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Magdalena A. Stroka-Wetsch

Regional Variation in the Supply of General and Medical Practitioners and its Consequences for Inpatient Service Utilization



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Regional Variation in the Supply of General and Medical Practitioners and its Consequences for Inpatient Service Utilization

Abstract

There is widespread concern about the consequences of the undersupply of outpatient care for the utilization of inpatient care. It is common knowledge in the media that urban areas often are characterized by an oversupply of health care providers, while rural areas suffer from shortage. As such, the undersupply of outpatient medical care in rural areas can lead to higher utilization of inpatient care due to both substitution effects and the possible disastrous health consequences if medical care is not received frequently or quickly enough. On the basis of administrative data from the largest sickness fund in Germany, this study analyzes the relationship between the district density of general as well as medical practitioner and the individual number of hospitalizations. We find evidence for a significant negative association between the share of general and medical practitioners in the population and the utilization of inpatient health care services, measured in the amount of yearly hospitalizations.

JEL-Code: IIO

Keywords: Hospital utilization; general practitioner; medical practitioner; shirking regions; medical undersupply; fixed-effects; administrative data

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¹ Magdalena Stroka-Wetsch, RWI and Hochschule für Öffentliche Verwaltung, Duisburg. We are grateful to our colleagues from the former WINEG for the access to the data of the Techniker Krankenkasse and the financial support by the Leibniz Science Campus Ruhr.-All correspondence to: Magdalena Stroka-Wetsch, RWI, Hohnenzallernstr. 1-3, 45128 Essen, Germany, e-mail: stroka@rwi-essen.de

1 Introduction

Population decline in Germany goes hand in hand with the shrinking supply of medical care, especially in rural areas. While the threat of undersupplied medical care in rural areas is well documented in the literature (see e.g. Humphreys and Rolley, 1998), little is known about the consequences of the undersupply of outpatient care for the utilization of inpatient care.

Not only Germany but most developed countries face the challenging problem of an increasing demand for health services by the aging population on the one side and financial limitations in the health care system on the other side. Thereby, the inpatient sector accounts for over 37% of overall health expenditures in Germany (Statistisches Bundesamt, 2019). The OECD (2013) considers these expenditures as responsible for the rapid growth of overall health care spendings. Hence, policymakers and researchers try to find ways to increase the system efficiency in the health care sector. Kodner (2009) suggests integrated care, i.e. improved usage of synergies and better linkage between various health care providers, including general as well as medical practitioners and hospitals as a solution and possibility to improve efficiency as well as quality of care. Nevertheless, as long as this linkage is not established or is difficult to establish due to an undersupply of outpatient care in especially rural areas with potentially overstrained general and medical practitioners, inefficiencies in the health care market can be expected.

The argument for the hypothesized link between the regional concentration of general and medical practitioners and the utilization of hospitals is that a sufficient supply of outpatient services can prevent hospitalizations twofold: first, by out-patient treatments that replace inpatient treatments and second, by the supply of out-patient health care services that improve the health conditions or prevent from diseases and hence reduce the number of hospitalizations. Nevertheless, the empirical literature has not yet been able to satisfactorily settle whether, and especially, to what extent the concentration of general and medical practitioners affects hospital utilization.

This is the first study that analyses the association between the supply of health services focusing on the regional density of general and medical practitioners on hospital utilization at the individual level in Germany. We improve upon the existing literature by

using an arguably richer and better suited data set for the underlying question. Moreover, we use more timely data and difference out time-invariant individual heterogeneity by estimating fixed effects regressions (in Section 2, we discuss our contribution to the literature in more detail).

