Labor Supply and Wage Formation Under Skill Shortages and Labor Market Tightness

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Chapter 1

Introduction

The relevance of skilled labor in the production process is axiomatic to economists. From basic representations of production processes in undergraduate textbooks to advanced discussions in scientific papers, production functions capture the interplay between labor at different skill levels and capital. Similarly, it is widely accepted that workers' skills significantly impact economic outcomes. As Nobel Memorial Prize laureate Gary S. Becker (Becker 1995) noted:

> "Of course, machines and other physical capital are important. But alone they are far from sufficient in producing growth because skilled workers and managers, and innovative entrepreneurs are needed to operate complicate machinery, to produce efficiently, to develop new products and processes, and to utilize innovations from other countries."

Conversely, a shortage of skilled labor can have adverse economic consequences, limiting the availability of essential goods and services. Over the last two decades, such lack of well-trained skilled labor has become a prominent topic in economic policy debates within industrialized nations. Reports from governmental, supranational, and intergovernmental organizations, have raised concerns about an increasing shortage of skilled labor (Vandeplas & Thum-Thysen 2019, European Centre for the Development of Vocational Training 2018, 2015, OECD 2017). Against this background, this dissertation investigates labor supply and wage-setting. It focuses on the example of nursing, as this profession not only plays a crucial role in public health but is also among those most affected by skill shortages in many developed countries. The majority of the chapters of this dissertation (chapters 2 to 4) examine labor supply, specifically

nurses' occupational retention, their preferences for job characteristics, and the heterogeneity in these preferences. The final main chapter (chapter 5) addresses demand-side responses, specifically wage adjustments in response to nurse shortages. The analyses draw on a variety of German data sources and employ multiple econometric methods. The aim of this dissertation is to provide empirical evidence on these issues and discuss the broader implications of these findings for the nursing sector, and, where applicable, for the labor market more broadly, offering insights relevant to economic and policy decision-makers.

Tight labor markets are defined by firms competing for a relatively limited pool of job seekers to fill a comparatively large number of vacancies (Bossler & Popp 2024). Analytically, labor market tightness is typically measured as the ratio of vacancies to unemployed individuals–i.e., the number of open positions per unemployed person–and reflects the difficulty of hiring new personnel or finding new employment within a particular labor market (Cahuc et al. 2014). Labor and skill shortage refer to situations in which the demand for (skilled) labor exceeds its available supply (Stevens 2007). Specifically, labor shortage describes scenarios where open positions remain unstaffed, while skill shortage occurs when positions requiring specific skills cannot be filled due to a lack of suitably qualified candidates. These shortages arise either because there are insufficient candidates willing to fill the positions or because the available candidates lack the necessary skills. Such shortages are commonly measured through metrics such as unfilled or hard-to-fill vacancies (McGuinness et al. 2018).[1]

Evidence on labor and skill shortages remains contentious, despite considerable public attention. Academic studies and reports from government-related institutions using employer survey data indicate shortages across different regions, occupations, and industries (Healy et al. 2015, European Commission 2015). However, these findings are met with skepticism due to ambiguities in survey questions and, at times, contradictory results across different surveys (Cappelli 2015, European Commission 2015). Recording actual vacancies is less susceptible to subjective perceptions within a firm. Data on the number of vacancies, vacancy rates, and vacancy durations have thus become standard measures in public labor and skill shortage monitoring systems (Bennett & McGuinness 2009, Statistik der Bundesagentur für Arbeit 2020*a*, Eurostat 2024*b*, U.S. Bureau of Labor Statistics 2024*b*) and are frequently used to assess skill shortages in academic research (e.g., Elliott et al. 2007, Bennett & McGuinness 2009, Fang

[1]Some studies incorporate adjustment mechanisms into their definitions, considering shortages as scenarios where open positions cannot be filled at the prevailing wage rate (European Centre for the Development of Vocational Training 2018).

2009, Horbach & Rammer 2022). When evaluated using these measures, skill shortages have been rising in recent years across industrialized economies. Focusing on the EU and the U.S., vacancy rates, aside from a decline during the COVID-19 pandemic, have increased almost uniformly in the EU from under 1.5 percent in 2014 to over 3 percent in 2022 (Eurostat 2024*a*,*b*). Similarly, the U.S. vacancy rate more than doubled between 2014 and 2022, rising from below 3 percent to over 7 percent (U.S. Bureau of Labor Statistics 2024*b*). Although vacancy rates have started to decline since 2022, they remain at historically high levels, with labor markets exceptionally tight at low unemployment rates (Eurostat 2024*a*, U.S. Bureau of Labor Statistics 2024*a*).

Germany is no exception among EU states; here too, vacancy rates more than doubled between 2014 and 2022, rising from under 2 percent to over 4 percent. With the exception of the COVID-19 pandemic period, vacancy rates increased almost continuously from at least 2010 until 2022, before returning to a comparatively high pre-pandemic level thereafter (IAB 2024). Data from the German Federal Employment Agency provide a more detailed view. In its reporting on the skills situation and regular updates on skill shortage indicators, the Agency utilizes occupation-specific data on job vacancies, unemployment, and wages.[2] For all skilled occupations, the most significant single indicator of skill shortage–the average duration of vacancies–has increased markedly over the past decade. Between 2012 and 2022, this duration rose by over 80 percent, from 76 days to 139 days. Simultaneously, the number of open positions grew from just over 250,000 to more than 500,000. Labor market tightness has followed a similar trend; the number of unemployed individuals per 100 vacancies, an inverse measure of tightness, has fallen to merely a third of its 2012 level. Not all occupations, however, are equally affected. A closer examination of occupational data from 2023 reveals a highly differentiated landscape. While many occupations do not experience significant shortages, others face severe deficits. Out of the 230 skilled occupations analyzed by the Federal Employment Agency, 61 show no shortage, 71 are under observation (indicating they are near shortage levels), and 98 are classified as shortage occupations. The median vacancy duration varies significantly across occupations, ranging from single-digit figures to over 200

[2]See Statistik der Bundesagentur für Arbeit (2024*a*) for the latest occupation-level indicators and a range of reports on indicator trends over time. For its analysis, the Federal Employment Agency further considers changes in the share of older employees, the proportion of unfilled training positions, the graduate-to-employee ratio, and substitutability potential as *risk indicators*; in addition, it examines occupational mobility, employment rates, part-time employment rates, and self-employment rates as *supplementary indicators* (Statistik der Bundesagentur für Arbeit 2020*b*).

days (Statistik der Bundesagentur für Arbeit 2024*a*).

The reasons behind tightening labor markets and skill shortages are manifold and do not affect all occupations and industries uniformly. Fluctuations in labor demand due to economic cycles of expansion and recession are obvious contributors to changes in skill shortages. However, practices like labor hoarding have kept vacancy rates relatively high in Europe even during recent economic downturns (Giupponi & Landais 2023). Other contributing factors are more structural. Among these are restrictions on market entry through occupational licensing (Kleiner & Soltas 2023), shifts in habits and norms–such as the decrease in hours worked per worker in Germany (Statistisches Bundesamt 2024)–and mismatches between educational outcomes and the skill requirements of the labor market. Broad drivers of change, such as technological change, also play a role by altering task compositions and thereby increasing demand for certain tasks while reducing it for others (Acemoglu & Autor 2011, Goos et al. 2014). Technologies like machine learning could potentially mitigate skilled labor shortages (Brunello & Wruuck 2021), though estimates vary regarding the extent of tasks that could realistically be automated or replaced (Frey & Osborne 2017, Nedelkoska & Quintini 2018, Autor 2022). In Germany, the IAB Vacancy Survey directly queries employers on their reasons for unfilled positions. The most commonly cited issues are an insufficient number of applicants and a lack of adequate professional qualifications among candidates (IAB 2024).

The adverse impacts of skill shortages are highlighted by numerous economic studies. Labor market tightness, along with the effects of shifts in labor supply and demand, has been extensively researched. However, increases in labor demand or decreases in labor supply do not necessarily imply shortages or heightened labor market tightness (Bossler & Popp 2024). Recently, a growing body of causal studies has begun to examine the specific consequences of skill shortages and labor market tightness on firms and the labor market. Findings show that shortage conditions can dampen firms' labor demand (Bossler & Popp 2024), negatively impact employment levels (Beaudry et al. 2018), and increase hiring costs (Bossler & Popp 2024, Muehlemann & Strupler Leiser 2018). Moreover, skill shortages have been shown to exert upward pressure on wages. Interestingly, these wage effects appear to be asymmetric, reducing wage inequality by disproportionately benefiting lower-wage earners (Brunow et al. 2022, Autor et al. 2023).

The effects of skill shortages are particularly pronounced when they impact industries crucial to essential services. Two prominent examples are health care and geriatric services. Within

this context, nursing stands out due to its critical role in public health; a shortage of nursing personnel, for instance, can lead to adverse health outcomes and even fatalities (Friedrich & Hackmann 2021). Furthermore, while the question of whether there is a general shortage of skilled workers remains complex and varies significantly across occupations, the situation for nurses is less contested. "The world desperately needs more nurses," headlined *The Economist* in its Graphic Detail series in December 2020, citing the World Health Organization (WHO) estimate that "6 million extra nurses are needed globally" (*The world desperately needs more nurses* 11/12/2020).[3] This headline echoes numerous scientific publications that document such shortages and explore the factors affecting nurse labor supply. The urgency in the search for additional nursing staff is tied to their indispensable role in health care. Nurses account for 59 percent of the global health care workforce and 57 percent in Europe. As the largest professional group in the health sector, a nursing shortage constitutes an international concern. The estimated global shortfall of 5.9 million nurses in 2018 is projected to decrease slightly to 5.7 million by 2030–leaving substantial gaps within a workforce that counted 27.9 million in 2018 and is expected to reach 36 million by 2030 (World Health Organization 2020). Notably, the WHO regards nursing supply as essential to achieving Sustainable Development Goal 3: to "Ensure healthy lives and promote well-being for all at all ages" (see World Health Organization 2020 and United Nations 2015). In response, governments worldwide are increasingly recognizing the critical importance of the nursing workforce and enacting relevant policies. A 2018 OECD survey of member countries indicated that the recruitment of long-term care workers was rated as a high-priority policy challenge in most countries (OECD 2020). Additionally, a survey of national nursing associations found that 74 percent of these associations reported government commitments to policies aimed at expanding the nursing labor supply (International Council of Nurses 2021). Germany is among the countries facing pronounced nursing shortages. According to the German Federal Employment Agency, nurses are among the most in-demand professionals. In 2023, nurses scored second highest on the Agency's overall indicator for shortage occupations, with open nursing positions remaining vacant for a median duration of 112 days (Statistik der Bundesagentur für Arbeit 2024*a*).[4]

Although it has garnered more attention recently, the nursing shortage is not a new phenomenon. In some regions, a shortage of nurses has been observed for decades (Kingma 2001,

[3]The WHO more precisely estimated a shortfall of 5.9 million nurses (World Health Organization 2020).

[4]Only professions in renewable energy technology were even more scarce, according to the Federal Employment Agency.

Shields & Ward 2001, Lu et al. 2012). Factors contributing to this shortage include challenging working conditions, health issues, and early exits from the profession. Recently, two exogenous events have heightened the focus on nurse labor supply: the COVID-19 pandemic and population aging. During the pandemic, the critical role of nurses in public health became evident, bringing attention to both the working conditions in nursing and labor supply concerns within the sector. Nurses, positioned at the forefront of the pandemic response, faced considerable additional strain, leading to widespread concerns that a significant number would leave the profession as a consequence (International Council of Nurses 2021). Demographic aging, a trend already prominent before the pandemic, continues to influence the sector. Population aging is a substantial driver of skill shortages in general and in nursing in particular (Sachverständigenrat 2018, Brunello & Wruuck 2021). An aging society, especially prominent in developed countries, exacerbates the nursing shortage by intensifying demand for health and care services as the proportion of elderly individuals grows. Additionally, as care workers retire, the smaller size of younger cohorts complicates efforts to replace them, potentially leading to a declining labor supply over the medium term. Consequently, the importance of a robust nursing workforce is set to increase in the future. Moreover, there is little prospect for alleviating the nursing shortage through technological substitution. The German Federal Employment Agency estimates that only 25 to 50 percent of nursing tasks could potentially be automated or handled by computers and computer-controlled machines.[5] Similar estimates for OECD countries indicate a low likelihood of automation for health and care workers more broadly (OECD 2020).[6]

Motivated by the shortage of nurses across various countries, the first three main chapters of this dissertation examine determinants of nurses' labor supply. These studies contribute to a diverse and multifaceted body of literature addressing issues related to nurses' labor supply.

One segment of this literature explicitly examines nurses' labor supply decisions. One approach estimates the wage elasticity of nurses' labor supply overall, though findings are somewhat inconclusive. Several studies suggest that nurses' labor supply is relatively inelastic to wage changes, although the effects' magnitude varies across job types and age groups (see Di Tommaso et al. 2009, Andreassen et al. 2017, and the literature reviews by Antonazzo et al. 2003 and Shields 2004). A different result emerges when both the intensive and extensive

[5]See the table appendix in Statistik der Bundesagentur für Arbeit (2020*b*).

[6]Additionally, nursing work demands specialized knowledge. In Germany, the standard training period for nurses is three years, which is shorter than in several other countries (World Health Organization 2020).

margins of labor supply are considered. Hanel et al. (2014) examines labor supply responses at both margins and finds a greater wage elasticity of labor supply than in previous studies. Another line of research focuses on nurses' intentions to leave either their employer or the nursing profession altogether. These intentions are associated with factors such as personal characteristics (e.g., age and ethnicity), job characteristics (e.g., pay and work organization), and job satisfaction (Kankaanranta & Rissanen 2008, Beecroft et al. 2008, Shields & Ward 2001, Parry 2008, Simon et al. 2010). However, intentions to leave the employer or profession do not always result in actual exit (Beecroft et al. 2008). Research on actual exit decisions is relatively limited. Holmås (2002) and Frijters et al. (2007) analyze nurses' decisions to leave the Norwegian public health service and the British National Health Service (NHS), respectively. Both studies indicate that wages and working conditions influence nurses' likelihood of leaving, although Frijters et al. (2007) finds only a minor effect of wages on retention rates, concluding that working conditions (assumed to be less favorable within the NHS compared to other employers) play a more significant role. Extensive studies on determinants of exiting the nursing profession are scarce. In a study on nurses in New South Wales, Doiron & Jones (2006) finds that establishment size and individual factors, such as age, sex, and experience, correlate with the likelihood of leaving the profession. Using retrospective survival analysis with career history data, Nooney et al. (2010) examines a cross-section of U.S. nurses, finding that those with higher incomes, children at home, higher nursing degrees, or female gender are more likely to change jobs. Despite the substantial literature, comprehensive multivariate analyses of factors associated with nurses leaving the profession are rare and often focus on specific exit events, subsets of nurses, or constrained regional labor markets–studies from a European or German perspective are notably lacking. Chapter 2 presents a study on nurses' retention within the occupation, analyzing associated factors using German data. The employed dataset provides a precise assessment of exit events and allows for differentiation across nursing subgroups and types of exit events, while the main results focus on the single risk event of leaving the occupation entirely. These results highlight, among other factors, the role of wages and family circumstances and the extent to which the impact of these factors varies by target destination.

A second branch of the literature explores factors that can make nursing jobs more attractive. Survey experiments have become a common tool for analyzing preferences regarding job characteristics among nurses and other health professionals. Numerous studies have used this technique to assess preferences among various other or broader groups of (future) employees (Scott 2001, Mas & Pallais 2017, Wiswall & Zafar 2018, Maestas et al. 2023, Fuchsman et al.

2023). Such experiments enable researchers to determine employees' preferences for different work arrangements, allowing for a causal interpretation of the results. A substantial body of research, both in developed and developing countries, has examined factors influencing the willingness to accept nursing job offers (Doiron et al. 2014, Scott et al. 2015, Fields et al. 2018, Soekhai et al. 2019). Nearly all of these studies indicate that pay is a crucial component of job attractiveness, yet other factors also play an essential role. These include objective factors like working hours (Scott et al. 2015) and shift patterns (Doiron et al. 2014), as well as subjective factors such as competencies, autonomy, and work relationships (Scott et al. 2015, Fields et al. 2018). However, causally interpretable studies specifically targeting Europe, and especially Germany, are currently lacking. Chapter 3 of this dissertation presents findings from a survey experiment that investigates determinants of nursing job attractiveness. Consistent with international literature, the results demonstrate the high relevance of subjective factors in determining job appeal, though certain objective factors, particularly contract duration and significant wage increases, also strongly influence job attractiveness.

Preferences for job characteristics can vary considerably depending on individual characteristics and tastes. Building on the analysis of average treatment effects, willingness-to-pay measures, and basic interaction effects in chapter 3, chapter 4 examines heterogeneity in the effects of the job characteristics studied in the previous chapter. This chapter goes beyond standard approaches to analyzing heterogeneity in comparable survey experiments, which typically rely on standard interaction models. The methodology employed, the Sorted Partial Effects Method introduced by Chernozhukov, Fernández-Val & Luo (2018), enables a comprehensive presentation of effect heterogeneity and allows for a structured analysis of how differences emerge across specific characteristics. Additionally, the individual characteristics and self-reported work attitudes in the survey data enable a nuanced analysis, revealing clear differences in respondents' attitudes toward the examined job characteristics across identifiable factors.

The majority of this thesis focuses on labor supply decisions and their determinants. Chapter 5 shifts the emphasis to labor demand. According to classic economic models, skill shortages should not persist in the absence of market frictions or employer market power. As Cappelli (2015) points out:

> "The notion of a shortage is foreign [...] to most all economics-based models. Indeed, shortages in general are typically seen as occurring only in the context of market failure, such as wartime wage freezes or restrictions on mobility, and to be

temporary until candidates and employer adjust."

One expected adjustment in response to labor shortages is a reaction on the demand side, such as wage increases. However, the market mechanisms that should ideally allocate labor efficiently through wage adjustments may be constrained by frictions. Factors like employer market power, specific worker expectations, and institutional frameworks can introduce significant frictions. Recent studies have begun to explore this issue (Frohm 2020, Kölling 2022, Autor et al. 2023, Le Barbanchon et al. 2023, Groiss & Sondermann 2024), identifying wage adjustments in response to shortages, although these effects vary by context and are subject to market conditions. While it remains debated whether higher wages alone can effectively address the nursing shortage, evidence suggests that wage increases could partially improve nurse supply. Prior literature shows overwhelmingly positive associations between wage levels and factors like job retention, job attractiveness, and occupational choice. Similar positive associations are found in the studies presented in chapters 2 through 4. Chapter 5 of this dissertation contributes new evidence on wage reactions to skill shortages and examines how these reactions interact with existing market conditions.

The studies in this dissertation utilize a range of data sources and methodologies tailored to address the specific research questions as closely as possible. Chapter 2 uses daily administrative data and applies survival analysis techniques to investigate occupational retention. Chapter 5 employs individual-level data on employment relationships, wages, and working hours, supplemented by data from the German Federal Employment Agency, to examine wage responses to skill shortages with explicit consideration of part-time employment. To address the simultaneous determination of wages by both sides of the market, an instrumental variable (IV) strategy is implemented. Since no suitable existing data source was available for analyzing preferences for working conditions and their heterogeneity, the data for chapters 3 and 4 were collected via a self-conducted survey experiment. This approach enables a causal interpretation of the Random Effects (RE) estimates in chapter 3 and facilitates a heterogeneity analysis in chapter 4 using the relatively new Sorted Partial Effects (SPE) methodology, based on contextual variables gathered within the survey itself.

To conclude this introduction, the four studies that constitute the main body of this dissertation are briefly outlined.

Analyzing nurses' decisions to leave their profession–a duration analysis

In chapter 2, nurses' decisions to leave the profession are examined, focusing on the associations between exit propensity and factors such as personal characteristics, job attributes, recent labor market histories, and regional labor market conditions. This study utilizes data from the Sample of Integrated Labor Market Biographies 1975-2014 (SIAB 7514), a highly reliable source of German administrative data that captures the labor market biographies of a 2-percent sample of all individuals in jobs subject to social security contributions. This dataset is enriched with regional labor market characteristics. Survival analysis methods are applied to this daily spell data, enabling the estimation of the impacts of individual, firm, and regional characteristics on nurses' exit behavior while accounting for duration dependence. Specifically, a piecewise constant mixed proportional hazards model is used, which accounts for unobserved individual heterogeneity and provides a flexible framework for modeling the baseline hazard rate. Findings are presented from a single-risk model focused on leaving nursing regardless of the destination, as well as from a competing risks analysis that differentiates between target states: unemployment, employment in another occupation, and employment in another occupation within or outside the health and social sectors. The results indicate that younger nurses, lower-paid nurses, nurses in the social sector, and those employed by smaller organizations are more likely to leave the profession than their counterparts, regardless of their specific nursing roles or care settings. Nurses are more likely to exit the profession when there are more alternative occupational opportunities available, with the competing risks analysis suggesting that this is primarily driven by transitions to other occupations. Thanks to the comprehensive labor market biographies in this dataset, past labor market experiences of individuals prior to the study period can be incorporated. Nurses with a history of unemployment or prior employment in a different field exhibit a higher propensity to leave nursing, while those who have recently completed vocational training show only a moderate propensity to exit. Given that the nursing workforce is predominantly female, gender differences in exit behavior are also investigated. Both male and female nurses are less likely to leave when employed part-time, though this effect is notably stronger for female nurses. Among female nurses, part-time employment combined with parenthood further reduces the likelihood of leaving. The competing risks analysis reveals that the destination of nurses leaving the profession varies by regional labor market conditions, individual characteristics, wages, and, notably, prior labor market experiences. Additionally, two institutional changes within the German nursing sector are examined: the introduction of Diagnosis-Related Groups (DRGs) and the nursing minimum wage. No evidence is found that

either policy change significantly impacted the duration of nurses' careers. Understanding the factors associated with nurses' decisions to leave the profession can inform strategies aimed at improving nurse retention and attracting appropriate candidates to the field. Differentiating between exit routes provides further insights and can lead to more targeted policy implications. Chapter 2 concludes by discussing several potential implications derived from these findings.

The attractiveness of jobs in the German care sector: Results of a factorial survey

Where chapter 2 focuses on factors associated with nurses leaving the profession, chapter 3 examines the factors that can attract nurses to nursing positions. The study presented in this chapter utilizes data from a self-conducted survey targeting both active and former nurses within a specific region in Germany. The survey included a factorial survey experiment, an experimental approach particularly suited to assessing personal opinions and less susceptible to social desirability bias than traditional interview methods. Approximately 1,300 participants (both active and former nurses) were asked to rate a series of synthetic job postings, each containing information on nine systematically varied job characteristics. This experimental setup allows for a causal interpretation of the findings. The estimation results reveal that the attractiveness of nursing jobs is strongly influenced by "soft," subjective characteristics, such as team atmosphere and time allocated for patient care. In contrast, "hard," more objective factors, like the number of hours worked, exhibit smaller estimated effects. An exception among the objective factors is contract duration, which emerges as one of the most important job attributes–an especially notable finding given the pronounced skill shortages in nursing occupations. With wage levels also varied across the synthetic job offers, the required wage increase needed to compensate for less desirable job attributes can be estimated, providing a monetary value (willingness to pay) for each characteristic. The findings indicate that while wages do have a statistically significant effect on job attractiveness, substantial wage increases would be necessary to achieve the same level of attractiveness as the most highly rated soft factors or to compensate for less favorable characteristics related to these factors. As a final step, interaction effects are explored both between job characteristics and between job and individual characteristics. Although variations in the magnitude of effects are found, their direction is generally consistent across individual characteristics, job settings, and specific roles. Notably, positive interaction effects are observed between favorable job characteristics, with the strongest interactions occurring among the attributes yielding the largest main effects.

This study not only highlights which factors employers and policymakers could address to enhance the appeal of nursing jobs but also identifies promising combinations of job attributes that could have particularly strong effects on job attractiveness.

Heterogeneous effects of monetary and non-monetary job characteristics on job attractiveness in nursing

Chapter 4 links directly to the analysis of interaction effects in chapter 3, but goes far beyond it. In this study, a novel methodological approach described by Chernozhukov, Fernández-Val & Luo (2018) is applied to analyze preference heterogeneity regarding non-monetary job characteristics and trade-offs between wage and non-monetary job characteristics. This approach provides a more concise description of preference heterogeneity than traditional subgroup analysis. Using data from a self-conducted factorial survey experiment involving nurses, the study reveals significant heterogeneity in the effects of individual job characteristics and in the trade-offs between wage and non-monetary job characteristics, as well as factors associated with this effect heterogeneity. Working hours and gender emerge as primary drivers of these effects, with additional differences observed in the motivations that influence a nurse's initial decision to enter the profession. The study also identifies positive interaction effects between wage and other job characteristics, suggesting that individuals value combinations of high wages and favorable non-monetary characteristics more as the wage increases. However, the results also indicate that nearly all individuals in the study are willing to trade non-monetary job characteristics for higher wages if wage changes are substantial enough. These findings suggest that tailoring job characteristics to align with diverse preferences may be a more effective and efficient strategy for attracting workers than a "one size fits all" approach. Additionally, in the presence of heterogeneous preferences, job offers with specific characteristics can serve as a sorting mechanism to attract employees with desired qualities. In the context of nursing jobs, there is evidence supporting the effectiveness of such differentiation. The results further imply that higher wages can compensate for less desirable non-monetary job characteristics. However, this can be costly depending on the characteristic, the individual, and the available alternatives.

The reaction of wages to skill shortage in nursing

The potential positive role of wages in the labor supply of nurses has been addressed in every preceding chapter. Moreover, calls for wage increases have become a central theme in both public and scientific debates on strategies to boost the nursing labor supply. Chapter 5 presents a study that exploits regional and temporal differences to analyze whether wage adjustments in response to skilled labor shortages in nursing actually occur in Germany. The study focuses on variations across different healthcare institutions and employment conditions. Using data from the German Structure of Earnings Survey (GSES) and the German Federal Employment Agency, it examines the impact of demand for health and care services on nursing wages. Applying a fixed effects instrumental variables approach to address endogeneity concerns, the study finds that wages in privately owned institutions and among nurses not covered by collective agreements adjust in response to labor shortages, unlike in public institutions or among those under collective agreements. Additionally, wage responsiveness is observed among smaller employers but not larger ones. The study further reveals that wage responses primarily occur in long-term care facilities, with no significant adjustments in hospital settings, regardless of ownership, collective agreement status, or employer size. These differences in wage reactions partly align with economic theory and previous findings, corresponding to variations in market frictions and potential productivity differences. However, the specific institutional framework within Germany's health and care sector may also play a role. Overall, the absence of wage reactions to skill shortages across large parts of the nursing labor market highlights inefficiencies in wage formation within the nursing sector, especially when considered alongside the findings previously presented in this dissertation and the broader literature on the relationship between wages and nurse labor supply.

Chapter 2

Analyzing nurses' decisions to leave their profession–a duration analysis

2.1 Introduction

Many countries have been suffering from skilled labor shortages in nursing occupations for a couple of years now (Drennan & Ross 2019). In Germany, employers were not able to fill open health nurse positions within 173 days and geriatric nurse positions within 188 days on average in 2020 (Statistik der Bundesagentur für Arbeit 2020*b*). Several countries undertook measures to increase the nurse labor supply, such as a push for increased immigration of nurses, changes in nursing training or the implementation of new occupational profiles (Buchan et al. 2015, Marć et al. 2019). Germany, for example, introduced a nationwide action plan, the Concerted Action on Nursing (Konzertierte Aktion Pflege der Bundesregierung 2019). The shortage in nursing personnel has become a severe problem during the COVID-19 pandemic (Begerow et al. 2020). One strategy to increase the supply of nurses is to raise their retention rates. Yet, though several studies exist on factors associated with the nursing labor supply on different levels, literature on factors associated with nurses' decisions to leave their occupation–and therefore, guidance for corresponding policies–is relatively scarce (Drennan & Ross 2019).

This paper contributes to the literature on factors associated with nurses' decisions to leave their occupation. Though there exist previous analyses on factors influencing nurses' labor supply in general, as well as their intention and actual decision to leave nursing jobs or the

health care system, evidence on factors driving nurses' decision to leave the occupation entirely is scarce, focuses on specific leaving events, or relies on less rich and less precise data or relatively short time horizons. In this study, I use highly reliable and precise German administrative data, which contain labor market biographies of a 2-percent sample of all individuals in jobs subject to social security payments, augmented with data on regional characteristics. In my econometric analysis, I apply survival analysis methods to daily spell data, allowing me to estimate the impacts of individual, firm, and regional characteristics on nurses' exit behavior, while accounting for duration dependence. I pay special attention to factors that are subject to adjustments by employers and political players, such as wages. Other factors of special interest are those that help identify situations and groups associated with particularly high risks of exiting the occupation, such as characteristics of the regional labor market and nurses' prior labor market experience. Unlike previous studies, I can account for specific events in individuals' labor market biographies in my analysis, not just general work experience, and I find differences in the propensity to leave between individuals who enter immediately after vocational training, re-enter after the birth of a child, or have had periods of work or unemployment of different lengths in the recent past. I aim to provide evidence on where action is needed to keep nurses in their occupation. From a public policy standpoint, it may be problematic if nurses leave their occupation in general. It may, however, be more worrying if they leave for unemployment rather than for other work in the health and social sector. Therefore, I do not only apply single risk analysis but also competing risks analysis to study how different leaving events are associated with different personal, regional, and job characteristics. The results point to remarkable differences in the effects of individual, job, and regional characteristics, most prominently previous labor market experience, on the different leaving propensities. Last, I briefly look at two institutional changes associated with nursing that occurred during the first decade of the 21st century: the introduction of the system of diagnosis-related groups (DRGs) and the introduction of a minimum wage for nurses in Germany. Neither change appears to have significantly affected nurses' occupational durations.

The rest of the paper is structured as follows: In section 2.2, I summarize the relevant literature on nurses' decisions to supply labor, focusing on studies that analyze factors associated with the *intention* and the *actual decision* to leave a nursing job, the health sector or even the occupation. In section 2.3, I present the data. In section 2.4, I present the econometric methods used. Section 2.5 contains the results of univariate and multivariate survival analyses. Section 2.6 concludes.

2.2 Literature

The shortage of nurses in various countries has placed the nurses' labor supply on the international research agenda. Three strands of literature are particularly relevant for my analyses. One strand focuses on actual, former, and potential nurse *labor supply in general*. Two other strands focus on the *intention* and, alternatively, the *actual decision* of nurses to leave nursing or the health care system.[1]

The literature on the nurse *labor supply in general* focuses on the effects of wages on labor supply, yielding ambiguous findings. Shields (2004) and Antonazzo et al. (2003) provide overviews of earlier research in economics on nurse labor supply. Shields (2004) concludes that labor supply is rather unresponsive to wage changes, and deduces that non-pecuniary job aspects are of great importance. Di Tommaso et al. (2009) and Andreassen et al. (2017) reach similar conclusions in recent Norwegian studies, too. Furthermore, Andreassen et al. (2017) find differences in wage elasticity across job types and greater labor market mobility for younger nurses (and older nurses to some extent). Moreover, Di Tommaso et al. (2009) estimate varying labor supply elasticities across different parts of the health care system, suggesting possibilities for shifting labor within the system through wage adjustments (e.g., between different jobs and between daytime work and shift work). Antonazzo et al. (2003), on the contrary, conclude that the effect of one's own wages on labor supply is rather ambiguous, whereas a spouse's or household income and the presence of very young children negatively affect labor supply. Hanel et al. (2014) differentiate between shift types and occupations in their estimation model and account for labor supply decisions on intensive and extensive margins. They find significantly greater wage elasticity of labor supply for nursing degree holders in their Australian survey data than earlier studies that did not make that distinction (Hanel et al. 2014).

The *intention to leave one's employer* is associated with personal and job characteristics. Kankaanranta & Rissanen (2008) find associations among one's own wage and the share of income from shift work, the possibility for specialization, monotony of work, and excessive duties for a sample of Finnish registered nurses. Beecroft et al. (2008) analyze data on newly employed pediatric nurses in the US. They find that older respondents who did not get their

[1]With the exception of nurses' *intention to leave*, I focus on economic literature on nurses' labor supply. There also exists a body of literature from the point of view of nursing studies. Regarding the latter, Hayes et al. (2006) and Hayes et al. (2012) provide broad literature overviews on nurses' turnover.

ward choice, as well as respondents who worked in institutions with lower environmental and organizational characteristics scores (such as control over practice, opportunities for advancement, workplace ties, and relationships) and those who sought more social support were more likely to exhibit turnover intent.

The intention to leave an employer is also associated with job satisfaction. Kankaanranta & Rissanen (2008) establish this connection indirectly via structural modeling techniques. Shields & Ward (2001) focus on nurses' intentions to leave the British National Health Service (NHS) and explicitly take the association between job satisfaction and intent to leave into account. Analyzing data from a 1994 national survey of British NHS nurses, they find overall job satisfaction and satisfaction with different job aspects to be important determinants of the intention to quit working in the NHS. Satisfaction with promotion and training opportunities are of particular importance, whereas satisfaction with workload and pay are less important. They further find that younger nurses, better educated nurses, highly specialized nurses, and members of ethnic minorities want to quit the NHS more frequently.

Other than the formerly named studies, Parry (2008) and Simon et al. (2010) analyze the intention to leave the *profession* and the intention to leave one's *employer*, with one result being that factors partially differ between those two outcomes. For the German sample of the Nurses' Early Exit Study, Simon et al. (2010) find that age, burnout, professional commitment and job satisfaction are associated with both the intention to leave one's profession and employer. The intention to leave one's profession is further found to be associated with marital status, weekly working hours, and work–family conflict. Intention to leave an organization is further associated with organizational and local characteristics.[2] For newly graduated nurses in Australia, Parry (2008) finds a statistically significant relation between professional and organizational commitment and intent to leave the profession. Furthermore, she finds that the intention to change employers is statistically significantly related to job satisfaction, organizational commitment, and the intention to leave the occupation.

The *intention* to leave one's employer or profession may differ from the actual leaving decision. Using Kaplan-Meier estimation, Beecroft et al. (2008) find that the overwhelming majority of those having voiced turnover intention were still with their original employer after 24 months. Only a few studies focus on nurses' *actual leaving decisions*, some of which analyze the decision

[2]In an earlier study, Simon et al. (2005) presented analyses based on the German sample of the Nurses' Early Exit-Study of 2003.

to leave the public health care system. Holmås (2002) analyzes Norwegian public sector nurses' employment durations by employing a discrete time-proportional hazard framework. Controlling for the fact that wages may partly be a compensation for unfavorable working hours (shifts), he finds that wages and working conditions affect nurses' propensities to leave public sector nursing. Employing data from the UK's Quarterly Labour Force Survey, Frijters et al. (2007) analyze factors associated with nurses' NHS employment durations. Applying single-risk models and a competing-risks model, Frijters et al. (2007) find a significant but small wage effect on retention rates and conclude that nurses' working conditions (which are assumed to be less pleasant in the NHS than with other employers) are of greater importance regarding the decision to leave the NHS. Furthermore, they find that younger nurses, nurses with shorter duration of employment in the NHS, nurses in managerial positions, and nurses employed in smaller establishments show a higher propensity to leave the NHS.

Some studies analyze the decision to leave the profession. A part of this literature focuses on specific leaving events–such as early retirement (Friis et al. 2007, North et al. 2014), leaving within the first years of practice (Giver et al. 2011), or time to exit after training (Cunich & Whelan 2010)–or concern specific differentiations in leaving behavior (Daniels et al. 2012). Several studies analyze factors associated with nurses' actual exit from the profession on a broader basis. Doiron & Jones (2006) employ administrative data on registered nurses in New South Wales, and analyze which of the nurses registered in 1996 were still registered one year later. Doiron & Jones (2006) find that nurses working in larger hospitals, hospitals with larger nursing staff, and hospitals with higher expenditures are less likely to leave. Higher age, more experience, and more hours of work are associated with lower leaving probability, whereas being male is associated with a higher leaving probability (Doiron & Jones 2006). Employing data from a European one-year survey, Rongen et al. (2014) find that reduced work ability, being female, and young age are associated with higher probability of leaving the profession. Nooney et al. (2010) apply retrospective survival analysis, where data on professional history were collected as part of a survey from a cross-section of U.S. nurses. They find that nurses change careers more often if they have higher income, children at home, a higher nursing degree, or are female. Other than that, studies on nurses actually leaving their profession are scarce.[3]

[3]A handful of studies concern nurses' leaving behavior in Germany (Hasselhorn et al. 2003, Hall 2012, Behrens et al. 2007, Hackmann 2010, Wiethölter 2012). Those studies focus on analyzing the extent of nurses' exiting or the number of nurses still working in their training occupation after several years, apply basic descriptive analysis, and focus on distinct areas like federal states (an exception is Simon et al. (2010), who

This study adds to the literature on job and occupation duration in occupations strongly affected by skill shortages. I further contribute to the literature on nursing supply. My results are of interest, as multivariate analyses on factors associated with nurses exiting their occupation are especially rare. Those that exist are based on less rich or less precise data. They are of significance to policymakers and employers, as they yield important clues on possibilities to keep nurses in their occupation and provide relevant information for recruiting and rehiring processes. Finally, all existing studies either focus solely on nurses in health care or do not differentiate between nurses in health and nurses in geriatric care. To the best of my knowledge, I am the first to present separate analyses on factors associated with occupation duration for the different nursing occupations, specialized in health and geriatric care.

2.3 Data

I base my empirical analysis on the weakly anonymous Sample of Integrated Labor Market Biographies 1975-2014 (SIAB 7514), a large administrative data set from Germany.[4] This dataset is based on a 2-percent random sample drawn from the Integrated Employment Biographies (IEB). The IEB contain data on all individuals in Germany who either worked on an employment contract, which is subject to social security contributions (data from 1975 on), or worked under a marginal employment contract (data from 1999 on).[5] The IEB further contain data on all benefit recipients according to German Social Code III or II legislation (from 1975 and 2005 on, respectively), as well as data on officially registered job seekers and participants in programs of active labor market policies (from 2000 on). The dataset is provided by the Research Data Center of the German Federal Employment Agency (BA) at the Institute for Employment Research.

Data on individual employment episodes are provided by employers in the mandatory process of social security notifications. Data on episodes with other labor market statuses stem from the administrative processes of the BA and the agencies responsible for implementing German

studied factors associated with the intention to exit nursing; see above). The evidence is not entirely clear, though.

[4]The data were accessed onsite at the Research Data Centre of the Federal Employment Agency (BA) at the Institute for Employment Research and via remote data access at the Research Data Centre.

[5]Marginal employment is a form of tax-free employment in Germany. Over the time span of this analysis the maximum monthly earnings from a marginal employment rose from 325 to 400 euros IAB-Forum (2019).

Social Code II legislation. The data contain information on employment biographies and a set of individual characteristics as well as characteristics of employment and labor market status, such as an individual's occupation or the reason for the termination of a period of unemployment benefit reception. The administrative nature of the data collection process results in highly reliable information as far as the respective data are relevant when determining social security payments or the processes of the BA or other data-supplying agencies (e.g., wage and duration of an employment episode). Some variables of less importance to administrative purposes, such as education levels, are less reliable and may contain a considerable number of missing values. Overall, the SIAB 7514 contains over 50 million observations, representing over 1.7 million individuals. The SIAB captures information exact to the day. Information on civil servants, self-employed persons, and regular students is not part of the data. See Antoni et al. (2016) for detailed information on the SIAB data.

I combine the SIAB data with information on regional characteristics at the county level (Kreise). To account for the local labor market situation, local settlement patterns, and local age composition, I augment the data with information on characteristics such as the local unemployment rate, population density, and average age of the population. The respective data stem from BBSR (2019) and the Federal Statistical Office of Germany (Statistisches Bundesamt 2019). For data availability reasons, I employ data from these sources for the years 1998-2010. For employment episodes ending later than November 30, 2011, occupations are reported based on a new occupation classification (Klassifikation der Berufe 2010, KldB 2010). As it is not possible to transfer the old classification system into the new one with precision, I do not use episodes beginning after 2010. Data on relevant regional characteristics are only available as of 1998. Contrary to previous studies (e.g., Holmås 2002 or Frijters et al. 2007, which employed stock sampling), I employ a flow sample. This means that the sample comprises individuals who entered the analyzed state during a particular interval, which avoids oversampling of longer spells (Cameron & Trivedi 2005, pp. 625-628). The flow sample covers the years 1998-2009, with censoring at the end of 2010.

I undertook several steps of data preparation. To correct for missing or potentially misreported values in the administrative education variable, I employed the imputation procedure described in Fitzenberger et al. (2005). The SIAB contains information on employment episodes subject to social security contributions and marginal employment episodes. However, marginal employment is not documented in the data prior to April 1, 1999. To ensure consistency regarding the covered employment episodes without losing all observations older than April 1, 1999, I drop

all marginal employment spells from the data when defining occupational episodes. Because the East German health care system was organized differently from the West German one until 1990 and because the East German labor market for care workers was in a different state than the West German one in the mid-1990s, I focus on West German employment spells. I exclude vocational training spells from the data, as a large share of the geriatric nurses in Germany receive training in vocational schools rather than in establishments. Such training episodes are not part of the SIAB data. I am also interested in the leaving behavior of skilled employees in care occupations who supply labor in tight labor markets, and not in the supply and survival of apprentices. I only analyze spells of persons whose educational level is at least as high as vocational training. Persons over the age of 50 might leave their occupation because of early retirement or due to permanent health issues (a known problem in care occupations) more often than younger people. As my interest lies in nurses' early exits from their occupation, I exclude spells for persons older than 50 years from the data.

Other than survey data, the SIAB data are highly reliable because of their administrative nature. As a random sample drawn from the IEB, the SIAB as a whole is not prone to problems of sample selection or attrition. To my knowledge, no German dataset other than the SIAB covers such an extensive part of an individual's labor market biography with such precision. The information on the episodes of employment biographies, as well as their duration, have particularly high precision because of their administrative relevance. Therefore, the data are especially well suited for job and duration analysis, and have already been used by several authors for that purpose (Boockmann & Steffes 2010, Antoni & Jahn 2009, Giannelli et al. 2012, 2016).

2.4 Econometric methods

To analyze the interdependences among personal, regional, and firm characteristics, changes in macroeconomic and political surroundings, and occupation durations, I apply the piecewise constant mixed proportional hazards model (see e.g., Cameron & Trivedi 2005, pp. 591, 613-616). The probability of leaving work or an occupation is, among others, a function of time elapsed since taking up the occupation. Accounting for a time dimension in standard, e.g., linear or bivariate, regression models is especially problematic, as duration data are typically not normally distributed and often, as is the case here, contains right-censored observations.

Standard estimation techniques would lead to inefficient or even biased estimates in this case. Duration methods are especially suited in such cases as they account for time dependencies either in offering methods to abstract estimation from time elapsed or by directly modelling such relation. They further handle right-censored observations naturally (Jenkins 2005, pp. 8-10; Cleves et al. 2016, pp. 1-6).

For a piecewise constant mixed proportional hazards model, the conditional hazard rate $\lambda(x)$ takes the form

$$\lambda(\mathbf{x}) = \lambda_0(t, \alpha)\phi(\mathbf{x}, \beta)\nu,\ \nu > 0\,, \tag{2.1}$$

where the baseline hazard $\lambda_0(t, \alpha)$ is a step function with k steps, such that

$$\lambda_0(t, \alpha) = e^{\alpha_j},\ c_{j-1} \leq t < c_j,\ j = 1, ..., k \tag{2.2}$$

where $c_0 = 0$, $c_k = \infty$, and $c_1, ..., c_{k-1}$ are additional breakpoints. From breakpoint to breakpoint, the baseline hazard rate remains constant. Parameters α determine the magnitude of the respective baseline hazards and are estimated with the rest of the parameters from the data. Though I can account for a set of individual characteristics by incorporating them in my estimation model directly, an a priory unknown amount of unobserved or unobservable characteristics may influence the individual decision to leave. This can bias my estimation results even if such unobserved heterogeneity was uncorrelated with the regressors (Cameron & Trivedi 2005, pp. 611-612; Jenkins 2005, p. 81). I account for such heterogeneity by introducing a multiplicative heterogeneity term into my model. ν represents the unobserved heterogeneity. As is proposed by Abbring & van den Berg (2007), I assume that ν is gamma distributed with mean one and variance θ, which can be estimated from the data. The alternative approach, to assume ν follows an inverse Gaussian distribution, leads to similar estimation results (see table 2.1 and table 2.8 in the appendix).

To ensure flexibility as well as estimability of the model, I split analysis time into intervals of 28 days during the first year of an employment episode. After the first year, I split analysis time every 60 days. From the third year on, I split analysis time every 180 days. In this way, the model remains reasonably flexible without becoming too extensive. As failure events occur to a decreasing and more stable amount, the more time elapsed, it seems sensible to split at

shorter intervals at the beginning than later.[6]

The influence of the variables in my model on the risk of leaving care may differ with respect to different target states or different reasons for leaving the occupation. To account for this, I further differentiate between two kinds of models.

First, I analyze individuals leaving nursing occupations regardless of what they do after leaving using single-risk duration models. The dependent variable I analyze is occupation duration, which is the time that elapses after a person enters an occupation until she either leaves it or until her spell is censored due to lack of further information. In my analysis, an individual enters an occupation (becomes "at risk") by taking up employment in a new job and a new occupation. I count reentry into a previously held occupation as new occupation if the gap between the last and the present employment in that occupation amounts to 90 days or more.[7] Conversely, an individual leaves the risk set if she leaves an occupation for more than 90 days (after this period, she could become at risk anew). An individual leaves her occupation (the failure event) if she leaves the risk set and the last episode in the risk set contains one of the following employer notifications: end of employment, break of employment following reception of compensation benefits, or break of employment because of parental leave. Spells are censored if an individual leaves the risk set without exhibiting a failure. The maximum length of an episode is 1,825 days, meaning that longer episodes are censored after 1,825 days. After December 31, 2010, all remaining spells are censored.[8]

In a second set of models, I employ a competing risks framework. Here, the conditional hazard rate becomes

$$\lambda_j(\mathbf{x}) = \lambda_{0j}(t, \alpha)\phi(\mathbf{x}, \beta)\nu_j, \tag{2.3}$$

and is now specific to hazard of type j. The different types of hazard I consider here are transition into unemployment, transition into employment in a different occupation, and finer-grained employment in another occupation in or outside the domain of health and social occupations. This is motivated by the fact that for health policy as well as for the welfare

[6] Antoni & Jahn (2009), Giannelli et al. (2012, 2016) take a similar approach. The decreasing trend in failure events becomes apparent in figure 2.1.

