depicted in Figure 1.1.

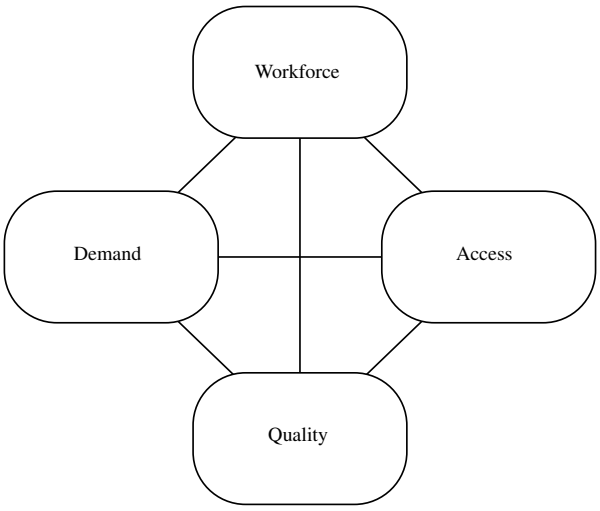

FIGURE 1.1: Challenges of the elderly care market

In Chapter 2, my co-authors and I examine the effect of a higher density of providers in the ambulatory home health care market on the *quality* of care. Generally, one would assume that increasing density would result in competition with improved quality. However, our findings suggest that the significant role of *nursing workforce* questions this assumption. Chapter 3 examines the management metrics of nursing homes in the context of an urgent *personnel shortage*. Our findings depict a distinct escalation process that starts with publishing job vacancies, progresses to an increase in personnel workload, and ultimately results in reduced *access* and capacities. Chapter 4 contributes to

the question why individuals in need of care *demand* stationary nursing home care. One of the answers highlights the limited availability of informal home care options. The final Chapter 5 explores higher single room standards in nursing homes and whether those restrict *access* for individuals in severe need of care. Additionally, we analyze the impact on the informal home care market when access to nursing home care is limited. In the next paragraphs, I introduce the chapters in detail and explain how they address the four main challenges in the elderly care market (see also Table 1.1).

TABLE 1.1: Overview dissertation projects

Project	**Research Question**		**Data**	
Provider Density and Quality in Home Health Care	What is the effect of provider density on the quality of home health care provision?		Transparency report cards, INKAR, IAB	
Addressed Challenges	*Quality*	*Workforce*	*Demand*	*Access*
Nurse Shortage and Capacity Management of Nursing Homes	How do nursing homes manage capacities in times of workforce shortage?		German Care Statistic INKAR, IAB	
Addressed Challenges		*Workforce*		*Access*
Regional Variation in the Utilization of Nursing Home Care in Germany	What drives the regional variation of nursing home care utilization?		German Care Statistic INKAR, IAB	
Addressed Challenges			*Demand*	*Access*
Nursing Home Access and Informal Home Care Recipients' Well-Being	What is the effect of increasing single-room shares on nursing home access and informal home care?		German Care Statistic INKAR, IAB	
Addressed Challenges			*Demand*	*Access*

Chapter 2, **Provider Density and Quality in Home Health Care**, discusses the effect of ambulatory home health care provider density on the reported quality. The German regulators aim to promote the supply of home health care provision and thereby increase access to formal care. Thus, regulators try to keep barriers to market entry to a minimum. As a consequence, the density of home health care providers has increased over the last decade. Microeconomic models predict higher quality in more competitive areas when consumers can compare the quality and choose among providers, with prices being regulated. The underlying idea is that, if prices are regulated, providers will compete on dimensions other than the price to gain market shares (Gaynor and Town, 2011). If this effect also applies to the home health care market, the expansion of supply can increase access to formal care and higher quality of care. To analyze this empirically, we use the quality report cards from 2011 to 2019. In our analyses, we instrument the ambulatory home health care provider density with the regional nursing home density to account for potential endogeneity between demand and provider density. Contrary to the theoretical prediction, our results reveal that higher provider density leads to slightly lower rather

than higher care quality. In a second step, we then discuss two potential channels for these effects. In contrast to Forder and Allan (2014), we do not find any significant correlation between prices and provider density in Germany. As an alternative explanation it becomes evident that excessive demand for formal care hinders the competition in quality from unfolding as expected. Further, we find, that the lack of qualified nursing staff - the main input factor in nursing care - seems to decrease quality. We also examine whether a higher provider density correlates with better access to formal long-term care provision. We can show that an increase in home health care providers access is associated with a reduction in informal home care provision. Our findings demonstrate the complex connection between the formal care access, quality and nursing personnel as a crucial input factor.

Chapter 3, **Nurse Shortage and Capacity Management of Nursing Homes**, aims to investigate the capacity management of nursing homes experiencing personnel shortage. For our estimations, we utilize the German Care Statistic provided by the German Federal Statistical Office. The dataset encompasses a comprehensive sample of German long-term care facilities, personnel, and recipients, covering the years from 2007 to 2017. It provides valuable insights into personnel qualifications, job roles, and contractual working hours. In addition, we augment data on open nurse vacancies from the Research Institute of the Federal Employment Agency (IAB). Our data provide not only information about employed nursing personnel but also about the lacking workforce. We investigate how various capacity management metrics in nursing homes, including the nurse-to-resident ratio, the qualification mix of nursing personnel, and the occupancy ratio, correlate with the county-level number of published vacancy notes. These vacancy notes serve as our measure of nursing shortages. Our methodological approach involves the use of pooled cross-sectional data and linear regression analyses. The capacity management metrics we examine are highly relevant from a public health policy perspective. For example, the nurse-to-resident ratio can be seen as a proxy for the nursing homes' ability to provide intensive, high-quality care (Kang et al., 2023; Shi et al., 2023; Dierckx de Casterlé et al., 2020; Sefidani Forough et al., 2020; Teng et al., 2010). Our findings reveal that higher nursing shortages are correlated with a significantly lower nurse-to-resident ratio, a shift in the staff qualification mix, and a reduced overall provision of care.

Chapter 4, **Regional Variation in the Utilization of Nursing Home Care in Germany**, takes a closer look at the demand side of formal care. Here, we examine regional heterogeneity in the utilization of nursing home care in Germany. The regional shares of the care-dependent population in nursing homes vary between 51 to 160 percent of the national average, which was 29 percent in 2017. We use comprehensive data that combines the German Care

Statistic with regional demographics and socio-economics information from the German Statistical Offices (INKAR). Inspired by the health care services utilization model proposed by Andersen and Newman (2005), we identify four groups of regional characteristics contributing to nursing home demand. We call them the care needs, care recipients' predisposing and enabling characteristics, as well as supply. In our analyses, we estimate ordinary least squares (OLS) models with regional and time fixed effects to uncover the variation in the utilization of nursing home care. To account for spatial dependencies in utilization as well as regional shock spillovers we additionally apply spatial autoregressive (lag) models. Our models can predict more than 70 percent of the regional variation of nursing home utilization. Therefore, we can contribute to the discussion regarding driving factors of future nursing home care demand.

Chapter 5, **Nursing Home Access and the Effect on Informal Home Care**, concentrates on how access to nursing home care is impacted by the trend of increasing number of single rooms in nursing homes. This trend is driven by the growing emphasis on person-centered-care and further reinforced by the introduction of regulatory requirements in approximately half of the German federal states. This chapter makes a valuable contribution to addressing two open questions: Do more single rooms decrease access to nursing home care? If so, do these single room shares also affect the level of care dependency in the informal home care sector or can the elderly care market mitigate this effect by reallocating more individuals in severe needs to nursing home care? We hypothesize that building single rooms rather than shared-rooms prevent nursing homes from keeping up with the increasing demand for nursing home care. As a consequence, access reductions result in inadequate care provision for individuals in severe need of care besides a higher burden for the family care givers in informal home care. While residents benefit from more privacy due to person-centered-care, we assume that a larger share of individuals in severe need of care is redirected into informal home care (Bakx et al., 2020; Groenou and Boer, 2016). Despite an unbroken trend towards more single rooms and regulations for higher shares, we are the first to evaluate this trend. We base our analyses on the data from the German Care Statistic. The data reveal an extensive overview about the whole elderly care market including the individuals in need of care and the facilities. We apply an instrumental variable approach to estimate a causal effect. Our instruments are inspired by the single room quotas introduced by federal state authorities which have a direct effect on the nursing homes' single room shares. We reveal a negative effect of higher-single room shares on the access to nursing homes. However, the share of individuals in severe need of care remains unaffected. This is a positive message for all informal home care givers and care recipients. Thus, our results reveal substantial access limitations due to higher-single room shares,

which however do not result in higher shares of severely dependent individuals in informal home care nor in a higher burden for informal care givers.

The four chapters of this dissertation provide several valuable contributions to the literature, both with regard to the data that was used as well as the insights that the results provide. First, we are among the first researchers to use data from the German Care Statistic, which cover a vast scope of information and therefore enable us to conduct in-depth analyses with regard to the German elderly care markets. Second, we use novel data from the transparency reports that are provided by the comparison engines by PAULA, AOK, as well as BKK. We collected this dataset by scraping the information from the available comparison engines. To our knowledge, we are the first researchers who work with the data, thereby contributing to the analysis of home health care quality. Third, the results we obtain from our analyses contribute to the understanding of the market mechanisms within the elderly care sector. Here, we establish a clear causal relationship between home health care provider accessibility and the quality of care. Additionally, we shed light on how nursing homes address personnel shortages and draw conclusions about nursing home access. Furthermore, we provide insights into factors explaining regional variation in nursing home care. Finally, we show that access limitation due to a higher number of single rooms increases in nursing home care and evaluate the effect on informal home care. Thereby, our empirical findings uncover previously unexplored relationships and causal interactions among the four key challenges in the care market: quality, workforce, demand, and access.

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Chapter 2

Provider Density and Quality in Home Health Care: What Role Does Labor Supply Play?

With Annika Herr and Olena Izhak

2.1 Introduction

Home health care is designed to help care-dependent people maintain their independence by providing medical care and assistance with basic daily tasks in their homes. As a result of demographic trends, there has been a significant increase in demand for home health care over the past 20 years (Blümel et al., 2020; Bundesamt, 2020). Germany has low market entry barriers to promote the supply of care providers. As a result, the number of providers increased, on average, by 19% across all German counties. An average provider served 32% more patients in 2019 than in 2011. However, only high-quality home health care provision can significantly delay the transition to nursing home care, increase patient satisfaction, and ultimately reduce long-term costs for complex care (Pick and Brüggemann, 2016).

In this study, we analyze the effect of home health care provider density (measured by the number of providers within a specific radius) on provider's reported quality. We then discuss two potential channels for the effects: price elasticity of demand (similar to Forder and Allan (2014)) and the supply of (qualified) nursing staff (inspired by the theoretical ideas of Bardey and Siciliani (2021)). We also examine whether a higher provider density correlates with better access to professional LTC provision and, in turn, a lower regional share of informal care.

Microeconomic models predict higher quality in more competitive areas when consumers can compare the quality and choose among providers, and when prices are regulated, which is the case for hospitals and LTC providers in many countries, including Germany (Gaynor and Town, 2011; Brekke et al., 2010; Brekke et al., 2007; Karlsson, 2007; Beitia, 2003; Nuscheler, 2003; Gravelle and Masiero, 2000). The underlying idea is that, if prices are regulated, providers will compete within non-price dimensions to gain market shares (Gaynor and Town, 2011). However, research on changes in the market structure of LTC is scarce and inconclusive (Yang et al., 2021; Hackmann, 2019; Forder and Allan, 2014; Jung and Polsky, 2014; Zinn, 1994). Using two-stage least squares regressions, Zinn (1994) finds that competition has non-linear effects on Medicare and Medicaid-financed nursing homes, while Forder and Allan (2014) examine the British nursing home sector and show that more competition decreases quality due to increased price pressure. Hackmann (2019) simulates price and competition effects on quality and finds only minor quality increases when market concentration decreases. Jung and Polsky (2014) are the first to analyze home health care providers. Their results reveal a nonlinear impact of competition that also differs across the chosenquality indicators in the United States.

Our research makes several contributions to the existing literature. First, we add to the scarce literature on home health care, compiling a novel data on provider quality and location. More specifically, we are the first to analyze the provider density causally using a unique set of quality report cards that have been collected and published by an independent administrative agency. To measure effects on LTC quality, we construct indices based on specific reported quality indicators. Second, we exploit changes in the nursing home market to inform about our identification strategy and apply an instrumental variable approach to account for potential endogeneity between quality and provider density. Third, we introduce new theoretical ideas and emphasize the importance of a sufficient supply of skilled nursing personnel. Based on four repeated cross-sections with regional and time fixed effects and a large set of controls, we find that higher provider density leads to lower home health care quality, though the effect is small. In contrast to Forder and Allan (2014), we do not find any significant correlation between prices and provider density in Germany that may explain the effect.

Therefore, we seek an alternative explanation: similar to the ideas of Bardey and Siciliani (2021), we stipulate that the lack of *qualified* nursing staff – the main input factor in nursing care – may potentially decrease quality.[1]

[1]Ruffini (2022) shows that higher minimum wages lead to higher quality in US nursing homes.

We use data from the German employment agency at the county level and observe an increasing absolute number of vacant nursing positions in areas with more providers, which is indeed associated with lower quality. We can also show that the increase in the number of home health care providers is correlated with a lower share of informal care at the county level. Thus, at the same time, extra home health care is an important factor to satisfy demand for professional LTC.

In Section 2.2, we first present the institutional setup and our theoretical ideas on the relation between home health care density and quality. In Section 2.3, we discuss our identification strategy. Next, we describe the data and institutional background of our chosen outcome variables. In Section 2.5, we report our main results and analyze two potential channels that may explain them. We conclude by summarizing our key findings and their implications in Section 2.7.

2.2 Institutional setup and theoretical considerations

2.2.1 Market entry and prices for home health care in Germany

The market for HHC providers is characterized by regulated prices, public quality reporting, and low barriers to market entry. LTC insurance covers the home health care (HHC) services in line with the elderly's diagnosed level of needs. The so called Medical Review Board (MRB)[2] and also assigns one of five levels of care dependency to people who are in need of care (§15 SGB XI). Level one implies minor physical and cognitive constraints, while level five points to severe cognitive and physical limitations. German statutory LTC insurance is mandatory and reimburses the claimed services according to the degree of care dependency or a lump-sum payment for informal care while care recipients bear the remaining costs if they ask for more services (§4 SGB XI). Cost per service is regulated at the provider or federal state level and must not vary by the payer. Care prices result from providers negotiating with health insurance funds or political bargaining processes.[3] Market entry is simple. Since HHC is provided at home, only office and supply storage space is necessary for providers to operate. Furthermore, providers can freely choose their location and start their business with one registered nurse (also self-employed) and one car. Following the market-opening clause (§72 SGB XI) providers receive a supplier contract with the LTC insurances if they fulfill the requirements.

[2]MRB: The Medical Review Board (MRB) is an independent institution for health care quality evaluation (www.bundesgesundheitsministerium.de last time accessed in October 2023).

[3]The German price regulation is specific to each federal state and ranges from provider-level price negotiations with the LTC insurance funds based on §89 SGB XI to fixed prices for each provider within a federal state. Providers cannot set prices freely (§82 SGB XI) or offer LTC services in addition to the agreed ones (Heiber, 2019). LTC insurance would not agree to prices that are decoupled from remuneration tariffs or average costs.

The supplier contracts with the insurances ensure reimbursement. Quality is monitored regularly by the MRB, an independent institution, and is published online for each provider. For more details on the quality information we use, compare Section 2.4.1.

2.2.2 Theoretical considerations

We now present three theoretical concepts that can enhance our understanding of the relationship between market entry and quality in the HHC industry. Drawing from these theories, we can formulate our hypotheses to be tested empirically.

We assume that HHC providers produce a single differentiated good with a high quality being strictly preferred (Tirole et al., 1988). Following Konetzka and Perraillon (2016) and Herr et al. (2016), publicly disclosed quality reports increase the quality of LTC.

Given fixed prices, non-binding capacities and full information, classic microeconomic theory suggests that an increase in provider density leads to an improvement in quality since firms cannot adjust prices to increase (or maintain) quantity (Gaynor and Town, 2011).

More specifically, in this framework, all providers have the same input prices including variable costs and a fixed cost component. The variable costs depend on the quantity and the level of quality. Demand elasticity for quality increases with the number of providers in a market. Following this, an increase in providers is accompanied by an increase in equilibrium quality.

Second, Forder and Allan (2014) explore the English NHS, a nursing home market where providers determine the prices. Increasing competition leads to price reductions, which has negative implications for quality. However, in our specific setting, providers have limited bargaining power to raise prices due to regulated reimbursement processes. Hence, the likelihood of setting their own prices is low.

Nevertheless, some providers may still be motivated to negotiate lower prices to increase demand. This could be advantageous for efficient providers who can attract more customers by offering lower prices while maintaining an acceptable quality level. It is important to note that the bargaining process may be influenced by the average regional price. Consequently, this may put downward pressure on prices, leading to a decrease in the average quality.

Third, inspired by Bardey and Siciliani (2021), who offer insights into the two-sided nature of the LTC markets, we highlight the importance of the nurses' bargaining position vis-à-vis the providers, where the care recipients play a

minor role (we rather observe excess demand than excess supply). In the labor market, the aggregated demand for labor (D_1) depends on the respective wage level. Aggregated labor supply is separated into registered nurses (S^{hq}) and assistant nurses (S^{lq}). We assume that the regulated price ($\overline{p}$) defines the highest possible wage HHC providers can pay for nurses at non-zero profits.

To satisfy total market demand until q^1, providers employ less expensive nursing assistants q_1^{lq}, who provide lower quality, to work alongside registered nurses. The resulting mix of registered nurses and assistants ((q^{hq}/q^{lq})) represents quality in our theoretical framework (Büscher et al., 2022).

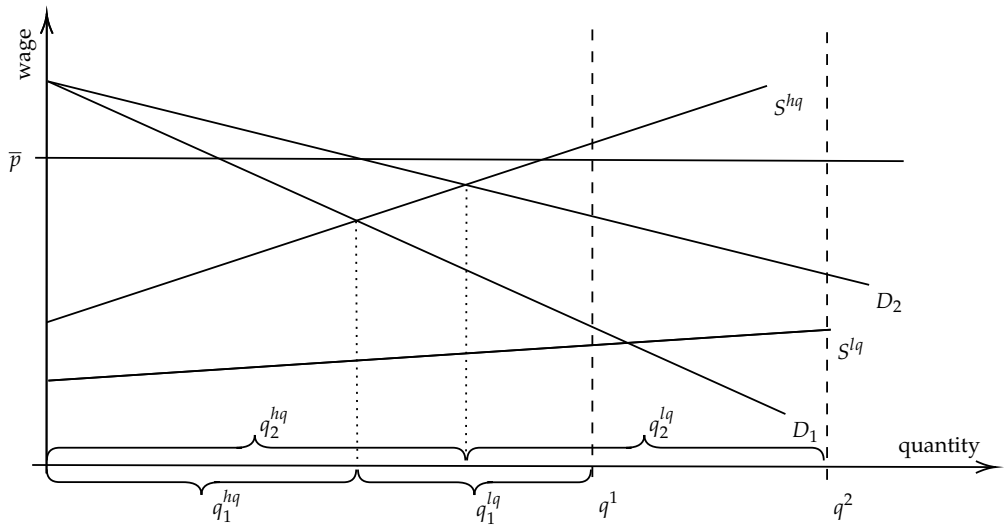

FIGURE 2.1: Labor demand and supply along different provider densities

Figure 2.1 describes our idea graphically. We set a fixed price $\overline{p}$. We model two levels of quantity demanded by care recipients ($q^{1,2}$), where the increase in demand for HHC is due to demographic trends and increased morbidity. Further, we assume that providers can always employ less expensive nursing assistants such that all care recipients receive some kind of HHC (up to q^2). We compare the labor market demand with lower and higher provider density (D_1 and D_2). An increase in the number of providers turns the demand for nurses upward (D_2). As market entry barriers and upfront costs are low, more providers enter the market to offer their services. Here, the supply of registered nurses (S^{hq}) and assistant nurses (S^{lq}) remains constant in the long run. The number of nurses may increase in the long run, though.

As a result of the demand shift, there is a shift in the distribution of nursing personnel among the HHC providers. Due to the shortage of professional nursing personnel and regulated reimbursement levels, providers are compelled to employ a combination of registered and assistant nurses. In turn, the qualification mix is now lower compared to the previous situation ($q_1^{hq}/q_1^{lq} > q_2^{hq}/q_2^{lq}$), which reduces quality.

Figure 2.1 depicts a scenario where the equilibrium wage for nurses remains below $\overline{p}$. If the demand for nurses increases further, the allocation effect would be supplemented by a wage cap for registered nurses and even more assistant nurses would be employed. Here, we run into a market failure which ultimately results in a lower quality due to a lower qualification mix of the nursing personnel.

Based on the theoretical frameworks presented, we can identify three potential channels that shed light on the connection between provider market entry and quality. First, we can establish the classic microeconomic model, where we would anticipate a positive impact of competition for care recipients on quality when prices are regulated. Second, still, providers may negotiate lower prices to increase demand, which would reduce the average quality. Third, if there is under-supply, a negative effect on the quality could arise due to a shortage of qualified nursing personnel in regions with higher market density.

2.3 Identification strategy

We estimate a multivariate linear model with repeated cross-sections and regional and time fixed effects. Our approach to modeling the relation between quality and supplier density has been widely used to estimate the effects of hospital provider competition (see Gaynor and Town, 2011, and Jung and Polsky, 2014, who focus on the HHC setting).

Equation (2.1) presents our empirical model. We regress disclosed quality q_{it} on provider density within multiple radii r around provider i in year t, where quality varies from 0 to 100.

$$Q_{it} = \beta_0 + \beta_1 DEN_{irt} + \beta_2 \mathbf{DS}_{ct} + \beta_3 \mathbf{CS}_{it} + \gamma \overline{p}_{mt}^{NH} + \kappa_c + \tau_t + \varepsilon_{it} \tag{2.1}$$

We also include a vector of regional demand characteristics at the county level (DS_{ct}). The regional characteristics represent four categories: demographics, medical infrastructure, labor force, and income, and other regional indicators. We provide further details about the controls in the Appendix (Table A.1). Additionally, we include provider size dummies to control for the number of care recipients. Size tertile fixed effects allow us to control for different cost structures (CS_{it}) and economies of scale. We can observe HHC prices only for the last wave in 2019. While earlier studies omit price information from the model (e.g., Gaynor and Town, 2011), we use the municipality's average nursing homes' out-of-pocket contribution per month ($\bar{p}_{mt}^{NH}$) as a proxy for the regulated regional price level. Nursing home price regulation deviates from the HHC regulation. However, the average nursing home care prices correlate

with the HHC prices due to similar cost structures and the federal states' willingness to pay. We also add county (κ_c) and time (τ_t) fixed effects to control for county-specific regulation and preferences with respect to HHC and audit wave-specific properties. We cluster standard errors at month and county of the quality-assessment ($county \times assessment\,month \times year$).

We expect the market structure to be endogenously related to quality, e.g., due to reverse causality and/or omitted variable bias (Yang et al., 2021). This may bias the provider density's point estimate in Equation (2.1) despite using control variables for many observable regional characteristics and regional fixed effects for unobservable time-invariant characteristics.

In practice, the bias is likely coming from the following four channels. First, options and preferences for informal LTC by relatives or friends are unobservable and depend on cultural background, income, family structures, flexible work arrangements or the opportunity cost of providing informal care (Plöthner et al., 2019). This may affect both provider density and its quality. HHC is very likely to be paired with informal care provided by relatives. We assume that demand for HHC and therefore provider density may be lower if patients get more informal support. HHC quality, on the other hand, may be higher in regions with more informal care due to a closer monitoring by caring relatives. Furthermore, relatives can also offer a helping hand. Therefore, we expect that the true effect is larger than the downward biased OLS estimate.

Second, we cannot observe the patients' health status. A more severe case-mix affects care intensity, which requests more qualified personnel and therefore affects quality. We expect higher provider density in areas where, on average, the care dependent have poorer health and thus demand is higher. Again, we expect this will contribute to a downward bias of our OLS estimates.

Third, we include the nursing home care out-of-pocket prices as a proxy to control for an average LTC-price level. However, we cannot observe the price sensitivity of high-skilled nurses. Union tariffs can give some orientation, but we do not observe the individual or regional reservation wages. Concluding from our theoretical model, nurses have a higher reservation wage if provider density is higher (for example, because they can shop around for positions with better wages). On the other hand, a higher reservation wage is also associated with a lower skill mix, as the price cap hinders the provider's ability to employ more high-skilled nurses.

Finally, we expect a reverse causality effect. Disclosed high quality can result in lower provider density if new providers prefer to avoid strong competitors.

To eliminate the endogeneity, we instrument the HHC provider density with the number of nursing homes located within a 10 km radius of a given HHC

provider. As a second instrument, we also count nursing homes within a 5 to 10 km band around the HHC unit leaving out the first 5 km around the HHC provider in order to not interfere with similar demand characteristics. Figure 2.2 illustrates the idea.

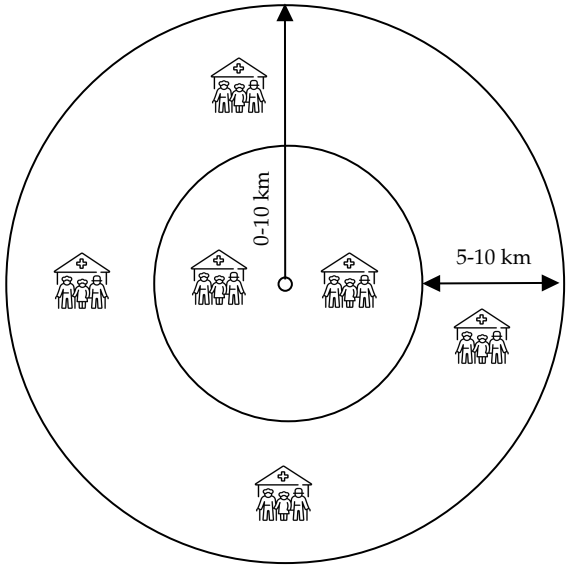

FIGURE 2.2: Instrument for provider density: graphical explanation
Note: This figure shows exemplary nursing homes built within a 10 km radius and a 5 to 10 km band around the HHC provider represented by the center of the circle.

We assume that the nursing home care and the HHC markets are closely related since providers in both markets offer a form of LTC and are regulated by the same regional bodies and communities. Regions could be attractive for LTC providers due to LTC-friendly policies. The basic idea originates from the industrial economic literature in terms that providers in both markets face similar input prices. This allows us to get rid of unobserved demand characteristics that drive the endogeneity of the provider density.

Regarding the exclusion restriction, we argue that nursing home provider density is exogenous with respect to the HHC demand, because they serve different consumer groups. The literature clearly indicates that the elderly prefer LTC at home rather than being provided for in a nursing home (Karsch-Völk et al., 2012; Plöthner et al., 2019). This is in line with the regulatory guidelines saying: "HHC is preferred to nursing home care" (§3 SGB XI). HHC is less resource-intensive and patients know, once transferred to nursing home LTC, it is unlikely for them to recover and return to HHC. We conclude that nursing home provider density is unrelated to unobservable characteristics of the HHC demand.

To offer care services at a high-quality level, both nursing homes and HHC providers need high-skilled nursing personnel. Hence, both markets could interact within the labor market dimension. To make sure that HHC and nursing home providers are not affected by the same price sensitivity of nurses,

our second instrument includes nursing homes at least 5 km away from the HHC provider. Nurses often have part-time jobs and are unlikely to respond to job offers outside their direct catchment area. Furthermore, nurses prefer working either in nursing homes or in HHC since both types of work are very different. They are not likely to switch from one type to the other.

Lastly and most importantly, we argue that entry decisions differ vastly between nursing homes and HHC providers. While the first are interested in long-term returns, which mostly depend on the demand side, the latter depend more on the availability of nursing care staff to be able to enter or expand the services. Both, entry and exit are easier for HHC providers, which increases fluctuation and flexibility.

Equations (2.2) and (2.3) present our two-stage least squares model, including the instrumented provider density measure.

First stage:

$$DEN_{irt}^{HHC} = \alpha_0 + \gamma_1 DEN_{irt}^{NH} + \alpha_1 \mathbf{DS}_{ct} + \alpha_2 \mathbf{CS}_{it} + \alpha_3 \overline{p}_{mt}^{NH} + \kappa_c + \tau_t + v_{it} \quad (2.2)$$

Second stage:

$$Q_{it} = \beta_0 + \beta_1 \widehat{DEN_{irt}^{HHC}} + \gamma_1 \mathbf{DS}_{ct} + \gamma_2 \mathbf{CS}_{it} + \gamma_3 \overline{p}_{mt}^{NH} + \kappa_c + \tau_t + u_{it} \quad (2.3)$$

2.4 Data

We use three sets of data for our analysis. First, the quality report cards provide information on all HHC and nursing homes. The data cover four waves of publicly reported audits, corresponding to the biannual rhythm of the German LTC statistics in 2011, 2013, 2015, and 2019. The transparency reports contain detailed quality information, the number of customers on the day of inspection, and prices for nursing home care (prices for HHC in wave 2019 only). Since our data provides information about nearly every LTC provider in Germany, including their addresses, we are able to derive provider densities based on a specific radius, for both nursing homes and HHC providers.

Second, we use the "Indicators and Maps of Regional and Urban Development" (Bundesamt für Bauwesen und Raumordnung, 2023) that comprise socioeconomic and demographic indicators at the county level.

Third, we add information on nurse-type-specific job vacancies in HHC providers at county level provided by the Institute of Employment and Research (Statistik der Bundesagentur für Arbeit, 2023).

2.4.1 German quality report cards

The Medical Review Boards of the German Statutory Health Insurance (MRB)[4] regularly inspect the quality of nursing homes and HHC providers. The latter are evaluated based on 46 criteria, formally divided into four broad categories: nursing services, medical services, organization, and customer satisfaction (see Appendix A. 2 for detailed survey questions by category). In practice, these categories measure the outcome quality of care, the quality of medically indicated procedures, the corresponding quality of organizational and contractual arrangements as well as the quality based on a customer survey, respectively (Hasseler and Wolf-Ostermann, 2010). The MRB assesses HHC providers based on audits and in-person surveys of the care recipients. Auditors randomly select and interview up to nine care recipients of each provider to ensure the inspection criteria are being met (Sünderkamp et al., 2014).

Insurance companies used to publish summarized results of the MRB inspections as German school grades from one (=very good) to five (=failed) online on public comparison engines (AOK's `www.pflege-navigator.de` or BKK's `https://pflegefinder.bkk-dachverband.de/`). The primary purpose of these engines is to enhance the transparency of the LTC market and to help seniors and their relatives make better care provider choices. The report cards also list all single quality criteria and price information. We provide an example of an English translation of the quality report cards and the 46 quality criteria in Appendix A. 1 Figure A.1.

Following Hasseler and Wolf-Ostermann (2010), the quality report cards' indicators need to be treated carefully. Not all of them provide valid information on the actual medical or service quality, which results in non-realistically good school grades. Thus, analogously to Herr et al. (2016) and Herr and Hottenrott (2016) for nursing homes, we identify a subsample of relevant indicators singled out during interviews with nurses. We allocate the indicators into two categories, namely nursing quality and medical quality.

The nursing quality comprises six labor and compliance-related survey questions such as following the protocol and fulfilling the contractual agreements. For medical quality, we use three questions, for example, the share of care recipients for whom the medication provided by the HHC provider corresponds to the doctor's prescription. In Appendix A. 3, we list the corresponding survey questions. To address the concerns of overestimating the reported quality, we value the indicator results more strictly. For each criterion, we assign the value of 100 if it perfectly meets the requirements for *all* inspected residents

[4]German: Medizinischer Dienst der Krankenkassen (MDK)
The MRB is an independent non-profit organization providing socio-medical specialist advice to the German Statutory Health and Nursing Care Insurances and is organized at federal state level.

and zero otherwise, following Herr and Saric-Babin (2016). Subsequently, we construct our quality indices (Q_i) as averages over the selected criteria and obtain values between zero (none is fulfilled for all care recipients) and one hundred (all are fulfilled).

$$Q_i = \frac{1}{n} \sum_{i=1}^{N} q_i \quad i = 1, \ldots, n \tag{2.4}$$

2.4.2 Provider density

Competing HHC providers are located within a fixed regional market area of a maximum 20 km mandated by the regulation (§72 SGB XI). To quantify provider density, we apply two market-size definitions and count the number of HHC providers within 10 km and 20 km radius areas around each of the 10,000 providers in our data.

We do not use conventional concentration measures for two reasons. Firstly, following the two-sided market model from Bardey and Siciliani (2021), the relevant competition differs over whether we use the number of care recipients or the number of nurses to calculate market shares. Deciding for one of the two would mean anticipating what HHC providers are competing for. Second, our data does not provide any information about the nursing personnel at the provider level. Since we want to be open regarding the labor market channel, we use provider density as the only competition indicator.

2.4.3 Descriptive statistics

The four transparency-report waves comprise 47,649 observations in total. For our analyses, we exclude outliers with respect to the size and density of suppliers. This includes three German cities: Hamburg, Berlin, and Munich (4,091 observations) as well as monopolies (i.e., a single provider within a 10 or 20 km radius) in the respective provider density area (3,419 observations). Furthermore, we lose 1,017 observations due to missing information. Our final sample represents approximately 10,000 outpatient LTC providers per wave and results in 41,658 observations in total. Figure 2.3 indicates that the quality of care increases over time. Here, we compare the final sample and the initial sample to show that our sample is representative. We present similar plots for the provider density in Appendix A. 4.

In Table 2.1, we present our sample summary statistics. On average, providers offer fair nursing care quality with a mean of 75 and a corresponding standard deviation of 28, which is relatively constant over time. Medical care quality increases from 77 in 2011 to 85 in 2019.

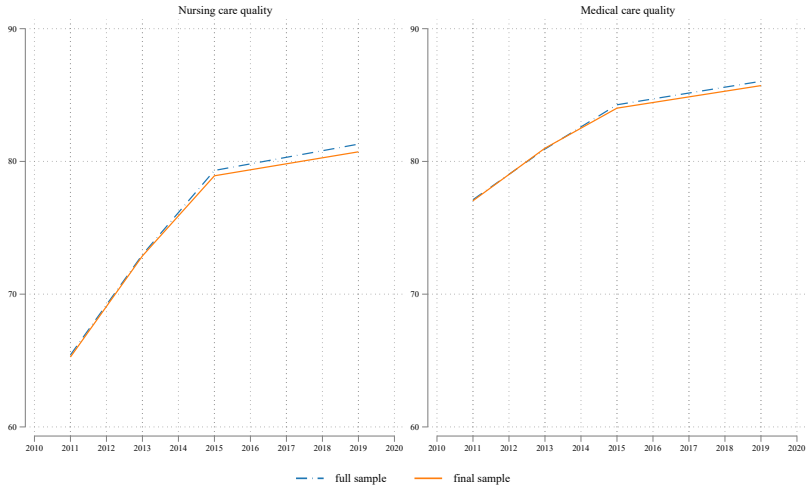

FIGURE 2.3: Quality indicators in full and final sample
Source: LTC quality report cards 2011–2019 provided by the Medical Review Boards (MRB). Observations: full sample 47,649; final sample 41,658. Excluded observations besides outliers: monopoly regions and mega cities such as Hamburg, Munich, and Berlin. *Note:* We compare the average quality in the full sample (dashed line) with our final sample (bold line). Trends over time are congruent in every quality specification.

In our main analyses, we focus on the 10 km radius market definition. However, we also include a broader radius of 20 km in our robustness checks. We show provider densities for the 10 and 20 km radius. We can refer from the descriptive statistics that, on average, we observe 30 HHC providers in a 10 km radius market and 84 providers within 20 km. Over time and across Germany, we find some heterogeneity in density, including a small decrease from 2011 to 2015 (30 to 26 within 10 km) and an increase after 2015 to an all-time high of 34. We also present individual provider information such as capacity and prices (the latter for 2019 only). On average, HHC providers serve 94 people in need of care. However, there is a striking variation in provider size across facilities and time.

In the same table, below the HHC provider densities, we present those for the nursing home market within a 10 km radius and 5–10 km radius band around the HHC provider. These indicators serve as instruments for the HHC provider density. The respective nursing home density is, on average, lower compared to HHC. In a 10 km radius, we observe, on average, 19 nursing homes. We postulate that this originates from larger facilities, higher investment costs, and lower demand for nursing home care. Again, descriptive evidence presents large variations since few HHC providers have zero nursing homes in the vicinity and others have more than 100.

Additional information regarding socio-economic and demographic heterogeneity at a county level is provided in Table A.1 in Appendix A. 4.

TABLE 2.1: Descriptive statistics

	2011–2019			
	mean	sd	min	max
Quality indicators				
Nursing care quality [index: 0-100]	74.56	28.06	0	100
Medical care quality [index: 0-100]	82.01	29.05	0	100
Home health care provider density				
Provider density [#], county	43.76	30.44	2	197
Provider density (log), county	3.555	.6848	.6931	5.283
Provider density [#], municip.	17.41	28.22	1	185
Provider density (log), municip.	1.887	1.357	0	5.22
Provider density [#], 10km radius	30.15	33.35	1	215
Provider density (log), 10km radius	2.836	1.111	0	5.371
Provider density [#], 20km radius	83.96	83.43	1	458
Provider density (log), 20km radius	3.981	.9666	0	6.127
Indiv. provider information				
Provider capacity [#]	94.43	73.09	1	514
Price per point [€]	.0518	.0065	.0372	.0683
Nursing home market				
NH provider density [#], municip.	11.08	16.25	1	87
NH provider density, 10km radius	19.36	19.54	0	118
NH provider density, 5-10km radius	11.63	13.3	0	92
NH total price [€], municipality	2623	442.5	1911	4260
Own contribution [€], municipality	1532	724.1	626.8	3983
Observations	41,658			

Sources: Transparency Reports (facility-level) and indicators and maps of regional and urban development (INKAR). There are 41,658 observations (HHC ltc facilities) over four waves: 2011, 2013, 2015, 2019. Quality indicators: nursing care quality (indic. 1, 10, 11, 12, 13, 14), medical quality (indic. 19, 23, 24): formular: $Z_i = \frac{1}{n}\sum_{i=1}^{N} z_i$. Provider density on municipality and 10, 20 km radius-level.