The aim of this study is to provide evidence on the effect of market concentration of general and medical practitioners on the number of individual yearly hospitalizations. However, uncovering determinants of hospital utilization comes along with certain challenges. Evidently, 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-demographic characteristics of the individuals as well as information on the regional supply of general and medical practitioners. Administrative data from the sickness fund 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 into account adequately. 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 utilization of inpatient health care services. In a first step, we use linear regressions to determine the quantitative effect of general and medical practitioners' density on the amount of individual hospitalizations per year. In a second step, we refine our analysis by applying a two-part model in order to analyze both the intensive and extensive margins. In all models we exploit the panel structure of the underlying data.

We find significant negative effects of the density of general and medical practitioners on the utilization of inpatient health care services as measured in the amount of hospitalizations. Stated differently, higher shares of general and medical practitioners in the population go along with fewer hospitalizations. Nevertheless, this is only the case at the intensive and not the extensive margins as the two-part models show.

After an overview of the existing literature on this topic (Section 2), the paper describes the data source as well as the study population (Section 3), and discusses the empirical

strategy (Section 4). Results are presented in Section 5, followed by a discussion of policy implications.

2 Literature Review

Our study contributes to a large literature on the effects of regional supply of health institutions. Thereby, most of the literature deals with the concentration of inpatient institutions such as hospitals or nursing homes and analyses the effects of regional competition on quality outcomes. Based on various data sets (mainly from the USA) and various econometric methods, this literature indicates that higher densities improve quality of care, both, on the hospital market (see e.g. Cooper et al., 2011, Propper, Burgess and Gossage, 2008, Sari, 2002) as well as on the nursing home market (see e.g. Brekke et al., 2010, Hirth, 1999, Nyman, 1988a, Nyman, 1988b, Nyman, 1989, Mennicken et al., 2010).

Effects of market concentration of out-patient health care providers, such as general and medical practitioners are much less examined (Jürges and Pohl, 2012) and also less distinct in their findings. A part of the respective literature analyzes outcomes such as the share of mortality rates proportional to physician/population ratios. Shi and Starfield (2001) identify a significant negative association between the physician/population ratio and total mortality rates for U.S. metropolitan areas. However, after controlling for socio-economic determinants, this effect becomes insignificant for high-income areas. Chen and Lowenstein (1985) find a strong relationship between infant mortality and the regional physician supply 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%. Based on the same data source as used in this paper, Stroka-Westch, Talmann and Linder (2016) find significant effects of the concentration of general and medical practitioners in Germany and the provided quality of care, measured in prescriptions of inappropriate drugs for elderly.

Apart from the mentioned health outcomes there are also studies shedding light on the question of the density 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".

An alternative possibility for measuring the utilization 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 significantly 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.

Another line of the literature deals with how a given regional physician quantity influences the regional number of hospital admissions per 1,000 inhabitants (see e.g. van der Gaag, Rutten and van Praag, 1975). Bindman et al. (1995) find that communities where people perceive poor access to medical care have higher rates of hospitalization for chronic diseases. Nevertheless, these studies are based on regional data and hence control only for regional characteristics neglecting information on individual level. Thereby many other studies document significant effects of individual characteristics on the hospital utilization (see e.g. Manga, Broyles and Angus, 1987, Weber et al., 2000 and Wolinsky and Rodney, 1984).

Despite the large literature reviewed above, most related to our study are the following two publications based on individual data. Emery and Zheng (2018) use data from Canada to show that better access to preventive care can reduce use of acute care including hospitalizations, emergency departments visits as well as use of general practitioner services. Harwartz and Klein (2016) do not confirm these results for the USA: They find that especially quantity and severity of prior illness are positively correlated with the risk of hospitalizations. However, while medical prevention in terms of general practice visits is not associated with the risk of hospital admission, it reduces the length of stay in hospital. Due to missing data on the length of stay in hospital, we are not able to contribute

to the available studies on this topic (see e.g. Marshall et al., 2002, Omachonu et al., 2004 and Picone, Wilson and Chou, 2003).