[7] A threshold of 90 days is a common choice for gap-length or reentry limit in studies that concern the German labor market and employ data on a daily basis (e.g., Boockmann & Steffes 2010, Giannelli et al. 2016).

[8] A brief overview of the relevant definitions is given in table 2.3 in the appendix.

state, it is not only interesting to know what generally drives nurses out of their occupation, but also what drives them to these different target states. Also, analyses of leaving behavior with respect to different target states provide hints regarding the mechanisms that drive leaving behavior and the respective routes. I assume that hazards from the different types of risks are uncorrelated (independent risks assumption). Though it is not unrealistic that certain factors might influence leaving behavior into the different target states, and that these factors may be correlated, I minimize the influence of those uncontrolled dependencies by using an extensive number of variables covering possible differences among individuals at the firm and county levels. One specific source of concern may be individual preferences. Individual preferences for work may increase the tendency to leave for another type of employment and decrease the tendency to leave for unemployment. The tendency to leave for an occupation outside the health care and social domain may be associated with preferences for occupational mobility in the same way. To cope with such differences in individual preferences, I account for individuals' number of prior occupation episodes as well as labor market experience in the six years prior to the present employment episode, and include whether an individual worked outside the care industry or has been unemployed. I estimate the competing risks framework by estimating separate models for each kind of risk (Cameron & Trivedi 2005, pp. 640-647).

To differentiate between different starting conditions over individuals, I account for the labor market biography of an individual up to six years prior to entering their occupation under analysis. I differentiate between those who have gathered no experience in care in the last six years, those who have been employed in a care occupation up to 3 years, and those who have been employed in care occupations for 3-6 years. For all of those, I further differentiate individuals according to whether they had been unemployed during the last six years or whether they had been employed in a non-care occupation during that time.

I include several individual-level, firm-level, and county-level characteristics in the proportional hazard models. On the individual level, I include demographic characteristics (age group, sex, level of education, and German or non-German nationality) and occupational characteristics (occupation, part-time or full-time employment, daily wages, and the individual's previous labor market biography). On the firm level, I include firm size groups measured via the number of employees; location of the firm by federal state; and a categorical variable indicating whether the firm is a hospital, a nursing home, operates in the rest of the healthcare sector, or the rest of the social sector. On the county level, I employ demographic information (population density), as well as economic information (unemployment rate). Table 2.5 in the appendix

summarizes the variables and their definitions.

2.5 Results

Univariate analysis

Figure 2.1 contains Kaplan-Meier survival functions, which offer a descriptive overview of the occupation durations for examined health nurses (Health N.), geriatric nurses (Geriatric N.), health nursing assistants (Health Assist. N.), and all other occupations (Other occ.). Among all groups, individuals leave their occupation more often at the beginning of a new occupation episode, with especially high numbers leaving at the end of the first and the second year. The groups clearly differ in the number of individuals leaving their occupation. Health nursing assistants leave the fastest and are the only nursing occupation to leave faster than the group of all other occupations. Geriatric nurses leave their occupation almost as often as the group of all other occupations, and examined health nurses leave their occupation the least often. Overall, nurses do not seem to leave faster than the average compared to all other occupations.

Multivariate analysis

Figure 2.1 hints at the leaving behavior of the different nursing occupations and their leaving behavior compared to that of individuals working in other occupations. In the following, I further separate factors associated with a higher or lower tendency to leave one's occupation for individuals in nursing occupations, using proportional hazards models. Column (1) of table 2.1 displays estimation results for a piecewise constant mixed proportional hazards model. Table 2.7 in the appendix shows results for a Cox proportional hazards model. The models refer to examined hospital nurses, geriatric nurses, and hospital nursing assistants. I further differentiate the estimations with regard to the different occupations (see table 2.9 in the appendix).

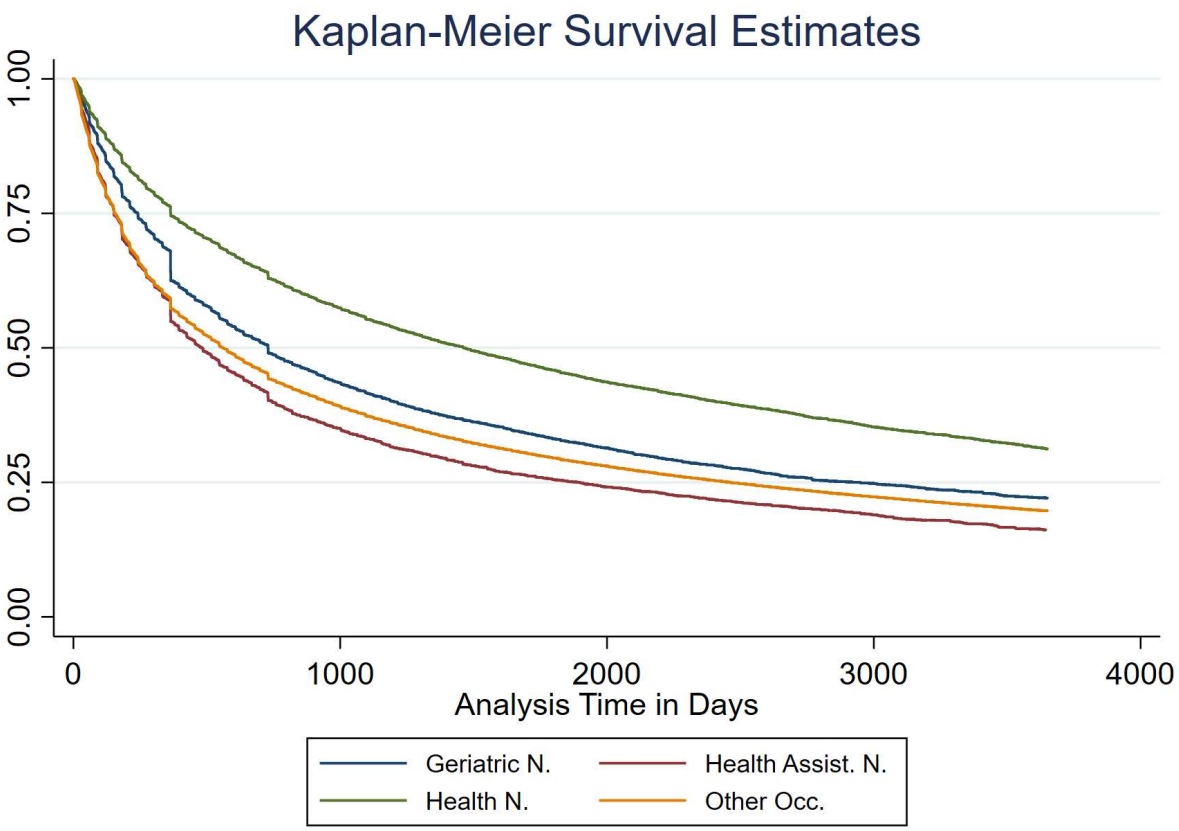


Figure 2.1 – Kaplan-Meier estimates by occupations

Annotations: Abbreviations and their meaning: Geriatric N. = geriatric nurses, Health Assist. N. = health nursing assistants, Health N. = examined health nurses, Other occ. = all other occupations.

Source: Own figure based on data of the SIAB 7514.

Basic individual characteristics

Most of the estimated coefficients are comparable in direction and size among the separate models, meaning they are relatively robust to changes in estimation approach.

The results for the time pieces which account for the time elapsed since an individual (re)entered a care occupation (reported in table 2.6 and figure 2.5 in the appendix) exhibit a decreasing pattern until half a year after entry, a point in time which is covered by the time piece of 168 to 196 days. Afterwards, the baseline hazard stays relatively constant. The time pieces including half a year, a year, and two years' time since entry deviate from this pattern, at these points leaving is especially likely.[9] The latter finding shows that nurses often leave after fixed intervals. This may be because employment contracts in Germany can often be terminated only at fixed times, such as the end of a quarter. The decreasing hazard over time and the fact that the hazard also decreases with age is in line with job search literature and a large amount of empirical literature on job changes. Namely, younger nurses and nurses who just (re)entered the occupation leave it more often (Jovanovic 1979, Burdett 1978; see Farber 1999 for a relevant overview). These results show that younger nurses and nurses who just (re)entered care should receive special attention in policies aimed at longer occupation duration of nurses, especially at the end of the first half and full year as well as the second year in the occupation. I find no statistically significant association between non-German nationality and leaving behavior.

Child rearing and work arrangements

A vast majority of workers in care occupations are female (see, e.g., Drennan & Ross 2019; the numbers in table 2.5–approximately 82 percent–are close to those Bogai 2017 reports for Germany). As women usually bear the lion's share of care work for children within their families,[10] the question arises whether having children increases women's tendencies to leave the occupation or whether they can combine care occupation employment and child rearing. Part-time work arrangements can be one way to do so. My data does not contain direct

[9] This evolution over time is preserved if the baseline hazard is approximated via a quadratic polynomial with dummies for the time intervals covering half a year, one year, and two years after nurses (re)entered the occupation. Respective results are given in table 2.11 in the appendix.

[10] Regarding Europe, see Eurofound 2017.

information on whether individuals have children. However, Müller & Strauch (2017) show a way to identify childbirth events for female workers in the SIAB data. Regarding women who receive social security benefits or who are seeking a job, they identify childbirth via the respective deregistration reports of "maternity benefit" or "maternity leave" in the data. Regarding employed women, they identify childbirth if women below age 40 (38 for the first child) exhibit an employment interruption "because of entitlement to other compensation," for which the interruption has to last for at least 98 days (the duration of maternity leave), as that same interruption notification can also indicate long-term sickness. I use their approach to identify mothers and the age of their children in my data.

In line with Doiron & Jones (2006), Nooney et al. (2010), and Rongen et al. (2014), I find women leave nursing less often than men do (see column (1) of table 2.10 in the appendix). When I further account for whether women and men work part-time or full-time, I find men and women leave less often when employed part-time (see column (1) of table 2.1). The effect is stronger for women, however. I further differentiate according to whether women have children younger than 14. With 53 percent, the decrease in the hazard rate for women with children is more than two times as large as the effect for women without children (see table 2.10 in the appendix). Therefore, part-time work seems to be a strategy female nurses use to align professional work and care work within their families. Providing more part-time positions may be a solution to keep more female nurses in the occupation. Female nurses may stay longer in a care profession if employed part-time, even if they do not have children, because of further unpaid care work within the family (e.g., for the elderly) or other reasons that I cannot identify (e.g., cultural values or health issues).

	Single risk estimation		Competing risks estimation Target states							
	(1) Single risk		(2) Unemployment		(3) Other occupation		(4) Health & social occupation		(5) Non-health & social occupation	
	Hazard ratio	z-value	Hazard ratio	z-value	Hazard ratio	z-value	Hazard ratio	z-value	Hazard ratio	z-value
Individual-level characteristics										
Wage										
(ref. 1st quartile)										
2nd quartile	0.63***	-20.72	0.60***	-14.23	0.71***	-7.47	1.02	0.33	0.44***	-11.38
3rd quartile	0.37***	-31.62	0.33***	-20.47	0.45***	-12.46	0.69***	-4.50	0.24***	-13.06
4th quartile	0.37***	-22.52	0.34***	-14.26	0.44***	-8.96	0.71***	-3.06	0.21***	-9.34
Age (ref. 18-30)										
31-40	0.73***	-12.93	0.85***	-3.99	0.67***	-7.92	0.73***	-4.65	0.61***	-6.38
41-50	0.60***	-18.71	0.78***	-5.81	0.62***	-8.80	0.65***	-6.04	0.59***	-6.18
German citizen	0.97	-0.84	0.90*	-1.68	1.33***	3.07	1.35**	2.46	1.29*	1.82
Sex and volume of work										
(ref. Male, full time)										
Male, part time	0.88**	-2.69	0.88*	-1.79	0.81**	-2.14	0.87	-1.20	0.68***	-2.93
Female, full time	1.05	1.58	0.92*	-1.67	1.01	0.18	1.31***	3.36	0.71***	-3.70
Female, part time	0.67***	-11.50	0.59***	-9.77	0.66***	-6.17	0.80**	-2.42	0.51***	-6.67
Occupation										
(ref. Geriatric nurse)										
Health nurse	0.86*	-1.64	0.85	-1.09	0.89	-0.66	0.83	-0.79	0.99	-0.02
Health nurse assist.	1.50***	4.65	1.60***	3.50	1.68***	3.03	1.57**	2.04	1.79**	2.15
Firm-level characteristics										
Institution										
(ref. Hospital)										
Nursing homes	1.28***	6.97	1.49***	6.58	2.11***	9.75	2.71***	9.51	1.51***	3.68
Health sector, rest	1.11***	2.33	1.25***	2.88	1.53***	4.40	1.72***	4.06	1.34**	2.06
Social sector, rest	1.22***	5.55	1.46***	6.16	1.77***	7.25	2.25***	7.50	1.32**	2.37
Firm size										
(ref. 20 employees)										
20-199	0.82***	-6.80	0.87***	-2.91	0.69***	-6.66	0.60***	-7.60	0.88	-1.32
Over 199	0.71***	-8.58	0.67***	-6.21	0.53***	-8.05	0.38***	-9.27	0.84	-1.46
Regional characteristics										
Population density	1.01***	7.89	1.00**	2.10	1.01***	6.16	1.01***	4.17	1.02***	4.59
Unemployment rate	0.98***	-3.27	1.01	1.50	0.97***	-2.68	0.98*	-1.65	0.96**	-2.28
Labor market biography										
Experience in previous 6 years (ref. 3-6 years in care)										
Vocational training	0.84***	-3.47	0.96	-0.47	1.07	0.68	1.12	0.86	1.09	0.50

No care experience and											
other exp.	unemp.										
no	no	1.08	1.19	1.61***	4.15	1.42**	2.67	1.23	1.23	1.86***	3.04
yes	no	1.15***	3.68	1.69***	7.62	1.36***	3.78	1.07	0.68	1.94***	5.21
no	yes	1.27***	3.64	2.45***	8.96	1.23	1.50	1.13	0.69	1.48*	1.76
yes	yes	1.29***	6.79	2.60***	14.76	1.27***	3.01	0.95	-0.47	1.95***	5.30
Up to 3 years of experience in care and											
other exp.	unemp.										
no	no	0.99	-0.28	1.16*	1.91	1.30***	3.08	1.14	1.18	1.63***	3.63
yes	no	1.19***	4.09	1.52***	5.41	1.52***	4.95	1.20*	1.62	2.19***	5.92
no	yes	1.32***	6.06	2.36***	11.35	1.28***	2.57	1.30**	2.23	1.28	1.42
yes	yes	1.24***	5.54	2.23***	11.89	1.23***	2.52	1.15	1.38	1.48***	2.87
3 to 6 years of experience in care and											
other exp.	unemp.										
yes	no	1.09	1.62	1.39***	3.40	1.31***	2.60	1.21	1.43	1.57***	2.65
no	yes	1.33***	5.65	2.06***	8.63	1.49***	3.99	1.46***	3.18	1.46**	2.06
yes	yes	1.38***	5.14	2.22***	8.01	1.38***	2.61	1.21	1.21	1.82***	2.96
Employment episodes (ref. 1)											
2		1.04	1.17	0.98	-0.34	1.06	0.89	1.09	1.09	1.00	0.02
3		0.99	-0.22	1.00	0.04	1.10	1.45	1.10	1.02	1.11	0.99
4		1.07*	1.82	1.06	0.94	1.27***	3.09	1.25**	2.23	1.27**	2.09
5		1.18***	3.75	1.29***	3.67	1.28***	2.73	1.24*	1.81	1.32**	1.99
6		1.50***	7.60	1.59***	5.73	1.81***	5.78	2.02***	5.35	1.49**	2.41
7 and more		1.66***	10.11	1.75***	7.50	1.80***	6.03	1.59***	3.56	2.17***	5.34
					Further controls						
Year		X		X		X		X		X	
Federal states		X		X		X		X		X	
Time pieces		X		X		X		X		X	
Constant		0.00***	-57.42	0.00***	-43.46	0.00***	-36.67	0.00***	-30.96	0.00***	-24.77
Theta		0.21		0.47		0.55		0.76		1.00	
Subjects		18,325		18,325		18,325		18,325		18,325	

Table 2.1 – Results from piecewise constant mixed proportional hazards estimation of occupation duration

Annotations: */**/*** = significant at the 10/5/1% level. Abbreviations for experience during previous 6 years: "other exp." = employment in other occupation during the last six years; and "unemp." = unemployed at some point during the last six years.

Source: Own calculations based on data of the SIAB 7514, BBSR (2019), and Statistisches Bundesamt (2019).

Job characteristics

Further, I find clear associations between several job factors and occupation duration. Nurses employed in the health sector leave their occupation less often than nurses employed in nursing homes or the rest of the social sector do. Nurses employed in hospitals leave their occupation

least often. Moreover, even after controlling for sectors, nurses who work with a larger employer (e.g., large hospitals, such as university hospitals) leave their occupation less often than nurses who work with smaller employers (e.g., small county hospitals) do. The association between an institution's size and leaving hazard exhibits different patterns across countries. For example, Holmås (2002) finds hazard rates increase for larger institutions, such as university hospitals, in Norway, while Frijters et al. (2007) and Doiron & Jones (2006) find the reversed effect for NHS nurses in the UK and nurses in Australia, respectively. The finding that nurses leave slower when their employer is larger is in line with what has previously been found for the job duration in the overall German labor market (Boockmann & Steffes 2010, Giannelli et al. 2012, Giannelli et al. 2016; examining work in temporary help agencies, only: Antoni & Jahn 2009). Explanations for this pattern could be sorting processes, where more motivated nurses sort into larger, and perhaps more specialized institutions, such as university hospitals, or in organizational features of larger institutions, which may offer more career options within the nursing occupation.

I also find a significant negative effect of daily wages on the propensity to leave nursing. Wages enter my model in the form of the four wage quartiles. Higher daily wages associate with a strong decrease in the probability of leaving nursing. The effect increases for the first, second, and third quartiles. However, the hazard ratio for the third wage quartile is the same as the one for the fourth quartile. Wage raises, therefore, may be an effective way to increase nurses' retention rates. The effect of higher wages seems to wear off at some point, however.[11]

Outside options

Furthermore, the availability of alternative job or occupational options on the regional labor market seems to drive the leaving decision. I approximate those options via local population density and unemployment. Nurses in more densely populated areas or in areas where unemployment is lower leave their occupation more often; employees should have more alternative options in flourishing labor markets in densely populated regions (Jovanovic 1979).

[11] As my data do not contain information on the exact number of hours worked and full- as well as part-time employees enter my estimation, the estimated wage effect may be confounded, in part, by different amounts of hours worked in a part-time contract. However, if I only consider full-time contracts (not reported), the results for the wage effect hardly differ.

Labor market biographies

Leaving behavior also differs with labor market biographies. Differentiating groups of nurses according to their prior labor market biographies, their experience in and out of care, and unemployment during the six years before they entered their present occupation episode in care, I find striking differences. I give the estimates for groups of care personnel with different experience among the other estimation results in the tables. However, for a handier representation of the respective estimates, figure 2.2 provides graphical representations of the coefficient estimates and the respective 95 percent confidence intervals. I differentiate the groups along three dimensions: (1) whether a person has been unemployed during the last 6 years (yes or no); (2) whether she worked in a non-care occupation during the last six years (yes or no); and (3) how long an individual worked in a care occupation in the prior six years (no exp. = not at all; some exp. = until 3 years; and more exp. = between 3 and 6 years). Table 2.4 in the appendix gives a detailed definition of the respective groups. The figure shows, first, care personnel leave their occupation more often if they had been employed with a non-care occupation in the six years before they entered their present occupation . Second, the same holds true for those nurses who were previously unemployed. Last, nurses who entered their present occupation episode directly after occupational training leave the least often. Regarding the amount of experience a nurse gained in care occupations during the six years prior to the present episode, I find no apparent effect on occupation duration. A nurse's occupation duration, therefore, is not associated with prior experience in nursing. Either nurses do not accumulate significant human capital *in the occupation*, meaning human capital accumulation predominantly happens during nurses' occupational training, or the human capital nurses accumulate while working in nursing is rather job-specific than occupation-specific.

To account for an individual's overall tendency to switch occupations, I incorporate into the estimation model the number of prior occupation episodes a person exhibited before becoming at risk. In line with previous literature, I find the higher the number of prior occupation episodes, the higher the tendency to leave the present occupation. Therefore, the number of prior episodes indeed differentiates between those more inclined and those less inclined to switch–a measure of the respective heterogeneity, which (Farber 1999, pp. 2466-2468) also discussed and Farber (1994) employed. Further, the number of prior episodes has recently been shown to be a signal for different work attitudes (Cohn et al. 2021).

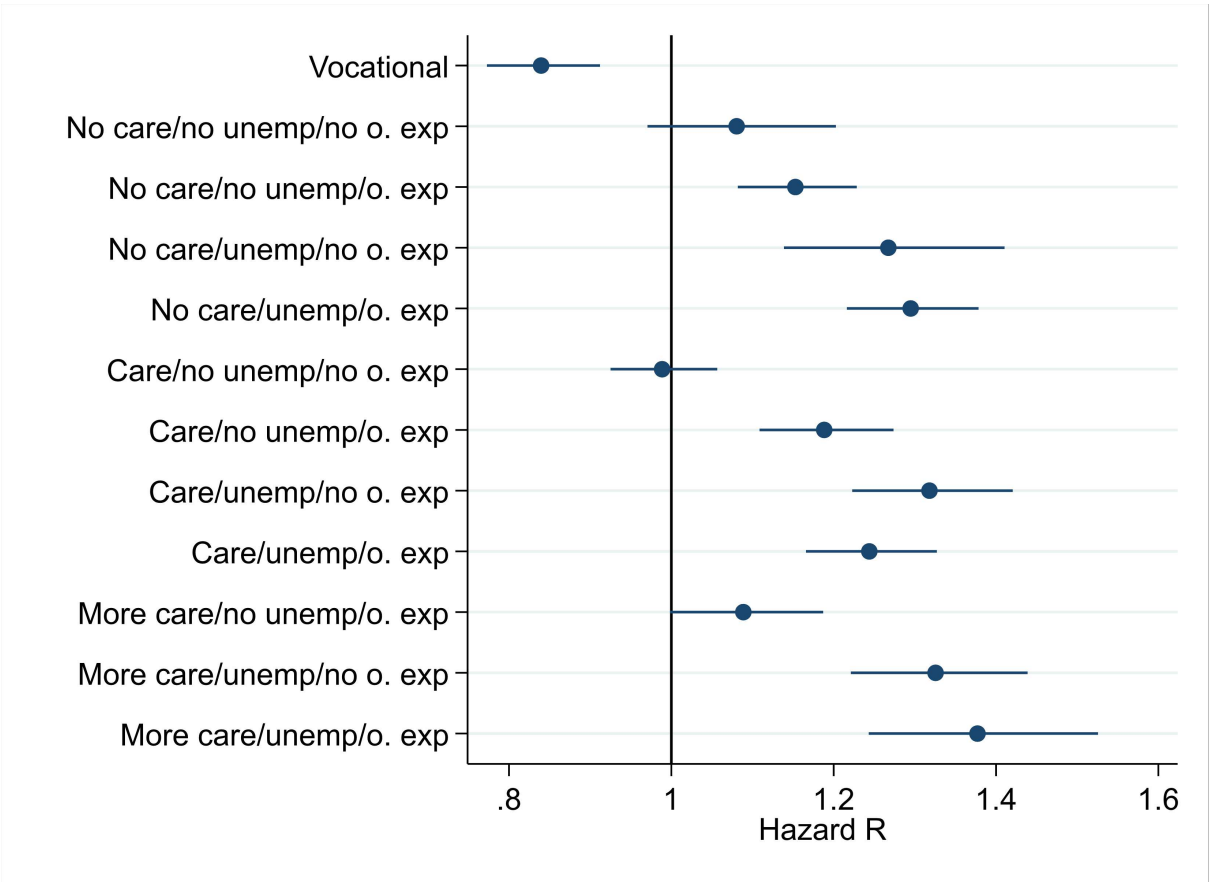


Figure 2.2 – Estimates for groups with different experiences before entry

Annotations: Dots indicate point estimates converted into hazard ratios, and blue lines indicate the 90 percent confidence interval around the point estimate. A group's labor market experience is indicated by whether they had experience in care during the previous six years (no care: no care experience; care: up to three years of experience; and more care: three to six years of experience during the past six years), whether they have been unemployed in the previous six years (no unemp: no unemployment, unemp: unemployed at some point during the last six years) and whether they have been employed in another occupation during the previous six years (no o. exp: no employment in other occupation; o. exp: employment in other occupation during the last six years). Those who just entered out of vocational training build the group vocational. Base category is no prior unemployment, no experience in another occupation and three to six years of experience in care during the last six years.

Source: Own figure based on data of the SIAB 7514.

Competing risks

From the viewpoint of health policy and the welfare state, it is not only interesting to know what drives nurses out of their occupation but also what drives them into different target states. Nurses leaving into unemployment are a larger issue for the welfare state than those leaving for another occupation. Nurses leaving for another occupation in the health and social domain may seem less problematic than those who leave for a completely different occupation. In addition, analyses of leaving behavior, with respect to different target states, provide hints regarding the mechanisms that drive leaving behavior and the respective routes. Therefore, I differentiate the association between labor market biographies and leaving behavior over different target states-unemployment, employment in another occupation, employment in an occupation in the spectrum of health and social occupations, and employment in an occupation outside the spectrum of health and social occupations. Columns (2) to (5) of table 2.1 display results of competing risks estimations regarding the respective target states. Regarding the target state of unemployment, previous unemployment experience is a powerful indicator of an exit into unemployment. However, previous experience in other occupations also has a positive effect on the tendency to become unemployed, though not as large as the effect of previous unemployment. More experience in care diminishes the hazard of leaving into unemployment. Regarding the tendency to leave for another occupation, I find a positive association between previous experience in another occupation and the hazard of leaving. However, I also find a positive association between previous unemployment experience and the hazard rate.

There are also differences regarding other explanatory variables with regard to the respective target states. Nurses of German nationality have a lower propensity to leave for unemployment. Germans leave more often for other occupations, in general, and for other health or social occupations, in particular, than their non-German peers do. Wage is relevant in all leaving scenarios and the sizes of the effects of earning wages in one of the wage quartiles are comparable to the single risks estimation results for the target states of unemployment and employment in any other occupation. Differences show, however, in statistical significance and effect size regarding the propensity to leave to another occupation in the health and social sector or to an occupation outside this occupational sector. The tendency to leave to an occupation outside the health and social domain decreases considerably stronger with rising wages than the tendency to leave to an occupation inside the health and social sector. What is more, small differences in wages have a significant effect in the former case but not in the

latter. Wage increases, even smaller ones, may therefore be a way to keep nurses from leaving the health and social occupations altogether, even if larger wage increases would be needed to keep them from leaving to another occupation in the health and social domain.

I find two other striking patterns regarding different associations of local characteristics and leaving behavior differentiated by target states. As noted, nurses leave their occupation less often in counties where unemployment is higher. The picture becomes more nuanced when I differentiate between target states. On the one hand, I do not find a significant effect of the local unemployment rate on leaving into unemployment. On the other hand, where the unemployment rate is higher, nurses are less likely to leave for another occupation. This is sensible because other occupational options are scarcer where the local unemployment rate is higher. Therefore, nurses have worse chances to find employment in another occupation if they want to leave nursing. The other pattern, in which nurses leave for other occupations more often where population densities are higher, is also sensible. The more numerous and better the alternative occupational options, the higher the population density, and the higher the probability that a nurse takes one of those options. Overall, the competing risk analyses support the argument that nurses leave more often in areas where the unemployment rate is lower or the population density is higher, due to more abundant occupational alternatives. However, this means that care work would have to become more attractive relative to other employment to keep nurses from leaving for other occupations in counties where they have the possibility.

Heterogeneity among different care occupations

Care personnel in Germany, other than in other countries, have long been divided into different groups according to their main area of action and their level of occupational training. Geriatric nurses mainly work with elderly people, and hospital nurses mainly work in caring for the ill. Further, geriatric and hospital nurses may have the occupational education to work as a registered geriatric or hospital nurse or as a geriatric or hospital nursing assistant. This separation along areas of care and level of occupational education is grounded in the history and education system of care in Germany (Bogai 2017, pp. 23-44).

In my main model, I introduce an indicator variable for the different occupations I can differentiate in the data: one group is registered hospital nurses; another group is made up from

hospital nursing assistants; and the last group comprises registered geriatric nurses and geriatric nursing assistants, as I cannot differentiate between these two groups in my data. In line with the results of the Kaplan–Meier estimation, hospital nursing assistants leave their occupation significantly more often than nurses in the other occupations do, even after controlling for other factors. This seems at odds with Frijters et al. (2007), who find registered nurses and nurses in higher positions leave (in their case, the NHS) more often. On the one hand, this could be based on the different leave events with which Frijters et al. (2007) deal (leaving NHS rather than leaving the occupation) or the different organization of the German occupational system, for which registered nurses need to complete a three-year training and nursing assistants a one-year training. Therefore, registered nurses accumulate a significantly higher amount of occupation-specific human capital–which also indicates considerably higher wages (Bogai et al. 2015)–and which may leave them less inclined to leave their occupation. This is also sensible, as hospital nursing assistants are more inclined to leave nursing for an occupation outside the health and social domain than registered hospital nurses are, as can be seen in table 2.2 and column (5) of table 2.1. Further, registered hospital nurses leave nursing more often than geriatric nurses do. The effect is less clear, however. Differences in the tendency to leave between geriatric nurses and hospital nurses, as I found in the Kaplan-Meier estimation, are explained, at least in part, by other factors in my multivariate model. Notably, I get a much stronger effect for registered hospital nurses when excluding the sector variable from the model (not reported). This indicates that a reason for the lower propensity of registered health nurses to leave their occupation is that they would rather work in the health sector than in the social or any other sector, whereas geriatric nurses work in the social sector more often. The reason for the higher propensity for geriatric nurses to leave their occupation that I find in the Kaplan-Meier estimation, therefore, is partly explained by the sector in which they work, rather than in their respective occupation.

To examine potential differences in leaving behavior between the different groups of nurses, I further estimate a separate model for geriatric nurses (registered and assistants), one for registered hospital nurses, and one for hospital nursing assistants. The results are given in table 2.9 in the appendix. The results do not point to remarkable differences between the factors associated with geriatric or hospital nurses' leaving decisions. However, I find differences with regard to the occupational status nurses exhibit after leaving their occupation. Most of the nurses, for which I can define clear post-leaving states, leave into unemployment, another health occupation, or another occupation outside the health sector, where it is noticeable that

examined hospital nurses end up unemployed to a lower amount and employed in another health occupation to a higher amount than individuals from the other nursing occupations are. This may be because of the relatively higher overall education level of examined hospital nurses and better possibilities to transfer their human capital from hospital nursing to other health occupations. Table 2.2 reports the target states of nurses who left the occupation.

	Geriatric nurse	Registered hospital nurse	Hospital assistant nurse	All nursing occupations
Unemployed	28%	15%	28%	23%
Vocational training	2%	1%	3%	2%
Last episode	9%	14%	8%	11%
Employment subject to social security contributions				
Outside health occupations	10%	7%	11%	9%
In health occupation	27%	28%	23%	26%
Marginal employment				
Outside health occupations	3%	1%	4%	3%
In health occupation	5%	7%	6%	6%
Other, not defined	15%	28%	16%	20%
N	5,357	6,239	3,626	15,222

Table 2.2 – Occupational status up to 1 year after leaving the occupation

Source: Own calculations based on data of the SIAB 7514.

Changes in occupation-specific regulations

During the analyzed period, at least two relevant institutional changes occurred, which could have had an influence on nurses' occupation durations. For one thing, the introduction of diagnosis-related groups (DRG) in the reimbursement system of hospital services in Germany. In addition, Germany introduced a nursing minimum wage. The new reimbursement system was first introduced on a voluntary basis in 2003 and became mandatory in 2004. The system brought a new regulation for the reimbursement of hospital services based on diagnosis-based rates. Since its introduction, the German DRG system has been suspected to worsen working conditions among hospital personnel by way of an "economization" of hospital care, thereby fostering nurses' departures from the occupation (Braun et al. 2010, Braun et al. 2011; based

on studies regarding the introduction of the DRG system in the United States: Quasdorf 2010). The DRG system only deals with the reimbursement of hospital services. Hence, if the new DRG system actually raised the number of nurses leaving care, only nurses employed in hospitals should been affected. Therefore, the number of nurses leaving hospital nursing should have increased relative to the number of nurses leaving nursing outside a hospital framework after the DRG introduction. Figure 2.3 shows the number of health nurses and health nurse auxiliaries departing from care in a hospital framework relative to all nurses employed in hospitals (dashed black line), as well as the number of nurses leaving nursing who are employed in outpatient care (solid grey line) on a yearly basis. With few exceptions, the two lines move simultaneously over the relevant time interval–nothing hints at an increased leaving hazard for nurses in hospitals. This stays true in a multivariate context.[12] This could be a challenge to the thesis that nurses' working conditions in the hospital context worsened after introducing the DRG system in Germany. Otherwise, it could be the case that the working conditions did not worsen enough to drive a significant number of nurses out of the hospitals.

I find a similar result regarding the introduction of the nursing minimum wage. Figure 2.4 shows the number of geriatric nurses (solid black line), registered health nurses (solid grey line), and health nurse auxiliaries (dashed grey line) leaving their occupations relative to all nurses in the respective group on a semiannual basis. As assistant nurses receive the lowest pay, those should be the group most affected by the October 2010 introduction of the minimum wage. However, health nurse auxiliaries do not show a distinct downward trend in the relative number of individuals who left the profession. Therefore, introducing the minimum wage did not seem to have an immediate influence on nurses' leaving behavior.[13] At first sight, this seems at odds with economic theory and the results I present for the association between wage and nurses' occupation durations (i.e., higher wages are associated with longer occupation duration). However, this result is in line with previous results (Harsch & Verbeek 2012). It seems likely that the introduction of the minimum wage affected only a small share of nurses

[12]This conclusion does not change if, instead of studying the share of leavers, I analyze the predicted yearly hazard ratios, i.e., the "year effects" on leaving propensity, for the two groups after estimating a piecewise constant mixed proportional hazards model containing the same explanatory variables as model (1) reported in table 2.1. Figure 2.6 in the appendix depicts the respective predicted hazard ratios.

[13]This conclusion does not change if, instead of studying the share of leavers, I analyze the predicted semiannual hazard ratios, i.e., the "half-year effects" on leaving propensity, for the three groups after estimating a piecewise constant mixed proportional hazards model containing the same explanatory variables as model (1) reported in table 2.1. Figure 2.7 in the appendix depicts the respective predicted hazard ratios.

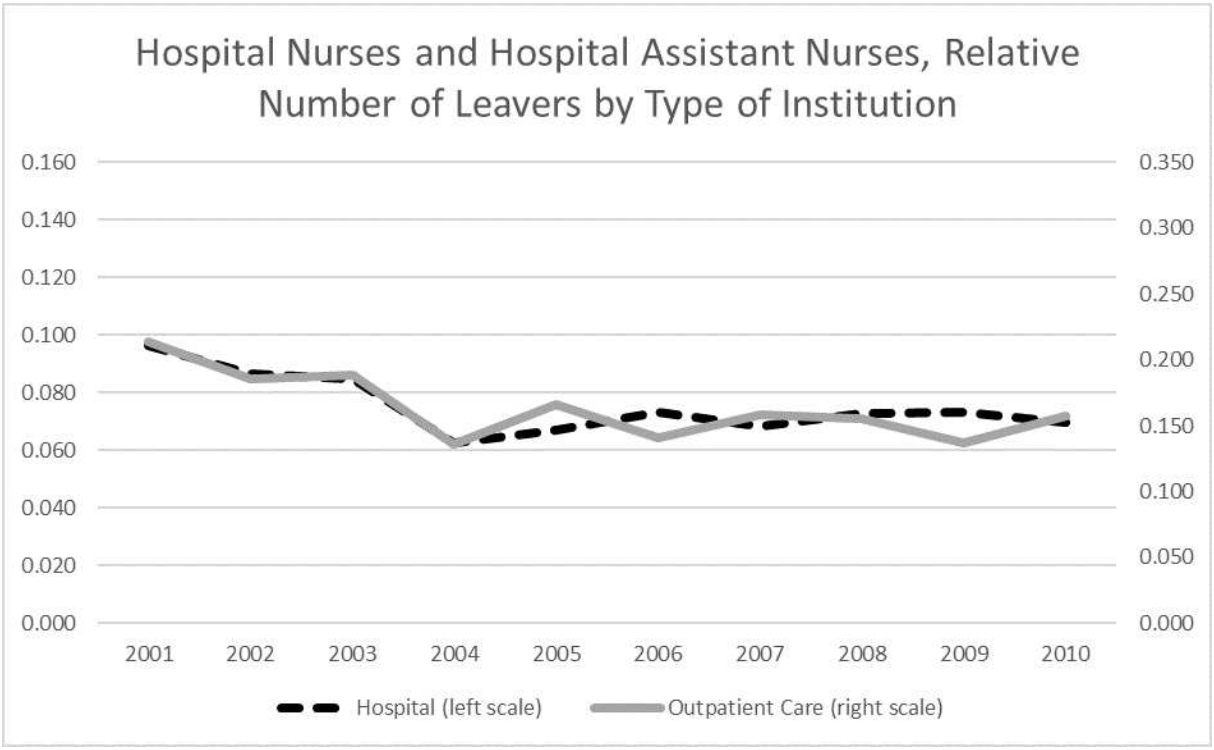


Figure 2.3 – Annual share of nurses leaving relative to their respective totals by institution

Source: Own figure based on data of the SIAB 7514.

Figure 2.4 – Semiannual share of nurses leaving relative to their respective totals by occupation

Source: Own figure based on data of the SIAB 7514.

in western Germany. However, reactions may take place with a longer time lag, for which I cannot account because of changes in reporting schemes in my data.

2.6 Conclusion

In this paper, I study the duration of nurses' occupation episodes and factors associated with longer or shorter occupation duration.

Other than one might guess in light of the public debate, nursing occupations overall do not exhibit specifically short occupation durations. There is already a skilled labor shortage in nursing, and the number of possible newly educated nurses is unlikely to rise significantly because of demographic changes. Thus, keeping nurses at work as long as possible can be seen as a key strategy for maintaining a sufficient number of nursing staff. I further estimate the impact of different factors on nurses' decisions to leave their occupation. Independently from the different nursing occupations and care settings (inpatient and outpatient care), younger nurses, nurses in the social sector, nurses working with a smaller employer, and nurses who receive lower wages leave their occupations more often than their respective counterparts do. A considerable share of nurses are employed part-time, and part-time employment decreases the leaving propensity of female nurses, in particular for nurses with children. In addition, nurses leave more often when alternative occupational options are better. Nurses who had been unemployed and nurses who had worked in a different occupation in the past have a higher probability of leaving the occupation, whereas nurses who have just finished vocational training have a lower propensity to leave. I employ competing risks analysis and analyze different target states. To where nurses leave their occupation differs with respect to regional characteristics, individual characteristics, wage, and experience. Finally, I cast a brief look at two institutional changes in the context of nursing in Germany: the introduction of the DRG system and the introduction of the nursing minimum wage. Neither influenced nurses' occupation durations.

My findings have implications for targeted hiring decisions and efficient ways to retain nurses in their occupations. Where possible, nurses should be hired directly after vocational training, and special effort should be undertaken to prevent breaks in their labor market biographies. Better possibilities to reconcile family commitments and care work could be one option to retain the mostly female care workforce in their occupations as long as possible and to prevent

significant breaks in their work biographies. When nurses are hired out of unemployment or after an employment episode in a different occupation, employers could offer special working arrangements and tailored training programs to ease the (re)entry into the nursing occupation. Where nurses have many professional alternatives, the attractiveness of care work must increase to keep nurses working in their occupation. However, keeping nurses at work as long as possible can only be part of an overall strategy to tackle the nursing labor shortage. Recruitment of new nursing personnel is also vital. One possibility to accomplish this is to recruit care personnel from abroad; another is to bring more domestic school graduates into nursing occupations. Knowledge about the factors determining young persons' career choice and influencing the decision to enter or not to enter a care profession is vital in this context and the subject of an ongoing scientific debate.

The data I employ offers detailed information on individuals' labor market biographies and highly reliable information on their employment; however, the data has no detailed information on socioeconomic variables and individuals' household contexts and family situations. I analyze interdependencies between occupation duration and individual characteristics, as far as possible. A more detailed analysis of the relationship between occupation duration and the respective characteristics remains a task for future research.

2.7 Appendix to chapter 2

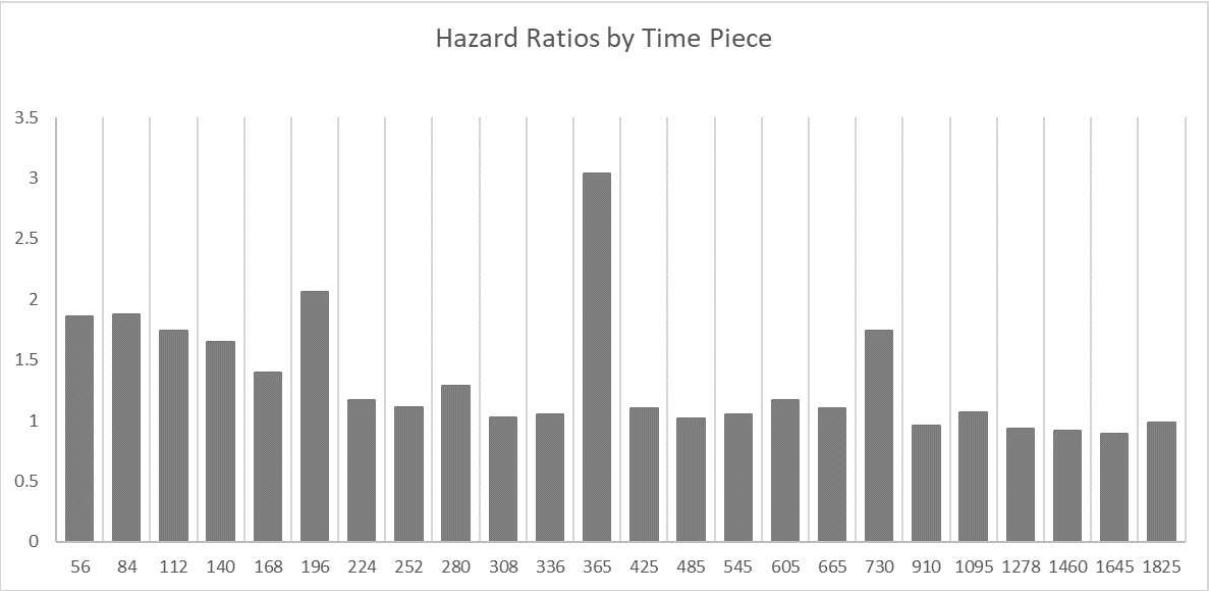


Figure 2.5 – Results from proportional hazards estimation, hazard ratios for time pieces

Source: Own figure based on data of the SIAB 7514.

Duration in occupation – Failure with simultaneous job end, only	
Becoming at risk	Entering a new job and occupation
Leaving risk set	Leaving the occupation without return in the following 90 days or staying in occupation without wage for at least 90 days
Failure	Leaving risk set with - End of employment notification by employer ("grund == 30 or 40") - Break due to following reception of compensation benefits notification by employer ("grund == 51") - Break due to following parental leave episode notification by employer ("grund == 52")
Censored	Leaving risk set without a failure; alternatively: still in risk set on 31 December 2010

Posterior labor market state	
Employed in	
... different health occupation	Worker is employed in a health occupation (other than the current one) in the following episode (one year after current occupation at maximum)
... different occupation, not health	Worker is employed in another occupation (no health occupation) in the following episode (one year after current occupation at maximum)
Unemployed	Worker is unemployed in the following episode
No status or employed without income	No information on the worker's posterior status, or status is employed with income equal to zero
In vocational training (reported)	Vocational training is reported in the following episode
Last episode	There are no following episodes of the individual covered by the data

Table 2.3 – Definitions of entry, exit, posterior labor market state

The posterior labor market statuses after taking up the respective occupation take into account information up to one year after leaving.

Variable		Mean	Definition
Vocational training		0.10	Entering after vocational training
No experience in care and			
other exp.	unemp.		
no	no	0.03	Neither registered unemployment nor employment episodes during the 6 prior years
yes	no	0.11	Experience outside care during the prior 6 years
no	yes	0.03	Some period of unemployment during the prior 6 years
yes	yes	0.12	Some period of unemployment during the prior 6 years and experience outside care during the prior 6 years
Up to 3 years experience in care and			
other exp.	unemp.		
no	no	0.09	Up until 3 years of experience in care during the prior 6 years
yes	no	0.07	Up until 3 years of experience in care during the prior 6 years and experience outside care during the prior 6 years
no	yes	0.06	Up until 3 years of experience in care during the prior 6 years and some period of unemployment during the prior 6 years
yes	yes	0.10	Up until 3 years of experience in care during the prior 6 years and some period of unemployment during the prior 6 years and experience outside care during the prior 6 years
3 to 6 years experience in care and			
other exp.	unemp.		
no	no	0.19	Between 3 and 6 years of experience in care during the prior 6 years – base category
yes	no	0.05	Between 3 and 6 years of experience in care during the prior 6 years and experience outside care during the prior 6 years
no	yes	0.05	Between 3 and 6 years of experience in care during the prior 6 years and some period of unemployment during the prior 6 years
yes	yes	0.03	Between 3 and 6 years of experience in care during the prior 6 years and some period of unemployment during the prior 6 years and experience outside care during the prior 6 years

Table 2.4 – Experience in prior 6 years, definitions

Source: Own calculations based on data of the SIAB 7514.

