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Abstract

We use administrative data from the largest sickness fund in Germany to analyze the relationship between the district density of general and medical practitioner and the quality of care provided to the frail elderly. The quality of care is studied considering prescriptions of potentially inappropriate drugs. We find evidence for a significant positive effect of the share of general and medical practitioners in the population on the provided outpatient health care services.

JEL Classification: I10

Keywords: Priscus-list; inappropriate medication; drugs; fixed-effects; administrative data; elderly; competition; quality of medical supply

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1 Magdalena A. Stroka-Wetsch, Federal University of Applied Administrative Sciences, RWI and WINEG; Anna Talmann,RUB and RWI; Roland Linder, WINEG. *– Helpful comments by Thomas Bauer, and participants of the Annual Meeting of the dggö (Konstanz) are gratefully acknowledged. We are grateful to our colleagues from the WINEG for the access to the data of the Techniker Krankenkasse.* *– All correspondence to: Anna Talmann, Ruhr-Universität Bochum, Universitätsstr. 150, 44801 Bochum, Germany, e-mail: Anna.Talmann@rub.de*

1 Introduction

In recent years, both population aging and quality of medical care have attracted the attention of researchers and policy advisors in all developed countries. Facing the demographic change, coming along with an increasing old-age dependency ratio, the prevention of the expected cost explosion in the health care sector belongs to the central health economic challenges of this century. As frail elderly usually suffer from bad health conditions and are in need of more and often also pricier health services, the compliance of quality standards especially regarding this population group is essential. Mistakes in the medical supply usually go along with both, profound impairments of the health status and high medical costs. Hence, securing quality of care can be considered as an instrument to relieve both health care and long-term care insurance funds.

Searching for determinants of quality of medical care, increasing competition among suppliers of health services is often considered as an effective measure. Although the out-patient sector provides most health services and the health expenses of this sector exceed health expenditures of the in-patient segment (Statistisches Bundesamt, 2014) most studies analyze the effect of market concentration on quality of stationary institutions such as hospitals and nursing homes (c.f. section 2). Regardless of the utilized measurement there is strong evidence on a positive effect of competition on quality. The effects of market concentration of office-based physicians on the quality of care are much less discussed in the literature (Jürges and Pohl, 2012).

Thereby, it is common knowledge in the media that competition between office-based physicians occurs only in urban areas often characterized by an oversupply of health care providers, while rural areas suffer from shortage. In a fixed-fee health care system - such as in Germany - competition can only be performed via quality. Hence, the lack of competition due to the undersupply of medical care in rural areas can lead to quality shortcomings in these regions. However, in research intensive fields quality can only be maintained or improved by keeping knowledge up to date. Therefore, competition should facilitate incentives to constantly adapt to new research results and their implications. Likewise, a low patient/physician ratio should allow for more time per case and thus enable physicians to better yield to the specific conditions of each patient and apply appropriate quality of care.

The aim of this study is to provide evidence on the effect of market concentration of general and medical practitioners on the provided quality of care concentrating on health care provision for frail elderly. However, uncovering determinants of provided quality of care comes along with certain challenges. To begin with there is the need of a comparable and profound measure of the outcome-based quality. We are the first to use a medical guideline that has been published in 2010 addressing potentially inappropriate prescriptions for elderly (Priscus-list) as an objective und reliable quality indicator.

Evidently, beside an objective and reliable quality measure like the Priscus-listed prescriptions having access to appropriate data plays an important role in our research question. The data should cover a sufficient large sample from different regions; record a long list of variables on socio-economic characteristics of the patients as well as information on the competitive situation of medical care providers. Administrative data from the Techniker Krankenkasse (TK), which we employ in the empirical analysis, in combination with information about physician densities on the county level provided by the Federal Institution for Research on Building, Urban Affairs and Spatial Development (BBR) fit perfectly for our purpose.