We go beyond the existing literature as, to the best of our knowledge, this is the first study using much larger data with more than 13 million observations. Moreover, we use the wealth of information of administrative data that has — so far — not been used in the given context. Thereby the use of claims 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). We are the first to uncover the relationship between the density of general and medical practitioners and the number of individual hospitalizations for Germany.

3 Data and Sample Selection

The dataset for the empirical analysis is constructed using information on individuals from the largest sickness fund in Germany — the TK — in combination with information on county level provided by the BBR. Like all other sickness funds in Germany, the provider of our data, the TK, collects administrative and claims data on their insured. From the large pool of these routine data our sample is based on the basic claims data with general socio-demographic information as well as detailed information on the individual health status and health car utilization. The dataset is an unbalanced panel of the years 2007-2009. Some individuals change their insurance company or pass away, but the majority of individuals is observed over three years. Out of more than ten million insured of the TK we focus on people older than 18. Moreover, the estimation sample only includes individuals living in Germany since the information of health care utilization on insured living abroad is potentially incomplete.

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. Nevertheless, also some limitations go along with the claims data. The data

does not include any economic information (expect work-position) and due to sharpened data protection regulations it is not possible to get the data for more up-to-date periods.

The dependent variable is measured in yearly numbers of individual hospitalizations. Information on concentration of informal health care provision is measured on county level and includes the number of general and medical practitioners per 1,000 inhabitants. A further variable includes the degree of rurality of the county. Moreover, a list on sociodemographic outcomes including gender, age and employment status is included in the analysis. Further control variables, mainly information on the health status, are dichotomously measured variables on a range of diagnoses (identified using the International Classification of Diseases (ICD-10) code) indicating a certain disease is diagnosed at least once either in the out-patient or inpatient health service field in the considered year. Also, information on informal care provision to a dependent person is considered. Table 1 shows the descriptive statistics of all variables considered in the empirical analysis¹.

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

Table 1: Descriptive statistics

| | Mean | St.D. |
|--|--------|--------|
| Dependent variables: | | |
| Number of hospitalizations | 0.142 | 0.560 |
| Probability of hospitalization | 0.100 | 0.300 |
| Independent variables: | | |
| County characteristics | | |
| Density of general practitioners | 0.638 | 0.076 |
| Density of medical practitioners | 1.752 | 0.565 |
| Rurality | 15.106 | 23.190 |
| Individual characteristics: | | |
| Socio-demographic characteristics | | |
| Age | 45.285 | 15.760 |
| Female | 0.437 | 0.496 |
| Self-employed | 0.052 | 0.222 |
| Part-time worker | 0.105 | 0.307 |
| Unemployed | 0.062 | 0.242 |
| Pensioner | 0.200 | 0.400 |
| Student | 0.326 | 0.178 |
| Employer | 0.650 | 0.477 |
| Carer | 0.003 | 0.060 |
| Health status | | |
| Stroke | 0.011 | 0.103 |
| Cardiac infarction | 0.001 | 0.038 |
| Other diseases of the circulatory system | 0.064 | 0.477 |
| Invasive neoplasms | 0.064 | 0.245 |
| Diseases of the digestive system | 0.063 | 0.243 |
| Diabetes | 0.007 | 0.086 |
| Death | 0.023 | 0.151 |

Observations: 13,445,390.

Next, we consider the individual number and probability of hospitalization in three different types of topological areas, i.e. urban, urbanized and rural area², in order to verify the undersupply hypothesis postulated in section 1. As shown in Table 2, the probability as well as the amount of hospitalizations is not different in rural, urbanized or urban areas³. However, urbanized and rural areas are characterized by a slightly lower amount of mean density of medical practitioners 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

² While urban areas have a density of above 300 inhabitants/km², urbanized areas are characterized by a density of at least 100 inhabitants/km² and rural areas have less than 100 inhabitants/km².