Variable	Mean	Definition
		Individual-level characteristics
Wage	58.53	Daily wage in Euros deflated to 2010 consumer prices
Part time	0.44	1 if observation refers to part-time employment episode, 0 if full-time
Age	32.69	Age
Female	0.82	1 if observation refers to female, 0 in observation refers to male individual
German citizen	0.94	1 if observation refers to a German citizen, 0 otherwise
Occupation		
Geriatric nurse	0.35	1 if observation refers to a geriatric nurse,
	0.35	0 otherwise
Health nurse	0.43	1 if observation refers to a health nurse,
		0 otherwise
Health nurse assist.	0.23	1 if observation refers to a health nurse assistant, 0 otherwise
		Firm-level characteristics
Institution		
Hospital	0.33	1 if observation refers to employment in a hospital, 0 otherwise
Nursing homes	0.36	1 if observation refers to employment in a nursing home, 0 otherwise
Health sector,	0.07	1 if observation refers to employment in the rest of the health sector
Rest		(not hospital), 0 otherwise
Social sector,	0.23	1 if observation refers to employment in the rest of the social sector
Rest		(not nursing home), 0 otherwise
Firm size		
<20 employees	0.12	1 if observation refers to employment in an establishment with less than
		20 employees, 0 otherwise
20-199	0.51	1 if observation refers to employment in an establishment
		with 20-199 employees, 0 otherwise
Over 199	0.37	1 if observation refers to employment in an establishment with more than
		199 employees, 0 otherwise
		Regional characteristics
Population density	9.22	Local population density (100 inhabitants per km^2)
Unemployment rate	8.35	Local unemployment rate in percent
		Labor market biography
Employment episodes		Running sum of occupation episodes as defined for the analysis
1	0.26	1 if first episode, 0 otherwise
2	0.27	1 if second episode, 0 otherwise
3	0.20	1 if third episode, 0 otherwise
4	0.12	1 if fourth episode, 0 otherwise
5	0.06	1 if fifth episode, 0 otherwise
6	0.04	1 if sixth episode, 0 otherwise
7 and more	0.05	1 if seventh episode or episode of higher count, 0 otherwise

Table 2.5 – Variables and definitions

Source: Own calculations based on data of the SIAB 7514.

	All nurses	
	Piecewise constant proportional hazards model - heterogeneity	
Time pieces: Days, up to	Hazard ratio	z-stat
56	1.86***	11.05
84	1.88***	11.09
112	1.74***	9.50
140	1.65***	8.35
168	1.40***	5.34
196	2.06***	12.27
224	1.17**	2.28
252	1.11	1.46
280	1.29***	3.69
308	1.03	0.41
336	1.05	0.69
365	3.04***	19.49
425	1.10	1.50
485	1.02	0.34
545	1.05	0.80
605	1.17**	2.40
665	1.10	1.46
730	1.74***	8.97
910	0.96	-0.76
1095	1.07	1.10
1278	0.93	-1.13
1460	0.92	-1.26
1645	0.89	-1.55
1825	0.98	-1.36
Theta	0.21	
N	502,478	
Subjects	18,323	

Table 2.6 – Results from proportional hazards estimation, hazard ratios for time pieces

Source: Own calculations based on data of the SIAB 7514, BBSR (2019), and Statistisches Bundesamt (2019).

		Cox-PH model	
		Hazard ratio	z-value
Individual-level characteristics			
Wage			
(ref. 1st quartile)			
2nd quartile		0.64***	-20.05
3rd quartile		0.39***	-29.28
4th quartile		0.40***	-20.41
Age (ref. 18-30)			
31-40		0.73***	-13.21
41-50		0.60***	-18.65
German citizen		0.98	-0.43
Sex and volume of work			
(ref. Male, part time)			
Male, part time		0.89**	-2.41
Female, full time		1.05***	1.58
Female, part time		0.69***	-10.95
Occupation			
(ref. Geriatric nurse)			
Health nurse		0.89	-1.29
Health nurse assist.		1.49***	4.68
Firm-level characteristics			
Institution (ref. Hospital)			
Nursing homes		1.22***	5.92
Health sector, rest		1.11***	2.19
Social sector, rest		1.20***	5.21
Firm size			
(ref. <20 employees)			
20-199		0.82***	-7.07
Over 199		0.72***	-8.90
Regional characteristics			
Population density		1.01***	8.65
Unemployment rate		0.98***	-3.70
Labor market biography			
Experience in previous 6 years (ref. 3-6 years in care)			
Vocational training		0.84***	-3.74
No care experience and			
other exp.	unemp.		
no	no	1.06	0.99
yes	no	1.13**	3.37
no	yes	1.24***	3.53
yes	yes	1.22***	5.32
Up to 3 years of experience in care and			
other exp.	unemp.		

no	no	1.02	0.45
yes	no	1.21***	4.53
no	yes	1.36***	6.83
yes	yes	1.28***	6.44
3 to 6 years of experience in care and			
other exp.	unemp.		
yes	no	1.07	1.35
no	yes	1.33***	5.91
yes	yes	1.38***	5.10
Employment episodes (ref. 1)			
2		1.05*	1.70
3		1.01	0.37
4		1.11***	2.78
5		1.20***	4.15
6		1.53***	8.18
7 and more		1.75***	11.15
Further controls			
Year		X	
Federal states		X	
Time pieces		-	
Constant		-	
Theta		-	
Subjects		18,317	

Table 2.7 – Results from proportional hazards estimation without frailty term

Annotations: */**/*** = significant at the 10/5/1% level. Abbreviations for experience during previous 6 years: "other exp." = employment in other occupation during the last six years; and "unemp." = unemployed at some point during the last six years.

Source: Own calculations based on data of the SIAB 7514, BBSR (2019), and Statistisches Bundesamt (2019).

		Single risk estimation	
		Hazard ratio	z-value
Individual-level characteristics			
Wage			
(ref. 1st quartile)			
2nd quartile		0.62***	-20.74
3rd quartile		0.36***	-31.63
4th quartile		0.37***	-22.54
Age (ref. 18-30)			
31-40		0.73***	-12.96
41-50		0.59***	-18.73
German citizen		0.96	-0.88
Sex and volume of work			
(ref. Male, full time)			
Male, part time		0.88**	-2.71
Female, full time		1.05	1.56
Female, part time		0.67***	-11.47
Occupation (ref. Geriatric nurse)			
Health nurse		0.86*	-1.63
Health nurse assist.		1.51***	4.64
Firm-level characteristics			
Institution (ref. Hospital)			
Nursing homes		1.28***	6.95
Health sector, rest		1.11**	2.32
Social sector, rest		1.22***	5.54
Firm size (ref. <20 employees)			
20-199		0.82***	-6.81
Over 199		0.71***	-8.62
Regional characteristics			
Population density		1.01***	7.87
Unemployment rate		0.98***	-3.26
Labor market biography			
Experience in previous 6 years (ref. 3-6 years in care)			
Vocational training		0.84***	-3.49
No care experience and			
other exp.	unemp.		
no	no	1.08	1.15
yes	no	1.15***	3.67
no	yes	1.26***	3.59
yes	yes	1.30***	6.78
Up to 3 years of experience in care and			
other exp.	unemp.		
no	no	0.98	-0.38
yes	no	1.19***	4.03

no	yes	1.31***	5.86
yes	yes	1.24***	5.46
3 to 6 years of experience in care and			
other exp.	unemp.		
yes	no	1.09*	1.65
no	yes	1.33***	5.65
yes	yes	1.38***	5.14
Employment episodes (ref. 1)			
2		1.04	1.17
3		0.99	-0.23
4		1.07*	1.76
5		1.18***	3.63
6		1.49***	7.44
7 and more		1.64***	9.71
Further controls			
Year		X	
Federal states		X	
Time pieces		X	
Constant		0.00***	-57.11
Theta		0.26	
Subjects		18,325	

Table 2.8 – Results from proportional hazards estimation with inverse Gaussian frailty term

Annotations: */**/*** = significant at the 10/5/1% level. Abbreviations for experience during previous 6 years: "other exp." = employment in other occupation during the last six years; and "unemp." = unemployed at some point during the last six years.

Source: Own calculations based on data of the SIAB 7514, BBSR (2019), and Statistisches Bundesamt (2019).

		Piecewise constant PH model - heterogeneneity					
		GN		HN		HN Assists.	
		Hazard ratio	z-value	Hazard ratio	z-value	Hazard ratio	z-value
Individual-level characteristics							
Wage							
(ref. 1st quartile)							
2nd quartile		0.56***	-15.87	0.72***	-8.33	0.68***	-9.11
3rd quartile		0.32***	-21.13	0.46***	-15.65	0.37***	-13.24
4th quartile		0.26***	-17.78	0.45***	-12.37	0.70***	-3.28
Age (ref. 18-30)							
31-40		0.79***	-6.05	0.75***	-7.19	0.66***	-9.22
41-50		0.65***	-10.22	0.61***	10.03	0.54***	-11.80
German citizen		1.03	0.42	0.99	-0.20	0.94	-0.85
Sex and volume of work							
(ref. Male, part time)							
Male, part time		0.68***	-4.77	1.23**	2.17	0.90	-1.45
Female, full time		1.03	0.64	1.15***	2.58	1.03	0.48
Female, part time		0.65***	-7.94	0.74***	-4.66	0.70***	-5.93
Firm-level characteristics							
Institution (ref. Hospital)							
Nursing homes		1.10	1.09	1.46***	6.87	0.95	-0.84
Health sector, rest		1.07	0.60	1.16**	2.58	0.78***	-3.21
Social sector, rest		1.04	0.51	1.38***	5.14	0.93	-1.05
Firm size (ref. <20 employees)							
20-199		0.85***	-3.47	0.83***	-3.56	0.77***	-4.71
Over 199		0.83***	-2.96	0.70***	-5.16	0.63***	-6.14
Regional characteristics							
Population density		1.01***	5.55	1.01***	5.75	1.00**	2.19
Unemployment rate		0.99	-1.70	0.96***	-4.74	1.01	0.79
Labor market biography							
Experience in previous 6 years							
(ref. 3-6 years in care)							
Vocational training		0.98	-0.21	0.76***	-3.61	1.07	0.58
No care experience and							
other exp.	unemp.						
no	no	1.19	1.59	0.99	-0.07	1.15	1.00
yes	no	1.17**	2.44	1.15**	1.99	1.14*	1.68
no	yes	1.44***	3.60	1.16	1.13	1.23*	1.69
yes	yes	1.40***	5.28	1.17**	2.05	1.21***	2.48
Up to 3 years experience in care and							
other exp.	unemp.						
no	no	0.93	-0.88	0.94	-1.21	1.30***	2.98
yes	no	1.16**	2.02	1.15**	2.11	1.31***	3.19
no	yes	1.42***	4.63	1.34***	4.14	1.34***	2.94

yes	yes	1.27***	3.69	1.30***	3.89	1.30***	3.33
3 to 6 years experience in care and							
other exp.	unemp.						
yes	no	1.17*	1.76	1.05	0.67	1.02	0.19
no	yes	1.28***	2.91	1.44***	5.04	1.33***	2.49
yes	yes	1.40***	3.36	1.55***	4.26	1.21	1.53
Employment episodes (ref. 1)							
2		1.10**	2.05	1.10*	1.64	0.93	-1.36
3		1.04	0.73	1.06	0.90	0.94	-0.97
4		1.09	1.50	1.13*	1.77	1.08	1.13
5		1.23***	2.97	1.25***	2.71	1.16*	1.89
6		1.47***	4.64	1.70***	5.39	1.47***	4.18
7 and more		1.81***	7.93	1.98***	7.03	1.61***	5.83
Further controls							
Year		X		X		X	
Federal states		X		X		X	
Time pieces		X		X		X	
Constant		0.00***	-35.55	0.00***	-39.00	0.00***	-33.42
Theta		0.20		0.15		0.13	
Subjects		7,415		8,543		4,999	

Table 2.9 – Results from proportional hazards estimation of occupation duration by occupation

Annotations: */**/*** = significant at the 10/5/1% level. Abbreviations for experience during previous 6 years: "other exp." = employment in other occupation during the last six years; and "unemp." = unemployed at some point during the last six years.

Source: Own calculations based on data of the SIAB 7514, BBSR (2019), and Statistisches Bundesamt (2019).

		Piecewise constant PH model - heterogeneneity			
		Women and men (1)		Women: With and without children (2)	
		Hazard ratio	z-value	Hazard ratio	z-value
Individual-level characteristics					
Wage					
(ref. 1st quartile)					
2nd quartile		0.62***	-20.93	0.65***	-17.35
3rd quartile		0.36***	-31.78	0.41***	-25.85
4th quartile		0.37***	-22.67	0.38***	-21.19
Age (ref. 18-30)					
31-40		0.73***	-13.29	0.77***	-9.60
41-50		0.59***	-18.97	0.55***	-19.90
German citizen		0.97	-0.87	1.01	0.13
Women		0.95**	-2.06	-	-
Part time		0.68***	-17.65	-	-
Sex and volume of work					
(ref. Full time, no child)					
Part time, no child		-	-	0.79***	-8.51
Full time, child(ren)		-	-	0.87	-3.19
Part time, child(ren)		-	-	0.47***	-20.92
Occupation (ref. Geriatric nurse)					
Health nurse		0.86*	-1.64	0.93	-0.71
Health nurse assist.		1.52***	4.77	1.49***	3.89
Firm-level characteristics					
Institution (ref. Hospital)					
Nursing homes		1.28***	7.06	1.27***	6.16
Health sector, rest		1.11**	2.22	1.10*	1.67
Social sector, rest		1.23***	5.61	1.22***	5.03
Firm size (ref. <20 employees)					
20-199		0.81***	-6.99	0.82***	-6.08
Over 199		0.71***	-8.72	0.73***	-7.22
Regional characteristics					
Population density		1.01***	8.14	1.01***	6.88
Unemployment rate		0.98***	-3.28	0.98***	-3.19
Labor market biography					
Experience in previous 6 years					
(ref. 3-6 years in care)					
Vocational training		0.85***	-3.27	0.66***	-4.94
No care experience and					
other exp.	unemp.				
no	no	1.08	1.23	0.99	-0.14
yes	no	1.16**	3.88	1.10**	2.12
no	yes	1.27**	3.62	1.20**	2.49

yes	yes	1.30***	6.88	1.24***	4.99
Up to 3 years experience in care and					
other exp.	unemp.				
no	no	0.99	-0.26	0.97	-0.60
yes	no	1.20***	4.25	1.12**	2.37
no	yes	1.32***	6.15	1.27***	4.77
yes	yes	1.25***	5.65	1.19***	3.91
3 to 6 years experience in care and					
other exp.	unemp.				
yes	no	1.10*	1.66	1.04***	0.63
no	yes	1.33***	5.73	1.34***	5.50
yes	yes	1.38***	5.20	1.38***	4.80
Employment episodes (ref. 1)					
2		1.03	1.07	1.10***	2.74
3		0.99	-0.27	1.09***	2.34
4		1.07*	1.78	1.17***	3.60
5		1.19***	3.77	1.31***	5.28
6		1.50***	7.62	1.77***	9.58
7 and more		1.66***	10.13 1.86***	11.03	
Further controls					
Year		X		X	
Federal states		X		X	
Time pieces		X		X	
Constant		0.00***	-57.15	0.00***	-52.64
Theta		0.21		0.18	
Subjects		18,322		14,870	

Table 2.10 – Results of proportional hazards estimation of occupation duration accounting for sex and children

Annotations: */**/*** = significant at the 10/5/1% level. Abbreviations for experience during previous 6 years: "other exp." = employment in other occupation during the last six years; and "unemp." = unemployed at some point during the last six years.

Source: Own calculations based on data of the SIAB 7514, BBSR (2019), and Statistisches Bundesamt (2019).

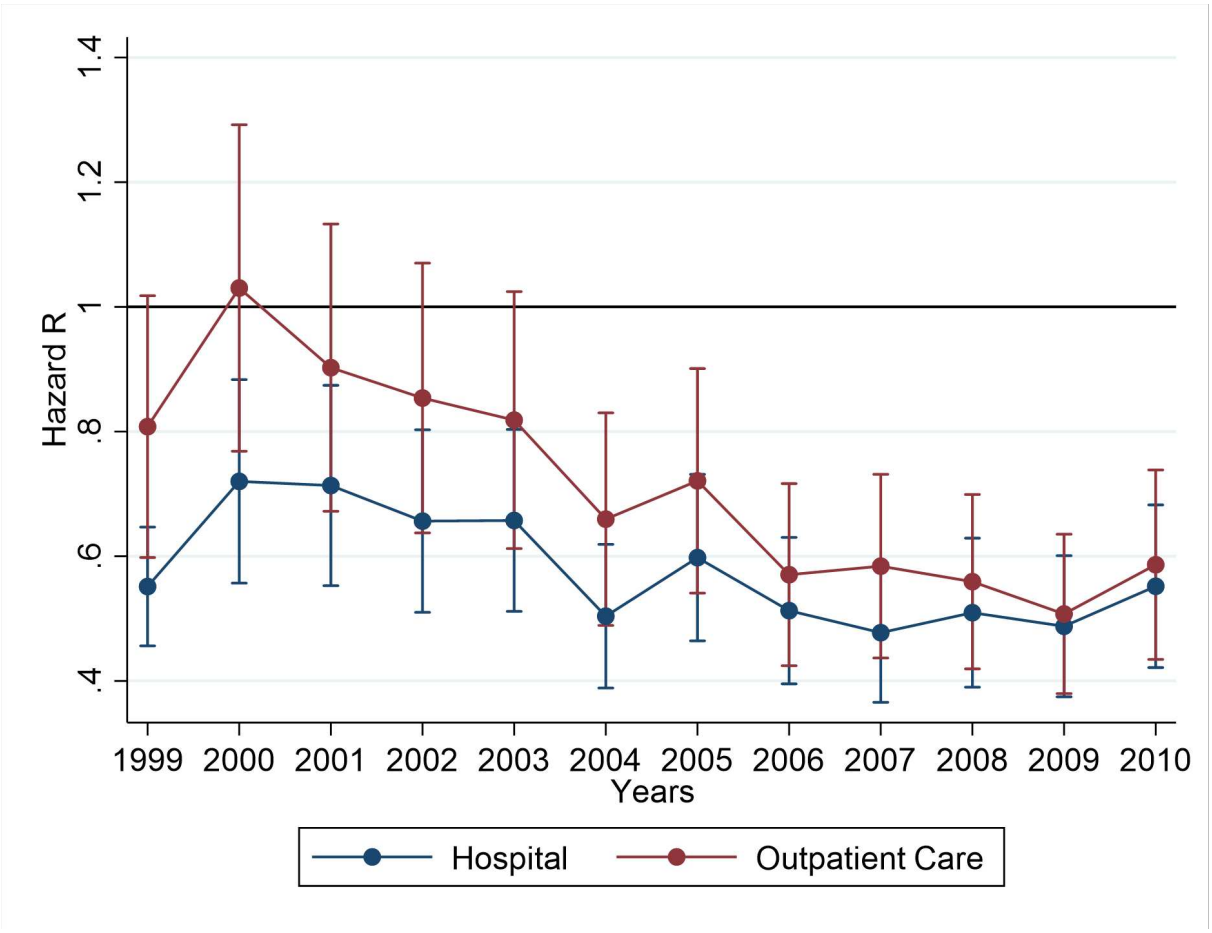


Figure 2.6 – Results from a multivariate proportional hazards estimation, hazard ratios for years for nurses employed in hospitals and outpatient care

Source: Own figure based on data of the SIAB 7514.

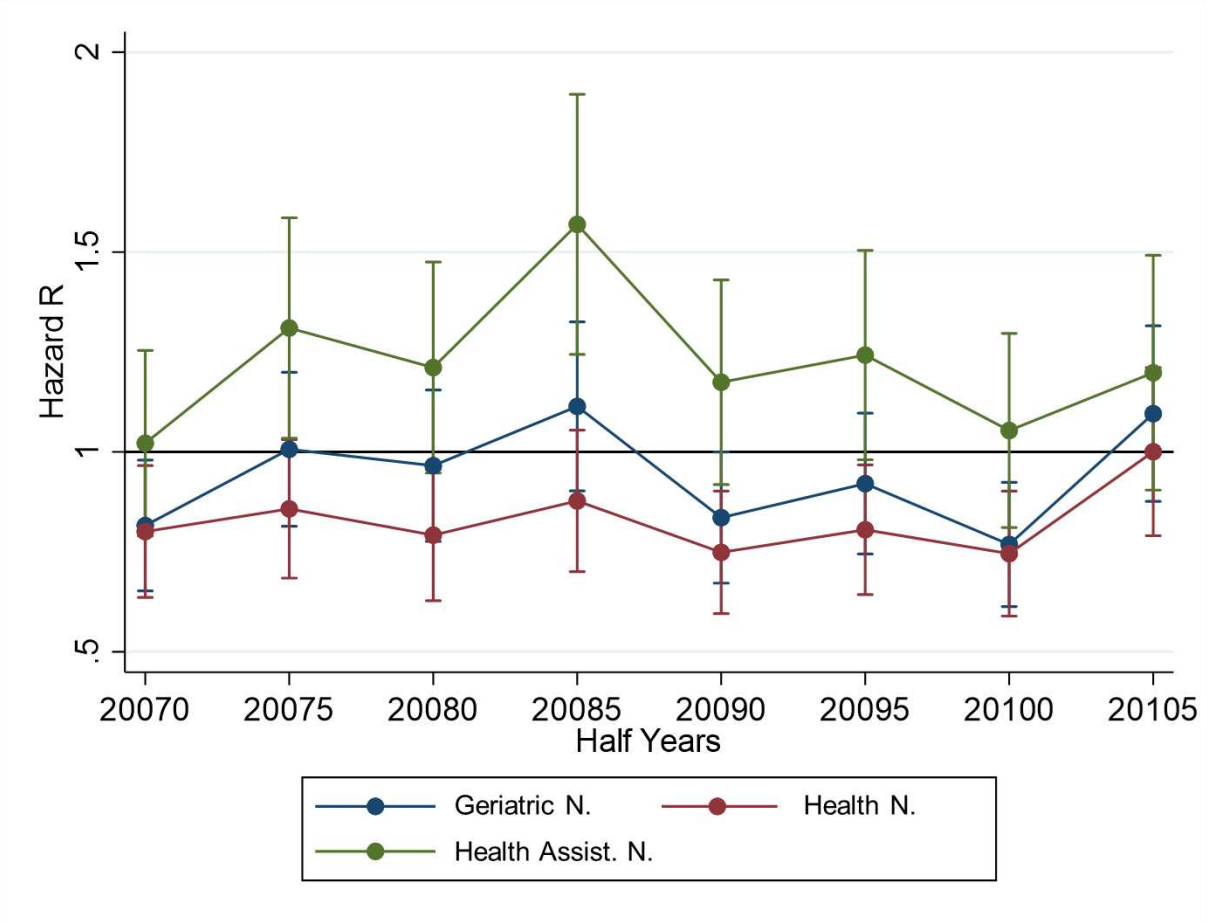


Figure 2.7 – Results from a multivariate proportional hazards estimation, hazard ratios for years for nurses employed in hospitals and outpatient care

Annotation: Abbreviations and their meaning: Geriatric N. = geriatric nurses, Health Assist. N. = health nursing assistants, Health N. = examined health nurses. 20070, 20080, 20090, and 20100 refer to the first half of the years 2007, 2008, 2009, and 2010, respectively. 20075, 20085, 20095, and 20105 refer to the second half of the years 2007, 2008, 2009, and 2010, respectively.

Source: Own figure based on data of the SIAB 7514.

		Single risk estimation	
		Hazard ratio	z-value
Individual-level characteristics			
Wage			
(ref. 1st quartile)			
2nd quartile		0.65***	-19.78
3rd quartile		0.39***	-30.25
4th quartile		0.41***	-21.06
Age (ref. 18-30)			
31-40		0.75***	-12.48
41-50		0.62***	-18.02
German citizen		0.97	-0.68
Sex and volume of work			
(ref. Male, full time)			
Male, part time		0.89***	-2.55
Female, full time		1.05*	1.70
Female, part time		0.69***	-11.14
Occupation (ref. Geriatric nurse)			
Health nurse		0.85*	-1.81
Health nurse assist.		1.50***	4.71
Firm-level characteristics			
Institution (ref. Hospital)			
Nursing homes		1.26***	6.75
Health sector, rest		1.10**	2.19
Social sector, rest		1.21***	5.30
Firm size (ref. <20 employees)			
20-199		0.82***	-6.72
Over 199		0.73***	-8.46
Regional characteristics			
Population density		1.01***	7.81
Unemployment rate		0.98***	-3.27
Labor market biography			
Experience in previous 6 years (ref. 3-6 years in care)			
Vocational training		0.86***	-2.98
No care experience and			
other exp.	unemp.		
no	no	1.11	1.64
yes	no	1.16***	3.88
no	yes	1.28***	3.92
yes	yes	1.27***	6.55
Up to 3 years of experience in care and			
other exp.	unemp.		
no	no	1.02	0.63
yes	no	1.20***	4.56

no	yes	1.35***	6.79
yes	yes	1.26***	6.11
3 to 6 years of experience in care and			
other exp.	unemp.		
yes	no	1.08	1.46
no	yes	1.33***	5.92
yes	yes	1.37***	5.23
Employment episodes (ref. 1)			
2		1.05	1.58
3		1.01	0.24
4		1.09**	2.30
5		1.20***	4.15
6		1.50***	7.91
7 and more		1.67***	10.77
Further controls			
Year		X	
Federal states		X	
Specific time pieces			
169-196 days		1.43***	9.09
337-365 days		2.41***	24.67
666-730 days		1.74***	13.08
Time elapsed		0.999***	-15.05
Time elapsed^2		1.00***	7.24
Constant		0.00***	-59.04
Theta		0.11	
Subjects		18,325	

Table 2.11 – Results from proportional hazards estimation of occupation duration, baseline hazard modeled as quadratic polynomial with dummies for specific time intervals

Annotations: */**/*** = significant at the 10/5/1% level. Abbreviations for experience during previous 6 years: "other exp." = employment in other occupation during the last six years; and "unemp." = unemployed at some point during the last six years.

Results on the factor variables "169-196 days", "337-365 days", and "666-730 days" give the hazard ratios for the respective time intervals after entry. "Time Elapsed" and "Time Elapsed^2" refer to analysis time since entry and analysis time since entry squared.

Source: Own calculations based on data of the SIAB 7514, BBSR (2019), and Statistisches Bundesamt (2019).

Chapter 3

The attractiveness of jobs in the German care sector: Results of a factorial survey

3.1 Introduction

For a couple of years, Germany, among other countries, has been suffering from a skilled labor shortage in nursing occupations (Drennan & Ross 2019, Statistik der Bundesagentur für Arbeit 2020*b*). Due to their significance for the health sector, the shortage in nursing personnel has received particular attention in the general public as well as in the scientific community. Several countries took up strategies to tackle the problem, such as a push for increased immigration of nurses, changes in nursing training, or the implementation of new occupational profiles (Buchan et al. 2015, Marć et al. 2019). Nurses' labor supply also entered the international research agenda. The literature identifies pecuniary and non-pecuniary job characteristics which can increase nurses' labor supply (Antonazzo et al. 2003, Shields 2004, Di Tommaso et al. 2009, Doiron et al. 2014, Hanel et al. 2014, Andreassen et al. 2017), the time nurses stay with their job or occupation (Shields & Ward 2001, Holmås 2002, Frijters et al. 2007, Kankaanranta & Rissanen 2008, Cunich & Whelan 2010, Zeytinoglu et al. 2011, Brewer et al. 2012), nurses' job satisfaction (Lu et al. 2005, 2012, 2019), and nurses' willingness to accept job offers (Doiron et al. 2014, Scott et al. 2015, Fields et al. 2018, Soekhai et al. 2019).

Our paper relates closely to this literature, particularly to the papers analyzing nurses' willingness to accept job offers which typically apply discrete choice experiments (DCEs – see e.g., Doiron et al. 2014, Scott et al. 2015, Fields et al. 2018; see Soekhai et al. 2019 for an overview). Similar to this literature, we analyze potential determinants of the attractiveness of nursing job offers and nurses' job offer acceptance via a factorial survey experiment, which allows us to receive nurses' judgements on a randomly assigned set of jobs and estimate the causal effects of potential determinants. This method further allows for insights into the implicit preferences of interviewees and to mitigate a potential social desirability bias of the answers in the survey (Auspurg & Gundert 2015). Because of its benefits, the factorial survey method has already been applied in the literature on job offer acceptance and job attractiveness (Abraham et al. 2013, Auspurg & Hinz 2015, Bähr & Abraham 2016).[1]

To our best knowledge, we are, however, the first to investigate the causal relations of several job characteristics on job offer acceptance and job attractiveness for a cross-section of nurses of all working age groups in a European country in general and for Germany in particular. Results from extant studies for other, even industrialized, countries, such as Australia or the U.S., can only partly be transferred to the different institutional settings in Europe and Germany. Some previous studies are based on broader groups, like nurses and midwives (Scott et al. 2015) or nurses and doctors (Song et al. 2015), or very specific groups, like highly specialized surgical technologists (Saunders et al. 2019). Due to the different institutional contexts and analyzed groups, previous studies further do not cover all the job characteristics investigated in this paper like contract duration, roster reliability, or institutional setting. Yet, our results show that these factors have a significant influence on nurses' job offer acceptance.

Our results point to four major findings. First, attractiveness of care jobs is affected most strongly by rather soft characteristics such as atmosphere within the team and time for patients. Hard factors play a considerably smaller role. Second, there exists one very important hard factor: Contract duration is estimated to be among the most important job factors, a remarkable finding given that nursing occupations suffer from severe skill shortages. Third, though wages have a statistically significant influence on attractiveness, substantial wage raises would be needed in order to yield higher attractiveness gains than the top-rated soft factors, or to compensate for less pleasant job characteristics with respect to those factors. Lastly, even after controlling for other job characteristics, hospital nursing is rated more attractive

[1] Abraham et al. (2013), Auspurg & Hinz (2015), and Bähr & Abraham (2016) all employ wave V of the Labor Market and Social Security Panel (PASS Trappmann et al. 2013).

than geriatric nursing. This finding reinforces the argument for a recent policy change in the German system of vocational training for nurses, where training for geriatric and hospital nurses was unified.

The rest of the paper is organized as follows: In the next section, we present related literature. In section 3.4, we describe our data, in section 3.5, we describe our estimation methods. We present our results in section 3.6. In section 3.7, we provide concluding remarks and political implications of our results.

3.2 Related literature and hypotheses

How to make nursing jobs more attractive and thereby expand the nursing labor supply has aroused research interest in these times of a widespread shortage of nurses. Factors associated with the attractiveness of nursing jobs are analyzed through the lens of research on labor supply elasticity, job retention, nurses' job satisfaction, and job offer acceptance.

Wage raises are one publicly advocated measure to cope with the nursing labor shortage (Konzertierte Aktion Pflege der Bundesregierung 2019).[2] The effects of wage raises on the attractiveness of care jobs are not uncontroversial, however: Shields (2004) and Antonazzo et al. (2003) provide overviews over research on the wage elasticity of the nurse labor supply. Shields (2004) concludes that labor supply is rather unresponsive to wage changes, a conclusion Di Tommaso et al. (2009) and Andreassen et al. (2017) reach in more recent studies for Norway, too. Antonazzo et al. (2003), on the contrary, conclude that the significance of the effect of nurses' wages on labor supply is rather unclear, as some papers in their review point to significant effects whereas others do not. Differentiating between shift types and occupations in their estimation model and accounting for labor supply decisions on the intensive as well as on the extensive margin, Hanel et al. (2014), employing Australian survey data, find a significantly higher wage elasticity of labor supply for nursing degree-holders than former studies without that distinction. There is also evidence that wage level is associated with nurses' job and occupational retention. Kankaanranta & Rissanen (2008) find an association between intent to leave one's employer and one's wage as well as the share of income from shift work

[2]Whether and how wage raises can be achieved and which role individual characteristics and institutional settings play in this context lies beyond the scope of this paper. See e.g., Ariste & Béjaoui (2019) or Hirsch & Schumacher (2005) for respective research.

for a sample of Finnish registered nurses. Frijters et al. (2007) and Holmås (2002) detect statistically significant effects of the wage level on nurses' decision to leave the British NHS and the Norwegian public healthcare system, respectively. Their estimated effects differ with respect to their economic significance, though. Doiron et al. (2014) evaluate which factors influence job offer acceptance of nurses in Australia by employing a DCE. They find salary to be the most important factor for job selection. This result is driven by the fact that they evaluate a rather large wage rise of over 50 percent, however. In a study regarding nurses in the US, Fields et al. (2018) also find a significant effect of earnings on job choice, but they also find that nurses were willing to give up part of their earnings for other favorable job characteristics. The finding that income is an important but not a dominating job characteristic is in line with findings of further studies on nurses and midwives in Australia, public sector nurses in Malawi, nurses and midwives in Peru, doctors and nurses in China, and nurses in Thailand (Mangham & Hanson 2008, Huicho et al. 2012, Kunaviktikul et al. 2015, Scott et al. 2015, Song et al. 2015). Wage and wage expectations have similarly been documented as relevant, though not dominating, determinants of whether or not students start vocational training in a nursing occupation (Kugler 2021). The wage level is also a source of job satisfaction. Lu et al. (2012) and Lu et al. (2005) provide overviews of the literature on job satisfaction among nurses, identifying remuneration as a source of nurses' job satisfaction commonly identified in the literature.

It is quite undisputed that non-pecuniary work aspects have a profound influence on the attractiveness of care jobs. Indeed, a vast number of characteristics have been found to be associated with nurses' intention or decision to start or keep working with an employer, or to stay in the healthcare system or in the nursing occupation. Among those are rather objective, hard factors such as working hours (Shields & Ward 2001, Holmås 2002, Frijters et al. 2007, Simon et al. 2010, Zeytinoglu et al. 2011, Scott et al. 2015), shift arrangements (Doiron et al. 2014, Holmås 2002) and contract duration or time until getting a permanent contract (Frijters et al. 2007, Cunich & Whelan 2010, Huicho et al. 2012, Rockers et al. 2013). Furthermore, subjective, soft factors have been found to be associated with the attractiveness of care jobs. Among those are time pressure and quality of care (Estryn-Behar et al. 2010), competences and autonomy, and work relationships (Beecroft et al. 2008, Estryn-Behar et al. 2010, Scott et al. 2015, Fields et al. 2018). Apart from this, a broad range of non-pecuniary factors are also evaluated with regard to their effects on nurses' job satisfaction. The literature summaries by Lu et al. (2005), Lu et al. (2012), and Lu et al. (2019) also discuss the association

between non-pecuniary factors and nurses' job satisfaction. According to their analyses, the abovementioned factors play a prominent role in job satisfaction literature, too.

The intention or decision to start or keep working in nursing is also associated with individual factors. These include an individual's family situation, age, experience, tenure (Shields & Ward 2001, Holmås 2002, Frijters et al. 2007, Estryn-Behar et al. 2010), and ethnic background (Shields & Ward 2001).

Our research interest lies in the determination and quantification of the effects of job characteristics on job attractiveness and job offer acceptance. A vast set of factors has been evaluated in the literature, which can be divided into three major categories: pecuniary job factors, particularly wage; objective (or hard) non-pecuniary job factors such as working hours; and subjective (or soft) non-pecuniary job factors, such as autonomy. Objectively measurable factors like wage or working hours have produced a greater extent of quantitative literature analyzing their effects than is the case for rather subjective factors like autonomy. However, although a majority of the cited literature points to a positive effect on the attractiveness of nursing jobs (e.g., labor supply, job choice, job satisfaction and job retention), the effect of wage is not undisputed, be it in terms of its mere existence or in terms of its size. Differences in the estimated sizes of the wage effect seem to evolve along different outcomes evaluated (e.g., job retention vs. job acceptance), methodological approaches and region. Also, extant results are not easily transferable to the institutional settings in European countries, such as Germany. In accordance with the literature, we hypothesize that pecuniary as well as objective and subjective non-pecuniary factors significantly influence job attractiveness and job offer acceptance–though it is a priori unclear how large the absolute or relative effects of factors from the three domains are. Employing the factorial survey method, we test the significance of factors from those domains for job attractiveness and quantify their absolute and relative influence using a broad sample of nurses in a European country. To our best knowledge, no such experimental analysis of nurses' job preferences for a cross-section of nurses of all working age groups in a European country exists. How individual factors influence the interest to work in specific nursing jobs is not a concern of this paper, as we study the attractiveness of care jobs rather than the full set of determinants of labor supply in care.

3.3 Institutional background

Some peculiarities regarding the provision of care services in Germany have to be considered when analyzing the attractiveness of care jobs in the German context. Care personnel in Germany has long been divided into different groups according to their main areas of action as well as their levels of occupational training. Whereas geriatric nurses mainly work with elderly people, hospital nurses mainly work in the care for the sick. Further, geriatric and hospital nurses may have the occupational education to work as a registered geriatric or hospital nurse, or as a geriatric or hospital nursing assistant according to their vocational education. This separation along areas of care and level of occupational education is grounded in the history and education system of care in Germany (Bogai 2017, pp. 23-44). The different areas of activity could be associated with different levels of attractiveness, and geriatric nursing has been found to be viewed as less attractive than hospital nursing.[3] This differentiation should be considered, as we surveyed German nurses in this study.

It is not only occupations that are differentiated between care for the elderly and care for the sick in Germany. Reimbursement rules also differ. Nursing services in healthcare are mainly paid for by health insurance, which cover the full amount of the respective costs. Geriatric nursing services are paid for by long-term care insurance, which only covers a share of long-term care expenditures; the rest of the long-term care expense has to be borne by the care recipient (Bogai 2017). Also, the services provided and the amounts institutions can charge for services in health as well as geriatric care are strongly regulated and differ between outpatient geriatric care, outpatient health services, hospital care services and inpatient geriatric services (Simon 2017, pp. 242-244, 298-301, 301-304, 323-325).

These regulations limit organizations' freedom regarding the provision of the respective services and set limits to how care work is organized–limits we had to consider when we set up the hypothetical job offers. The reimbursement rules in the provision of health and geriatric services further limit the range for nurses' wages, bounding nurses' wages from above. On the other hand, nurses' wages are also bounded from below due to a specific minimum wage for nurses (Harsch & Verbeek 2012). Within these boundaries, wages for nurses in hospitals are further regulated, as they are mostly employed under the rules of collective agreements. In geriatric

[3]Compared to geriatric nursing, hospital nursing not only has a better image among pupils and their parents, but pupils' motivation to take up geriatric nursing is also lower than their motivation to take up hospital nursing (Bomball et al. 2010, Matthes 2016).

nursing, collective agreements are less common (Simon 2017, pp. 212–213). The institutional situation of bounded and partly collectively regulated wages leads to a situation where nurses' wages are not as flexible as in other sectors. However, nurses' wages still exhibit significant variation, as Bogai et al. (2015) show. In our context, this allows for (synthetic) job offers that contain a significant range of wages without offering too unrealistic wage rates. Still, although employers' flexibility in establishing favorable working conditions may seem limited, some adjustments are still possible.

3.4 Data

3.4.1 Survey method

To assess the question of which factors drive job attractiveness and job offer acceptance, we ran a standardized survey among current and former care workers. As we exclusively sampled persons who work or have in the past worked in care, we focus on what attracts the core nursing labor potential (back) to nursing jobs. To study how new segments of the population could be attracted into care professions, individuals who never worked in nursing would have to be interviewed, too. In setting up the survey, the following considerations were taken into account: (1) care workers do not need to be explicitly aware of each and every of their own preferences, which ultimately influence their perception of the attractiveness of a given job. (2) Even if they were, several aspects could be highly correlated and thus difficult to disentangle if respondents were asked directly about their influences on job offer acceptance. (3) Among other factors, our survey involves issues that are likely to suffer from social desirability bias, such as the hourly wage or whether care professionals prefer to have much excess time for patients. To account for these aspects, the survey consisted of two parts. One part of the survey was traditionally item-based and served the purpose to query control variables. The main part of the survey was designed as a factorial survey where care workers were presented with vignettes describing fictional advertisements of care jobs.[4]

A factorial survey differs from a traditional item-based survey insofar as several parameters relevant to the research question are enquired in a coherent unit of meaning at the same

[4]A detailed description of the methodology of the vignette survey would take up too much space here. A great introduction can be found in Auspurg & Gundert (2015).

time, instead of asking several separate questions. Thus, respondents to a factorial survey always evaluate an overall set of variables that are interrelated and can influence each other. When combining multiple variables with multiple characteristics many different vignette texts are possible. By presenting several systematically varied constellations, the influence of the individual dimensions can be separated in the analyses.

3.4.2 Survey design

As part of the factorial survey, the fictional job advertisement (see table 3.1) was presented to care workers in form of a series of vignettes in text form. The vignettes follow a $2^7 3^1 8^1$ experimental design, which generates a systematic variation of the individual text modules. To measure the influence of pecuniary job characteristics, the vignettes contained wage as one dimension. To access the influence of soft non-pecuniary characteristics, work autonomy, time for patients, atmosphere within the team and roster reliability enter the vignettes. We address the influence of hard non-pecuniary job characteristics via the type of care activity (hospital or geriatric nursing), the kind of care institution (in- or outpatient care), working hours and contract duration. We selected the specific dimensions for the respective domains in a multistage process which included an exploration of the relevant literature, expert interviews and pre-tests to identify the most prominent or most relevant dimensions. The dimensions of care activity and care institution are not prominent in the international literature; differentiation along those characteristics is important in the German context, however. Reading from top to bottom, the right column of table 3.1 lists all conceivable vignette constellations.

To reduce the survey load, a fractionalized[5] sample of 200 vignettes was drawn from all possible combinations of vignette dimensions and distributed to the various questionnaires by fractionalized blocking, so that each respondent received ten different vignettes. The questionnaires were randomly assigned to the respondents to ensure the vignette variables were independent from respondent characteristics. The survey uses a Resolution V design with a D-efficiency[6] of 95. The results thus have a high internal validity. In concrete terms,

[5]This means a sample with maximum information in the sense of the orthogonality of the vignette dimensions is drawn ("efficient design"). The higher information density of fractionalized samples as opposed to random samples is evidenced by research (Johnson et al. 2006, Kuhfeld et al. 1994). The criterion for the efficiency of sampling is the D-efficiency (see next footnote).

[6]The D-efficiency is a measure of the orthogonality of the constellations of the vignette universe depicted

Dimension	Level	Vignette text
Activity		In the locality where you have been working so far, a job in
(Act)	1	hospital nursing
	2	geriatric nursing
		is advertised
Institution		at an
(Inst)	1	inpatient care institution
	2	outpatient nursing service
Working		in
hours (Hours)	1	full time (39 h/week)
	2	50% part time (20 h/week).
Wage (Wage)		The gross hourly wage without supplements for Sundays,
		public holidays and night work is
	1	11 euro. The monthly gross earnings are thus around [11*20 / 11*39].
	2	14 euro. The monthly gross earnings are thus around [14*20 / 14*39].
	3	17 euro. The monthly gross earnings are thus around [17*20 / 17*39].
	4	20 euro. The monthly gross earnings are thus around [20*20 / 20*39].
	5	23 euro. The monthly gross earnings are thus around [23*20 / 23*39].
	6	26 euro. The monthly gross earnings are thus around [26*20 / 26*39].
	7	29 euro. The monthly gross earnings are thus around [29*20 / 29*39].
	8	32 euro. The monthly gross earnings are thus around [32*20 / 32*39].
Contract		The position is on a
duration (FTC)	1	one-year fixed-term contract without prospect of extension.
	2	one-year fixed-term contract with prospect of extension.
	3	permanent contract.
Autonomy		Through acquaintances, you have learned that nurses at this employer have
(Auto)	1	little
	2	much
		autonomy with regard to the order in which they perform their tasks.
Time for care		As part of the job, you would have
recipient /	1	little
patient (Time)	2	plenty of
		time to talk to the care recipient/patient about personal subjects.
Cordial team		The team members are
(Team)	1	not very friendly.
	2	very friendly.
Roster		Unforeseen services and roster changes are
reliability	1	rarely
(Roster)	2	frequently
		to be expected.

Table 3.1 – Vignette dimensions and levels

Source: Factorial survey of (former) care workers, IAW, own representation.

How attractive is this job offer to you?											
Very unattractive											Very attractive
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
1	2	3	4	5	6	7	8	9	10	11	
How likely would you be to accept this job offer? If you were employed at the time, you would have to give up your current job.											
Very unlikely											Very likely
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
1	2	3	4	5	6	7	8	9	10	11	

Table 3.2 – Vignette rating scales

Source: Factorial survey of (former) care workers, IAW, own representation.

all the main effects, along with all two-way interactions of the vignette dimensions, can be estimated in isolation from each other. Analyzing our final sample, we do not find two single dimensions with a correlation coefficient larger than 0.1.

The care workers evaluated a) how attractive the presented job offer is to them and b) how likely they would accept that job offer, under the condition that they would have to give up their current job if they had one. Table 3.2 presents the rating scales.

To estimate the causal effects of the vignette dimensions on the attractiveness of the fictitious jobs, we first relied on the experimental design, which allowed us to separate the effects of the single dimensions. Second, to abstract from the fact that the evaluation of the vignettes might be affected by other unknown confounding variables, the vignette text was preceded by a vignette intro. In the intro, essential confounders, which possibly affect job attractiveness, but are not under the control of the employer or not in the focus of this study (e.g., commuting distance from home), were "controlled" by being (fictitiously) held at a level that remained constant across the vignettes.

The survey underwent several rounds of cognitive pre-testing with experts and nurses.

in the sample, i.e., the full factorial. It takes on values between 0 and 100, where 100 represents complete orthogonality.

3.4.3 Caveats and limitations

Though factorial surveys offer several advantages, some issues must be addressed in designing such a survey. Generally, the vignettes, together with the vignette intro, need to contain all information relevant to rate the vignettes. Also, factorial surveys evaluate hypothetical situations, not actual situations. Other than this, some more specific issues need to be considered.