Finally we need to estimate models that take the underlying data generating process adequately into account. We apply two types of regression models in order to assess the effect of density of general and medical practitioner in a certain region on the quality of health care services for frail elderly. In a first step, we use simple ordinary least squares (OLS) regressions to determine the quantitative effect of general and medical practitioners' density on the amount of prescribed Priscus-listed drugs. In a second step, we refine our analysis by applying a double-hurdle model as proposed by {Cragg 1971 #2} in order to analyze both the intensive and extensive margins of potentially inappropriate drug prescriptions. This model allows both margins to be determined by different processes and therefore relaxes strong assumptions of other models, i.e. the Tobit model.

In all our models we find significant positive effects of the density of general and medical practitioners on the quality of health care services for frail elderly. Hence, higher shares of general and medical practitioners in the population go along with fewer prescriptions of inappropriate drugs at both the intensive and extensive margins.

The rest of the paper is organized as follows: Section 2 provides a brief overview over the existing literature followed by a description of the data. Estimation issues are discussed in section 4 followed by the presentation of the results. The last section is devoted to a brief conclusion and discussion.

2 Literature Review

There is a large literature dealing with the effect of competition on the quality of stationary institutions such as hospitals and nursing homes. Based on various data sets (mainly from the USA), as well as various econometric methods, this literature indicates that competition improves quality of care, e.g. on the hospital market (see e.g. Cooper et al., 2011, Propper, Burgess and Gossage, 2008, Sari, 2002) and the nursing home market (see e.g. Brekke et al., 2010, Hirth, 1999, Nyman, 1988a, Nyman, 1988b, Nyman, 1989, Mennicken et al., 2010).

However, the effect of market concentration of office-based physicians on quality of care is much less examined and also less distinct in the findings. A part of the respective literature analyzes outcomes such as the share of mortality rates proportional to physician/population ratio. Shi and Starfield (2001) identify a significant negative association between primary care physician supply and total mortality rates for U.S. metropolitan areas. This effect becomes insignificant though for high-income areas, after controlling for socio-economic determinants. Chen and Lowenstein (1985) find a strong relationship between infant mortality and the physician/population ratio for most developing countries but no relationship for industrialized countries. Morris and Gravelle (2008) use the body mass index (BMI) as an outcome measure and find that a 10% increase in the supply of general practitioners reduces the mean BMI by about 4%.

Another possibility for measuring the quality of primary care are admission rates for ambulatory care sensitive conditions (ACS), i.e. conditions where appropriate ambulatory care prevents or reduces the need for admission to hospitals. Laditka, Laditka and Probst (2005) identify a negative relationship between high physician density and hospitalization rates for ACS in rural, but not in urban areas in the U.S.. Laditka (2004) also utilizing U.S. data finds that low as well as high supply areas have high ACS hospitalization risks while adequate supply areas have significant lower risks. While the findings for high supply areas seem unexpected, they can be explained by supplier-induced hospitalization. Contrary to these results, Krakauer et al. (1996) find that physician supply levels have negligible effects on admission rates for ACS.

Apart from the mentioned health outcomes there are also studies sheding light on the question of the density/quality effect of physicians' service using subjective information obtained from patients such as average time spent per patient. Rizzo and Zeckhauser (1992) find significant positive effects of physician density on time spend per patient. Carlsen and Grytten (2000) as well find that an increase in the number of physicians leads to improved consumer satisfaction measured in categories such as "the physician's professional skills", "information about diagnoses and treatment" or "the outcome treatment".

Another line of the literature deals with how a given physician quality influences the appropriateness of health care as suggested by medical guidelines. Since the health care market can be characterized by imperfect consumer information and patients with insufficient health literacy, general practitioners are the predominant agents for the delivery of primary health care and thus the quality of their services is of premost importance (Arrow, 1963, Kenkel, 1990). For example Maurer (2009) as well as Schmitz and Wübker (2011) examine the influence of physician quality – as measured by a quality score which uses patients' responses to five questions regarding their doctors' geriatric assessments –on the probability of getting a flu shot and identify strong positive effects for this relationship. Doyle, Ewer and Wagner (2010) utilize a natural experiment where nearly 30,000 patients were randomly assigned to clinical teams that were either ranked among the top or the lower medical institutions. They find that the group of patients treated by the higher ranked institutions has up to 25% less expensive stays mainly due more correct and faster executed tests.