2.5 Results

Figure 2.4 indicates a negative correlation between the log of provider density and nursing quality and medical quality.

We regress provider-specific quality on the logged provider density within a pre-defined radius corresponding to our empirical model from Section 2.3. Table 2.2 reports the baseline results of Eq. (2.1) for the 10 km radius. The first column includes provider density only. We find a significant negative effect on both nursing and medical quality. Subsequently, we include the control variables and several fixed effects to take up more quality variation. The coefficients shrink slightly, but signs and significance levels are robust. The variance inflation tests do not hint at multicollinearity (results are available upon request).

However, we expect the ordinary least squares coefficients (OLS) to be biased.

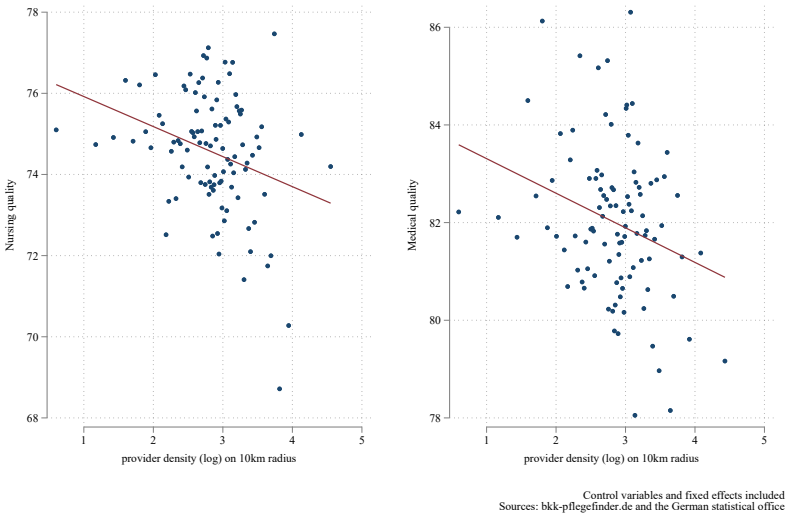

FIGURE 2.4: Scatter plot of quality and HHC provider density
Source: LTC quality report cards 2011–2019 provided by the Medical Review Boards (MRB). Observations: full sample 47,649; final sample 41,658. Excluded observations besides outliers: monopoly regions and mega cities such as Hamburg, Munich, and Berlin. *Note:* The binned scatter plots present the relationship between the quality measures and the provider density.

To verify the reliability of the negative relation, we go one step further and apply an IV approach, instrumenting the HHC provider density with the number of surrounding nursing homes.

Columns three ($IV_{\leq 10km}$) and four (IV_{5-10km}) provide our IV results instrumenting the HHC density with the nursing home density first on a 10 km radius and second on a $5-10$ km ring around the HHC provider. Again, we find significant negative effects. As expected, the instrumental regression results exceed the OLS point estimates in column 2 with all controls. Our instrument appears to be strong, as the first-stage F-statistics of the excluded coefficients are well over 100 (Staiger and Stock, 1997). In the first stage, we see our assumptions confirmed in that higher HHC provider density is associated with higher nursing home density (see Table A.3).

In Table 2.2, the point estimate for our first IV model ($IV_{\leq 10km}$) equals -1.45 or $\sim$ 2% at the mean for nursing care quality and -1 (or 1.2%) for medical care quality if provider density increases by one standard deviation. The effect size increases to 2.3 (or 3% for nursing care quality in our second IV model, which uses nursing home density within a 5 to 10 km distance.

The effect size appears small. However, since the density is increasing each year and variation is large, it is important to understand the mechanisms to be able to address decreasing quality in the HHC market.

TABLE 2.2: Effect of provider density on care quality in 10 km radius

	Nursing care quality			
	OLS_{10km}	OLS_{10km}	$IV_{\leq 10km}$	$IV_{05-10km}$
Provider density (log), 10 km radius	-.9816***	-.7404***	-1.446***	-2.287***
	(.1601)	(.2108)	(.3996)	(.4978)
Controls		×	×	×
Wave FE		×	×	×
County FE		×	×	×
Mean outcome variable	74.562	74.562	74.562	74.562
Provider density s.d.	1.11	1.11	1.11	1.11
Observations	41658	41658	41658	41658
1st stage excl. F-statistic			4699.65	3250.19
F-statistic	37.58	49.80	49.96	50.15
R2	0.002	0.136	0.136	0.135
	Medical care quality			
	OLS_{10km}	OLS_{10km}	$IV_{\leq 10km}$	$IV_{05-10km}$
Provider density (log), 10km radius	-1.233***	-.8528***	-1.049**	-.9654*
	(.1534)	(.227)	(.4074)	(.5121)
Controls		×	×	×
Wave FE		×	×	×
County FE		×	×	×
Mean outcome variable	82.013	82.013	82.013	82.013
Observations	40530	40530	40530	40530
1st stage excl. F-statistic			4618.30	3242.93
F-statistic	64.65	25.05	24.95	24.92
R2	0.002	0.075	0.075	0.075

$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$;
Standard errors clustered on county*assessment-month*year level in parentheses.
Sources: Transparency Reports (at facility-level) 'bkk-pflegefinder.de' and indicators and maps of regional and urban development at county level (INKAR: German Statistical Office). Four waves: 2011, 2013, 2015, 2019: in total 41,658 or 40,530 observations. Estimation strategy: $Q_{it} = \beta_0 + \beta_1 DEN_{irt} + \beta_2 \mathbf{DS}_{ct} + \beta_3 \mathbf{CS}_{it} + \gamma \overline{p}_{mt}^{NH} + \kappa_c + \tau_t + \varepsilon_{it}$; Outcome variable: nursing care quality $\in (0, 1/6, \ldots, 6/6)$ and medical quality $\in (0, 1/3, \ldots, 3/3)$; Density indicators: (log) number of providers in 10 km radius. Regional control variables at individual and county level are provided in the Appendix in Table A.1 or more details results in App. A. 6. Fixed effects: wave fixed effects and county fixed effects (4 digits); Instruments: (IV1: $IV_{<10km}$) NH market density two years prior within 10km radius and net number of NH entries in last two year within 10 km radius; (IV2: $IV_{05-10km}$) or NH provider density within 5–10 km radius.

2.5.1 Robustness checks

Our main analyses present a negative relation between provider density and quality. These results also hold for the 20 km radius (Table A.5 for regression results and Table A.4 for the first stage including controls in Appendix A. 6).

Since provider density is higher within a larger radius, we expect larger effects in magnitude. The effects are, on average, twice as large as for the 10 km radius. Here, the effect corresponds to a quality decrease by three to four points. Again, medical quality estimates are, on average, smaller but comparable (-2.25 and -1.75, respectively). The effects we find are small, but robust in sign and significance across all provider density and quality measures.

We next examine the non-linearity of the effect. For this, we split the sample into provider density tertiles with zero to 11, 12 to 30, and 31 to 2015 providers within 10 km. Table A.10 in Appendix A. 7 reports how the effect changes across the provider densities. We can rule out that the effect is driven by the

extremes. Rather, we show significant negative effects for the middle-sized provider densities.

We also exploit the different price regulations across German federal states. Prices are fixed in three federal states (Rhineland Palatine, Baden-Wuerttemberg, and Saxony-Anhalt), while in the other states, the LTC insurances negotiate with the individual providers. Splitting Germany into the two subsamples, we find that the estimated effects are both negative, but, on average, are larger in the fixed price regions. We provide results in more detail in Appendix A. 7.

2.6 Potential channels

The result that an increasing number of providers in a certain radius decreases quality slightly are in line with the two other potential mechanisms discussed in Section 2.2: the price channel in line with Forder and Allan (2014) or the labor supply mix related to Bardey and Siciliani, 2021.

First, Forder and Allan (2014) show that price reductions due to fiercer competition reduce the quality of nursing homes in the English NHS. Recent literature finds that quality also decreases with lower prices in German and Swiss nursing homes, leaving out competition (Herr and Saric-Babin, 2016; Reichert and Stroka, 2018; Heger et al., 2022). Since German LTC prices are negotiated or fixed at the county level, we argued that LTC prices are negotiated or regulated independent of the competitors. Still, we test first whether prices are correlated with provider density.

We observe prices for 7,965 HHC providers in 2019. This allows us to estimate a cross-sectional model at the provider level:

$$p_i^{amb} = \beta_0 + \beta_1 DEN_{ir}^{amb} + X_c + S_s + \kappa_c + \epsilon_{i,c} \tag{2.5}$$

where p_i^{amb} indicates individual comparable prices for 2019 and DEN_{ir}^{amb} is the provider density in a 10 km radius. We include the provider's size and controls at county level and county fixed effects.

We first show in Table 2.3 in columns 1 and 2 that indeed higher prices are indeed correlated with higher quality, as expected. Column 3 presents the correlation between density and prices, which turns out to be close to zero and statistically not different from zero. This supports our hypothesis that negotiated HHC prices are not affected by provider density.

We now turn to the second channel. Following Foster and Lee (2015), nursing personnel with adequate qualifications is essential for maintaining a high level of care quality. Besides little room for substitution of capital for qualified labor

TABLE 2.3: Provider density, quality, and HHC prices

	Nursing care qual.	Medical care qual.	HHC price
Provider spec. point value	470.7***	379***	
	(77.1)	(77.18)	
Provider density (log), county			-4.5e-05
			(6.1e-05)
Controls	×	×	×
County FE	×	×	×
Mean outcome variable	80.138	85.089	0.052
Observations	7965	7774	7965
F-statistic	15.35	9.43	156.82
R2	0.162	0.108	0.668

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;
Standard errors clustered at the county level in parenthesis.
Data was provided by bkk-pflegefinder.de and by the German statistical office (indicators and maps of regional and urban development). Estimation model (col. 1-2): $Q_{it} = \beta_1 P_{it} + \mathbf{X}_{ct} + \tau_c + \kappa_c + u_{c,t}$ Dependant variable Q_{it}: Quality indicators at individual level (Nursing quality and medical quality). Variable of interest: Prices for HHC (only 2019). Estimation model (col. 3): $P_{it} = \beta_1 DEN_{it} + \mathbf{X}_{ct} + \tau_c + \kappa_c + u_{i,t}$ Dependant variable P_{it}: HHC price (e.g., neg. point value) at individual level for 2019. Variable of interest: (logL provider density).
Regional control variables at county level are provided in the Appendix in Table A.1. Fixed effects: county fixed effect (4 digits).

in LTC providers, there is a severe shortage of nursing personnel in Germany (Büscher et al., 2022; Bonacker and Geiger, 2022). If demand for qualified personnel cannot be satisfied due to labor shortage, HHC providers recruit more unskilled personnel. This can even be of greater concern in areas facing increasing provider density compared to other regions. A long list of literature provides evidence showing that employing unqualified personnel in nursing homes is likely to result in lower care quality (Konetzka et al., 2008; Castle and Anderson, 2011; Lee et al., 2014; Lin, 2014).

Our data do not provide information about the actual qualification mix at the provider level. However, we can observe vacancies at the county level differentiated into registered nurses and nursing assistants. This gives us an idea about the regional lack of nurses and the qualification mix.

Figure 2.5 presents a positive correlation between HHC provider density and the number of vacancies at the county level.

Besides the simple correlation, we also estimate a linear regression 2.6).

$$V_{ct} = \beta_0 + \beta_1 DEN_{ct} + X_{ct} + \kappa_c + \tau_t + u_{ct} \tag{2.6}$$

We regress the number of vacancies V in county c at time t on the provider density, control variables at county level X_{ct} as well as county κ_c and wave τ_t fixed effects. In this regression, we look at 395 counties over a time horizon of four waves (2011, 2013, 2015, and 2019).

Table 2.4 confirms a robust significant positive correlation between HHC provider density and job vacancies for both registered and assistant qualification levels. An increase of the county's provider density by one standard deviation or 30 providers within a 10 km radius is associated with 3.2 more vacancies

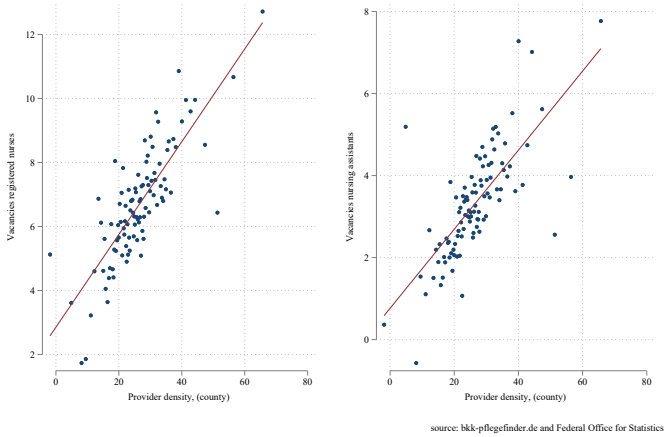

FIGURE 2.5: Scatter plot of nurse job vacancies and HHC provider density
Source: LTC quality report cards 2011–2019 provided by the Medical Review Boards (MRB) and job vacancies by the German employment agency. *Note:* The binned scatter plots present the relationship between job vacancies for nurses and HHC provider density.

TABLE 2.4: Provider density and vacancies

	Nursing personnel vacancies		
	All nurses	Registered nurses	Assistant nurses
Provider density (log), county	4.801**	3.104***	1.636*
	(1.928)	(1.177)	(.847)
Controls	×	×	×
Wave FE	×	×	×
State FE	×	×	×
Mean outcome variable	15.849	10.244	5.529
Observations	41658	41658	41658
F-statistic	24.15	15.05	33.54
R2	0.665	0.654	0.597

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;
Standard errors clustered on county level in parenthesis.
Sources: Transparency Reports (at facility level) 'bkk-pflegefinder.de' and indicators and maps of regional and urban development at county level (INKAR: German Statistical Office). Four waves: 2011, 2013, 2015, 2019: in total counties. County-level aggregated data. Estimation strategy: $V_{ct} = \beta_0 + \beta_1 DEN_{ct} + X_{ct} + \kappa_c + \tau_t + u_{ct}$ Dependant variable: Open positions in HHC facilities for nurses with specific qualifications at county level. Regional control variables at county level are provided in the Appendix in Table A.1. Fixed effects: wave fixed effects and state fixed effects.

per county (20.56% compared to the mean), on average. The correlation is larger for registered nurses than for nursing assistants, which might be due to a more severe shortage of the former qualification level, and directly confirms our hypothesis.

To test the hypothesis that a lack of (registered) nurses is correlated with lower quality, we estimate model 2.7 and replace the outcome with average quality at the county level.

$$Q_{ct} = \beta_0 + \beta_1 V_{ct} + X_{ct} + \kappa_c + \tau_t + u_{ct} \tag{2.7}$$

We find an increasing number of vacancies in a county to be associated with

TABLE 2.5: Vacancies and provider quality

	HHC quality measures					
	Nursing care quality			Medical care quality		
Vacancies total, county	-.109**			-.1166***		
	(.0442)			(.0309)		
Vacancies registered nurses, county		-.1978***			-.2222***	
		(.0679)			(.0471)	
Vacancies nursing assistants, county			-.1177			-.103
			(.0857)			(.0636)
Controls	×	×	×	×	×	×
Wave FE	×	×	×	×	×	×
State FE	×	×	×	×	×	×
Mean outcome variable	74.343	74.343	74.343	82.558	82.558	82.558
Observations	1579	1579	1579	1579	1579	1579
F-statistic	55.40	57.70	51.09	29.30	29.35	28.75
R2	0.523	0.525	0.520	0.372	0.375	0.367

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;
Standard errors clustered at county level in parenthesis.
Data was provided by bkk-pflegefinder.de and by the German statistical office (indicators and maps of regional and urban development). Estimation model: $Q_{ct} = \beta_0 + \beta_1 V_{ct} + X_{ct} + \kappa_c + \tau_t + u_{ct}$. Dependent variable: Quality indicators aggregated at county level. Variable of interest: Open positions for nurses with specific qualifications. Regional control variables at county level are provided in the Appendix in Table A.1. Fixed effects: wave fixed effects and state fixed effects.

lower quality (see Table 2.5) given a set of control variables and county fixed effects that control, for example, for wage levels and health. In counties with 10 more vacancies, the quality is, on average, one percentage point lower. The coefficient is double the size for registered nurses compared to assistant nurses. Further, the correlation with vacancies for assistant nurses is not significant for both quality measures. This is in line with the literature and supports our assumption that a high number of vacancies for high-qualified nurses is harmful to the average quality. Point estimates could be biased in this setup. However, the effect is robust across all quality measures for registered nurses.

Figure 2.6 summarizes the results regarding the potential channels explaining the negative relation between provider density and quality.

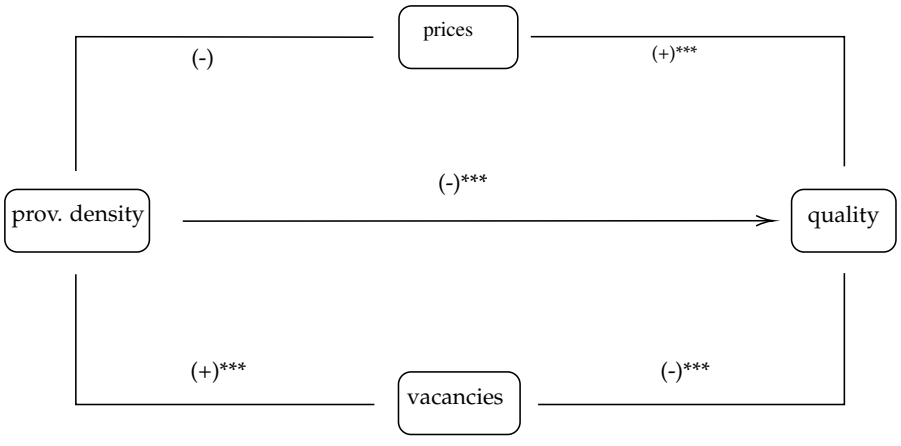

FIGURE 2.6: Mechanisms influencing quality via provider density in HHC
Note: The sketch shows the two possible channels to explain a decrease in quality due to higher provider density: lower prices or lower availability of qualified personnel.

To summarize, the price channel presented by Forder and Allan (2014) turns out not to be relevant in this setup; prices are tightly regulated and do not correlate with provider density in the German HHC market in 2019. In contrast,

HHC provider density and regional skilled nurses' vacancies are positively correlated. We postulate that a higher density increases the number of vacant positions, which, in turn, decreases the quality due to a lack of qualified nursing staff.

2.6.1 HHC density and informal care

For a broader picture, we analyze the relation between LTC provider density and access to professional LTC. Our findings in Table 2.6 show that higher density is associated with more HHC recipients and less people in informal care who probably waited to get into the professional system. Thus, to mitigate the trade-off between satisfying the increase in demand and maintaining high quality across all providers, more effort needs to be put into the increase in the number of qualified nursing staff.

TABLE 2.6: Provider density and access to HHC

	Share HHC (10km)	Share HHC (20km)	Share HHC (county)	Share IHC (county)
HHC provider density (log), 10km	1447***			
	(24.54)			
HHC provider density (log), 20km		4687***		
		(72.06)		
HHC provider (log), county			2160***	-1.072***
			(53.01)	(.138)
Controls	×	×	×	×
Wave FE	×	×	×	×
County FE	×	×	×	×
Mean outcome variable	2801.404	7895.682	4143.435	47.866
Observations	41658	41658	41658	41658
F-statistic	855.59	648.06	771.49	586.91
R2	0.891	0.904	0.937	0.758

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;
Standard errors clustered at the county level in parenthesis.
Data was provided by bkk-pflegefinder.de and by the German statistical office (indicators and maps of regional and urban development). Estimation model (col. 1-2): $A_{ct} = \beta_0 + \beta_1 \widehat{DENS}_{rt}^{HHC} + \gamma_1 \mathbf{DS}_{ct} + \gamma_2 \mathbf{CS}_{it} + \gamma_3 \overline{p}_{mt}^{NH} + C_c + T_t + u_{it}$: Access: number of HHC supplied people in need of LTC. We assume that capacity HHC providers labor at full capacities. Variable of interest: HHC provider density. 4^{th} column indicates the informal care side. Regional control variables at county level are provided in the Appendix in Table A.1. Fixed effects: county fixed effect (4 digits).

2.7 Discussion and conclusion

We investigate the effect of provider density on the quality of HHC. In our main analysis, we show that in the German HHC market, a larger provider density decreases the nursing and medical quality of care slightly, but significantly. In the second step, we investigate the channels through which provider density affects HHC quality. Forder and Allan (2014) argue that fiercer price competition explains the quality decrease in more competitive nursing home markets. We can exclude this channel since there is no correlation between provider density and prices in Germany. We find that higher provider density

is associated with a higher demand for nursing personnel in terms of job vacancies for qualified staff which, in turn, is associated with a lower quality of care. If the lack of qualified nurses is larger, providers need to employ more nursing assistants rather than registered nurses to provide services. Demographic trends toward an increasingly older society, increasing demand for professional LTC, and a lack of qualified personnel are not unique to Germany and may become more pronounced with regulations promoting HHC provider entry.

However, there are limitations to our study. Firstly, we do not observe the provider's case mix or allocation of care levels. To address this, we control for demographic trends at the county level and use an instrument that is exogenous with respect to the HHC demand, which rules out concerns regarding omitted variable bias. Secondly, we do not have information about the HHC providers' personnel qualification mix, so we use vacancy data at the county level to approximate the lack of qualified personnel.

Our final analysis regarding the impact of more HHC providers on access to professional LTC reveals a rise in the share of the care-dependent population receiving formal care and a decline in the share of people receiving only informal care, where professional care probably improves the situation of the care-dependent people that did not have access before, even if, on average, the provider's quality slightly decreases. Our study has two important policy implications in regions with increasing demand. We recommend both investing in the supply of well-trained nursing personnel to keep quality high and, simultaneously, enabling market entry in HHC to improve access to professional care for people in informal care. By doing so, we can expect higher provider density to translate into better quality of care for those relying on HHC provision.

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A. Appendix

A. 1 Example of German quality report cards

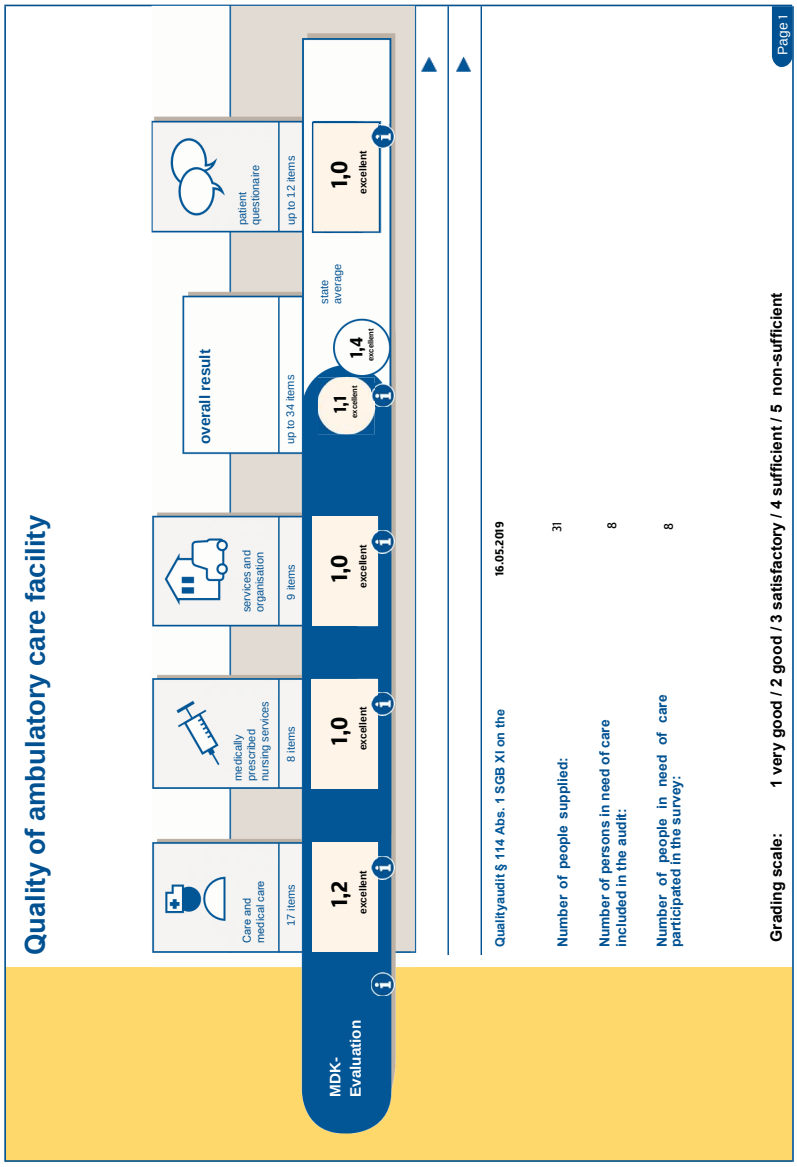

FIGURE A.1: Example of first page of a transparency report

A. 2 Home health care quality items/criteria translated into English

Item 1 – 17 Nursing Services
Response:"Completely fulfilled for x out of X persons in need of care"

1. Are the individual wishes regarding personal hygiene taken into account within the framework of the agreed service provision?
2. Is personal hygiene within the scope of the agreed service provision appropriate within the possibilities of influence of the care facility?
3. Are the individual wishes for food and drink within the framework of the agreed service provision considered?
4. Has the agreed liquid supply service been carried out in a comprehensible manner?
5. Are the individual risks associated with the supply of liquids recorded if benefits are agreed for this area?
6. Has the person in need of care or his or her relative been informed of any identified risks of liquid supply in the context of agreed body-related care measures of personal hygiene, nutrition or liquid supply?
7. Was the agreed food intake service carried out in a comprehensible manner?
8. Are individual nutritional risks recorded if benefits have been agreed?
9. Has the person in need of care or a relative been informed in the context of agreed body-related care measures of personal hygiene, nutrition or liquid supply in case of identifiable risks in the area of nutrition?
10. Are individual resources and risks associated with segregation recorded if services have been agreed?
11. Does the agreed service support excretion/incontinence care performed in a comprehensive manner?
12. If an individual decubitus risk of a care dependent is recognized decubitus during the provision of agreed services, is this then recorded?
13. Are the individual risks relating to the contractures taken into account when the agreed services are provided?
14. Are the agreed mobility services and their development carried out in a comprehensible manner?

15. Are biographical and other characteristics of people with dementia taken into account in the provision of services?
16. Are relatives informed about how to interact with people with dementia who need long-term care in the context of service provision?
17. Is it clear from the nursing documentation that an initial consultation was held?

Item 18 – 25 Medically indicated Nursing Services
Response:"Completely fulfilled for x out of X persons in need of care"

18. Are the nursing measures for the treatment of chronic wounds or pressure sores based on the current state of the art?
19. Does the medication correspond to the medical prescription?
20. Does the medical treatment meet the medical prescription?
21. Is the blood pressure measurement carried out and evaluated according to the doctor's prescription and are the necessary consequences drawn from this?
22. Is the blood sugar measurement carried out and evaluated according to the doctor's prescription and are the necessary consequences drawn from this?
23. Is the injection carried out in accordance with the doctor's prescription in a comprehensible manner, documented and, in case of complications, the doctor informed?
24. Are compression stockings/bandages properly applied?
25. Is active communication with the doctor comprehensible in the event of the need for treatment care?

Item 26 - 34 Service and Organization
Response:"Yes / No"

26. Will the nursing service provide a cost estimate of the expected costs before the start of the contract?
27. Are there effective rules within the care service to ensure that data protection is guaranteed?
28. Are there written procedural instructions on the behavior of carers in emergency situations with people in need of care?
29. Are employees regularly trained in first aid and emergency procedures?

30. Is there a written policy on dealing with complaints?
31. Is there a plan for further training to ensure that all personnel working in the care sector are involved in the training?
32. Is the area of responsibility/the tasks for the senior nurse specified?
33. Is the area of responsibility/the tasks for the housekeeping employees specified?
34. Is the constant availability and operational readiness of the care service with regard to the agreed services guaranteed?

35 - 46 Customer Survey
Response:"Completely fulfilled for x out of X persons in need of care"

35. Has a written care contract been concluded with you?
36. Were you informed by the nursing service before the start of the service about the costs you expect to incur or have to take over yourselves?
37. Have the times of the care services been coordinated with you?
38. Do the nursing personnel ask you what clothing you want to wear?
39. Does a group of nursing personnel visit you in a manageable size?
40. Are the nursing services available and ready for action if required?
41. Are you supported/motivated by the nursing personnel to wash partially or completely by yourself?
42. Do the personnel give you tips and advice (information) on care?
43. Has anything changed for the better after a complaint?
44. Do the nursing personnel respect your privacy?
45. Are the employees polite and friendly?
46. Are you satisfied with the domestic services of the nursing service?

A. 3 Quality categories

1. Nursing Quality

Nursing quality is related to the outcome quality. This sort of quality is difficult to measure in the LTC context regarding customer's high age and the low survival rate. That's why we look at the quality provided by nurses in terms of following the protocol and fulfilling contractual agreements.

1. Are the individual wishes regarding personal hygiene taken into account within the framework of the agreed service provision?

10. Are individual resources and risks associated with segregation recorded if services have been agreed?

11. Does the agreed service support excretion/incontinence care performed in a comprehensive manner?

12. If an individual decubitus risk of a care dependent is recognized decubitus during the provision of agreed services, is this then recorded?

13. Are the individual risks relating to the contractures taken into account when the agreed services are provided?

14. Are the agreed mobility services and their development carried out in a comprehensible manner?

2. Medical Care Quality

This measure is based on how well the medication provided by the HHC provider compares to the doctor's prescription:

19. Does the medication correspond to the medical prescription?

23. Is the injection carried out in accordance with the doctor's prescription in a comprehensible manner, documented and, in case of complications, the doctor informed?

24. Are compression stockings/bandages properly applied?

A. 4 Descriptive statistics

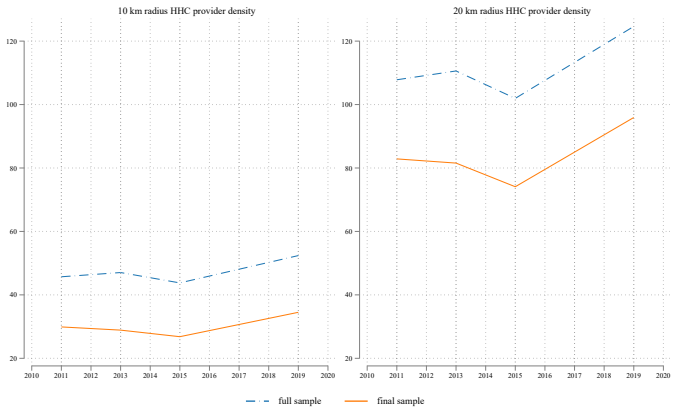

FIGURE A.2: Density indicators in the full and final sample

Source: MRB LTC quality report cards 2011–2019. Observations: full sample 47,649; final sample 41,658. Excluded observations besides outliers: monopoly regions and mega cities such as Hamburg, Munich, and Berlin. *Note:* We compare the full sample (dashed line) with our final sample (bold line) with respect to the outcome variable density. Dropping the outlier cities decreases the average market density. However, trends are parallel over time in 10 and 20 km specifications.

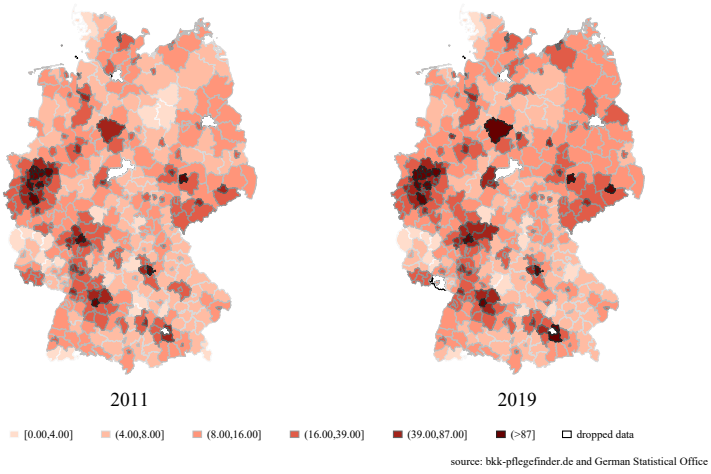

FIGURE A.3: HHC provider density 2011 and 2019

Source: MRB quality report cards 2011 and 2019 *Note:* The maps present the absolute number of HHC providers in 2011 (left) and 2019 (right).

TABLE A.1: Descriptive statistics for the control variables

	2011–2019			
	mean	sd	min	max
Demographics				
Age group 65–75 [%], county	10.89	1.355	7.4	16.1
Age group 75+ [%], county	11.05	1.717	6.6	18.14
Life expectancy, county	83.39	.6357	81.39	85.47
Medical infrastructure				
GPs [/100,000 inh.], county	54.85	19.32	1.521	181.6
Hospital beds [/10,000 inh.], county	6.244	3.143	0	29.86
NH density [#], county	32.06	21.86	2	174
Ppl in need of inf. LTC [%], county	47.87	6.41	28.84	66.4
NH pers. [/10,000 inh.], county	90.93	18.05	41.7	174.9
Vacancies total [#] in HHC, county	15.85	17.5	0	146
Vacancies trained nurses [#] in HHC, county	10.24	10.78	0	93
Vacancies assistant nurses [#] in HHC, county	5.529	7.752	0	72
Labor force and income				
Employed people [%], county	82	3.868	59.7	96.01
Employed in service sector [%], county	19.06	7.561	2.51	42.8
Female unemployed [%], county	6.476	2.938	1.35	17.1
Unemployed professionals [%], county	40.94	5.425	12.9	60.4
Female unemployed older 55 [%], county	21.32	4.879	11.3	39.19
Elderly rec. of social aids [%], county	17.16	14.97	1.29	81.1
GDP [1,000€/inh.], county	3,200	8,500	140	73,000
Pension [€], county	879.3	85.72	615.5	1119
Further regional indicators				
Population density [$/km^2$], county	625.3	759.6	35.61	3074
Foreigners [%], county	8.419	5.481	.7	36.56
Guest beds [/1,000 inh.], county	186.4	343.9	0	3521
Rurality [% inh. in region $\leq 150\, inh./km^2$], county	25.55	27.92	0	100
Land price [EUR/m^2], county	154.3	189.1	0	1683
Observations		41658		

Sources: Indicators and maps of regional and urban development (county level). 41,658 observations (HHC facilities) over four waves: 2011, 2013, 2015, 2019.

TABLE A.2: Descriptive statistics annually

	2011		**2013**		**2015**		**2019**		2011-2019			
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	min	max
Quality indicators												
Nursing care quality [index: 0-100]	65.27	29.04	72.88	27.23	78.92	25.57	80.72	27.6	74.56	28.06	0	100
Medical care quality [index: 0-100]	77.04	31.98	80.99	29.66	84.01	27.58	85.71	26.09	82.01	29.05	0	100
HHC provider density												
Provider density [#], county	41.89	28.88	41.91	27.68	40.68	27.42	49.92	35.5	43.76	30.44	2	197
Provider density (log), county	3.515	.6748	3.522	.6732	3.488	.6744	3.68	.6976	3.555	.6848	.6931	5.283
Provider density [#], municip.	17.4	27.28	16.47	26.63	15.83	25.97	19.71	31.99	17.41	28.22	1	185
Provider density (log), municip.	1.891	1.366	1.847	1.347	1.811	1.326	1.989	1.38	1.887	1.357	0	5.22
Provider density [#], 10km radius	29.9	32.06	28.89	31.21	26.82	29.06	34.5	39.03	30.15	33.35	1	215
Provider density (log), 10km radius	2.828	1.121	2.806	1.1	2.75	1.075	2.947	1.133	2.836	1.111	0	5.371
Provider density [#], 20km radius	82.87	80.87	81.55	80.03	74.09	69.53	95.92	97.49	83.96	83.43	1	458
Provider density (log), 20km radius	3.967	.9791	3.959	.9588	3.897	.9218	4.091	.9911	3.981	.9666	0	6.127
Indiv. provider information												
Provider capacity [#]	84.2	65.43	87.94	65.71	92.29	68.3	111.6	86.12	94.43	73.09	1	514
Price per point [€]	.	.	.	.	.	.	.0518	.0065	.0518	.0065	.0372	.0683
Nursing home market												
NH provider density [#], municip.	9.913	14.04	13	18.82	10.94	16.25	10.52	15.4	11.08	16.25	1	87
NH provider density, 10km radius	17.26	16.64	23.07	23.12	18.81	18.69	18.35	18.66	19.36	19.54	0	118
NH provider density, 5-10km radius	10.35	11.38	13.92	15.92	11.17	12.52	11.11	12.69	11.63	13.3	0	92
NH total price [€], municipality	2430	324.9	2485	345.3	2557	357.7	2985	471.6	2623	442.5	1911	4260
Own contribution [€], municipality	1147	324.8	1200	344.7	1224	359.3	2463	665.8	1532	724.1	626.8	3983
Observations	10,215		10,307		9,935		11,201			41,658		

Sources: Transparency Reports (facility level) and indicators and maps of regional and urban development (BBR). 41,658 observations (HHC facilities) over four waves: 2011, 2013, 2015, 2019. Quality indicators: nursing care quality (indic. 1, 10, 11, 12, 13, 14), medical quality (indic. 19, 23, 24): formular: $Z_i = \frac{1}{n}\sum_{i=1}^{N} z_i$. Provider density at municipality and 10, 20 km radius level.