³ However, the differences are statistically insignificant.

urbanized and rural areas.⁴ Hence, it seems important to differentiate between general and medical practitioners.

| | Urbar | n area | Urbaniz | ed area | Rura | l area |
|----------------------------------|-------|--------|---------|---------|------|--------|
| | Mean | St. D. | Mean | St. D. | Mean | St. D. |
| Density of general practitioners | 0.63 | 0.08 | 0.65 | 0.07 | 0.68 | 0.09 |
| Density of medical practitioners | 1.82 | 0.55 | 1.67 | 0.59 | 1.52 | 0.50 |
| Number of hospitalizations | 0.14 | 0.56 | 0.14 | 0.54 | 0.14 | 0.55 |
| Probability of hospitalization | 0.10 | 0.30 | 0.09 | 0.30 | 0.10 | 0.30 |
| Observations | 9,658 | 3,660 | 4,742 | 1,301 | 1.28 | 5,030 |

Table 2: Main variables by type of area

4 Empirical Strategy

Descriptive statistics indicate differences in the provision with out-patient health care by general and medical practitioners depending on the type of region (Table 2). In our empirical analyses we further investigate whether these differences go along with different utilization of inpatient care (i.e. hospitalizations) as a result of potential undersupply with out-patient health care by general and medical practitioners in certain areas. As 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 we employ a regression analysis based on individual data to take a manifold list of potential confounding factors into account.

We estimate the following model to investigate whether general or medical practitioners' density affects the individual yearly number of hospitalizations:

$$\mathbf{y}_{it} = \beta_0 + \beta_1 \mathbf{prac}_{it} + \beta_2 \mathbf{rur}_{it} + \beta_3 \mathbf{X}_{it} + \lambda_i + \varepsilon_{it}$$
(1)

where the dependent variable y_{it} is indicating the number of hospitalization of person *i* in year t, **prac**_{it} denotes either the density of physicians representing the share of general or general and medical practitioners, respectively. **rur**_{it} comprises county characteristics (i.e. rurality) and **X**_{it} is a vector of control variables for individual characteristics of the insured (e.g. age, gender, employment, health status, etc.). Although we control for a long list of confounding factors one might argue that there are still unobserved factors left that both affect the number of hospitalizations and the density of out-patient health providers.

⁴ Nevertheless, given the infrastructure in urbanized and rural areas the access to general practitioners can be regardless of the higher densities more difficult in these areas compared to urban areas.

This would lead to biased estimates of the variables of primary interest. To overcome these potential problems we assume that these factors are time-invariant (captured by λ_i) and exploit the panel structure of the underlying data. ϵ_{it} is the error term and β_0 to β_3 are coefficient vectors to be estimated.

In order to assess the effect of density of general/medical practitioners in a certain region, we apply two types of regression models. In a first step we use linear regressions to determine the effect of physician density on the amount of the individual number of hospitalizations. In a second step, we refine our analysis as the dependent variable exhibit a high share of zeros. Therefore, we apply a two-part specification. The two-part model assumes that the probability of hospitalization and the number of hospitalizations are results of two different processes. Following Schmitz and Stroka (2013), we use a linear probability model for the first part and a linear regression of the logged outcome variable for the second part. The control variables in these models are the same as presented in equation (1). All models exploit the panel structure of the data and are calculated using random- as well as fixed effects. However, the Hausman-test suggest to rely on the fixed-effects results and therefore we concentrate on fixed-effects results in the next sections.

As fixed-effects models identify the estimation parameters only through within-variation over time, it is necessary that the amount of hospitalizations as well as the shares of densities of general and medical practitioners change over time. This is the case in the underlying data. While the within-variation of the dependent variable is 0.40 it equals 0.02 for general practitioners and 0.01 for medical practitioners.

Results

Tables 3 and 4 show 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 relationship⁵. For brevity reasons, results on the long list of control variables for each of the considered models are provided in Tables A2-A5 in the Appendix.