Despite the large literature reviewed above, which relies predominantly on U.S. data, there appears to be only one study on the effects of physician density on the quality of medical care provision in Germany. This study comes very close to our approach in terms of studying the relationship between district general practitioners density and the quality of care provided to older adults on the basis of medical guidelines. Using German SHARE Data, Jürges and Pohl (2012) use indicators of process quality of care related to the management of risk factors for cardiovascular diseases and prevention of falls among older patients as an outcome. Contrary to theoretical expectations and our results, they find only weak and insignificant effects of physicians' density on the quality of care. There are several limitations to their study though. First, the number of observations per district available in their data is quite small (8-12) leading to possibly inaccurate district averages for the quality measures. Since the degree of adherence to medical guidelines relies on self-reported patient answers, the objectiveness and reliability of these measures might be called into question. Both circumstances can lead to measurement error in the explanatory variables and thus to an attenuation bias. Due to our large administrative data set and objective quality measure we are able to overcome both problems.

We go beyond the existing literature as, to the best of our knowledge, this is the first study identifying the effect of market concentration of doctors on quality of out-patient medical care using potentially inappropriate prescriptions as an objective process measure gained from administrative data. Hence, we improve upon the existing literature in various ways. First, we use the wealth of information of administrative data that has so far not been used in the given context. Thereby the use of data from sickness funds goes along with many advantages and allows for the appropriate analysis of certain questions which are hardly to answer with any other source of data (Reinhold et al., 2011). Second, our innovative measure of process quality of care has not been used so far in studies on quality of care. The biggest advantage of our measure is that it can be measured at both, the extensive and intensive margin of inappropriate prescriptions and that it neither relays on subjective processes nor applies to only a selected group of elderly (e.g. with certain diseases). Third, the problem of left-truncation of the data is solved using a double-hurdle model. This model has not been applied in analyses with similar dependent variables on inappropriate drug intake so far. Finally, we contribute to the literature on the determinants of inappropriate drug prescriptions and the effects of competition among general practitioners on the quality of health care that are both hardly analyzed in Germany.

3 Data and Sample Selection

The dataset for the empirical analysis is constructed using information on individuals from the second largest sickness fund in Germany — the TK — in combination with information on county level provided by the BBR. Our data refers to the year 2009 and includes 30,039 dependent persons receiving in-formal, either informal and/or formal care. The data provided by the TK are of administrative nature as they are generated predominantly through billing processes between providers of health services and the insurance company. Hence, data reliability should be relatively high because most records are reported by experts such as physicians. Moreover, the data contains a long list of very detailed information on health outcomes and socio-demographic characteristics of the individuals.

Out of more than eight million insurants of the TK we focus on people older than 65 and in need of care, as they are at the highest risk of suffering health impairments from inappropriate medication due to their general weak health condition. The dependent variable on prescriptions of drugs is measured in daily defined doses (DDDs) and contains the yearly prescribed amount of DDDs of drugs from the Priscus-list. This list with 83 drugs from 18 drug categories specifically fits to the circumstance prevailing in Germany (Holt, Schmiedl and Thürmann, 2010) and resembles similar international lists such as the Beers-list (Beers et al., 1992). The list identifies medications that pose potential risks (including harmful side effects that may be life-threatening and other adverse drug events) outweighing potential benefits for people 65 and older.

The independent variables, mainly information on the health status, are dichotomously measured variables on a range of diagnoses identified using the Anatomical Therapeutic Chemical (ATC) classification as well as information on yearly numbers of hospitalizations and consultations. Variables on care dependency include information on the received care service (in-patient or out-patient formal and/or informal care) as well as information on the care level which correspondents to the severity of an individual's disability. In Germany, the long-term care insurances, which are part of the health insurances, distinguish between three care levels with increasing severity of care which are formally assessed by an independent Medical Review Board of the Statutory Health Insurance Funds. While care level 1 comes along with nursing needs of at least 90 minutes per day on average, care level 2 includes at least 180 minutes of average daily care. Care level 3 is the highest one and involves an average of over 300 minutes of daily nursing needs.