A. 5 First stage regression results

TABLE A.3: First stage estimates (10 km radius)

	Provider density (log), 10 km radius			
	Nursing care quality		Medical care quality	
	$IV_{\leq 10km}$	$IV_{05-10km}$	$IV_{\leq 10km}$	$IV_{05-10km}$
Nursing home density, 10 km radius	.0396***		.0398***	
	(5.8e-04)		(5.9e-04)	
Nursing home density, 05 to 10 km radius		.04***		.0402***
		(7.0e-04)		(7.1e-04)
Controls	×	×	×	×
Wave FE	×	×	×	×
County FE	×	×	×	×
excl. F-statistic	4699.65	3250.19	4618.30	3242.93
Observations	41658	41658	40530	40530

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;
Standard errors clustered at county*assessment-month*year level in parenthesis.
Sources: Transparency Reports (at facility level) and indicators and maps of regional and urban development at county level.
Four waves: 2011, 2013, 2015, and 2019. Estimation strategy (2nd stage): $Q_{it} = \beta_0 + \beta_1 \widehat{DENS}_{rt}^{HHC} + \beta_2 \mathbf{DS}_{ct} + \beta_3 \mathbf{CS}_{it} + \gamma \overline{p}_{mt}^{NH} + \kappa_c + \tau_t + \varepsilon_{it}$; (1st stage): $DENS_{rt}^{HHC} = \beta_0 + \beta_1 ME_{rt}^{NH} + \gamma_1 \mathbf{DS}_{ct} + \gamma_2 \mathbf{CS}_{it} + \gamma_3 \overline{p}_{mt}^{NH} + C_c + T_t + u_{it}$; Competition variable: number of HHC providers. Instruments: (IV1: $IV_{<10km}$) NH provider density within 10 km radius; (IV2: $IV_{05-10km}$) NH provider density within 5–10 km radius. Regional control variables at county level are provided in the Appendix in Table A.1. Fixed effects: wave fixed effects and county fixed effects (4 digits).

TABLE A.4: First stage estimates (20 km radius)

	Provider density (log), 20 km radius			
	Nursing care quality		Medical care quality	
	$IV_{\leq 10km}$	$IV_{05-10km}$	$IV_{\leq 10km}$	$IV_{05-10km}$
Nursing home density, 10 km radius	.0184***		.0186***	
	(4.9e-04)		(4.9e-04)	
Nursing home density, 5 to 10 km radius		.022***		.0222***
		(4.8e-04)		(4.9e-04)
Controls	×	×	×	×
Wave FE	×	×	×	×
County FE	×	×	×	×
excl. F-statistic	1434.93	2101.21	1422.15	2071.97
Observations	41658	41658	40530	40530

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;
Standard errors clustered at county*assessment-month*year level in parenthesis.
Sources: Transparency Reports (at facility level) and indicators and maps of regional and urban development at county level. Four waves: 2011, 2013, 2015, and 2019. Estimation strategy (2nd stage): $Q_{it} = \beta_0 + \beta_1 \widehat{DENS}_{rt}^{HHC} + \beta_2 \mathbf{DS}_{ct} + \beta_3 \mathbf{CS}_{it} + \gamma \overline{p}_{mt}^{NH} + \kappa_c + \tau_t + \varepsilon_{it}$; (1st stage): $DENS_{rt}^{HHC} = \beta_0 + \beta_1 ME_{rt}^{NH} + \gamma_1 \mathbf{DS}_{ct} + \gamma_2 \mathbf{CS}_{it} + \gamma_3 \overline{p}_{mt}^{NH} + C_c + T_t + u_{it}$; Competition variable: number of HHC providers. Instruments: (IV1: $IV_{<10km}$) NH provider density within 10 km radius; (IV2: $IV_{05-10km}$) NH provider density within 5–10 km radius. Regional control variables at county level are provided in the Appendix in Table A.1. Fixed effects: wave fixed effects and county fixed effects (4 digits) .

A. 6 Detailed regression results

TABLE A.5: Effect of provider density on care quality (20 km radius)

	Nursing care quality			
	OLS_{20km}	OLS_{20km}	$IV_{\leq 10km}$	$IV_{05-10km}$
Provider density (log), 20 km radius	-1.362***	-1.163***	-3.114***	-4.154***
	(.1934)	(.2802)	(.8625)	(.9053)
Controls		×	×	×
Wave FE		×	×	×
County FE		×	×	×
Mean outcome variable	74.562	74.562	74.562	74.562
Provider density s.d.	0.97	0.97	0.97	0.97
Observations	41658	41658	41658	41658
1st stage excl. F-statistic			1434.93	2101.21
F-statistic	49.64	49.92	49.93	50.04
R2	0.002	0.136	0.135	0.134
	Medical care quality			
	OLS_{20km}	OLS_{20km}	$IV_{\leq 10km}$	$IV_{05-10km}$
Provider density (log), 20 km radius	-1.285***	-.8189***	-2.25**	-1.748*
	(.1849)	(.3039)	(.875)	(.927)
Controls		×	×	×
Wave FE		×	×	×
County FE		×	×	×
Mean outcome variable	82.013	82.013	82.013	82.013
Provider density s.d.	0.97	0.97	0.97	0.97
Observations	40530	40530	40530	40530
1st stage excl. F-statistic			1422.15	2071.97
F-statistic	48.29	24.98	24.90	24.89
R2	0.002	0.075	0.075	0.075

$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$;
Standard errors clustered at county*assessment-month*year level in parenthesis.
Sources: Transparency Reports (at facility level) 'bkk-pflegefinder.de' and indicators and maps of regional and urban development at county level (INKAR: German Statistical Office). Four waves: 2011, 2013, 2015, 2019: in total 41,658 or 40,530 observations. Estimation strategy: $Q_{it} = \beta_0 + \beta_1 \widehat{DENS}_{rt}^{HHC} + \beta_2 \mathbf{DS}_{ct} + \beta_3 \mathbf{CS}_{it} + \gamma \overline{p}_{mt}^{NH} + \kappa_c + \tau_t + \varepsilon_{it}$; Dependant variable: nursing care quality $\in (0, 1/6, \ldots, 6/6)$; Density indicators: (log) number of providers in 20 km radius. Regional control variables at individual and county level are provided in the Appendix in Table A.1 or more details results in App. A. 6. Fixed effects: wave fixed effects and county fixed effects (4 digits) ; Instruments: (IV1: $IV_{<10km}$) NH market density two years prior within 10 km radius and net number of NH entries in last two year within 10 km radius; (IV2: $IV_{05-10km}$) or NH provider density within 5–10 km radius.

TABLE A.6: Effect of provider density on nursing care quality (10 km radius)

	Nursing care quality		
	OLS_{10km}	$IV_{\leq 10km}$	$IV_{05-10km}$
Provider density (log), 10 km radius	-.7404***	-1.446***	-2.287***
	(.2108)	(.3996)	(.4978)
Provider capacity	-.0055***	-.0059***	-.0063***
	(.0018)	(.0018)	(.0019)
Population density, county	-6.6e-04	-2.6e-04	2.2e-04
	(7.2e-04)	(7.5e-04)	(7.7e-04)
Total population, share age group $65-75$, county	1.033***	1.084***	1.146***
	(.2639)	(.2648)	(.2661)
Proportion population 75 years and older of total population, county	-.2969	-.3043	-.3132
	(.225)	(.2248)	(.2249)
Provider density, county	3.2e-04	.0029	.0059
	(.0141)	(.0142)	(.0142)
Avg. life expectancy, county	-.0754	-.0738	-.072
	(.4704)	(.4697)	(.4699)
General practitioners per 100,000 inhabitants, county	-.0016	-7.2e-04	3.4e-04
	(.0108)	(.0108)	(.0108)
Hospital beds per 10,000 inhabitants, county	-.0656	-.0791	-.0951
	(.0766)	(.0767)	(.0769)
Employed people per 100 inhabitants, county	-.0761	-.0856	-.097
	(.0807)	(.0807)	(.081)
Care recipients informal care, share, county	.005	.0013	-.0032
	(.042)	(.042)	(.0421)
Share foreigners, county	-.0056	-.0127	-.0211
	(.104)	(.104)	(.1042)
Personnel in stat. facilities per 10,000 inh., county	.0324***	.0299***	.0269**
	(.0115)	(.0116)	(.0116)
Female unemployment rate,county	-.2659**	-.2475*	-.2255*
	(.1284)	(.1282)	(.1283)
Share of employees in person-related services, county	-.0625	-.0564	-.0491
	(.0503)	(.0503)	(.0504)
Share unemployed specialists,county	-.0882**	-.0901**	-.0923**
	(.0429)	(.0429)	(.0429)
Unemployed females ≥ 55, county	-.066	-.0679	-.0702
	(.0745)	(.0745)	(.0746)
Land price [EUR/m2], county	.0041**	.0043***	.0046***
	(.0016)	(.0016)	(.0016)
Share rurality, county	.0276**	.0216*	.0145
	(.0125)	(.0128)	(.0131)
Use of social aids for elderly, county	-.0451*	-.0457*	-.0463*
	(.0252)	(.0252)	(.0252)
Guest beds per 1,000 inhabitants, county	-.0037***	-.0037***	-.0038***
	(7.1e-04)	(7.1e-04)	(7.1e-04)
Avg. pensions, county	-.0026	.0011	.0054
	(.0066)	(.0068)	(.0069)
Avg. own contribution n.h., municip.	.0031***	.0031***	.0031***
	(4.5e-04)	(4.5e-04)	(4.5e-04)
GDP per capita [000 EUR], county	-2.1e-08	-2.0e-08	-1.9e-08
	(3.4e-08)	(3.4e-08)	(3.4e-08)
Wave FE	×	×	×
County FE	×	×	×
Mean outcome variable	74.562	74.562	74.562
Provider density s.d.	1.11	1.11	1.11
Observations	41658	41658	41658
1st stage excl. F-statistic		4699.65	3250.19
F-statistic	49.80	49.96	50.15
R2	0.136	0.136	0.135

$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$;
Standard errors clustered at county*assessment-month*year level in parenthesis.
Sources: Transparency Reports (at facility level) 'bkk-pflegefinder.de' and indicators and maps of regional and urban development at county level (INKAR: German Statistical Office). Four waves: 2011, 2013, 2015, 2019: in total observations. Estimation strategy: $Q_{it} = \beta_0 + \beta_1 \widehat{DENS}_{rt}^{HHC} + \beta_2 \mathbf{DS}_{ct} + \beta_3 \mathbf{CS}_{it} + \gamma \overline{p}_{mt}^{NH} + \kappa_c + \tau_t + \varepsilon_{it}$; Dependant variable: nursing care quality $\in (0, 1/6, \ldots, 6/6)$; Density indicators: (log) number of providers . Fixed effects: wave fixed effects and county fixed effects (4 digits) ; Instruments: (IV1: $IV_{<10km}$) NH provider density within 10 km radius; (IV2: $IV_{05-10km}$) NH provider density within 5 to 10 km radius.

TABLE A.7: Effect of provider density on nursing care quality (20 km radius)

	Nursing care quality		
	OLS_{20km}	$IV_{\leq 10km}$	$IV_{05-10km}$
Provider density (log), 20 km radius	-1.163***	-3.114***	-4.154***
	(.2802)	(.8625)	(.9053)
Provider capacity	-.0054***	-.0059***	-.0063***
	(.0018)	(.0019)	(.0019)
Population density, county	-5.7e-04	2.9e-04	7.5e-04
	(7.2e-04)	(8.1e-04)	(8.2e-04)
Total population, share age group 65–75, county	1.073***	1.233***	1.318***
	(.2644)	(.2725)	(.2742)
Proportion population 75 years and older of total population, county	-.3237	-.3819*	-.4129*
	(.2253)	(.2268)	(.2273)
Provider density, county	.0013	.0076	.0109
	(.0141)	(.0144)	(.0145)
Avg. life expectancy, county	-.0556	-.0197	-6.2e-04
	(.4705)	(.4703)	(.4711)
General practitioners per 100,000 inhabitants, county	-.0014	5.1e-04	.0015
	(.0108)	(.0109)	(.0109)
Hospital beds per 10,000 inhabitants, county	-.0862	-.1446*	-.1756**
	(.0769)	(.0805)	(.081)
Employed people per 100 inhabitants, county	-.0823	-.1094	-.1239
	(.0808)	(.0816)	(.082)
Care recipients informal care, share, county	.0089	.0088	.0088
	(.042)	(.042)	(.042)
Share foreigners, county	-.0114	-.0338	-.0457
	(.104)	(.1046)	(.1047)
Personnel in stat. facilities per 10,000 inh., county	.032***	.027**	.0243**
	(.0116)	(.0117)	(.0117)
Female unemployment rate,county	-.2794**	-.2696**	-.2643**
	(.1282)	(.1281)	(.1282)
Share of employees in person-related services, county	-.0604	-.046	-.0383
	(.0503)	(.0507)	(.0507)
Share unemployed specialists,county	-.0873**	-.089**	-.0899**
	(.0429)	(.0428)	(.0428)
Unemployed females $\geq$55, county	-.0721	-.0858	-.093
	(.0745)	(.0748)	(.075)
Land price [EUR/m2], county	.0042***	.0046***	.0049***
	(.0016)	(.0016)	(.0016)
Share rurality, county	.0267**	.0147	.0082
	(.0125)	(.0135)	(.0136)
Use of social aids for elderly, county	-.0521**	-.0648**	-.0716***
	(.0252)	(.0258)	(.026)
Guest beds per 1,000 inhabitants, county	-.0037***	-.0039***	-.0039***
	(7.1e-04)	(7.1e-04)	(7.1e-04)
Avg. pensions, county	.0021	.0165*	.0242***
	(.0068)	(.009)	(.0092)
Avg. own contribution n.h., municip.	.0031***	.0031***	.0032***
	(4.5e-04)	(4.5e-04)	(4.5e-04)
GDP per capita [000 EUR], county	-2.3e-08	-2.4e-08	-2.5e-08
	(3.4e-08)	(3.4e-08)	(3.4e-08)
Wave FE	×	×	×
County FE	×	×	×
Mean outcome variable	74.562	74.562	74.562
Provider density s.d.	0.97	0.97	0.97
Observations	41658	41658	41658
1st stage excl. F-statistic		1434.93	2101.21
F-statistic	49.92	49.93	50.04
R2	0.136	0.135	0.134

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;
Standard errors clustered at county*assessment-month*year level in parenthesis.
Sources: Transparency Reports (at facility level) 'bkk-pflegefinder.de' and indicators and maps of regional and urban development at county level (INKAR: German Statistical Office). Four waves: 2011, 2013, 2015, 2019: in total observations. Estimation strategy: $Q_{it} = \beta_0 + \beta_1 \widehat{DENS}_{rt}^{HHC} + \beta_2 \mathbf{DS}_{ct} + \beta_3 \mathbf{CS}_{it} + \gamma \overline{p}_{mt}^{NH} + \kappa_c + \tau_t + \varepsilon_{it}$; Dependant variable: nursing care quality $\in (0, 1/6, \ldots, 6/6)$; Density indicators: (log) number of providers . Fixed effects: wave fixed effects and county fixed effects (4 digits); Instruments: (IV1: $IV_{<10km}$) NH provider density within 10 km radius; (IV2: $IV_{05-10km}$) NH provider density within 5 to 10km radius.

TABLE A.8: Effect of provider density on medical care quality (10 km radius)

	Medical care quality		
	OLS_{10km}	$IV_{\leq 10km}$	$IV_{05-10km}$
Provider density (log), 10 km radius	-.8528***	-1.049**	-.9654*
	(.227)	(.4074)	(.5121)
Provider capacity	.0047**	.0046**	.0047**
	(.0019)	(.0019)	(.0019)
Population density, county	6.9e-04	8.0e-04	7.5e-04
	(7.7e-04)	(7.9e-04)	(8.0e-04)
Total population, share age group 65–75, county	-.1142	-.1	-.106
	(.2889)	(.2895)	(.2904)
Proportion population 75 years and older of total population, county	-.0561	-.0582	-.0573
	(.2449)	(.2446)	(.2446)
Provider density, county	.0268*	.0275*	.0272*
	(.0148)	(.0149)	(.015)
Avg. life expectancy, county	1.701***	1.701***	1.701***
	(.5158)	(.515)	(.515)
General practitioners per 100,000 inhabitants, county	-.023*	-.0227*	-.0228*
	(.0122)	(.0122)	(.0122)
Hospital beds per 10,000 inhabitants, county	.0992	.0954	.097
	(.0833)	(.0835)	(.0837)
Employed people per 100 inhabitants, county	.1382*	.1355*	.1366*
	(.0821)	(.0821)	(.0822)
Care recipients informal care, share, county	-.0493	-.0504	-.0499
	(.0458)	(.0459)	(.0459)
Share foreigners, county	-.0279	-.0298	-.029
	(.1081)	(.1079)	(.1079)
Personnel in stat. facilities per 10,000 inh., county	.0218*	.0211	.0214*
	(.0128)	(.0128)	(.0129)
Female unemployment rate,county	.291**	.2961**	.2939**
	(.141)	(.1413)	(.1414)
Share of employees in person-related services, county	-.1089**	-.1073**	-.108**
	(.0526)	(.0525)	(.0527)
Share unemployed specialists,county	-.0959**	-.0964**	-.0962**
	(.0456)	(.0455)	(.0455)
Unemployed females $\geq$55, county	-.0187	-.0192	-.019
	(.0794)	(.0792)	(.0792)
Land price [EUR/m2], county	.0016	.0016	.0016
	(.0016)	(.0016)	(.0016)
Share rurality, county	-5.5e-04	-.0022	-.0015
	(.014)	(.0143)	(.0145)
Use of social aids for elderly, county	-.114***	-.1141***	-.1141***
	(.0272)	(.0272)	(.0272)
Guest beds per 1,000 inhabitants, county	-.0016**	-.0016**	-.0016**
	(7.2e-04)	(7.2e-04)	(7.2e-04)
Avg. pensions, county	-.0166**	-.0155**	-.016**
	(.0073)	(.0074)	(.0076)
Avg. own contribution n.h., municip.	.0015***	.0016***	.0016***
	(5.0e-04)	(5.0e-04)	(5.0e-04)
GDP per capita [000 EUR], county	5.0e-09	5.3e-09	5.2e-09
	(3.7e-08)	(3.6e-08)	(3.6e-08)
Wave FE	×	×	×
County FE	×	×	×
Mean outcome variable	82.013	82.013	82.013
Provider density s.d.	1.11	1.11	1.11
Observations	40530	40530	40530
1st stage excl. F-statistic		4618.30	3242.93
F-statistic	25.05	24.95	24.92
R2	0.075	0.075	0.075

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;
Standard errors clustered at county*assessment-month*year level in parenthesis.
Sources: Transparency Reports (at facility level) 'bkk-pflegefinder.de' and indicators and maps of regional and urban development at county level (INKAR: German Statistical Office). Four waves: 2011, 2013, 2015, 2019: in total observations. Estimation strategy: $Q_{it} = \beta_0 + \beta_1 \widehat{DENS}_{rt}^{HHC} + \beta_2 \mathbf{DS}_{ct} + \beta_3 \mathbf{CS}_{it} + \gamma \overline{p}_{mt}^{NH} + \kappa_c + \tau_t + \varepsilon_{it}$; Dependent variable: medical quality $\in (0, 1/3, \ldots, 3/3)$; Density indicators: (log) number of providers. Fixed effects: wave fixed effects and county fixed effects (4 digits); Instruments: (IV1: $IV_{<10km}$) NH provider density within 10 km radius; (IV2: $IV_{05-10km}$) NH provider density within 5 to 10 km radius.

TABLE A.9: Effect of provider density on medical care quality (20 km radius)

	Medical care quality		
	OLS_{20km}	$IV_{\leq 10km}$	$IV_{05-10km}$
Provider density (log), 20 km radius	-.8189***	-2.25**	-1.748*
	(.3039)	(.875)	(.927)
Provider capacity	.005***	.0045**	.0047**
	(.0019)	(.0019)	(.0019)
Population density, county	5.6e-04	.0012	9.7e-04
	(7.7e-04)	(8.4e-04)	(8.5e-04)
Total population, share age group 65–75, county	-.1098	.0056	-.0349
	(.2889)	(.2956)	(.2969)
Proportion population 75 years and older of total population, county	-.0716	-.115	-.0998
	(.2449)	(.2462)	(.2463)
Provider density, county	.0264*	.031**	.0294*
	(.0148)	(.0152)	(.0153)
Avg. life expectancy, county	1.712***	1.735***	1.727***
	(.5161)	(.5157)	(.5159)
General practitioners per 100,000 inhabitants, county	-.0232*	-.0217*	-.0223*
	(.0122)	(.0122)	(.0122)
Hospital beds per 10,000 inhabitants, county	.091	.0477	.0629
	(.0836)	(.0874)	(.0878)
Employed people per 100 inhabitants, county	.1385*	.1186	.1256
	(.0822)	(.0829)	(.0829)
Care recipients informal care, share, county	-.0448	-.0447	-.0447
	(.0458)	(.0458)	(.0457)
Share foreigners, county	-.029	-.0456	-.0397
	(.1082)	(.1084)	(.1083)
Personnel in stat. facilities per 10,000 inh., county	.0227*	.019	.0203
	(.0128)	(.013)	(.013)
Female unemployment rate,county	.2728*	.2796**	.2772**
	(.1409)	(.1407)	(.1407)
Share of employees in person-related services, county	-.1102**	-.0998*	-.1034*
	(.0526)	(.0528)	(.0529)
Share unemployed specialists,county	-.0944**	-.0956**	-.0952**
	(.0456)	(.0455)	(.0455)
Unemployed females $\geq$55, county	-.0218	-.0314	-.028
	(.0794)	(.0794)	(.0794)
Land price [EUR/m2], county	.0015	.0019	.0017
	(.0016)	(.0016)	(.0016)
Share rurality, county	.0015	-.0073	-.0042
	(.014)	(.0149)	(.015)
Use of social aids for elderly, county	-.1186***	-.1279***	-.1246***
	(.0273)	(.0276)	(.0277)
Guest beds per 1,000 inhabitants, county	-.0016**	-.0017**	-.0016**
	(7.2e-04)	(7.2e-04)	(7.2e-04)
Avg. pensions, county	-.015**	-.0044	-.0081
	(.0075)	(.0095)	(.0098)
Avg. own contribution n.h., municip.	.0015***	.0016***	.0016***
	(5.0e-04)	(5.0e-04)	(5.0e-04)
GDP per capita [000 EUR], county	3.3e-09	2.5e-09	2.8e-09
	(3.6e-08)	(3.7e-08)	(3.7e-08)
Wave FE	×	×	×
County FE	×	×	×
Mean outcome variable	82.013	82.013	82.013
Provider density s.d.	0.97	0.97	0.97
Observations	40530	40530	40530
1st stage excl. F-statistic		1422.15	2071.97
F-statistic	24.98	24.90	24.89
R2	0.075	0.075	0.075

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;
Standard errors clustered at county*assessment-month*year level in parenthesis.
Sources: Transparency Reports (at facility level) 'bkk-pflegefinder.de' and indicators and maps of regional and urban development at county level (INKAR: German Statistical Office). Four waves: 2011, 2013, 2015, 2019: in total observations. Estimation strategy: $Q_{it} = \beta_0 + \beta_1 \widehat{DENS}_{rt}^{HHC} + \beta_2 \mathbf{DS}_{ct} + \beta_3 \mathbf{CS}_{it} + \gamma \overline{P}_{mt}^{NH} + \kappa_c + \tau_t + \varepsilon_{it}$; Dependent variable: medical quality $\in (0, 1/3, \ldots, 3/3)$; Density indicators: (log) number of providers. Fixed effects: wave fixed effects and county fixed effects (4 digits); Instruments: (IV1: $IV_{<10km}$) NH provider density within 10 km radius and; (IV2: $IV_{05-10km}$) NH provider density within 5 to 10 km radius.

A. 7 Robustness checks

TABLE A.10: Separated in size-tertiles: Provider density and care quality

	Size tertile interactions			
	Nursing care quality		Medical care quality	
	OLS_{10km}	OLS_{10km}	$IV_{\leq 10km}$	$IV_{05-10km}$
Provider density (log), 10 km radius	-.1291	-.0832	-.4141	-.0832
	(.428)	(.43)	(1.621)	(.4293)
Density in 10 km radius (tertile=2) × Prov. density (log), 10 km	-1.256	-2.332**	-.2453	-2.332**
	(1.012)	(.9965)	(.65)	(.9949)
Density in 10 km radius (tertile=3) × Prov. density (log), 10 km	-1.38*	.1983	-.3883	.1983
	(.7955)	(.945)	(.8709)	(.9434)
Controls		×	×	×
Wave FE		×	×	×
County FE		×	×	×
Mean outcome variable	82.008	82.008	82.008	82.008
Observations	40365	40365	40365	40365
F-statistic	15.99	24.42	24.72	24.42
R2	0.003	0.076	0.076	0.076

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;
Standard errors clustered at county*assessment-month*year level in parenthesis.
Sources: Transparency Reports (at facility-level) 'bkk-pflegefinder.de' and indicators and maps of regional and urban development at county level (INKAR: German Statistical Office). Four waves: 2011, 2013, 2015, 2019. Estimation strategy: $Z_{it} = \beta_0 + \beta_1 \widehat{DENS}_{rt}^{HHC} + \gamma_1 \mathbf{DS}_{ct} + \gamma_2 \mathbf{CS}_{it} + \gamma_3 \overline{P}_{mt}^{NH} + C_c + T_t + u_{it}$; Dependent variable: medical quality $\in (0, 1/3, \ldots, 3/3)$; Density indicators: (log) number of providers . Regional control variables at individual and county level are provided in the Appendix in Table A.1. Fixed effects: wave fixed effects and county fixed effects (4 digits) ; Instruments: (IV1: $IV_{<10km}$) NH market density two years prior within 10 km radius and net number of NH entries in last two year within 10km radius; (IV2: $IV_{05-10km}$) or NH provider density within 5 to 10 km radius. Size tertiles: class1 [4-54 residents], class2 [55 - 102 residents], class3 [103 - 511 residents].

TABLE A.11: HHC price regulation: Provider density and care quality

	Nursing care quality					
	negotiated prices			fixed prices		
	OLS_{10km}	$IV_{\leq 10km}$	$IV_{05-10km}$	OLS_{10km}	$IV_{\leq 10km}$	$IV_{05-10km}$
Provider density (log), 10 km radius	-.647***	-1.281***	-2.027***	-2.386**	-3.541*	-5.559**
	(.2156)	(.4089)	(.5101)	(1.034)	(1.835)	(2.216)
Controls	×	×	×	×	×	×
Wave FE	×	×	×	×	×	×
County FE	×	×	×	×	×	×
Mean depend. variable	74.619	74.619	74.619	73.628	73.628	73.628
Provider density s.d.	1.11	1.11	1.11	1.09	1.09	1.09
Observations	39257	39257	39257	2401	2401	2401
1st stage excl. F-statistic		4332.04	3022.16		376.29	234.79
F-statistic	47.48	47.60	47.77	.	95.56	101.33
R2	0.136	0.136	0.135	0.167	0.167	0.163
	Medical care quality					
	negotiated prices			fixed prices		
	OLS_{10km}	$IV_{\leq 10km}$	$IV_{05-10km}$	OLS_{10km}	$IV_{\leq 10km}$	$IV_{05-10km}$
Provider density (log), 10 km radius	-1.154***	-1.212***	-1.23**	-2.425***	1.117	2.821
	(.1559)	(.4172)	(.5224)	(.7486)	(1.772)	(2.296)
Controls		×	×		×	×
Wave FE		×	×		×	×
County FE		×	×		×	×
Mean outcome variable	82.117	82.117	82.117	80.311	80.311	80.311
Provider density s.d.	1.11	1.11	1.11	1.09	1.09	1.09
Observations	38192	38192	38192	2338	2338	2338
1st stage excl. F-statistic		4252.04	3019.30		369.90	231.82
F-statistic	54.75	24.75	24.70	10.49	90.99	91.25
R2	0.002	0.074	0.074	0.008	0.142	0.140

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;
Standard errors clustered at county*assessment-month*year level in parenthesis.
Sources: Transparency Reports (at facility level) 'bkk-pflegefinder.de' and indicators and maps of regional and urban development at county level (INKAR: German Statistical Office). Four waves: 2011, 2013, 2015, 2019. Estimation strategy: $Q_{it} = \beta_0 + \beta_1 \widehat{DENS}_{rt}^{HHC} + \beta_2 \mathbf{DS}_{ct} + \beta_3 \mathbf{CS}_{it} + \gamma \overline{P}_{mt}^{NH} + \kappa_c + \tau_t + \varepsilon_{it}$; Dependent variable: nursing care quality $\in (0, 1/6, \ldots, 6/6)$ and medical quality $\in (0, 1/3, \ldots, 3/3)$; Density indicators: (log) number of providers . Regional control variables on individual and county level are provided in the Appendix in Table A.1. Fixed effects: wave fixed effects and county fixed effects (4 digits); Instruments: (IV1: $IV_{<10km}$) NH market density two years prior within 10 km radius and net number of NH entries in last two year within 10 km radius; (IV2: $IV_{05-10km}$) or NH provider density within 5 to 10 km radius.

Chapter 3

Nurse Shortage and Capacity Management of Nursing Homes

With Dörte Heger, Annika Herr, and Arndt Reichert

3.1 Introduction

In numerous advanced economies, there has been a growing discrepancy between the number of retiring workers and incoming younger entrants in the labor market. Such demographic shifts have significantly contributed to labor shortages in various sectors (e.g. Duval et al., 2022). A prime example is the nursing sector where personnel shortages have been escalating over time, reaching critical levels (World Health Organization, 2020; Buerhaus et al., 2007).

The coronavirus pandemic further exacerbated the nurse shortages by decreasing the labor force participation among older nurses (e.g., Spetz, 2021). Additionally, those who continued working have been absent more often due to illness (e.g., Schug et al., 2022). Important health care consequences likely include prolonged waiting lists for people in need of care, inadequate care, and in extreme cases, the shutdown of entire nursing homes (Görres et al., 2020; Netten et al., 2003). While it appears paradoxical that the same demographic shift generates both an increased demand of nursing care and a potential reduction of supply of care services, in certain countries, like Germany, the magnitude of the problem has become so glaring that it has spurred intense public debates. These discussions recently started to revolve around triage protocols, questioning whether nursing homes should deprioritize elderly individuals with minimal care needs (ARD, 2023).

In this paper, we aim to investigate the strategies German nursing care providers employ to address labor shortages within the nursing sector. We employ data from the official German Care Statistic spanning 2007 to 2017, which encompasses the universe of German care facilities, personnel, and care recipients

(both formal and informal). This dataset is augmented with administrative vacancy information at the county-level on all publicly reported nursing positions that stem from the capacity planning of individual nursing homes, provided by the Research Institute of the Federal Employment Agency (Statistik der Bundesagentur für Arbeit, 2023).

Nursing homes have various management strategies at their disposal to address nursing personnel shortages. Once traditional capacity planning measures, such as job advertisements in local newspapers and at the Federal Employment Agency, are exhausted, they can resort to capacity management methods. Specifically, they might increase the number of residents assigned to each nurse. They can also replace registered nurses with nurse assistants, and vice-versa. However, these strategies may threaten the quality of care. Regulations therefore stipulate minimum nurse-to-resident ratios (see Table D.4), which may cause nursing homes having reached the critical threshold to leave rooms empty. In this case, the occupancy ratio will decrease, diminishing profitability. Hence, rather than quality of care, this strategy threatens the financial sustainability of the care provider. If a nursing home is unprofitable over several years, the probability to exit the market increases.

We investigate how various capacity management metrics of nursing homes including the nurse-to-resident ratio, the qualification mix of the nursing personnel, and the occupancy ratio correlate with the county-level number of published vacancy notes, which we use as our measure of nursing shortages. Notably, on average, there are three times as many vacancy notes as there are nursing candidates, indicating that many of these positions remain vacant for extended periods (Federal Employment Agency, 2022). Our methodological approach involves utilizing pooled cross-sectional data and linear regression analyses.

The examined capacity management metrics are highly relevant from a public health policy perspective. For instance, the nurse-to-resident ratio likely serves as proxy for the nursing homes' ability to provide personnel intensive, high-quality care. With a shortage of nursing staff, a higher risk of compromised patient safety, reduced attention to detail, and a greater likelihood of patient mistreatment have been reported (Kang et al., 2023; Shi et al., 2023; Dierckx de Casterlé et al., 2020; Sefidani Forough et al., 2020; Teng et al., 2010).

We find higher nursing shortages to be accompanied by a substantially lower nurse-to-resident ratio, a shift of the staff qualification mix, and a reduced overall provision of care. As to the latter, we find a negative relationship between nurse shortages and the occupancy ratio, which implies that the number of nursing home residents is reduced. This is problematic for the financial sustainability of nursing homes because reimbursement rates are negotiated

based on the assumption of maximum utilization of available beds. With persistently reduced occupancy ratios, the long-term financial viability of these institutions comes into question. In fact, current trends suggest that every fourth nursing home operates at a deficit (Heger et al., 2021). Consequently, the looming nursing shortages stand as a potential threat to the sustainability and future of elderly care in countries like Germany. In the conclusion, we discuss potential measures to mitigate the extent of the problem.

This paper is the first to empirically study capacity management strategies used by nursing homes in response to nursing shortages. As opposed to nursing shortages, Ching et al. (2015) show that limited bed capacity results in the rationing of services for nursing home residents. Other studies estimate the effects of nursing shortages on the well-being of the nursing workforce (e.g., Sebastiano et al., 2017). To develop a better understanding of provider decisions in relation to nurse capacity planning as opposed to the management of existing capacity, Harrington and Swan (2003) assess the relationship between nursing hours and nurse turnover rates, resident case mix, and nursing wages.

Our paper connects with several studies that examine the relationship between demand and capacities in nursing homes. For example, Bae et al. (2019) model the interaction of nursing capacity and demand, finding that appropriate capacity planning can improve system indicators such as waiting times for beds, occupancy, and quality. Similarly, Pilny and Stroka (2015) examine the relationship between the demand for long-term in-patient care and the regional supply of nursing home beds. Van Gameren and Woittiez (2005) relate the demand for higher elderly care provision to access to informal care. Bauer and Stroka (2013) investigate whether the labour market participation and the education level of women are correlated with the prices of nursing homes.

There is some more literature available for hospital care. Most closely connected with our study is the analysis of Blegen et al. (2008) showing that nursing staffing levels in both intensive care and non-intensive care units decrease as the supply of registered nurses in the surrounding geographic area decreases. Further available studies examine ways to use existing nursing capacity in hospitals more effectively (Maloney et al., 2007; Elkhuizen et al., 2007) and the effects of nursing shortages on quality of medical care as well as care costs (Griffiths et al., 2023; Milstein and Schreyoegg, 2020; Bridges et al., 2019; Weiss et al., 2011; Needleman et al., 2002).

The remainder of the paper is organized as follows. Section 3.2 presents shortly

the institutional background and a theoretical idea, which highlights the relation between personnel shortage and the use of nursing home capacity management strategies. Section 4.3 describes the data sources and defines the variables, Section 3.4 explains the estimation strategy. Section 3.5 presents descriptive statistics and the regression results. Section 4.6 discusses the findings and concludes.

3.2 Background

3.2.1 Institutional background

Nursing homes (NHs) in Germany face low entry restrictions, but high entry costs. The largest part of the marginal costs is driven by nursing care personnel. The mandatory long-term care insurance as well as the social security system for the poor negotiate the prices, which are fixed at NH level for at least one year. Prices depend on past costs and the NH's negotiation strength. To receive the full amount of investments costs, NHs need high occupancy ratios(Kienitz, 2016). NHs are obligated to provide a predefined nurse-to-residents ratio (see Table D.4 in the appendix).

3.2.2 Theoretical considerations

We apply a standard equilibrium model of the labor market to explain the situation of personnel shortage. The model is illustrated in Figure B.1 in the Appendix. A shift in the supply curve indicates that, at a specific wage, fewer nursing personnel are willing to provide care, causing the equilibrium between demand and supply of labor to be reached at a higher wage.

The consequence of the shifting supply is a reduction in the number of nurses who provide care in the market, which limits the facilities' ability to provide sufficient, high-quality care as they either need to employ fewer qualified NP per resident or stop admitting new residents, i.e., reducing the occupancy ratio.

In Germany, the nursing shortage problem is likely to have disproportionate effects due to substantive wage rigidity in the market. This is explained by difficult and time-consuming negotiations about the NH reimbursement rates between the providers and the long-term care insurers that have provided nursing homes limited margins to pay higher wages (Krachler et al., 2021; Rothgang, 2010). Under the assumption that wages cannot increase, even less nurses will supply care.[1]

[1]Consistent with the focus of the empirical analyses which are on the shift on the supply side, in our model, we abstract from shifts of the demand curve resulting from the demographic change. With flexible wages, an increased demand for nursing care may offset the effects of nurse supply shortages as the willingness to pay for nursing services will provide incentives

3.3 Data

For this study, we combine the German Care Statistic provided by the Statistical Offices of the Länder at the Research Data Center of Hannover (FDZ, 2020) with data from the Research Institute of the Federal Employment Agency (Statistik der Bundesagentur für Arbeit, 2023) and indicators of regional and urban development from the Federal Office for Building and Regional Planning (Bundesamt für Bauwesen und Raumordnung, 2023, INKAR) for the period 2007 to 2017. Hence, our study period does not include the coronavirus pandemic.

The German Care Statistic is collected biennially in December and includes rich information on the universe of German NHs and their residents, home health care providers and their clients as well as informal care recipients. We restrict our analysis to care provision for the elderly in long-term care facilities[2] and exploit information on the NH level, covering the number and care level of their permanent residents as well as the qualification mix, contractual working time, and tasks performed by the staff (FDZ, 2020).

To capture staff shortages, we include vacancy data from the Research Institute of the Federal Employment Agency. This data provides us with the number of all open positions (yearly averages) in NHs for nursing assistants (NA), registered nurses (RN), and specialists (SN) aggregated at the county level (Statistik der Bundesagentur für Arbeit, 2023).[3] Whereas other research aims to approximate personnel shortage by the nurses' workload (Bridges et al., 2019), open positions are arguably a more direct measure of personnel shortage. NHs publish job advertisements for one specific nurse type even if they look for more than one. Thus, the vacancy ratio likely underestimates the actual nurse shortage. This measurement error yields attenuation bias and, hence, conservative point estimates in the regression analyses.

Lastly, further information on the county level such as characteristics of their working population, medical infrastructure, wealth, and demographic composition is drawn from the INKAR data (Bundesamt für Bauwesen und Raumordnung, 2023).

The analyses are conducted at the Research Data Center (FDZ) in Hannover. To protect the confidentiality of individual care facilities in the Care Statistic,

for individuals to supply more labor in the nursing market. Under this condition, it will be an empirical question whether the supply- or demand-side effect of the demographic shift prevails. Yet, in the presence of wage rigidity, changes on the demand side are not affecting the effects of a shift in the supply of nurses in the model.

[2] We drop individuals below 65 years of age (around 500,000 individuals) and facilities that are only providing day- and short-term care (15,823 facilities)

[3] Employers are required by law to report open positions to the federal employment agency (REF - add: § 164 SGB IX).

we present descriptive statistics that cover the full dataset, rather than the final data that excludes missing values and outliers.