As factorial surveys are more complex than standard surveys, particular effort is needed in order not to overburden respondents with the survey setup. Specifically, the number of the vignettes presented to every respondent, the number of dimensions every vignette contains as well as the levels per vignette dimension need to be considered. Although a larger number of dimensions would enable us to study more job characteristics, vignettes with too many dimensions can become too complex, overburden respondents and lead to inconsistent judgments (Sauer et al. 2011). Also, if respondents are presented with too many vignettes, they have been found to show fatigue effects, or employ specific rating heuristics (Sauer et al. 2011, 2014). We, therefore, follow the methodological literature, which suggests (depending on the concrete setup) a maximum number of nine vignette dimensions and ten vignettes per respondent (Auspurg & Gundert 2015). The subjects in our cognitive pretests did not report being overburdened by the number of vignettes or the processing of the vignette text itself. Regarding the number of levels per dimension, we must consider several factors. Although a finer scaling of the dimensions enables a finer differentiated effect estimation, this would also mean that a larger set of vignettes would have to be evaluated. In order to get efficient results, a limitation on a subset of all possible scale values is needed.[7] Seven of the dimensions in our experimental setup, therefore, contain two levels, only. This could become problematic if we chose too extreme levels for the dimensions with only two levels. We considered the scaling of all dimensions during the cognitive pretests. The pretests did not point to a too extreme understanding of the alternatives. And even if one were to believe, the two levels were extreme, they can be seen as an upper bound to the effect arising from more fine-grained levels.

As we pointed out, all vignette studies are limited in the number of dimensions included. On the other hand, the vignettes, together with the vignette intro, need to contain all information relevant to rate the vignettes. Specifically, the results of an experiment could be biased if

[7] In the case of more levels, we would lose in efficiency considerably. If we increased the levels for the variables "working hours", "autonomy", "time for care recipient / patient", "cordial team", and "roster reliability" by one, we would only reach a D-efficiency of 65 with the original vignette sample of size 200.

individuals associate single levels of included dimensions with characteristics which are not included. In setting up the vignettes for our research question, we chose single characteristics for the three domains of pecuniary, objective non-pecuniary and subjective non-pecuniary job factors from a wide range of potential characteristics in a multistage process. We identified the relevant dimensions from national and international literature and expert interviews and verified the choice of the final set in two rounds of cognitive pretests. We incorporated relevant characteristics which did not become part of the vignettes in the vignette intro. The results of our cognitive pretests make us confident that we did not miss out on information which would influence the results of our study.

We also must consider the extent of the response scale. If too extensive response scales are used, individuals may bunch at the round numbers or neutral values (Sauer et al. 2014). We therefore employ a 11-point scale, which has been found to work well in the literature (Auspurg & Gundert 2015).

3.4.4 Sampling procedure and sample characteristics

The survey was addressed to current and former nurses who work or who have worked in the regional planning area (RPA) of Heilbronn-Franken, Germany. RPAs are constructed for the purpose of carrying out nationwide comparisons and assessing large-scale regional tendencies and explicitly rely on the concept of an economic centre surrounded by a more rural periphery. The precise RPA of Heilbronn-Franken was chosen as a region which is comparable to the regions surrounding it with respect to socio-demographic factors, and as it is not adjacent to other national states (Austria, France, Switzerland) because proximity to a national border would bring about specific peculiarities that could affect the intended analyses. Our gross sample was drawn from the Integrated Employment Biographies (IEB) from the Federal Employment Agency (BA) and consisted of 8,116 individuals who worked as professional caregivers in the named RPA at the time of the sampling or who had worked as professional caregivers in the RPA during the five years prior to sampling. The sample was stratified by employment status (current vs. former care professionals), (former) profession (nurses vs. geriatric nurses), and the kind of institution the respondents (formerly) worked in (inpatient vs. outpatient care).[8] Within these strata, interviewees were drawn at random.

[8]Data access was provided within the context of a § 75 SGB X application.

The IEB contain process data at the person level from the procedures of the BA and cover almost all individuals who have been in paid employment at some point (Antoni et al. 2019, p. 7).

Data collection was carried out in the form of paper and pencil interviews (PAPIs) in November and December 2018. To generate high response rates, the participants also received a letter of recommendation from the German Nurses Association Southwest (DBfK). Participation was further incentivized via vouchers for a big internet retailer given to the first 800 respondents to mail back their questionnaire. We received a total of 1,607 completed questionnaires (around a 20 percent response rate). After data cleansing, we were left with 1,313 completed interviews.[9] More than 1,000 of those correspond to active nurses. Our net sample is comparable to the gross sample in terms of the sex and age of respondents. However, German, currently active registered nurses (with completed vocational training) working in a stationary care setting were overrepresented.[10]

Table 3.3 gives an overview of the basic sample distribution across care professions and care status. Nearly half of all respondents in our sample belong to the nursing care sector, about one third belong to elder care and about one fifth claim to work in both nursing care and elder care at the same time. Nearly four fifths of the sample consist of current nurses, while the remaining fifth is constituted by former nurses. The former nurses in our sample belong to nursing care more frequently than the current nurses do, and in elder care there are fewer former nurses than across all care sectors.

Beyond the information presented in table 3.3, about two-thirds of the current nurses work in

[9] A large part of the data cleansing consisted of checking whether respondents' answers were consistent with the questionnaire filters.

[10] Possible reasons for this are–besides differences in the willingness to participate in the interview–inter alia (1) an erroneous record of the respondents' characteristics within the data on which the sampling procedure is based (at least insofar as these are not relevant for the calculation of the social security contributions) and (2) changes in the variables between the time of the sampling procedure and the interview (in particular with regard to the status as former/active nurse or the care setting). To deal with these possible problems, we refer to the self-classification of the respondents in the survey to determine central individual information (former/active status, care setting). This is also sensible, as vignette ratings may be related to a person's present status and setting rather than to possibly different information gathered at the time of sampling. Overall, it therefore does not seem sensible to reweight the sample because of the stated differences. It should be pointed out that the named differences may, if anything, affect the external validity of our results; the internal validity is not affected.

		Current nurses	Former nurses	Total
Nursing care	n	461	153	614
	Row %	75%	25%	100%
	Column %	44%	56%	47%
Elder care	n	355	43	398
	Row %	89%	11%	100%
	Column %	34%	16%	30%
Both at the same time	n	224	77	301
	Row %	74%	26%	100%
	Column %	22%	28%	23%
Total	n	1,040	273	1,313
	Row %	79%	21%	100%
	Column %	100%	100%	100%

Table 3.3 – Care worker sample by care sector and nurses' care status (current vs. former nurses)

Source: Care worker survey, own calculations.

inpatient care, yet with considerable differences between care sectors. Although nurses working in inpatient care account for the majority of respondents from nursing care and elder care (83 percent and 72 percent, respectively), only every tenth respondent working in both nursing care and elder care at the same time (and in the same job) belongs to inpatient care. About nine out of 10 respondents are female and German. Average age is 45 years. 85 percent of the respondents have at least five years of experience in direct care. All respondents have completed vocational training as a nurse. More than half of the respondents hold a secondary school diploma (German *Realschulabschluss*).

3.5 Methods

We estimate the relationship

$$y_{ij} = \mu + \mathbf{x}_j'\beta + \alpha_i + \varepsilon_{ij} \ , \tag{3.1}$$

where y_{ij} denotes the attractiveness or job offer acceptance evaluation of job offer j for person i, μ is a constant, $\mathbf{x}$ is a vector of observable characteristics of the job offer, β is a vector

of parameters measuring the influence of the observable characteristics on the attractiveness evaluation, α is an unobserved individual effect at the person level, and ε is an individual and job offer-specific error term.

When set up effectively, the factorial survey design virtually rules out endogeneity issues related to the vignette dimensions, as correlation between them is eliminated as much as possible and surveys are assigned to each respondent at random. The job characteristics are therefore uncorrelated with the individual and job-specific error term ε (strict exogeneity assumption) and the unobserved individual effect α by design (random effects assumption) (Auspurg & Gundert 2015, pp. 91–92, Wooldridge 2010, pp. 291–292). We therefore estimate random effects (RE) models, which yield more efficient estimates of the effects of the job characteristics than the standard OLS estimator (Auspurg & Gundert 2015, pp. 91–92, Wooldridge 2010, pp. 291–297).[11]

An instructive way to grasp the size of the effects of the different characteristics on job offer acceptance and job attractiveness is how much extra wage an individual would have to be compensated with for a less pleasant job characteristic, meaning by how much pay would have to rise for a job offer to be ranked as attractive as another, otherwise equal job offer, where one characteristic k is more positive (x_k changes from 0 to 1). In this case, the overall change in job attractiveness would be zero, and hence

$$\beta_w \log(\text{wage} + \Delta\text{wage}) = \beta_w \log(\text{wage}) + \beta_k \ , \tag{3.2}$$

where Δwage is the change in wage retained as compensation for the less pleasant working conditions. Re-transforming wage to the original scale and rearranging this equation, we get

$$\Delta\text{wage in } \% = \left[\exp\left(\frac{\beta_k}{\beta_w}\right) - 1\right] \cdot 100 \ , \tag{3.3}$$

which yields the compensation needed to keep job attractiveness constant when x_k changes from 1 to 0 (Auspurg & Gundert 2015 propose a comparable approach). As an example, this compensation measure answers the following question: How much more does an employer have to pay for a job on a fixed-term contract compared with a job on a permanent contract in order for two otherwise comparable job offers to be similarly attractive?

[11] To check the sensitivity of our results, we also estimated RE ordered logit models, which account for the ordinal nature of our outcome variable. The results were nearly the same and are available from the authors upon request. As the proportional odds assumption on which the RE ordered logit model relies does not seem very realistic given that our outcome variable has so many levels, we chose to stick with the linear RE model.

3.6 Results

Table 3.4 shows the RE estimates of the effects of the vignette dimensions on job attractiveness (column (1)) and the willingness to accept a job offer (column (2)). The dependent variables in our models are measured on an 11-point scale. Therefore, the absolute size of the coefficient of a job characteristic shows by how much the rating of a job offer changes, if the characteristic changes by one unit (i.e., from a less favorable to a more favorable manifestation or from hospital nursing to geriatric nursing and from inpatient care to outpatient care, respectively). Wages are an exception and discussed separately.

First, we note that all coefficients have the expected positive sign and almost all characteristics have a statistically significant effect on job attractiveness and job acceptance throughout the models. Furthermore, the results differ only slightly between the models. The order of the effect sizes is similar with regard to job attractiveness and willingness to accept a job offer (see below). In absolute sizes, the estimated effects on job acceptance (including the constant) are considerably smaller, though, which could be due to the more serious consequences implied by the question regarding job acceptance relative to the attractiveness rating.

The sizes of the estimated coefficients differ considerably. When we arrange the different factors by effect size from largest to smallest, we get the following order: 1. Team, 2. Time for patients, 3. Contract duration, 4. Roster reliability, 5. Autonomy, 6. Volume of work, 7. Care sector, and 8. Care institution. The effect of the wage variable is not part of the enumeration due to its continuous nature and will be discussed separately. Notably, with the exception of contract duration, we estimate the largest effects for rather soft factors of work atmosphere and organization of work. Working with a very cordial team as opposed to a less cordial team increases attractiveness and acceptance ratings by more than one point on the 11-point scales. An offer for a job in which staff has more time for patients is also rated higher by around one scale point. Working on a reliable roster gains job offers around 0.7 scale points on the attractiveness scale, and just below 0.6 points on the acceptance scale. More autonomy leads to a 0.5 scale-point gain on the attractiveness scale and just below a 0.4-point gain on the acceptance scale. Hard job factors such as the volume of work and employment in the care sector have a lower influence on job attractiveness. One hard job factor that has a large impact on job attractiveness is contract duration. The rating difference between a job offer with a one-year fixed-term contract without prospect of extension and a permanent contract

amounts to around 0.9 and just over 0.8 points on the attractiveness and the acceptance scale, respectively. Although this finding is in line with results from other studies (Frijters et al. 2007, Cunich & Whelan 2010, Huicho et al. 2012, Rockers et al. 2013), it seems puzzling in times of skilled labor shortage in nursing. It seems that (former) nurses are either not aware of the fact that skill shortage gives them advantages in the labor market or have another reason to value long contracts especially highly; this could be because they are particularly risk averse, feel less valued if they are offered fixed contracts, or simply do not like to change their employer because they want to work with the same team for as long as possible or fear the need to change location if they search for a new job. On the other hand, with between 20 and 30 percent of contracts, an unexpectedly high share of nurses have been working under fixed-term contracts in Germany in recent years. Although the numbers differ between sources, they are non-negligible throughout them whether from surveys (Kliner et al. 2017, p. 51) or from personal calculations based on administrative data on German employment histories (SIAB).[12] The high shares are surprising, as employers should have an incentive to tie nurses to them as long as possible and offer attractive working conditions due to skill shortage. Furthermore, we see from other publications and our own calculations based on the SIAB that the share of fixed-term contracts in the care occupations has been significantly higher than the average share over all other occupations (Kliner et al. 2017, Statistik der Bundesagentur für Arbeit 2018) and other occupations subject to skilled labor shortage in recent years. The latter in particular is unexpected as the demand for care services can almost surely be considered to rise, for instance, due to demographic change (Hackmann 2010, Hackmann & Moog 2010). A distinct aspect of nursing work in Germany is the division of nursing occupations into hospital nurses, mainly caring for the sick, and geriatric nurses, mainly caring for the elderly (Bogai 2017, pp. 23–44). We find that, even after controlling for the other job characteristics in our model, geriatric nursing is still considered significantly less attractive than hospital nursing, which is in line with results from previous (survey) studies in Germany (Bomball et al. 2010, Matthes 2016). As we control for several characteristics which usually separate geriatric from hospital nursing jobs (e.g., lower wage in geriatric nursing Bogai et al. 2015), our hypothesis is that we measure the overall worse image of geriatric nursing in this way.

[12] To that end, we employed information for the year 2014 from the weakly anonymous Sample of Integrated Labor Market Biographies (SIAB) 1975 - 2014. The data were accessed on-site at the Research Data Centre (FDZ) of the Federal Employment Agency (BA) at the Institute for Employment Research (IAB) and/or via remote data access at the FDZ. Data documentation: Antoni et al. (2016).

Although it is difficult to compare our results with earlier research quantitatively due to significant differences in the scientific approaches and the methods applied, qualitatively, our results for the importance of non-pecuniary job characteristics are in line with earlier work on nurses' intention or decision to start or keep working with an employer, or to stay in the healthcare system or in the nursing occupation, which found non-pecuniary factors to have significant effects on the named domains of nurses' labor supply (Shields & Ward 2001, Holmås 2002, Frijters et al. 2007, Cunich & Whelan 2010, Estryn-Behar et al. 2010, Zeytinoglu et al. 2011, Huicho et al. 2012, Rockers et al. 2013, Doiron et al. 2014, Scott et al. 2015, Fields et al. 2018).

Although the ordering of the effect is the same in the job attractiveness model as in the job acceptance model, the effect sizes differ less strongly in the job acceptance model. When confronted with the more serious decision about actually quitting one's job for a new job offer, objective factors seem to gain relative importance in comparison to a ranking in attractiveness.

An intuitive way to grasp the quantitative relevance of the different job characteristics is the wage change percentage an individual would have to receive in order to be compensated for a less attractive manifestation of a specific job characteristic. Table 3.5 gives the respective calculations. The ordering of the amounts of compensation is naturally the same as the ordering of the effect sizes. However, in this way, the relevance can be quantified in a monetary way. Looking at job attractiveness, wage would have to rise by 47 percent to compensate for a less cordial team, 40 percent to compensate for less time with patients, 30 percent to compensate for a fixed-term contract without a chance of prolongation instead of a permanent contract and 23 percent to compensate for a less reliable roster. The considerable size of these wage compensations already implies that wage itself, though statistically significant, may not play the largest role for care workers' perception of jobs.

In addition, as shown in table 3.4, a wage increase by 1 percent increases job attractiveness by about 0.035 points. To approximate the effect of a realistically possible wage change, we adhered to the latest rise in the minimum wage for qualified nursing assistants in Western Germany: over the course of 2020 and 2021, minimum wages for qualified nursing assistants[13] in Western Germany will increase from 11.35 to 12.50 euros, which corresponds to a 10-percent rise in wages.[14] For those hospital nurses working under a public service collective

[13]Nursing assistants who have undergone the respective vocational training.

[14]Doiron et al. (2014) evaluated the effect of a wage rise from the lowest to the highest level in their

agreement, a wage increase of 8 percent has been gained with the 2019 collective agreement. Thus, wage raises of this size would by far have a smaller impact on job attractiveness and job offer acceptance than most of the other job characteristics we evaluated.[15] Our results are therefore in line with the large part of the literature that estimates the effects of wage changes on labor supply and retention of nurses that are so small in size that substantial wage increases would be required to yield economically significant effects on the supply of nurses (Andreassen et al. 2017, Di Tommaso et al. 2009, Shields 2004, Frijters et al. 2007). Our results with regard to wages are further in line with results of DCEs on nurses' job preferences which found earnings to have a significant but not dominating effect on job choice (Mangham & Hanson 2008, Huicho et al. 2012, Kunaviktikul et al. 2015, Scott et al. 2015, Song et al. 2015, Fields et al. 2018).[16]

We also evaluated the interaction effects between vignette dimensions, as well as between vignette dimensions and respondents' current work situation. Table 3.6 provides an overview of the results regarding the former interaction, and statistically significant effects are marked by grey bars. Evaluating the interactions, we observed three interesting points. First, we found hardly any interaction effect between activity or institution and other vignette dimensions. This means that the same factors are relevant for nursing care and elder care as well as for inpatient care and outpatient care jobs, and therefore the same policies could increase the attractiveness of jobs among the different institutions and activities. Second, wherever we found significant interaction effects between dimensions, they were mostly positive. This means that changes that increase attractiveness amplify each other. Third, we found the largest interaction effects for interactions with the factors that exhibited the largest main effects. Therefore, it could be a rewarding strategy for employers and policymakers to improve simultaneously on more than one of the dimensions with the largest effects. Due to the interaction effects between the evaluated job characteristics, it becomes increasingly costly for an employer to compensate (possible) employees for less pleasant working conditions with respect to more than one job

survey–an increase by over 55 percent. This seems to be an implausible wage increase for an otherwise similar position. A natural, data-driven approach would be the evaluation of changes by one standard deviation in the corresponding variable. The standard deviation of the log-wage variable in our vignette setup is 0.34. A wage change by 34 percent would yield the third highest effect on the attractiveness and the fourth highest effect on the acceptance measure. However, wage changes by over 30 percent still seem unrealistically high.

[15] The change in y due to a $\frac{\Delta \text{wage}}{\text{wage}}$ change in wages is given by $\Delta y = \beta_w \cdot \log\left(\frac{\Delta \text{wage}}{\text{wage}} + 1\right)$.

[16] The results would further be in line with what Doiron et al. (2014) found in a comparable study for young Australian nurses, if Doiron et al. (2014) had evaluated a more realistic change in wages than they did.

characteristic. Put another way, with an increasing number of unpleasant job characteristics, employers' wage offers must increase over-proportional.

Table 3.7 shows the interaction effects between vignette dimensions and respondents' current work situation. The results indicate that all but geriatric nurses and nurses working in outpatient care prefer healthcare jobs to jobs in geriatric care. Regarding in- and outpatient care, we found that nurses prefer jobs in the same kind of institution they are or have been employed in–that is, nurses in inpatient care prefer jobs in inpatient care, and those in outpatient care prefer jobs in outpatient care. Another difference can be found with respect to full-time versus part-time jobs. All but former nurses show a preference for full-time jobs. Regarding wages and team spirit, we found effects of the same direction for all groups of nurses, although the effects differ in size. Regarding the other job characteristics (contract duration, autonomy, time for patients and reliable rosters), we found no differences with respect to the different groups of nurses. The effects are therefore quite comparable across the different groups of interviewees. However, there may exist variation in the ratings on the personal level over further individual characteristics. A subject of separate, ongoing research is to what extent groups with differing individual characteristics value specific job characteristics differently.

	(1)	(2)
	Attractiveness Linear RE	Acceptance Linear RE
Hospital nursing	0.144***	0.118***
	(0.038)	(0.035)
Outpatient nursing service	0.066	0.038
	(0.043)	(0.041)
Full time (39 h/week)	0.463***	0.389***
	(0.045)	(0.043)
ln (hourly wage)	3.503***	2.679***
	(0.074)	(0.073)
1-year FTC with prospect of	0.665***	0.585***
extension	(0.048)	(0.045)
Permanent contract	0.914***	0.832***
	(0.050)	(0.046)
Much autonomy of how to work	0.517***	0.389***
	(0.041)	(0.039)
Plenty of time for care	1.173***	0.881***
recipients/patients	(0.042)	(0.040)
Very friendly team	1.339***	1.015***
	(0.042)	(0.041)
Reliable roster	0.729***	0.584***
	(0.041)	(0.038)
Constant	-9.498***	-7.336***
	(0.220)	(0.219)
Observations	12,758	12,700
Adjusted/overall R2	0.297	0.211
rho	0.264	0.294

Table 3.4 – Main effects of job characteristics on job attractiveness and job acceptance, RE estimation results

Notes: */**/*** = significant at the 10/5/1% level. Standard errors clustered at the care worker level. Vignette dimensions and their manifestations (reference categories are underlined): Activity: *Hospital nursing and geriatric nursing*. Institution: *Inpatient care and outpatient nursing service.* Working Hours: *Full time and 50 % part time*. Wage: *eight wage levels.* Contract duration: *One-year fixed-term contract without prospect of extension, one-year fixed-term contract with prospect of extension, permanent contract.* Autonomy: *Little autonomy and much autonomy.* Time for patient: *Little time for patient and plenty of time for patient.* Team: *Not very friendly and very friendly.* Roster reliability: *Rare unforeseen services and roster changes and frequent unforeseen services and roster changes*.

Source: Care worker survey, own calculations.

	(1)	(2)
	Attractiveness Linear RE	Acceptance Linear RE
Hospital nursing	0.042	0.045
Outpatient nursing service	0.019	0.014
Full time (39 h/week)	0.141	0.156
1-year FTC with prospect of extension	0.209	0.244
Permanent contract	0.298	0.364
Much autonomy of how to work	0.159	0.156
Plenty of time for care recipients/patients	0.398	0.389
Very friendly team	0.466	0.461
Reliable roster	0.232	0.243

Table 3.5 – Compensation for worse working conditions

Notes: */**/*** = significant at the 10/5/1% level. Standard errors clustered at the care worker level. Vignette dimensions and their manifestations (reference categories are underlined): Activity: *Hospital nursing and geriatric nursing*. Institution: *Inpatient care and outpatient nursing service.* Working Hours: *Full time and 50 % part time*. Wage: *eight wage levels.* Contract duration: *One-year fixed-term contract without prospect of extension, one-year fixed-term contract with prospect of extension, permanent contract.* Autonomy: *Little autonomy and much autonomy.* Time for patient: *Little time for patient and plenty of time for patient.* Team: *Not very friendly and very friendly.* Roster reliability: *Rare unforeseen services and roster changes and frequent unforeseen services and roster changes*.

Source: Care worker survey, own calculations.

	Activity	Institution	Working hours	Wage	Contract duration	Autonomy	Time for patients	Team	Roster reliability
Activity	x	0	0	0	0	0.191	-0.149	0	0
Institution	0	x	0	0	0.154	-0.157	0	0	0
Working hours	0	0	x	0.007	0.000	0.191	0	0.212	0.139
Wage	0	0	0.007	x	0.015	0.005	0.011	0.013	0.008
Contract duration	0	0.154	0	0.015	x	0.402	0.398	0.681	0.290
Autonomy	0.191	-0.157	0.191	0.005	0.402	x	0.251	0.285	0.178
Time for patients	-0.149	0	0	0.011	0.398	0.251	x	0.510	0.313
Team	0	0	0.212	0.013	0.681	0.285	0.510	x	0.258
Roster reliability	0	0	0.139	0.008	0.290	0.178	0.313	0.258	x

Table 3.6 – Two-way interactions of vignette dimensions

Notes: */**/*** = significant at the 10/5/1% level. Standard errors clustered at the care worker level. Vignette dimensions and their manifestations (reference categories are underlined): Activity: *Hospital nursing and geriatric nursing*. Institution: *Inpatient care and outpatient nursing service.* Working Hours: *Full time and 50 % part time*. Wage: *eight wage levels.* Contract duration: *One-year fixed-term contract without prospect of extension, one-year fixed-term contract with prospect of extension, permanent contract.* Autonomy: *Little autonomy and much autonomy.* Time for patient: *Little time for patient and plenty of time for patient.* Team: *Not very friendly and very friendly.* Roster reliability: *Rare unforeseen services and roster changes and frequent unforeseen services and roster changes*.

Source: Care worker survey, own calculations.

	Hospital nurses	Geriatric nurses	Current nurses	Former nurses	Nurses in inpatient care	Nurses in outpatient care
Activity	+	0	+	++	+	0
Institution	0	0	0	0	−	+
Contract duration	+	+	+	0	++	+
Wage	+	++	++	+	++	+
Team	+	++	+	+	+	++

Table 3.7 – Cross-level interactions

Notes: Interactions between respondent characteristics (horizontally) and vignette dimensions (vertically) are expressed. 0: no interaction effect, +: positive interaction effect, ++: positive interaction effect, which is significantly larger than the effect for the other respective category, −: negative interaction effect. Standard errors are clustered at the care worker level. Dependent variable: job offer acceptance. Vignette dimensions and their manifestations (reference categories are underlined): Activity: *Hospital nursing and geriatric nursing.* Institution: *Inpatient care and outpatient nursing service.* Contract duration: *One-year fixed-term contract without prospect of extension, permanent contract.* Wage: *eight wage levels.* Team: *Not very friendly and very friendly.*
Source: Care worker survey, own calculations.

3.7 Summary and conclusions

Many countries, among them Germany, are suffering from a shortage of nursing personnel. How to tackle this shortage has become a topic of major interest for politics and social sciences. In this paper, we explicitly analyze the influence of job characteristics on the attractiveness of nursing jobs. Using factorial survey methods on a self-conducted survey of (former) nurses, we identified important characteristics for job attractiveness, as well as job offer acceptance, and quantified their influence. Our study is related to the research on nurses' labor supply, nurses' job and occupation retention and nurses' job choices. However, to our best knowledge, we are the first to investigate the causal relations of several job characteristics on job offer acceptance and job attractiveness regarding a cross-section of nurses of all working age groups in a European country and for Germany in particular.

We identified four major findings from our results. The first is that the attractiveness of care jobs is strongly affected by non-pecuniary job characteristics–a finding earlier studies reached as well (Shields & Ward 2001, Holmås 2002, Frijters et al. 2007, Cunich & Whelan 2010, Estryn-Behar et al. 2010, Simon et al. 2010, Zeytinoglu et al. 2011, Doiron et al. 2014). We further found, however, that attractiveness is affected most strongly by rather soft job characteristics, such as atmosphere within the team and time for patients. Rather hard factors play a considerably smaller role.

The second major finding is that there exists one hard job factor that is very important: contract duration is estimated to be among the most important job factors for job attractiveness and job offer acceptance; although this is in line with results from previous studies (Frijters et al. 2007, Cunich & Whelan 2010, Huicho et al. 2012, Rockers et al. 2013), it is a remarkable finding regarding jobs in occupations exhibiting severe skill shortage. This is particularly notable because nurses should easily find a new job after leaving their present one. This disapproval of fixed-term contracts may reflect nurses' strong preference for secure employment and aversion to new work environments. This is further remarkable in so far as fixed-term contracts still exist (20 to 30 percent of nurses are working under a fixed-term contract) in times of skill shortage and the share of fixed-term contracts is even higher than the average share over all occupations and other occupations with skilled labor shortage (Kliner et al. 2017, Statistik der Bundesagentur für Arbeit 2018; own calculations based on SIAB). Rather, employers should have an incentive to offer permanent contracts because it will be difficult for them to hire new nurses if they leave after the end of the fixed term due to nursing skill shortage and because permanent positions would be an effective way to increase attractiveness. Why employers offer fixed-term contracts in times of skill shortage in a part of the economy where demand is almost sure to rise (Hackmann 2010, Hackmann & Moog 2010) is open to future research. First possible explanations may lie in the reaction of firms to heterogeneous worker preferences (Long et al. 2008), an extensive screening phase of firms to guarantee quality standards or a fixed time horizon in the case of parental leave replacement.

The third major finding deals with wages. Although the wage has a statistically significant influence on attractiveness, substantial wage increases would be required to yield higher attractiveness gains than the top-rated soft factors or to compensate for less pleasant job characteristics with respect to those factors. As a consequence, monetary compensation for unpleasant working conditions will be costly. To compensate for unpleasant working conditions with respect to the most relevant job characteristics (e.g., team, time with care recipients/patients, contract duration) wage raises between 20 and 47 percent would be necessary. This is far from what policymakers and employers were willing to offer in minimum wage raises or in collective agreements so far. If employers and policymakers want to significantly increase the attractiveness of nursing jobs and are not willing to provide substantial wage raises, changes in other job characteristics will be necessary. Especially rewarding strategies will be those providing improvement on more than one of the relevant job characteristics.

The last major point deals with a German peculiarity: the separation between geriatric and

hospital nursing occupations. Our results show that, even after controlling for other job characteristics, hospital nursing is still rated more attractive than geriatric nursing. This is, for one thing, in line with what we assumed from previous literature (Bomball et al. 2010, Matthes 2016). This finding, for another thing, reinforces the argument for a recent policy change in the German system of vocational training for nurses, where training for geriatric and hospital nurses was unified (Deutscher Bundestag 2017). In light of our findings, one could argue that the change to a more generalist training for nurses could at least increase the attractiveness of training to become a geriatric nurse.

3.8 Appendix to chapter 3

Vignette intro

"Jobs differ in many ways. The following part of the survey contains descriptions of some fictitious job offers in nursing and care for the elderly. All vacancies are fictitious but could happen in reality. We selected all features of the offered positions at random. At the end of each job description, we would like to hear from you about how attractive the job offered is to you and how likely you would be to accept it if it were offered to you. To do this, we ask you to place your cross on the attached response scales according to your assessment. You can answer the job descriptions in any order. If necessary, you can correct your answers at any time during the survey. Please note the following:

1. All offered positions are activities in direct nursing care.
2. The prerequisite for the start of all positions offered is a completed training as a specialist in health and nursing, health and child care or geriatric care.
3. All jobs are in the same place as your previous job.
4. There are enough quality childcare facilities near all jobs.
5. At all workplaces, there is a normal shift operation with industry-standard extent of night and weekend services as well as on-call duty.
6. All employers have an average number of employees or beds.
7. All employers are highly regarded in nursing circles."

Source: Care worker survey.

Chapter 4

Heterogeneous effects of monetary and non-monetary job characteristics on job attractiveness in nursing

4.1 Introduction

The relevance of trade-offs between wages and non-monetary job characteristics for job choice has long been recognized in economic research, as has the relevance of heterogeneous preferences of workers in the process of sorting labor to jobs (Rosen 1986). Empirical studies analyzing the preferences of workers and potential applicants for job characteristics affirm the importance of both monetary and non-monetary job characteristics (Montgomery & Ramus Catherine A. 2011, Doiron et al. 2014, Eriksson & Kristensen 2014, Scott et al. 2015, Mas & Pallais 2017, Fields et al. 2018, Maestas et al. 2023, Wiswall & Zafar 2018, Soekhai et al. 2019, Johnson 2021, Non et al. 2022). Results obtained by conventional subgroup analysis show considerable heterogeneity regarding individual preferences and the willingness-to-pay for pleasant job characteristics and shed light on the consequences of employees' respective sorting behavior. Non et al. (2022), Maestas et al. (2023), Wiswall & Zafar (2018), Mas & Pallais (2017), and Eriksson & Kristensen (2014) find differences in preferences for job characteristics by gender that can help explain the gender pay gap, as women and men sort into jobs with different characteristics. Heterogeneities also arise with respect to other individual characteristics, such as age, present wage, education (Maestas et al. 2023, Eriksson &

Kristensen 2014), qualification (Johnson 2021), and ethnicity (Maestas et al. 2023). What is more, Maestas et al. (2023) find that gaps in favorable working conditions between ethnicity, age, and education groups do not align with differences in the respective individual preferences.

Results based on subgroup analyses provide convenient measures of the respective preference structures. However, they only give a mere presentation of average and group-average effects. To provide a complete representation of the effect heterogeneity, we apply the Sorted Effects Method (SEM) described by Chernozhukov, Fernández-Val & Luo (2018), to systematically analyze preference heterogeneity regarding job characteristics and trade-offs between wage and non-monetary job characteristics. The standard approach, i.e., to present results for selected subgroups, may raise the suspicion that researchers have searched for subgroups with distinguished treatment effects (Assmann et al. 2000, Cook et al. 2004, Wager & Athey 2018). The classification analysis tackles this concern and gives a more salient representation of where significant differences can be found, and where not. Potentially the heterogeneous partial effects could be estimated using other methods, such as novel machine learning methods (e.g. Athey et al. 2019, Nie & Wager 2019, Chernozhukov et al. 2017). In this paper we follow Chernozhukov, Fernández-Val & Luo (2018) and apply a linear interactive model.

Because of their significance for public health, we focus on nurses' preferences over job characteristics. We employ data from a self-conducted survey experiment, which focused on the relevance of the team atmosphere, the time nurses have with their patients, work autonomy, roster reliability, contract duration, and whether a job is in part or full time. In a companion paper, Kroczek & Späth (2022) analyze the same data set and present estimates of average effects. They find that all this six characteristics have a significant effect on job attractiveness. Further studies confirm the relevance of a positive work environment with respect to team and management (Doiron et al. 2014, Fields et al. 2018, Li et al. 2023), autonomy and working hours (Scott et al. 2015), as well as permanent employment contracts (Huicho et al. 2012, Rockers et al. 2013) for nursing job attractiveness in discrete choice experiments. The time for patients and roster reliability have been studied less in the previous literature but have been shown to have a significant average effect on job attractiveness by Kroczek & Späth (2022).

On average the effects of the team atmosphere, the time nurses have with their patients, work autonomy, roster reliability, contract duration, and full-time employment are positive; however, the effects may vary. Full-time employment, for example, may be preferred by some individuals, but others may prefer part-time jobs in order to balance work with other obligations. A high

degree of work autonomy or more time for patients could also be important for some people, while others prefer less work autonomy or quick completion of daily tasks. Even with regard to the generally positively perceived characteristics of a good team, a permanent contract and a reliable roster, differences in importance can exist. To analyze these heterogeneities, we adopt two perspectives. First, we analyze the six non-monetary job characteristics, separately. Second, we study trade-offs between non-monetary job characteristics and wages. To analyze such trade-offs, it is common to convert the effects of non-monetary characteristics into wage changes (Scott 2001, Doiron et al. 2014, Eriksson & Kristensen 2014, Scott et al. 2015, Mas & Pallais 2017, Fields et al. 2018, Wiswall & Zafar 2018, Non et al. 2022). The rate at which individuals will trade wage against non-monetary characteristics, the willingness-to-pay, is informative, and often provides a handier interpretation than the estimation coefficients. The measure is usually calculated from average effects or group average effects, and therefore is only a summary of the trade-offs individuals will make on average. Our approach differs in that we account for two potential sources of heterogeneity. First, we present trade-offs between wages and non-monetary characteristics at different wage levels. Thus, instead of a single measure of willingness-to-pay for a job characteristic across all wage levels, we consider trade-offs across different wage increases at different base wages; this does not give us a single measure of willingness-to-pay, but we can represent differences in trade-off propensities across different wage differentials and base wages. Second, for these trade-offs, we again represent heterogeneity across individual and occupational characteristics.

We find significant effect heterogeneity regarding the non-monetary job characteristics and the trade-offs between wage and non-monetary job characteristics. In line with previous studies, we find heterogeneities with respect to gender (Non et al. 2022, Maestas et al. 2023, Wiswall & Zafar 2018, Mas & Pallais 2017, Eriksson & Kristensen 2014) and age (Maestas et al. 2023, Eriksson & Kristensen 2014; concerning nursing jobs: Doiron et al. 2014). Other than previous studies, we also find heterogeneities with respect to further characteristics related to an individual's present job, such as working hours, contract duration, and job satisfaction. We also extend the scope of previously analyzed potential drivers of heterogeneity and examine relations to the respondent's motivation to enter their occupation. Individuals who value time with their patients especially high stated that they entered nursing because they wanted to work with humans and wanted to work in an occupation with diverse tasks significantly more often. These individuals are less willing to trade time with the patients for wages. Our main results account for multiple testing. We find that the p-values of the corresponding tests for statistical

significance are sensitive to multiple testing problems and could, therefore, in a standard subgroup analysis, in which many subgroups are analyzed, lead to false discoveries of significant differences (Romano et al. 2010). Other than Maestas et al. (2023) and Eriksson & Kristensen (2014), our results do not indicate that the relevance of non-monetary working conditions generally increases with an individual's present wage level. However, our results show that individuals value combinations of high wages and positive non-monetary characteristics higher, the higher the wage, i.e., we find positive interaction effects between offered wage and offered non-monetary characteristics. We therefore reach the same conclusion as Maestas et al. (2023), that amenities are normal goods, the willingness-to-pay increases as individuals have more wage available, and which is in line with the findings of Hamermesh (1999) and Pierce (2001), that taste for amenities is wage-elastic. However, our results show that almost all individuals trade non-monetary job characteristics for higher wages if wage changes are large enough.

Our results point to implications for policymakers and employers in general, as well as regarding nursing occupations. The general implications closely relate to two conclusions from the hedonic theory of wages; namely that workers with heterogeneous preferences sort to jobs that best match these preferences, and that job characteristics can therefore be used as a sorting device, as well as the notion of compensating wage differentials, i.e., that differences in (dis-)amenities between jobs are compensated for by wage differentials (Rosen 1986). First, as our results show that (potential) employees exhibit heterogeneous preferences over job characteristics, there may not exist the one ideal measure (or bundle of measures) to make jobs more attractive. Differentiation of job characteristics (job offers) to fit those differing preferences can therefore be a more effective and efficient way to attract workers than a "one size fits all" solution. What is more, a smart combination of compensation and amenities can help attract workers with desired characteristics. A notion that has already been explicitly considered in the case of nursing (Heyes 2005). Second, higher wages can be used to compensate for non-monetary job characteristics. However, our results also show that this can be costly, depending on the characteristic, the individual, and the alternatives. Further, it may be fruitful to combine high wages and other pleasant job characteristics to attract personnel. With special consideration of nursing occupations, we identify salient characteristics, along which we find effect heterogeneity, such as the present number of working hours. Employers could differentiate recruitment efforts along those characteristics in order to attract employees more efficiently.

The rest of this paper is structured as follows. We provide an overview of our data in section 4.2. The methodological background of our analysis is laid out in section 4.3. In section 4.4 we present our results. Section 4.5 concludes.

4.2 Data

For our analysis, we employ data from a self-conducted survey of (former) nurses to assess the question of which factors drive job attractiveness and job offer acceptance. The survey comprised two parts, a factorial survey and an item-based part. In the factorial survey, we presented each respondent with ten vignettes, describing fictional advertisements of care jobs. We then asked the care workers to rate the attractiveness of the fictional job offers on an eleven point scale. As an analysis of heterogeneity in the effects of job characteristics requires extensive individual information, we surveyed information on the respondents and their present and previous work situation in the item-based part.

The survey was conducted as paper and pencil interview in a specific region in Germany in late 2018. In total we received information from 1,607 filled questionnaires, which amounts to a response rate of around 20 percent. After data cleansing, we were left with 1,313 completed interviews. Because of missing values, our analysis is based on 7,408 rated job offers. Though we are not able to perform a thorough comparison of the individuals' characteristics in our analysis and in the gross sample as we collect the lions share of the analyzed information from answers to the survey questions, we can compare the share of women, the share of Germans, and the average age between the gross sample and the analysis sample. Table 4.13 in the appendix provides the respective averages and p-values of t-tests for differences in the means. We find that the share of women and the average age is similar in both samples, the share of non-Germans, which is already very small in the gross sample, is significantly smaller among the respondents in our analysis sample.[1]

[1] A lower response rate of foreign nationals is not an uncommon phenomenon in surveys (Etter & Perneger 1997).

4.2.1 The factorial survey

The factorial survey allows for insights into the implicit preferences of interviewees and mitigates a potential social desirability bias of the answers in the survey (Auspurg & Hinz 2015). Because of its benefits, the factorial survey method has already been applied in the literature on job offer acceptance and job attractiveness (Abraham et al. 2013, Auspurg & Gundert 2015, Bähr & Abraham 2016, Wiswall & Zafar 2018). As part of the factorial survey, fictional job advertisements were presented to care workers in form of a series of vignettes in text form. The methodological considerations which guided the choice of the number of vignette dimensions, their levels, and the selection of the eventual vignette sample that entered the survey are laid out in the following section and in more detail in the additional appendix.

The vignettes contain wage as one dimension. To access the influence of non-pecuniary characteristics, work autonomy, time for patients, atmosphere within the team, roster reliability, working hours, contract duration, the type of care activity (hospital or geriatric nursing), and the kind of care institution (in- or outpatient care) enter the vignettes. We selected the specific dimensions for the respective domains in a multistage process which included an exploration of the relevant literature, expert interviews, and pre-tests to identify the most prominent or most relevant dimensions. The dimensions of care activity and care institution are not prominent in the international literature and are not discussed in this analysis; differentiation along those characteristics is relevant in the German context, however. Reading from top to bottom, the right column of table 4.14 in the additional appendix lists all conceivable vignette constellations, i. e., the vignette universe from which we draw the (factorial) vignette sample.

The care workers evaluated how attractive the presented job offer is to them. Table 4.15 in the additional appendix presents the rating scale. We employ a 11-point scale, which has been found to work well in the literature (Auspurg & Hinz 2015).

To abstract from the fact that the evaluation of the vignettes might be affected by other unknown confounding variables, the vignette text was preceded by a vignette intro. In the intro, essential confounders, which possibly affect job attractiveness, but are not under control of the employer or not in the focus of this study (e.g., commuting distance from home), were "controlled" by being (fictitiously) held at a level that remained constant over the vignettes.

4.2.2 Design of the factorial survey

Choice of number of dimensions, levels, and vignettes per respondent

As factorial surveys are more complex than standard surveys, particular effort is needed in order not to overburden respondents with the survey setup. Specifically, the number of the vignettes presented to every respondent, the number of dimensions every vignette contains as well as the levels per vignette dimension need to be considered. Although a larger number of dimensions would enable us to study more job characteristics, vignettes with too many dimensions can become too complex, overburden respondents and lead to inconsistent judgments (Sauer et al. 2011). Also, if respondents are presented with too many vignettes, they have been found to show fatigue effects or employ specific rating heuristics (Sauer et al. 2011, 2014). We, therefore, follow the methodological literature, which suggests (depending on the concrete setup) a maximum number of nine vignette dimensions and ten vignettes per respondent (Auspurg & Hinz 2015).

The vignette universe and the vignette sample

All combinations of the vignette characteristics in our survey (see table 4.14 in the additional appendix) constitute a universe of $2^7 3^1 8^1 = 3072$ vignettes. To reduce the survey load, we therefore draw a sample from the original vignette universe. Determination of the size of the vignette sample was guided by considerations on the separability of the vignette dimensions and the expected number of rated vignettes. Therefore, we are looking for an efficient sample with the smallest number of vignettes to be evaluated, so that each vignette is evaluated by as many people as possible. We measure the efficiency of the sample by the D-efficiency, a measure of the orthogonality of the vignette dimensions with respect to each other.[2] A rule of thumb says that this should exceed 90 for a sufficiently orthogonal sample design (Auspurg & Hinz 2015, p. 29). How the sample is drawn also depends on the number of interaction terms which should be identified. In the case of our survey, all main effects and all two-way interactions should be identified (Resolution V design, Auspurg & Hinz 2015, pp. 26-27). In

[2]The D-efficiency is a measure of the orthogonality of the constellations of the vignette universe depicted in the sample. It takes on values between 0 and 100, where 100 represents complete orthogonality.

result, we drew a fractionalised[3] sample of 200 vignettes, which were blocked to 20 decks by fractionalised blocking. The sample reaches a D-efficiency of 95, which lies well above the rule of thumb threshold.

The vignettes were blocked in 20 decks of ten vignettes, whereby the decks where assembled in a way as to maximize the same target criteria as in drawing the vignette sample, i. e. orthogonalization of the characteristics while preserving identifiability of the main effects and all two-way interactions (Auspurg & Hinz 2015). Unlike the composition of the decks, their internal arrangement was random. The questionnaires, and with them the decks, were then randomly mailed to the respondents.

Even though we cannot control who is responding, i. e., we cannot control that every vignette is rated by several people, we are quite confident that vignette characteristics and individual characteristics are not confounded; on average each vignette in our net sample was rated by over 35 persons. Moreover, we achieve a high degree of independence in the net sample with respect to the characteristics of the vignettes. Analyzing our final sample, we find the correlation coefficients between all single dimensions to be below 0.05.[4]

4.2.3 Sample characteristics

Table 4.1 gives the basic summary statistics of our analysis data set. The numbers in the table refer to all the characteristics we employ in analyzing effect heterogeneity, individual characteristics, individual's motivation to become a nurse, characteristics of the job an individual presently holds, and a summary of the manifestations of the vignette characteristics in the analyzed job offers. Also, the average rating of a job offer is given.

With regard to individual characteristics, the high proportion of women among the respondents is particularly striking, which is typical for the nursing profession. In addition, it is also evident that almost 30 percent of the respondents have a child of school age. With regard to the motivation to become a nurse, the desire to have contact with people at work stands out

[3]This means a sample with maximum information in the sense of the orthogonality of the vignette dimensions is drawn ("efficient design"). The higher information density of fractionalised samples as opposed to random samples is evidenced by research (Johnson et al. 2006, Kuhfeld et al. 1994). The criterion for the efficiency of sampling is the D-efficiency (see previous footnote).

[4]Table 4.12 in the appendix presents the respective correlation coefficients.