Information on competition in health care is measured on county level and includes the number of general practitioners per 1,000 inhabitants and the number of medical practitioners per 1,000 inhabitants. Further variables include the number of hospital beds in the county and the degree of rurality. As the literature shows that there are significant differences in medication in the in- and out-patient nursing care sector (see e.g. Stroka forthcoming), we account for this fact by controlling for provided care service, i.e. in- or outpatient formal or informal care. Observations with values above the 99th percentile - including implausible high observations potentially due to data errors - are excluded from the sample to reduce problems with outliers. Table 1 shows the descriptive statistics of all variables considered in the empirical analysis[1].

Table 1: Descriptive statistics

	Mean	St.D.
Dependent variable:		
Priscus DDD	72.31	139.15
Priscus binary	0.44	0.50
Independent variables:		
Density of physicians		
Density of general practitioners	6.25	0.71
Density of medical practitioners	17.31	5.32
County characteristics		
Hospital provision	62.69	29.00
Rurality	13.45	21.68
Individual characteristics:		
Demographic information		
Age	79.74	8.14
Male	0.51	0.50
Care dependency		
Care level 2	0.34	0.47
Care level 3	0.10	0.30
Informal and formal out-patient care	0.35	0.48
Formal out-patient care	0.04	0.20
Health status		
Depression and bipolar disorder	0.32	0.47
Schizophrenia, schizotypal and delusional disorders	0.04	0.19
Dementia	0.30	0.46
Mental disorders due to psychoactive substance	0.07	0.25
Other mental disorders	0.04	0.20
Stroke	0.30	0.46
Cardiac infarction	0.09	0.28
Other diseases of the circulatory system	0.93	0.25
Invasive neoplasms	0.29	0.45
Diseases of the musculoskeletal system	0.73	0.44
Diseases of the genitourinary system	0.65	0.48
Parkinson's disease	0.15	0.36
Number of hospitalizations	1.08	1.68
Number of consultations	33.82	31.36
Death	0.23	0.42
Region		
Eastern Germany	0.07	0.25

Observations: 22,765.

[1] See Table A1 in the Appendix for detailed variable definitions.

In the next step, we consider the prescriptions of drugs from the Priscus-list in three different types of topological areas, i.e. urban, urbanized and rural area[2], in order to verify the undersupply hypothesis postulated in section 1. As shown in Table 2, the probability as well as the amount of prescriptions of drugs from the Priscus-list is slightly higher in rural areas than in urbanized or urban areas[3]. However, urbanized areas are characterized by a slightly lower amount of mean prescribed amounts of drugs from the Priscus-list compared to urban areas. The difference between rural and urban or urbanized areas can be considered as a first hint towards quality differences in regions with lower densities of medical practitioners as rural areas are typically characterized by the lowest densities of health care providers. For general practitioners, however, the urban-rural divide is less distinct. In contrast to the density of medical practitioners, the density of general practitioners is even slightly higher in rural areas. Hence, it seems important to differentiate between general and practical practitioners.

Table 2: Inappropriate prescriptions by type of area

	Urban area		Urbanized area		Rural area	
	Mean	St. D.	Mean	St. D.	Mean	St. D.
Density of general practitioners	6.14	0.69	6.42	0.64	6.66	0.93
Density of medical practitioners	17.73	5.08	16.77	5.73	15.55	5.16
Priscus DDD	73.20	140.94	72.07	137.35	77.55	137.24
Priscus binary	0.44	0.50	0.44	0.50	0.47	0.50
Observations	14,687		6,571		1,507	

4 Empirical Strategy

Descriptive statistics indicate a correlation between medical care provision measured in daily doses of potentially inappropriate medication and the type of region. Likewise the type of region is correlated with density of health care providers (Table 2). We further investigate whether there are other explanatory factors beside the density of the health care providers e.g. health care recipients and thus the demanders of health care services might themselves vary between regions. Therefore, we employ a regression analysis based on individual data to take a manifold list of potential confounding factors into account.

[2] While urban areas have a density of about 300 inhabitants/km^2, urbanized areas are characterized by a density of at least 100 inhabitants/km^{2}and rural areas have less than 100 inhabitants/km^2.

[3] However, the differences are statistically insignificant.