The first column of Table 3 and 4 shows the estimation results for linear regressions performed with density of general practitioners and density of medical practitioners

⁵ 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

respectively. Considering the fixed effects results, both densities have a significant impact on the number of yearly hospitalizations but differ noticeably in their size. One additional general practitioner per 1,000 inhabitants goes along with a reduction of the yearly number of individual hospitalizations by 0.12 on average. One additional medical practitioner per 1,000 habitants is associated with a reduction of the number of individual hospitalizations by 0.03 on average. As the mean number of yearly hospitalizations is 0.14 (see Table 1) this seems to be a noticeable effect.

Results of the linear probability model as the first part of the two-part model are included in column 2, followed by the results of second part with logged positive outcomes in column 3. Overall, the first part of the two-part model confirms the OLS results. 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 additional general practitioner per 1,000 inhabitants reduces the probability hospitalization by 9.0 percentage points while an increase in the number of medical practitioners by one per 1,000 inhabitants reduces the same probability by 2.5 percentage points. With respect to the second step of the two-part model, the obtained results show no significant effects. Hence, the negative results in the linear specification can entirely be explained by a higher probability of hospitalization in regions with less general and medical practitioners per 1.000 inhabitants.

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.

| - | Linear models | Two-part models | | Linear models Two-part | |
|----------------------------------|---------------|-----------------|-----------------|------------------------|--|
| | | 1st part: LPM | 2nd part: ln(Y) | | |
| Model 1: | | | | | |
| Density of general practitioners | -0.003 | -0.004*** | 0.020*** | | |
| | (0.002) | (0.001) | (0.005) | | |
| Model 2: | | | | | |
| Density of medical practitioners | 0.001** | -0.001*** | 0.004*** | | |
| | (0.000) | (0.000) | (0.001) | | |
| Observations | 13,445,390 | 13,445,390 | 1,511,631 | | |

Table 3: The effects of density of physicians on individual hospitalizations: Randomeffects models

Notes: Significant at ***: 1% level; **: 5% level; *: 10% level. Cluster-robust standard errors in parentheses.

| Table 4: The effects of dense | sity of physicians on individu | al hospitalizations: Fixed-effects |
|-------------------------------|--------------------------------|------------------------------------|
| models | | |

| | Linear models | Two-part models | |
|----------------------------------|---------------|-----------------------|-----------------|
| fa | | 1st <u>p</u> art: LPM | 2nd part: ln(Y) |
| Model 1: | | | |
| Density of general practitioners | -0.122*** | -0.090*** | -0.012 |
| | (0.014) | (0.008) | (0.074) |
| Model 2: | | | |
| Density of medical practitioners | -0.033*** | -0.025*** | -0.020 |
| | (0.006) | (0.003) | (0.031) |
| Observations | 13,445,390 | 13,445,390 | 1,511,631 |

Notes: Significant at ***: 1% level; **: 5% level; *: 10% level. Cluster-robust standard errors in parentheses.

5 Conclusion

In view of the current discussion in Germany concerning doctor shortages in rural areas, this study aims to identify the effect of physician density on inpatient service utilization measured in the number of individual hospitalizations.

We use administrative data from a health insurance fund with very detailed information on the usage of the health care system and supplement the individual data with information on the general and medical physician density on county level. With our large data set with more than13 million observations, we provide first results on the given research question for Germany, a country that is the largest in Europe with a pronounced social security system and subject to a strong demographic change with an ageing population. In line with theoretical expectations, our results indicate significant effects of general and medical physician density on the inpatient utilization as measured in hospitalizations. However, the density of both general and practical practitioners goes along with less hospitalizations only at the intensive but not on the extensive level.

Given the underlying data we are only able to focus on the number of yearly hospitalizations disregarding the length of stay. Moreover, we have no information on details of the hospital stays and hence we can only assume that some of the observed hospitals stays in areas with a lower practitioner-inhabitant ratio were preventable (e.g. with a better outpatient medical supply). Although our ability to interpret our estimates as causal effects is limited by self-selection of individuals in different areas characterized by different levels of rurality and different medical supply, our study highlights the potential of improved access to outpatient care to address among others the problem of increased demand among an aging population in light of limited financial resources. We, therefore, address the fiscal challenges of the medical sector with hospitals accounting for a large share of medical spending.