As capacity management metrics, we employ the NP to NH resident ratio (NP/resident) calculated individually for each facility j in year t, where the number of personnel is measured in full-time equivalent staff (FTE) and we focus on permanent residents. We calculate this ratio for all NP, RNs, and NAs separately, to consider differences in skill-mix. While NP does not represent all personnel working in a NH, as shown in Figure 3.1, NP represents the input most crucial to care provision.

We also apply the qualification mix (NA share) as a capacity management metric to examine the different compositions of nursing personnel and their potential for substitution. This ratio is calculated as the relation of registered nurses (or nursing assistants) in FTE to the total number of nursing personnel in FTE.

We also use the number of beds for permanent care, the number of residents per NH, and the home-specific occupancy ratio. This ratio is calculated as the proportion of permanent NH beds occupied by NH residents compared to all available permanent beds in the NH at a given point in time.

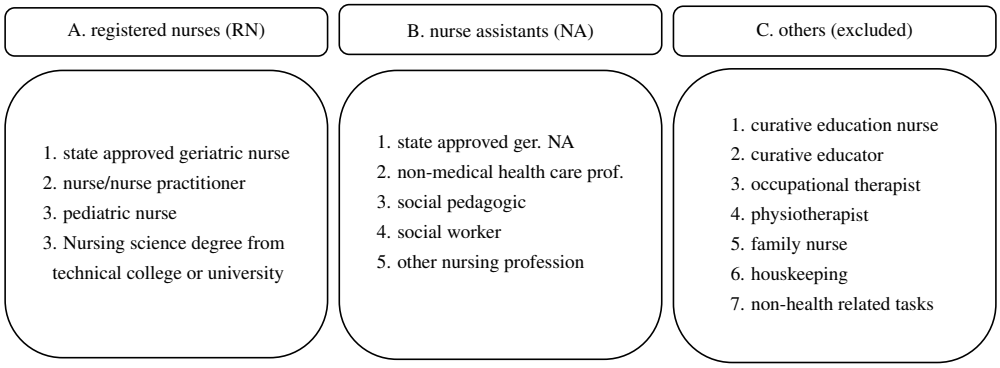

FIGURE 3.1: Overview of nurse qualifications

Note: We follow the profession classification of the Research Institute of the Federal Employment Agency (Bundesagentur für Arbeit, 2011, IAB).
A. *Registered nurses (RN) are professional care givers with a specific vocational training of 3 to 5 years. They provide basic care, medical treatments, and administrative support.*
B. *Nurse assistants (NA) are professional care givers with a vocational training of 1 to 2 years. They assist with personal hygiene, meal assistance, and, under supervision, administer medications and work alongside other RN.* ***C.*** *We exclude professions that do not involve direct care contact with residents .*

We use the county-specific NP vacancy ratios to assess NP shortage. This measure has already been applied in other studies (Grumbach et al., 2001; Buchan and Calman, 2004; Rondeau et al., 2008). Here, we define the vacancy ratio (NP-vacancy) as the number of open positions divided by the total budgeted positions. The latter includes both vacant and filled positions at the county level. To differentiate the personnel shortages by types of qualification, we calculate qualification-specific vacancy ratios for all NP, RN, and NA (Eq. 3.1).

$$\text{NP-vacancy}^{i}_{c,t} = \frac{vac^{i}_{c,t}}{bud.\ pos.^{i}_{c,t}} = \frac{vac^{i}_{c,t}}{filled\ pos.^{i}_{c,t} + vac^{i}_{c,t}},\ where\ i \in \{all, RN, NA\} \tag{3.1}$$

3.4 Estimation strategy

We employ a multiple linear regression model with pooled cross-sectional data to regress NH capacity management metrics (CMM) on the NP-vacancy (see Equ. 3.2). Note that CMM is measured at the facility level (j), while we observe the NP-vacancy at the county level (k). We include control variables both at the facility as well as county level. Further, we include time fixed effects (τ_t) and regional fixed effects based on spatial planning regions[4] (κ_r), and ownership type fixed effects (ρ_p). Standard errors are clustered at the county level.

$$\text{CMM}^{i}_{j,t} = \beta_0 + \beta_1 \text{NP-vacancy}^{i}_{k,t} + \beta_2 \mathbf{X}_{j,t} + \beta_3 \mathbf{X}_{k,t} + \tau_t + \kappa_r + \rho_p + \epsilon_{j,k,t},\ where\ i \in \{all, RN, NA\} \tag{3.2}$$

To ensure that our observed relationships between vacancy ratios and the CMMs are not driven by other factors, we include control variables that might influence NH capacities (Kelly et al., 2022; Winter et al., 2020; Huiwen et al., 2020; Lee et al., 2012; Blegen et al., 2008; Harrington and Swan, 2003). We group the control variables into categories such as facility characteristics, working population, medical infrastructure, wealth, and demographics, with the latter category primarily focusing on the working population.[5] To rule out concerns of multicollinearity, we pairwise calculate Pearson correlations and variance inflation factors (VIF). We find no abnormalities or high VIF values, indicating that multicollinearity is not an issue in the regression analysis (results are available upon request).

3.5 Results

In this section, we first present descriptive statistics and then report the results for the relationship between capacity management and nurse shortage.

Table 3.1 presents descriptive statistics for the key variables. On average, 42 NHs are located within one county, each providing residence for, on average,

[4] A spatial planning region is an administrative concept. The region is larger than a county and used, e.g., to regulate the regional number of general practitioners.

[5] Descriptive statistics for all covariates can be found in B.1 in the Appendix.

TABLE 3.1: Descriptive statistics

	2007-2017			
	mean	sd	p10	p90
Basic NH information				
Nursing homes, county	42.21	45.40	13	62
All nurses (NP, FTE)	28.41	16.77	10.75	48.75
Registered nurses (RN, FTE)	15.16	9.04	6.00	26.25
Nursing assistants (NA, FTE)	13.25	8.89	3.75	24
NH residents	70.27	40.76	25	120
Age of NH residents	82.77	3.81	79.12	86.07
Personnel-to-resident ratios				
NP	.404	.160	.314	.527
RN	.216	.117	.156	.309
NA	.189	.085	.113	.267
Skill-mix				
Share RN	.550	.120	.420	.690
Beds				
Occupancy ratio	.885	.127	.724	1
Number of NH beds, county	3622	5111	1027	5587
Vacancy ratio				
NP	.053	.024	.026	.083
RN	.066	.030	.033	.104
NA	.037	.022	.012	.067
Observations	59,903			

Data source: Long-term care (LTC) statistics (facility level), vacancies from the German Institute of Employment Research (IAB) (county level), INKAR data (county level). 59,903 observations (nursing home LTC facilities): [six waves] 2007 (9,205), 2009 (9,676), 2011 (9,972), 2013 (10,197), 2015 (10,383), 2017 (10,432). German LTC statistic: Research center of the Federal and State Statistical Offices, care statistics, [10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0]

70 residents with a mean age of slightly below 83 years. The average NP-to-resident ratio in a facility is 0.42, indicating that approximately one NP-FTE supervises two to three residents.

On average, a NH employs 15 RN and 13 NA (all numbers represent FTE). The RN-to-resident ratio equals 0.22, which corresponds to a bit more than five residents per RN. For assistant nurses (NA), the average ratio is 0.19, i.e. slightly lower than the ratio for RNs. This latter finding is also documented by the average skill mix. The mean NA share equals 0.55.

Descriptive information for further control variables including additional facility-specific and regional information as well as data on outpatient and informal care are provided in the Appendix in Table B.1.

Figure 3.2 illustrates the regional variation of NH vacancy ratios separately for all NP, RNs, and NAs aggregated at the spatial planning region level. Vacancy ratios tend to be somewhat lower in Southern Germany and, on average, higher for RNs than for NAs. Vacancy ratios for RNs are, e.g., especially high in the North and North-East of Germany, while the East shows particularly high vacancy ratios for NAs.

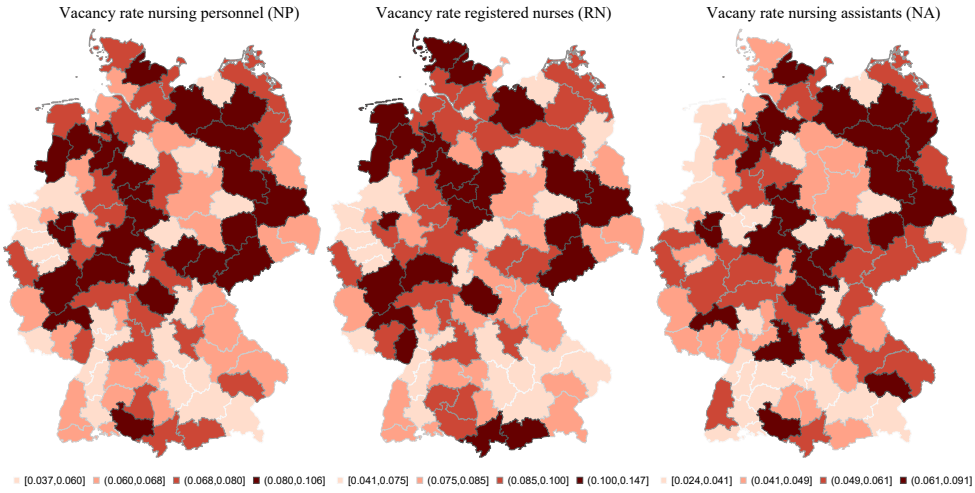

FIGURE 3.2: Vacancy ratios across the German spatial planning regions in 2017
Note: Vacancy ratios are derived from own calculations (see Equ. (3.1)). We calculate the vacancy ratio for all nurses (NP), registered nurses (RN) and nursing assistants (NA). Profession definitions are provided in Figure 3.1. *Sources:* (1) Care Statistic: Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0] (2) Vacancy data: Research Institute of the Federal Employment Agency, IAB

Figure 3.3 illustrates the time trends of the average vacancy ratios. NP-vacancy goes down between 2007 and 2009, but has continuously increased since. While the overall development of RN- and NA-vacancy ratios is similar, the RN-vacancy ratio has experienced a small decline between 2011 and 2013, while the NA-vacancy ratio shows a small decline between 2009 and 2011. Overall, the vacancy ratio seems low, which is consistent with an underestimated nurse shortage. Still, the variation across counties is very informative since this underestimation is true for all regions.

Figure 3.4 visually confirms a negative linear relationship between the vacancy ratio and the nurse-to-resident ratio controlling for time-varying regional covariates. Our multivariate regression results analyze this relationship further.

Our regression results for the nurse-to-resident ratios are displayed in Table 3.2. The first column presents the results for the shortage of all NP. The findings reveal a statistically significant negative point estimate of -0.23. In a county with a one standard deviation higher NP-vacancy (2.4 percentage points), the NP-to-resident ratio is lower by 0.6 percentage points or 1.37 percent. The second and third columns display the estimates for the respective

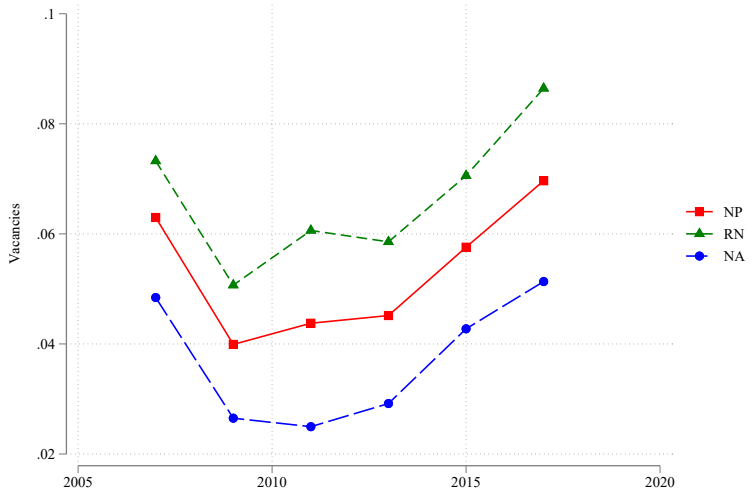

FIGURE 3.3: Vacancy ratios by nurse qualification from 2007 to 2017

Note: Vacancy ratios are derived from own calculations (see Equ. (3.1)). We calculate the vacancy ratio for all nurses (NP), registered nurses (RN) and nursing assistants (NA). Profession definitions are provided in Figure 3.1. *Source:*(1) Care Statistic: Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0] (2) Vacancy data: Research Institute of the Federal Employment Agency, IAB

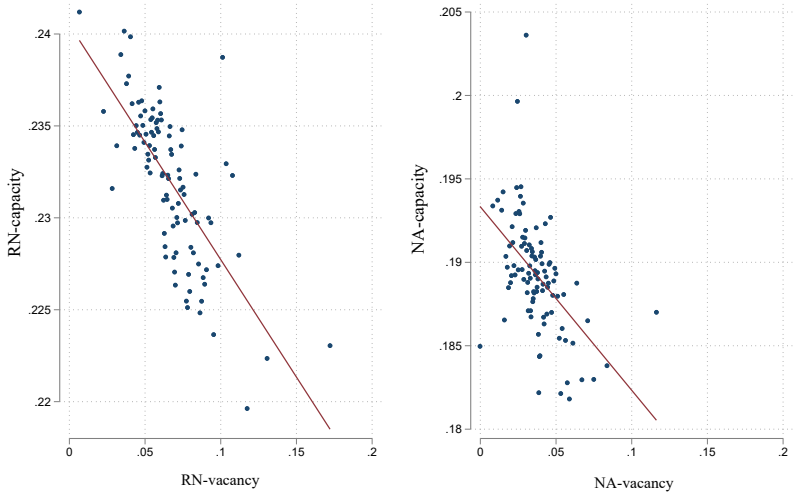

FIGURE 3.4: Scatter plot of nurse-to-resident ratios and nurse vacancies by qualification

Note: Figure 3.4 is a bin scatter plot with RN left and NA right, which clusters all observations into 100 bins with comparable observations. Covariates and fixed effects are included. *Source:* (1) Care Statistic: Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0]. (2) Vacancy data: Research Institute of the Federal Employment Agency, IAB.

ratios for RNs (-2.1 percent in a county with a one s.d. higher RN-vacancy) and NAs (-3.2 percent, respectively). [6]

[6]Since preferences for NH care, as well as regulations regarding nursing personnel requirements differ across Germany by state, we analyze the vacancy ratios in the counties relative to the state average. The results are in line with those from our main specification and show that higher vacancy ratios correspond to lower state NP-to-resident ratio relative to the state average (see Table B.2 in the Appendix). Hence, we can eliminate the concern that state regulations or varying long-term care policies influence our findings.

TABLE 3.2: Nursing vacancies and nurse-to-residents ratio

	NP	RN	NA
NP-vacancy	-.2261***		
	(.0386)		
RN-vacancy		-.1504***	
		(.0229)	
NA-vacancy			-.1252***
			(.0233)
Controls	×	×	×
Wave FE	×	×	×
Regional FE	×	×	×
Owner FE	×	×	×
Mean outcome variable	0.404	0.216	0.189
Observations	59,865	59,865	59,865
F-statistic	23.07	24.80	24.23
R2	0.152	0.171	0.087

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Standard errors clustered at the county level in parentheses. Data source: care statistics (FDZ, 2020) (facility level), transparency reports (facility level), vacancies from the German Institute of Employment Research (Statistik der Bundesagentur für Arbeit, 2023) (county level), indicators and maps of regional and urban development (Bundesamt für Bauwesen und Raumordnung, 2023) (county level). Observations (stat. nursing facilities): [six waves] 2007 (9,205), 2009 (9,676), 2011 (9,972), 2013 (10,197), 2015 (10,383), 2017 (10,432). Estimating equation: $\text{CMM}^{i}_{j,t} = \beta_0 + \beta_1 \text{NP-vacancy}^{i}_{k,t} + \beta_2 \mathbf{X}_{j,t} + \beta_3 \mathbf{X}_{k,t} + \tau_t + \kappa_r + \rho_p + \epsilon_{j,k,t}$; Outcome: Nurse-to-resident ratio by qualification. Explanatory variable: Vacancy ratio nurses (NP-vacancy), Vacancy ratio registered nurses (RN-vacancy), Vacancy ratio nurse assistants (NA-vacancy). Control variables at the facility level and at the county level in Table B.1 in the Appendix. Fixed effects: Wave fixed effects, county fixed effects, and owner fixed effects.

We also examine the potential substitution effects between RNs and NAs. The degree to which these two professional qualifications serve as complements rather than substitutes is an empirical question. Table 3.3 presents the estimation results for the skill composition in terms of the share of NAs. The first column displays the model for RN-vacancy ratios, while the second column shows the same model for NA-vacancy ratios. In both cases, the vacancy ratios are significantly correlated with the qualification mix. The share of NAs is 0.3 percentage points or 0.7 percent larger if the vacancy ratio for registered nurses per county is larger by 1 s.d. (i.e., +3 percent, where the average is 45 percent). The opposite relationship is observed for the shortage of nurse assistants (-0.8 percent at the mean if NA-vacancy is 2.2 percent higher). Based on the results in this table, we conclude that, to some degree, nurse assistants act as substitutes for the shortage of registered nurses and vice-versa. Hence, NHs have a valuable lever to manage a skill-specific nurse shortage. In addition, we look at the number of residents per NH and beds per NH (Table 3.4) as additional capacity management metrics. While our findings do not show any significant relationships between vacancy ratios and the average number of NH beds, we observe that the NH has 1.2 fewer residents considering the distance of the 10^{th} percentile of the NP-vacancy ratio to the 90^{th} percentile. The results for RN and NA are quantitatively similar and weakly statistically different from zero .

TABLE 3.3: Nursing vacancies and qualification mix

	NA share	NA share
RN-vacancy	.1054***	
	(.0225)	
NA-vacancy		-.1624***
		(.03)
Controls	×	×
Wave FE	×	×
Regional FE	×	×
Owner FE	×	×
Mean outcome variable	0.450	0.450
Observations	59865	59865
F-statistic	40.49	40.58
R2	0.141	0.141

$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$; Standard errors clustered at the county level in parentheses. Data source: care statistics (FDZ, 2020) (facility level), transparency reports (facility level), vacancies from the German Institute of Employment Research (Statistik der Bundesagentur für Arbeit, 2023) (county level), indicators and maps of regional and urban development (Bundesamt für Bauwesen und Raumordnung, 2023) (county level). Observations (stat. nursing facilities): [six waves] 2007 (9,205), 2009 (9,676), 2011 (9,972), 2013 (10,197), 2015 (10,383), 2017 (10,432). Estimating equation: Qualification $\text{mix}_{j,t} = \beta_0 + \beta_1 \text{NP-vacancy}^N_{k,t} + \beta_2 \mathbf{X}_{j,t} + \beta_3 \mathbf{X}_{k,t} + \tau_t + \kappa_r + \rho_p + \epsilon_{j,k,t}$; outcome: Nursing personnel qualification (NP-qualification); explanatory variable: vacancy ratio registered nurses (RN-vacancy), vacancy ratio nurse assistants (NA-vacancy). Control variables at the facility level and at the county level in Table B.1 in the Appendix. Fixed effects: Wave fixed effects, county fixed effects, and owner fixed effects.

Finally, we bring the two capacity management metrics together in the occupancy ratio. It relates the number of residents to the number of beds in a NH and might be lower or higher, depending on whether the numerator or denominator correlates more strongly with our nurse shortage measure. Table 3.5 shows that the occupancy ratio is significantly lower with a higher vacancy ratio. This result is mostly driven by the shortage of RNs. For a one percentage point higher RN vacancy ratio, the occupancy ratio is .1 percentage points lower. Considering a difference in the RN-vacancy ratio between several adjacent spatial planning regions of 10 percentage points (Figure 3.2), our estimation results imply a difference in the number of residents and the occupancy ratio between the same planning regions of about two residents and roughly 1 percentage point, respectively.

These findings appear plausible. While altering the number of beds is arguably difficult in the short- and even medium-term, due to regulated nurse-to-resident ratios, the number of residents and, thus, the occupancy ratio is directly related to personnel shortage and especially to a shortage of RN. Since NHs need a high occupancy ratio to generate sufficient income, this finding suggests an increase in the risk of NHs at the margin exiting the care market as a result of the nursing shortage.

TABLE 3.4: Nursing vacancies and NH access

	Permanent beds			Number of residents		
NP-vacancy	-13.96			-21.84**		
	(13.46)			(9.688)		
RN-vacancy		-4.222			-13.15*	
		(10.5)			(7.496)	
NA-vacancy			-17.31			-18.69*
			(13.56)			(11.05)
Controls	×	×	×	×	×	×
Wave FE	×	×	×	×	×	×
Regional FE	×	×	×	×	×	×
Owner FE	×	×	×	×	×	×
Mean outcome variable	79.876	79.876	79.876	70.27	70.27	70.27
Observations	59,865	59,865	59,865	59.865	59,865	59,865
F-statistic	21.16	21.19	21.16	60.35	55.42	48.65
R2	0.153	0.153	0.153	0.129	0.129	0.129

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Standard errors clustered at the county level in parentheses. Data source: care statistics (FDZ, 2020) (facility level), transparency reports (facility level), vacancies from the German Institute of Employment Research (Statistik der Bundesagentur für Arbeit, 2023) (county level), indicators and maps of regional and urban development (Bundesamt für Bauwesen und Raumordnung, 2023) (county level). Observations (stat. nursing facilities): [six waves] 2007 (9,205), 2009 (9,676), 2011 (9,972), 2013 (10,197), 2015 (10,383), 2017 (10,432). Estimating equation: (1) $\text{Capacity}_{j,t} = \beta_0 + \beta_1 \text{NP-vacancy}^N_{k,t} + \beta_2 \mathbf{X}_{j,t} + \beta_3 \mathbf{X}_{k,t} + \tau_t + \kappa_r + \rho_p + \epsilon_{j,k,t}$, (2) $\text{residents}_{j,t} = \beta_0 + \beta_1 \text{NP-vacancy}^N_{k,t} + \beta_2 \mathbf{X}_{j,t} + \beta_3 \mathbf{X}_{k,t} + \tau_t + \kappa_r + \rho_p + \epsilon_{j,k,t}$; Outcome: Permanent beds or number of residents per nursing home. Explanatory variable: Vacancy rate all nurses (NP-vacancy), Vacancy rate registered nurses (RN-vacancy), Vacancy rate nurse assistants (NA-vacancy). Control variables at the facility level and at the county level in Table B.1 in the Appendix. Fixed effects: Wave fixed effects, county fixed effects, and owner fixed effects.

TABLE 3.5: Nursing vacancies and NH occupancy ratios

	Occupancy ratio		
NP-vacancy	-.1062***		
	(.0281)		
RN-vacancy		-.0996***	
		(.0221)	
NA-vacancy			-.054*
			(.0304)
Controls	×	×	×
Wave FE	×	×	×
Regional FE	×	×	×
Owner FE	×	×	×
Mean outcome variable	0.886	0.886	0.886
Observations	59.865	59,865	59,865
F-statistic	49.74	49.81	49.69
R2	0.197	0.197	0.197

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Standard errors clustered at the county level in parentheses. Data source: care statistics (FDZ, 2020) (facility level), transparency reports (facility level), vacancies from the German Institute of Employment Research (Statistik der Bundesagentur für Arbeit, 2023) (county level), indicators and maps of regional and urban development (Bundesamt für Bauwesen und Raumordnung, 2023) (county level). Observations (stat. nursing facilities): [six waves] 2007 (9,205), 2009 (9,676), 2011 (9,972), 2013 (10,197), 2015 (10,383), 2017 (10,432). Estimating equation: $\text{Occ-ratio}_{j,t} = \beta_0 + \beta_1 \text{NP-vacancy}^N_{k,t} + \beta_2 \mathbf{X}_{j,t} + \beta_3 \mathbf{X}_{k,t} + \tau_t + \kappa_r + \rho_p + \epsilon_{j,k,t}$; Outcome: occupancy ratio (Occ-rate)= (occupied beds)/(total perm. beds). Explanatory variable: Vacancy rate all nurses (NP-vacancy), Vacancy rate registered nurses (RN-vacancy), Vacancy rate nurse assistants (NA-vacancy). Control variables at the facility level and at the county level in Table B.1 in the Appendix. Fixed effects: Wave fixed effects, county fixed effects, and owner fixed effects.

3.6 Discussion and conclusion

This study explores the relationship between nursing personnel shortage and capacity management strategies employed by NHs, a topic of increasing relevance given the demographic development in most high-income countries. We measure personnel shortage using county-level vacancy ratios, differentiated by the skill-level of nursing personnel. We observe a strong negative correlation of the vacancy-ratio measures with the nurse-to-resident ratios. We show that another capacity management measure of NHs is to adjust the qualification mix of their nursing workforce, depending on the degree of shortage for different types of nurses. We further find a moderate reduction in the occupancy ratio of NHs. This finding is supported by the statistically insignificant relationship between nursing shortages and the number of NH beds, which indicates that managing the shortage of nurses by reducing the number of beds is not an immediate solution. Hence, a reduction in the workforce will tautologically translate into a reduced occupancy ratio.

In quantitative terms, our estimation results suggest a difference of roughly two home residents and a percentage point in the occupancy ratio between adjacent planning regions that display a strong difference in the shortages of nurses, respectively. However, multiple hires for a single vacancy or institutions not advertising vacancies as required could cause us to substantially underestimate these correlations. Finding nevertheless significant correlations underscores the relevance of the uncovered relationships.

While our results can strictly only be interpreted as correlations, we argue that a causal effect is probable. First, we include various control variables to capture variation in the NH residents or substitution on the demand side. Second, we control for factors that may shift labor supply more generally. Third, we include wave, regional, and ownership type fixed effects, effectively excluding additional potential confounding factors.

Our study sheds light on the expected changes in the NH market as a result of this trend of increasing personnel shortage. For one, the number of residents per nurse is expected to increase while the individual time for each resident and therefore the intensity of care is expected to decrease. The resulting time pressure for nurses is likely to compromise patient safety and increase the risk of mistreatment. For another, while NHs do not diminish their size in our study, occupancy ratios and the number of residents decrease. A persistently reduced occupancy ratio can imply the financial instability of NHs, especially if these are already at an elevated risk to exit the market (Heger et al., 2021). A promising area for future research is to employ a longer time frame to empirically analyze the relationship between nursing shortages and NH closures.

Our findings highlight the necessity to address the nursing shortage problem to ensure sufficient care supply as well as care security. It seems crucial to augment the nursing workforce through methods like enhancing job appeal and decrease the demand for nurses by improving overall health of the elderly as well as utilizing tools to lessen the workload of nurse practitioners. Potential solutions encompass simplifying access to patient data with electronic health records, facilitating distant consultations through tele-medicine, utilizing wearable gadgets for instant patient surveillance, and assistic robotic systems both, within NHs and in home health care.

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B. Appendix

B. 1 Theoretical model

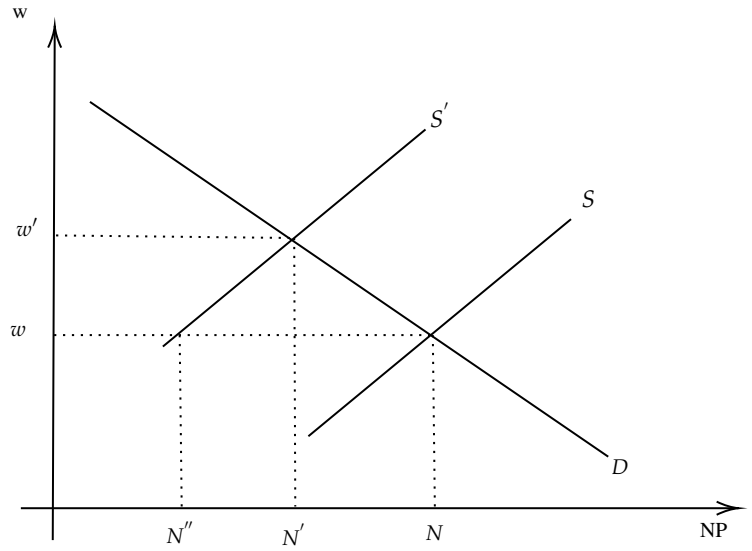

FIGURE B.1: Illustration of the nurse labor market in case of personnel shortages

The figure shows the relationship between nursing personnel, NP, (x-axis) and wages (y-axis). The nursing supply at a given wage is displayed by S. The demand for nurses is displayed by D. A general equilibrium exists with N and w. For an illustration of the implications of nursing shortages, we introduce a shift of the NP supply curve from S to $S^{'}$, which results in a different equilibrium at $N^{'}$ and $w^{'}$ with less nurses at at higher wage. The shift can be interpreted as regional differences. Under the assumption that wages cannot increase, even less nurses will supply care. For example, in the extreme case of full wage rigidity, we observe a reduction from N to $N^{''}$.

B. 2 Data description

TABLE B.1: Descriptive statistics for the control variables

	2007-2017			
	Mean	S.D.	p10	p90
Facility characteristics				
Share of single-rooms	.6224	.277	.2133	1
Weighted average price, NH care [EUR]***	1649	437.6	1104	2200
Age stationary LTC recipients	82.78	3.817	79.13	86.08
Working population				
Female unemployed ratio	.06904	.03116	.033	.115
Share female unemployed older 55	.1827	.04789	.123	.246
Share unemployed professionals	.4233	.05824	.353	.498
Share employed in service sector	.2245	.04351	.17	.2817
Medical infrastructure				
GPs [/100,000 inh.]	201.3	49.56	147	251.7
Hospital beds [/10,000 inh.]	6.086	3.047	2.79	9.7
Amb. facility density	58.99	93.79	13	99
Ambulatory personnel [/10,000 inh.]	24.97	7.31	16.65	35.23
Regional wealth				
Monthly household income [EUR]	1677	232	1393	1963
Monthly gross income [EUR]	2398	396.3	1916	2902
Communal depts [EUR/ inhabitant]	1581	1320	364.6	3237
Land price [EUR/m^2]	154.6	180.2	31.7	327
Avg. pension [EUR]	844.9	80.8	735.5	952.5
Share in need of social assistance	.2197	.1466	.071	.447
Demographics				
Share age group 50–65	.2732	.02288	.243	.303
Avg. age female population	45.05	2.006	42.8	48.1
Population density [/km^2]	694.5	932.4	95	2113
Rurality [% inh. in region $\leq 150\, inh./km^2$]	.2521	.2731	0	.679
Care-dependency, weighted average level	1.771	.2091	1.526	2.019
Share severe need of amb. LTC recipients	.134	.05012	.08054	.2069
Share severe need of inf. LTC recipients	.08763	.03388	.05532	.139
Ppl in need of inf. LTC	12499	18606	3227	20469
Observations	59,903			

Data source: care statistics (FDZ, 2020) (facility level), vacancies from the German Institute of Employment Research (Statistik der Bundesagentur für Arbeit, 2023) (county level), INKAR data (Bundesamt für Bauwesen und Raumordnung, 2023) (district level). 59,903 observations (nursing home LTC facilities): [six waves] 2007 (9,211 obs.), 2009 (9,678 obs.), 2011 (9,973 obs.), 2013 (10,200 obs.), 2015 (10,389 obs.), 2017 (10,452 obs.). German LTC statistic: Research center of the Federal and State Statistical Offices, care statistics, [10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0]

B. 3 Robustness checks

TABLE B.2: Nursing capacity and vacancy ratio difference to state

	Capacity measure		
	NP-capacity-diff	RN-capacity-diff	NA-capacity-diff
NP-vacancy	-.2005***		
	(.0387)		
RN-vacancy		-.1314***	
		(.0229)	
NA-vacancy			-.118***
			(.0232)
Controls	×	×	×
Wave FE	×	×	×
Regional FE	×	×	×
Owner FE	×	×	×
Mean outcome variable	0.000	0.000	0.000
Observations	59,865	59,865	59,865
F-statistic	10.95	13.55	7.81
R2	0.127	0.147	0.050

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Standard errors clustered at the couty level in parentheses. Data source: care statistics (FDZ, 2020) (facility level), transparency reports (facility level), vacancies from the German Institute of Employment Research (Statistik der Bundesagentur für Arbeit, 2023) (county level), indicators and maps of regional and urban development (Bundesamt für Bauwesen und Raumordnung, 2023) (county level). Observations (stat. nursing facilities): [six waves] 2007 (9,205), 2009 (9,676), 2011 (9,972), 2013 (10,197), 2015 (10,383), 2017 (10,432). Estimating equation: NP-capacity-diff$_{j,t} = \beta_0 + \beta_1$NP-vacancy$^{N}_{k,t} + \beta_2 \mathbf{X}_{j,t} + \beta_3 \mathbf{X}_{k,t} + \tau_t + \kappa_r + \rho_p + \epsilon_{j,k,t}$; Outcome: Nursing capacity (NP-capacity-diff), -registered nurses (RN-capacity-diff), -assistant nurses (NA-capacity-diff). Explanatory variable: Vacancy rate all nurses (NP-vacancy), Vacancy rate registered nurses (RN-vacancy), Vacancy rate nurse assistants (NA-vacancy). Control variables at the facility level and at the county level in Table B.1 in the Appendix. Fixed effects: Wave fixed effects, county fixed effects, and owner fixed effects.

TABLE B.3: Nurse-to-resident regulation

	Care level 1	Care level 2	Care level 3	Care level 4	Care level 5
Schleswig-Holstein	6.96-5.71	5.43-4.45	3.99-3.27	3.12-2.56	2.81-2.3
Hamburg	13.4	4.6	2.8	1.99	1.77
Lower Saxony	6.5-4.6	4.29-3.7	3-2.59	2.2-1.96	2.05-1.76
Bremen	6.14-6.53	4.79-5.09	2.92-3.1	2.07-2.2	1.84-1.96
North Rhine-Westphalia	8.00	4.66	3.05	2.24	2.00
Hesse	7	1.0	1.5	1.9	2.1
Rhineland-Palatine	7	4.07	3.23	2.56	1.8
Baden-Wuerttemberg	6.11-4.37	4.76-3.40	3.26-2.41	2.55-1.84	2.32-1.67
Bavaria	6.70	3.49	2.56	2.00	1.82
Saarland	6.32	3.16	2.85	2.59	2.49
Berlin	7.25	3.9	2.8	2.2	1.8
Brandenburg	4.21	3.28	2.89	2.25	1.76
Mecklenburg Wester-Pommerania	8.05-6.08	4.52-3.59	3.41-2.40	2.71-1.76	2.48-1.76
Saxony	8	4.41	3.21	2.47	2.23
Saxony-Anhalt	.	4.5-3.67	3.34-2.7	2.61-2.11	2.1-1.82
Thuringia	.	.	.	.	.

Number of residents per registered nurse (RN) full-time equivalents.

Chapter 4

Regional Variation in the Utilization of Nursing Home Care in Germany

With Annika Herr and Amela Saric-Babin

4.1 Introduction

There is significant regional variation in the utilization of nursing home care in the German long-term care system, where the unadjusted county mean varies from 16 percent to 51 percent of elderly (aged +65 years) individuals living in nursing homes, with an average of 32 percent.

Home health care is prioritized over nursing home care as per the long-term care system's organizational principle, aiming to keep care recipients in their familiar environment for as long as possible (SGB XI §3).[1]

Understanding the disparities in nursing home utilization is crucial due to substantially higher public[2] and private expenditures on nursing homes compared to home health care, and addressing these regional differences is essential for shaping future LTC policies in response to population aging and increasing demand.

Numerous papers have explored the reasons behind regional heterogeneity in healthcare utilization. Prominent examples in this regard include Finkelstein et al. (2016), who found that a significant portion of the variation in healthcare utilization can be attributed to demand factors. On the other hand,

[1] The need for caregiving arises if individuals require assistance with the activities of daily living due to advanced age, health- or mental-related problems for a minimum of six months (SGB XI §14).

[2] In 2021, annual cost for nursing homes were, on average, €21,000 compared to €9,400 for home health care per person (GKV-Spitzenverband, 2022).

Cutler et al. (2019) argue that supply-side characteristics play a more substantial role compared to demand in explaining regional heterogeneity in the US. Godøy and Huitfeldt (2020) reveal the influence of socio-economic factors in explaining regional variation in health care utilization and mortality in Norway. Regarding health care utilization in Germany, Salm and Wübker (2020) identify demographics and patient characteristics as playing a large role. They utilize individual patient migration as an instrument to investigate this phenomenon. Another study by Felder and Tauchmann (2013) adopts the spatial autoregressive approach and examines patients' movement from one state to another based on superior health care provision or regulations. Their findings highlight the importance of state-specific regulations in terms of promoting competition among states. Augurzky et al. (2012), Kopetsch and Schmitz (2014), and Göpffarth et al. (2016) analyze regional variation of different types of health care utilization in Germany. More specifically, Augurzky et al. (2012) examine the regional differences in the utilization of hospitals. Kopetsch and Schmitz (2014) analyze the usage of ambulatory care services by to physicians, and Göpffarth et al. (2016) focus on health care expenditures across Germany. Some studies apply spatial autoregressive models and show that correlations are significant but small across counties. All but one study, as is common in this literature, present correlations between the outcomes and the regional explanatory factors.

In terms of long-term care provision, Duell et al. (2020) examine the regional variation in the utilization of nursing home care in the Netherlands. They observe a notable shift toward an increased reliance on publicly financed homes. Mennicken et al. (2014) focus on the differences in remuneration rates among nursing homes in North Rhine-Westphalia. They find that approximately 70 percent of the regional price differences can be explained. Explanatory factors include the characteristics of residents, nursing homes, and districts, but the largest part is explained by regionally different kinds of negotiations between nursing homes and the long-term care insurances. In a study that is closely related to ours, Ozegowski and Sundmacher (2014) analyze the discrepancy between the demand (or needs) and utilization of home health care. They identify supply factors and regional demographics as the primary contributors to this gap. Pilny and Stroka (2016) examine how the regional availability of nursing homes affects elderly care decisions using a discrete choice setting with four different types of formal and informal care provision. Their study employs resident-level administrative data obtained from a large German health insurance. They find that the decision for choosing inpatient care in nursing homes is significantly driven by the regional supply of nursing home beds.

Our contribution to the existing literature lies in the integration of the health care services utilization model proposed by Andersen and Newman (2005)

with insights from recent analyses of regional variations. Notably, our study is the first to analyze spatial variations in nursing home utilization.