We estimate the following model to investigate whether health practitioners' density affects the quality of provided care measured in prescriptions of drugs from the Priscus-List:

$$\mathbf{y}_i = \beta_0 + \beta_1 \mathbf{prac}_i + \beta_2 \mathbf{cch}_i + \beta_3 \mathbf{Z}_i + \varepsilon_i$$

where the dependent variable $\mathbf{y}_i$ is either binary indicating whether person *i* receives any drugs from the list or not, or continuous indicating the prescribed amount of DDDs for each person *i*. $\mathbf{prac}_i$ denotes the density of physicians representing the share of general or general and medical practitioners, respectively. $\mathbf{cch}_i$ comprises county characteristics (e.g. hospital provision and rurality) and $\mathbf{Z}_i$ is a vector of control variables for individual characteristics (e.g. age, gender, care dependency, health status, etc.). ε_i is the error term.

In order to assess the effect of density of general/medical practitioner in a certain region, we apply two types of regression models. In a first step we use simple OLS regressions to determine the quantitative effect of physicians density on the amount of prescribed DDD. In a second step, we refine our analysis due to two different reasons. For one thing, we face a limited dependent variable with a nontrivial positive probability for a lower bound at zero that is a continuous randomly distributed over the positive values. We also argue that the mechanism determining whether physicians prescribe drugs defined as inappropriate or not, is different from the mechanism determining the prescribed amount. Because the first is a basic decision depending upon the knowledge of the respective physician (e.g. his knowledge about the inappropriateness of certain drugs) and the latter is driven by the number and characteristics of each person's illnesses. In other words, we have to different data determining processes. The first one determines whether $\mathbf{y}_i$ takes up a positive value or not. Then, given a positive value, the second one determines the actual value of $\mathbf{y}_i$.

The first reason, being the problem of left truncation, suggest the necessity to estimate a Tobit model. The second reason, however, violates one of the key assumptions underlying Tobit models for corner solutions, i.e. the determination of the size of the variable when it is not zero depends on the same parameters determining the probability of its being zero. Therefore, we utilize a more flexible alternative to the Tobit model as proposed by Cragg (1971) that allows for different driving factors and hence relaxes the strong assumption of the Tobit model. This alternative, often referred to as two-stage or double-hurdle model, incorporates the probit model to determine the probability of taking any Priscus-listed drugs and the truncated normal model for given positive values of the dependent variable.

5 Results

Table 3 shows the results of the variables of main interest, i.e. the density of general and medical practitioners. Note, however, that we obtained the results for these two variables in separate models since the two groups of practitioners do not have a competitive relationship[4]. For brevity reasons, results on the long list of control variables for each of the considered models are provided in Tables A2-A3 in the Appendix.

The first column of Table 3 shows the estimation results for OLS regressions performed with density of general practitioners and density of medical practitioners respectively. Both densities have a significant impact on the amount of prescribed DDDs but differ noticeably in their size. The effect of one more general practitioner per 10,000 habitants reduces the prescription of Priscus-listed drugs by 4.6 DDDs per person/year on average. The effect of one more medical practitioner per 10,000 habitants reduces the prescription of drugs by only about 1.2 DDDs per person/year on average.

Marginal effects of the probit regression in the first part of the double-burden model are included in column 2, followed by the results of the normal truncated model in column 3. Overall, the double-hurdle model confirms the OLS results in their direction and size. Again the size of the marginal effect of density of general practitioners is almost four times bigger than for density of medical practitioners. Specifically, one more medical practitioner per 10,000 habitants reduces the probability of receiving inappropriate drugs at all by 6.4 percentage points while an increase in the number of medical practitioners by one (per 10,000 habitants) decreases the probability by 1.7 percentage points. With respect to the second step of the double-hurdle model, the obtained results confirm the reduction of prescribed DDDs of Priscus-listed drugs by 4.8 DDDs per one

[4] We argue against a competitive relationship for two reasons. One, from 2004-2013 people insured in statutory health care had to pay Co-payments of €10 for visits to general doctors in any given quarter and additionally €10 for every medical practitioner if they visited one without a referral from a general doctor. Analyzing both groups in the same regression would ignore the different driving factors. Second, in contrast to general practitioners who serve primary and non-severe help, medical practitioners are highly specialized on one specific medical field. Thus, the overlap of medical indications between them is fairly low.

more general practitioner and by 1,2 DDDs per one more medical practitioner (both per 10,000 habitants). All obtained results are statistically significant at the 1% level.