Given our results it should be of great political interest to ensure that the already present shortage of supply in rural areas is not enlarged. Hence, incentives to attract more doctors to the countryside should be enhanced. Moreover, given the ongoing reductions of bed capacities in hospitals and plans for hospital closures, the coherence and synergy between distinct levels of care should be improved and increase the system efficiency.

To find reliable solutions for the ongoing problems due to the demographic change and shirking regions more research is needed. Future studies on the underlying research question might apply the instrumental variable approaches, which could not be implemented in this study, as the data did not include valid instruments. Moreover, using more detailed data future studies might distinguish between preventable and notpreventable hospitalizations.

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Appendix

| | Table A1: | Definition | of Variables |
|--|-----------|------------|--------------|
|--|-----------|------------|--------------|

| Variable | Description |
|--|--|
| Dependent variables: | * |
| Number of hospitalizations | number of hospitalizations in the considered year |
| Probability of hospitalization | =1 if at least one hospitalization in the considered year, 0 otherwise |
| Independent variables: | |
| County characteristics | |
| Density of general practitioners | number of general practitioners per 1,000 inhabitants on county level |
| Density of medical practitioners | number of medical practitioners per 1,000 inhabitants on county level |
| Rurality | share of inhabitants in communities with density population below 150 inhabitants/km² |
| Individual characteristics: | |
| Socio-demographic characteristics | |
| Age | age of individual |
| Female | = 1 if male, 0 otherwise |
| Self-employed | =1 if self-employed. 0 otherwise (reference group: civil servant) |
| Part-time worker | =1 if part-time worker or home worker. 0 otherwise |
| Unemployed | =1 if unemployed. 0 otherwise (reference group: civil servant) |
| Pensioner | =1 if pensioner. 0 otherwise (reference group: civil servant) |
| Student | = 1 if student, 0 otherwise (reference group: civil servant) |
| Employed | = 1 if employed, 0 otherwise (reference group: civil servant) |
| Carer | = 1 if informal carer, 0 otherwise |
| Health status | |
| Stroke | = 1 if stroke was diagnosed in the considered year, 0 otherwise |
| Cardiac infarction | = 1 if cardiac infraction was diagnosed in the considered year, 0 otherwise |
| Other diseases of the circulatory system | = 1 if other diseases of the circulatory system were diagnosed in the considered year, 0 otherwise |
| Invasive neoplasms | = 1 if invasive neoplasms were diagnosed in the considered year, 0 otherwise |
| Diseases of the digestive system | =1 if diseases of the digestive system were diagnosed in the considered year. 0 otherwise |
| Diabetes | =1 if diabetes were diagnosed in the considered year. 0 otherwise |
| Death | = 1 if death was diagnosed in the considered year, 0 otherwise |