We use comprehensive data combining the German Care Statistic with regional socio-economic and demographic data at the county level from 2007 to 2019 (biennially). The Care Statistic of the German Statistical Offices of the Länder comprises the entire German care-dependent population and all care facilities. Our methodological approach follows the small area variation studies by Cutler and Sheiner (1999) on health expenditures, successfully applied to other German health care markets by Augurzky et al. (2012), Kopetsch and Schmitz (2014), and Ozegowski and Sundmacher (2014). We estimate ordinary least squares (OLS) models with regional and time fixed effects to uncover the variation of our outcome variable. To account for spatial dependencies in utilization and regional shock spillovers inspired by Gupta et al. (2022) and Ozegowski and Sundmacher (2014), we additionally apply spatial autoregressive (lag) models.

Our analysis reveals that caregiving needs explain 33 percent of the regional variation in nursing home utilization. Regional predisposing indicators, such as the opportunity for informal care, account for an additional 3 to 18 percent (depending on the order of inclusion). Regional enabling factors, including wealth and rurality, make slightly smaller contribution, explaining only an additional 2 to 12 percent of the variation. The supply of healthcare infrastructure captures the largest part additional to care needs with 14 to 25 percent. Regional and time-fixed effects added as the final controls additionally explain 5 percent of the variation. Furthermore, we identify a small yet significant presence of spatial interdependencies.

Overall, our model achieves a good measure of fit, with an R^2 of maximal 73 percent. These findings have important policy implications. In particular, they demonstrate that the degree of informal-care support and long-term care supply correlate highly with the demand for nursing home care. Thus, policymakers could either stimulate informal caregiving in some areas by reducing the double burden of work and caring or, in turn, increase the availability of nursing home care to reduce the need for informal care provision.

Section 4.2 introduces the model of health services utilization, followed by Section 4.3, which focuses on the data and provides descriptive statistics. We introduce the estimation strategy in Section 4.4 and then present our results in Section 4.5. Section 4.6 concludes.

4.2 A model of health services utilization

We examine the regional disparities in the utilization of nursing home (NH) care by employing a modified version of the Andersen-Newman model of health care utilization (Andersen and Newman, 2005). The model distinguishes between 4.2.1 individual determinants, 4.2.2 supply of long-term care (LTC) services, and 4.2.3 societal determinants of utilization.

FIGURE 4.1: Overview Andersen-Newman model of health care utilization

Illustration of the three indicator groups derived from the Andersen-Newman model of health care utilization: (1) individual determinants, (2) health services supply, (3) societal determinants.

4.2.1 Individual determinants of utilization

As individual determinants of utilizing health care services are multi-faceted, we specify three groups of personal characteristics: caregiving needs, predisposing factors, and enabling factors.

Caregiving needs correspond to individual disabilities or the health status. As caregiving needs, we include the county-level average care degree as it corresponds to the average health status. German regulations distinguish between three degrees of LTC severity in our data. People who have been assigned an LTC degree receive financial support from LTC insurances (see respective allowances in Table C.1). Degree one indicates a moderate health while higher levels correspond to more severe health problems. Care recipients in care degree three are disproportionately highly represented in NHs (Schulz, 2012). We decided to add the share of LTC recipients in care levels two and three to our model to capture severe needs. In a robustness check, we replace these proxies with the weighted average care-dependency level in a county:

$$care\_level\_mean = share\_level1 + 2 \times share\_level2 + 3 \times share\_level3 \quad (4.1)$$

where *share_level1*, *share_level2* and *share_level3* denote the shares of care recipients (%) in the respective care levels.

Age correlates with emergence of frailties and therefore serves as a proxy for health care needs and patterns of medical care use (Andersen and Newman, 2005). We account for the share of the oldest (aged 85+) among elderly care recipients who are more likely to use NH care than their younger peers (Pickard, 2011; Schulz, 2012).

Predisposing characteristics capture the individual propensity to utilize health services based on the surrounding socio-demographic conditions. Typical predisposing indicators are gender, marital status, support from children or any other relatives, employment, and education. We employ a number of variables as proxies for the existence of informal-care support. For example, we include the share of female care recipients, the shares of men and women in the active workforce, population in the age group 50 to 65, and the average life expectancy. Labor force participation is defined as the share of men (or women) aged between 15 and 65 years in the active workforce.[3] A higher share of women among care recipients could be indicative of less informal-care support. Women are widowed more often than men, which deprives them of the key source of informal care and increases the probability of NH entry given the same age.[4] The effect of employment on the choice of the type of care is ambiguous. Employment reduces the capacity to provide informal care; yet flexible work arrangements (part-time, mini-jobs) can help reconcile work and care duties (Alders et al., 2015). The propensity of daughters to provide informal care is generally higher than that of sons (Freedman, 1996; Wolf et al., 1997; van Houtven and Norton, 2004; Charles and Sevak, 2005). We expect that a higher share of women in the active workforce is associated with a higher use of NH care, while the effect of men's participation is not clear a priori. For example, women could partly substitute work with caregiving, while their spouses compensate for the earnings foregone by working more.[5] Finally, we employ the share of the population aged between 50 and 65, since the majority of caregiving relatives (children and their spouses) fall into this age span.[6] In a robustness check, we replace it with the age group 35 to 65 years. We also include life expectancy and postulate that higher life expectancy is associated with better health in older ages, resulting in lower demand for NH care.

Enabling characteristics predominantly cover the propensity of the affordability and accessibility of NH care. Here, we include rurality, GDP per capita,

[3] Unfortunately, we do not observe the actual working arrangements (full-time, part-time, mini jobs) or the registered job seekers.

[4] The life expectancy of women (men) in Germany in 2021 was, on average, 83.4 (78.5) years (Bundesamt für Bauwesen und Raumordnung, 2023).

[5] Around 48 percent of women in the active workforce in 2019 were part-time employed, while the corresponding share of men was only 11.2 percent (Bundesamt für Bauwesen und Raumordnung, 2023).

[6] Augurzky et al. (2012) suggest that most informal caregivers are between 55 to 69 years of age, which we approximate with the available data (50 to 65 years).

household income, average pension for seniors, the utilization of social aids for the elderly, communal debts, and the weighted average price for NH care.

Rurality serves as a proxy for travel times as distance influences facility choices (Kenney and Dubay, 1992; McAuley et al., 2009; Augurzky et al., 2012; Schmitz and Stroka, 2013). We postulate that NH care in Germany is more frequently utilized in urban than in rural areas. Rurality is measured as the share of the county's population in municipalities with a population density of less than 150 residents per square kilometer. NH care is considered to be a normal good, meaning that demand is negatively affected by higher prices and positively influenced by income. Regional wealth relates to the utilization of NH care. Therefore, we include various measures of income and impoverishment, such as social aids for the elderly and communal debts. Living in an NH is relatively expensive, with an average co-payment of €1,620 per month (Table 4.1). Consequently, higher income is expected to correlate with more utilization. In line with this, Bakx et al. (2015) report that being in the bottom income quartile in Germany decreases the probability of using any formal LTC. Similarly, Augurzky et al. (2012) and Eibich and Ziebarth (2014) find that higher income positively impacts the utilization of hospital and physician services. We include NH price as the weighted average own contribution (out-of-pocket or covered by the social insurance system) across the care levels with weights $w_i = \frac{LTCI_i}{\sum_{i=1}^{3} LTCI_i}$, where $LTCI_i$ denotes the maximum monthly allowance paid by the public LTC insurance funds for the care level i.[7]

4.2.2 Health services supply

Health services supply encompasses the resources and organization of healthcare delivery. This category includes personnel, equipment, materials, geographic distribution of resources, and procedures employed once a patient is admitted into the system. To approximate the regional supply of healthcare services, we consider various provider characteristics. Firstly, we include the number of hospitals beds, which can potentially serve as a temporary alternative for NH, especially following surgical interventions in seniors (Kümpel, 2019). Secondly, we postulate that the availability of home health care (HHC) may also contribute to delaying the utilization of NH care. To assess the supply of NH care, we calculate the ratio of NH places to the care-dependent population in the respective catchment area, which is defined as a radius of 60 km around a county's center. For instance, in the highly urbanized state of North Rhine-Westphalia, care recipients may choose an NH outside their home county as they are easily accessible within similar distances (Kopetsch

[7] Our dataset does not provide price information for hardship and dementia cases. We therefore include only prices for care levels 1 to 3.

and Schmitz, 2014). We add the proportion of single rooms, the nursing personnel staffing as well as vacancies in geriatric care, which correspond to the number of open nursing positions in that county. Lastly, we control for the NH's quality (see Section C. 2). For an overview, all variables are grouped and defined briefly including sources in Table C. 1.

4.2.3 Societal determinants

Finally, societal determinants of NH choice include the technology available to physicians and behavioral norms. Societal determinants of utilization are generally not observable (McAuley et al., 2009). We hypothesize that the regional fixed effects capture not only the geographic differences in technology, but also differences in behavioral norms. Detailed variable descriptions are provided in Table C.1.

4.3 Data and descriptive statistics

We use the German Care Statistic from the Statistical Offices of the Länder at the Research Data Center of Hannover. The Care Statistic span from 2007 to 2017, reflecting the German care situation on December 1^{st} every two years. The data comprise all five million care recipients entitled to public or private LTC insurance allowances in Germany. They also cover all NH care and HHC providers, e.g., the ownership type, the number of available places, the type of utilized caregiving services, and the fees to be paid to the care facility for caregiving, accommodation, and meals. Therefore, our data include both informal-care recipients and professional care recipients, where the latter are differentiated between NH care and HHC. To focus on regional variation rather than individual determinants of NH entry, we aggregate the Care Statistic at the county level.

We supplement the German Care Statistic with indicators of regional and urban development at the county level provided by the Federal Office for Building and Regional Planning (Bundesamt für Bauwesen und Raumordnung, 2023).[8] We further add labor market information from the German Institute for Employment Research (Statistik der Bundesagentur für Arbeit, 2023).

Our final sample covers six waves, recorded every two years, spanning from 2007 to 2019. We excluded all the under 65s in need of care and also all care facility providers excluding elderly care (e.g., care for kids or psychiatric care) or facilities that provide only short-term care and day or night care. In compliance with the data security rules enforced by the research data center, we aggregated neighboring counties with fewer than three NHs per ownership

[8] In German: Indikatoren und Karten zur Raum- und Stadtentwicklung (INKAR), link: https://www.inkar.de/ last time accessed in October 2023.

type and county, leaving 379 regions covering all 420 counties across the 16 federal states (2, 274 observations in total). The dependent variable measures the share of elderly (over 65s) care recipients in a county living in nursing homes, which is 32 percent, on average. This ratio varies from 16 to 51 percent over federal states.

TABLE 4.1: Descriptive statistics

	2007-2017			
	mean	sd	p1	p99
Nursing home utilization				
Care recipients in nursing homes [%], county	31.60	7.60	15.80	50.50
Caregiving needs				
Care recipients[%], county				
in care level 2	35.00	5.60	2.71	51.00
in care level 3	11.1	3.10	5.00	19.30
Care-dependency, weighted average level	0.461	0.051	0.358	0.586
Care recipients, share [%], county				
aged 85+	43.60	3.90	33.70	52.30
Predisposing				
Female nursing home residents [%], county	68.90	2.20	64.30	74.00
Labor force participation [%], county				
female	76.70	4.20	67.00	85.30
male	84.60	4.30	72.30	92.60
Total population [%], county				
age group 50–65	21.40	2.50	16.70	27.60
age group 35–65	48.50	1.60	44.50	52.70
Avg. life expectancy [years], county	83.40	0.678	81.94	84.98
Enabling				
GDP per capita [000 EUR], county	31.832	14.278	15.594	89.866
Social assistance [%], county	19.29	12.78	3.7	62.8
Avg. pension [EUR], county	832.84	84.67	654.5	1036.75
Monthly household income [EUR], county	1679.12	244.88	1228	2419
Rurality ** [%], county	29.30	29.70	0.01	100
Communal depts [EUR/ inhabitant], county	1637.27	1358.34	0.00	6946.1
Weighted average co-payment, NH care [EUR]***	1619.67	328.67	906.75	2351.27
Care level 1	1437.30	312.25	736.77	2290.33
Care level 2	1574.14	328.96	845.39	2297.49
Care level 3	1780.47	361.09	1052.46	2521.97
LTC supply				
Hospital beds, [per 10,000 inh.]	6.38	3.84	0	19.29
Single room share [%], county	61.00	11.10	36.00	85.30
Nursing home places-to-care dependents	0.379	0.102	0.204	0.668
Home health care facilities [#], county	33.659	40.74	7	180
Share of full-time nurses [%], county	35.90	8.50	17.70	58.90
Vacancies for ger. care, total	40.92	51.49	3.83	219.33
Nursing care quality	0.697	0.150	0.286	1
Observations		2,274		

We report descriptive statistics for all German elderly care-dependent individuals (aged 65+) entitled to public and private long-term care insurance allowances, and counties for the years 2007, 2009, 2011, 2013, 2015, 2017. Averages are expressed at county level. *Labor force participation is a share of males/females in the age group 15–65 in the active workforce. **Rurality is defined as a share of county's population living in municipalities with population density lower than 150 residents per km^2. ***Price for inpatient care refers to a price negotiated for each nursing home net of the long-term care allowance. It is expressed as a weighted average of prices for different care levels. *Data sources*: Statistical Offices of the Länder, Care Statistic, , 2007–2017 (DOI: 10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0), own calculations; INKAR database of the Federal Office for Building and Regional Planning (BBR); Transparency report cards from the BKK comparison engine for stationary LTC https://pflegefinder.bkk-dachverband.de/.

Table 4.1 summarizes all variables included in our model. For detailed variable definitions compare Section 4.2 and Table C. 1 in the Appendix.

Figure 4.2 clearly demonstrates regional disparities across federal states. NH care is most frequently used in Schleswig-Holstein, Bavaria, and Hamburg. In Schleswig-Holstein, the proportion of care recipients in NHs is consistently

9 to 10 percent higher than the national average. Conversely, Brandenburg, Hesse, and Bremen fall 5 to 6 percent below the average.

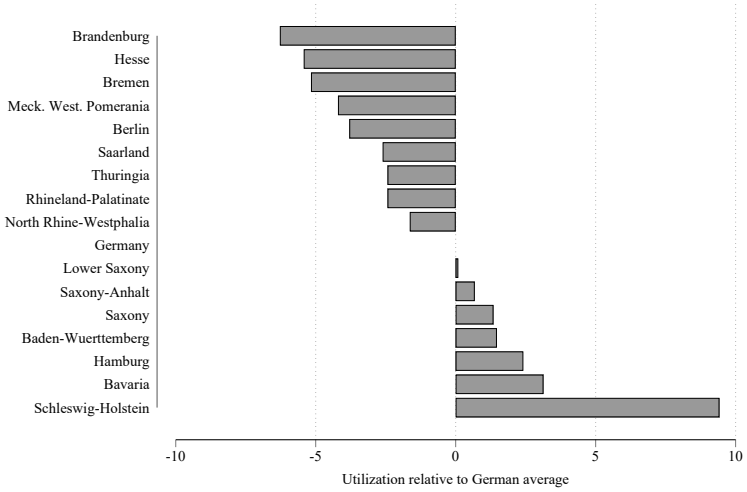

FIGURE 4.2: NH utilization across federal states

Data source: Statistical Offices of the Länder, Care Statistic, 2007 to 2017 (DOI: 10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0). *Note:* This figure shows federal-state differences of NH care utilization relative to the German average over time from 2007 to 2017. Differences are provided in percentage points.

The appendix provides more figures that visualize the regional variation in LTC utilization across care types and its changes over time. From these maps, we can discern certain patterns. Figure C.1 illustrates the variation in NH care across counties in 2007 and 2017. NH care appears to be more prevalent in the northern and southern regions of Germany. For the two other care types, there is a higher utilization of HHC in the northeast (Figure C.2) and greater reliance on informal care in the southwest (Figure C.3).

4.4 Estimation strategy

Our estimation approach follows Cutler and Sheiner (1999), Augurzky et al. (2012), and Kopetsch and Schmitz (2014) and allows us to net out the variation that is due to systematic differences between the counties. We gradually add groups of explanatory variables to the regression and infer their explanatory power from the changes in goodness-of-fit measures. Our preferred order of inclusion corresponds to the relevance of each group for the decision to enter an NH. We start off with caregiving needs and subsequently include predisposing, enabling, and supply variables (captured by $\mathbf{X_{ct}}$ in Eq. (4.2) in $c = 1, .., C$ counties over $t = 1, .., T$ time periods). Finally, we add time fixed effects τ_t and MRB[9] fixed effects ρ to account for unobservable factors at the relevant administration level r.

[9]The different Medical Review Boards (MRB), which set rules to negotiate prices and monitor quality on behalf of the health insurances, operate at federal state level except for North Rhine-Westphalia (separated into North Rhine and Westphalia-Lippe), Hamburg (combined

The simple linear regression equation is given as

$$y_{ct} = \mathbf{X}'_{ct}\beta + \rho_r + \tau_t + \mu_{ct} \tag{4.2}$$

where y_{ct} is the share of care recipients in NH care in county c and year t. μ_{ct} indicates the IID disturbances term.

We also run a linear fixed effects model to take into account unobservable differences across counties that are constant over time (Belotti et al., 2017). Since the explanatory power of each variable block varies based on the sequence of inclusion, we also specify alternative sequences for robustness analyses.

As German counties cluster in bigger regions, there may be correlations of health care use across counties. Hence, we want to account for confounding spatial dependencies originating from interactions between counties. To achieve this, we employ spatial regression models. Given that spatial regressions are not designed to uncover the explained variation of the outcome, we use these estimations primarily for the purpose of interpreting the coefficients.

In spatial interaction-based models, collective behaviors and aggregate patterns are assumed to emerge from the interaction of agents across social, economic, and geographic dimensions (LeSage, 2015; Anselin, 2002). Interaction can be a) endogenous, where the group causally influences individual behavior, b) exogenous, where individual behavior varies with exogenous characteristics of the group, or c) correlated, where similar behavior is due to similar individual characteristics and institutional environments (Manski, 2000). The underlying idea is that actions chosen by one individual influence the constraints, expectations, and preferences in her reference group (Revelli, 2006).

Endogenous interactions in NH care may arise from cultural factors. For example, high use of NH care may increase its broader societal acceptance. In our context, exogenous interaction can be attributed to a wider effect of local developments. For example, the closure of a large NH in one county is likely to boost the demand for NH care in neighboring counties. Negative economic shocks will increase unemployment, which could increase the degree of informal care support. Correlated interactions result from factors that cannot be observed in the data. Examples include a high prevalence of conditions that often precede moving to an NH, such as mental diseases and strokes, or a good quality of care in a particular region.

We follow Kopetsch and Schmitz (2014) and Gupta et al. (2022), who analyze spatial dependencies in other health care markets, and assume that the use

with Schleswig-Holstein) and Berlin (combined with Brandenburg). An overview of federal state LTC regulations is available at `http://www.biva.de/gesetze/laender-heimgesetze/`, last time accessed in October 2023.

of NH care follows a spatial autoregressive process. Equations (4.3) and (4.4) formally describe the estimation procedure of the spatial autoregressive combined model (SAC) model, including a spatially lagged outcome and error term:

$$y_{ct} = \Delta W y_{jt} + \mathbf{X'}_{ct}\beta + \rho_r + \tau_t + u_{ct} \tag{4.3}$$

$$u_{ct} = \rho W u_{jt} + \epsilon_{ct}, \tag{4.4}$$

where W originates from the spatial contiguity weight matrix, and u_{ct} and ϵ_{ct} are vectors of spatially correlated residuals and IID disturbances, whereby $\epsilon_{ct} \sim N(0, \sigma^2\mathbf{I})$. We denote Wy_{jt} and Wu_{jt} as spatial lags of the dependent variable and regression residuals, respectively. The subscript j captures the neighboring counties. The spatial contiguity weight matrix W parameterizes the interaction between the counties, i.e., it captures the influence of the use of NH care in county j on county i. We adopt a geographical contiguity criterion and assign $W = 1$ if counties share a common border or if the distance between their centroids is less than 60 kilometers, and 0 otherwise (Moscone et al., 2007).[10] Coefficient Δ captures the relationship between the use of NH care in nearby counties conditional on explanatory variables. Coefficient ρ captures the combined effect of demand shocks and unobservables. The spatial contiguity weight matrix is generated using the `spmat` command in Stata 17 (Drukker et al., 2013). Since the majority of LTC regulations are delegated to the federal state or local MRB, we include fixed effects at MRB level. In addition, we capture potential changes in demand or supply over time via wave fixed effects. To run the spatial lag models, we apply the `spreg` command in Stata 17 (Drukker et al., 2013). Standard errors are clustered at the MRB times year level.

In addition to the SAC, we estimate two more simple spatial autoregressive models: the spatial lag model (SLM) and the spatial error model (SER) (Elhorst, 2014). The SLM includes only a lagged outcome variable (see Equ. (4.3), while the SEM has only a lagged error term (combination of Equ. (4.2) and Equ. (4.4)). These simplifications rule out other spatial dependencies, respectively.

[10] Distances are calculated based on centroid coordinates provided by the German Office for Cartography and Geodesy (BKG), publicly available at `http://www.geodatenzentrum.de/auftrag1/archiv/vektor/vg2500/` last time accessed in October 2023.

4.5 Results

4.5.1 Explaining variation in NH utilization

Linear regression results are presented in Table 4.2. We gradually include blocks of explanatory variables following the sequence described in Section 4.2. The explanatory power of each block is measured by the change in the adjusted r-squared (R^2), which expresses the proportion of explained variation in the dependent variable (Wooldridge, 2021). Standard errors are robust to heteroscedasticity and are clustered at the MRB times year level. We can reject multicollinearity of the different control variables using VIF tests after the linear regression.

We find that the proxies for caregiving needs have an explanatory power of around 33 percent of the variation (Table 4.2: Model 1). Including predisposing variables raises this proportion to 51 percent (Model 2). Enabling factors add relatively little to the explanatory power of our model, increasing the R^2 to 55 percent (Model 3). The measures of supply add 14 percentage points, with an R^2 of 69 percent (Model 4). Finally, regional and time fixed effects increase the adjusted R^2 to 73 percent (Model 5). This may be traced back to the influence of unobserved political and regulatory differences or differences in culture and individual preferences. Model 6 describes our panel data approach with county fixed effects. Here, we capture around 50 percent of the overall variation. In particular, we explain 46 percent of the variation between and more than 60 percent within the counties.

The explanatory power of individual variable blocks may also change with the respective order of inclusion. We tried multiple alternative sequences in Table 4.3. Although the respective explanatory power of each block varies, our main findings are confirmed. Always keeping the caregiving needs as a basis, the additional explanatory power of predisposing variables lies between 3 and 18 percent. Enabling variables explain 2 to 12 percent of the variation, while supply variables capture 14 to 25 percent. Thus, on average, supply explains the highest proportion of the variation (additional to caregiving needs), followed by predisposing variables and the regional enabling characteristics.

To evaluate the model's fit, Figure C.4 presents the ratio of observed-to-predicted shares of care-dependent elderly in NHs by quartile of the observed share of NH utilization (Göpffarth et al., 2016). The unadjusted model can predict neither very low nor very high utilization. The more indicators are added, the closer the predictions get to the observed values (getting closer to one from below and above).

TABLE 4.2: Explanation of NH utilization

	Share of nursing home care (county)					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Caregiving needs						
Care recipients, share in care level 2	-0.0375	-0.0401	0.0109	0.0817***	0.3531***	0.3403***
	(0.033)	(0.031)	(0.034)	(0.028)	(0.094)	(0.045)
Care recipients, share in care level 3	0.8903***	0.3991***	0.5980***	0.5483***	0.5144***	0.4122***
	(0.094)	(0.096)	(0.112)	(0.098)	(0.100)	(0.058)
Care recipients, share aged 85+, county	0.8021***	1.0518***	1.1753***	0.6823***	0.7786***	0.9046***
	(0.064)	(0.063)	(0.068)	(0.087)	(0.092)	(0.049)
Predisposing						
Care recipients, share female		0.6425***	0.2509 *	0.5802 ***	0.6009***	0.4787***
		(0.137)	(0.149)	(0.121)	(0.152)	(0.077)
Labor force participation, share female		0.4599***	0.2325***	0.1644 **	0.0883	-0.2126***
		(0.075)	(0.085)	(0.070)	(0.082)	(0.066)
Labor force participation, share male		-0.1660**	-0.0742	-0.0054	0.0599	0.2149***
		(0.068)	(0.071)	(0.050)	(0.061)	(0.054)
Total population, share age group $50-65$		-0.9587***	-1.0901***	-0.3790***	-0.3675 **	-0.2022 *
		(0.123)	(0.136)	(0.110)	(0.151)	(0.109)
Avg. life expectancy		-0.0332***	-0.0381***	-0.0130***	-0.0132***	-0.0006
		(0.005)	(0.005)	(0.004)	(0.004)	(0.003)
Enabling						
(log) GDP per capita			-0.0060	-0.0120	-0.0108	0.0181 *
			(0.008)	(0.007)	(0.007)	(0.010)
Use of social aids for elderly			-0.00636	0.0349	0.0214	0.0776**
			(0.025)	(0.020)	(0.021)	(0.027)
Avg. pension			0.1181***	0.1395***	0.1365***	0.1462***
			(0.025)	(0.020)	(0.021)	(0.027)
Share Rurality			-0.0178 *	-0.0004	-0.0063	-0.0120**
			(0.010)	(0.008)	(0.008)	(0.006)
(log) Household income			0.0378	-0.0228	-0.0405	-0.0275
			(0.031)	(0.019)	(0.026)	(0.028)
(log) Communal depts			0.0006	-0.0013	-0.0005	-0.0003
			(0.001)	(0.001)	(0.001)	(0.002)
(log) Weighted average price			-0.0768***	-0.0245 **	-0.0075	-0.0097
			(0.014)	(0.012)	(0.015)	(0.010)
LTC supply						
Hospital beds				-0.0000	0.0004	0.0018 **
				(0.001)	(0.001)	(0.001)
Single room share				0.0050	-0.0070	-0.0719***
				(0.017)	(0.017)	(0.020)
Home health care facilities				-0.0003***	-0.0004***	-0.0004***
				(0.000)	(0.000)	(0.000)
Nursing home places-to-care dependents				0.3785***	0.3154***	0.0954***
				(0.045)	(0.047)	(0.016)
Share of full-time stationary staff				-0.0122	0.0034	0.0326
				(0.022)	(0.024)	(0.023)
Vacancies. for ger. care, total				0.0002***	0.0002***	0.0000
				(0.000)	(0.000)	(0.000)
Nursing care quality				0.0268***	0.0046	-0.0010
				(0.009)	(0.013)	(0.008)
MRB FE					×	×
Time FE					×	×
Indiv. FE					×	×
adj. R-squared	0.3331	0.5121	0.5487	0.6854	0.7270	0.5029
R-squ. within						0.6435
R-squ. between						0.4636
Observations	2274	2274	2274	2274	2274	2274

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$ Standard errors are clustered at the MRB times year level. Specifications: (1) caregiving needs; (2) + predisposing; (3) + enabling (without supply); (4) + enabling (with supply); (5) + MRB and year fixed effects; (6) + individual and year fixed effects. *Data sources*: Statistical Offices of the Länder, Care Statistic, 2007–2017 (DOI: 10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0); INKAR database of the Federal Office for Building and Regional Planning (BBR).

4.5.2 Accounting for spatial autocorrelation in the preferred model

After having identified Model (5) to explain most of the variation in NH use and before turning to the interpretation of specific determinants, we test whether there is spatial autocorrelation in utilization or in the errors of our regression model and, if yes, control for it. The goodness of fit of the models varies minimally when controlling for autocorrelation such that we can only focus on Model (5) in the following Dale and Fortin (2009).

To start descriptively, Figure 4.3 illustrates the direction of spatial autocorrelations. We can see that spatial dependencies indeed play a role. Furthermore,

TABLE 4.3: Reduction of the variation, baseline vs. alternative ordering

	R^2	Δ	ρ
Baseline specification			
Need	0.334	–	–
+ Predisposing	0.514	.0009	.108
+ Enabling	0.553	.004	.105
+ LTC supply	0.689	.007	.082
Alternative ordering 1			
+ Enabling	0.453	-.011	.137
+ LTC supply	0.659	-.003	.126
+ Predisposing	0.689	.007	.073
Alternative ordering 2			
+ LTC supply	0.603	.006	.078
+ Enabling	0.659	.008	.073
+ Predisposing	0.689	.007	.082
Alternative ordering 3			
+ Enabling	0.453	-.011	.137
+ Predisposing	0.552	.003	.126
+ LTC supply	0.689	.004	.105
Alternative ordering 4			
+ Predisposing	0.514	.0009	.108
+ LTC supply	0.667	.0059	.081
+ Enabling	0.689	.007	.082

We report changes in adjusted R^2 from the inclusion of blocks of explanatory variables in different sequences. Coefficient Δ captures the relationship between the use of stationary care in nearby counties, conditional on explanatory variables. Coefficient ρ captures the combined effect of demand shocks and unobservables. *Data source*: Statistical Offices of the Länder, Care Statistic, 2007 – 2017, own calculations.

the Moran-I coefficient of 0.19 rejects the null hypothesis of zero spatial autocorrelation across counties.[11] Figure C.5 shows the regional spatial correlations in a map where red fields indicate negative and blue fields positive spatial dependencies by below or above average utilization.

Next, we sequentially account for spatial dependencies as described in Section 4.4 and estimate three different models (SLM, SER, and SAC). Table 4.4 shows that spatial autocorrelation plays a small but significant role. Since both the spatial dependencies in utilization (SLM) and spatial correlation of shocks (SER) can be detected, we consider the SAC to be our preferred model.

[11] The Moran-I coefficient is calculated as $I = \frac{N}{\sum_i \sum_j w_{ij}} \frac{\sum_i \sum_j w_{ij}(X_i - \bar{X})(X_j - \bar{X})}{\sum_i (X_i - \bar{X})^2}$, where N is the number of spatial units, w_{ij} is an element of the spatial contiguity weight matrix, X is the vector of covariates, and $\bar{X}$ is the mean of X (Luc Anselin, 1995).

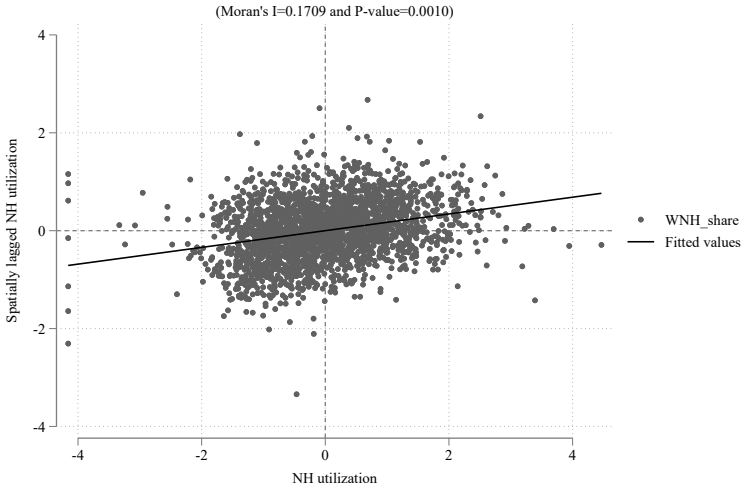

FIGURE 4.3: Moran's I scatter plot
Data source: Statistical Offices of the Länder, Care Statistic, 2007–2017, own calculations.
Notes: The Moran scatterplot displays how the selected attribute's values at each location relate to the average value of the same attribute at neighboring locations. The upper-right (lower-left) quadrant represents cases where both the attribute value and the local average value exceed (lie below) the overall average value, indicating positive spatial autocorrelation. The other two quadrants indicate negative spatial autocorrelation. The dominant groups within these quadrants determine the overall tendency towards positive, negative or no spatial autocorrelation. (see: Project 4: Calculating Global Moran's I and the Moran Scatterplot [link: https://www.e-education.psu.edu/geog586/node/672] last time accessed in October 2023)

4.5.3 Interpretation of correlations

Since the OLS results are very similar (Table C.3 compares the OLS and the SAC results), we interpret both together.

The first block, the extent of caregiving needs, is positively correlated with NH utilization across all models. This is in line with several studies showing needs to largely drive the decision to enter an NH (Augurzky et al., 2012).

Second, a higher share of female care recipients is associated with significantly higher use of NH care. There is also a positive and significant relationship with the share of the oldest (aged 85+). Controlling for all other factors, NH care is used intensively in counties with a higher female labor participation. Women, especially in more traditional family roles, are more likely to care for their spouse or parents. A higher share of people aged 50 to 65 is related to a less intense use of NH care, which is in line with our hypothesis that this generation is very likely to care for their parents.

Third, while four enabling indicators are not significant in the OLS setting, they are in the spatial model. As expected, pensions and social assistance are positively correlated and communal debts are negatively correlated with NH use. However, the GDP or the household income are negatively correlated, everything else equal. A reason for this could be that richer households can afford to employ private nurses. Fourth, other factors held constant, the use of

NH care is significantly higher in regions with a higher density of NH places. The HHC services coefficient is negative and significant, however, its size is negligible. The supply of hospital beds is comparably small, but positive. Considering that we can only provide correlations, we cannot interpret the coefficients causally. For example, since HHC is usually combined with informal care support by the relatives, its explanatory power might already be captured by the predisposing variables.

TABLE 4.4: Explanation of NH utilization including spatial dependencies

	Share of nursing home care (county)		
	SLM	SER	SAC
Caregiving needs			
Care recipients, share in care level 2	0.3640 ***	0.3916 ***	0.3897 ***
	(0.046)	(0.049)	(0.049)
Care recipients, shar ein care level 3	0.5160 ***	0.6091 ***	0.5993 ***
	(0.052)	(0.054)	(0.054)
Care recipients, share aged 85+	0.7757 ***	0.8159 ***	0.8113 ***
	(0.042)	(0.043)	(0.042)
Predisposing			
Care recipients, share female	0.5953 ***	0.5633 ***	0.5723 ***
	(0.079)	(0.078)	(0.078)
Labor force participation, share female	0.0923 **	0.1277 ***	0.1249 ***
	(0.047)	(0.048)	(0.048)
Labor force participation, share male	0.0389	0.0572	0.0429
	(0.036)	(0.037)	(0.037)
Total population, share age group $50-65$	-0.3363 ***	-0.4097 ***	-0.3848 ***
	(0.088)	(0.089)	(0.089)
Avg. life expectancy	-0.0128 ***	-0.0139 ***	-0.0141 ***
	(0.002)	(0.002)	(0.002)
Enabling			
(log) GDP per capita [000 EUR]	-0.0078 *	-0.0108 ***	-0.0091 **
	(0.004)	(0.004)	(0.004)
Use of social aids for elderly	0.0246 *	0.0371 ***	0.0390 ***
	(0.014)	(0.014)	(0.014)
(log) avg. pensions	0.1008 ***	0.1449 ***	0.1247 ***
	(0.021)	(0.022)	(0.022)
Share Rurality	-0.0100**	-0.0033	-0.0060
	(0.005)	(0.005)	(0.005)
(log) Household income	-0.0393 ***	-0.0367 ***	-0.0374 ***
	(0.013)	(0.013)	(0.013)
(log) Communal depts [EUR]	-0.0009	-0.0009	-0.0010*
	(0.001)	(0.001)	(0.001)
(log) Weighted average price	-0.0115	-0.0000	-0.0035
	(0.011)	(0.012)	(0.012)
LTC supply			
Hospital beds, [per 10,000 inh.]	0.0007 **	0.0004	0.0006 **
	(0.000)	(0.000)	(0.000)
Single room share	-0.0041	-0.0110	-0.0085
	(0.011)	(0.010)	(0.010)
Home health care facilities	-0.0004 ***	-0.0004 ***	-0.0004 ***
	(0.000)	(0.000)	(0.000)
Nursing home places-to-care dependents	0.3119 ***	0.2863 ***	0.2883 ***
	(0.013)	(0.013)	(0.013)
Share of full-time stationary staff	-0.0013	0.0042	0.0006
	(0.014)	(0.014)	(0.014)
Vacancies. for ger. care, total	0.0002 ***	0.0002 ***	0.0002 ***
	(0.000)	(0.000)	(0.000)
Nursing care quality	0.0092	0.0063	0.0082
	(0.009)	(0.009)	(0.009)
lambda (λ)			
Constant	0.0080 ***		0.0071 ***
	(0.001)		(0.002)
rho (ρ)			
Constant		0.0715 ***	0.0634 ***
		(0.006)	(0.007)
MRB FE	×	×	×
Time FE	×	×	×
adj. R-squared	0.7344	0.7294	0.7325
Observations	2274	2274	2274

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Standard errors are clustered at the MRB times year level
Specifications: (1) Spatial Lag Model (SLM): outcome variable is lagged, (2) Spatial Error Model (SEM): lagged error term, (3) Spatial Autoregressive Combined Model (SAC): includes both, the lagged dependent variable and a lagged error term
Data sources: Statistical Offices of the Länder, Care Statistic, 2007–2017 (DOI: 10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0); INKAR database of the Federal Office for Building and Regional Planning (BBR).

Coefficients on spatial dependencies in the utilization and correlation of shocks are small, although highly significant. For comparison, we estimate Equ. (4.2)

without regional and time fixed effects (see column (1) in Table C.4). As expected, spatial correlations in the error term are larger in magnitude.

We introduce three more alternative specifications in Table C.4. In the second column, we replace the shares of care recipients in levels 2 and 3 with the weighted average care-dependency level including all three care levels in a county (Column (2)). The weighted care-dependency level reveals the same positive correlation with nursing home utilization.

Further, we replace the share of the population in the age group 50 to 65 with the age group 35 to 65 in column (3). This allows us to consider a broader group of potential informal caregivers. The point estimates are also in the negative range, albeit they are only half the magnitude. From this result, it is obvious that informal care receives greater attention within the elderly age group.

Lastly, the final specification remains the same as the baseline. However, the nursing home utilization measure is now based on a catchment area limited to counties where the centroids are within 30 kilometers of the county. The coefficients remain relatively stable compared to the main SAC model in Table 4.4.

4.6 Discussion and conclusion

We explore the factors explaining regional variation in the utilization of NHs for the elderly in Germany. Germany is characterized by a generous coverage for people in need, where the mandatory LTC insurance covers a part of the care costs, while the social insurance covers the remaining out-of-pocket costs for people who cannot afford them. Still, we observe large variation in the usage of NH care across counties.