Hence, the density of both general and practical practitioners goes along with lower Priscus-listed prescriptions at both the intensive and extensive level. These results are in accordance with our expectations reflecting a positive effect of competition on the provided quality of care.

Table 3: The effects of density of physicians on prescriptions of drugs from the Priscus-list for out-patients

	OLS	Double-Hurdle Model	
		Frequency (probit)	Severity (normal truncated)
Model 1:			
Density of general practitioners	-4.620***	-0.064***	-4.817***
	(1.384)	(0.013)	(1.282)
Model 2:			
Density of medical practitioners	-1.152***	-0.017***	-1.218***
	(0.239)	(0.002)	(0.225)

Notes: Significant at ***: 1% level; **: 5% level; *: 10% level. Observations: 22,765. Bootstraped cluster-robust standard errors at the regional level in parentheses. Marginal effects calculated at means (in case of probit).

6 Conclusion

In view of the current discussion in Germany concerning doctor shortages in rural areas and the premise that a low supply of physicians in an area is associated with low quality of care (KBV, 2013) this study aims to identify the effect of physician density on quality of medical care. In order to measure quality of provided care by the physicians, we rely on a newly developed medical guideline - the Priscus-list. Specifically, we study the relationship between the prescribed DDD of potentially inappropriate drugs for elderly and the density of general and medical practitioners.

We use administrative data from a health insurance fund with very detailed prescription information and supplement the individual data with information on the general and medical physician density on county level. The effect of the physician density on the prescription of inappropriate medication is estimated using both linear and double-hurdle models. In line with theoretical expectations, our results indicate significant and sizeable effects of physician density on the prescribing of inappropriate medication.

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Appendix

Table A1: Definition of Variables

Variable	Description
Dependent variables:	
Priscus DDD	sum of prescribed DDDs of drugs from the Priscus-List in the considered year
Priscus binary	= 1 if any DDDs of drugs from the Priscus-List were prescribed in the considered year
Independent variables:	
Density of physicians	
Density of general practitioners	number of general practitioners per 10,000 inhabitants on county level
Density of medical practitioners	number of medical practitioners per 10,000 inhabitants on county level
County characteristics	
Hospital provision	number of beds in hospitals per 10,000 inhabitants on county level
Rurality	share of inhabitants in communities with density population below 150 inhabitants/km^2
Individual characteristics:	
Demographic information	
Age	age of individual
Male	= 1 if male, 0 otherwise
Care dependency	
Care level 2	= 1 if care provision to impaired person in care level 2, 0 otherwise (reference group: care level 1)
Care level 3	= 1 if care provision to impaired person in care level 3, 0 otherwise (reference group: care level 1)
Informal and formal out-patient care	= 1 if recipient of informal and formal out-patient care, 0 otherwise (reference group: recipient of informal out-patient care)
Formal out-patient care	= 1 if recipient formal out-patient care, 0 otherwise (reference group: recipient of informal out-patient care)
In-patient care	= 1 if recipient in-patient care, 0 otherwise (reference group: recipient of informal out-patient care)
Health status	
Depression and bipolar disorder	= 1 if depression or disorder (ICD-10: F31-F38, F06.3) were diagnosed in the considered year , 0 otherwise
Schizophrenia, schizotypal and delusional disorders	= 1 if schizophrenia, or schizotypal and delusional disorders (ICD-10: F20-F29) were diagnosed in the considered year , 0 otherwise
Dementia	= 1 if dementia (ICD-10: F00-F03) was diagnosed in the considered year, 0 otherwise
Mental disorders due to psychoactive substance	= 1 if other mental disorders (ICD10: F10-F19) were diagnosed in the considered year, 0 otherwise
Other mental disorders	= 1 if mental disorders due to psychoactive substance (ICD10: F04-F06.2, F06.4-F09,F30,F39-F99) were diagnosed in the considered year, 0 otherwise
Stroke	= 1 if stroke (ICD10: I61, I63, I64) was diagnosed in the considered year, 0 otherwise
Cardiac infarction	= 1 if cardiac infraction (ICD-10: I21-I22) was diagnosed in the considered year, 0 otherwise
Other diseases of the circulatory system	= 1 if other diseases of the circulatory system (ICD-10: I00-I99 without I21-I22, I61, I63, I64) were diagnosed in the considered year, 0 otherwise
Invasive neoplasms	= 1 if invasive neoplasms (ICD-10: C00-C97) were diagnosed in the considered year, 0 otherwise
Diseases of the musculoskeletal system	= 1 if diseases of the musculoskeletal system (ICD-10: M00-M99) were diagnosed in the considered year, 0 otherwise
Diseases of the genitourinary system	= 1 if diseases of the genitourinary system (ICD-10: N00-N99) were diagnosed in the considered year, 0 otherwise
Parkinson's disease	= 1 if Parkinson's disease (ICD-10: G20-G22) was diagnosed in the considered year, 0 otherwise
Injuries and poisoning	= 1 if Injuries and poisoning (ICD-10: S00-T98) were diagnosed in the considered year, 0 otherwise
Number of hospitalizations	number of hospitalizations in the considered year
Number of consultations	number of consultations in the considered year
Death	= 1 if death was diagnosed in the considered year, 0 otherwise
Region	
Eastern Germany	=1 if Eastern Germany, 0 otherwise