Individual characteristics			
	Mean	SD	N (Respondents)
Age in years	43.71	12.16	751
German	0.97	0.15	751
Female	0.87	0.33	751
Matriculation standard	0.23	0.42	751
Child below 14	0.28	0.45	751
Partner with a job	0.65	0.48	751
Motivation to become a nurse			
	Mean	SD	N (Respondents)
Human contact	0.81	0.39	751
Diverse work	0.62	0.49	751
Help others	0.60	0.49	751
Career/Development	0.35	0.48	751
Teamwork	0.43	0.50	751
Safe job	0.41	0.49	751
Medical interest	0.67	0.47	751
Social interest	0.47	0.50	751
Present job characteristics			
	Mean	SD	N (Respondents)
Working hours	29.78	9.78	751
Unplanned shifts per month	2.56	2.55	751
Hourly wage	18.41	4.81	751
Work in direct care	0.90	0.30	751
Fixed-term employed	0.10	0.29	751
Satisfaction with job (scale 1-4)	2.88	0.78	751
Vignette characteristics and rating			
	Mean	SD	N (Vignettes)
Attractiveness rating (scale 1-11)	3.87	3.02	7,408
Team	0.50	0.50	7,408
Time for patients	0.50	0.50	7,408
Autonomy	0.48	0.50	7,408
Reliable roster	0.51	0.50	7,408
Permanent contract	0.32	0.47	7,408
Full-time employment	0.51	0.50	7,408
Wage	21.54	6.89	7,408

Table 4.1 – Summary statistics

Source: Care worker survey and Integrated Employment Biographies (IEB) from the Federal Employment Agency (BA).

in particular, with 81 percent stating this as the motivation for becoming a nurse. High proportions of 62 and 60 percent of respondents attached importance to diverse work and work in which they can help others, respectively, when choosing the occupation. In terms of their current job, the average respondent was more satisfied with their work. For the vignette characteristics, it becomes clear that for all characteristics that were recorded with two levels, approximately 50 percent of the cases are accounted for by each materialization. The contract duration was recorded in three levels (fixed, fixed with the prospect of extension, permanent), of which we only analyze the difference between any contract with a fixed duration and a permanent contract due to the clearer interpretation. Therefore only 32 percent of jobs offer a permanent contract. The average wage of the job advertisements is 21.54 euros. On average, the jobs are rated rather in the lower range with 3.87 points out of 11, but as expected, the ratings show a strong variation.

4.3 Methods

4.3.1 Framework

We observe $i : 1, ..., N$ individuals who obtain $j : 1, ..., J$ hypothetical job advertisements. Each observation can be described by (Y_{ij}, X_i, W_{ij}), where Y_{ij} denotes the attractiveness rating of the advertisement j by individual i, X_i is a vector of individual specific characteristics, and $W_{ij} \in \{0, 1\}$ is a randomly assigned treatment indicator. The definition of W_{ij} depends on the exact question (single job characteristics or their trade-offs with wages) and therefore refers to different types of treatments in different contexts.

In the first part of the paper, we analyze the impact of important job characteristics on the attractiveness rating of a job offer. W_{ij} is equal to one if the job advertisement has a certain characteristic and zero if not. We consider the following characteristics:

- cordial team, where W_{ij} takes the value 1 for an advertisement with a very cordial and 0 for an advertisement with a less cordial team,
- time for patients, where W_{ij} takes the value 1 for an advertisement with much time for

patients and 0 for an advertisement with little time for patients,[5]

- autonomy, where W_{ij} takes the value 1 for an advertisement with much autonomy and 0 for an advertisement with little autonomy,
- roster reliability, where W_{ij} takes the value 1 for a job with a very reliable roster and 0 for a less reliable roster,
- contract duration, where W_{ij} takes the value 1 for a job with a permanent contract and 0 for a job with a fixed-term contract,
- and full-time employment, where W_{ij} takes the value 1 for a full-time job and 0 for a part-time job.

Because of the factorial survey design, job characteristics are independent from each other. Therefore, we use separate models for each job characteristic without controlling for the others.

In the second part of the paper, we analyze the substitution between the non-monetary characteristics and hourly wages. In this context, W_{ij} equals 0 if a job advertisement offers a more pleasant non-monetary characteristic (e.g., a more cordial team) at some defined base wage. We call this a non-monetary job offer. We compare this job offer to one that offers an alternative wage, which is equal to or larger than the base wage, but offers a less pleasant respective job characteristic (e.g., a less cordial team). In the latter case, W_{ij} equals 1. This kind of job offer is called a monetary job offer. For job offers that offer neither the base wage nor the alternative wage, W_{ij} is not defined.

Using information on Y_{ij} and W_{ij}, we can write the average effect of a binary treatment W_{ij} as

$$\bar{\tau} = \mathbb{E}\left[Y_{ij}(W_{ij} = 1) - Y_{ij}(W_{ij} = 0)\right]. \tag{4.1}$$

However, effects may differ with respect to individual characteristics X_i. If this is the case, policymakers might want to differentiate their policies between target groups. Therefore, the aim of this paper is to estimate treatment effects of a binary treatment W_{ij} conditional on given individual characteristics $X_i = x$,

$$\tau(x) = \mathbb{E}\left[Y_{ij}(W_{ij} = 1) - Y_{ij}(W_{ij} = 0)|X_i = x\right]. \tag{4.2}$$

[5] Job offers either offer little or much time to "occasionally have a personal conversation with the patients".

4.3.2 The Sorted Effects Method

To analyze the heterogeneity in treatment effects, we apply the Sorted Effects Method, an approach to summarize effect heterogeneity proposed by Chernozhukov, Fernández-Val & Luo (2018). The main idea is to estimate the entire set of partial effects sorted in increasing order and to rank them according to effect size, rather than to present one measure for the effect of interest, e.g., the average effect. Chernozhukov, Fernández-Val & Luo (2018) provide general results and means to apply them in different frameworks, one of which is the interactive linear model with additive error term:

$$Y_{ij} = g(T_{ij}) + \varepsilon_{ij} = Z(W_{ij}, Q_{ij})'\beta + \varepsilon_{ij},\ T_{ij} = (W_{ij}, Q_{ij}), \tag{4.3}$$

where $Z(W_{ij}, Q_{ij})$ contains the treatment indicator W_{ij} as well as Q_{ij}, which comprises transformations of X_i as well as interactions between W_{ij} and X_i, which capture the treatment effect heterogeneity with respect to individual characteristics. The starting point is the estimation of the predictive effects (PE), the treatment effects for all individual-specific realizations $Q_{ij} = q$. In the case of an interactive linear model with additive error term of the form of equation 4.3, the PE is given by

$$\tau(t) = Z(1, q)'\beta - Z(0, q)'\beta, \tag{4.4}$$

where β is a column vector comprising coefficients on all elements of q, in our analysis interactions between all individual characteristics and the treatment indicator. If μ is the distribution of T in the population, aggregation of the PEs over μ yields the average treatment effect. However, Chernozhukov, Fernández-Val & Luo (2018) propose to report the entire set of PEs, $\tau(T)$, sorted in increasing order and indexed by ranking $u \in [0, 1]$. The u-th quantile of $\tau(T)$ is the uth-Sorted Partial Effect (u-SPE). Displaying the SPEs at different (increasing) values of u, i.e., at different quantiles of the estimated effect, yields a one-dimensional representation of the heterogeneity in the PEs.

Empirically, sample analogs of τ and μ are employed to obtain estimators of the SPEs. In case of the interactive linear model with additive error, the PE estimator $\hat{\tau}(t)$ is obtained by replacing β in equation 4.4 with its ordinary least squares estimator $\hat{\beta}$,

$$\hat{\tau}(t) = Z(1, q)'\hat{\beta} - Z(0, q)'\hat{\beta}. \tag{4.5}$$

The sample analog of μ, $\hat{\mu}(t)$, is estimated using the empirical cumulative distribution of t for

all observations in sample S,

$$\hat{\mu}(t) = \sum S\, 1\{T_{ij} \leq t\} / \sum S\,, \tag{4.6}$$

where $1\{\cdot\}$ is an indicator function and hence $\sum S\, 1\{T_{ij} \leq t\}$ is the number of observations in the sample for which characteristics T_{ij} are smaller or equal to t. $S = 1$ for observations in the sample (e.g., the treated subpopulation) and $S = 0$ for observations outside the sample (e.g., the untreated subpopulation). We calculate $\hat{\mu}(t)$ from the entire distribution, i.e., $S = 1$ for all observations.

4.3.3 Omnibus test for heterogeneity

To test for effect heterogeneity, we follow Chernozhukov, Demirer, Duflo & Fernández-Val (2018). They suggest estimating a linear model of the form

$$Y_{ij} = \alpha + \beta_1 \left[W_{ij} * \bar{\tau}\right] + \beta_2 \left[W_{ij} * (\hat{\tau}(t) - \bar{\tau})\right] \tag{4.7}$$

via ordinary least squares, where $\hat{\tau}(t)$ is the predicted effect for individual i with characteristics t, $\bar{\tau}$ is the average of these predictions over μ. Intuitively, we regress the observed job rating Y_{ij} on the average added value of the treatment, the individual added value that depends on individual characteristics and on a constant that captures the mean attractiveness. Therefore, β_2 captures the heterogeneity captured by the model. Put differently, if β_2 is statistically significantly different from zero, the null hypothesis of no effect heterogeneity is rejected.

4.3.4 Classification analysis

To analyze associations between individual-level characteristics and effect heterogeneity, Chernozhukov, Fernández-Val & Luo (2018) suggest undertaking a classification analysis (CA). The aim is to understand how observations with high and low effect sizes, e.g., in the upper and lower u percent of the effect distribution, differ in observable characteristics. The classification analysis for the u-least and u-most affected subpopulation (u-CA) then comprises two steps:

1. Assign all observations with $\tau(T) < \tau^*(u)$ to the u-*least affected* subpopulation, and all observations with $\tau(T) > \tau^*(1-u)$ to the u-*most affected* subpopulation.

2. Obtain the moments and distribution of the characteristics of observations in the least and most affected subpopulation.

To obtain the empirical u-CA, $\tau(T)$ and $\tau^*(u)$ are replaced by their sample analogs $\hat{\tau}(T)$ and $\hat{\tau^*}(u)$. Then the moments and distribution of the characteristics of observations in the least and most affected subpopulations are estimated by their empirical analogs in the least and most affected subsamples.

Following Chernozhukov, Fernández-Val & Luo (2018), we analyze differences between the upper and lower ten percent quantile of the effect distribution. To check the robustness of the classification analysis, we also calculate the differences between the upper and lower 20 percent quantile. As a central part of their paper, the authors further provide consistent estimators of measures of variation (standard errors and confidence bands) for both the SPE and the CA based on bootstrap procedures. In comparing the characteristics of the least and most affected groups we simultaneously test several hypothesis. This can lead to the false rejection of the (true) null hypothesis of no difference in values between the two groups. Chernozhukov, Fernández-Val & Luo (2018) implement a single-step multiple testing procedure to control the familywise error rate, the probability of one or more false discoveries (Romano et al. 2010). We base our inference regarding the differences between most and least affected groups on this single-step method, which provides conservative p-values at the "cost" of power.[6]

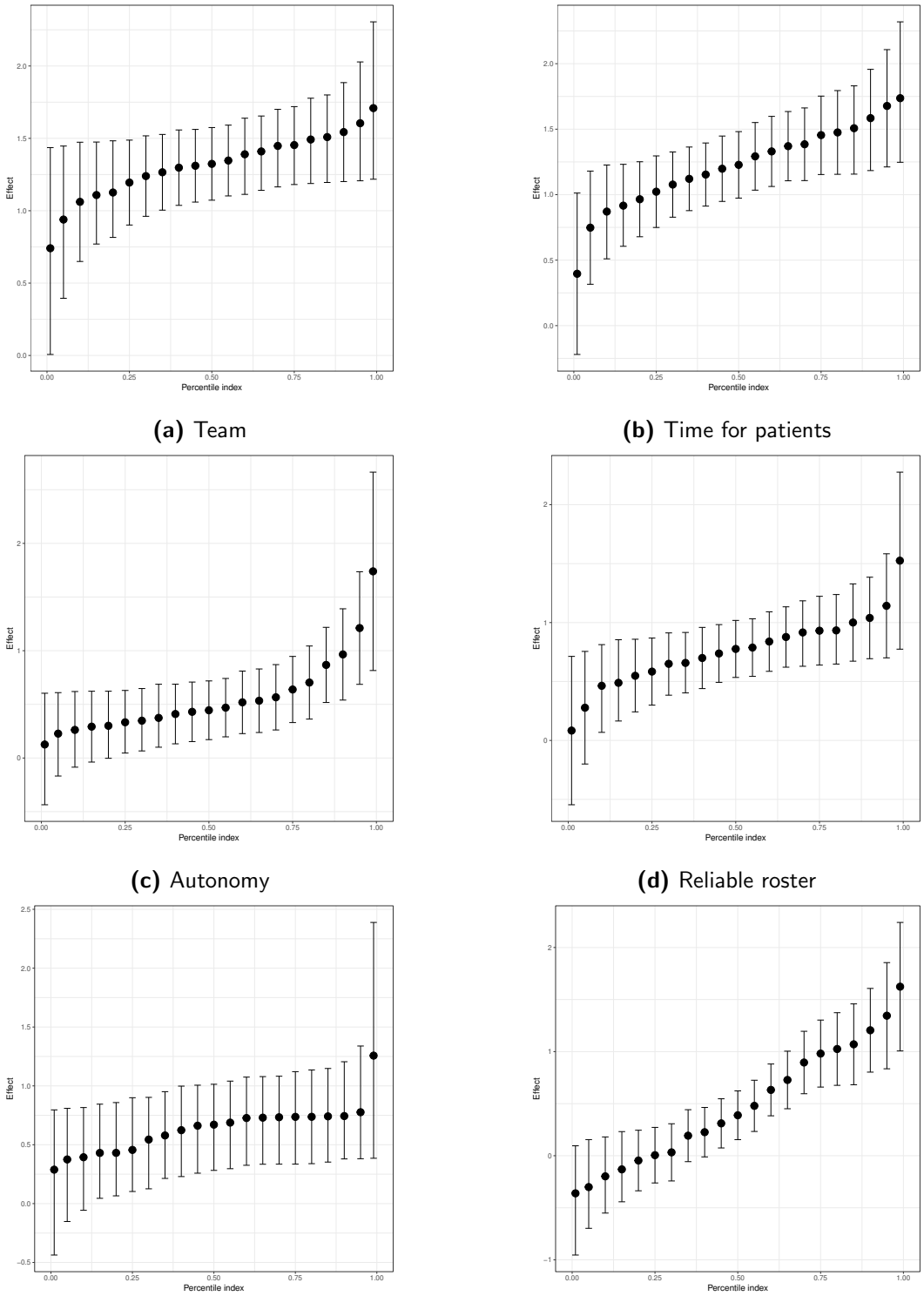
4.4 Results

4.4.1 Effect of job characteristics

Sorted effects

The average treatment effect provides a useful summary of the impact of a treatment. However, an average treatment effect is only a summary measure for a number of individual treatment effects, which can differ significantly. In this section, we use the SEM described in

[6]As Chernozhukov, Fernández-Val & Luo (2018) point out, p-values based on step-down methods may provide higher power, see also Romano et al. (2010).



(a) Team

(b) Time for patients

(c) Autonomy

(d) Reliable roster

(e) Permanent contract

(f) Full time

Figure 4.1 – Sorted Partial Effects of a cordial team, much time for patients, more autonomy, a reliable roster, a permanent contract, and full-time employment on job attractiveness. Estimates and 90 percent bootstrap confidence bands.

Notes: The average partial effects of a cordial team, much time for patients, more autonomy, a reliable roster, a permanent contract, and full-time employment amount to 1.3, 1.2, 0.5, 0.8, 0.6, and 0.5 points on the attractiveness scale, respectively.

section 4.3.2, to describe how the treatment effects differ.[7] To test for heterogeneity, we apply the omnibus test described in section 4.3.3. Figure 4.1a shows the SPE for an increase in the quality of a team, from a less cordial team to a very cordial one. On average, this raises the attractiveness by 1.3 points on the ten-point scale. The estimated effect sizes for individuals with different characteristics range from 0.7 at the 0.01 percentile to 1.7 at the 0.99 percentile. A more cordial team has a positive effect for individuals in all percentiles. The size of the effect clearly differs, though. Based on the omnibus test, we can reject the null of no presence of heterogeneity in effect sizes. Figure 4.1b shows the results for an increase in the time nurses have for their patients. The estimated average effect is 1.2. The SPE shows greater effect heterogeneity compared with the effect of a cordial team. The estimated SPE ranges from 0.4 to 1.7. As indicated by the omnibus test, there is a statistically significant amount of heterogeneity in effect sizes. The SPEs of more autonomy and of a reliable roster are shown in figures 4.1c and 4.1d, respectively. The effects range from 0.1 to 1.7, with an average effect of 0.5 for autonomy and from 0.1 to 1.5, with an average effect of 0.8 for a reliable roster. Again, the tests for heterogeneity are significant. Panels 4.1e and 4.1f of figure 4.1 exhibit the SPEs for jobs with a permanent rather than a fixed contract and full-time vs. part-time jobs. The point estimate of the treatment effect of a permanent contract, again, is positive at all quantiles, from 0.3 at the first to 1.3 at the 99^{th} percentile. The respective average effect is 0.6. Full-time employment is the only presented characteristic, which exhibits negative point estimates for the lowest quantiles. Though the average effect is clearly positive at 0.5, i.e., full-time employment is preferred on average and even the effect at the first percentile is not statistically different from zero at the five percent significance level, the point estimates range from -0.4 to 1.6.

In summary, the SPEs give a more complete picture of what is behind the average effects. As the SPEs for all characteristics but full-time employment only take on positive values, all analyzed characteristics other than full time are undisputed positive job features. The negative point estimates for full-time employment show that some individuals may prefer part-time employment, though most prefer full-time jobs. All job characteristics exhibit a statistically significant amount of heterogeneity. However, the extent differs. A good team does not only have the largest average effect, the SPE also shows a small degree of effect heterogeneity compared with the other analyzed characteristics. This further underlines the important role

[7] We present estimates of the 1, the 99 percent quantile and, for the 5 to the 95 percent quantile in steps of 5 percentage points.

of a cordial team. A permanent contract also shows comparatively little effect heterogeneity. Nevertheless, some individuals value a permanent contract, whereas others do not care about the contract situation. The SPEs reveal a much larger amount of heterogeneity of having more autonomy, more time for patients, and full-time employment. Preferences regarding these three job characteristics are much more heterogeneous than preferences for a good team or a reliable roster.

Classification analysis

To explain the drivers of heterogeneity, we follow Chernozhukov, Fernández-Val & Luo (2018) and report results from a classification analysis. Here, we analyze whether there exist significant differences in characteristics between observational units in the lower and in the upper 10 percent quantile of effect sizes. In table 4.2 we present the differences between the means of the respective characteristics in the least and most affected group. Individuals in the most and least affected groups differ regarding their individual and work situation as well as their work satisfaction and their motivation to becoming a nurse, initially. When we adjust for multiple testing, only a few differences remain statistically significant. These differences partly align with results of previous research. However, we also uncover preference heterogeneity with respect to further characteristics.

The CAs reveal differences with regard to personal characteristics, an individual's present job, and their motivation to becoming a nurse, in the first place. With regard to personal characteristics, we find that women have a significantly higher preference for working part time than men do. This is in line with previous research (Wiswall & Zafar 2018) and matches the fact that women are working part-time jobs more often than men do.[8] What is more, a good team is valued higher by women than by men. Regarding the other job attributes we do not find significant differences between those who value them very high and those who do not value those attributes very much. Mas & Pallais (2017) show that differences between women and men in preferences for work arrangements–in their case working from home and avoiding irregular schedules–is driven by women with young children. Eriksson & Kristensen (2014) also find a relation between young children and preferences for flexible working hours. Focusing on nurses, Doiron et al. (2014) reach the same conclusion. Having children below the age of 14

[8]Regarding Europe and Germany, see `https://ec.europa.eu/eurostat/web/products-eurostat-news/w/EDN-20230303-1`.

	Team	Time	Autonomy	Reliable roster	Permanent contract	Full time
Personal characteristics						
Age	-1.652	1.406	-7.348 *	-4.148	-0.664 **	-14.251 ***
German nationality	0.025	-0.063	-0.247 ***/+++	0.108	-0.299 ***/++	0.080 *
Female	0.825 ***/+++	0.301 **	0.180	0.159 **	0.403 **	-0.925 ***/+++
Schooling	0.353 **	-0.570 ***	0.355 ***	0.262 *	-0.307	0.269 *
Child below age 14	0.578 ***	0.599 ***	-0.250	-0.195	0.187	-0.119
Partner with a job	0.549 ***	0.693 ***	-0.166	-0.378 **	0.001	-0.375 **
Motivation to become a nurse						
Human contact	-0.233	0.903 ***/+++	-0.265 *	-0.351 **	-0.034	-0.214 *
Diverse work	-0.372 *	0.807 ***/+	0.418 **	0.304	0.361 *	-0.372 **
Help others	-0.177	0.719 ***	-0.192	-0.136	1.084 ***/+++	-0.604 ***/+
Career/Developm.	0.098	0.040	0.346 **	0.664 ***	0.009	0.066
Teamwork	-0.023	-0.516 ***	-0.569 ***	-0.328	-0.153	-0.308 *
Safe job	-0.174	0.009	0.072	-0.660 ***	-0.154	0.113
Med. interest	0.484 **	-0.137	-0.220	0.188	0.284	0.286 *
Social interest	-0.487 **	-0.072	0.225	-0.479 **	0.120	-0.481 ***
Present job characteristics						
Hours	-22.082 ***/+++	-21.867 ***/+++	-7.436 **	-9.318 **	12.297 **	22.288 ***/+++
Unplanned shifts per month	-0.129	0.356	-0.695	-1.568	-1.920	-0.143
log of hourly wage	0.020	0.129	-0.493 ***	-0.342 *	-0.693 ***	-0.131
Works in direct care	0.277 **	0.245	-0.130	0.065	0.387 ***	0.276 **
Fixed-term employed	0.333 **	-0.093	0.718 ***/+++	0.396 **	-0.175	-0.228 **
Satisfaction with job	0.809 **	0.336	-0.440 *	-1.469 ***/++	0.081	-0.049

Table 4.2 – Classification table – Difference in the average characteristics of the individuals in the upper and lower 10 percent of the effect distribution in the sample by treatment

Notes: +++, ++, +: Plus signs indicate significance of the differences between the individuals in the upper and lower 10 percent of the effect distribution, the most and least affected individuals, adjusted for multiplicity to account for joint testing of zero differences between all the variables in the table at conventional significance levels $1\%, 5\%, 10\%$, respectively.
***, **, *: Asterisk signs indicate significance of the differences between the individuals in the upper and lower 10 percent of the effect distribution, the most and least affected individuals, for tests of the single differences at conventional significance levels $1\%, 5\%, 10\%$, respectively.
P-values are obtained by bootstrap with 500 repetitions.

(a minimum age of compulsory education in Germany) does not evolve as discriminatory factor with regard to preferences for job characteristics in our analysis. We further find differences with respect to nationality. We differentiate between Germans and Non-Germans and find that a higher degree of work autonomy is more important to Non-Germans. Non-Germans also value permanent contracts more than Germans do.

With respect to the present job characteristics, the present number of working hours is the clearest discriminatory factor for individual preferences. Full-time employees show stronger preferences for full-time jobs, which indicates sorting in line with individual preferences, and have weaker preferences for team atmosphere and time for the patients. Individuals working under a fixed-term contract have a stronger preference for more autonomy. Individuals who are less satisfied with their job exhibit higher preferences for roster reliability, potentially their dissatisfaction is driven by the wide spread of unreliably organized rosters in nursing.

Notably, other than previous studies (Maestas et al. 2023, Eriksson & Kristensen 2014) we find no indication that non-monetary working conditions are valued higher, if an individual's present wage is higher.[9] We also analyzed differences in preferences with regard to the initial motivation to become a nurse. We find respective differences in preferences only in selected cases when accounting for multiple testing. In line with their initial motivation, nurses who value time with their patients higher, entered nursing because they wanted to work in contact with humans. An initial motivation for diverse work is also more prevalent. The picture is less clear for those who started working in nursing because they wanted to help others. They show a stronger preference for permanent contracts and a weaker preference for full-time work, possibly, altruistic motivation is associated with responsibilities outside the job, driving the preference for a stable, but part-time job.

Similar to Chernozhukov, Fernández-Val & Luo (2018), we compute the difference between the upper and lower ten percent quantile of the effect distribution. Since these may represent individuals with quite extreme effects, we also analyze the differences of the characteristics between the upper and lower 20 percent of the effect distribution (see table 4.10 in the appendix). Generally, there are smaller differences in individual characteristics between the top and bottom 20 percent because these also include observations that are more similar with

[9]However, as we present in section 4.4.2, we do find interaction effects between wage and non-monetary characteristics, meaning that combinations of high wages and positive non-monetary characteristics are valued higher, the higher the wage of the potential job.

respect to their characteristics. Overall, our conclusions remain the same and, therefore, are robust with respect to comparing larger effect quantiles.

4.4.2 Substitution monetary v. non-monetary

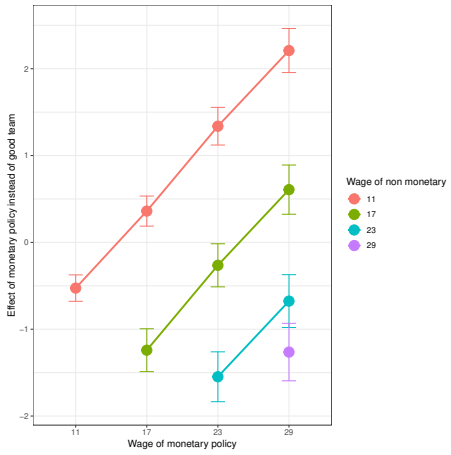
Up to this point, we analyzed each measure separately. In this section, we study whether care workers would either prefer higher wages or rather prefer one of the non-monetary characteristics analyzed above.

Trade-offs between wages and non-monetary job characteristics are often represented by calculating willingness-to-pay measures, which refer to the average willingness to pay for a job characteristic in a population or subgroup and are based on the transformation of average effects in the respective (sub)population. Our analysis differs from the conventional approach by accounting for two potential sources of heterogeneity. First, we present trade-offs between wages and non-monetary characteristics at different wage levels. Thus, instead of a single measure of willingness-to-pay for a job characteristic across all wage levels covered, we consider trade-offs across different wage increases at different base wages; this does not give us a single measure of willingness-to-pay, but we can represent differences in trade-off propensities across different wage differentials and base wages. Second, for these trade-offs, we again represent heterogeneity across individual and occupational characteristics.

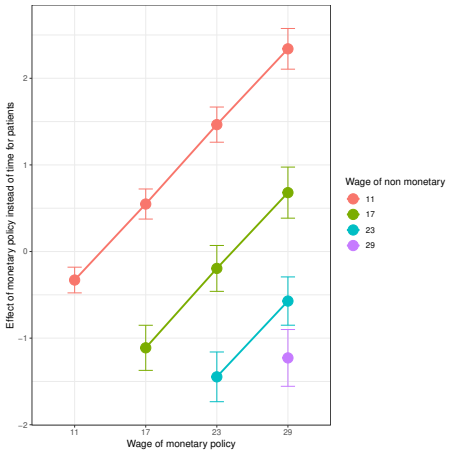
To this end, we compare job advertisements with different wages that do not offer a specific non-monetary job characteristic (i.e., monetary job offers) to advertisements that provide the non-monetary job characteristic, but offer a smaller (or equal) wage (i.e., non-monetary job offers). First, we present the average effects of the respective combinations. Afterwards, we focus on the underlying heterogeneity of the effects. As above, we present SPEs and conduct a classification analysis.

Average effects

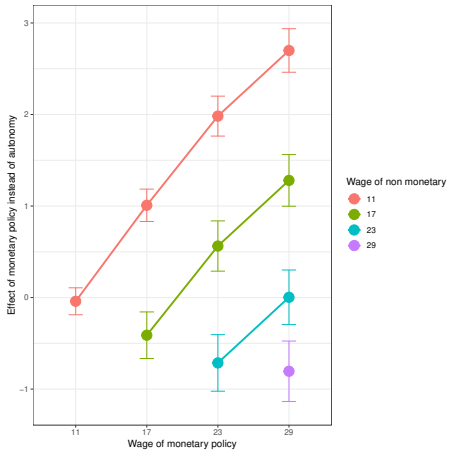
Figure 4.2 summarizes the trade-offs. Each panel shows the average effects for one non-monetary job characteristic. Each dot represents the average effect of offering the monetary instead of the non-monetary job. Dots with the same color refer to the same base wage. If the effect is positive, individuals on average prefer the monetary job offer (i.e., the job that



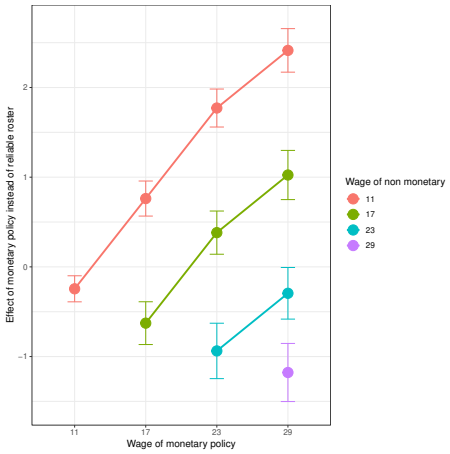
(a) Team



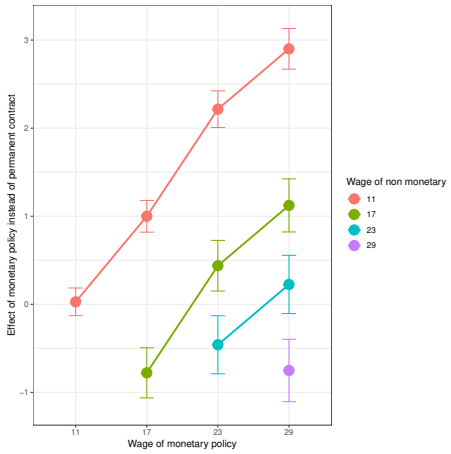
(b) Time for patients



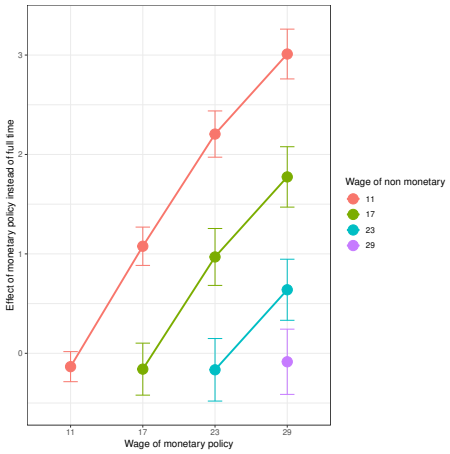
(c) Autonomy



(d) Reliable roster



(e) Permanent contract



(f) Full time

Figure 4.2 – Average effects on job attractiveness of the substitution of a job with higher wage and without a specific characteristic for a job with a base wage level and a cordial team, much time for patients, more autonomy, a reliable roster, a permanent contract, or full-time employment.

Estimates and 95 percent heteroscedasticity-consistent uniform confidence bands.

is not offering the respective non-monetary characteristic). If the effect is negative, then the non-monetary job offer is more favored, on average. For example, the green line in panel (a) shows the effects of offering wages 17, 23 and 29 euros without a good team (monetary policy) instead of 17 euros and a good team (non-monetary policy). The effect of offering 23 euros without a good team instead of 17 euros and a good team is negative, indicating that the non-monetary policy is preferred. In contrast, the effect offering 29 euros without a good team instead of 17 euros with a good team is positive, showing that the monetary policy is preferred.

Two major results arise from figure 4.2. First, regarding the relative differences in wage levels. The larger the wage difference between the non-monetary and the monetary job offer, the bigger the effect. The curves are roughly linear, i.e., the same wage raises on average yield the same relative increase in job attractiveness over the whole observed wage distribution. Therefore, we do not observe a diminishing marginal utility of wage. Second, regarding different base wage levels. Here, different patterns arise. Comparing the first points of the subfigures regarding a good team, more time for patients, autonomy, roster reliability, and contract duration, panels 4.2a-4.2e, we observe that the monetary job offer with the same wage level but without the non-monetary job characteristic becomes less attractive with rising base wages. This points to an interaction effect between wage and non-monetary job characteristics. This means that there is a premium for the combination of pleasant non-monetary characteristics and higher wages. Hence, the higher the base wage level, the more have wages of monetary offers to be raised, in order to compensate for less pleasant non-monetary job characteristics. The figure is different for full-time work. Giving up the non-monetary job offer at the base wage level does not become increasingly unpleasant with higher base wages. The wage increases necessary to compensate for a part-time rather than a full-time contract do not increase with higher base wages, even though full-time work is clearly preferred on average. We do not find an interaction effect between offered wages and full time.

Sorted effects

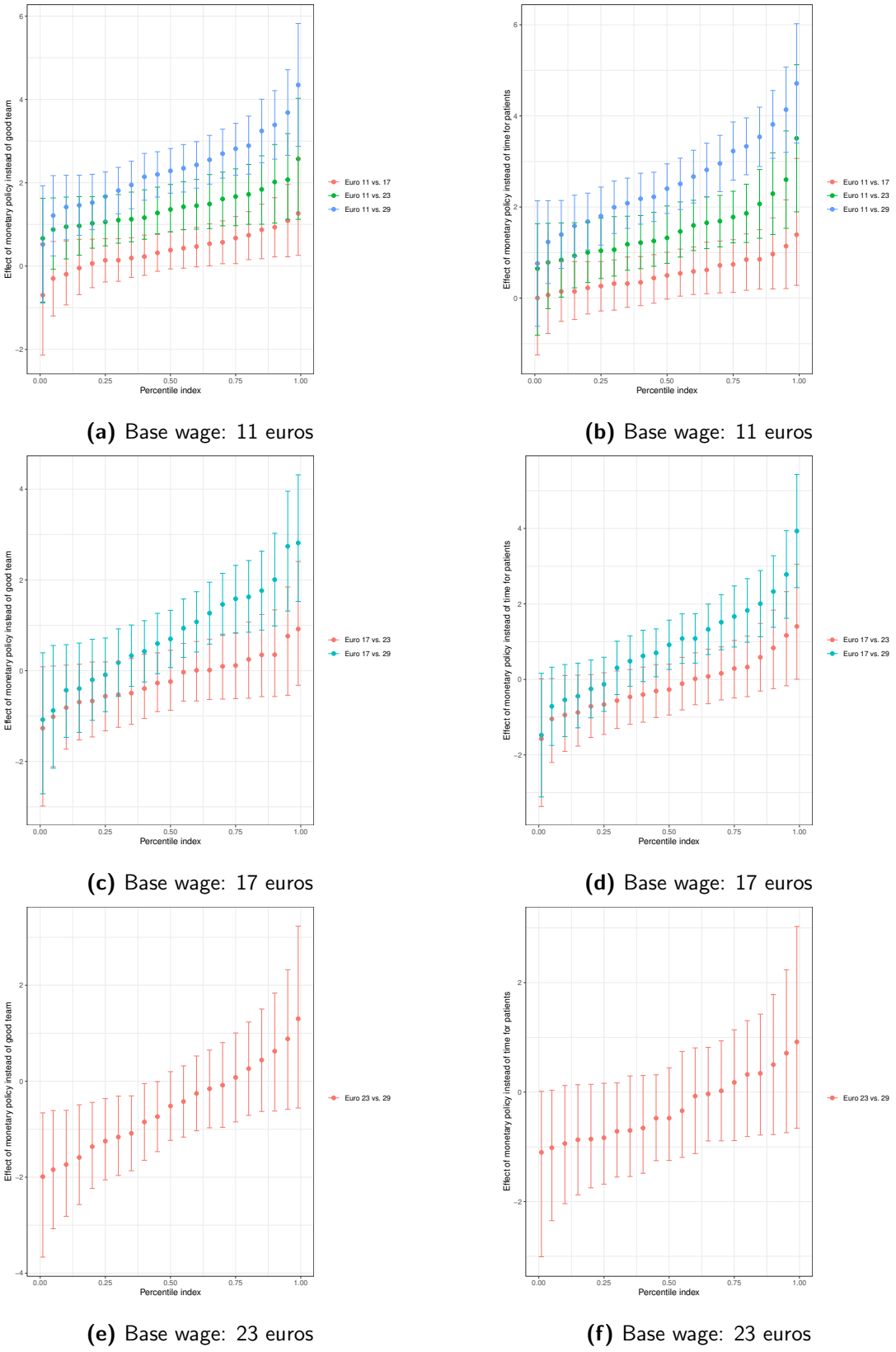
We further analyze heterogeneities in the trade-offs between wage and non-monetary job characteristics. The panels in figure 4.3 depict the SPEs for the non-monetary advertisements that offer a good team or much time for patients. Non-monetary advertisements offering more autonomy and a reliable roster are depicted in figure 4.4. Figure 4.5 depicts the SPEs

for non-monetary advertisements that offer a permanent contract or a full-time position.

As shown by the omnibus test, the results show that it strongly depends on individual characteristics, whether a monetary or a non-monetary job offer is preferred. Though the estimated effects of wage compensation differ between the job characteristics in absolute size, we find common patterns. For high wage differences from a low base wage level, i.e., from 11 euros hourly to 23 to 29 euros per hour, the monetary job offer is almost always preferred to the non-monetary one. As we saw in the analysis of the average effects, with higher base wage levels of the non-monetary job offer, the monetary offer has to offer higher wages, in order to compensate for the loss of a good team, for less time for patients, for less autonomy, or a less reliable roster. We further find that the estimated effects are significantly different from zero at some points of the effect distribution, whereas they are not at other points of the distribution. In these cases, some individuals prefer the monetary offer, whereas others prefer the non-monetary one. Overall, we find increasing wages may be a way to compensate for worse working conditions. Whether and how well this works depends on the wage differential between the monetary and the non-monetary jobs as well as individual characteristics, however. It works better for larger wage changes and lower wages of non-monetary job offers. Compensating for worse working conditions is also easier for less prominent non-pecuniary job characteristics, i.e., less autonomy is priced away more easily than a worse team.

Classification analysis

In order to analyze the nature of the heterogeneity uncovered by the SPE-analysis, we again conduct a classification analysis. Table 4.3 gives the results of the classification analysis regarding the presented trade-offs for selected characteristics, only. The complete results are given in tables 4.4-4.9 in the appendix.



(a) Base wage: 11 euros

(b) Base wage: 11 euros

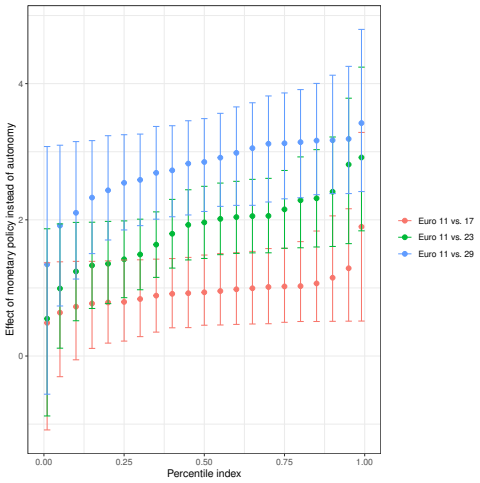
(c) Base wage: 17 euros

(d) Base wage: 17 euros

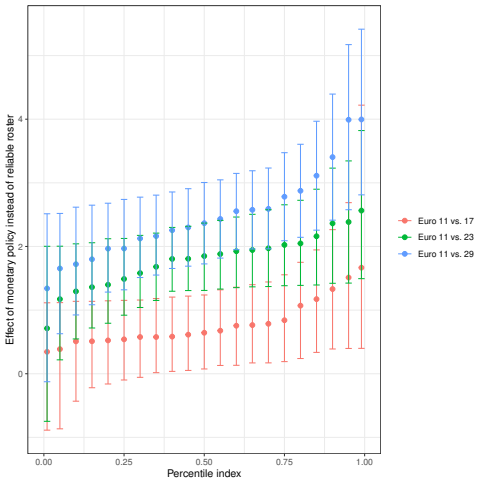
(e) Base wage: 23 euros

(f) Base wage: 23 euros

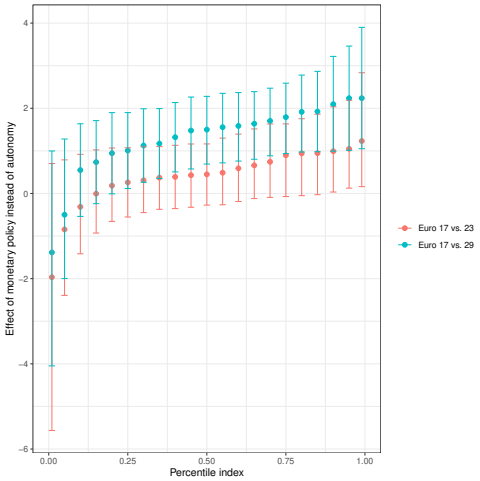
Figure 4.3 – Sorted Partial Effects on job attractiveness of the substitution of a job with higher wage for a job with a base wage level and cordial team (left) or much time for patients (right). Estimates and 90 percent bootstrap confidence bands.



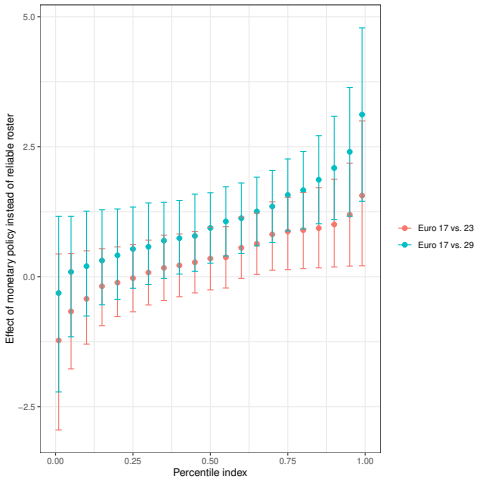
(a) Base wage: 11 euros



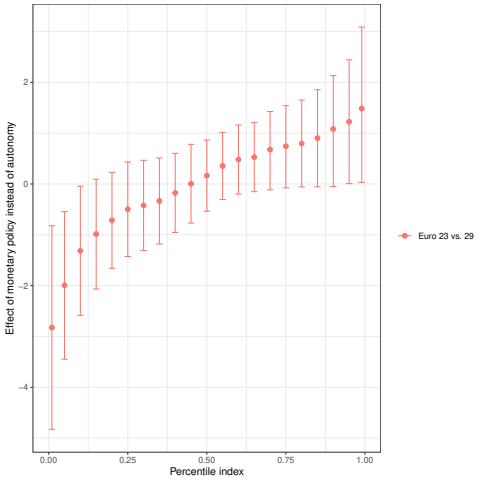
(b) Base wage: 11 euros



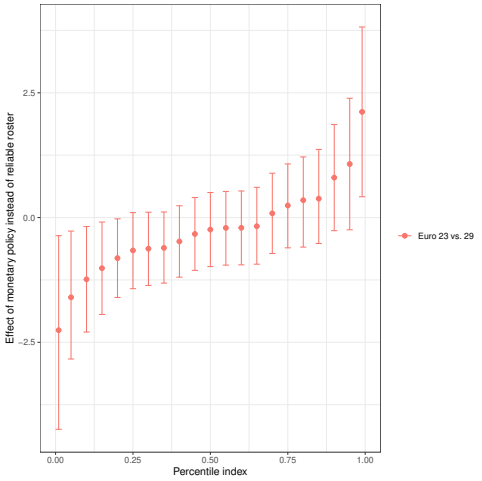
(c) Base wage: 17 euros



(d) Base wage: 17 euros

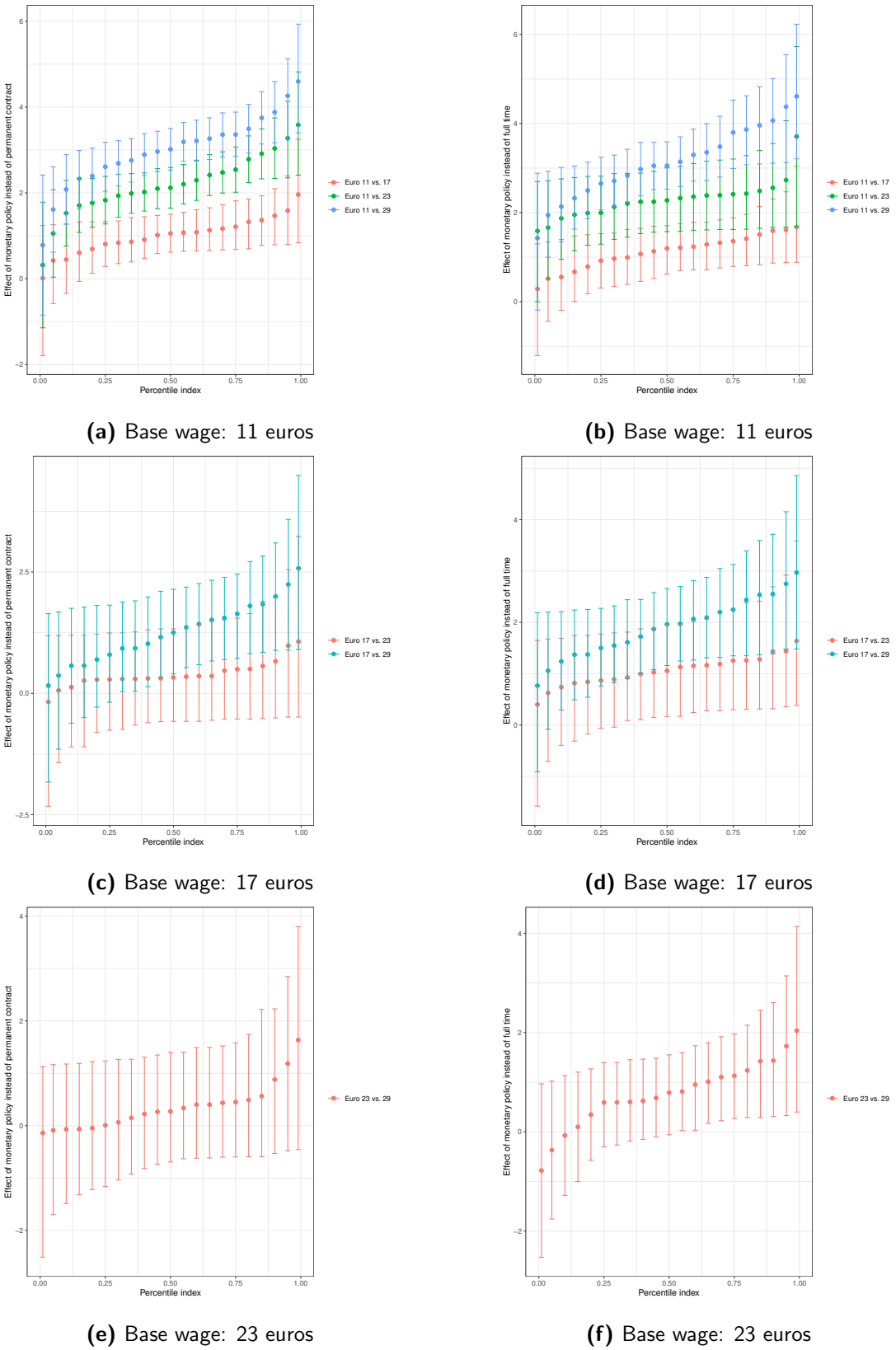


(e) Base wage: 23 euros



(f) Base wage: 23 euros

Figure 4.4 – Sorted Partial Effects on job attractiveness of the substitution of a job with higher wage for a job with a base wage level and much autonomy (left) or a reliable roster (right). Estimates and 90 percent bootstrap confidence bands.