We apply the Andersen-Newmann model of health services utilization to differentiate across five categories of determinants (Andersen and Newman, 2005), namely caregiving needs as the most important baseline determinants, plus predisposing factors, enabling factors, LTC supply, and broader unobserved differences at the county level.

Our findings reveal that next to caregiving needs and LTC supply, predisposing factors also explain a large part of the variation. The enabling characteristics, such as wealth-related factors and rurality, explain a relatively small part. Overall, we are able to explain more than 70 percent of the regional variation in NH utilization from 2007 to 2017. This is comparable to previous regional variation studies on other health care markets. Unexplained variation could

possibly be attributed to cultural differences, individual health characteristics, different types of working arrangements, family structure, or population flows.

In a second step we attribute spatial dependencies and correlations to our main analyses to account for regional spillover effects. We find that estimates from models with and without spatial dimensions are mostly similar. Moreover, spatial coefficients are rather low in magnitude. Thus, we conclude that spatial dependencies do not play a major role in the LTC market when controlling for a large set of determinants.

We use the German Care Statistic covering the full population of care recipients and care providers, which enables us to exclude issues that selected samples may have: First, our analysis is not truncated since we observe not only the NH residents, but the entire care-dependent population including informal care and HHC, and all providers. Second, we are able to identify elderly care recipients living in NHs (in contrast to other people in need who also live in NHs), who are the primary focus of our analysis. Third, we can infer the average out-of-pocket payments for NHs from the provider-level data.

Our proxies for care needs, the assigned care levels, capture only a daily amount of required care, without providing information about the actual types of impairments. Some of them may be more strongly associated with the use of NH care than others. For example, cognitive disabilities, dementia, and malignant tumors are found to be consistent predictors of NH entry (Luppa et al., 2010; Schulz, 2012). Informally caring for people with these types of disorders may be more difficult than for those with physical impairments, irrespective of their care-dependency level. Accounting for more detailed health characteristics, and in particular without distinguishing between physical and cognitive impairments, would be fruitful for future research to make more finite statements on the role of caregiving needs.

Our results have important policy implications. In particular, the negative association between the use of NH care and the availability of informal-care support implies that the role of informal caregiving is critical. In light of the growing care-dependent population and a high need for a qualified workforce, informal caregivers need to be adequately supported and compensated for their efforts.

A positive relationship between the density of NH places and the use of NH care suggests that subsidizing the expansion of NH places in low-supply areas may be necessary in order to secure adequate care for the population in need. In Germany, enabling factors such as GDP, income, and rurality have only little impact, which makes NH utilization not a question of income.

Furthermore, NH entries take place for various reasons, including a lack of adequate caregiving in domestic surroundings via HHC, the individual's inability to do household chores, and a lack of social contacts. LTC arrangements targeting each of these dimensions separately could be a promising future course.

More household support and an emphasis on the social dimension of care could keep people in their domestic surroundings for longer. Furthermore, implementing more mixed solutions, such as assisted living, could help people in need of care participate in daily community life.

Finally, we should strengthen the concept of an NH as a "last resort" for those who really require it. This way, we could at the same time better organize the provision and better meet individual preferences.

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C. Appendix

C. 1 Variable description

TABLE C.1: Description of included variables

	Description	Datasource
Nursing home utilization		
Care recipients in nursing homes [%], county	Share of people in need of care receiving NH care	Care statistic
Caregiving needs		
Care recipients in care level 1-3 [%], county	Share of people in need of care within a specific care level	Care statistic
Care-dependency, weighted average level	Weighted care level: $care\_level\_mean = share\_level1 + 2 \times share\_level2 + 3 \times share\_level3$	Care statistic
Care recipients aged 85+, share [%], county	Share of people in need of care aged 85 and older	Care statistic
Predisposing		
Female nursing home residents [%], county	Share of female care recipients within a nursing home	Care statistic
Labor force participation [%], county	Share of employed individuals in the county per 100 inhabitants of working age (15-65)	INKAR
Total population [%] age group 50 (35)–65, county	Share of residents aged 50 (35) to under 65 as a proportion of the total population	INKAR
Avg. life expectancy [years], county	Average life expectancy in years	INKAR
Enabling		
GDP per capita [000 EUR], county	Gross Domestic Product (GDP) in absolute terms, in thousands of euros	INKAR
Social assistance [%], county	Share of the population receiving basic elderly support among residents aged 65 years and older	INKAR
Avg. pension [EUR], county	Average monthly amount of pension payment in euros	INKAR
Monthly household income [EUR], county	Average disposable household income in euros per resident	INKAR
Rurality ** [%], county	Share of residents in counties with a population density of $< 150\, indiv./km2$	INKAR
Communal depts [EUR/ inhabitant], county	Communal debts in euros per resident	INKAR
Weighted average co-payment, NH care [EUR]***	Weighted avg. own contribution across care levels $(w_i = \frac{LTCI_i}{\sum_{i=1}^{3} LTCI_i} \times OOP)$	INKAR
LTC supply		
Hospital beds, [per 10,000 inh.]	Hospital beds per 1,000 inhabitants	INKAR
Single room share [%], county	Average share of single rooms in a nursing home	Care statistic
Nursing home places-to-care dependents	Number of nursing home beds per people in need of care	Care statistic
Home health care facilities [#], county	Number of home health care providers within the county	Care statistic
Share of full-time nurses [%], county	Share of full-time contracts compared to the number of nurses	Care statistic
Vacancies for ger. care, total	Number of open job positions for geriatric care nurses	IAB
Nursing care quality	Index of nursing care quality (see Section C. 2 for further information)	Transparency reports

Data sources: **Care statistic**: Care statistic, (DOI: 10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0); **INKAR** database of the Federal Office for Building and Regional Planning (BBR); **IAB**: German Institute for Employment Research; **Transparency reports**: Transparency report cards from the BKK comparison engine for stationary LTC: https://pflegefinder.bkk-dachverband.de/.

C. 2 Nursing quality index

The Medical Review Boards[12] of the German Statutory Health Insurance (MRB) regularly inspect the quality of NHs. The assessment is based on 77 criteria, formally divided into four broad categories: "Care and medical Care", "Dealing with dementia patients residents," "Care and Everyday life," and "Housing, nutrition services, Housekeeping, and hygiene." The MRB assesses NH care providers based on audits and surveying of the care recipients. Auditors randomly select and interview up to nine care recipients of each provider and note for how many of those the inspection criteria are being met and then translate this into school grades from 1 to 5 (Sünderkamp et al., 2014). These grades are then averaged across all criteria. This procedure has been largely criticized by professionals since average school grades can hide insufficient quality. Hence, we follow Herr and Saric-Babin (2016) and translate the assessment outcomes into more strict results. First, we select seven criteria that reflect nursing quality. Second, for each criterion, we assign the value of 1 if it is fulfilled for *all* inspected residents and zero otherwise. Subsequently, we construct our quality indices (Q_i) as averages over the selected criteria and obtain values between zero (none is fulfilled for all care recipients) and one (all are fulfilled).

$$Q_i = \frac{1}{n} \sum_{i=1}^{N} q_i \quad i = 1, \ldots, n \tag{5}$$

The nursing quality comprises these seven survey questions:

1. Are the records for the treatment of chronic wounds or pressure ulcers (e.g., wound documentation) evaluated, if necessary is the doctor informed, and are the measures adjusted?
2. Is the nutritional status appropriate within the scope of the facility's capabilities?
3. Is the liquid supply adequate within the scope of the facility's capabilities?
4. Is a systematic pain assessment conducted?
5. Are individual risks and resources assessed for residents with urinary incontinence or with urinary catheters?
6. Is the individual risk of falling assessed?
7. Do consents or approvals exist for freedom-restricting measures?

[12] German: Medizinischer Dienst der Krankenkassen (MDK)
The MRB is an independent non-profit organization providing socio-medical specialist advice to the German Statutory Health and Nursing Care Insurances and is organized at federal state level.

C. 3 Descriptive figures

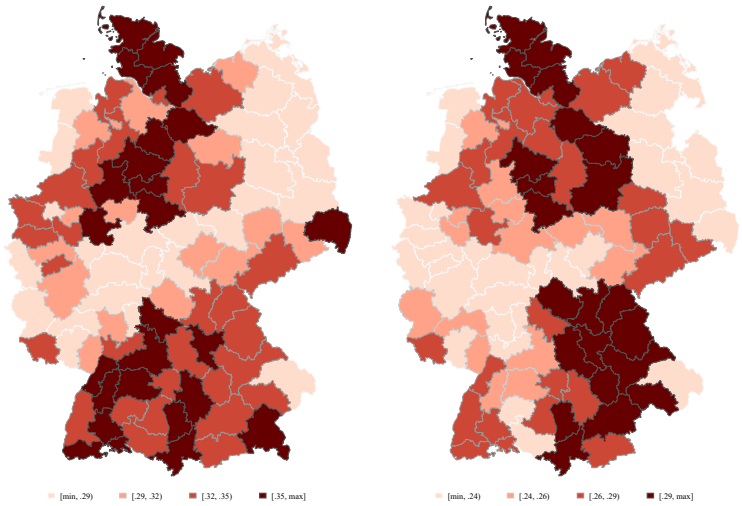

FIGURE C.1: Shares of NH residents across Germany in 2007 and 2017
Data source: Statistical Offices of the Länder, Care Statistic, 2007 and 2017 (DOI: 10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0). *Note:* Regional variation of the share of care dependent elderly in NHs to all care recipients in Germany between 2007 (left) and 2017 (right) for different percentiles (p10, p25, p50, p75, p90). For data security reasons, we cannot show the maximum or minimum.

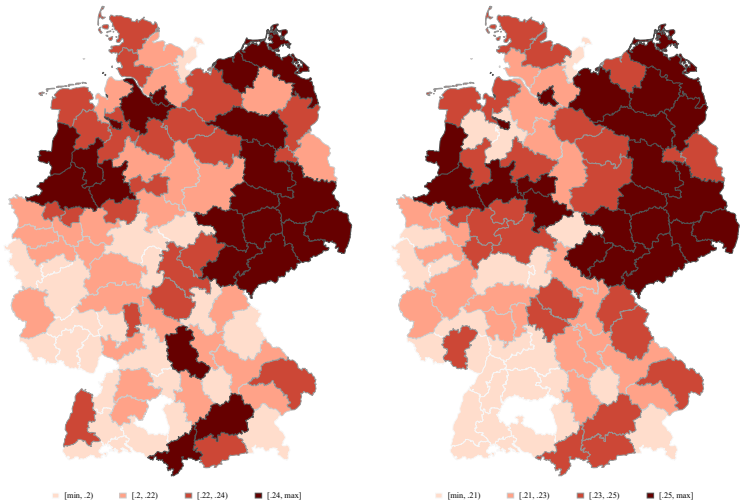

FIGURE C.2: Shares of HHC recipients across Germany
Data source: Statistical Offices of the Länder, Care Statistic, 2007 and 2017 (DOI: 10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0). *Note:* Regional variation of the share of people in HHC to all care recipients in Germany between 2007 (left) and 2017 (right) for different percentiles (p10, p25, p50, p75, p90). For data security reasons, we cannot show the maximum or minimum.

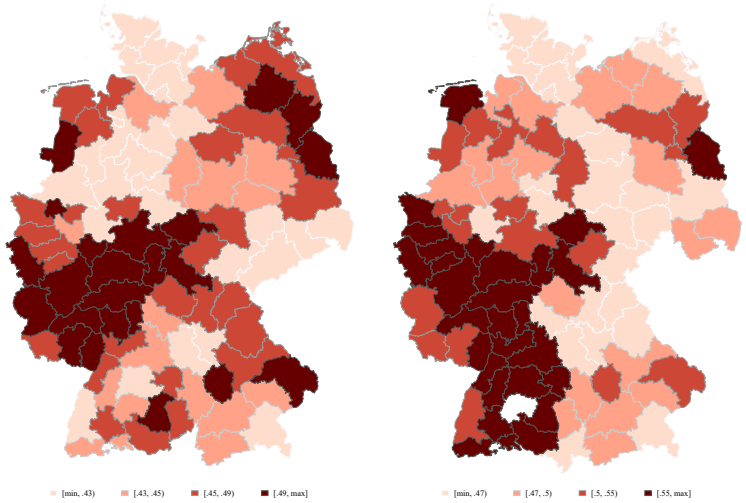

FIGURE C.3: Shares of IHC recipients across German counties in 2007 and 2017
Data source: Statistical Offices of the Länder, Care Statistic, 2007 and 2017 (DOI: 10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0). *Note:* Regional variation of the share of people in informal care to all care recipients in Germany between 2007 (left) and 2017 (right) for different percentiles (p10, p25, p50, p75, p90). For data security reasons, we cannot show the maximum or minimum.

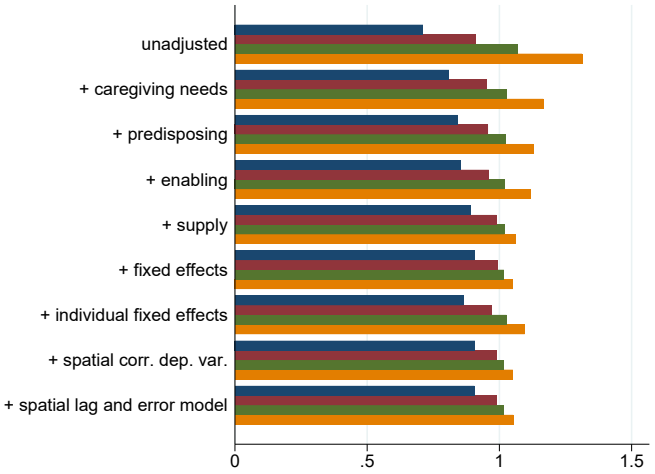

FIGURE C.4: Observed-to-predicted ratio of NH residents share

Note: We classify the counties into quartiles based on the unadjusted shares of care recipients in NH . blue: lowest 25%, red: 25–49%, green: 50–75%, yellow: highest quartile. The specifications used are as follows: 1. Unadjusted; 2. Adjusted for need; 3. additionally adjusted for predisposing factors; 4. + enabling factors; 5. + NH supply; 6. + MRB area and time dummies. *Data source*: Statistical Offices of the Länder, Care Statistic, from 2007 to 2017, own calculations.

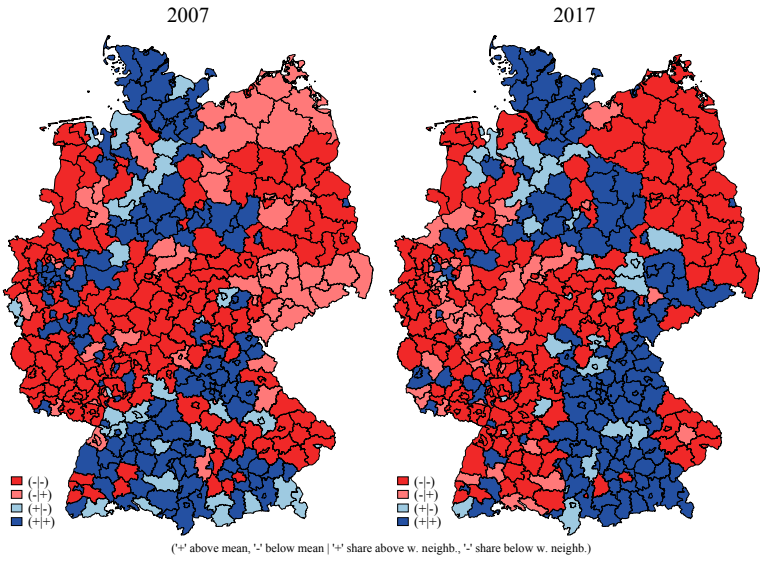

FIGURE C.5: Shares of NH residents and spatial dependence

Average shares of care recipients in NH for the years 2007 to 2017 across counties above or below national average and the sign of its spatial dependence. (-,+) utilization below mean, positive spatial dependence; (-,-) utilization below mean, negative spatial dependence; (+,-) utilization above mean, negative spatial dependence; (+,+) utilization above mean, positive spatial dependence. *Data source*: Statistical Offices of the Länder, Care Statistic, 2007 to 2017, own calculations.

C. 4 Descriptive tables

TABLE C.1: Long-term care insurance funds' allowance

	2007	**2009**	**2011**	**2013**	**2015**	**since 2017**
Informal home care						
Care level 0	-	-	-	120	123	316
Care level I	205	215	225	235	244	316
Care level II	410	420	430	440	458	545
Care level III	665	675	685	700	728	728
Home health care						
Care level 0	-	-	-	305	316	545
Care level I	384	420	440	450	468	689
Care level II	921	980	1040	1100	1144	1298
Care level III	1432	1470	1510	1550	1612	2612
Hardship case	1918	1918	1918	1918	1995	1995
Nursing home care						
Care level 0	-	-	-	-	-	770
Care level I	1023	1023	1023	1023	1064	770
Care level II	1279	1279	1279	1279	1330	1262
Care level III	1432	1470	1510	1550	1612	1775
Hardship case	1688	1750	1825	1918	1995	2005

We present the maximum monthly allowance (Euros) paid by the German public long-term care insurance for home care, ambulatory, and stationary care. Depending on their contributions, care recipients with private insurance are entitled to higher allowances. *Source:* https://pflegestärkungesgesetz.de, last time accessed in October 2023.

TABLE C.2: Cross-correlation table

	CR share in stat. LTC	CR level 2	CR level 3	CR avg. Level	CR 85+	CR 85+ level 3	CR female	Labor part. female	Labor part. male	Pop share 35-65
CR share in stat. LTC	1									
CR level 2	-0.1731*	1								
CR level 3	0.4065*	-0.4504*	1							
CR avg. Level	0.2436*	0.4696*	0.5768*	1						
CR 85+	0.4443*	0.0381	0.0881*	0.1220*	1					
CR 85+ level 3	0.5223*	-0.4160*	0.9466*	0.5555*	0.3929*	1				
CR female	0.3982*	-0.2412*	0.3798*	0.1549*	-0.0954*	0.3263*	1			
Labor part. female	-0.1808*	0.2701*	-0.2526*	-0.0026	0.0226	-0.2278*	-0.3840*	1		
Labor part. male	-0.2084*	0.1502*	-0.0720*	0.0662*	-0.0347	-0.0833*	-0.3791*	0.6022*	1	
Pop share 35-65	-0.2766*	-0.0573*	-0.0227	-0.0749*	-0.3747*	-0.1332*	-0.0320	0.3530*	0.2627*	1
Pop share 50-65	-0.4497*	0.1678*	-0.4820*	-0.3231*	-0.1640*	-0.4899*	-0.4681*	0.6420*	0.4434*	0.5193*
Avg. Life exectancy	-0.0357	0.1611*	-0.0580*	0.0900*	0.5246*	0.1062*	-0.3654*	0.2175*	0.0684*	-0.0917*
GDP per capita	0.1802*	0.0358	0.0251	0.0576*	0.3899*	0.1525*	-0.1273*	-0.1617*	-0.0809*	-0.3227*
Social aids	0.0755*	-0.0714*	-0.1532*	-0.2167*	0.1976*	-0.0749*	-0.0843*	-0.4140*	-0.3152*	-0.4039*
Avg. Pension	-0.1707*	0.1557*	-0.5428*	-0.3943*	-0.0915*	-0.5165*	-0.1335*	0.2988*	0.0354	0.1739*
Rurality	-0.1994*	0.0411*	0.0721*	0.1089*	-0.2281*	-0.0059	-0.1278*	0.3399*	0.1908*	0.3738*
Household income	0.0088	0.2815*	-0.1181*	0.1407*	0.5715*	0.0650*	-0.4836*	0.2358*	0.2801*	-0.0486*
Comm. Depts	-0.1011*	-0.0782*	-0.1460*	-0.2160*	-0.0926*	-0.1638*	0.0716*	-0.3592*	-0.1688*	-0.1365*
Hospital beds	0.2727*	-0.0594*	0.0410	-0.0138	0.2050*	0.1158*	0.2021*	-0.1983*	-0.3423*	-0.4134*
Single room share	-0.1991*	0.0775*	-0.3007*	-0.2265*	-0.0011	-0.2798*	-0.1729*	0.0303	-0.0240	-0.0933*
Amb. facilities	-0.1277*	-0.0384	-0.1856*	-0.2186*	-0.1171*	-0.1996*	0.0145	-0.0542*	-0.1615*	0.1241*
Nh place ratio	0.7293*	-0.2284*	0.3768*	0.1637*	0.3728*	0.4744*	0.2491*	-0.2249*	-0.1956*	-0.2949*
Share full time nurses	0.2669*	-0.2234*	0.2397*	0.0326	0.1612*	0.2732*	0.1454*	-0.3126*	-0.2637*	-0.0461*
Vac. ger. care	-0.0407	0.0720*	-0.2215*	-0.1532*	-0.0042	-0.2016*	-0.0624*	-0.1145*	-0.1523*	-0.0142
Nursing care qual.	-0.1682*	0.0817*	-0.2790*	-0.2011*	-0.0114	-0.2580*	-0.1875*	0.0399	-0.0079	0.0293
Weighted avg. price	-0.0836*	0.1582*	-0.1336*	0.0126	0.4033*	-0.0052	-0.3429*	-0.2165*	0.0505*	-0.2218*

	Pop share 50-65	Avg. Life exectancy	GDP per capita	Social assistance	Avg. Pension	Rurality	Household income	Comm. Depts	Hospital beds	Single room share
Pop share 50-65	1									
Avg. Life exectancy	-0.0273	1								
GDP per capita	-0.2981*	0.2805*	1							
Social assistance	-0.3004*	-0.0018	0.5562*	1						
Avg. Pension	0.4021*	0.1537*	0.1064*	0.0540*	1					
Rurality	0.3718*	-0.1679*	-0.3992*	-0.5233*	-0.2962*	1				
Household income	0.1102*	0.5932*	0.3742*	0.1249*	0.0494*	-0.1580*	1			
Comm. Depts	-0.0222	-0.3181*	-0.0089	0.3808*	0.0043	-0.1853*	-0.1606*	1		
Hospital beds	-0.2093*	-0.0710*	0.4459*	0.4362*	0.1062*	-0.3418*	-0.0959*	0.1698*	1	
Single room share	0.0934*	0.1618*	0.1359*	0.2227*	0.3102*	-0.1530*	0.0463*	-0.0045	0.0709*	1
Amb. facilities	-0.0140	0.0133	0.0887*	0.2751*	0.2846*	-0.1333*	-0.0469*	-0.0406	-0.0235	0.0913*
Nh place ratio	-0.4560*	-0.0841*	0.1771*	0.0936*	-0.3037*	-0.1531*	0.0533*	-0.0272	0.2476*	-0.2978*
Share full time nurses	-0.3368*	0.0279	0.1708*	0.2454*	-0.1504*	-0.1986*	0.1463*	0.1741*	0.0657*	-0.2733*
Vac. ger. care	-0.0795*	0.0402	0.1766*	0.3895*	0.2505*	-0.2127*	0.0629*	0.0162	0.0124	0.1161*
Nursing care qual.	0.1619*	0.1793*	0.0180	0.0783*	0.2178*	-0.0633*	0.0804*	-0.0342	-0.1309*	0.2424*
Weighted avg. price	-0.1246*	0.3544*	0.3910*	0.4712*	-0.0169	-0.4049*	0.5699*	0.1926*	0.0453*	0.2511*

	HHC facilities	Nh place ratio	Share full time nurses	Vac. ger. care	Nursing care qual.	Weighted avg. price
HHC facilities	1					
Nursing home places-to-care dependents	-0.1316*	1				
Share full time nurses	0.0617*	0.3770*	1			
Vac. ger. care	0.8334*	-0.0669*	0.0891*	1		
Nursing care qual.	0.1408*	-0.2513*	-0.1076*	0.1762*	1	
Weighted avg. price	0.0315	-0.0740*	0.1009*	0.1903*	0.1332*	1

*Significant at 5% level or higher. *Data source:* Statistical Offices of the Länder, Care Statistic,

TABLE C.3: Compare coefficients of OLS and SAC

	Model 5	SAC	Comparison
Caregiving needs			
Care recipients, share in care level 2	0.3531***	0.3897 ***	(=)
	(0.094)	(0.049)	
Care recipients, share in care level 3	0.5144***	0.5993 ***	(=)
	(0.100)	(0.054)	
Care recipients, share aged 85+	0.7786***	0.8113 ***	(=)
	(0.092)	(0.042)	
Predisposing			
Care recipients, share female	0.6009***	0.5723 ***	(=)
	(0.152)	(0.078)	
Labor force participation, share female	0.0883	0.1249 ***	(n.s. $\rightarrow$ ***)
	(0.082)	(0.048)	
Labor force participation, share male	0.0599	0.0429	(=)
	(0.061)	(0.037)	
Total population, share age group $50-65$	-0.3675 **	-0.3848 ***	(=)
	(0.151)	(0.089)	
Avg. life expectancy	-0.0132***	-0.0141 ***	(=)
	(0.004)	(0.002)	
Enabling			
(log) GDP per capita [000 EUR]	-0.0108	-0.0091 **	(n.s. $\rightarrow$ **)
	(0.007)	(0.004)	
Use of social aids for elderly	0.0214	0.0390 ***	(n.s. $\rightarrow$ ***)
	(0.021)	(0.014)	
(log) avg. pensions	0.1365***	0.1247 ***	(=)
	(0.021)	(0.022)	
Share Rurality	-0.0063	-0.0060	(=)
	(0.008)	(0.005)	
(log) Household income	-0.0405	-0.0374 ***	(n.s. $\rightarrow$ ***)
	(0.026)	(0.013)	
(log) Communal depts [EUR]	-0.0005	-0.0010*	(n.s. $\rightarrow$ *)
	(0.001)	(0.001)	
(log) Weighted average price	-0.0075	-0.0035	(=)
	(0.015)	(0.012)	
LTC supply			
Hospital beds, [per 10,000 inh.]	0.0004	0.0006 **	(n.s. $\rightarrow$ **)
	(0.001)	(0.000)	
Single room share	-0.0070	-0.0085	(=)
	(0.017)	(0.010)	
Home health care facilities	-0.0004***	-0.0004 ***	(=)
	(0.000)	(0.000)	
Nursing home places-to-care dependents	0.3154***	0.2883 ***	(=)
	(0.047)	(0.013)	
Share of full-time stationary staff	0.0034	0.0006	(=)
	(0.024)	(0.014)	
Vacancies. for ger. care, total	0.0002***	0.0002 ***	(=)
	(0.000)	(0.000)	
Nursing care quality	0.0046	0.0082	(=)
	(0.013)	(0.009)	
MRB FE	$\times$	$\times$	
Time FE	$\times$	$\times$	
adj. R-squared	0.7270	0.7325	
Observations	2274	2274	

$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$
Specifications: (1) Model 5 (see Table 4.2), (2) Spatial Autoregressive Combined Model (SAC) (see Table 4.4)
Data sources: Statistical Offices of the Länder, Care Statistic, 2007–2017 (DOI: 10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0); INKAR database of the Federal Office for Building and Regional Planning (BBR).

TABLE C.4: Robustness regression results

	(1) SAC	(2) SAC	(3) SAC	(4) SAC
Caregiving needs				
Care recipients, share in care level 2	0.083***		0.307***	0.291***
	(0.031)		(0.055)	(0.055)
Care recipients, share in care level 3	0.787***		0.704***	0.675***
	(0.057)		(0.061)	(0.061)
Care-dependency, weighted average level		0.978***		
		(0.078)		
Care recipients, share aged 85+	1.135***	1.175***	1.138***	1.174***
	(0.042)	(0.045)	(0.047)	(0.045)
Predisposing				
Care recipients, share female	0.299***	0.258***	0.217**	0.258***
	(0.074)	(0.085)	(0.086)	(0.085)
Labor force participation, share female	0.262***	0.265***	0.232***	0.269***
	(0.048)	(0.054)	(0.054)	(0.054)
Labor force participation, share male	-0.090**	-0.092**	-0.125***	-0.094**
	(0.037)	(0.040)	(0.040)	(0.040)
Total population, share age group $50-65$	-0.881***	-0.652***		-0.652***
	(0.085)	(0.099)		(0.099)
Total population, share age group $35-65$			-0.350***	
			(0.089)	
Avg. life expectancy	-0.034***	-0.031***	-0.028***	-0.031***
	(0.002)	(0.002)	(0.002)	(0.002)
Enabling				
(log) GDP per capita [000 EUR]	-0.004	0.000	0.005	-0.000
	(0.004)	(0.004)	(0.004)	(0.004)
Use of social aids for elderly	0.037***	0.032**	0.056***	0.031**
	(0.014)	(0.014)	(0.014)	(0.014)
Avg. pension	0.139***	0.210***	0.199***	0.211***
	(0.019)	(0.025)	(0.025)	(0.025)
Share Rurality	-0.015***	-0.015***	-0.018***	-0.015***
	(0.005)	(0.005)	(0.005)	(0.005)
(log) Household income	0.025*	-0.015	-0.010	-0.015
	(0.014)	(0.015)	(0.015)	(0.015)
(log) Communal depts [EUR]	0.002***	0.002***	0.002***	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
(log) Weighted average price	-0.076***	-0.055***	-0.044***	-0.055***
	(0.010)	(0.013)	(0.013)	(0.013)
LTC supply				
Hospital beds, [per 10,000 inh.]	0.000	0.001*	0.001*	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)
Single room share	-0.004	-0.009	-0.005	-0.009
	(0.010)	(0.010)	(0.010)	(0.010)
HHC facilities	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Nursing home places-to-care dependents	0.312***	0.286***	0.294***	0.288***
	(0.013)	(0.013)	(0.013)	(0.013)
Share of full-time empl. nurses	-0.008	0.002	0.002	0.001
	(0.014)	(0.014)	(0.014)	(0.014)
Vacancies for ger. care, total	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Nursing care quality	0.025***	0.009	0.009	0.008
	(0.007)	(0.009)	(0.009)	(0.009)
lambda (λ)				
Constant	0.004*	0.004**	0.006***	0.004**
	(0.002)	(0.002)	(0.002)	(0.002)
rho (ρ)				
Constant	0.108***	0.081***	0.080***	0.081***
	(0.005)	(0.006)	(0.006)	(0.006)
MRB FE		×	×	×
Time FE		×	×	×
adj. R-squared	0.5451	0.6455	0.6405	0.6456
Observations	2274	2274	2274	2274

$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$
Specifications: Spatial Autoregressive Combined Model (SAC)
Data sources: Statistical Offices of the Länder, Care Statistic, 2007–2017 (DOI: 10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0); INKAR database of the Federal Office for Building and Regional Planning (BBR).

Chapter 5

Nursing Home Access and the Effect on Informal Home Care:

Revealing the Impact of Single Rooms

5.1 Introduction

The need of accessible elderly care becomes apparent when either yourself or close family members require daily support in everyday life. In Germany, every year the number of individuals in need of care increases by around half a million (Heger et al., 2021). Hence, many families face the question: "Should we provide the necessary care ourselves through informal home care, or is formal care a more suitable choice?".

Generally, informal home care givers do not have formal healthcare training. Therefore, informal home care provision for individuals with severe needs poses a risk of inappropriate care quality. Many care giving individuals find themselves in the situation of having to choose between their careers and providing informal home care. Engaging in caring for relatives often entails a lower salary (Carrino et al., 2023; Simard-Duplain, 2022; Carr et al., 2018; Schmitz and Westphal, 2017), but also a high level of mental and physical strain (De Zwart et al., 2017; Bauer and Sousa-Poza, 2015; Schmitz and Stroka, 2013). Hence, providing informal home care is not only a matter of ensuring adequate elderly care but also has implications for the availability of the workforce in the labor market.

Individuals with severe care needs receive professional care in nursing homes. Nursing homes provide qualified personnel and adapted living environments, especially designed for people with impairments. While nursing homes typically provided double rooms for residents, the predominant care model shifted

to Person-Centered Care with a substantial increase of single-rooms in the beginning of the 2000s. The new paradigm aims to place the resident at the center of the care organization. This emphasis originates from improving care for people with dementia and was introduced by Kitwood (1993) in the UK. Specific to the Person-Centered Care is the emphasis on providing more privacy in nursing homes. While residents benefit from more individual care provision, we hypothesize that a larger portion of severely dependent individuals are redirected into informal home care provided by untrained family members due to limited access (Backman et al., 2021; Bakx et al., 2020; Groenou and Boer, 2016). Our hypothesis is supported by the allocation of nursing home places based on a first-come, first-served principle and waiting list procedures, rather than allocation based on care dependency.

In this project, we identify the growing emphasis of Person-Centered Care as a driver for limited nursing home access since it goes along with an increase of nursing home single-room shares (Backman et al., 2021). This research makes a valuable contribution to addressing two open questions: Do more single-rooms decrease access to nursing home care? If so, do these single-room shares also influence care dependency in the informal home care sector, or can the care market mitigate this effect through a different distribution of health care needs? Answering these questions contributes to two strands of the literature. First, we can contribute to research evaluating the pattern of single-rooms in nursing homes. Second, we contribute to the literature regarding the substitution of stationary nursing home care and informal home care.

We emphasize the substitution relationship between informal home care and nursing home care in our main analysis. Ambulatory home health care plays only a minor role in this research. We focus on informal care for two reasons: Firstly, informal family caregivers typically lack specialized training, which can pose a significant risk to individuals with severe care needs in informal home care settings. Secondly, the capacity of professional home health care providers is constrained by a widespread shortage of nurses. In contrast, informal home care is not subject to capacity limitations. Consequently, caregivers often prioritize providing assistance to their family members over their professional commitments. This is relevant since it can affect the overall welfare.

The German nursing home rating report gives a descriptive overview on single-room shares in Germany reporting a clear trend towards more single-rooms. (Heger et al., 2021). Following the report, this poses a financial challenge to the providers as prices are regulated. The trend towards more single-rooms is further reinforced by the introduction of regulatory requirements for single-room

quotas in approximately half of the German federal states[1]. However, research on the effects of single-rooms or quotas on access is scarce. *Pflegemarkt.de* reveals first descriptive results. They analyze the introduction of single-room quotas in two German federal states, namely North-Rhine Westphalia (NRW) and Baden-Wuerttemberg (BW). While the quotas had only minor decreasing effects on access in BW, they discovered several nursing home closures in NRW, leading to constraints on access (Pflegemarkt, 2018; Pflegemarkt, 2019). There is one more paper by Herr and Saric-Babin (2016) who estimate the effect of single-room quotas on social welfare assuming multiple scenarios of transforming double- into single-rooms. They run simulations to find an overall welfare decline due to lower access to nursing home care.

Charles and Sevak (2005) find a substituting relationship between nursing home- and informal home care. Their findings reveal a negative effect on the share of informally provided individuals as nursing homes enter the market. Bremer et al. (2017) compare eight European countries regarding the effect of informal home care giving on formal care option. They find a substitution as more informal home care provision along less use of formal care.

In our case, we argue that increasing the availability of single-room accommodations is associated with a reduced likelihood of access for individuals with severe care needs. This can result from either converting double rooms into single rooms (following Herr and Saric-Babin (2016)) or from a slower expansion of nursing home capacity compared to the rising care dependency of the population. We assume that families may be compelled to opt for informal home care due to limited access. This offers a new perspective on the substitution relationship between nursing home care and informal home care.

Our analysis splits into two strands. In the first strand, we analyze the relationship between the single room shares and nursing home access measures. In the second strand, we examine the effect of single room shares on the informal home care sector. Here, we focus on the share of individuals in severe need of care because they require professional care assistance which places a significant burden on informal home care givers.

For both strands, we estimate a pooled cross-sectional model using relevant covariates, regional, and time fixed effects. Consequently, we apply an instrumental variable (IV) approach to estimate the causal effect of single-room shares. Our instruments are inspired by the single-room quotas introduced by federal state authorities which have a direct effect on the single-room shares.

[1] Terranus.de (n.d.), verbraucherzentrale.nrw (n.d.), landesrecht-bw.de (n.d.), gesetze-rechtsprechung.sh (n.d.), landesrecht-hamburg.de (n.d.), and berlin.de (n.d.)

We use the German Care Statistic.(FDZ, 2020).[2] This data includes every individual in need of care between 2007 and 2019. So, we obtain a comprehensive picture of the whole LTC market and can provide insights on reallocation of individuals with significant care needs into informal home care.

Our results reveal that higher single-room shares negatively affect the access to nursing home care which is in line with our hypotheses. However, our results indicate no robust significant effect on the health of informal home care recipients. We find some first evidence that individuals in severe need of care without a nursing home place demand ambulatory home health care. These providers can relieve the informal home care givers with hygiene and medical procedures at the care recipients' homes.

In the following, we introduce the German institutional background of the care market regarding the assessment of care dependency, and the introduction of Person-Centered-Care in Section 5.2. In Section 5.3, we describe our data and our outcome measures. Subsequently, we describe our empirical approach and present our findings in Section 5.5. Lastly, we discuss our results regarding possible challenges as confounding influences and conclude with an outlook.

5.2 Institutional framework

To be considered in need of care, individuals undergo an assessment by the Medical Review Board (MRB). The MRB is an independent entity and it is responsible for evaluating healthcare quality. Further they assign five levels of care dependency to the individuals in need of care. Higher care levels are assigned to individuals with more severe care needs.[3]

The German elderly care system is divided into informal home care (IHC), home health care (HHC) providers, and nursing home (NH) Care. Those three care types are imperfect substitutes, they all provide care as a single good but addressed to different levels of needs. Depending on the health conditions and the degree of independence in daily life, individuals choose one of these care types. IHC encompasses the majority of individuals in need of care and is characterized by family support in daily life (Fischer and Müller, 2020). Care recipients and IHC givers receive a premium from the care insurance to cover basic health care costs (see Table D.3). As IHC givers are typically

[2]The data can be assessed via the Research Data Center of the Statistical Offices of the Länder and include information on all people assigned to care dependency in Germany as well as information on all home health care services and nursing homes. This includes information on nursing personnel, size of providers and prices

[3]Since the implementation of the Care Strengthening Act in 2017, the definition of the care levels changed, expanding from three to five levels. These five care levels provide a more detailed description of the care dependency status. However, for translation purposes, we continue to use the previous three levels along with an additional category for hardship care, as was done before 2017. Appendix D. 2 illustrates the reallocation of care levels.

semi-professionals, care recipients in IHC generally require fewer care procedures and have relatively mild health-related impairments. If health conditions deteriorate, IHC is complemented by home health care. These providers encompass the performance of specific medical, personal hygiene procedures but also include the washing and fulfilling household tasks. HHC providers employ qualified registered nurses complemented by nurse assistants. Therefore, HHC provides an opportunity for individuals with significant care needs to continue living at home while receiving appropriate care. The third type, NH care, takes place in residential facilities specifically designed to provide the needs of severely dependent individuals. Costs of accommodation are primarily paid by the individuals in need of care. It is the most expensive option of care provision. High demand for scarce nursing home places leads to providers operating at nearly full capacities (around 90%), which is also necessary to run them profitably. Hence, NHs maintain waiting lists, and care recipients often experience waiting times of several weeks to months before securing a bed (Arntzen et al., 2022). One reason for might these access limits might be the transition to more single-rooms and establishing the Person-Centered-Care model.