Table A2: The effects of density of general practitioners on prescriptions of drugs from the Priscus-list

	OLS	Double-Hurdle Model	
		Frequency (probit)	Severity (normal truncated)
County characteristics			
Density of general practitioners	-4.620***	-0.064***	-4.817***
	(1.384)	(0.013)	(1.282)
Hospital provision	0.034	0.001**	0.093***
	(0.037)	(0.000)	(0.018)
Rurality	0.031	0.001***	0.101**
	(0.044)	(0.000)	(0.023)
Individual characteristics: Demographic information			
Age	-0.996***	-0.005***	-0.975***
	(0.127)	(0.001)	(0.075)
Male	-10.971***	-0.163***	-9.018***
	(1.963)	(0.018)	(1.157)
Care dependency			
Care level 2	6.271***	0.084***	6.583***
	(2.023)	(0.019)	(1.041)
Care level 3	12.461***	0.174***	10.849***
	(3.340)	(0.031)	(1.655)
Informal and formal out-patient care	7.967***	-0.002	3.481
	(2.057)	(0.043)	(2.468)
Formal out-patient care	9.475**	0.065***	3.802***
	(4.626)	(0.019)	(1.280)
Health status			
Depression and bipolar disorder	35.626***	0.340***	35.143***
	(2.160)	(0.019)	(1.149)
Schizophrenia, schizotypal and delusional	35.880***	0.351***	34.306***
	(6.214)	(0.047)	(1.962)
Dementia	-13.305***	-0.118***	-13.757***
	(2.063)	(0.020)	(1.085)
Mental disorders due to psychoactive substance	16.490***	0.097***	10.827***
	(4.179)	(0.034)	(1.679)
Other mental disorders	2.291	0.165***	-0.400
	(4.392)	(0.043)	(2.393)
Stroke	0.292	0.019	0.316
	(2.049)	(0.019)	(1.019)
Cardiac infarction	-7.064**	-0.041	-10.301***
	(2.965)	(0.030)	(2.000)
Other diseases of the circulatory system	2.622	0.011	3.600*
	(3.732)	(0.035)	(2.058)
Invasive neoplasms	-2.888	0.026	-4.246***
	(2.048)	(0.019)	(1.197)
Diseases of the musculoskeletal system	4.270**	0.118***	4.206**
	(2.059)	(0.020)	(1.727)
Diseases of the genitourinary system	8.865***	0.122***	6.801***
	(1.993)	(0.019)	(1.058)
Parkinson’s disease	-6.768***	0.046*	-5.306***
	(2.641)	(0.025)	(1.513)
Number of hospitalizations	-0.103	0.034***	-0.827*
	(0.607)	(0.006)	(0.432)
Number of consultations	0.265***	0.003***	0.382***
	(0.035)	(0.000)	(0.016)
Death	-17.328***	0.098***	-24.927***
	(1.975)	(0.021)	(3.138)
Region			
Eastern Germany	-9.137**	-0.177***	-12.637
	(3.720)	(0.035)	(2.352)
Constant	152.951***	0.143	-6.477
	(13.486)	(0.123)	(7.225)
Observations		22,765	22,765