(a) Base wage: 11 euros

(b) Base wage: 11 euros

(c) Base wage: 17 euros

(d) Base wage: 17 euros

(e) Base wage: 23 euros

(f) Base wage: 23 euros

Figure 4.5 – Sorted Partial Effects on job attractiveness of the substitution of a job with higher wage for a job with a base wage level and a permanent contract (left) or a full-time position (right, v. part time at higher wage).

Estimates and 90 percent bootstrap confidence bands.

	Base wage 11 euros			Base wage 17 euros		Base wage 23 euros
	Alternative wage					
	17 euros	23 euros	29 euros	23 euros	29 euros	29 euros
Age						
Team	-8.279	-21.191 +	-10.806	4.436	-2.167	-8.849
Time for patients	-34.441 +++	-24.443 +++	-14.941	-9.930	4.041	-0.494
Autonomy	-17.652	-16.923	-14.674	-3.739	-5.567	-2.655
Reliable roster	-20.904 +	-15.028	-17.879 +	2.690 ++	-4.552	4.855
Permanent contract	-26.472 +++	-25.949 +++	-19.466 ++	2.637	6.381	-8.811
Full time	-18.704	-17.577	-12.081	13.912	12.364	19.091 +
Female						
Team	-0.386	0.043	-0.863 +++	-0.058	-0.729 +++	-0.891 ++
Time for patients	-0.577	0.020	-0.379	-0.313	-0.444 +	-0.434
Autonomy	-0.013	-0.179	-0.499	-0.136	-0.155	-0.190
Reliable roster	-0.598 +	-0.528 +	-1.025 +++	-0.386	-0.851 +++	-0.513
Permanent contract	-0.680	-0.240	-0.797 +++	0.537	-0.157	-1.020 +++
Full time	0.648+++	0.389	-0.091	0.515	0.009	-0.104
Motivation - Human contact						
Team	0.203	-0.478	-0.208	-0.243	-0.167	0.020
Time for patients	-0.575	-0.791 +++	-0.462	-1.036 +++	-0.629 ++	-0.682
Autonomy	0.297	-0.192	-0.080	-0.606	-0.516	0.126
Reliable roster	0.042	-0.348	-0.273	-0.377	-0.247	-0.054
Permanent contract	0.751	-1.067	-0.785	-0.977	-0.844	-0.622
Full time	0.494	-0.176	-0.057	-0.286	-0.355	0.042
Motivation - Diverse work						
Team	-0.509	-0.400	-0.293	-0.781	-0.503	-0.178
Time for patients	-0.423	0.205	-0.528	-0.497	-0.851 +++	-1.015 ++
Autonomy	0.241	-0.570	-0.797	-0.945 ++	-0.880 +++	-0.780 ++
Reliable roster	0.244	-0.510	-0.694	-0.592	-0.763 +++	-1.003 +++
Permanent contract	0.221	-0.303	-0.395	-0.811	-0.607	-0.634
Full time	-0.204	-0.202	-0.637	-0.479	-0.889 +	-0.392
Motivation - Teamwork						
Team	-0.613	-1.076 +++	-0.556	-0.804 +	-0.445	-0.454
Time for patients	-0.311	-0.311	-0.757 ++	0.165	-0.336	-0.568
Autonomy	0.645	-0.032	-0.079	-0.271	-0.149	-0.050
Reliable roster	-0.345	-0.536	-0.412	-0.546	-0.356	-0.457
Permanent contract	0.266	-0.145	-0.040	-0.502	-2.217	-0.602
Full time	-0.434	-0.478	-0.931 +++	-0.623	-0.939 ++	-0.719
Hours						
Team	0.475	16.527 +	23.325 +++	18.726 ++	24.074 +++	26.422 +++
Time for patients	10.971	12.669	20.920 +++	21.771 +++	26.402 +++	26.920 +++
Autonomy	0.099	5.125	28.707 +++	6.358	20.530 +++	19.759 +++
Reliable roster	13.928	23.329 +++	27.587 +++	16.520 ++	23.664 +++	17.912 +++
Permanent contract	-9.569	-7.888	22.447 +++	-0.475	25.358 +++	12.677
Full time	-16.511	-14.831	6.030	-20.218 +	-16.338	-8.406
Satisfaction with job						
Team	0.450	-0.775	-1.106	-1.435 +	-1.640 +++	-0.290

Time for patients	-0.167	-0.734	-0.993 +	-0.803	-0.602	0.077
Autonomy	-0.268	-1.778 +++	-0.743	-0.984	-0.375	0.324
Reliable roster	-0.348	-1.396 ++	-0.730	-1.405	-0.918	0.075
Permanent contract	0.751	-1.067	-0.785	-0.977	-0.844	-0.622
Full time	0.418	-1.368	-1.776 +++	-0.554	-1.464 ++	-1.033

Table 4.3 – Classification table – Difference in the average characteristics of the individuals in the upper and lower 10 percent of the effect distribution in the sample by treatment. Treatment is the substitution of higher wages for a favorably job characteristic at a base wage. Differentiation by individual characteristic (**bold**), job offer characteristic (row), base wage (super-column), and alternative wage (column).

Notes: $+++$, $++$, $+$: Plus signs indicate significance of the differences between the individuals in the upper and lower 10 percent of the effect distribution, the most and least affected individuals, adjusted for multiplicity to account for joint testing of zero differences between all the variables in the table at conventional significance levels $1\%, 5\%, 10\%$, respectively.
P-values are obtained by bootstrap with 500 repetitions.

As in the case of the single evaluations of the job characteristics, we find significant differences between the most and least responsive groups with regard to their personal and job characteristics as well as their motivation to become a nurse. For most of the job characteristics studied, women are less willing than men to accept a job with worse non-monetary characteristics at higher pay. Women are less inclined to trade a good team, a reliable roster, or a permanent contract for higher wages than men are, which is in line with previous research, showing higher willingness to trade wage for amenities and job security for women (Maestas et al. 2023, Wiswall & Zafar 2018). Like Maestas et al. (2023) we find–though regarding different characteristics–that the willingness to trade non-monetary job characteristics also decreases along the age gradient. Older individuals are especially more inclined to accept a low base wage rather than to receive a fixed-term contract. Regarding job characteristics, we, again, find especially clear heterogeneity with respect to working hours in the present job. Working more hours in the present job is associated with a higher willingness to give up non-monetary characteristics for higher wages. This is true for all job characteristics we analyze but working full time. Although mostly not statistically significant, individuals who are more willing to trade a full-time job for a part-time job with a lower wage are working less hours in their current job. Regarding an individual's satisfaction with their job, the picture is less clear. Nevertheless, we obverse the general pattern that individuals who are more satisfied with their present job are less inclined to trade job characteristics for wages. Regarding the initial motivation to become a nurse, we find reasonable associations. Those, who become nurses because they wanted to

have contact with humans are less willing to trade more time for patients for higher wages, nurses who prefer diverse work are less willing to trade autonomy, and nurses who wanted to work in a team are (in part) less willing to trade a good team for higher wages. Overall, we find heterogeneity regarding trade-off decisions with respect to stronger wage increases rather than to smaller ones.

Table 4.11 in the appendix shows the classification analysis for the upper and lower 20 percent of the effect distribution for comparison. The results in this table lead to the same conclusions as the results in table 4.3.

4.5 Conclusion

We provide an extensive analysis of heterogeneity in preferences over non-monetary job characteristics and trade-offs between wage and non-monetary job characteristics. To that end, we employ data from a self-conducted factorial survey experiment of nurses in Germany. Specifically, we study heterogeneity in the preferences for six non-monetary job characteristics: team atmosphere, the time nurses have with their patients, work autonomy, roster reliability, contract duration, and whether a job is in part or full time. Preference heterogeneity regarding job characteristics is usually analyzed via subgroup analysis. We use novel econometric methods proposed by Chernozhukov, Fernández-Val & Luo (2018) to provide a more holistic analysis of heterogeneous preferences for job characteristics and describe how most and least responsive individuals differ. We take two perspectives. Firstly, we analyze the non-monetary job characteristics, separately. Secondly, we study the trade-offs between the job characteristics and higher wages. Notably, the two perspectives provide complementary results. Analysis of the single job characteristics shows, which groups are especially responsive to specific changes in non-monetary features and can therefore be attracted via respective improvements. The analysis of the trade-offs shows, which groups are more or less willing to give up certain characteristics for higher wages. We find substantial heterogeneity in both respects. This highlights the importance to account for preference heterogeneity on both sides of the trade-off and among different wage rates. As a result of this analysis and in line with previous studies (Maestas et al. 2023, Eriksson & Kristensen 2014, Hamermesh 1999, Pierce 2001), we further conclude that individuals value combinations of high wage offers and positive non-monetary characteristics higher, i.e., the willingness-to-pay for amenities increases with wage. Full-time

employment is an exception in this regard, preferences for full- or part-time employment seem to differ less among wage levels.

Our results provide implications for policy-makers' as well as employers' actions, in general, and regarding nursing, in particular. Overall, the fact that preferences for job characteristics differ indicates that the one ideal measure (or bundle of measures) to make jobs more attractive may not exist. Rather than searching for a "one size fits all" solution, job offers should be differentiated to better suit individual preferences. Age, gender, present job characteristics, and individual work motivation seem to be especially fruitful dimensions along which offers could be differentiated. Such differentiation also offers the possibility to use job characteristics as a sorting device to attract workers with the desired characteristics, a notion put forward by hedonic wage theory (Rosen 1986) and which has been explicitly considered in the case of nursing labor (Heyes 2005). Applied to our results, this means that full-time jobs should be offered to attract men and more amenities to attract women. To attract full-time workers, amenities seem to be less important than a new full-time job at a high wage. And in order to attract individuals with a specific motivation, e.g., a desire to work in contact with people, offering the possibility to fulfill such motivation is especially fruitful and the attempt to trade it for higher wages less promising. With respect to nurses, particularly, our results show how to attract such groups, which are highlighted in the public debate as target groups for recruiting new professionals. Higher wages might attract more men and full-time workers, and more autonomy and the offer of permanent contracts could help attract foreign nurses. However, the majority of existing care workers are women of German nationality for whom a good team and the opportunity to work part time are particularly important–and who are also less willing to trade amenities for wage increases. Differentiation of job characteristics may therefore be important in order to be attractive to these heterogeneous groups of workers. And there actually is some evidence for such differentiation in nursing jobs. Evidence from qualitative interviews, which we gathered as part of our recent research on nursing job characteristics, suggests that some employers, especially large ones like big nursing homes or university hospitals, indeed offer jobs with heterogeneous characteristics to nurses and overcome problems along teams by rearranging team composition, if needed. Further, there exist initiatives for a different organization of the provision of care work, yielding different packages of job characteristics nurses could choose from by switching employers.[10]

[10]See e.g., the model of *Buurtzorg* (https://www.buurtzorg-deutschland.de/) and *AAP - Autonome ambulante Pflegeteams* (https://www.if-gm.de/index.php/forschungsprojekte/projekt-aap-autonome-ambulante-

Further, our analysis of the trade-offs between wages and non-monetary job characteristics shows that in working areas or times where labor supply is especially scarce (e.g., in nursing in intensive care units during the COVID-19 pandemic), stronger measures to attract employees may be needed. In those cases, combinations of pleasant non-monetary job characteristics and higher wages are called for, as such combinations achieve especially positive impacts on job offer attractiveness. Also, job characteristics need to be especially pleasant, in order to attract personnel where highly qualified, and therefore highly paid, personnel is sought for, as it becomes increasingly difficult to "price away" pleasant non-monetary job characteristics if workers already have a higher income (e.g., at their previous job). Where such jobs can only be offered in unpleasant circumstances, strong wage raises would be needed in order to increase job attractiveness.

Because of the descriptive nature of the study, some questions are left open. Most prominently, why is the number of working hours that strongly associated with effect sizes? We cannot unveil the underlying causal relation with our data. However, the respective association is very clear and should be examined in future research. In this context, we would like to point out two limitations of our study. First, due to the setup of our survey experiment, we can not analyze the effects of specific combinations of job characteristics as we can not identify interactions beyond second order between job attributes. Future research could use alternative study designs to investigate the effects of common combinations of wages and amenities. Second, although we find heterogeneity along important characteristics, there could be much more heterogeneity. Our method allows us to determine in a statistically valid way which dimensions of heterogeneity are significant, taking into account multiple testing problems. However, there may exist an a priori unknown mass of possibly important variables, which our data does not cover. For example, overall household income, detailed information on the family situation, or a precise description of the respondent's present job. Future research on the heterogeneity of workers' preferences over job characteristics could embody such information. The methodology presented in Chernozhukov, Fernández-Val & Luo (2018) applied in this paper yields an appropriate tool-set to do so. Instead of an interactive linear model machine learning methods such as generalized random forests Athey et al. (2019) or double machine learning Chernozhukov et al. (2017) can be used to estimate the effect distribution. Such methods relax the linearity assumption imposed by our model, but require a large sample size.

pflegeteams).

4.6 Appendix to chapter 4

	Base wage 11 euros			Base wage 17 euros		Base wage 23 euros
	Alternative wage					
	17 euros	23 euros	29 euros	23 euros	29 euros	29 euros
Present job characteristics						
Hours	0.475	16.527 +	23.325 +++	18.726 ++	24.074 +++	26.422 +++
Unplanned shifts per month	-2.340	-1.981	0.950	0.106	1.782	0.645
log of hourly wage	0.454	0.269	-0.056	0.409	0.082	-0.105
Works in direct care	-0.109	-0.258	0.170	-0.086	0.232	0.142
Fixed-term employed	0.184	0.103	0.378	-0.470	-0.053	-0.134
Satisfaction with job	0.450	-0.775	-1.106	-1.435 +	-1.640 +++	-0.290
Motivation to become a nurse						
Human contact	0.203	-0.478	-0.208	-0.243	-0.167	0.020
Diverse work	-0.509	-0.400	-0.293	-0.781	-0.503	-0.178
Help others	0.154	-0.402	-0.359	-0.157	-0.448	-0.358
Career/Developm.	0.118	0.398	0.224	-0.416	-0.465	0.076
Teamwork	-0.613	-1.076 +++	-0.556	-0.804 +	-0.445	-0.454
Safe job	0.530	-0.116	0.293	-0.577	-0.061	-0.084
Med. interest	-0.367	-0.166	0.137	-0.565	-0.305	-0.839 ++
Social interest	0.010	-0.303	-0.569	-0.437	-0.611	-0.771
Personal characteristics						
Age	-8.279	-21.191 +	-10.806	4.436	-2.167	-8.849
German nationality	-0.117	0.048	-0.011	-0.043	-0.106	-0.080
Female	-0.386	0.043	-0.863 +++	-0.058	-0.729 +++	-0.891 ++
Schooling	0.409	0.353	0.398	0.049	0.133	-0.281
Child below age 14	-0.616	-0.234	-0.404	-0.573	-0.620	0.327
Partner with a job	-0.830 ++	-0.338	-0.552	-0.738	-0.670 +	0.011

Table 4.4 – Classification table for the treatment cordial team – Difference in the average characteristics of the individuals in the upper and lower 10 percent of the effect distribution in the sample for the treatment cordial team

Notes: +++, ++, +: Plus signs indicate significance of the differences between the individuals in the upper and lower 10 percent of the effect distribution, the most and least affected individuals, adjusted for multiplicity to account for joint testing of zero differences between all the variables in the table at conventional significance levels $1\%, 5\%, 10\%$, respectively.

P-values are obtained by bootstrap with 500 repetitions.

	Base wage 11 euros			Base wage 17 euros		Base wage 23 euros
	Alternative wage					
	17 euros	23 euros	29 euros	23 euros	29 euros	29 euros
Present job characteristics						
Hours	10.971	12.669	20.920 +++	21.771 +++	26.402 +++	26.920 +++
Unplanned shifts per month	-2.067	0.396	-1.118	0.977	0.328	0.715
log of hourly wage	0.077	-0.252	-0.092	-0.196	-0.112	-0.309
Works in direct care	-0.128	-0.211	0.080	-0.142	0.047	0.161
Fixed-term employed	-0.162	0.535	0.071	0.289	0.046	-0.014
Satisfaction with job	-0.167	-0.734	-0.993 +	-0.803	-0.602	0.077
Motivation to become a nurse						
Human contact	-0.575	-0.791 +++	-0.462	-1.036 +++	-0.629 ++	-0.682
Diverse work	-0.423	0.205	-0.528	-0.497	-0.851 +++	-1.015 ++
Help others	-0.692	-0.556	-0.573	-0.022	-0.151	-0.221
Career/Developm.	0.651	0.326	0.487	-0.135	-0.015	0.284
Teamwork	-0.311	-0.311	-0.757 ++	0.165	-0.336	-0.568
Safe job	0.134	0.258	-0.110	0.265	-0.221	-0.150
Med. interest	0.458	0.647	-0.053	0.121	-0.263	-0.654
Social interest	-0.142	-0.113	-0.130	-0.426	-0.173	-0.277
Personal characteristics						
Age	-34.441 +++	-24.443 +++	-14.941	-9.930	4.041	-0.494
German nationality	-0.148	0.165	0.026	-0.255 ++	-0.157	0.054
Female	-0.577	0.020	-0.379	-0.313	-0.444 +	-0.434
Schooling	0.836 ++	0.523 +	0.445	0.520	0.293	-0.289
Child below age 14	0.027	-0.147	-0.212	-0.216	-0.606	-0.432
Partner with a job	-0.377	-0.347	-0.135	-0.590	-0.613 +	-0.383

Table 4.5 – Classification table for the treatment time for patient – Difference in the average characteristics of the individuals in the upper and lower 10 percent of the effect distribution in the sample for the treatment time for patient

Notes: +++, ++, +: Plus signs indicate significance of the differences between the individuals in the upper and lower 10 percent of the effect distribution, the most and least affected individuals, adjusted for multiplicity to account for joint testing of zero differences between all the variables in the table at conventional significance levels $1\%, 5\%, 10\%$, respectively.

P-values are obtained by bootstrap with 500 repetitions.

	Base wage 11 euros			Base wage 17 euros		Base wage 23 euros
	Alternative Wage					
	17 euros	23 euros	29 euros	23 euros	29 euros	29 euros
Present job characteristics						
Hours	0.099	5.125	28.707 +++	6.358	20.530 +++	19.759 +++
Unplanned shifts per month	-0.140	-0.667	-0.358	2.302	1.851	0.206
log of hourly wage	0.588	0.191	0.024	0.702 ++	0.231	0.177
Works in direct care	-0.566 +	0.122	-0.049	0.102	0.278	0.326
Fixed-term employed	0.464	-0.504 ++	-0.201	-0.436	-0.162	-0.481
Satisfaction with job	-0.268	-1.778 +++	-0.743	-0.984	-0.375	0.324
Motivation to become a nurse						
Human contact	0.297	-0.192	-0.080	-0.606	-0.516	0.126
Diverse work	0.241	-0.570	-0.797	-0.945 ++	-0.880 +++	-0.780 ++
Help others	-0.520	-0.250	-0.262	-0.301	-0.264	0.177
Career/Developm.	0.541	-0.233	0.052	-0.424	-0.248	-0.160
Teamwork	0.645	-0.032	-0.079	-0.271	-0.149	-0.050
Safe job	0.037	0.282	0.360	-0.214	0.088	0.311
Med. interest	-0.703	0.687 ++	0.198	0.258	-0.502	0.200
Social interest	-0.527	-0.518	-0.272	0.096	0.303	0.467
Personal characteristics						
Age	-17.652	-16.923	-14.674	-3.739	-5.567	-2.655
German nationality	0.119	-0.010	-0.089	0.181	0.176 +	0.018
Female	-0.013	-0.179	-0.499	-0.136	-0.155	-0.190
Schooling	0.070	0.191	-0.522	0.249	-0.333	-0.605 ++
Child below age 14	0.487	0.197	0.116	0.106	-0.044	-0.099
Partner with a job	0.225	-0.530	-0.155	-0.262	0.067	0.047

Table 4.6 – Classification table for the treatment autonomy – Difference in the average characteristics of the individuals in the upper and lower 10 percent of the effect distribution in the sample for the treatment autonomy

Notes: +++, ++, +: Plus signs indicate significance of the differences between the individuals in the upper and lower 10 percent of the effect distribution, the most and least affected individuals, adjusted for multiplicity to account for joint testing of zero differences between all the variables in the table at conventional significance levels $1\%, 5\%, 10\%$, respectively.

P-values are obtained by bootstrap with 500 repetitions.

	Base wage 11 euros			Base wage 17 euros		Base wage 23 euros
	Alternative wage					
	17 euros	23 euros	29 euros	23 euros	29 euros	29 euros
Present job characteristics						
Hours	13.928	23.329 +++	27.587 +++	16.520 ++	23.664 +++	17.912 +++
Unplanned shifts per month	2.380	0.193	2.653	2.008	4.331 +	3.279
log of hourly wage	-0.021	-0.035	-0.132	0.201	0.273	0.299
Works in direct care	0.347	0.450	0.365	0.442	0.527	0.450
Fixed-term employed	0.699 +	-0.045	0.007	-0.055	0.028	-0.327 +
Satisfaction with job	-0.348	-1.396 ++	-0.730	-1.405	-0.918	0.075
Motivation to become a nurse						
Human contact	0.042	-0.348	-0.273	-0.377	-0.247	-0.054
Diverse work	0.244	-0.510	-0.694	-0.592	-0.763 +++	-1.003 +++
Help others	-0.504	-0.227	-0.712	-0.013	-0.323	-0.279
Career/Developm.	0.680	-0.526	0.144	-0.737 ++	-0.282	-0.631
Teamwork	-0.345	-0.536	-0.412	-0.546	-0.356	-0.457
Safe job	0.725	0.334	0.293	0.485	0.082	-0.238
Med. interest	-0.430	0.771 ++	0.095	0.358	-0.015	0.260
Social interest	-0.325	0.118	-0.150	0.344	0.106	0.629
Personal characteristics						
Age	-20.904 +	-15.028	-17.879 +	2.690 ++	-4.552	4.855
German nationality	-0.271	-0.023	-0.064	-0.143	-0.083	-0.027
Female	-0.598 +	-0.528 +	-1.025 +++	-0.386	-0.851 +++	-0.513
Schooling	0.201	0.142	0.300	0.249	0.114	-0.372
Child below age 14	0.329	-0.125	0.116	0.082	-0.016	0.006
Partner with a job	-0.252	-0.433	0.041	-0.179	0.061	0.186

Table 4.7 – Classification table for the treatment reliable roster – Difference in the average characteristics of the individuals in the upper and lower 10 percent of the effect distribution in the sample for the treatment reliable roster

Notes: +++, ++, +: Plus signs indicate significance of the differences between the individuals in the upper and lower 10 percent of the effect distribution, the most and least affected individuals, adjusted for multiplicity to account for joint testing of zero differences between all the variables in the table at conventional significance levels $1\%, 5\%, 10\%$, respectively.

P-values are obtained by bootstrap with 500 repetitions.

	Base wage 11 euros			Base wage 17 euros		Base wage 23 euros
	Alternative wage					
	17 euros	23 euros	29 euros	23 euros	29 euros	29 euros
Present job characteristics						
Hours	-9.569	-7.888	22.447 +++	-0.475	25.358 +++	12.677
Unplanned shifts per month	-1.788	-2.343	1.748	2.318	4.637 +	1.160
log of hourly wage	0.144	0.290	0.275	-0.012	0.103	0.680
Works in direct care	-0.301	0.005	0.275	-0.610 ++	-0.409	0.452
Fixed-term employed	0.149	0.257	0.214	0.646 +	0.176	-0.259
Satisfaction with job	0.751	-1.067	-0.785	-0.977	-0.844	-0.622
Motivation to become a nurse						
Human contact	-0.078	-0.281	-0.438	-0.931 ++	-0.723 +	-0.251
Diverse work	0.221	-0.303	-0.395	-0.811	-0.607	-0.634
Help others	-0.859 ++	-0.757 +	-0.563	-0.451	-0.335	-0.298
Career/Developm.	0.487	0.008	0.286	-0.524	0.177	-0.516
Teamwork	0.266	-0.145	-0.040	-0.502	-2.217	-0.602
Safe job	0.292	-0.146	0.184	-0.455	0.099	-0.699
Med. interest	0.823 +	0.563	0.646 ++	-0.093	0.200	0.115
Social interest	-0.030	-0.157	-0.079	-0.071	-0.209	0.337
Personal characteristics						
Age	-26.472 +++	-25.949 +++	-19.466 ++	2.637	6.381	-8.811
German nationality	0.065	0.109	0.034	-0.025	0.009	0.173
Female	-0.680	-0.240	-0.797 +++	0.537	-0.157	-1.020 +++
Schooling	0.388	0.625 ++	0.290	0.132	-0.223	0.134
Child below age 14	0.544	0.144	0.131	0.268	-0.244	0.046
Partner with a job	-0.297	-0.200	-0.354	-0.393	-0.336	0.125

Table 4.8 – Classification table for the treatment permanent position – Difference in the average characteristics of the individuals in the upper and lower 10 percent of the effect distribution in the sample for the treatment permanent position

Notes: +++, ++, +: Plus signs indicate significance of the differences between the individuals in the upper and lower 10 percent of the effect distribution, the most and least affected individuals, adjusted for multiplicity to account for joint testing of zero differences between all the variables in the table at conventional significance levels $1\%, 5\%, 10\%$, respectively.

P-values are obtained by bootstrap with 500 repetitions.

	Base wage 11 euros			Base wage 17 euros		Base wage 23 euros
	Alternative wage					
	17 euros	23 euros	29 euros	23 euros	29 euros	29 euros
Present job characteristics						
Hours	-16.511	-14.831	6.030	-20.218 +	-16.338	-8.406
Unplanned shifts per month	-1.488	-0.185	-0.235	17.676	0.993	1.029
log of hourly wage	0.148	0.085	-0.221	0.183	-0.046	-0.209
Works in direct care	0.034	-0.250	-0.730 +++	-0.509	0.475	0.311
Fixed-term employed	0.250	0.769 +++	0.306	0.241	0.075	0.164
Satisfaction with job	0.418	-1.368	-1.776 +++	-0.554	-1.464 ++	-1.033
Motivation to become a nurse						
Human contact	0.494	-0.176	-0.057	-0.286	-0.355	0.042
Diverse work	-0.204	-0.202	-0.637	-0.479	-0.889 +	-0.392
Help others	-0.371	-0.086	0.110	-0.228	0.147	0.703
Career/Developm.	0.001	0.278	-0.121	-0.236	-0.331	0.319
Teamwork	-0.434	-0.478	-0.931 +++	-0.623	-0.939 ++	-0.719
Safe job	-0.160	-0.131	-0.070	-0.390	-0.234	0.113
Med. interest	-0.055	-0.181	0.105	-0.559	-0.172	-0.778 +
Social interest	-0.338	-0.314	-0.158	-0.272	0.088	0.306
Personal characteristics						
Age	-18.704	-17.577	-12.081	13.912	12.364	19.091 +
German nationality	0.293+++	-0.078	-0.105	0.063	-0.003	-0.304 ++
Female	0.648+++	0.389	-0.091	0.515	0.009	-0.104
Schooling	-0.137	0.677	0.008	0.649	-0.401	-0.612
Child below age 14	-0.194	-0.141	0.575	-0.895+	-0.015	0.324
Partner with a job	0.073	-0.189	0.227	0.160	0.408	0.269

Table 4.9 – Classification table for the treatment full time – Difference in the average characteristics of the individuals in the upper and lower 10 percent of the effect distribution in the sample for the treatment full-time employment

Notes: +++, ++, +: Plus signs indicate significance of the differences between the individuals in the upper and lower 10 percent of the effect distribution, the most and least affected individuals, adjusted for multiplicity to account for joint testing of zero differences between all the variables in the table at conventional significance levels $1\%, 5\%, 10\%$, respectively.

P-values are obtained by bootstrap with 500 repetitions.

	Team	Time	Autonomy	Reliable roster	Permanent contract	Full time
Personal characteristics						
Age	-0.707	1.041	-3.340	-1.530	-3.475	-11.253 ***
German nationality	0.005	-3.918	-0.110 ***/+++	0.058	-0.139 ***/++	0.001
Female	0.625 ***/+++	0.228 **	0.175	0.529 ***/++	0.399 ***	-0.560 ***/+++
Schooling	0.225 *	-0.474 ***/+	0.356 ***	0.156	-0.293 *	0.264 **
Child below age 14	0.550 ***	0.571 ***/+++	-0.274 *	-0.054	0.191	-0.270 **
Partner with a job	0.468 *	0.489 ***	-0.152	-0.174 **	0.068	-0.272 **
Motivation to become a nurse						
Human contact	-0.167	0.650 ***/+++	-0.180	-0.187	0.121	-0.137
Diverse work	-0.177	0.481 ***	0.425 **	0.495 ***	0.389 **	-0.261 **
Help others	-0.163	0.515 ***	-0.182	0.037	1.184 ***/+++	-0.441 ***/+
Career/Developm.	0.091	-0.039	0.300 **	0.409 **	0.132	0.120
Teamwork	-0.091	-0.483 ***	-0.342 *	-0.278 *	0.157	-0.174
Safe job	-0.249	-0.100	0.003	-0.257	0.172	0.232 *
Med. interest	0.449 **	-0.153	-0.028	0.017	0.291 *	0.221 *
Social interest	-0.233	-0.019	0.135	-0.310 *	0.143	-0.383 ***
Present job characteristics						
Hours	-20.277 ***/+++	-18.219 ***/+++	-7.967 **	-8.709 **	4.781	22.330 ***/+++
Unplanned shifts per month	-1.250	0.568	-0.468	-1.809 **	-1.717 **	-0.170
log of hourly wage	0.020	0.072	-0.427 ***	-0.284 **	-0.471 ***	0.089
Works in direct care	0.184 *	0.213 **	-0.107	-0.267 ***	0.247 **	0.180 ***
Fixed-term employed	0.189 *	-0.069	0.474 ***/++	0.287 ***	-0.162	-0.948
Satisfaction with job	0.670 **	0.132	-0.332	-0.977 ***/+	0.202	0.283

Table 4.10 – Classification table – Difference in the average characteristics of the individuals in the upper and lower 20 percent of the effect distribution in the sample by treatment

Notes: +++, ++, +: Plus signs indicate significance of the differences between the individuals in the upper and lower 20 percent of the effect distribution, the most and least affected individuals, adjusted for multiplicity to account for joint testing of zero differences between all the variables in the table at conventional significance levels $1\%, 5\%, 10\%$, respectively.
***, **, *: Asterisk signs indicate significance of the differences between the individuals in the upper and lower 20 percent of the effect distribution, the most and least affected individuals, for tests of the single differences at conventional significance levels $1\%, 5\%, 10\%$, respectively.
P-values are obtained by bootstrap with 500 repetitions.

	Base wage 11 euros			Base wage 17 euros		Base wage 23 euros
	Alternative wage					
	17 euros	23 euros	29 euros	23 euros	29 euros	29 euros
Age						
Team	-3.786	-20.220 +++	-13.192	3.994	1.296	-6.218
Time for patients	-28.126 +++	-20.212 +++	-11.706	-8.956	-2.477	-1.704
Autonomy	-14.014	-13.747	-14.561	2.329	-2.542	-4.858
Reliable roster	-17.102	-13.822	-14.121	4.444	0.844	-1.133
Permanent contract	-20.775 +++	-21.964 +++	-13.874 +	6.230	4.164	-5.103
Full time	-11.878	-14.659	-8.251	12.734	14.580	12.099
Female						
Team	-0.155	-0.002	-0.600 +++	-0.183	-0.556 +++	-0.602 +++
Time for patients	-0.376	0.018	-0.283	-0.234	-0.351 +++	-0.455
Autonomy	-0.175	-0.121	-0.278	-0.090	-0.143	-0.167
Reliable roster	-0.651 +++	-0.363	-0.758 +++	-0.199	-0.615 +++	-0.512 ++
Permanent contract	-0.047	-0.159	-0.512 +++	0.341	-0.157	-0.560 +++
Full time	0.421 ++	0.231	0.001	0.397	0.013	-0.059
Motivation - Human contact						
Team	0.092	-0.475 +	-0.232	-0.306	-0.165	-0.073
Time for patients	-0.419	-0.683 +++	-0.425 +	-0.803 +++	-0.431 +	-0.397
Autonomy	0.227	-0.015	-0.178	-0.325	-0.395	0.011
Reliable roster	0.004	-0.276	-0.249	-0.178	-0.149	-0.006
Permanent contract	-0.022	-1.768	-0.369	-0.788 +++	-0.675 ++	-0.172
Full time	0.450	0.026	-0.040	-0.209	-0.299	0.114
Motivation - Diverse work						
Team	-0.344	-0.483	-0.311	-0.497	-0.355	-0.129
Time for patients	-0.164	0.178	-0.398	-0.396	-0.694 +++	-0.695
Autonomy	0.351	-0.227	-0.544	-0.693 +	-0.880 +++	-0.619 +
Reliable roster	0.213	-0.383	-0.578	-0.445	-0.542 +	-0.700 ++
Permanent contract	0.166	-0.211	-0.328	-0.725	-0.541	-0.734 +
Full time	0.009	-0.202	-0.500	-0.343	-0.799 ++	-0.364
Motivation - Teamwork						
Team	-0.494	-0.843 +++	-0.406	-0.499	-0.219	-0.203
Time for patients	-0.005	-0.112	-0.420	0.065	-0.091	-0.396
Autonomy	0.613	-0.019	-0.225	-0.226	-0.019	-0.020
Reliable roster	-0.059	-0.147	-0.345	-0.267	-0.407	-0.286
Permanent contract	0.239	-0.088	-0.044	-0.468	-0.284	-0.603
Full time	-0.254	-0.253	-0.832 +++	-0.296	-0.897 +++	-0.606
Hours						
Team	2.885	12.585 +	23.341 +++	16.498 +++	20.813 +++	26.017 +++
Time for patients	13.460	12.130 ++	21.325 +++	16.014 +++	21.134 +++	27.636 +++
Autonomy	-1.286	6.250	22.450 +++	6.345	18.937 +++	14.359 +++
Reliable roster	14.220 ++	15.267 ++	22.067 +++	12.721 +	18.458 +++	15.099 +++
Permanent contract	-8.933	-7.202	14.475 +++	-0.303	21.427 +++	7.054
Full time	-16.916 ++	-12.834	4.183	-16.795 ++	-2.431	-7.332
Satisfaction with job						
Team	0.252	-0.382	-0.952 +	-1.241 ++	-1.399 +++	-0.441

Time for patients	-0.216	-0.566	-0.783	-0.931	-0.562	0.152
Autonomy	-0.121	-1.277 +++	-0.637	-0.738	-0.086	0.156
Reliable roster	-0.394	-1.079 ++	-0.884	-1.031 ++	-0.973 +	0.242
Permanent contract	0.618	-0.904	-0.946 +	-0.743	-0.684	-0.315
Full time	0.836	-1.265 ++	-1.432 +++	-0.648	-0.741	-0.610

Table 4.11 – Classification table – Difference in the average characteristics of the individuals in the upper and lower 20 percent of the effect distribution. Treatment is the substitution of higher wages for a favorably job characteristic at a base wage. Differentiation by individual characteristic (**bold**), job offer characteristic (row), base wage (super-column), and alternative wage (column).

Notes: +++, ++, +: Plus signs indicate significance of the differences between the individuals in the upper and lower 20 percent of the effect distribution, the most and least affected individuals, adjusted for multiplicity to account for joint testing of zero differences between all the variables in the table at conventional significance levels $1\%, 5\%, 10\%$, respectively.

P-values are obtained by bootstrap with 500 repetitions.

	Team	Time	Autonomy	Reliable roster	Permanent contract	Full time
Personal characteristics						
Team	1	0.001	-0.042	0.030	0.011	0.012
Time	0.001	1	-0.013	-0.020	0.000	0.004
Autonomy	-0.042	-0.013	1	0.004	0.020	0.001
Reliable roster	0.030	-0.020	0.004	1	-0.001	-0.041
Permanent contract	0.011	0.000	0.020	-0.001	1	-0.014
Full time	0.012	0.004	0.001	-0.041	-0.014	1
# of observations	7,408					

Table 4.12 – Matrix of correlation coefficients between treatment variables

	Average	
	Gross sample	Net sample
Share women	0.871	0.874
p-value	**0.872**	
Share German	0.926	0.977
p-value	**0.000**	
Average age	0.440	0.437
p-value	**0.574**	
# of individuals	8,176	751

Table 4.13 – Comparison between gross sample and analysis sample

4.7 Additional appendix to chapter 4

Choice of the survey method

For our analysis, we employ data from a self-conducted survey of (former) nurses to assess the question of which factors drive job attractiveness and job offer acceptance. In setting up the survey, the following considerations were taken into account: (1) care workers do not need to be explicitly aware of each and every of their own preferences, which ultimately influence their perception of the attractiveness of a given job. (2) Even if they were, several aspects could be highly correlated and thus difficult to disentangle if respondents were asked directly about their influences on job offer acceptance. (3) Among other factors, our survey involves issues that are likely to suffer from social desirability bias, such as the hourly wage or whether care professionals prefer to have much excess time for patients. To account for these aspects, the survey consisted of two parts. One part of the survey was traditionally item-based and served the purpose to query control variables. The main part of the survey was designed as a factorial survey in which the nursing staff were presented with vignettes describing fictitious advertisements of care jobs. The respondents were then asked to rate these advertisements with respect to their attractiveness and the probability that they would accept the position.

Description of the factorial survey

A factorial survey differs from a traditional item-based survey insofar as several parameters relevant to the research question are enquired in a coherent unit of meaning at the same time, instead of asking several separate questions. Thus, respondents to a factorial survey always evaluate an overall set of variables that are interrelated and can influence each other. When combining multiple variables with multiple characteristics many different vignette texts are possible. By presenting several systematically varied constellations, the influence of the individual dimensions can be separated in the analyses (see Auspurg & Hinz 2015 for an extensive introduction).

When conducting a factorial survey, various particularities must be taken into account in order to obtain a valid data base. As part of this process, we must first decide on the content of

the job advertisements–specifically, which job characteristics (vignette dimensions) with which levels to include, what the outcome variable is, and how to control for potential confounders. The set of all possible combinations of the job characteristics (vignette universe) usually results in more vignettes than can be presented to the respondents, as the number of respondents is limited. Therefore, in a further step, a sample is drawn from the vignette universe. Instead of drawing a random sample of vignettes, vignettes are sampled such that the vignette dimensions are orthogonal to each other, ensuring causal identification of the effects. In this step, all parameters that the factorial survey aims to identify have to be specified. In the following, the whole procedure of creating our factorial survey is described in more detail.

Survey design

As part of the factorial survey, the fictional job advertisement (see table 4.14) was presented to care workers in form of a series of vignettes in text form. The methodological considerations which guided the choice of the number of job characteristics in the vignettes, the dimensions, their levels, and the selection of the outcome variables are laid out in the following.

Choice of number of dimensions, levels, and vignettes per respondent

As factorial surveys are more complex than standard surveys, particular effort is needed in order not to overburden respondents with the survey setup. Therefore, the number of the vignettes presented to every respondent, the number of dimensions every vignette contains as well as the levels per vignette dimension need to be chosen with care. Although a larger number of dimensions would enable us to study more job characteristics, vignettes with too many dimensions can become too complex, overburden respondents and lead to inconsistent judgments (Sauer et al. 2011). Also, if respondents are presented with too many vignettes, they have been found to show fatigue effects or employ specific rating heuristics (Sauer et al. 2011, 2014). We, therefore, follow the methodological literature, which suggests (depending on the concrete setup) a maximum number of nine vignette dimensions and ten vignettes per respondent (Auspurg & Hinz 2015). The subjects in our cognitive pre-tests (see below) did not report being overburdened by the number of vignettes or the processing of the vignette text itself. Regarding the number of levels per dimension, we must consider several factors. Although a finer scaling of the dimensions enables a finer differentiated effect estimation,

Dimension	Level	Vignette text
Activity		In the locality where you have been working so far, a job in
(Act)	1	hospital nursing
	2	geriatric nursing
		is advertised
Institution		at an
(Inst)	1	inpatient care institution
	2	outpatient nursing service
Working		in
hours (Hours)	1	full time (39 h/week)
	2	50% part time (20 h/week).
Wage (Wage)		The gross hourly wage without supplements for Sundays,
		public holidays and night work is
	1	11 euro. The monthly gross earnings are thus around [11*20 / 11*39].
	2	14 euro. The monthly gross earnings are thus around [14*20 / 14*39].
	3	17 euro. The monthly gross earnings are thus around [17*20 / 17*39].
	4	20 euro. The monthly gross earnings are thus around [20*20 / 20*39].
	5	23 euro. The monthly gross earnings are thus around [23*20 / 23*39].
	6	26 euro. The monthly gross earnings are thus around [26*20 / 26*39].
	7	29 euro. The monthly gross earnings are thus around [29*20 / 29*39].
	8	32 euro. The monthly gross earnings are thus around [32*20 / 32*39].
Contract		The position is on a
duration (FTC)	1	one-year fixed-term contract without prospect of extension.
	2	one-year fixed-term contract with prospect of extension.
	3	permanent contract.
Autonomy		Through acquaintances, you have learned that nurses at this employer have
(Auto)	1	little
	2	much
		autonomy with regard to the order in which they perform their tasks.
Time for care		As part of the job, you would have
recipient /	1	little
patient (Time)	2	plenty of
		time to talk to the care recipient/patient about personal subjects.
Cordial team		The team members are
(Team)	1	not very friendly.
	2	very friendly.
Roster		Unforeseen services and roster changes are
reliability	1	rarely
(Roster)	2	frequently
		to be expected.

Table 4.14 – Vignette dimensions and levels

How attractive is this job offer to you?											
Very unattractive											Very attractive
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
1	2	3	4	5	6	7	8	9	10	11	
How likely would you be to accept this job offer? If you were employed at the time, you would have to give up your current job.											
Very unlikely											Very likely
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
1	2	3	4	5	6	7	8	9	10	11	

Table 4.15 – Vignette rating scales

this would also mean that a larger set of vignettes would have to be evaluated. In order to get efficient results, a limitation on a subset of all possible scale values is needed. Seven of the dimensions in our experimental setup, therefore, contain two levels, only. This could become problematic if we chose too extreme levels for the dimensions with only two levels. We considered the scaling of all dimensions during the cognitive pre-tests (see below). The pre-tests did not point to a too extreme understanding of the alternatives.

Choice of specific dimensions, levels, and outcomes

To measure the influence of monetary job characteristics, the vignettes contain wage as one dimension. To access the influence of non-monetary characteristics, work autonomy, time for patients, atmosphere within the team, and roster reliability enter the vignettes. We address the influence of non-monetary job characteristics via the type of care activity (hospital or geriatric nursing), the kind of care institution (in- or outpatient care), working hours, and contract duration. We selected the specific dimensions for the respective domains in a multistage process which included an exploration of the relevant literature, expert interviews, and pre-tests to identify the most prominent or most relevant dimensions. The dimensions of care activity and care institution are not prominent in the international literature; differentiation along those characteristics is important in the German context, however. Reading from top to bottom, the right column of table 4.14 lists all conceivable vignette constellations, i. e., the vignette universe.

The care workers evaluated a) how attractive the presented job offer is to them and b) how likely they would accept that job offer, under the condition that they would have to give up their current job if they had one. Table 4.15 presents the rating scales. We employ a 11-point scale, which has been found to work well in the literature (Auspurg & Hinz 2015).

Vignette intro

To estimate the causal effects of the vignette dimensions on the attractiveness of the fictitious jobs, we first relied on the experimental design, which allowed us to separate the effects of the single dimensions. Second, to abstract from the fact that the evaluation of the vignettes might be affected by other unknown confounding variables, the vignette text was preceded by a vignette intro. In the intro, essential confounders, which possibly affect job attractiveness, but are not under control of the employer or not in the focus of this study (e. g., commuting distance from home), were "controlled" by being (fictitiously) held at a level that remained constant over the vignettes. The vignette intro reads as follows:

"Jobs differ in many ways. The following part of the survey contains descriptions of some fictitious job offers in nursing and care for the elderly. All vacancies are fictitious but could happen in reality. We selected all features of the offered positions at random. At the end of each job description, we would like to hear from you about how attractive the job offered is to you and how likely you would be to accept it if it were offered to you. To do this, we ask you to place your cross on the attached response scales according to your assessment. You can answer the job descriptions in any order. If necessary, you can correct your answers at any time during the survey. Please note the following:

1. All offered positions are activities in direct nursing care.
2. The prerequisite for the start of all positions offered is a completed training as a specialist in health and nursing, health and child care or geriatric care.
3. All jobs are in the same place as your previous job.
4. There are enough quality childcare facilities near all jobs.
5. At all workplaces, there is a normal shift operation with industry-standard extent of night and weekend services as well as on-call duty.