5.2.1 Introduction of Person-Centered-Care and single-room quotas

The term Person-Centered-Care (PCC) originates from improving care for people with dementia and was introduced by Kitwood (1993) in the UK. Specific to the PCC is the emphasis on providing more privacy in NHs. Therefore, the PCC framework identifies a significant trend toward higher single-room shares in nursing home (Kelly et al., 2019). Recent studies have evaluated the concept and find improvements in care provision for the residents suffering from dementia (Sjögren et al., 2013; Winzelberg et al., 2005). It turns out that PCC in NHs results in higher satisfaction, more privacy (Cusack et al., 2023), and lower infection rates (Zhu et al., 2022).

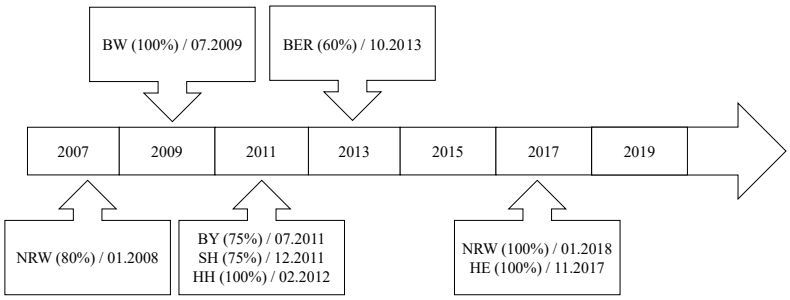

FIGURE 5.1: Introduction of single-room quotas in Germany
Note: Figure 5.1 illustrates the introduction date of the single-room quotas. NRW had first introduced the reform in 2008 with 80% and then raised the quota in 2018 after transition time to 100%. BW, Bavaria (BY), Schleswig-Holstein (SH), Hamburg (HH), Berlin (BER), Hesse (HE).

German NH care adapts this trend and move away from traditional shared rooms to more single-rooms. German regulators emphasize this trend by step wise introducing binding single-room quotas starting in 2008. Figure 5.1 illustrates the introduction of quota levels at different points in time. North-Rhine Westphalia (NRW) became the first state to introduce a mandatory quota of 80% for single-rooms in 2008. Six more states have since followed suit (Schleswig-Holstein, Hamburg, Berlin, Hesse, Baden-Wuertemberg (BW), Bavaria and in 2023 Lower Saxony). The fact that an increasing number of federal states are implementing quotas shows that there is also a political desire for a high single-rooms share.[4]

5.3 Data and descriptive statistics

We use a comprehensive dataset based on three data sources. We link the German Care Statistic (FDZ, 2020) with the German indicators of regional and urban development (INKAR,Bundesamt für Bauwesen und Raumordnung, 2023) and with data from the Research Institute of the Federal Employment Agency (IAB, Statistik der Bundesagentur für Arbeit, 2023).

The Care Statistic spans from 2007 to 2019, gathering data on December 1^{st} every two years from care facilities and care insurances. Thus, it provides a full overview on care recipients in informal- and formal care, as nursing facilities, and the nursing personnel. More specifically, the data contains individual details regarding location, age, gender, and the care dependency for all five million individuals in need of care in Germany. Furthermore, we have information about the type of care and we are able to observe the respective nursing home location, its ownership type and the number of available places (including single-rooms). Additionally, the data include detailed information on prices and the facility's personnel, such as their positions, qualifications, and employment contracts. We supplement the Care Statistic with regional economic, demographic, and labor market information from the INKAR and IAB data and link these data at the county level (smallest regional level in the Care Statistic).

The data from the Federal Office for Building and Regional Planning (INKAR) provides regional information on demographics, economic parameters, and population at the county level. We use this data to illustrate the regional demographics and wealth in our models. In addition, we append data from the German Employment Agency (IAB) including nurse vacancy information reported by NHs at the county level.

[4]The last state that introduced the single-rooms quota was Lower-Saxony in 2023 Terranus.de (n.d.).

The data preparation process and analysis were conducted at the Research Data Center of the Statistical Offices of the Länder in Hanover. The Care Statistic comprise a full sample of all NHs in Germany. The number of NHs has steadily increased over the years. The number of homes rises from approximately 11,000 in 2007 to around 15,300 in 2019. Our dataset data contains in total 91,500 observations. Since we are interested in permanent NH care, we exclude 15,823 providers providing only short-term or day-care. This leaves us with a final sample of 75,676 observations.

In Table 5.1, we summarize key information on our outcome variables. In addition to a summary of the entire time period, we offer separate information for the years 2007 and 2019. We consider 2007 as the last data point before the introduction of PCC or the first single-room quotas, respectively. 2008 marked the beginning of the single-room share trend. 2019 represents the most recent data point we can observe. We anticipate that the regulations had already influenced the single-room shares by this time. Hence, we can compare the development of the outcomes over a time period of more than 10 years. Table D.1 in the appendix illustrates information to classify the regional conditions for elderly care.

TABLE 5.1: Descriptive statistics

	2007		2019		2007–2019			
	mean	sd	mean	sd	mean	sd	p10	p90
NH information								
Number of NHs per county	48.76	65.15	64.82	66.53	57.61	66.12	16	88
NH beds	78.69	14.73	74.70	9.80	80.64	45.49	31	120
NH residents	70.47	13.19	68.55	9.00	72.25	40.76	25	120
NH single-room shares								
Single-room share	.5648	.2845	.7009	.2666	.6312	.2816	.2128	1.00
Single-room quota	.	.	.5396	.4575	.5396	.4575	0	1.00
NH access measures								
NH occupancy rate	.8833	.1477	.9103	.1148	.8889	.1320	.7347	1.00
Free NH beds to individuals in *severe* need of care	.0467	.0787	.0075	.0175	.0309	.0652	0	.0948
Free NH beds to individuals in need of care	.0048	.0079	.0011	.0026	.0030	.0061	0	.0092
Registered nurses to residents (level 3+)	.2226	.1517	.1866	.1483	.2009	.1446	.0331	.3766
IHC health indicators								
IHC recipients in severe need of care (level 3+)	.0944	.0429	.1275	.0253	.0988	.0458	.0568	.1564
Age of IH care recipients	66.73	1.92	68.34	1.85	67.99	2.00	65.44	70.44
SR instruments								
2007 single-room share distance to 2019 single-room quota	.	.	.2037	.2254	.2037	.2254	0.00	.5026
2007 single-room share distance to 2019 single-room state level	.	.	.1247	.2012	.1247	.2012	-.1552	.3560
Observations	11,029		15,380		91,502			

Table 5.1 illustrates basic descriptive statistics for 2007, 2019, and 2007–2019 respectively. In total, we observe 91,502 observations in the full sample. For the restricted sample, we exclude short term and day care facilities (15,823 observations). Hence, in the final sample we include 75,676 observations. Due to confidentiality rules, we are only allowed to provide information about the unrestricted sample in the descriptive output.
Abbreviations: informal home (IH) care , nursing home (NH). *Source*: Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]. Further descriptive information for the control variables are reported in Table D.1.

We calculate the single-room share by dividing the number of single-rooms by the total number of available rooms:

$$\text{SR-share}_j = \frac{single\,rooms_j}{\sum NH\,rooms_j} \tag{5.1}$$

Table 5.1 reports an increase of the share of single-rooms since 2007. The share of single-rooms increased from 56 percent to a level of 70 percent on average with a standard deviation of 27 percentage points. Considering the reported value of the 90th percentile, many NHs already offer 100 percent single-rooms. The respective single-room quota varies between 60 percent in BER and 100 percent in states as NRW or BW. 2007 indicates no values as the quota was first introduced in 2008.[5] As states without quota indicate a value of 0, the average level quota level across Germany indicates 53 percent. Figure 5.2 illustrates the regional variation of single-room shares across Germany in 2007 and most recent in 2019. In 2007, the single-room shares were higher ($>$ 70 percent) in the North and partially in the north-west but in principle higher in the mid-east. For comparison reason, we keep the 2007 thresholds for the quartiles. We find strong increases in the counties with binding quotas as BW (south-west) and NRW (west). The map indicates a clear increase in the share of single-rooms in those states with binding quotas but also an overall increase in the shares.

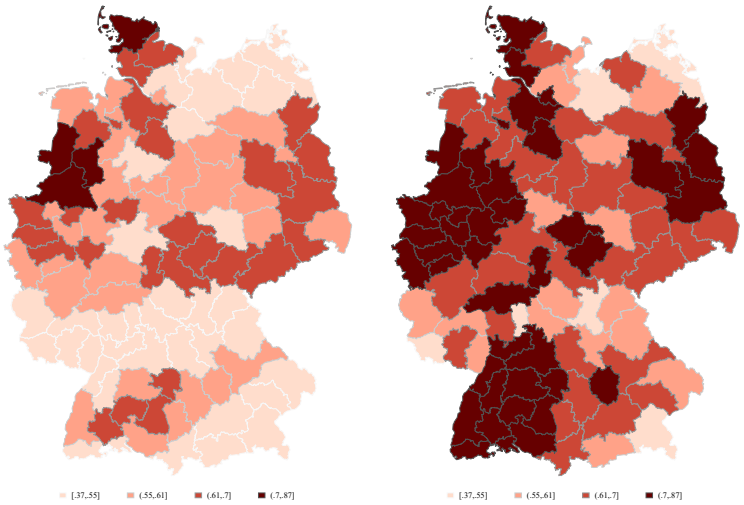

FIGURE 5.2: NH single-room shares across Germany

Note: Figure 5.2 illustrates the regional variation of single-room shares allocated into quartiles (2007 on the left and 2019 on the right). Due to data security, fields indicate a more aggregated regional level than the county level. Here, we report single-room shares at the spatial planning region. *Source:* Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]

Measuring the access to formal NH care is a challenge, as it depends on three key indicators, demand, personnel, and the number of beds, or occupancy ratio, respectively. We define four measures for NH care access. Our primary indicator is the occupancy ratio of NHs. NHs typically need to maintain near-full bed capacities to remain profitable. However, they are obligated to reserve a small portion of bed capacity for emergency cases or short-term care, usually around 10 percent. We argue when NHs deviate from this reserve toward a

[5] In the Appendix, we provide more information on the single-room quotas and a German map indication the regional variation (see Figure D.2)

higher occupancy ratio, it indicates lack of access, because these facilities may face challenges accommodating those individuals in urgent need. To include the demand side, our second indicator indicates the number of free NH beds per individuals in severe need of care (care level 3+), who are not yet receiving NH care. Thus, individuals in IHC and HHC. In other words, we measure the probability of finding a NH bed for those in severe need. As the probability decreases the access is more limited. This access measure anticipates that individuals in care level 3+ are more likely to require NH care based on their specific care dependency. Table 5.1 reports one free NH bed for every 30 individuals indicating a probability of receiving this bed of 3 percent. In 2007, this number was 25, and by 2019, it had significantly risen to over 130. The focus on care level three plus hardship cases might be too imprecise (e.g. also individual in lower care level could demand NH care). therefore, we extend this measure to all IHC and HHC individuals in need of care for robustness reasons.

Since the single-room share primarily affects the number of beds rather than staff, we include a personnel-capacity measure only for robustness checks. This measure indicates the number of registered nurses (RN) per residents in severe need of care. We assume the number of RN per residents to increase with the share of single-rooms. This might indicate a better care provision for those in NH care but also a decrease in the number of care recipients.

Figure 5.3 illustrates the single-room shares and our access measures. The single-room share exhibits an unbroken upwards trend. Before the introduction of the PCC model, NHs indicated a 55 percent single-room share, which then increased to an average of around 70 percent. On the other hand, we can see a clear decline NH care access.

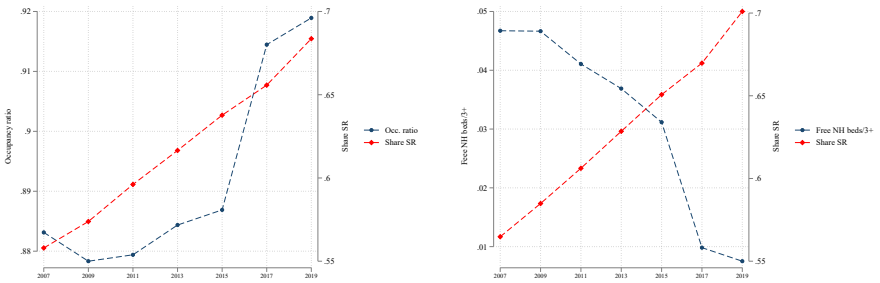

FIGURE 5.3: Single-room shares and NH care access

Note: Figure 5.3 illustrates the average single-room shares in NHs and our access indicators from 2007 to 2019 in Germany. On the left, we show the occupancy ratio and on the right the number of free beds per individual in severe need of care (care level 3+) in HHC and IHC.
Source: Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]

On the left, we observe an increase in the occupancy ratio from approximately 88 percent to 92 percent. Our argument is that NHs react to the increase in single-room shares by reducing their reserve bed capacity to stay profitable.

The ratio of free beds to individuals in severe need of care reports a consistent decrease over time. A notable breakpoint occurred in 2017, which must be handled with caution as it stems from the redefinition of care criteria. However, the trend both before and after 2017 indicates a tendency towards reduced access for individuals in care level 3 and hardship cases.

Care dependency and the health status of individuals in IHC is relevant for the adequate care provision and also regarding the burden of IHC giving. We have no specific information about diseases or the time IHC givers spend with providing care. However, the respective care level defines the extend of autonomy providing us with a proxy of care needs. To estimate the effect on the load on IHC givers, we apply the regional share of the individuals in severe need (e.g., care level 3+). As Figure 5.4 illustrates, NH care reveals a stable share of individuals in care level 3+ which is higher than in the IHC sector. According to Table 5.1 the share of individuals in care level 3+ within the IHC sector was 9.4 percent in 2007 and increased to 12.75 percent in 2019. This increase is particularly notable when considering the rise in the number of IHC recipients.

As a second measure, we include the average age of all individuals receiving IHC. We argue that the care dependency is closely related with age. On average, individuals in IHC are 68 years old, which is younger than those in NH care. Furthermore, we observe a distinct trend toward a slightly older IHC population in 2019. We calculate our IHC measures at the county level which indicates the smallest regional level available.

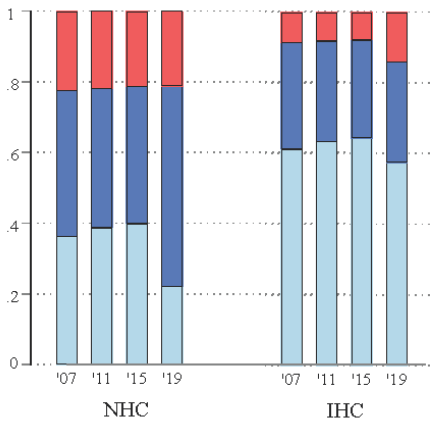

FIGURE 5.4: Care level distribution in NH care and HHC

Note: Figure 5.4 illustrates the distribution of care dependency across NH care (NHC) and IHC over time. Light-blue indicates care level 1, dark-blue indicates care level 2 and red indicates care level 3 and severe cases (care level 3+). *Source:* Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]

5.4 Identification strategy

We employ a multiple linear regression model with pooled cross-sectional data. We regress the single-room shares on nursing home access measures, and subsequently on the care dependency of individuals in IHC. The model includes multiple covariates to ensure that the outcome (nursing home access or care dependency in IHC) is not driven by other factors than the single-room shares (Kelly et al., 2022; Winter et al., 2020; Gaughan et al., 2015; Costa-Font et al., 2019). Our control variables describe demographics, working population, medical infrastructure, and wealth .[6] Besides covariates, we include time- and regional fixed effects. Our analysis include six waves from 2007 to 2019.

Equation 5.2 illustrates our regression model to analyze the relationship of single-room shares and nursing home access.

$$\text{access}_{j,t} = \alpha_1 SR_{j,t} + \mathbf{X}_{c,t} + \kappa_r + \tau_t + \varepsilon_{jt} \tag{5.2}$$

where $\text{access}_{j,t}$ indicates our access measures at the facility level, discussed in Section 5.1. The nursing home's single-room share is denoted by $SR_{j,t}$. This parameter includes values between 0 and 1 (e.g., 0 to 100 percent). The vector $\mathbf{X}_{c,t}$ encompasses covariates at the county level and κ_r and τ_t indicate regional and time fixed-effects. The error term is denoted as $\varepsilon j, c, t$. Standard errors are clustered at the federal state times year level.

For IHC, we estimate Model (5.3) analogous to Model (5.2). We employ a similar empirical strategy, but since the IHC is not bound to specific facilities and is therefore measured at a regional level, we aggregate our sample at the county level (subscript c). Hence, we regress the average percentage of single rooms on the county's proportion of individuals receiving IHC at care level 3+:

$$\text{IHC3+}_{c,t} = \gamma_1 \overline{SR}_{c,t} + \mathbf{X}_{c,t} + \kappa_c + \tau_t + \varepsilon_{ct} \tag{5.3}$$

The individual single-room share is based on an unobervable management strategy that we can not capture in our basic regression model. It is in particular problematic if these management metrics do primarily drive our outcome measures. As a result, our regression estimates could be biased.

Price regulations are binding for NHs. One surprising fact is that the price for a single-bed room is higher but not substantially higher than for a single bed

[6] Descriptive statistics for all covariates can be found in D.1 in the Appendix.

in shared rooms[7]. From this, we refer that NHs are more profitable by offering double bed rooms and the owners have a clear incentive to keep single-room shares low. By maintaining a lower percentage of single-room accommodations, we anticipate that these NHs have a higher bed capacity. This, in turn, enables NHs to maintain lower occupancy ratios and ensures a stable bed reserve for emergency cases. Consequently, the probability of finding a bed in these NH is likely to be higher. In both cases, the OLS regressions results would underestimate the effect of higher single-room shares.

At the aggregated level, as for examining the effect on regional IHC, we anticipate the results of management strategies on the nursing home market. Generally, PCC has become preferred by residents and nursing personnel. As a consequence, the NHs start transforming double- into single-rooms to not exit the market in the long run. Both management decisions, either transforming the bed capacities or the market exit of low single-room share NHs, lead to an average regional increase in the percentage of single rooms. At the same time, this is likely to decrease in the total number of beds. As a consequence, we assume more individuals in severe needs resting in IHC.

Both the impact on nursing home access and the care dependency in IHC may be substantially underestimated. Therefore, we employ an instrumental variable (IV) approach to mitigate the potential bias caused by confounding management decisions. To exclude management strategies to maintain low single-room shares, we make use of the single-room quotas first introduced in the year 2008. We calculate the gap of single-room shares between the pre-quota period (2007) and the quota level in 2019. Our IV analysis therefore is a cross-sectional analysis for our final period.

We argue that the difference of the quota level and the pre-quota single-room shares is exogenous to individual nursing home management decisions in 2019. First, the quota supporting the PCC model was unknown in 2007 and serves as a political threshold. Second, using the distance to 2007 we consider single-room shares prior to PCC. We argue, that single-room shares were not a significant concern at that time. Third, management strategies in 2019 cannot influence past decisions.

However, we expect the distance of 2007 single-room shares to the quota exhibiting a strong correlation with single-room shares in 2019, as it reflects the opportunities for increasing the individual percentage of single rooms. We contend that NHs face individual constraints in expanding their single-room capacity, primarily determined by the nursing home's physical infrastructure.

[7] see example https://www.landleben-vilsen.de/download/pflegekostentabelle.pdf last time accessed in October 2023

Some NHs may find it impossible to convert double rooms, as noted by Pflegemarkt (2018), while others can do so more cost-effectively, thereby deriving greater profit from single rooms than others. Therefore, a greater distance between the average single-room share in 2007 and the quota level predict lower single-room shares by 2019. For NHs without quota level, we indicate a value of zero. As around half of German federal states do not have quotas yet (e.g., many zeros in our instrument), we introduce a second instrument for robustness. Analogue to the other instrument, we take the single-room share in 2007 and calculate the distance to the federal state average in 2019. Now the respective market in 2019 indicates the upper benchmark rather than regulations. One limitation could be that a single nursing home also contributes to the federal state average. However, the management decision of a single nursing home has little impact considering there are approximately 1,000 NHs per federal state.

Equation (5.4) illustrates our first stage model with $SR\_distance_j^{07\text{-}19}$ indicating the instruments. Equations (5.5) and (5.6) show the second stage for both the access estimation (facility-level) and the care dependency in IHC (county-level):

First stage:

$$SR_j = \beta_1 SR\_distance_j^{07\text{-}19} + \mathbf{X}_c + \kappa_r + \varepsilon_{j,c} \tag{5.4}$$

Second stages:

$$\text{access}_j = \delta_1 \widehat{SR}_j + \mathbf{X}_c + \kappa_r + \varepsilon_c \tag{5.5}$$

$$\text{IHC3+}_c = \delta_1 \widehat{\widehat{SR}}_c + \mathbf{X}_c + \kappa_r + \varepsilon_c \tag{5.6}$$

5.5 Results

The fundamental hypothesis of this research posits that when access to NH care is constrained due to limited availability, individuals are obligated to rest in IHC. This hypothesis finds support in Figure 5.5. We can illustrate a descriptive correlation between our access measures and the percentage of individuals with severe care needs. On the left side, access is approximated by the occupancy ratio, and the right plot illustrates the relationship with the number of free beds per individual with severe care needs. Figure 5.5 clearly demonstrates a negative correlation between access measures and the proportion of individuals with severe care needs resting in IHC.

In the following, we continue with the identification strategy outlined in Section 3.4. First, we show if higher single-room shares significantly effect our access measures. Afterwards, we report the effect on the care dependency

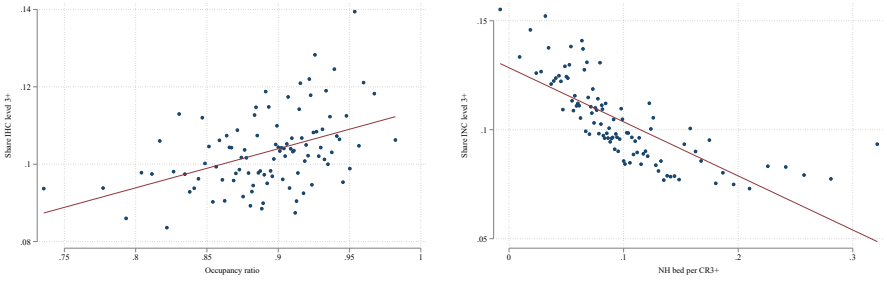

FIGURE 5.5: Scatter plot of access and individuals with severe needs in IHC
Note: The scatter plots illustrate the correlation between access (left occupancy ratio, right free beds per individuals in severe need of care (IHC and HHC). The figure clusters all observations into 100 bins with comparable correlation (binned scatter plot) and we include covariates.
Source: Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]

measure to examine whether increasing single-room shares also lead to more individuals in severe needs resting in IHC.

Table 5.2 provides the results for the limiting effects on nursing home access. It illustrates both measures, the occupancy ratio and the probability of finding a NH bed (NH bed to individuals in severe need of care). The initial columns $OLS_{2007\text{-}2019}$ present the relationship estimated by using linear regressions over a time period from 2007 to 2019. Despite using covariates as well as fixed-effects, we expect the ordinary least squares coefficients to be biased. Therefore, As described, we employ an IV approach which follows in the subsequent three columns considering only the year 2019.

The first column reports a positive and significant association between the single-room share and the respective occupancy ratio of 0.0486. Therefore, an increase of the single-room share by one standard deviation (0.28) corresponds with an average increase of the occupancy ratio by 1.36 percentage points, or 1.53 percent. To compare the point estimates with our IV results we employ the same regression for the year 2019 only. Column OLS_{2019} indicates a significant estimate of 0.0388 which is slightly smaller than for the result for the complete sample corresponding with 1 percentage point increase of the occupancy ratio (2019 single room share sd: .2666). The IV results in the columns IV_{quota} and IV_{fstate} report larger and significant effects compared to the OLS_{2019} regression (0.0407 and 0.0596). This is in line with our argumentation of a potential downwards bias of the OLS estimation. An increase of the single-room shares by one standard deviation increases the occupancy ratio by 1.1 to 1.6 percentage points.

The results support the hypotheses that NHs with higher single-room shares minimize their bed reserves to stay profitable and therefore limit the access for emergency cases. Both instruments indicate the same sign and a comparable effect size which proves some robustness of the result. This result reveals a

decrease of bed reserves for emergency cases from 9 to 7.4 which corresponds to an average decline from 6.7 beds to 5.5 beds per NH.

TABLE 5.2: Relationship between single-rooms and NH care access

	Occupancy rate				Available beds to CL3+			
	$OLS_{2007–2019}$	OLS_{2019}	IV_{quota}	IV_{fstate}	$OLS_{2007–2019}$	OLS_{2019}	IV_{quota}	IV_{fstate}
Single-room share	.0486***	.0388***	.0407***	.0596***	-.0098**	-.0033***	-.0058**	-.0054***
	(.0078)	(.0079)	(.0095)	(.0097)	(.0037)	(9.6e-04)	(.0029)	(.0015)
Controls	×	×	×	×	×	×	×	×
Year FE	×				×			
Regional FE	×	×	×	×	×	×	×	×
Mean outcome variable	0.889	0.910	0.910	0.910	0.031	0.008	0.008	0.008
Observations	75666	10996	10996	10996	75666	10996	10996	10996
1st stage excl. F-statistic			95.86	403.07			95.86	403.07
F-statistic	50.38	300.27	794.89	1056.30	85.45	255.35	658.73	1320.28
R2	0.117	0.092	0.092	0.090	0.308	0.284	0.283	0.283

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Standard errors clustered at federal state level in parenthesis.
Description: Column $OLS_{2007–2019}$ reports OLS regression results including observations from 2007 to 2019; Column OLS_{2019} reports OLS cross-sectional analyses with 2007 data for comparison purpose with IV_{quota} and IV_{fstate} ; Column IV_{quota} reports an instrumental variable approach on a cross-sectional basis using the distance from 2007 individual SR shares to the 2019 SR quota level; Column IV_{fstate} reports our second instrumental variable results using the distance from 2007 individual SR shares to the 2019 federal state average. Regression equation $access_j = \beta_0 + \beta_1 S\widehat{Rshare}_j + \gamma \mathbf{X}_c + \kappa_r + v_{jc}$; Outcomes: Occupancy rate of nursing homes and Ratio of free beds to the individual in severe need of care outside the nursing home. More details on variables are provided in Table 5.1 and Table D.1. See for more details Tables D.8 and D.9. *Source:* Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]

The results for the probability of finding a nursing home bed (available beds to CL3+) are in line with those reported for the occupancy ratio. Column $OLS_{2007–2019}$ reports a point estimate of -0.01. With respect to an increase of the single-room share by one standard deviation (sd: 0.28) nursing home access decreases by 0.28 percentage points, or 9 percent respectively. Our IV estimators indicate significant point estimates of -0.0058 and -0.0054, which are slightly larger than the linear OLS regression estimate. Overall, increasing the percentage of single-rooms by one standard deviation has a substantial impact on the probability of finding a nursing home bed for individuals in severe need of care. Considering the outcome mean, the effect varies between 18.9 and 20 percent.

Our first stage estimates confirm the hypothesis that our instruments are significantly associated with a lower percentage of single-rooms in 2019. We can reject the hypotheses of weak instruments. Our first-stage excluded F reveals a value between 30 and 400 which is sufficiently high (for more details see Table D.7 in the Appendix).

Reinforcing the trend towards more single-rooms has a negative effect on the NH care access measures. In our robustness analysis we include two further measures for NH care access. Since every care dependent individual is allowed to choose the NH care, rather than only individuals in severe needs, we adjust our access measure by calculating number of free beds per all individual in need of care in IHC and HHC. Furthermore, we include the number of registered nurses per NH residents in severe need of care. Results are provided in the appendix, Chapter D. 5. First, we find small but robust negative effects on the probability of finding a NH place if we include all individuals in need of care (Table D.5). This supports our results for the main access measures.

Second, we find a significant increase of the RN-to-residents ratio. We argue that the single-room introduction primarily affects the number of beds rather than the personnel. In turn, the number of residents decreases compared to the number of registered nurses per NH. Therefore, our results suggest, that PCC actually brings the residents into the center of care provision as the number of nurses per resident in severe need of care increases by 26 percent (Table D.6).

After finding a negative effect of the single-room share on access to NH care, we now emphasize the effect on the care dependency in IHC. There is an apprehension that individuals in severe need of care are forced to stay in IHC due to lacking access to NH care. Table 5.3 presents the estimation results for 2,848 county observations, with care dependency outcomes on the left and the average age of individuals receiving IHC on the right. With respect to our OLS model in column $OLS_{\text{2007-2019}}$, we find the hypotheses supported. An average increase of the single-room share by one standard deviation (0.28) is associated with in an average increase in the share of individuals in severe need of care of 1.25 percentage points and a higher average age of one year in IHC. However, analyzing this relationship by using the IV setting, the effects disappear (see columns OLS_{2019}, IV_{quota}, and IV_{fstate}).

TABLE 5.3: Relationship between single-rooms and care dependency in IHC

	IHC CL3+				IHC age			
	$OLS_{2007–2019}$	OLS_{2019}	IV_{quota}	IV_{fstate}	$OLS_{2007–2019}$	OLS_{2019}	IV_{quota}	IV_{fstate}
Single-room share	.0449**	.0119	.0129	.0113	3.87*	-.0083	2.838	.9049
	(.0193)	(.0102)	(.0344)	(.0184)	(2.063)	(.8896)	(2.444)	(1.523)
Controls	×	×	×	×	×	×	×	×
Year FE	×				×			
Regional FE		×	×	×		×	×	×
Mean outcome variable	0.098	0.128	0.128	0.128	67.99	68.34	68.34	68.34
Observations	2848	400	400	400	2848	400	400	400
1st stage excl. F-statistic			31.62	97.81			31.62	97.81
F-statistic	15.08	50.24	79.17	44.63	32.98	632.15	865.27	37.35
R2	0.810	0.867	0.867	0.867	0.867	0.751	0.744	0.750

$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$; Standard errors clustered at federal state level in parenthesis.
Description: Column $OLS_{2007–2019}$ reports OLS regression results including observations from 2007 to 2019; Column OLS_{2019} reports OLS cross-sectional analyses with 2007 data for comparison purpose with IV_{quota} and IV_{fstate} ; Column IV_{quota} reports an instrumental variable approach on a cross-sectional basis using the distance from 2007 individual SR shares to the 2019 SR quota level; Column IV_{fstate} reports our second instrumental variable results using the distance from 2007 individual SR shares to the 2019 federal state average. Regression equations (1) IHC CL3+$_c = \beta_0 + \beta_1 \widehat{SR}_c + \gamma \mathbf{X}_c + \kappa_c + v_c$, (2) IHC age$_c = \beta_0 + \beta_1 \widehat{SR}_c + \gamma \mathbf{X}_c + \kappa_c + v_c$ Outcomes: Share of IHC recipients in severe need of care and age of IHC recipients. More details on variables are provided in Table 5.1 and Table D.1. See for more details Tables D.10 and D.11. *Source:* Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]

To understand, where the demand has shifted to, we also analyze the effect on severe care dependency in NH care and HHC. Table D.12 shows no significant effect in the NH care sector but in the HHC sector. An increase in the single-room shares by one standard deviation corresponds with an increase of the share of severely care dependent individuals by 2.2 percentage points (see IV_{quota}). These are primary results and we need more information about the conditions in HHC which goes beyond this paper. However, we can state that the additional burden due to higher single-room shares does not rest at the family care givers in IHC. Moreover, we find first evidence that individuals in severe need of care receive adequate professional care by HHC providers.

5.6 Discussion and conclusion

The implementation of PCC raises concerns about potential access limitations in the nursing home sector due to higher single-room shares. There is a substantial fear that individuals in severe need of care may no longer find available NH care beds. In this research, we are investigating the increasing share of single-rooms and its impact on access and the care dependency in IHC.

We find a robust negative impact of the increasing number of single-rooms on NH care access. This leads to a significant increase in occupancy ratios, thereby reducing capacities for emergency cases. Furthermore, the probability to receive a nursing home bed decreases with higher single-room shares. These effects are notably substantial relative to the respective outcome means.

The share of individuals in severe need of IHC does not increase significantly. Although our estimates are positive for the share and for the age in the OLS regression, the effects become insignificant in the IV setting. We find first evidence, that HHC has begun to deprioritize elderly individuals with minimal care needs. We find significant effect for HHC providers regarding the average share of individuals in severe need of care.

Based on our findings, we conclude that single-room shares have a robust negative effect on NH access. However, we can also state, that the number of nurses per care recipients increases, which is in line with the idea of PCC. We find that the percentage of individuals in severe need of care in the IHC is not increasing. Therefore, we anticipate, care recipients and informal care givers do not necessarily suffer from the single-room shares. Nevertheless, those individuals in severe need of care need professional care provision. First evidence suggests that HHC providers take those individuals without access to NH care. However, ambulatory home health care providers are also struggling with a serious personnel shortage. Therefore, it is necessary to evaluate the burden for ambulatory nurses in future research and to make statements about the provided care quality.

In general, we suggest to adjust access through waiting lists according to respective needs. For example, implementing a regional allocation system for care recipients across different care settings could mitigate the issue of being forced to choose inappropriate or less preferred care types. Factors such as severity of health care needs and the availability of IHC can be considered alongside waiting time when determining eligibility for nursing home beds. This becomes particularly important when available capacities are reduced due to higher single-room shares.

We summarize that PCC leads to limited NH access but also provides a higher nurse-to-residents ratio. However, the increase in the number of single-rooms

has no direct negative effect on IHC which is a positive message for all IHC givers and care recipients. We conclude, it is essential to consider the entire care market when the capacity of one sector is affected. Especially regarding the IHC, it is crucial to steadily assess the burden on caregivers which is high already. In the end, the objective should be to ensure sufficient care for all individuals in need without overburdening IHC givers.

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D. Appendix

D. 1 Descriptive tables

TABLE D.1: Descriptive statistics for the control variables

	2007		2019		2007-2019			
	mean	sd	mean	sd	mean	sd	p10	p90
Share of care type								
Informal home care (IHC)	.2914	.0635	.5434	.0577	.4837	.0689	.3962	.5752
Home health care (HHC)	.2220	.0407	.2282	.0438	.2249	.0416	.1739	.2813
Nursing home care (NH care)	.3285	.0617	.2284	.0390	.2914	.0635	.2131	.3745
Demographics								
Total population								
age group 35–65	.4842	.0136	.4796	.0152	.4843	.0155	.466	.503
Avg. life expectancy	82.95	.58	83.70	.69	83.46	.67	82.63	84.37
Population density	710.4946	949.6963	691.202	962.3491	693.0584	946.8056	92	2113
Labor force and wealth								
Female unemployment ratio $>$ 55 years	.1277	.0209	.2353	.0527	.1936	.0530	.129	.268
Monthly household income	1504.37	202.22	1957.59	208.51	1722.97	250.81	1407	2045
Average pension per month	82.95	.59	83.70	.69	860.44	84.72	747.75	971.25
Land price	141.53	132.18	211.93	322.76	161.97	211.49	30.8	331.99
Rurality (share of rural area)	.2618	.2719	.2605	.2824	.2569	.2752	0.00	.682
Health infrastructure								
Hospital beds, [per 10,000 inh.]	5.9963	3.0180	5.9964	3.0180	6.0799	3.0240	2.8	9.7
Number of individuals in need of care	10426.27	17147.46	19546.36	26898.79	14284.42	21584.5	3409	23692
Full-time equivalents RN per NH	20.4306	10.6516	19.0870	9.8911	19.7835	9.9605	8.9357	32.0662
Full-time equivalents NA per NH	13.4183	9.2265	16.8153	10.2851	15.5974	9.9099	5.0109	27.9808
Vacancies for geriatric care	45.9424	53.3933	44.4856	50.3206	45.9006	54.9011	10	90
Avg. price for NH accommodation	19.4440	4.1048	24.8048	5.6646	21.8135	5.2433	16.33	29.96
Observations	11,029		15,380		91,502			

Table D.1 illustrates basic descriptive statistics for the covariates at the county level for the periods 2007, 2019, and 2007–2019 respectively. In total, we observe 91,502 observations in the full sample. For the restricted sample, we exclude short term and day care facilities (15,823 observations). Hence, in the final sample we include 75,676 observations. Due to confidentiality rules, we are only allowed to provide information about the unrestricted sample in the descriptive output.
Abbreviations: informal home care (IHC), home health care (HHC), nursing home (NH), single rooms (SR), registered nurses (RN), nursing assistants (NA). Alle covariates are included except the shares of care type. *Source:* Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2019.00.02.1.1.0].

D. 2 Redefinition of the concept of care dependency

"The concept of care dependency involves further differentiation of the three care levels that were in effect until the end of 2016, now expanded to five care grades. This comprehensive concept of care dependency is associated with a comprehensive assessment tool to determine the level of care needed.

With the new assessment called "Begutachtungsassessment", the capabilities of the care-dependent individual are measured. The degree of independence in six relevant areas of care, such as cognitive and communicative abilities or handling disease- and therapy-related demands, is assessed. The instrument also takes into account the specific assistance and support required by individuals with cognitive or psychological limitations. Based on the assessment results, the person is assigned to one of the five care grades." German Central Association of Health Insurance Funds: www.gkv-spitzenverband.de [last time accessed in October 2023]

Care levels before 2017	Care levels after 2017
1	1
1	2
2	3
3	4
hf	5

TABLE D.2: Reallocation of care levels after 2016 (inspired by (Heger et al., 2021))

In 2017, the existing concept of care, consisting of three care levels, was adapted. To provide a more accurate representation of actual care needs, the system was replaced with five care grades. The transition to the new care grades was implemented gradually until 2017, with the introduction of Care Level 0 and the Hardship Case (HF) under the first Pflegestärkungsgesetz (Care Strengthening Act). Weconverted the care grades from the years 2017 and 2019 into care levels. With the introduction of the care grades, individuals who were at the higher end of a care level group were upgraded, but there were no downgrades. Consequently, the conversion resulted in an overall increase in the number of individuals classified into higher care levels.