Notes: Significant at ***: 1% level; **: 5% level; *: 10% level. Observations: 22,765. Bootstraped cluster-robust standard errors at the regional level in parentheses. Marginal effects calculated at means (in case of probit).

Table A3: The effects of density of medical practitioners on prescriptions of drugs from the Priscus-list

	OLS	Double-Hurdle Model	
		Frequency (probit)	Severity (normal)
County characteristics			
Density of medical practitioners	-1.152***	-0.177***	-1.218***
	(0.239)	(0.023)	(0.225)
Hospital provision	0.108***	0.002***	0.121***
	(0.042)	(0.000)	(0.039)
Rurality	-0.061	-0.000	-0.062
	(0.048)	(0.000)	(0.052)
Individual characteristics:			
Demographic information			
Age	-0.992***	-0.005***	-1.020***
	(0.127)	(0.001)	(0.128)
Male	-10.986***	-0.163***	-9.798***
	(1.964)	(0.018)	(1.789)
Care dependency			
Care level 2	6.278***	0.084***	5.525***
	(2.023)	(0.019)	(1.898)
Care level 3	12.395***	0.174***	11.484***
	(3.339)	(0.031)	(3.440)
Informal and formal out-patient care	7.908***	0.007	7.848***
	(2.057)	(0.043)	(4.198)
Formal out-patient care	10.003**	0.064***	8.075***
	(4.627)	(0.019)	(2.052)
Health status			
Depression and bipolar disorder	35.715***	0.342***	33.248***
	(2.159)	(0.019)	(1.757)
Schizophrenia, schizotypal and delusional	35.736***	0.349***	29.053***
	(6.211)	(0.047)	(4.217)
Dementia	-13.346***	-0.118***	-13.343***
	(2.063)	(0.020)	(2.267)
Mental disorders due to psychoactive substance	16.780***	0.102***	14.404***
	(4.181)	(0.034)	(3.093)
Other mental disorders	2.206	0.163***	4.982
	(4.392)	(0.432)	(5.507)
Stroke	0.301	0.019	0.653
	(2.048)	(0.019)	(2.238)
Cardiac infarction	-7.002**	-0.040	-8.510***
	(2.966)	(0.030)	(3.209)
Other diseases of the circulatory system	2.604	0.010	3.380
	(3.729)	(0.035)	(3.762)
Invasive neoplasms	-2.849	0.027	-2.172
	(2.048)	(0.019)	(2.080)
Diseases of the musculoskeletal system	4.380**	0.120***	4.305***
	(2.059)	(0.020)	(1.720)
Diseases of the genitourinary system	8.776***	0.121***	7.930***
	(1.993)	(0.019)	(1.902)
Parkinson's disease	-6.876***	0.044*	-6.574**
	(2.640)	(0.025)	(3.243)
Number of hospitalizations	-0.116	0.034***	-0.362
	(0.607)	(0.006)	(0.883)
Number of consultations	0.267***	0.003***	0.257***
	(0.035)	(0.000)	(0.028)
Death	-17.328***	0.098***	-24.913***
	(1.973)	(0.021)	(3.185)
Region			
Eastern Germany	-9.215**	-0.180***	-9.329
	(3.707)	(0.036)	(3.312)
Constant	140.163***	-0.016	-20.320***
	(11.250)	(0.104)	5.645
Observations		22,765	22,765

Notes: Significant at ***: 1% level; **: 5% level; *: 10% level. Observations: 22,765. Bootstraped cluster-robust standard errors at the regional level in parentheses. Marginal effects calculated at means (in case of probit).