6. All employers have an average number of employees or beds.

7. All employers are highly regarded in nursing circles."

Pre-testing

The survey underwent several rounds of cognitive pre-testing with experts and nurses in order to test its comprehensibility, the relevance and closeness to reality of the chosen dimensions and levels, and its intellectual demand.

Setting up the final survey architecture

Vignettes per person and expected response rate

Our design assigns ten vignettes to each person. Each vignette should be evaluated by more than one person, Auspurg & Hinz (2015) suggest a minimum of five persons per vignette, in order to disentangle the effects of vignette from individual characteristics. This consideration, together with the size of our gross sample, the expected response rate–and therefore the expected number of rated vignettes– and considerations on the efficiency of our survey design guided the determination of our vignette sample.

The size of the gross sample was about 8,000 people. Based on experience from previous surveys, we expected (conservatively) a response rate of up to 10 percent, i. e., around 8,000 rated vignettes. The response rate was at 20 percent significantly higher than expected. Even with this high response rate, we could not have all the $2^7 3^1 8^1 = 3072$ vignettes in our vignette universe to be rated by five individuals, and a separation of vignette and individual effects would not have been possible. To reduce the survey load, we therefore sample from the original vignette universe.

Drawing an efficient vignette sample

Vignette sampling

To determine the vignette sample, several factors have to be considered. It is obvious that we lose information relative to a survey based on the whole vignette universe if we only use a subsample of all possible combinations of the dimensions, i. e., if we employ a fractional factorial instead of the full factorial in the study.

Full factorial			Sample		
A	**B**	**C**	**A**	**B**	**C**
0	0	0	0	0	0
0	0	1			
0	1	0	0	1	0
0	1	1			
1	0	0			
1	0	1	1	0	1
1	1	0			
1	1	1	1	1	1

Table 4.16 – Left part: All combinations of three binary dimensions A, B, and C. Right part: A Sample.

Table 4.16 illustrates this with a toy example of a vignette universe with three binary dimensions. The left side of the table shows the full vignette universe, while the right side shows an exemplary sample. If we were to draw this sample, we would miss out on potentially relevant variation. For example, dimension C always has the same value as dimension A. As a result, the influence of both dimensions on the dependent variable would not be separable. Therefore, caution is required when drawing the vignette sample.

A straightforward way to draw a vignette sample would be random sampling. However, random vignette samples are generally inefficient because they lead to less precise estimates of the parameters in the analysis of the survey data than sampling methods that explicitly maximize the statistical information in the design. We employ D-efficient sampling to draw the vignette sample, which explicitly maximizes the statistical information in the data by searching for the

sample with the highest D-efficiency in a given setup. This approach leads to more precise estimates and a higher degree of orthogonality between the dimensions in the experiment. Put differently, the goal of this sampling procedure is to avoid situations like those illustrated in Table 4.16 and to enable precise, causally interpretable estimation results. The D-efficiency is defined as

$$\text{D-efficieny} = 100 \cdot \frac{1}{n_S \cdot |(X'X)^{-1}|^{\frac{1}{p}}} = 100 \cdot (\frac{1}{n_S} \cdot |(X'X)|^{\frac{1}{p}}) \,, \tag{4.8}$$

where X is the design matrix of the experiment, n_S is the size of the vignette sample, p is the number of coefficients in the estimation model that will be run on the data from the vignette survey, including intercept and coefficients for the interaction effects. $|(X'X)^{-1}|$ is the determinant of the inverse of the Fisher information matrix $X'X$. As the D-efficiency is inversely proportional to the determinant of the inverse of the Fisher information matrix for a given sample size and number of parameters (n_S and p), maximizing the D-efficiency corresponds to minimizing the determinant of the inverse of the Fisher information matrix. This, in turn, maximizes the information in the data, or equivalently, minimizes the variance (i. e., increases the precision) of the estimates. Since the D-efficiency reflects the orthogonality of the vignette dimensions in the sample, the vignette dimensions in the D-efficient sample are less correlated with each other than in a random sample. This makes it easier to make causal statements about the relationship between the evaluation of the vignette and its content with smaller numbers of cases (Auspurg & Hinz 2015, pp. 41-50).

To compute the D-efficiency, the design matrix of the experiment X has to be specified. This means we have to specify all the parameters, including the interactions between the vignette dimensions, before the survey begins (e. g., interaction between team and wage). This amounts to the choice of the design resolution. Surveys that only identify main effects and no interactions are called Resolution III designs. Surveys that identify main effects and some specific two-way interactions are called Resolution IV designs; in a Resolution V design, all main effects and all two-way interactions are identified. As it was our goal to not only estimate the relevance of single job characteristics on job attractiveness, but also to determine whether the effects of individual characteristics are amplified or moderated (for example, whether a good team is particularly important in jobs with low wages), we chose a Resolution V design (Auspurg & Hinz 2015, pp. 26-27).

The D-efficiency takes on values between 0 and 100, where 100 represents complete orthogonality. According to a rule of thumb, it should exceed 90 for a sufficiently orthogonal sample

design (Auspurg & Hinz 2015, p. 29). To draw the D-efficient vignette sample and to block the vignettes to decks efficiently, we used the SAS macro %Mktex (Kuhfeld 2010).

Our sample reaches a D-efficiency of 95, which lies well above the rule of thumb threshold. The results thus have a high internal validity. In concrete terms, all the main effects, along with all two-way interactions of the vignette dimensions, can be estimated in isolation from each other.

Blocking to decks and vignette sequence

Each respondent received ten vignettes. These were not sampled at random from the vignette sample, however. The vignette sample was divided (or blocked) into 20 decks of ten vignettes, each respondent assigned to one deck. The blocking to the decks was also done D-efficiency maximizing. To this end, the deck number is treated as an experimental factor that has to be orthogonalized. Unlike the composition of the decks, their internal arrangement of the vignettes in the decks was random. The questionnaires, and with them the decks, were then randomly mailed to the respondents.

Realized design quality of the survey

Even though we cannot control who is responding, i. e., we cannot control that every vignette is rated by several people, we are quite confident that vignette characteristics and individual characteristics are not confounded; on average each vignette was rated by over 60 persons. Moreover, we achieve a high degree of independence in the net sample with respect to the characteristics of the vignettes. Analyzing our final sample, we do not find two single dimensions with a correlation coefficient larger than 0.1.

Sampling of nurses

The survey was addressed to current and former nurses who work or who have worked in the regional planning area (RPA) of Heilbronn-Franken, Germany. RPAs are constructed for the purpose of carrying out nationwide comparisons and assessing large-scale regional tendencies

and explicitly rely on the concept of an economic centre surrounded by a more rural periphery. The precise RPA of Heilbronn-Franken was chosen as a region which is comparable to the regions surrounding it with respect to socio-demographic factors, and as it is not adjacent to other national states (Austria, France, Switzerland) because proximity to a national border would bring about specific peculiarities that could affect the intended analyses. Our gross sample was drawn from the Integrated Employment Biographies (IEB) from the Federal Employment Agency (BA) and consisted of 8,116 individuals who worked as professional caregivers in the named RPA at the time of the sampling or who had worked as professional caregivers in the RPA during the five years prior to sampling. The sample was stratified by employment status (currently vs. formerly working as a care professional), (former) profession (nurses vs. geriatric nurses), and the kind of institution the respondents (formerly) worked in (inpatient vs. outpatient care).[11] Within these strata, interviewees were drawn at random. The IEB contain process data at the person level from the procedures of the BA and cover almost all individuals who have been in paid employment at some point (Antoni et al. 2019, p. 7).

Data collection was carried out in the form of paper and pencil interviews (PAPIs) in November and December 2018. To generate high response rates, the participants also received a letter of recommendation from the German Nurses Association Southwest (DBfK). Participation was further incentivised via vouchers for a big internet retailer given to the first 800 respondents to mail back their questionnaire. We received a total of 1,607 filled-out questionnaires (around a 20 percent response rate). After data cleansing, we were left with 1,313 completed interviews.[12] More than 1,000 of those correspond to active nurses. Because of missing values, our analysis is based on 7,408 rated job offers. Our net sample is comparable to the gross sample in terms of the sex and age of respondents. However, German nurses are overrepresented.

[11] Data access was provided within the context of a § 75 SGB X application.

[12] A large part of the data cleansing consisted of checking whether respondents' answers were consistent with the questionnaire filters.

Chapter 5

The reaction of wages to skill shortage in nursing

5.1 Introduction

Skilled labor shortages and labor market tightness have become pressing issues in several industries across developed economies. A lively debate on the scope and consequences of this issue spans both scientific discussions (Cappelli 2015, Brunello & Wruuck 2021) and public discourse (*Why American unemployment needs to rise* 11/24/2022, Fuest & Jäger 2023). Recently, this debate has intensified due to the worsening of labor market shortages as a result of the COVID-19 pandemic (Autor et al. 2023). A commonly advocated solution, proposed by both politicians and economists, is to raise wages to address these shortages. Economic theory suggests that the price of labor should increase as scarcity rises, although not uniformly across the economy (Burdett & Mortensen 1998, Mortensen & Pissarides 1999, Elsby 2009, Autor et al. 2023). This paper analyzes wage reactions to demand-induced changes in skill shortages and how these reactions vary according to institutional and employer characteristics.

Our study focuses on the nursing labor market, particularly within health and care institutions, which is especially well-suited for this analysis for several reasons. First, this sector is heavily impacted by increasing skill shortages (European Centre for the Development of Vocational Training 2015, Drennan & Ross 2019). Second, these shortages are partly driven by the growing share and population of elderly individuals (Sachverständigenrat 2018), a development that

we consider independent of wage-setting behavior in the care sector. We use this demographic trend to identify a causal local effect of increasingly tight market conditions. Third, the nursing labor market provides valuable insights due to the relatively uniform educational backgrounds of nurses, who nonetheless work under varied market conditions and institutional settings, such as private and public employers and facilities of different sizes. These factors may lead to diverse reactions to changes in labor market tightness driven by fluctuating demand. Finally, nursing labor shortages are a significant public concern because of the crucial role nurses play in delivering health and geriatric care services.

To study wage reactions, we analyze data from 2010 to 2018, a period characterized by increasing skill shortages in nursing in Germany (Statistik der Bundesagentur für Arbeit 2024*b*). We use three waves of the German Structure of Earnings Survey (GSES), a linked employer-employee dataset, which we combine with information on regional skill shortages from the German Federal Employment Agency. Since wages, labor demand, and supply are determined simultaneously, we employ an instrumental variables approach to address endogeneity issues. We leverage the fact that the demand for health and care services rises significantly with age, using the regional share of inhabitants aged 65 and older as an instrument for regional labor shortages. To account for unobserved regional factors, such as economic performance, we apply a fixed-effects estimation approach. As wage reactions may be shaped by specific institutional conditions or employer characteristics, we differentiate the analysis by care settings (hospitals versus long-term care institutions), ownership structure (public versus private), size, and participation in collective bargaining.

We find that wage reactions to skill shortages occur in some parts of the nursing labor market, while in others, wages remain unaffected. Nurses receive higher wages when skill shortages are more severe in private institutions, but there is no significant relationship in public institutions. We also observe wage reactions in the absence of collective bargaining agreements, whereas no such reactions occur when wages are determined through collective bargaining. Wages respond to skill shortages in smaller institutions but not in larger ones, and in long-term care institutions but not hospitals. These differences in wage reactions partly align with economic theory and previous findings. Wage setting under collective agreements, in public institutions, and in larger organizations may exhibit rigidity, limiting wage adjustments not only downward but also upward (Elsby 2009, Babecký et al. 2010). Hospitals may be more productive, paying higher initial wages compared to long-term care institutions. As a result, the stronger wage reactions in long-term care align with theoretical expectations and prior research (Brunow et al.

2022, Autor et al. 2023).

Further explanations for differing wage reactions, or the complete absence of reactions in some parts of the market, can be attributed to the institutional framework within Germany's health and care sector. Public employers, particularly hospitals, typically provide contracts governed by collective bargaining rules, which could explain the lack of wage responses to shortages. This is plausible since collective agreements for hospitals and care institutions tend to be supra-regional in nature. Additionally, public employers, especially public hospitals, are often large institutions with relatively low regional competition, and their numbers are relatively small compared to the number of long-term care institutions, which increased during our study period, while the number of hospitals declined (Simon 2021). These employers may be able to exert market power, making them less inclined to raise wages during periods of shortage (Prager & Schmitt 2021). Furthermore, the restrictive price-setting in Germany's health and care services market, as outlined in section 5.3, may significantly delay or limit wage adjustments in response to demand increases. Overall, we find that wage reactions to demand-induced changes in labor market tightness are heterogeneous, varying according to employer characteristics and institutional differences.

The contribution of this paper is threefold: first, it provides evidence of wage responses across the nursing labor market as a whole; second, it offers a differentiated analysis of these responses–or lack thereof–based on employer characteristics; and third, it adds to the recent literature on market responses to skill shortages by providing evidence of differences in market reactions across various institutional settings. By focusing on care workers, this study also contributes to the literature on the influence of wages on the labor supply of nurses, an area where wage reactions to shortages have been underexplored. Furthermore, we provide new evidence on the role of employer characteristics and institutional settings in shaping wage dynamics.

The rest of the paper is structured as follows. Section 5.2 reviews the economic background and related literature. Section 5.3 discusses the relationship between demographic aging, the demand for care services, nursing wages, and the institutional framework of care provision in Germany. Section 5.4 outlines our data sources, while section 5.5 details the methodological approach. In section 5.6, we present the results of our empirical analysis, followed by a discussion of the findings and concluding remarks in section 5.7.

5.2 Economic background and literature

Economic models of the labor market suggest that wages will rise in response to an intensification of the labor shortage due to increased demand. The canonical model under full competition as well as models in a search and matching framework, whether under perfect or imperfect competition predict higher wages in a tighter labor market as reaction to such changes (Burdett & Mortensen 1998, Mortensen & Pissarides 1999, Manning 2021, Autor et al. 2023). However, further differentiation of these mechanisms along different market conditions and employer characteristics yield different predictions of the models with respect to whether and how strong wages react to demand induced shifts on the labor market. Wage reactions may be heterogeneous due to differences in employer productivity, leading us to expect stronger wage reactions in less productive firms (Burdett & Mortensen 1998, Autor et al. 2023). Wage reactions can further be attenuated if wages are not fully flexible due to constraints imposed by labor market institutions or collective bargaining agreements. Such rigidity should not only hinder cuts in (nominal or real) wages, but also, and as a result, mitigate wage increases, as the employers affected by downward wage rigidity should on average already pay higher wages and forward looking employers will dampen wage rises in the knowledge that they will not be able to enforce wage cuts in the future (Elsby 2009). Institutional framework conditions in certain markets and economic sectors can impose further frictions on wage determination.

In line with theory, empirical studies which examine the relationship between labor market tightness and wages largely find a positive relationship between tightness and wages. Though Fang (2009) finds no evidence that employers raise wages as response to labor shortages using longitudinal survey data from Canada, other, more recent studies establish such a positive relation. Notowidigdo (2020) uses a Bartik-type identification strategy (Bartik 1991) to estimate responses to local labor demand shocks and presents evidence on significant positive wage reactions to such shocks; Frohm (2020) analyses data from a large representative business survey in Sweden and also finds a significant association between reported shortage and wage growth. Taking a macro perspective, Domash & Summers (2022) show a positive relation between wage inflation and several indicators of labor market tightness, among them vacancy rates, for the U.S. labor market. In a recent study, Autor et al. (2023) analyze the effects of the increase in labor market tightness resulting from the Covid-19 pandemic on wages and wage compression. Consistent with the imperfectly competitive model they employ, they find significant overall wage growth following increases in tightness, which is stronger for low-wage

employees at less productive firms, leading to wage compression. Two other recent studies use Bartik-type instruments (Bartik 1991) to analyze responses to labor shortages and increased labor market tightness. Groiss & Sondermann (2024) utilize EU survey data and find that firms experiencing labor shortages pay a wage growth premium, which is higher in rapidly growing firms or in those with a high labor-to-capital ratio. Bossler & Popp (2024) study German data to analyze firms' labor demand reactions to increased labor market tightness and find firms to reduce employment as a result of increased tightness, which they attribute to rising pre-match hiring costs. In an analysis of other potential channels of effect, they employ their IV approach to estimate the effect of tightness on wages and find a small but significant effect. Kölling (2022) analyzes firm-level survey data and instruments labor shortage with its lag to study the effects of shortages on wages. He finds that hiring constraints lead to wage increases, but only in firms that are not bound by collective agreements. In a report covering several developed countries and the European Union, Duval et al. (2022) describe a positive relation between labor market tightness and wage growth, particularly among low-pay jobs, high-paying jobs are less affected.

On a more specific level, wage reactions to shortages of (well-educated) skilled workers have been analyzed only sporadically and mostly descriptively so far. In the aforementioned study by Kölling (2022), the author also finds that hiring constraints for skilled labor lead to wage increases, but again, only in firms not bound by collective agreements. Using survey data on Australian small- and medium-sized enterprises (SMEs), Healy et al. (2015) find that firms report to react to skill shortage by–among other measures–offering higher wages or improving working conditions. However, these measures cannot be differentiated because of the design of the survey. A couple of studies analyze reactions to skill shortages in Germany. Brunow et al. (2022) analyze how labor market tightness at market entry affects the wage growth of young workers. The authors assume that differences in labor market tightness are exogenous and therefore not simultaneously determined with individual wages. They find significant effects on wages, which are however significantly dampened for health-care workers, which they attribute to institutional specificity in the health care sector. Like Autor et al. (2023), Brunow et al. (2022) find stronger effects on wages at the lower part of the wage distribution. Burstedde & Schüler (2020), employing fixed-effects estimation of data on full-time employees in Germany, find mixed associations between skill shortage and wages. Whereas the highest trained individuals can gain higher wages because of skill shortage, the medium trained individuals do not. The authors focus on wage reactions at occupation level and

control for changes in the age composition and the share of full-time employed. They do not account for further composition effects because of individual factors, such as experience or firm characteristics, and the simultaneous determination of wages and labor supply and demand. In a further report employing German data, Arnold et al. (2017) present results from establishment surveys, showing that employers with problems staffing open positions report to be willing to pay higher wages to overcome these problems. They further analyze linked employer-employee data to study effects of skill shortage on entrance wages relative to wages of the existing labor force and find significant effects only for wages of low skilled employees. The authors point to possible biases in the wage response estimates and the possibility of addressing these with an instrumental variable approach, do not apply such an approach due to the small number of cases, however. Overall, causal evidence on wage reactions to shortages in skilled labor is scarce.[1] Regarding widely missing nursing personnel such evidence is, to our best knowledge, missing.

Rigid wage setting circumstances can be important in our analysis setting, as wage rigidity does not only compress wage cuts but also wage increases (Elsby 2009). Wage rigidity has been broadly documented in several studies. Based on the model and in line with the findings presented by Elsby (2009), Stüber & Beissinger (2012) yield further evidence for a compression of wage increases based on German data. Most recently, Ehrlich & Montes (2024) identify a substantial extent of wage rigidity in West-Germany throughout the 90s and early 2000s. Further studies have established a link between rigid wage setting and market and firm conditions. Dustmann & Schönberg (2009) document stronger wage compression in unionized firms in Germany. Using data from a survey on European firms, Babecký et al. (2010) find that collective bargaining coverage and employment protection as well as firm size and more labor intensive work are associated with wage rigidity.

Our study explores wage reactions to tightness-inducing demand changes on the example of nurses. Some studies have made arguments with respect to wage setting in the nursing labor market, specifically. A major topic of discussion is whether the labor market for nurses–a classic example of monopsonistic competition–is in fact a monopsonistic (Hirsch & Schumacher 1995, 2005, Staiger et al. 2010, Hirsch & Schumacher 2012, Matsudaira 2014). In two U.S. studies with quasi-experimental design, Matsudaira (2014) finds no evidence of monopsonistic wage setting in long-term care facilities, whereas Staiger et al. (2010) find evidence of a

[1] In their literature review on skill mismatch, covering skill shortage, McGuinness et al. (2018) only consider two papers, analyzing this relation.

monopsonistic labor market for hospital nurses. Addressing the issue more directly, Prager & Schmitt (2021) study the effects of employer consolidation in the hospital market and find decelerated wage growth of nursing staff because of increased employer market power. Heyes (2005) puts forward another argument than simple profit maximizing reasons for why nurses' wages may further be artificially low, i.e., that public institutions could set artificially low wages in order to use them as a sorting device, attracting only the sort of nurses with the "right" motivation, not those who are motivated by high pay.

In the political and public debate, wage raises for the scarce nursing personnel are motivated by the argument that rising wages increase nurse labor supply. Empirical results support this argument. Though a number of studies that focus on the intensive margin find nurses' labor supply to be rather unresponsive to wage changes or yield inconclusive results (Antonazzo et al. 2003, Shields 2004, Di Tommaso et al. 2009, Andreassen et al. 2017), reactions have been found to be significant and positive when effects on both the intensive and the extensive margin are taken into account (Hanel et al. 2014). Higher wages have further been found to have a positive effect on the attractiveness of care jobs (Scott 2001, Doiron et al. 2014, Scott et al. 2015, Song et al. 2015, Fields et al. 2018, Kroczek & Späth 2022), nurses' job and occupation retention (Holmås 2002, Frijters et al. 2007, Kankaanranta & Rissanen 2008, Kroczek 2023), and pupils' decision to enter the nursing profession (Kugler 2021). Moreover, nurse shortages have been found to be higher where nurses' remuneration is less competitive (Haskel & Martin 2001, Elliott et al. 2007, Combes et al. 2015, 2018). Political and public demands for increased wages for nurses with the intention to increase nurse labor supply are therefore rational. On the aggregate level, such wage increases only seem to occur slowly and unequally, however (Carstensen et al. 2022).

5.3 Institutional background and outset

5.3.1 Demographic aging, skill shortage in nursing, and wages

Demographic aging is a global trend that does not spare Germany (Bloom 2020). In recent decades, the average age of the German population and the number of aged people in Germany increased strongly. As the probability that an individual needs care services increases sharply from the late sixties on and rises almost exponentially after the age of 75, the demand for health

and care services increased significantly (Bogai 2017, Sachverständigenrat 2018). Already, demographic aging induced a shortage in skilled nursing labor (Sachverständigenrat 2018) that continues to this day and is reflected in a very tight labor market for nursing staff (Bundesagentur für Arbeit 2024). Demographic aging could also reduce the supply of workers and thus exacerbate the shortage. So far, however, the number of employees in Germany has risen steadily across all professions as well as in the care sector. This situation could change as soon as the baby boomers leave the labor market (Klinger & Fuchs 2020).

			Skilled nurses		
	Average age (years)	**Share of pop. aged 65+**	**Vacant positions**	**Vacancy time (days)**	**Hourly wage (real, in euro)**
Year					
2010	43.23	0.206	11,937	90	17.889
2014	43.90	0.211	13,792	115	17.634
2018	44.06	0.215	21,858	169	18.939

Table 5.1 – Measures of demographic aging, skill shortage in nursing, and hourly wages of skilled nurses

Source: Own calculations based on data from Statistik der Bundesagentur für Arbeit (2022), BBSR (2022), and GSES 2010, 2014, and 2018. Survey weights were used for all calculations with GSES 2010, 2014, and 2018.

Our study covers the years 2010 to 2018, a period clearly affected by the developments described. As can be seen in table 5.1, the average age of the German population rose from 43.23 to 44.06 years and the share of individuals of at least 65 years of age increased by four percent from 0.206 to 0.215. The number of open positions for skilled nurses increased by just over 80 percent and the time such positions could not be staffed increased by almost 90 percent. With an increase of six percent between 2010 and 2018, real wages of skilled nurses did only rise slightly in the same period. Although demographic change and skill shortage did not develop uniformly throughout Germany, the corresponding association between demographic change and skill shortage transfers to a more fine-grained level. We elaborate more on this association at the regional level in section 5.5.1.

5.3.2 Market conditions and market frictions

Though nurses are rather homogeneous with regard to their qualification and training, the market for health and care services in Germany is highly heterogeneous. More specifically, the market is characterized by heterogeneous employer characteristics and institutional settings, which levy different frictions on wage responses.

Nursing occupations in Germany

In Germany, the profession of registered nursing is subject to stringent regulations. To qualify as a registered nurse, one must complete a three-year training program. This standardization results in a workforce that is relatively homogeneous in terms of training duration. While the specific content of the training programs for health and geriatric nurses differs, graduates from both streams are employed in hospitals as well as long-term care services. However, geriatric nurses are significantly less likely to work in hospitals compared to how frequently health nurses work in outpatient or inpatient long-term care facilities (refer to 5.16 in the appendix). Recently, the differentiation between the various vocational training courses was eliminated, leading to a unified training curriculum for nurses across Germany.

The role of the institutional setting in Germany

In Germany, health and care services are delivered across three primary settings. Firstly, hospitals, which employ the majority of nurses. In 2020, approximately 486,000 individuals worked in the nursing departments of German hospitals (Statistisches Bundesamt 2022*a*). In terms of ownership, publicly owned hospitals account for nearly 50 percent of all hospital beds; non-profit organizations, such as religious groups, provide around 30 percent, while privately owned commercial hospitals supply about 20 percent of the beds (numbers for 2018, see Simon 2021). Secondly, inpatient care services, predominantly nursing homes, focus mainly on geriatric care. These facilities are primarily managed by non-profit and commercial private entities, with public ownership playing a minimal role. In 2019, about 313,000 nurses were employed in inpatient care services (Simon 2021). Thirdly, outpatient care services cater to geriatric and general healthcare needs, with a similar ownership structure to inpatient care services where commercial and non-profit private sectors dominate. In this sector, approximately

222,000 nurses were working in 2019 (Simon 2021). What is more, hospitals are mostly large institutions and their number is small compared to the number of long-term care institution and has been shrinking further during our study period; the number of long-term care institutions, on the other hand, has been growing (Simon 2021). Specific market frictions can occur in each of these settings.

From the perspective of a profit-maximizing employer, the most significant differences in this fragmented market are found in the strict regulation of pricing and cost reimbursement for health and care services within the predominantly public insurance system. In all settings, care services are primarily funded by statutory insurance carriers (health and long-term care insurance), although the methods and amounts of reimbursement to service providers vary. The services provided and the fees that institutions can charge for health and geriatric care are tightly regulated and vary between the settings described above (Simon 2021). In the healthcare sector, including hospitals and outpatient services, health insurance typically covers the full costs of services. Conversely, geriatric nursing services are financed by long-term care insurance, which only pays a portion of the expenses; the remainder must be covered by the care recipients (Bogai 2017).

Due to significant restrictions on price setting, an increasing demand for health and care services may not necessarily lead to higher prices. This is particularly true in healthcare, where nearly all costs are borne by statutory insurances. Moreover, while the prices for long-term care services are negotiated between care providers and payers at the state level, health service prices are negotiated nationally. Therefore, prices for health services do not reflect regional variation in demand. To account for the possible differences in market frictions, our analysis distinguishes between hospitals and long-term care institutions (both outpatient and inpatient facilities). Given that the division between private and public facilities is a defining characteristic of the German health and care services market, our analysis further differentiates by type of institution, whether private or public.

The institutional framework in Germany significantly influences wage setting. The introduction of a specific minimum wage for nurses in 2010 establishes a lower bound for nurse salaries, although its impact has been limited since few nurses earned wages below this threshold (Harsch & Verbeek 2012). Furthermore, wages are frequently determined by collective agreements that encompass a substantial portion of care personnel, especially in hospitals. In contrast, collective agreements are less prevalent in both inpatient and outpatient care settings (Bogai

2017). Our analyses are conducted separately, depending on whether an employer is governed by a collective agreement.

Hospitals and long-term care institutions differ significantly in size. According to the German Federal Statistical Office, in 2022, general hospitals in Germany had between under 50 and over 1,000 hospital beds (Statistisches Bundesamt 2023). In 2021, long-term inpatient care facilities cared for between less than ten and over 300 care recipients, though the overwhelming number cared for between ten and 150 recipients. Also in 2021, outpatient care providers had between below ten and more than 150 care recipients (Statistisches Bundesamt 2022*b*). As employer size has long been recognized to be positively correlated with wages (Green et al. 1996, Oi & Idson 1999), we differentiate between institutions of different size, measured by the number of employees.

Differences in wages

Wage disparities across different parts of the care labor market are evident, as detailed in table 5.2, which breaks down average wages by employer characteristics. The most significant differences occur between care settings. Nurses in hospitals command the highest wages, followed by those in inpatient long-term care, who earn more than outpatient care nurses but considerably less than hospital nurses. There are also differences by type of ownership, collective bargaining situation and size. Wages are higher in organizations that are predominantly publicly owned, in companies covered by collective agreements, and in large companies. The wage trends also vary across these characteristics. Hospital nurses, nurses in public institutions, and those covered by collective agreements experienced wage growth from 2010 to 2014 and again from 2014 to 2018. In contrast, wages for nurses in outpatient and long-term inpatient care, in private institutions, and not covered by a collective agreement declined in real terms between 2010 and 2014. With regard to the size of the institution, the differences in wage growth are less distinct.

Year	2010	2014	2018
Field of care			
All institutions	17.889	17.634	18.939
Hospitals	19.167	19.408	20.910
Outpatient care	15.448	15.112	16.087
Long-term care	16.386	15.589	16.826
Ownership			
Public institution	19.227	19.421	20.986
Private institution	17.406	17.109	18.370
Collective bargaining situation			
Collective agreement	18.958	19.018	20.588
No collective agreement	16.832	16.454	17.025
Size by group			
Small or medium institution	16.526	15.955	17.163
Large institution	19.109	19.101	20.605

Table 5.2 – Average real hourly wages by type of institution in euros by year

Source: Own calculations based on GSES 2010, 2014, and 2018. Survey weights were used for all calculations.

5.4 Data and definitions

To analyze how nurse wages respond to skill shortages, we utilize data from the German Structure of Earnings Survey (GSES). This quadrennial survey is conducted by the Federal Statistical Office and is mandatory for respondents. Our analysis includes data from the 2010, 2014, and 2018 survey waves, which provide comprehensive information on both employers and employees. Crucially, the GSES offers detailed insights into employees' hourly wages and other aspects of compensation, such as supplements and bonuses, which are particularly pertinent in care professions.[2] Additionally, the data encompass a variety of employee characteristics (e.g., age, sex, and education), job details (e.g., workload and tenure), and employer information (e.g., firm size and industry classification).

[2]Other potentially relevant datasets for wage analysis, such as administrative data from the German Social Insurance at the Federal Employment Agency, lack sufficient information on working hours. Additionally, voluntary surveys like the German Socio-Economic Panel have much smaller sample sizes, especially concerning the specific occupations central to this paper.

The German Structure of Earnings Survey (GSES) offers specific advantages over other datasets for our analysis, chiefly its high reliability due to its mandatory nature and the detailed information it provides on hourly wages. This detail is particularly critical given the high prevalence of part-time employment in nursing, as noted by (Bogai 2017). However, a notable limitation of the GSES is that it contains repeated cross-sectional data; that is, it does not track individuals and firms over time. This absence precludes the use of panel data methods at the individual level. Additionally, due to the two-stage random sampling procedure, analyses must be conducted using appropriate sample weights. These weights are included in the dataset and are employed in our analysis, which concentrates on nurses working in the health and social sectors.

The other data source we use is information on the regional level containing measures of skill shortage as well as further characteristics indicating the demand for care services. To measure shortage in skilled labor, particularly in nursing, we use indicators on the level of Planning Regions. Skill shortages have long been interpreted as difficulties in filling vacancies (Green et al. 1998, McGuinness et al. 2018), which have been operationalized through firms' reports on hard-to-fill vacancies (Bennett & McGuinness 2009), the number of vacancies (Haskel & Martin 1993, Bellmann & Hübler 2014, Horbach & Rammer 2022), the vacancy rate (Bennett & McGuinness 2009), and the duration for which positions have remained vacant (Osterman & Weaver 2014). Most often, these measures are derived from employer surveys.

Since our data lack firm-level information on skill shortages and because survey data on skill shortages can be susceptible to reporting biases by employers (Cappelli 2015), we utilize regional-level data from the German Federal Employment Agency (BA). The German Federal Employment Agency (BA) collects data on the number of vacancies, the average duration of vacancies at the occupational level, occupation-specific unemployment rates, and the unemployment-to-job ratio by occupation (German Federal Employment Agency, BA). Although all these measures provide information on shortage situations, we use the Federal Employment Agency's primary shortage indicator, the average time positions remain unfilled, as the shortage indicator in our analysis. This is because, first, it reflects the outcomes of actual market processes. While a long vacancy duration can also be due to other reasons than a shortage, such as inefficient search processes or poor working conditions, the (market) result of a long vacancy clearly indicates problems in filling certain positions. Conversely, the number of vacancies by itself might merely reflect the time it takes to match skills to jobs (Cappelli 2015). Second, unlike the number of job vacancies, the indicator does not depend on

the size of the labor market under review. Third, by focusing on the actual market outcome, the indicator abstracts from measures of potential labor supply, like occupation-specific unemployment rates or the unemployment-to-job ratio. Such measures are subject to inaccuracies. For example, it is unclear how many people are fundamentally available to the labor market but are not registered as seeking employment, or how many are registered as job-seekers but are not actually available to the labor market (Statistik der Bundesagentur für Arbeit 2020*a*). The indicator is available for vacancies across all job types, including those in skilled nursing occupations. It is derived from administrative data, specifically notifications from employers about job vacancies submitted to the BA (Statistik der Bundesagentur für Arbeit 2020*a*).

Lastly, we utilize additional indicators on the socio-economic structure and dynamics provided by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) through the INKAR-online tool (BBSR 2022). Specifically, we employ information on the regional age composition of the population in the Planning Regions as a proxy for regional demand for nursing services as instruments. We integrate this information on regional characteristics with GSES data at the level of 96 Planning Regions (RORs).

Tables 5.6-5.8 in the appendix provide summary statistics of the individual, firm, and regional characteristics of the observations used in our analyses.

5.5 Identification strategy

We investigate wage reactions to skilled labor shortages in nursing occupations. Equation 5.1 presents the structural equation, analyzing the effect of regional skilled labor shortages on individual wages.

$$Y_{it} = \alpha_j + \lambda_t + \rho s_{jt} + \mathbf{X}'_{it}\beta + \varepsilon_{it} \tag{5.1}$$

In equation 5.1, the dependent variable Y_{it} is the natural logarithm of the real hourly wage of individual i in year t. s_{jt} is a measure of regional scarcity of nursing labor in region j at time t. $\mathbf{X}_{it}$ includes individual and firm characteristics that may affect wages, such as age, tenure, level of education, and whether a firm is covered by a collective agreement. Regional labor scarcity (and further regional variables) are measured at the level of Planning Regions (ROR). The main parameter of interest is ρ, representing the influence of regional labor shortages on wages. Unobserved persistent regional differences, as well as a common time trend, may

influence wages and regional skill shortages. We account for such influence by incorporating regional and time fixed effects, represented by α_j and λ_t, in equation 5.1.

The identification of ρ is complicated by the fact that wages and the quantity of labor are determined simultaneously by both sides of the labor market. Our main hypothesis is that wages should rise in regions where nursing labor is scarce. However, nursing labor supply should increase (or scarcity should at least not increase as fast) where wages are higher or where wages rise faster. As a result, we cannot distinguish between scarcity-induced changes in wages and wage-induced changes in regional labor scarcity. To address this simultaneity issue, we employ an instrumental variables approach (Angrist & Pischke 2009). We discussed the association between the share of highly-aged individuals and the scarcity of nursing labor in section 5.3.1. We use this relation to instrument s_{jt} in equation 5.1 by the share of high-aged individuals.

$$s_{jt} = \gamma_j + \tau_t + \phi z_{jt} + \mathbf{X}'_{it}\eta + \upsilon_{jt} \tag{5.2}$$

Equation 5.2 presents the first stage, i.e., how the instrument determines regional skilled labor shortages. z represents the share of highly-aged individuals, γ_j are regional fixed effects, τ_t are time fixed effects, and $\mathbf{X}_{it}$ comprises the same individual and firm characteristics as in equation 5.1.

We apply two-stage least squares (2SLS) to analyze the effect of changes in nursing labor shortages on nurse wages induced by demographic aging. Under certain assumptions, the estimate of ρ in equation 5.1 gives this local average treatment effect (LATE). The 2SLS results do not apply to wage effects of nursing labor shortages attributable to other causes (Angrist & Pischke 2009). We further discuss these assumptions and the validity of our instrument in section 5.5.1.

5.5.1 Validity of the instrument

In section 5.3.1, we described how an aging German population demands more health and care services, leading to increasing scarcity in skilled nursing labor. In our analysis, we take up this notion and instrument the regional shortages in skilled nursing labor via an indicator of demographic change. Specifically, we use the natural logarithm of the regional share of individuals aged 65 and older as an instrument. To factor out migration movements in the denominator of our instrument, we employ a linear extrapolation of regional population size

since 2009 based on the time series from 1995 to 2009. Our instrument is

$$z_{jt} = \log\left(\frac{N_{65+}}{\tilde{N}_{total,09}}\right), \tag{5.3}$$

where N_{65+} is the number of individuals aged 65 and older and $\tilde{N}_{total,09}$ is the total population size, extrapolated since 2009, i.e., net of shocks in the overall population development.

Under certain assumptions, which we discuss in the following, we can identify the average causal effect of differences in skilled labor shortages induced by demographic aging on nurse wages conditional on covariates X.

Independence and exclusion: We assume $\{Y_{it}, s_{jt}\}z_{jt}|\mathbf{X}_{it}$, which means that, conditional on covariates $\mathbf{X}_{it}$, our instrument is both independent of the vector of potential outcomes and regional scarcity of nursing labor and affects Y via s, only (see, e.g., Angrist & Pischke 2009). A threat to this assumption can arise from persistent regional differences that are associated with both nursing wage levels and the share of older individuals. For example, older individuals might systematically cluster in regions with weak economic performance. Another threat arises from shared developments over time, such as general economic trends and the steady growth of the elderly population. We account for such associations by introducing regional and time fixed effects. The independence assumption could also be violated by regionally differing changes in the age structure and nursing wages, for example, due to regional economic shocks and associated migration patterns.

A potential concern specifically relates to the nursing workforce. Identification may be affected if older people migrate from regions with high nursing wages to regions with lower nursing wages in order to avoid high care costs. As outlined in section 5.3, in hospitals and outpatient health care, health insurance covers the full costs of services, whereas geriatric nursing services are covered partly by long-term care insurance, with the remainder borne by the care recipient. Wage increases in geriatric nursing–particularly in long-term inpatient care–could therefore be passed on to care recipients, potentially driving old-age migration away from regions with rising wages in geriatric nursing facilities. To analyze this potential issue, we present the results of an estimation of the association between regional average wages and old-age migration in columns (1) and (2) of table 5.9 in the appendix. We find no significant association, which we take as an indication that our identification strategy is not impacted by old-age migration.

Even if no association exists between old-age migration and nursing wages, overall migration may still be associated with wages as people might move to regions where wages rise more

sharply. We present results of regressions of overall net migration on regional average nursing wages in columns (3) and (4) of table 5.9 in the appendix. Accounting for region and time fixed effects, we do not find a significant association between nursing wages and migration behavior. As overall internal and external migration exceeds old-age migration and may still be sensitive to economic shocks, we factor out migration movements from the denominator of our instrument. Specifically, instead of using the actual observed regional population at time t, N_{total}, we use the extrapolated population size $\tilde{N}_{total,09}$ as the denominator in our instrument.[3]

The independence assumption could also be violated if regions exhibiting stronger increases in the share of older individuals substantially differ from those with weaker increases. Differences in the economic situation are of special concern due to their relation to wages. We study the association between regional characteristics (mostly economic) and our instrument, and the variation remaining in our instrument after accounting for regional and time fixed effects via the following regression analysis (see Caliendo et al. 2017 for a similar approach) calling this the adjusted instrument:

$$z_{jt} = \alpha_j + \lambda_t + V_{jt}, \tag{5.4}$$

$$\hat{V}_{jt} = \delta X_{jt} + U_{jt}. \tag{5.5}$$

In the first step, we regress the instrument z on regional and time fixed effects, α_j and λ_t, thereby adjusting the instrument by accounting for fixed regional differences and a common time trend. The remaining residual $\hat{V}_{jt}$–the adjusted instrument–is then net of regional and time fixed effects. In the second step, we analyze relationships between $\hat{V}_{jt}$ and regional characteristics X_{jt}. A graphical representation illustrates how including regional and time fixed effects removes potentially problematic correlations between our instrument and regional characteristics. Figure 5.1 in the appendix shows scatter plots of z versus the log of several regional characteristics. All plots suggest some association between our instrument and the regional characteristics. Figure 5.2 shows scatter plots of the residual from equation 5.4–$\hat{V}_{jt}$–against the same regional characteristics. After accounting for regional and time fixed effects, hardly any association between the adjusted instrument and the regional characteristics is visible. We also verify this arithmetically. To test whether the residual is associated with changes in regional characteristics, we regress $\hat{V}_{jt}$ on regional characteristics X_{jt}. The results of the regression are presented in table 5.14, in the appendix.

[3] A specification where we extrapolate population development from 2005 yields comparable results.

When we regress z on the regional characteristics, the coefficients of five characteristics are significant at the five percent level, explaining a large part of the variation in z ($R^2 = 0.6$). After accounting for region and year fixed effects, the regional variables explain only 1.2 percent of the variance in the adjusted instrument $\hat{V}_{jt}$, and only one characteristic remains significant at the five percent level. To further check whether any association between the adjusted instrument $\hat{V}_{jt}$ and the local economic situation affects our identification, we include regional GDP per capita as an additional covariate. Table 5.13 in the appendix presents the respective results. We find no statistically significant relationship with GDP per capita, and our results remain largely unchanged.[4]

The assumption that the share of older individuals affects wages via labor shortages would be invalid if the instrument directly influences wages. One possible direct path would be through the age composition of the workforce. With demographic aging, the average age (and thus, experience) of the workforce increases, leading to higher wages. We control for this by including individual characteristics in our wage regression. To investigate whether demographic aging itself–independent of skills shortages–affects wage structure, we examine the correlation with wages in occupations less affected by skill shortages despite demographic trends. Table 5.12 in the appendix presents results of regressions of the regional share of older persons on wages in sectors not affected by skill shortages. We analyze three groups: individuals in the management and technical services industry, individuals in wholesale and retail, and a comparison group of individuals employed in industries where former nurses often work, mostly social institutions. We find no statistically significant relationship between the local share of inhabitants aged 65 and older and wages in these groups. Thus, we find no direct influence of the share of older individuals on wages.

First stage: We further assume that the share of older individuals z actually affects the regional scarcity of nursing labor s, i.e., that ϕ in equation 5.2 is different from zero. A widely used rule of thumb for this assumption is that the respective F-Statistics of the instruments in the first stage regression should exceed 10 (Staiger & Stock 1997). Table 5.3 shows the results of linear regressions of the natural logarithm of the average vacancy time (in days) for positions for skilled nurses (including those in inpatient and outpatient long-term care institutions and hospitals) on the natural logarithm of the regional share of individuals aged 65 and older. The

[4]We also examine whether there is a statistically significant relationship between changes in regional average nursing wages and GDP per capita. Controlling for region and time fixed effects, we find no significant relationship. Results are presented in table 5.10 in the appendix.

table includes region and year fixed effects, as well as the individual-level control variables used in our main analysis.[5] For all specifications, the results show that vacancy times are significantly longer in regions with a higher number of elderly individuals. Furthermore, the F-statistics exceed 10 in all cases, suggesting a strong association between the instrument and the endogenous variables.[6]

Monotonicity: Lastly, we assume monotonicity. This assumption rules out the possibility of decreases in skilled labor shortages in nursing due to demographic aging. It seems implausible that an increasing share of elderly individuals would reduce labor shortages in nursing by either providing labor in such a physically and mentally demanding occupation beyond pension age or by becoming healthier.

5.5.2 Accounting for institutional differences

The specific institutional setting in Germany, as described in section 5.3, may mitigate the effect of skill shortages on wages or, under certain circumstances, even obstruct it. To analyze whether institutional differences between hospitals and long-term care facilities affect wage reactions, we calculate separate estimations for each setting. Additionally, to account for employer size, we further distinguish by the number of employees. Variations may also occur between institutions that adhere to collective agreements and those that do not, as well as between public and private institutions. To examine these potential distinctions, we conduct separate estimations for each group.

[5]We estimate the model $s_{jt} = \alpha_j + \lambda_t + \gamma z_{jt} + \varepsilon_{jt}$ and test the hypothesis that γ is equal to zero.

[6]Table 5.11 in the appendix shows the respective results regarding the average vacancy time of positions for health nurses, geriatric nurses, and all skilled nurses on the regional share of individuals aged 65 years and older. The table presents results including solely region fixed effects, region and year fixed effects, and including region and year fixed effects with individual-level control variables. Again, the results point to a strong association between the instrument and the endogenous variables.

	All controls		
	All skilled nurses	**Care institutions**	**Hospitals**
log(share individuals aged 65+)	3.518***	4.121***	3.002***
	[0.731]	[0.979]	[0.682]
Year 2010 (base)			
Year 2014	0.192***	0.222***	0.137***
	[0.039]	[0.047]	[0.043]
Year 2018	0.398***	0.429***	0.332***
	[0.071]	[0.956]	[0.074]
Constant	-6.189***	-7.927***	-4.701**
	[2.222]	[2.376]	[2.070]
Region FEs	X	X	X
Individual-level controls	X	X	X
F-Statistic	23.15	17.71	19.35
N	58,769	16,433	33,190

Table 5.3 – Results from fixed effects regressions on the association between average vacancies (in days) and share of individuals aged 65+ years

Notes: Standard errors are clustered by Planning Region and given in square brackets. ***, **, *: Asterisks indicate significance of coefficients at the conventional significance levels $1\%, 5\%, 10\%$, respectively. Regressions further include Planning Region fixed effects where noted, respective coefficients are omitted for clarity. The F-Statistic refers to the instrument (share of individuals aged 65+).