| | Linear model | Two-part models | |
|--|--------------|-----------------|-----------------|
| | | 1st part: LPM | 2nd part: ln(Y) |
| County characteristics | | | |
| Density of general practitioners | -0.003 | -0.004*** | 0.020*** |
| | (0.002) | (0.001) | (0.005) |
| Rurality | 0.000*** | 0.000*** | -0.000 |
| | (0.000) | (0.000) | (0.000) |
| Individual characteristics: | | | |
| Socio-demographic information | | | |
| Age | -0.002*** | -0.001*** | -0.002*** |
| | (0.000) | (0.000) | (0.000) |
| Female | 0.039*** | 0.033*** | -0.003*** |
| | (0.000) | (0.000) | (0.001) |
| Self-employed | 0.002 | -0.006*** | 0.008*** |
| | (0.003) | (0.001) | (0.002) |
| Part-time worker | -0.003*** | -0.002*** | 0.001 |
| | (0.000) | (0.000) | (0.001) |
| Unemployed | 0.056*** | 0.025*** | 0.097*** |
| | (0.003) | (0.001) | (0.002) |
| Pensioner | 0.037*** | 0.013*** | 0.066*** |
| | (0.003) | (0.001) | (0.001) |
| Student | -0.031*** | -0.029*** | -0.028*** |
| | (0.003) | (0.001) | (0.002) |
| Employed | 0.007*** | -0.001 | -0.001 |
| | (0.003) | (0.001) | (0.001) |
| Carer | -0.008** | -0.006*** | -0.002 |
| | (0.003) | (0.001) | (0.002) |
| Health status | | (01001) | (0000) |
| Stroke | 0.097*** | 0.032*** | 0.061*** |
| | (0.003) | (0.001) | (0.001) |
| Cardiac infarction | 0.440*** | 0.040*** | 0.212*** |
| | (0.009) | (0.001) | (0.004) |
| Other diseases of the circulatory system | 1.300*** | 0.840*** | 0.128*** |
| | (0,002) | (0,000) | (0.001) |
| Invasive neoplasms | 0 224*** | 0.075*** | 0.185*** |
| | (0.001) | (0,000) | (0.001) |
| Diseases of the digestive system | 0 352*** | 0 194*** | 0.110*** |
| | (0.001) | (0,000) | (0,001) |
| Diabetes | 0.446*** | 0 179*** | 0.001) |
| | (0.005) | (0.001) | (0.00) |
| Death | 0.021*** | -0.015*** | 0.002) |
| | (0.001) | (0,000) | (0.002) |
| Observations | 13 445 390 | 12 445 200 | |
| 000000000 | 15,775,570 | 13 443 370 | 1,511,031 |

Table A2: The effects of density of general practitioners on individual hospitalizations: Random-effects models

| | Linear model | Two-pa | rt models |
|--|--------------|---------------|-------------------------|
| | | 1st part: LPM | 2nd <u>p</u> art: ln(Y) |
| County characteristics | | | |
| Density of medicall practitioners | 0.001** | -0.001*** | 0.004*** |
| | (0.000) | (0.000) | (0.001) |
| Rurality | 0.000*** | 0.000*** | 0.000 |
| | (0.000) | (0.000) | (0.000) |
| Individual characteristics: | | | |
| Socio-demographic information | | | |
| Age | -0.002*** | -0.001*** | -0.002*** |
| | (0.000) | (0.000) | (0.000) |
| Female | 0.039*** | 0.033*** | -0.003*** |
| | (0.000) | (0.000) | (0.001) |
| Self-employed | 0.002 | -0.006*** | 0.008*** |
| | (0.003) | (0.001) | (0.002) |
| Part-time worker | -0.003*** | -0.002*** | 0.001 |
| | (0.000) | (0.000) | (0.001) |
| Unemployed | 0.056*** | 0.025*** | 0.097*** |
| | (0.003) | (0.001) | (0.002) |
| Pensioner | 0.036*** | 0.013*** | 0.066*** |
| | (0.003) | (0.001) | (0.001) |
| Student | -0.032*** | -0.029*** | -0.029*** |
| | (0.003) | (0.001) | (0.002) |
| Employed | 0.006** | -0.001 | -0.001 |
| | (0.003) | (0.001) | (0.001) |
| Carer | -0.008** | -0.006*** | -0.002 |
| | (0.003) | (0.001) | (0.005) |
| Health status | | () | () |
| Stroke | 0.098*** | 0.032*** | 0.061*** |
| | (0.003) | (0.001) | (0.002) |
| Cardiac infarction | 0.442*** | 0.040*** | 0.212*** |
| | (0.009) | (0.001) | (0.004) |
| Other diseases of the circulatory system | 1.301*** | 0.840*** | 0.128*** |
| | (0.002) | (0.000) | (0.001) |
| Invasive neoplasms | 0.224*** | 0.075*** | 0 185*** |
| · | (0.001) | (0,000) | (0.001) |
| Diseases of the digestive system | 0.353*** | 0 194*** | 0 1 1 0 * * * |
| | (0.001) | (0.000) | (0.001) |
| Diabetes | 0.446*** | 0.179*** | 0.089*** |
| | (0.005) | (0.001) | (0.00) |
| Death | 0 115*** | -0.015*** | 0 104*** |
| | (0.003) | (0.010) | (0.003) |
| Observations | 13 445 390 | 13 445 390 | 1 511 621 |
| 36361 Valion3 | 15,745,570 | 13,443,370 | 1,311,031 |