D. 2.1 Care allowance of the statutory care insurance

TABLE D.3: Long-term care insurance funds' allowance

	2007	**2009**	**2011**	**2013**	**2015**	**since 2017**
Informal care						
Care level 0	-	-	-	120	123	316
Care level I	205	215	225	235	244	316
Care level II	410	420	430	440	458	545
Care level III	665	675	685	700	728	728
Home health care						
Care level 0	-	-	-	305	316	545
Care level I	384	420	440	450	468	689
Care level II	921	980	1040	1100	1144	1298
Care level III	1432	1470	1510	1550	1612	2612
Hardship case	1918	1918	1918	1918	1995	1995
Nursing home care						
Care level 0	-	-	-	-	-	770
Care level I	1023	1023	1023	1023	1064	770
Care level II	1279	1279	1279	1279	1330	1262
Care level III	1432	1470	1510	1550	1612	1775
Hardship case	1688	1750	1825	1918	1995	2005

We present the maximum monthly allowance (Euros) paid by the German public long-term care insurance for home care, ambulatory, and stationary care. Depending on their contributions, care recipients with private insurance are entitled to higher allowances. *Source:* https://pflegestärkungesgesetz.de, last time accessed in October 2023.

D. 3 Single-room quotas

North-Rhine Westphalia (NRW) became the first state to introduce a mandatory quota of 80% for single-room in 2008. Six more states have since followed suit (Schleswig-Holstein, Hamburg, Berlin, Hesse, Baden-Wuertemberg (BW), Bavaria and in 2023 Lower Saxony). The fact that an increasing number of federal states are implementing quotas shows that there is also a political desire for a high single-room share.[8] Figure D.1 illustrates the introduction of single-room quotas in the federal states on a timeline.

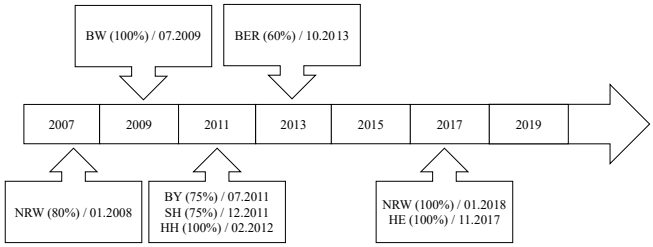

FIGURE D.1: Introduction of single-room quotas

All federal states allow a transition period of up to ten years for existing buildings, while new nursing homes must adhere directly to the quotas. As a result, the states have a mix of existing and new buildings that are gradually approaching the respective quotas. Figure D.2 illustrates the average single-room share in the spatial planning region and the corresponding quotas in 2019. From this figure, it is evident that not every nursing home has yet met the single-room requirements. In NRW and BW, the transition period already concluded in 2017. Consequently, we observe significantly higher shares in line with the quota level in these regions.

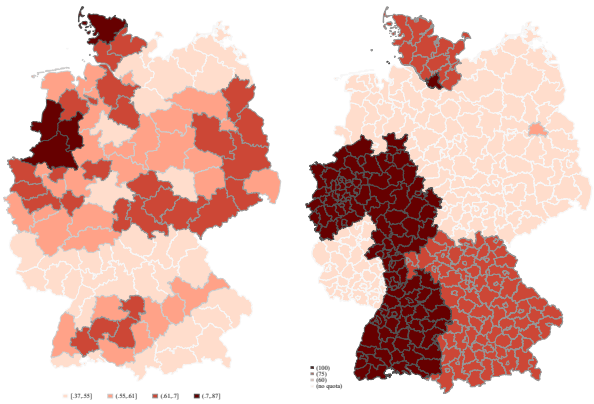

FIGURE D.2: NH single-room shares in 2007 and quotas in 2019

Note: Figure D.2 illustrates the allocation single-room shares on the left and the single-room quotas on the right in 2019 across Germany. NRW introduced a second quota after the transition time.
Source: Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0]

[8] The last state that introduced the single-room quota was Lower-Saxony in 2023 Terranus.de (n.d.).

TABLE D.4: Single-room share regulations across Germany in 2023

	SR-Quota	Law	Regulations
Schleswig-Holstein	min. 75%	SbStG	SbStG-DVO
Hamburg	100%	HmbWBG	HmbWBG
Lower Saxony	70%	NuWG	NuWGBauVO
Bremen	100%	BremWoBeG	BremWoBeGBauVO
North Rhine-Westphalia	100%	GEPA NRW	"WTG DVO APG DVO NRW"
Hesse	100%	HGBP	HGBPAV
Rhineland-Palatine	-	LWTG	LWTGDVO
Baden-Wuerttemberg	100%	WTPG	LHeimBauVO
Bavaria	min. 75%*	PfleWoqG	AVPfleWoqG
Saarland	-	LHeimGS	HeimMindBauVO
Berlin	min. 60%	WTG	WTG-BauV
Brandenburg	-	BbgPBWoG	SQV
Mecklenburg Wester-Pommerania	-	EQG M-V	EMindBauVO M-V
Saxony	-	SächsBeWoG	SächsBeWoGDVO
Saxony-Anhalt	80%	WTG LSA	WTG-MindBauVO
Thuringia	-	ThürWTG	HeimMindBauVO

Single-room quota level and the related law or regulation. These single-room quotas represent the status of September 2023.

D. 4 Descriptive German maps

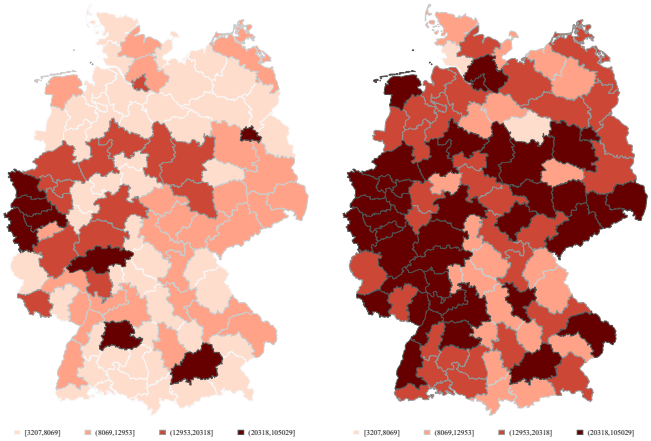

FIGURE D.3: Share of individuals in severe need of care in IHC across Germany
Note: Figure D.3 illustrates the allocation of severely care dependent individual in IHC in 2007 (left) and 2019 (right) across Germany. The information is aggregated on the spatial planning region.
Source: Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]

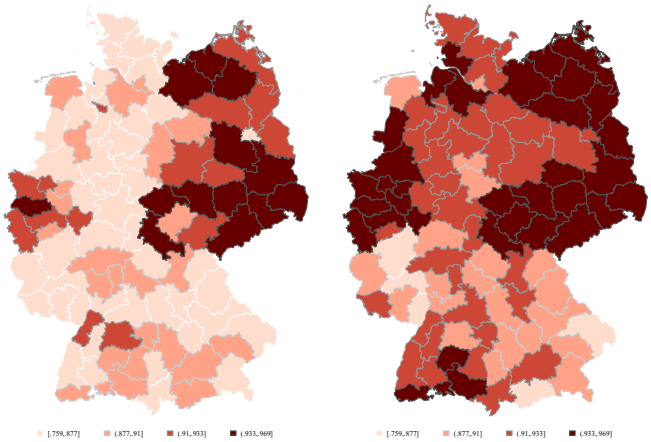

FIGURE D.4: NH occupancy ratios across Germany
Note: Figure D.4 illustrates the allocation of occupancy ratios in 2007 (left) and 2019 (right) across Germany. The information is aggregated on the spatial planning region.
Source: Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]

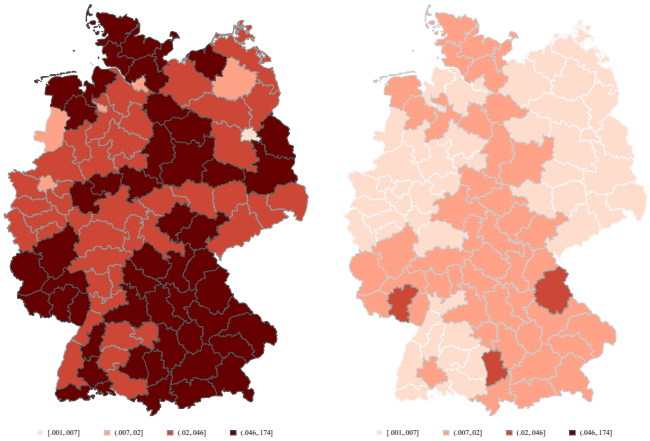

FIGURE D.5: Free NH beds per individuals in severe need of care across Germany
Note: Figure D.5 illustrates the allocation of free NH beds per individuals in severe need of care (IHC and HHc) in 2007 (left) and 2019 (right) across Germany. The information is aggregated on the spatial planning region.
Source: Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0] [10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2019.00.02.1.1.0]

D. 5 Robustness tables nursing home access

TABLE D.5: Single rooms and free beds to all individuals in need of care

	Free beds to all individuals in need of care (IHC and HHC)			
	$OLS_{2007–2019}$	OLS_{2019}	IV_{quota}	IV_{fstate}
Single-room share	-.00105**	-.00051**	-.00098*	-.00083***
	(.00042)	(.00018)	(.00054)	(.00028)
Age group 35–65	-.01942**	-.00737	-.00724	-.00728
	(.0073)	(.00552)	(.0053)	(.00529)
Life expectancy	-.0005**	-.00015	-.00015	-.00015
	(.00021)	(.00013)	(.00012)	(.00013)
Population density	8.6e-08	2.3e-07	2.3e-07*	2.3e-07*
	(2.7e-07)	(1.3e-07)	(1.3e-07)	(1.3e-07)
Unemployment ratio females > 55 years	-.0045*	.00025	.0002	.00021
	(.00222)	(.00114)	(.00107)	(.00109)
Monthly household income	2.5e-06**	6.9e-07*	6.9e-07**	6.9e-07**
	(9.2e-07)	(3.5e-07)	(3.4e-07)	(3.4e-07)
Average pension per month	6.5e-06	6.2e-06*	6.1e-06**	6.1e-06**
	(3.9e-06)	(2.9e-06)	(2.8e-06)	(2.8e-06)
Land price	-3.0e-08	-2.6e-07	-2.6e-07	-2.6e-07
	(9.2e-07)	(3.5e-07)	(3.3e-07)	(3.4e-07)
Rurality	-.00104	-.00019	-.00021	-.00021
	(.00079)	(.00038)	(.00038)	(.00037)
Hospital beds [per 10,000 inh.]	.00028***	.00012***	.00012***	.00012***
	(5.5e-05)	(3.2e-05)	(3.0e-05)	(3.0e-05)
Number of individuals in need of care	1.9e-09	-3.9e-08***	-3.8e-08***	-3.8e-08***
	(2.2e-08)	(1.3e-08)	(1.2e-08)	(1.2e-08)
Full-time equivalents RN per NH	-.00013***	-2.9e-05**	-2.9e-05***	-2.9e-05***
	(2.8e-05)	(1.1e-05)	(9.9e-06)	(1.0e-05)
Full-time equivalents NA per NH	-.00016***	-9.4e-05***	-9.5e-05***	-9.5e-05***
	(3.3e-05)	(1.9e-05)	(1.9e-05)	(1.9e-05)
Vacancies for geriatric care	-1.4e-05**	-2.0e-06	-2.3e-06	-2.2e-06
	(5.4e-06)	(2.7e-06)	(2.8e-06)	(2.7e-06)
Avg. price for NH accommodation	-8.3e-05	1.9e-05	1.9e-05	1.9e-05
	(4.9e-05)	(1.4e-05)	(1.3e-05)	(1.3e-05)
Constant	.05409***	.0131	.01279	.01289
	(.01729)	(.01001)	(.00962)	(.00967)
Year FE	×			
Regional FE	×	×	×	×
Mean outcome variable	0.003	0.001	0.001	0.001
Observations	75666	10996	10996	10996
1st stage excl. F-statistic			95.86	403.07
F-statistic	639.58	985.57	2615.11	2391.43
R2	0.336	0.294	0.293	0.294

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Standard errors clustered at federal state level in parenthesis.
Description: Column $OLS_{2007–2019}$ reports OLS regression results including observations from 2007 to 2019; Column OLS_{2007} reports OLS cross-sectional analyses with 2007 data for comparison purpose with IV_{quota} and IV_{fstate} ; Column IV_{quota} reports an instrumental variable approach on a cross-sectional basis using the distance from 2007 individual SR shares to the 2019 SR quota level; Column IV_{fstate} reports our second instrumental variable results using the distance from 2007 individual SR shares to the 2019 federal state average. Regression equation $Access_c = \beta_0 + \beta_1 \widehat{SRshare_c} + \gamma \mathbf{X}_c + \kappa_c + v_c$ Outcomes: Ratio of free beds to all individual in need of care outside the nursing home. More details on variables are provided in Table 5.1 and Table D.1. *Source:* Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]

TABLE D.6: Single rooms and nurses-to-residents in severe need of care

	RN-to-residents in severe need of care			
	$OLS_{2007–2019}$	OLS_{2019}	IV_{quota}	IV_{fstate}
Single-room share	.0036**	.0043*	.0189***	.0084*
	(.0014)	(.0021)	(.0054)	(.005)
Age group 35–65	.3678**	.5668*	.5628**	.5656**
	(.1383)	(.2927)	(.2805)	(.2815)
Life expectancy	-.0064	-.012	-.0122	-.012
	(.0056)	(.0083)	(.008)	(.008)
Population density	-2.7e-05***	-1.0e-05***	-1.0e-05***	-1.0e-05***
	(3.2e-06)	(2.7e-06)	(2.7e-06)	(2.7e-06)
Unemployment ratio females > 55 years	.0173	.0328	.0343	.0332
	(.0802)	(.1257)	(.1214)	(.121)
Monthly household income	1.0e-05	3.6e-05**	3.6e-05***	3.6e-05***
	(8.1e-06)	(1.2e-05)	(1.2e-05)	(1.2e-05)
Average pension per month	-3.1e-04***	-2.4e-04	-2.3e-04	-2.4e-04
	(8.7e-05)	(1.7e-04)	(1.7e-04)	(1.7e-04)
Land price	4.3e-06	-2.8e-05***	-2.8e-05***	-2.8e-05***
	(1.1e-05)	(9.3e-06)	(9.1e-06)	(9.0e-06)
Rurality	-.0073	-.0016	-9.0e-04	-.0014
	(.0088)	(.0164)	(.016)	(.0158)
Hospital beds [per 10,000 inh.]	-2.0e-04	-7.6e-04	-7.7e-04	-7.6e-04
	(8.2e-04)	(.0012)	(.0012)	(.0012)
Number of individuals in need of care	-2.1e-07	-4.5e-07	-4.6e-07	-4.6e-07
	(2.9e-07)	(4.1e-07)	(4.0e-07)	(3.9e-07)
Full-time equivalents RN per NH	.0139***	.0142***	.0142***	.0142***
	(6.1e-04)	(9.4e-04)	(9.1e-04)	(9.1e-04)
Full-time equivalents NA per NH	4.2e-04	6.1e-04	6.3e-04*	6.2e-04*
	(2.5e-04)	(3.6e-04)	(3.5e-04)	(3.5e-04)
Vacancies for geriatric care	4.4e-05	8.9e-05	9.9e-05	9.2e-05
	(4.5e-05)	(1.2e-04)	(1.2e-04)	(1.2e-04)
Avg. price for NH accommodation	7.3e-05	-5.5e-04	-5.8e-04	-5.6e-04
	(8.1e-04)	(.0012)	(.0011)	(.0011)
Constant	.5645	.8219	.8314	.8246
	(.4195)	(.5552)	(.5385)	(.5348)
Year FE	×			
Regional FE	×	×	×	×
Mean outcome variable	0.201	0.187	0.187	0.187
Observations	75666	10996	10996	10996
1st stage excl. F-statistic			95.86	403.07
F-statistic	180.96	220.78	260.03	272.02
R2	0.883	0.899	0.898	0.898

$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$; Standard errors clustered at federal state level in parenthesis.
Description: Column $OLS_{2007–2019}$ reports OLS regression results including observations from 2007 to 2019; Column OLS_{2007} reports OLS cross-sectional analyses with 2007 data for comparison purpose with IV_{quota} and IV_{fstate} ; Column IV_{quota} reports an instrumental variable approach on a cross-sectional basis using the distance from 2007 individual SR shares to the 2019 SR quota level; Column IV_{fstate} reports our second instrumental variable results using the distance from 2007 individual SR shares to the 2019 federal state average. Regression equation $\text{Access}_c = \beta_0 + \beta_1 \widehat{SRshare_c} + \gamma \mathbf{X}_c + \kappa_c + v_c$ Outcome: Ratio of registered nurses to NH residents in severe need of care. More details on variables are provided in Table 5.1 and Table D.1. *Source:* Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]

D. 6 First stage estimate tables

TABLE D.7: First stage regression results

	Single-room share in nursing homes (facility)		Single-room share in nursing homes (county)	
Instruments:				
Distance of single-room shares in 2007 to				
the single-room quota in 2019	-.7423***		-.5567***	
	(.0758)		(.0990)	
the average federal-state level in 2019		-.7606***		-.5912***
		(.0379)		(.0597)
Controls	×	×	×	×
Time FE	×	×	×	×
Regional FE	×	×	×	×
Mean outcome variable	0.631	0.631	0.631	0.631
Observations	10,996	10,996	400	400

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Robust standard errors in parenthesis.
Description: Column IV_{quota} reports the first stage regression for the distance of single-rooms to the quota in 2019; Column IV_{fstate} reports the first stage of the second instrumental variable using the distance to the 2019 federal state average. Regression equation SR share$_i$ $= \beta_0 + \beta_1 Distance_i + \gamma \mathbf{X}_i + \kappa_c + \upsilon_{j,c}$. More details on variables are provided in Table 5.1 and Table D.1.
Source: Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]

D. 7 Result tables including covariates

TABLE D.8: Relationship between occupancy ratio and the single-room share

	Occupancy ratio			
	$OLS_{2007–2019}$	OLS_{2019}	IV_{quota}	IV_{fstate}
Single-room share	.0486***	.0388***	.0407***	.0596***
	(.0078)	(.0079)	(.0095)	(.0097)
Age group 35–65	.2929*	.0211	.0206	.0154
	(.1531)	(.1447)	(.1403)	(.1401)
Life expectancy	.0077*	.005	.005	.0047
	(.0043)	(.0074)	(.0071)	(.0071)
Population density	-2.0e-06	-1.1e-05	-1.1e-05	-1.1e-05
	(4.3e-06)	(1.1e-05)	(1.0e-05)	(1.0e-05)
Unemployment ratio females $>$ 55 years	.0066	-.112*	-.1118**	-.1099**
	(.0338)	(.0563)	(.0545)	(.0553)
Monthly household income	-3.8e-05***	-4.0e-05	-4.0e-05	-4.0e-05
	(1.1e-05)	(2.8e-05)	(2.7e-05)	(2.7e-05)
Average pension per month	1.8e-05	2.8e-05	2.8e-05	3.2e-05
	(4.9e-05)	(8.1e-05)	(7.9e-05)	(7.7e-05)
Land price	1.9e-05	3.8e-05	3.8e-05	3.7e-05
	(1.4e-05)	(2.9e-05)	(2.8e-05)	(2.7e-05)
Rurality	.0033	.0136	.0137*	.0146**
	(.0054)	(.0079)	(.0076)	(.0073)
Hospital beds [per 10,000 inh.]	1.3e-04	-.0016**	-.0016***	-.0016***
	(4.2e-04)	(6.3e-04)	(6.0e-04)	(6.1e-04)
Number of individuals in need of care	4.9e-09	-9.8e-07	-9.8e-07	-9.9e-07
	(3.6e-07)	(1.4e-06)	(1.3e-06)	(1.3e-06)
Full-time equivalents RN per NH	.0013***	.0016***	.0016***	.0016***
	(1.7e-04)	(3.0e-04)	(2.9e-04)	(2.9e-04)
Full-time equivalents NA per NH	-1.4e-04	-3.2e-04	-3.2e-04	-2.9e-04
	(1.4e-04)	(3.4e-04)	(3.2e-04)	(3.2e-04)
Vacancies for geriatric nurses	-4.7e-05	3.6e-04	3.6e-04	3.7e-04
	(5.7e-05)	(4.5e-04)	(4.3e-04)	(4.3e-04)
Avg. price for NH accommodation	-1.0e-04	-.0019**	-.0019**	-.002**
	(7.3e-04)	(8.0e-04)	(7.7e-04)	(7.7e-04)
Constant	.0688	.5263	.5275	.5399
	(.3685)	(.5106)	(.4927)	(.4873)
Year FE	×			
Regional FE	×	×	×	×
Mean outcome variable	0.889	0.910	0.910	0.910
Observations	75666	10996	10996	10996
1st stage excl. F-statistic			95.86	403.07
F-statistic	50.38	102.27	794.89	2056.30
R2	0.117	0.092	0.092	0.090

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Standard errors clustered at federal state level in parenthesis.
Description: Column $OLS_{2007–2019}$ reports OLS regression results including observations from 2007 to 2019; Column OLS_{2019} reports OLS cross-sectional analyses with 2007 data for comparison purpose with IV_{quota} and IV_{fstate} ; Column IV_{quota} reports an instrumental variable approach on a cross-sectional basis using the distance from 2007 individual SR shares to the 2019 SR quota level; Column IV_{fstate} reports our second instrumental variable results using the distance from 2007 individual SR shares to the 2019 federal state average. Regression equation $\text{access}_j = \beta_0 + \beta_1 \widehat{SRshare}_j + \gamma \mathbf{X}_c + \kappa_r + v_{j,c}$ Outcomes: Occupancy ratio of nursing homes. More details on variables are provided in Table 5.1 and Table D.1. *Source:* Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]

TABLE D.9: Relationship between free beds per CR3+ and the single-room share

	Free beds to CL3+ (IHC and HHC			
	$OLS_{2007–2019}$	OLS_{2019}	IV_{quota}	IV_{fstate}
Single-room share	-.0098**	-.0033***	-.0058**	-.0054***
	(.0037)	(9.6e-04)	(.0029)	(.0015)
Age group 35–65	-.2292**	-.0534	-.0527	-.0528
	(.0919)	(.0367)	(.0354)	(.0352)
Life expectancy	-.008**	-.0015	-.0014*	-.0014
	(.0031)	(9.1e-04)	(8.7e-04)	(8.8e-04)
Population density	2.8e-06	1.7e-06	1.7e-06*	1.7e-06*
	(2.8e-06)	(1.0e-06)	(1.0e-06)	(9.9e-07)
Unemployment ratio females > 55 years	-.0214	.0031	.0028	.0028
	(.0275)	(.01)	(.0095)	(.0096)
Monthly household income	2.3e-05*	2.9e-06	3.0e-06	3.0e-06
	(1.3e-05)	(2.5e-06)	(2.4e-06)	(2.4e-06)
Average pension per month	1.1e-04**	5.2e-05**	5.1e-05***	5.2e-05***
	(4.3e-05)	(2.1e-05)	(2.0e-05)	(2.0e-05)
Land price	-3.1e-06	-1.5e-06	-1.5e-06	-1.5e-06
	(9.3e-06)	(2.6e-06)	(2.5e-06)	(2.5e-06)
Rurality	-.0116	-.001	-.0011	-.0011
	(.0085)	(.0026)	(.0026)	(.0026)
Hospital beds [per 10,000 inh.]	.0027***	7.4e-04***	7.4e-04***	7.4e-04***
	(5.3e-04)	(1.7e-04)	(1.6e-04)	(1.6e-04)
Number of individuals in need of care	1.7e-07	-2.5e-07***	-2.5e-07***	-2.5e-07***
	(2.5e-07)	(8.3e-08)	(8.0e-08)	(8.0e-08)
Full-time equivalents RN per NH	-.0013***	-1.9e-04**	-1.9e-04***	-1.9e-04***
	(2.4e-04)	(6.8e-05)	(6.3e-05)	(6.5e-05)
Full-time equivalents NA per NH	-.0017***	-6.3e-04***	-6.4e-04***	-6.4e-04***
	(2.9e-04)	(1.2e-04)	(1.1e-04)	(1.1e-04)
Vacancies for geriatric nurses	-1.8e-04***	-2.1e-05	-2.2e-05	-2.2e-05
	(5.5e-05)	(2.1e-05)	(2.1e-05)	(2.0e-05)
Avg. price for NH accommodation	-8.2e-04	1.4e-04	1.5e-04	1.5e-04
	(5.6e-04)	(1.0e-04)	(9.7e-05)	(9.8e-05)
Constant	.774***	.1214	.1197*	.12*
	(.2446)	(.0697)	(.0671)	(.0674)
Year FE	×			
Regional FE	×	×	×	×
Mean outcome variable	0.031	0.001	0.001	0.001
Observations	75666	10996	10996	10996
1st stage excl. F-statistic			95.86	403.07
F-statistic	85.45	255.35	658.73	1320.28
R2	0.308	0.284	0.283	0.283

$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$; Standard errors clustered at federal state level in parenthesis.
Description: Column $OLS_{2007–2019}$ reports OLS regression results including observations from 2007 to 2019; Column OLS_{2019} reports OLS cross-sectional analyses with 2007 data for comparison purpose with IV_{quota} and IV_{fstate} ; Column IV_{quota} reports an instrumental variable approach on a cross-sectional basis using the distance from 2007 individual SR shares to the 2019 SR quota level; Column IV_{fstate} reports our second instrumental variable results using the distance from 2007 individual SR shares to the 2019 federal state average. Regression equation $\text{access}_j = \beta_0 + \beta_1 \widehat{SRshare}_j + \gamma \mathbf{X}_c + \kappa_r + v_{j,c}$ Outcomes: Ratio of free beds to the individual in severe need of care outside the nursing home. More details on variables are provided in Table 5.1 and Table D.1. *Source:* Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]

TABLE D.10: Relationship between care IHC recipients' health and the single-room share

	Share of individuals in severe need of care in IHC (CL3+)			
	$OLS_{2007–2019}$	OLS_{2019}	IV_{quota}	IV_{fstate}
Single-room share	.0449**	.0119	.0129	.0113
	(.0193)	(.0102)	(.0344)	(.0184)
Age group 35–65	.0242	.0015	.0016	.0015
	(.2266)	(.0359)	(.0294)	(.0294)
Life expectancy	-.0021	.0027*	.0027**	.0027**
	(.0027)	(.0013)	(.0013)	(.0012)
Population density	-1.2e-04**	-1.1e-06	-1.1e-06	-1.1e-06
	(4.6e-05)	(2.2e-06)	(2.1e-06)	(2.0e-06)
Unemployment ratio females $>$ 55 years	-.0481**	-.0098	-.0098	-.0098
	(.0199)	(.0192)	(.0166)	(.016)
Monthly household income	-5.6e-06	9.5e-06	9.4e-06**	9.5e-06**
	(1.6e-05)	(5.6e-06)	(4.6e-06)	(4.7e-06)
Average pension per month	-4.7e-05	-5.2e-05**	-5.2e-05**	-5.2e-05**
	(1.4e-04)	(2.4e-05)	(2.3e-05)	(2.0e-05)
Land price	3.7e-05**	2.8e-06	2.8e-06	2.8e-06
	(1.4e-05)	(3.7e-06)	(3.0e-06)	(3.0e-06)
Rurality	-.0035	.0032	.0033	.0032
	(.0099)	(.003)	(.0021)	(.0022)
Hospital beds [per 10,000 inh.]	-.0041*	-2.6e-04*	-2.6e-04**	-2.6e-04**
	(.0021)	(1.5e-04)	(1.2e-04)	(1.2e-04)
Number of individuals in need of care	6.6e-08	-2.4e-08	-2.5e-08	-2.4e-08
	(2.8e-07)	(1.5e-07)	(1.1e-07)	(1.2e-07)
Full-time equivalents RN per NH	5.3e-04	3.9e-05	3.9e-05	3.9e-05
	(4.1e-04)	(1.8e-04)	(1.4e-04)	(1.4e-04)
Full-time equivalents NA per NH	-2.7e-04	-5.6e-04*	-5.6e-04*	-5.6e-04**
	(7.6e-04)	(3.1e-04)	(2.9e-04)	(2.7e-04)
Vacancies for geriatric nurses	-1.5e-04**	6.3e-05	6.4e-05**	6.3e-05**
	(5.7e-05)	(3.6e-05)	(2.6e-05)	(2.8e-05)
Avg. price for NH accommodation	-6.1e-04	-2.0e-05	-2.1e-05	-2.0e-05
	(6.0e-04)	(1.3e-04)	(1.1e-04)	(1.0e-04)
Constant	.4788**	-.0754	-.0752	-.0756
	(.2003)	(.0876)	(.0758)	(.0743)
Year FE	×			
Regional FE		×	×	×
Mean outcome variable	0.099	0.128	0.128	0.128
Observations	2848	400	400	400
1st stage excl. F-statistic			31.62	97.81
F-statistic	15.08	50.24	79.17	44.63
R2	0.810	0.867	0.867	0.867

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Standard errors clustered at federal state level in parenthesis.
Description: Column $OLS_{2007–2019}$ reports OLS regression results including observations from 2007 to 2019; Column OLS_{2019} reports OLS cross-sectional analyses with 2007 data for comparison purpose with IV_{quota} and IV_{fstate} ; Column IV_{quota} reports an instrumental variable approach on a cross-sectional basis using the distance from 2007 individual SR shares to the 2019 SR quota level; Column IV_{fstate} reports our second instrumental variable results using the distance from 2007 individual SR shares to the 2019 federal state average. Regression equations IHC CL3+$_c = \beta_0 + \beta_1 \widehat{SR}_c + \gamma \mathbf{X}_c + \kappa_c + v_c$ Outcomes: Share of IHc recipients in severe need of care. More details on variables are provided in Table 5.1 and Table D.1. *Source:* Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]

TABLE D.11: Relationship between IHC recipients' age and the single-room share

	IHC recipients' age			
	$OLS_{2007–2019}$	OLS_{2019}	IV_{quota}	IV_{fstate}
Single-room share	3.87*	-.0083	2.838	.9049
	(2.063)	(.8896)	(2.444)	(1.523)
Age group 35–65	9.535	-18.85**	-18.61***	-18.77***
	(6.069)	(7.103)	(5.675)	(5.771)
Life expectancy	.1958*	.3481***	.3068***	.3348***
	(.1062)	(.0814)	(.0739)	(.0698)
Population density	.0022***	-5.7e-05	-1.0e-04	-7.2e-05
	(6.6e-04)	(4.3e-04)	(3.4e-04)	(3.5e-04)
Unemployment ratio females $>$ 55 years	2.104	7.52***	7.64***	7.559***
	(1.478)	(2.069)	(1.535)	(1.662)
Monthly household income	.0022**	.0021***	.002***	.0021***
	(9.0e-04)	(5.9e-04)	(4.5e-04)	(4.9e-04)
Average pension per month	-1.1e-04	.0049	.0059**	.0052
	(.006)	(.0041)	(.0028)	(.0033)
Land price	3.8e-04	-3.5e-04	-3.6e-04	-3.5e-04
	(2.8e-04)	(6.1e-04)	(5.0e-04)	(5.0e-04)
Rurality	-.1036	1.459**	1.643***	1.518***
	(.2044)	(.5341)	(.4719)	(.4438)
Hospital beds [per 10,000 inh.]	-.0563*	.0041	.0049	.0043
	(.0287)	(.0225)	(.0191)	(.0187)
Number of individuals in need of care	-6.3e-06	8.5e-06	6.8e-06	8.0e-06
	(4.1e-05)	(1.9e-05)	(1.5e-05)	(1.5e-05)
Full-time equivalents RN per NH	.026*	-.0252*	-.0259**	-.0254**
	(.0134)	(.013)	(.0102)	(.0105)
Full-time equivalents NA per NH	-.0118	.0113	.0152	.0125
	(.0172)	(.0464)	(.0352)	(.0369)
Vacancies for geriatric nurses	-.0016	-.0042	-.0023	-.0036
	(.0012)	(.0067)	(.0054)	(.0056)
Avg. price for NH accommodation	.0509	.015	.0126	.0142
	(.0412)	(.0172)	(.0174)	(.0154)
Constant	29.21***	32.91**	33.51***	33.1***
	(7.424)	(11.21)	(8.89)	(9.098)
Year FE	×			
Regional FE		×	×	×
Mean outcome variable	67.99	68.34	68.34	68.34
Observations	2848	400	400	400
1st stage excl. F-statistic			31.62	97.81
F-statistic	32.98	632.15	865.27	37.35
R2	0.867	0.751	0.744	0.750

$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$; Standard errors clustered at federal state level in parenthesis.
Description: Column $OLS_{2007–2019}$ reports OLS regression results including observations from 2007 to 2019; Column OLS_{2019} reports OLS cross-sectional analyses with 2007 data for comparison purpose with IV_{quota} and IV_{fstate} ; Column IV_{quota} reports an instrumental variable approach on a cross-sectional basis using the distance from 2007 individual SR shares to the 2019 SR quota level; Column IV_{fstate} reports our second instrumental variable results using the distance from 2007 individual SR shares to the 2019 federal state average. Regression equations IHC $\text{age}_c = \beta_0 + \beta_1 \widehat{SR}_c + \gamma \mathbf{X}_c + \kappa_c + v_c$ Outcomes: Age of IHC recipients. More details on variables are provided in Table 5.1 and Table D.1. *Source:* Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]

TABLE D.12: Relationship between NH care and HHC recipients' health and the single-room share

	NH Care CL3	HHC CL3+			
	$OLS_{2007–2019}$	$OLS_{2007–2019}$	OLS_{2019}	IV_{quota}	IV_{fstate}
Single-room share	0535	.076**	.0736	.0818**	.0837*
	(0.0679)	(.0269)	(.0485)	(.0388)	(.045)
Age group 35–65	-.5529	-.3872**	.1159	.1166	.1167
	(.1911)	(.1708)	(.2479)	(.2075)	(.2049)
Life expectancy	-.0080	.0051**	.0177***	.0176***	.0175***
	(.0043)	(.0019)	(.0043)	(.004)	(.0034)
Population density	0043	-1.2e-06	-6.0e-06	-6.2e-06	-6.2e-06
	(.0000)	(2.2e-05)	(1.3e-05)	(1.0e-05)	(1.0e-05)
Unemployment ratio females $>$ 55 years	.0119	-.025	-.0066	-.0062	-.0061
	(.0594)	(.05)	(.0607)	(.052)	(.0508)
Monthly household income	-4.50e-06	-1.7e-05	1.2e-05	1.1e-05	1.1e-05
	(.0000)	(1.1e-05)	(1.6e-05)	(1.1e-05)	(1.3e-05)
Average pension per month	-.00016	7.3e-05	4.2e-06	7.1e-06	7.7e-06
	(.0002)	(1.2e-04)	(1.1e-04)	(8.2e-05)	(8.9e-05)
Land price	-.00001	1.3e-05	-1.9e-06	-1.9e-06	-2.0e-06
	(.0000)	(1.1e-05)	(2.0e-05)	(1.7e-05)	(1.7e-05)
Rurality	.0148	.0043	.0194	.02*	.0201*
	(.0061)	(.007)	(.0153)	(.0111)	(.0121)
Hospital beds [per 10,000 inh.]	-.00102	.002*	3.5e-04	3.5e-04	3.5e-04
	(.0016)	(.0011)	(6.1e-04)	(5.0e-04)	(5.0e-04)
Number of individuals in need of care	3.05e-06	1.2e-06*	-7.5e-07	-7.6e-07*	-7.6e-07
	(3.05e-06)	(5.6e-07)	(5.7e-07)	(4.4e-07)	(4.7e-07)
Full-time equivalents RN per NH	.00175	.0017***	.0021***	.0021***	.0021***
	(.0009)	(2.3e-04)	(7.0e-04)	(5.8e-04)	(5.8e-04)
Full-time equivalents NA per NH	.00175	2.8e-04	-.0012	-.0012	-.0012
	(.0007)	(1.0e-03)	(1.0e-03)	(8.5e-04)	(8.3e-04)
Vacancies for geriatric nurses	-.00006	1.2e-05	4.9e-04	5.0e-04**	5.0e-04*
	(.00009)	(7.8e-05)	(3.2e-04)	(2.4e-04)	(2.7e-04)
Avg. price for NH accommodation	.0018	.0012	-8.6e-04***	-8.7e-04***	-8.7e-04***
	(.00125)	(8.9e-04)	(2.0e-04)	(1.6e-04)	(1.7e-04)
Constant	1.092	-.361	-1.454***	-1.452***	-1.451***
	(.2494)	(.2515)	(.3488)	(.291)	(.2853)
Year FE		×			
Regional FE			×	×	×
Mean outcome variable	0.21	0.15	0.17	0.17	0.17
Observations	2848	2848	400	400	400
1st stage excl. F-statistic				31.62	97.81
F-statistic	4.10	14.10	15.06	29.51	96.71
R2	0.941	0.819	0.559	0.559	0.559

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Standard errors clustered at federal state level in parenthesis.
Description: Column $OLS_{2007–2019}$ reports OLS regression results including observations from 2007 to 2019; Column OLS_{2019} reports OLS cross-sectional analyses with 2007 data for comparison purpose with IV_{quota} and IV_{fstate} ; Column IV_{quota} reports an instrumental variable approach on a cross-sectional basis using the distance from 2007 individual SR shares to the 2019 SR quota level; Column IV_{fstate} reports our second instrumental variable results using the distance from 2007 individual SR shares to the 2019 federal state average. Regression equations IHC CL3+$_c = \beta_0 + \beta_1 \widehat{SR}_c + \gamma \mathbf{X}_c + \kappa_c + v_c$ Outcomes: Share of HHC recipients in severe need of care. More details on variables are provided in Table 5.1 and Table D.1. *Source:* Own calculations based on the Care Statistic, Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 -10.21242/22411.2019.00.02.1.1.0]