Source: Own calculations based on data from Statistik der Bundesagentur für Arbeit (2022), BBSR (2022), and GSES 2010, 2014, and 2018. Survey weights were applied for all calculations using GSES data from 2010, 2014, and 2018.

5.6 Results

In tables 5.4 and 5.5, we report the results of our OLS and 2SLS estimations of nurse wages on regional skill shortage. The upper parts of the tables present results from a fixed effects OLS estimation of equation 5.2. However, as pointed out in section 5.5, the OLS estimates may be biased as wages and the quantity of labor are determined simultaneously. To address this simultaneity issue, we instrument the regional scarcity of nurses by the natural logarithm of the regional share of individuals aged 65 and older, as defined in equation 5.3. The lower parts of tables 5.4 and 5.5 show the results of the respective 2SLS fixed effects estimations. Estimates in the lower parts therefore represent LATEs, reflecting the effects of changes in labor scarcity induced by demographic aging. All estimated models include region and year fixed effects.

Table 5.4 displays estimation results for skilled nurses across all care settings (long-term care and hospitals). Column (1) of table 5.4 presents estimation results without differentiation based on the presence of a collective agreement, ownership structure, or firm size. Without such differentiation, we find no significant effect of the average vacancy duration of nursing positions on wages. However, we find significant effects when we differentiate with respect to institutional characteristics. The OLS results show a positive association between our tightness measure and wages for nurses not covered by a collective agreement or employed at smaller employers. Our 2SLS results show significant effects of demand-induced scarcity on wages for nurses not covered by a collective agreement, employed by a private employer, or at a smaller employer. More specifically, the 2SLS results show that a 1 percent increase in demand-induced scarcity leads to a 0.18, 0.15, and 0.21 percent increase in wages for nurses not employed under a collective agreement, employed by a private employer, or employed in a relatively small institution, respectively. The LATEs estimated in the 2SLS estimation are notably larger than the OLS coefficients, which suggests that the relationship between wages and labor scarcity is indeed endogenous. Specifically, this points to a simultaneous determination of wages and labor scarcity: wages rise as a result of higher demand, as scarcity increases, and labor supply rises as a result of higher wages, reducing scarcity. Since the two effects are not separated in the OLS estimation, and only the 2SLS estimation focuses on demand-induced effects, the coefficients from the OLS estimation are expected to be smaller if the market outcome is indeed simultaneously determined.

Regression results, dependent variable: log of gross hourly wage							
	All skilled nurses						
Subsample	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collective agreement	-	Yes	No				
Public sector	-			Yes	No		
Large institution	-					Yes	No
	OLS results						
log(vacancy time)	0.025	-0.018	0.079***	0.001	0.040	-0.008	0.066*
Standard error	[0.019]	[0.018]	[0.030]	[0.024]	[0.025]	[0.013]	[0.019]
N	58,769	31,811	26,958	16,718	42,051	34,141	24,628
	2SLS results						
log(vacancy time)	0.069	0.014	0.177**	-0.064	0.147**	-0.003	0.206**
Standard error	[0.049]	[0.037]	[0.082]	[0.061]	[0.064]	[0.038]	[0.090]
N	58,769	31,811	26,958	16,718	42,051	34,141	24,628
F-Stat. 1st stage	23.15	30.89	17.10	14.78	21.59	23.48	20.34

Table 5.4 – Results of OLS and 2SLS regressions – log-wage, all skilled nurses

Notes: Standard errors are clustered by Planning Region. All regressions include year and Planning Region fixed effects, age grouped in three categories, tenure grouped in three categories, type of qualification, sex, and the natural logarithm of regional GDP per capita. Company size categories are not included in the regressions differentiated by size; the other regressions include company size in three groups. ***, **, *: Asterisks indicate significance of coefficients at the conventional significance levels of $1\%, 5\%, and 10\%$, respectively. Abbreviations: *sum* refers to total number of vacancies for skilled health and geriatric nursing positions. *Health N.* refers to vacancies for skilled health nursing positions.

Source: Own calculations based on GSES 2010, 2014, and 2018, and data from Statistik der Bundesagentur für Arbeit (2022) and BBSR (2022). Survey weights were used for all calculations.

Regression results, dependent variable: log of gross hourly wage														
	Care institutions							Hospitals						
Subsample	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Collective agreement	-	Yes	No					-	Yes	No				
Public sector	-			Yes	No			-			Yes	No		
Large institution	-					Yes	No	-					Yes	No
	OLS results							**OLS results**						
log(vacancy time)	0.067**	0.002	0.096***	-0.133	0.077***	0.041	0.076**	0.004	0.008	-0.009	0.024	-0.015	0.000	-0.021
Standard error	[0.029]	[0.037]	[0.036]	[0.152]	[0.029]	[0.047]	[0.034]	[0.014]	[0.016]	[0.026]	[0.024]	[0.019]	[0.012]	[0.075]
N	16,433	4,367	12,066	1,048	15,385	3,506	12,927	33,190	24,857	8,333	16,075	17,115	28,980	4,210
	2SLS results							**2SLS results**						
log(vacancy time)	0.135*	0.066	0.151*	-1.134	0.169**	-0.002	0.166**	0.003	-0.033	0.125	-0.064	0.051	-0.036	0.085
Standard error	[0.070]	[0.084]	[0.088]	[1.065]	[0.071]	[0.099]	[0.084]	[0.038]	[0.050]	[0.088]	[0.072]	[0.050]	[0.052]	[0.122]
N	16,433	4,367	12,066	1,048	15,385	3,506	12,927	33,190	24,857	8,333	16,075	17,115	28,980	4,210
F-Stat. 1st stage	17.71	22.54	13.91	1.36	17.22	15.14	16.06	19.35	18.38	14.06	7.78	19.46	16.62	20.27

Table 5.5 – Results of 2SLS regressions – log-wage, by institution, all nurses

Notes: Standard errors are clustered by Planning Region. All regressions include year and Planning Region fixed effects, age grouped in three categories, tenure grouped in three categories, type of qualification, sex, and the natural logarithm of regional GDP per capita. Company size categories are not included in the regressions differentiated by size; the other regressions include company size in three groups. ***, **, *: Asterisks indicate significance of coefficients at the conventional significance levels of $1\%, 5\%, and 10\%$, respectively. Abbreviations: *sum* refers to total number of vacancies for skilled health and geriatric nursing positions. *Health N.* refers to vacancies for skilled health nursing positions.

Source: Own calculations based on GSES 2010, 2014, and 2018, and data from Statistik der Bundesagentur für Arbeit (2022) and BBSR (2022). Survey weights were used for all calculations.

In table 5.5, we present differentiated results for the care settings. Columns (1) to (7) show estimation results for nurses working in inpatient long-term care and outpatient care institutions, while columns (8) to (14) present results for nurses in hospitals. The results indicate that the significant effects we observe when analyzing all institutions combined (without differentiation by care sector) are primarily driven by long-term care institutions. In contrast, we find no significant relationship between nurse shortages and wages for nurses in hospitals. For nurses working in long-term care institutions, the results are qualitatively comparable to those for all nursing institutions combined. There are no significant effects on the wages of nurses who are employed under a collective agreement, work with a public employer, or are employed at a large institution. The IV estimates indicate that in the absence of a collective agreement, a 1 percent increase in vacancy time, induced by an increase in the proportion of people aged 65 and older, leads to an increase in wages by 0.15 percent for nurses in long-term care facilities. For employees in the private sector, the effect is 0.17 percent. At employers that are not part of the largest third by size, the same increase in average vacancy time leads to a wage increase of 0.17 percent for nurses in long-term care facilities. Additionally, we find a positive effect of nurse shortages on wages in long-term care institutions, without differentiating the estimations by employer characteristics. In long-term care facilities, a 1 percent increase in vacancy time leads to an increase in wages by 0.14 percent. Again, the 2SLS estimates are larger than the OLS results, suggesting that the relationship between skill shortages and wages is simultaneously determined.

Taken together, wages react markedly heterogeneously to changes in labor market tightness. In long-term care, at employers not covered by collectively bargained contracts, privately owned, and smaller employers, wages show the positive reaction to increased shortage that we expect from theory (Burdett & Mortensen 1998, Autor et al. 2023). In these settings, a demand-induced increase in our scarcity measure by 1 percent leads to an increase in wages by 0.14 to 0.21 percent, depending on the specific subgroup. In hospitals, at employers covered by collectively bargained contracts, publicly owned, and larger employers, wages do not react. These differences in responsiveness may be explained by differences in the institutional settings and frictions, which restrict wage setting more at hospitals, under collective agreements, at public employers, and at larger employers than at their counterparts.

One possible explanation is the differences in the regulation of pricing and cost reimbursement for health and care services. Costs for health care services are predominantly covered by statutory insurance, whereas costs for long-term care are partly borne by care recipients.

Additionally, prices for health services are negotiated at the national level, while long-term care service prices are negotiated between care providers and payers at the state level. As a result, prices for health services do not reflect regionally varying demand patterns and may not react to demand-induced changes in labor scarcity, limiting the scope for wage reactions. Similarly, collective bargaining, public ownership, and employer size are factors associated with wage rigidity, constraining wage setting downward but also, as a consequence, upward (Elsby 2009).

Overall, the fact that, on average, and in many of the studied subgroups, wages do not react as the nurse labor market grows tighter aligns with the findings of Brunow et al. (2022) for entry-level wages. It also fits an argument often put forward concerning nursing labor: the presence of at least local employer market power in the labor market for nurses (Hirsch & Schumacher 1995, 2005, Staiger et al. 2010, Prager & Schmitt 2021), which employers use to lower their labor costs or to sort specific workers via lower wage rates (Heyes 2005). The fact that we find wage reactions in long-term care facilities but not in hospitals, which are generally larger and have been decreasing in number in recent years, unlike providers of inpatient and outpatient long-term care (Simon 2021), supports this argument. However, as for other possible frictions and consequences of institutional differences, we cannot provide definitive proof for this explanation. Future research could address potential explanations for these differences more extensively.

Lastly, when we compare the effects with the average wage levels in table 5.2, it becomes apparent that wage reactions occur predominantly in contexts where wages are generally lower. This aligns with theoretical considerations and earlier findings, which suggest that wages in less productive companies or sectors with lower wages respond more strongly to shortages than those in more productive companies with higher wages (Brunow et al. 2022, Autor et al. 2023). However, a resulting wage compression is not apparent in the aggregate data. On the contrary, real wage differences by sector and institutional characteristics have tended to increase over time, as shown in table 5.2.

5.7 Discussion and conclusions

In this analysis, we examine wage reactions to demand-induced changes in skill shortages and how these reactions differ based on institutional and employer characteristics. Our investigation focuses on the nursing labor market, drawing on three waves (2010, 2014, and 2018) of the German Structure of Earnings Survey, a large, representative employer-employee dataset provided by the German Federal Statistical Office. Additionally, we use regional data from various sources on skilled labor shortages and the characteristics of regional supply and demand for health services. To address endogeneity concerns, we apply a fixed-effects instrumental variables approach.

We find wage reactions to skill shortages in some parts of the nursing labor market, but not in others. In long-term care, among employers not covered by collectively bargained contracts, privately owned institutions, and smaller employers, wages respond to increased shortages, in line with theoretical predictions. A one percent demand-induced increase in our scarcity measure leads to an increase in nurse wages by 0.14 to 0.21 percent, depending on the setting. However, in hospitals–where most employers are large, publicly owned, and covered by collective bargaining agreements–wages do not appear to respond to labor shortages.

We argue that these differences may partly be explained by institutional settings and frictions. Restrictive price-setting and remuneration policies in the health and care sector limit employers' ability to adjust service prices in response to demand, effectively constraining wage responses. Collectively bargained wages do not account for local differences in labor demand and are associated with wage rigidity, as are public ownership and larger employer size, which may limit both upward and downward wage adjustments. Furthermore, wage adjustments tend to occur where wage levels are lower, while wages remain unresponsive in higher-paying, potentially more productive firms. Our results highlight the conditions under which labor markets react to changes in labor market tightness and those under which they do not. Moreover, while the market for care services is distinct, the variations observed across institutional settings and employer characteristics may be generalizable to the broader labor market. Recent studies underscore differences in market responses to skill shortages across institutional contexts and employer characteristics, reinforcing this assumption. However, these heterogeneous responses warrant further, more detailed investigation in future research.

With respect to nursing, the absence of wage reactions to skill shortages in large parts of

the labor market is notable for three main reasons. First, it suggests the presence of market frictions in the nursing labor market. Second, it underscores inefficiencies in wage formation within the nursing sector, as previous studies indicate that higher wages could actually boost the labor supply of nurses. Third, it conflicts with public and political demands for higher wages in nursing occupations facing skill shortages.

Overall, our finding that nurse wages do not react to regional shortages in parts of the nursing labor market suggests inefficiencies in this labor market, which is a central part of the health and care sector. As long as the overall supply of nursing labor does not increase significantly–whether through general wage increases or improvements in working conditions–institutions with the greatest need for nursing labor will continue to face recruitment challenges if they do not offer higher wages. So far, an increase in average nursing wages has not led to a reduction in labor market tightness. A decrease in labor supply, as the baby boomer generation reaches retirement age, combined with an increase in demand due to an aging society, may exacerbate the problem.

Some limitations of our study and areas for future research should be noted. First, our analysis of wage reactions is conducted at an aggregate level, treating the firm-level wage formation process as a "black box". While certain deductions can be made from the results regarding the potential reasons why higher levels of skill shortages–in nursing or other sectors–may not always lead to higher wages, more in-depth studies of the underlying processes are necessary. Future research could explore this question by employing a different, possibly more qualitative research approach, such as case studies and a thorough analysis of these underlying processes–an endeavor beyond the scope of this paper. Second, our results only provide indications of the possible channels that limit wage reactions. Other explanations are plausible. For instance, larger and state-owned employers may have greater capacity to implement improvements in non-wage working conditions. Additionally, public employers may exhibit less market orientation compared to private employers. However, the fact remains that a key mechanism for the efficient allocation of scarce labor–wage adjustments–is not being fully utilized. Third, wage effects could also be reduced by mechanisms inherent to the increasing shortage itself. In recent work, Bossler & Popp (2024) argue that pre-match hiring costs increase in tight labor markets, potentially dampening labor demand. Such an effect could, in turn, dampen wage effects. Finally, our analysis focuses on wage reactions to skill shortages in nursing within Germany, and the specific institutional context clearly influences the results. These findings may be transferable to other cases and countries with comparable institutional settings, such

as publicly owned hospitals in France. However, due to country-specific conditions and institutional frameworks in health care provision, further research across different countries and in markets for other skilled labor is necessary. Comparing these findings would enrich the debate on the functionality of health care markets and remuneration systems.

5.8 Appendix to chapter 5

Individual characteristics			
Year	2010	2014	2018
Wage in euros	17.889	17.634	18.939
	[4.025]	[4.215]	[4.183]
Age in years	41.834	42.956	43.959
	[10.637]	[11.278]	[11.739]
Tenure in years	10.662	11.162	11.639
	[9.334]	[9.916]	[10.711]
Sex (female)	0.837	0.848	0.836
	[0.370]	[0.359]	[0.370]
Education level			
Below A-levels & no vocational degree	0.019	0.014	0.014
	[0.136]	[0.118]	[0.117]
Below A-levels & vocational degree	0.806	0.784	0.761
	[0.395]	[0.412]	[0.427]
A-levels & no vocational degree	0.005	0.003	0.006
	[0.070]	[0.053]	[0.075]
A-levels & vocational degree	0.072	0.137	0.159
	[0.258]	[0.344]	[0.366]
University degree	0.051	0.017	0.014
	[0.220]	[0.127]	[0.119]
Unknown	0.047	0.045	0.046
	[0.212]	[0.208]	[0.209]
N	36,030	11,493	11,246

Table 5.6 – Summary statistics: Weighted means of individual characteristics by year, standard deviations in parentheses

Notes: We excluded Saxony-Anhalt from our analysis because of changes in the regional organization due to a local government reorganization (*Gebietsreform*) within our analysis period.

Source: Own calculations based on GSES 2010, 2014, and 2018. Survey weights were used for all calculations.

Firm characteristics			
Year	2010	2014	2018
# Employees	2926.412	1712.202	2152.585
	[21067.100]	[3012.912]	[4178.531]
Collective agreement			
No collective agreement	0.503	0.540	0.463
	[0.500]	[0.498]	[0.499]
On sectoral level	0.418	0.374	0.425
	[0.493]	[0.484]	[0.494]
On firm level	0.079	0.087	0.112
	[0.270]	[0.281]	[0.316]
Sector			
Hospital	0.526	0.537	0.519
	[0.499]	[0.499]	[0.500]
Nursing homes	0.233	0.238	0.248
	[0.423]	[0.426]	[0.432]
Outpatient care	0.083	0.121	0.143
	[0.276]	[0.326]	[0.350]
Other	0.157	0.103	0.091
	[0.364]	[0.304]	[0.287]
Public sector	0.265	0.227	0.218
	[0.441]	[0.419]	[0.413]
N	36,030	11,493	11,246

Table 5.7 – Summary statistics: Weighted means of firm characteristics by year, standard deviations in parentheses

Notes: We excluded Saxony-Anhalt from our analysis because of changes in the regional organization due to a local government reorganization (*Gebietsreform*) within our analysis period.

Source: Own calculations based on GSES 2010, 2014, and 2018. Survey weights were used for all calculations.

Regional characteristics			
Year	2010	2014	2018
Share individuals 65 years and older	43.447	44.276	44.549
	[1.417]	[1.563]	[1.662]
Average age	20.868	21.443	22.172
	[1.857]	[1.969]	[2.387]
N	96	96	96

Table 5.8 – Summary statistics: Means of regional characteristics by year, standard deviations in parentheses

Notes: We excluded Saxony-Anhalt from our analysis because of changes in the regional organization due to a local government reorganization (*Gebietsreform*) within our analysis period.

Source: Own calculations based on data from BBSR (2022).

Dependent variable: Net internal migration				
	65+ year olds		Population	
	(1)	(2)	(3)	(4)
Regional average nursing wage	-0.037		-0.034	
	[0.040]		[0.119]	
log(regional average nursing wage)		-0.585		-0.171
		[0.688]		[2.197]
Year 2010 (base)				
Year 2014	0.104	0.105	5.572***	5.577***
	[0.070]	[0.070]	[0.250]	[0.250]
Year 2018	0.194*	0.187*	4.268***	4.237***
	[0.103]	[0.101]	[0.327]	[0.329]
Constant	1.124	2.151	1.510	1.404
	[0.706]	[1.979]	[2.123]	[6.313]
N	273	273	273	273

Table 5.9 – Fixed effects regression results for migration employing regional values

Notes: Standard errors are clustered by Planning Region and given in square brackets. ***, **, *: Asterisks indicate significance of coefficients at the conventional significance levels $1\%, 5\%, 10\%$, respectively. Regressions further include Planning Region fixed effects where stated, respective coefficients are omitted due to reasons of clarity. F-Statistic refers to the F-Statistic of the instrument, Individuals of at least 65 years of age.

Source: Own calculations based on data from GSES 2010, 2014, and 2018 and BBSR (2022). Survey weights were used for all calculations with GSES 2010, 2014, and 2018.

	Dependent variable: log(GDP per capita)		Dependent variable: log(average gross earnings)	
	(1)	(2)	(3)	(4)
Regional average nursing wage	0.002		0.001	
	[0.002]		[0.001]	
log(regional average nursing wage)		0.031		0.021
		[0.023]		[0.018]
Year 2010 (base)				
Year 2014	0.146***	0.031	0.113***	0.113***
	[0.004]	[0.032]	[0.002]	[0.002]
Year 2018	0.252***	0.146***	0.221***	0.220***
	[0.005]	[0.004]	[0.003]	[0.003]
Constant	3.319***	0.252***	7.704***	7.659***
	[0.032]	[0.005]	[0.018]	[0.052]
Region FEs	X	X	X	X
N	273	273	273	273

Table 5.10 – Fixed effects regression results for GDP and wages employing regional values

Notes: Standard errors are clustered by Planning Region and given in square brackets. ***, **, *: Asterisks indicate significance of coefficients at the conventional significance levels $1\%, 5\%, 10\%$, respectively. Regressions further include Planning Region fixed effects where stated, respective coefficients are omitted due to reasons of clarity. F-Statistic refers to the F-Statistic of the instrument, Individuals of at least 65 years of age.

Source: Own calculations based on data from GSES 2010, 2014, and 2018 and BBSR (2022). Survey weights were used for all calculations with GSES 2010, 2014, and 2018.

	Region FEs			Year & Region FEs			All controls		
	Geriatric nurses	**Health nurses**	**All skilled nurses**	**Geriatric nurses**	**Health nurses**	**All skilled nurses**	**Geriatric nurses**	**Health nurses**	**All skilled nurses**
log(share individuals aged 65+)	11.146***	7.930***	9.887***	3.622***	3.397***	3.537***	3.771***	2.909***	3.518***
	[0.575]	[0.529]	[0.491]	[0.793]	[0.982]	[0.729]	[0.979]	[0.707]	[0.731]
Year 2010 (base)									
Year 2014				0.280***	0.093**	0.208***	0.234***	0.130***	0.192***
				[0.040]	[0.044]	[0.036]	[0.044]	[0.043]	[0.039]
Year 2018				0.599***	0.362***	0.508***	0.458***	0.331***	0.398***
				[0.057]	[0.060]	[0.050]	[0.093]	[0.076]	[0.071]
Constant	-29.322***	-19.607***	-25.515***	-6.560***	-5.874**	-6.297***	-6.824**	-4.409**	-6.189***
	[1.761]	[1.622]	[1.504]	[2.404]	[2.983]	[2.211]	[2.969]	[2.144]	[2.222]
Region FEs	X	X	X	X	X	X	X	X	X
Individual level controls							X	X	X
F-Statistic	376.21	224.34	406.00	20.86	11.95	23.54	14.84	16.93	23.15
N	281	272	266	281	272	266	17,838	42,965	58,769

Table 5.11 – Results from fixed effects regressions on the association between average vacancies in days and regional share of individuals aged 65+ years

Notes: Standard errors are clustered by Planning Region and given in square brackets. All regressions include year and Planning Region fixed effects. Regressions with all controls further include age in three groups, tenure in three groups, the type of qualification, sex, the natural logarithm of regional GDP per capita, and company size in three groups. ***, **, *: Asterisks indicate significance of coefficients at the conventional significance levels $1\%, 5\%, 10\%$, respectively. Regressions further include Planning Region fixed effects where stated, respective coefficients are omitted due to reasons of clarity. F-Statistic refers to the F-Statistic of the instrument, Individuals of at least 65 years of age.

Source: Own calculations based on data from Statistik der Bundesagentur für Arbeit (2022) and BBSR (2022). Survey weights were used for all calculations with GSES 2010, 2014, and 2018.

	Comparison group				Management and technical services				Wholesale and retail			
	All	No collective agreement	Private sector	No large institution	All	Collective agreement	Public sector	Large institution	All	Collective agreement	Public sector	Large institution
log(share individuals aged 65+)	0.045	0.045	0.045	0.045	0.152	0.371	0.298	0.138	0.285	0.429	0.304	0.278
	[0.221]	[0.221]	[0.221]	[0.221]	[0.234]	[0.254]	[0.264]	[0.224]	[0.192]	[0.312]	[0.193]	[0.262]
Year 2010 (base)												
Year 2014	-0.049***	-0.049***	-0.049***	-0.049***	-0.023*	-0.040***	-0.031**	-0.023**	-0.038***	-0.048***	-0.039***	-0.045***
	[0.013]	[0.013]	[0.013]	[0.013]	[0.012]	[0.014]	[0.013]	[0.011]	[0.009]	[0.012]	[0.009]	[0.012]
Year 2018	0.039*	0.039*	0.039**	0.039*	0.006	-0.012	-0.018	0.016	-0.015	-0.038	-0.017	-0.022
	[0.020]	[0.020]	[0.020]	[0.020]	[0.020]	[0.024]	[0.023]	[0.022]	[0.018]	[0.030]	[0.018]	[0.026]
Constant	2.318***	2.318***	2.318***	2.318***	1.922***	1.285	1.472*	1.972***	1.516**	1.067	1.460**	1.542*
	[0.675]	[0.675]	[0.675]	[0.675]	[0.712]	[0.774]	[0.804]	[0.682]	[0.588]	[0.953]	[0.591]	[0.802]
N	43,779	43,779	43,779	43,779	162,031	111,868	141,586	125,970	150,885	92,861	147,847	92,963

Table 5.12 – Results from fixed effects regressions on the association between log hourly wage and regional share of individuals aged 65+ years for sectors not or significantly less affected by skill shortage

Notes: Standard errors are clustered by Planning Region and given in square brackets. All regressions include year and Planning Region fixed effects, age in three groups, tenure in three groups, the type of qualification, sex, the natural logarithm of regional GDP per capita. We do not include company size categories in the regressions differentiated by size; the other regressions include company size in three groups. ***, **, *: Asterisks indicate significance of coefficients at the conventional significance levels $1\%, 5\%, 10\%$, respectively. Regressions further include Planning Region fixed effects where stated, respective coefficients are omitted due to reasons of clarity. F-Statistic refers to the F-Statistic of the instrument, Individuals of at least 65 years of age.

Source: Own calculations based on GSES 2010, 2014, and 2018, and data from data from Statistik der Bundesagentur für Arbeit (2022) and BBSR (2022). Survey weights were used for all calculations.

Regression results, dependent variable log of gross hourly wage, additional covariate: GDP per capita							
	All skilled nurses						
Subsample	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collective agreement	-	Yes	No				
Public sector	-			Yes	No		
Large institution	-					Yes	No
log(vacancy time)	0.064	0.013	0.170**	-0.070	0.141**	-0.004	0.196**
Standard error	[0.051]	[0.040]	[0.080]	[0.064]	[0.067]	[0.041]	[0.093]
N	58,769	31,811	26,958	16,718	42,051	34,141	24,628
F-Stat. 1st stage	26.95	29.91	24.29	15.49	25.97	25.75	26.12

Table 5.13 – Results of OLS and 2SLS regressions – log-wage, all skilled nurses

Notes: Standard errors are clustered by Planning Region. All regressions include year and Planning Region fixed effects, age in three groups, tenure in three groups, the type of qualification, sex, the natural logarithm of regional GDP per capita. We do not include company size categories in the regressions differentiated by size; the other regressions include company size in three groups. ***, **, *: Asterisks indicate significance of coefficients at the conventional significance levels $1\%, 5\%, 10\%$, respectively. Abbreviations: *sum* refers to the sum of vacancies regarding skilled health and geriatric nursing positions. *Health N.* refers to vacancies regarding skilled health nursing positions.

Source: Own calculations based on GSES 2010, 2014, and 2018, and data from Statistik der Bundesagentur für Arbeit (2022) and BBSR (2022). Survey weights were used for all calculations.

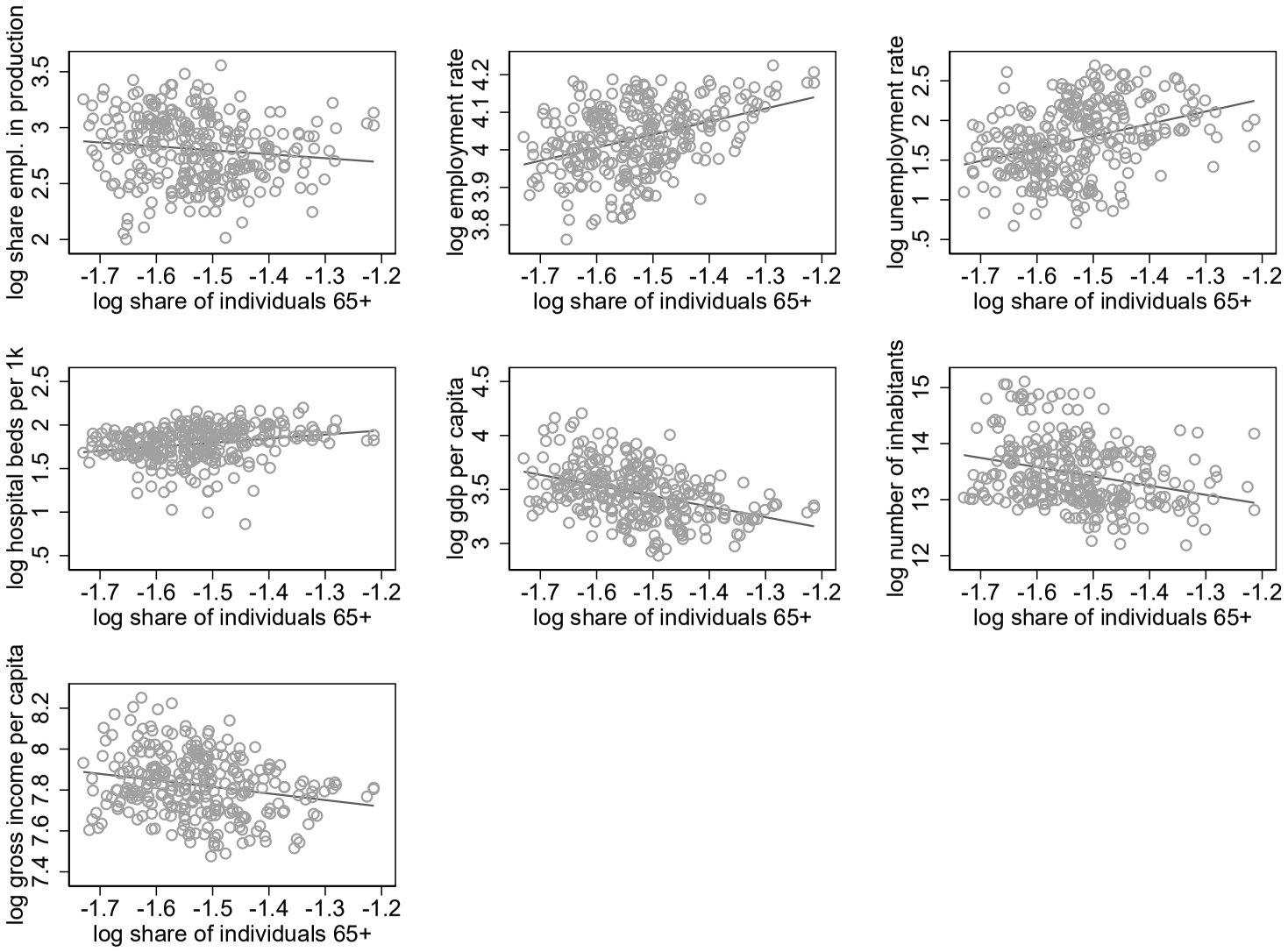


Figure 5.1 – Scatter plots of log share of individuals of age 65 and older versus log of several regional characteristics

Notes: The x axis shows the log share of individuals of age 65 and older (the instrument, z); the y axis shows the log of the regional characteristics. The circles indicate observations.

Source: Own figure based on data from Statistik der Bundesagentur für Arbeit (2022) and BBSR (2022).

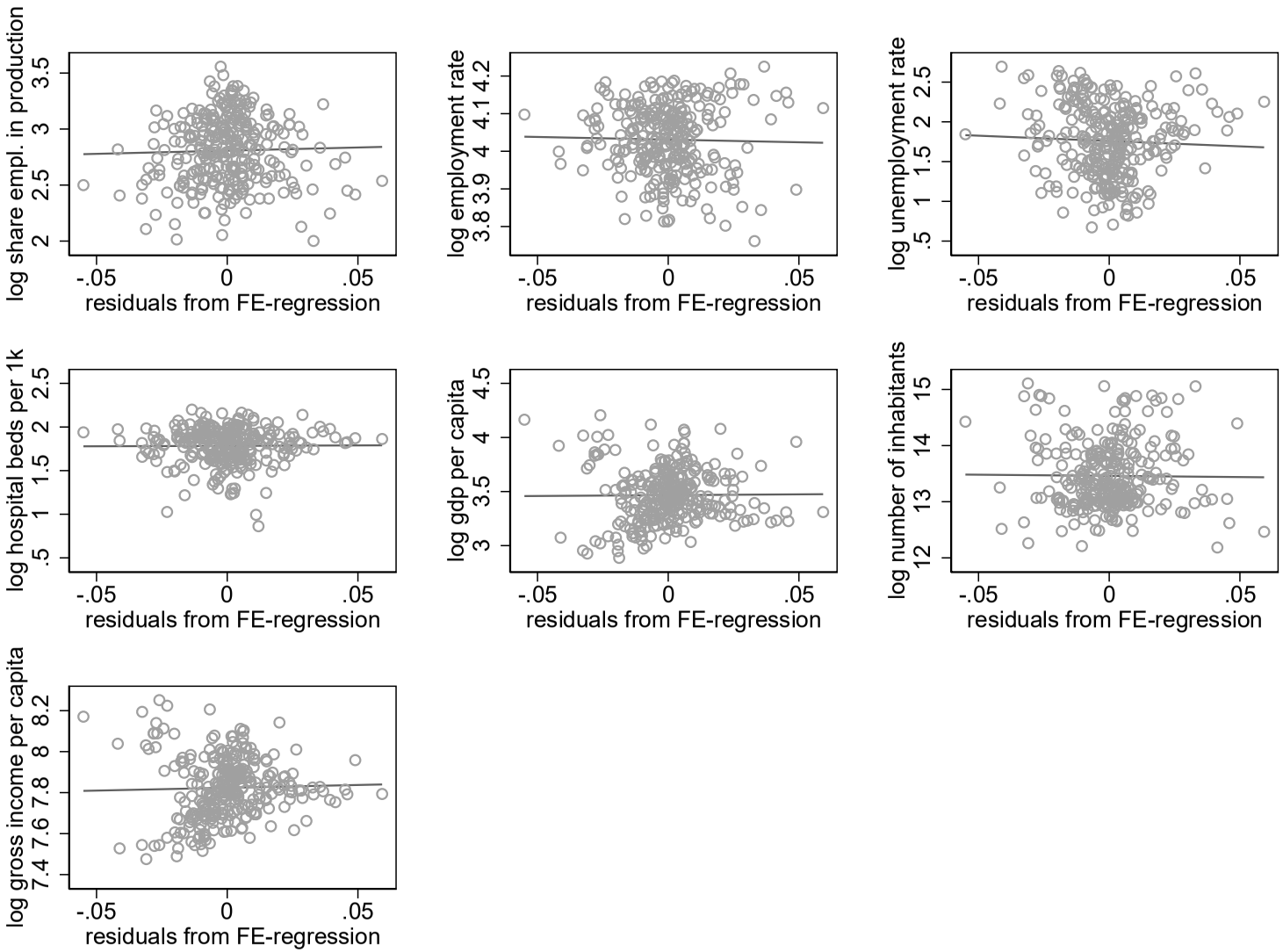


Figure 5.2 – Scatter plots of residual from fixed effects regression versus log of several regional characteristics

Notes: The x axis shows the residuals from equation 5.4 (the adjusted instrument, $\hat{V}_{jt}$); the y axis shows the log of the regional characteristics. The circles indicate observations. The circles indicate observations.

Source: Own figure based on data from Statistik der Bundesagentur für Arbeit (2022) and BBSR (2022).

	Unconditional instrument z	**Adjusted instrument $\hat{V}$**
	(1)	(2)
First stage (equation 5.4)		
		Fixed-effects regression on instrument
Year 2010 (base)		
Year 2014		0.030***
		[0.002]
Year 2018	-	0.095***
		[0.004]
Constant		-1.572***
		[0.002]
Region FEs		X
R^2		0.977
N		288
Second stage (equation 5.5)		
	Dependent variable:	Dependent variable:
	z: log(share individuals aged 65+)	$\hat{V}$: Residual from fixed-effects regression
	Number of statistically significant regional characteristics at the 5%-level	
Characteristics in the model	7	7
Significant at 5%-level	5	1
R^2	0.641	0.012
N	288	288

Table 5.14 – Regression of observed characteristics on the unconditional and adjusted instruments

Notes: Standard errors are clustered by Planning Region and given in square brackets. ***, **, *: Asterisks indicate significance of coefficients at the conventional significance levels $1\%, 5\%, 10\%$, respectively. Regressions further include Planning Region fixed effects where stated, respective coefficients are omitted due to reasons of clarity.
The regional characteristics in the models are: logarithms of: share of industry employment, share employed, share unemployed, GDP per capita, hospital beds per 1 thousand inhabitants, inhabitants, gross income per capita.
Source: Own calculations based on data from GSES 2010, 2014, and 2018 and BBSR (2022).

Regression results, dependent variable log of gross hourly wage														
	Skilled geriatric nurses							Skilled health nurses						
Subsample	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Collective agreement	-	Yes	No					-	Yes	No				
Public sector	-			Yes	No			-			Yes	No		
Large institution	-					Yes	No	-					Yes	No
	OLS results							OLS results						
log(vacancy time)	0.095	-0.019	0.127***	-0.109	0.102***	0.029	0.117***	-0.019	-0.006	-0.023	0.018	-0.030	0.001	-0.079*
Standard error	[0.031]	[0.040]	[0.042]	[0.116]	[0.032]	[0.034]	[0.039]	[0.017]	[0.017]	[0.029]	[0.024]	[0.020]	[0.043]	[0.011]
N	17,838	5,780	12,058	1,600	16,238	4,416	13,422	42,965	27,568	15,397	16,508	26,457	31,275	11,690
	2SLS results							2SLS results						
log(vacancy time)	0.207	0.144	0.259**	-0.507*	0.242***	-0.016	0.283***	-0.009	-0.043	0.099	-0.082	0.062	-0.035	0.066
Standard error	[0.082]	[0.105]	[0.113]	[0.263]	[0.086]	[0.096]	[0.105]	[0.053]	[0.058]	[0.083]	[0.077]	[0.067]	[0.046]	[0.118]
N	17,838	5,780	12,058	1,600	16,238	4,416	13,422	42,965	27,568	15,397	16,508	26,457	31,275	11,690
F-Stat. 1st stage	14.84	17.45	12.57	7.06	14.04	19.30	12.11	16.93	17.97	13.20	7.48	16.68	16.43	12.76

Table 5.15 – Results of 2SLS regressions – log-wage, by occupation

Notes: Standard errors are clustered by Planning Region. All regressions include year and Planning Region fixed effects, age in three groups, tenure in three groups, the type of qualification, sex, the natural logarithm of regional GDP per capita. We do not include company size categories in the regressions differentiated by size; the other regressions include company size in three groups. ***, **, *: Asterisks indicate significance of coefficients at the conventional significance levels $1\%, 5\%, 10\%$, respectively. Abbreviations: *sum* refers to the sum of vacancies regarding skilled health and geriatric nursing positions. *Health N.* refers to vacancies regarding skilled health nursing positions.

Source: Own calculations based on data from Statistik der Bundesagentur für Arbeit (2022) and BBSR (2022). Survey weights were used for all calculations.

In hospitals	
Health nurses	0.972
Geriatric nurses	0.028
N	33,866
In inpatient care	
Health nurses	0.226
Geriatric nurses	0.774
N	11,085
In outpatient care	
Health nurses	0.468
Geriatric nurses	0.532
N	5,990

Table 5.16 – Weighted shares of nursing staff belonging to a particular nursing profession

Source: Own calculations based on GSES 2010, 2014, and 2018. Survey weights were used for all calculations.

Year	2010	2014	2018
Field of care			
All institutions	16.672	17.546	19.659
Hospitals	17.864	19.311	21.705
Outpatient care	14.397	15.036	16.698
Long-term care	15.272	15.511	17.465
Ownership			
Public institution	17.920	19.324	21.784
Private institution	16.222	17.024	19.068
Collective bargaining situation			
Collective agreement	17.669	18.923	21.370
No collective agreement	15.687	16.372	17.672
Size by group			
Small or medium institution	15.403	15.875	17.815
Large institution	17.809	19.024	21.388

Table 5.17 – Average nominal hourly wages by type of institution in euros by year

Source: Own calculations based on GSES 2010, 2014, and 2018. Survey weights were used for all calculations.

Chapter 6

Conclusion

Over the past two decades, skill shortages have become a salient issue in industrialized nations. Against this background, this dissertation empirically investigates questions related to labor supply and wage formation, utilizing a variety of data sources and employing multiple econometric methods. The analyses focus on nursing, a profession particularly affected by skill shortages in many developed countries and essential to public health provision. The four main chapters of this dissertation offer empirical evidence on these topics and discuss the broader implications of the findings for the nursing sector and, where relevant, for the labor market more broadly. These studies contribute to a deeper understanding of labor supply decisions, workers' job preferences, and wage setting mechanisms in the context of skill shortages.

Chapter 2 employs survival analysis methods to examine individual, firm, and regional factors associated with individuals leaving the nursing profession, shedding light on elements that contribute to occupational retention and career exits. The results reveal that younger nurses, those employed by smaller organizations, and those earning lower wages are more likely to leave their occupation. Conversely, worse local outside options and, for female nurses with children, part-time employment reduce the likelihood of leaving. Additionally, previous unemployment or employment in other fields is linked to a higher probability of leaving, whereas nurses who have recently completed vocational training are less likely to exit the profession. The chapter also explores the target states of nurses' exits and the factors influencing these exit directions. Finally, it examines whether the introduction of Diagnosis-Related Groups (DRGs) and a nursing minimum wage impacted retention rates, finding no associations. To enhance nurse retention, efforts should focus on hiring nurses directly after vocational training and minimizing

breaks in their labor market biographies. Measures to better reconcile family commitments with nursing work could help retain the predominantly female care workforce and prevent significant career interruptions. For nurses returning after past breaks, employers could offer tailored working arrangements and training to facilitate reentry into the profession. Additionally, in regions where nurses have many professional alternatives, improving the attractiveness of nursing jobs will be crucial to retaining staff.

In chapter 3, the focus shifts to understanding what makes nursing jobs attractive and influences job acceptance. The results of a self-conducted experimental survey study indicate that, while both subjective and objective factors significantly influence job attractiveness, subjective factors play a considerably stronger role. Among the subjective factors, a positive team environment and sufficient time for patient care rank especially high, whereas, among the objective factors, contract duration has the strongest impact. The influence of wage changes can also be substantial, depending on the magnitude of the change. Willingness-to-pay analyses further reveal that, while higher wages can improve job attractiveness, substantial wage increases are needed to compensate for less tangible elements like team dynamics. Positive interaction effects between the analyzed factors suggest that strategies to enhance job attractiveness in nursing would be particularly effective when multiple relevant job characteristics are improved simultaneously.

Chapter 4 examines how preferences for job characteristics vary, employing the Sorted Partial Effects (SPE) methodology to analyze heterogeneity. This approach uncovers distinct differences in how nurses evaluate various job attributes based on individual characteristics and work attitudes, providing insights into the diversity of preferences and trade-offs between amenities and wages. In line with previous studies, the analysis shows that individuals place higher value on combinations of high wages and favorable non-monetary characteristics, meaning that the willingness-to-pay for amenities increases with wage levels. An exception is full-time employment, where preferences appear to vary less across different wage levels. The results highlight substantial heterogeneity in preferences for job characteristics, indicating that a single ideal measure–or bundle of measures–to enhance job attractiveness may not exist. Instead, job offers should be tailored to better align with diverse individual preferences to appeal to potential candidates. Such differentiation also provides an opportunity to use job characteristics as a sorting device to attract workers with the desired attributes.

Finally, chapter 5 examines wage responses to skill shortages in the nursing sector, using

an instrumental variable (IV) strategy at the regional level to analyze the causal impact on wages. The findings indicate that wage adjustments to shortages vary across sectors: in private facilities, facilities not bound by collective agreements, and smaller facilities, there is evidence of wage increases corresponding with skill shortages. In contrast, public facilities, facilities bound by collective agreements, and larger facilities show no wage response. Furthermore, long-term care facilities exhibit wage reactions, whereas hospitals do not. This divergence highlights the role of institutional factors, suggesting that labor market frictions and rigidities may constrain wage adjustments in certain parts of the market. The analyses in the previous chapters and prior studies emphasize that wages are positively associated with retention, job attractiveness, and occupational choices. The limited extent to which wages respond to shortages, however, remains surprising and deviates from theoretical expectations.

Overall, the results on labor supply under skill shortages highlight the factors influencing occupational retention and job attractiveness, which vary according to individual preferences and circumstances. In this way, the dissertation provides valuable implications for policymakers and employers on how to attract and retain scarce skilled labor. Some overarching implications emerge from the studies on labor supply (chapters 2 through 4). Political and employer actions aimed at increasing the supply of scarce skilled labor by attracting and retaining personnel could focus on raising wages, offering permanent contracts early in employees' careers, and addressing not only objective factors but also subjective ones, such as team spirit. These factors are especially effective when combined, due to interaction effects. Furthermore, the observed heterogeneity in the effects of job characteristics on attractiveness and trade-offs between factors–as well as the differing importance of these factors for occupational retention (e.g., for mothers)–underscores the importance of differentiating work arrangements to align with individual preferences and circumstances.

The finding that wages, as a crucial instrument for job attractiveness and occupational retention, only partially respond to shortages is, on the one hand, concerning, as it points to labor market frictions in the nursing sector and potentially in other segments of the labor market, which could be addressed. On the other hand, it highlights that there is still untapped potential to use wage adjustments as a vital tool for tackling skill shortages.

The presented results also highlight directions for future research. While the number of studies analyzing wage reactions in tight labor markets and under skill shortages is growing, important questions remain regarding the underlying processes and the factors moderating these wage

responses. In this dissertation, wage formation has been treated as a "black box," which future research could explore by examining wage dynamics under specific market frictions and, more broadly, under market imperfections. This dissertation focuses on the case of nurses in Germany, an important and illustrative example of markets affected by skill shortages. While several claims made in this doctoral thesis extend beyond the specific nursing labor market, further research on other labor markets is necessary to validate the generalizability of these findings. Additionally, the growing literature on causal mechanisms in skill-short and tight labor markets would benefit from more detailed analyses in future research. Finally, future research could leverage new data to address related questions. Due to typical data delays, the analyses in this dissertation rely on data collected prior to the COVID-19 pandemic. Given the significant impact of the pandemic on the health and care sector, investigating potential shifts in preferences and leaving behavior in response to this disruption would be particularly valuable.

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