Table A3: The effects of density of medical practitioners on individual hospitalizations:Random-effects models

| 7 | Linear model | Two-part models | |
|--|--------------|-----------------|-----------------|
| | - | 1st part: LPM | 2nd part: ln(Y) |
| County characteristics | | | |
| Density of general practitioners | -0.122*** | -0.090*** | -0.012 |
| | (0.014) | (0.008) | (0.074) |
| Rurality | 0.000 | 0.000 | -0.001 |
| | (0.000) | (0.000) | (0.001) |
| Individual characteristics: | | | |
| Socio-demographic information | | | |
| Age | 0.010*** | 0.005*** | 0.003*** |
| | (0.000) | (0.000) | (0.001) |
| Self-employed | -0.012*** | -0.010*** | -0.013 |
| | (0.004) | (0.002) | (0.018) |
| Part-time worker | -0.029*** | -0.021*** | -0.035*** |
| | (0.001) | (0.001) | (0.008) |
| Unemployed | 0.005 | 0.001 | 0.004 |
| | (0.003) | (0.002) | (0.013) |
| Pensioner | -0.016*** | -0.009*** | -0.036*** |
| | (0.004) | (0.002) | (0.013) |
| Student | -0.001 | -0.004** | -0.015 |
| | (0.004) | (0.002) | (0.023) |
| Employed | 0.007** | 0.003* | 0.007 |
| | (0.003) | (0.002) | (0.012) |
| Carer | -0.010*** | -0.004** | -0.026* |
| | (0.004) | (0.002) | (0.015) |
| Health status | | | |
| Stroke | 0.200*** | 0.081*** | 0.119*** |
| | (0.005) | (0.002) | (0.006) |
| Cardiac infarction | 0.477*** | 0.050*** | 0.263*** |
| | (0.009) | (0.002) | (0.007) |
| Other diseases of the circulatory system | 1.216*** | 0.820*** | 0.195*** |
| | (0.002) | (0.001) | (0.002) |
| Invasive neoplasms | 0.203*** | 0.072*** | 0.137*** |
| | (0.002) | (0.001) | (0.004) |
| Diseases of the digestive system | 0.388*** | 0.240*** | 0.154*** |
| | (0.001) | (0.001) | (0.002) |
| Diabetes | 0.445*** | 0.220*** | 0.185*** |
| | (0.005) | (0.001) | (0.005) |
| Death | -0.012*** | -0.021*** | -0.004 |
| | (0.002) | (0.001) | (0.008) |
| Observations | 13,445,390 | 13,445,390 | 1.511.631 |

Table A4: The effects of density of general practitioners on individual hospitalizations: Fixed-effects models

| | Linear model | Two-part models | |
|--|--------------|-----------------|-----------------|
| | | 1st part: LPM | 2nd part: ln(Y) |
| County characteristics | | | |
| Density of medical practitioners | -0.033*** | -0.025*** | -0.020 |
| | (0.006) | (0.003) | (0.031) |
| Rurality | 0.000 | 0.000 | -0.001 |
| | (0.000) | (0.000) | (0.001) |
| Individual characteristics: | | | |
| Socio-demographic information | | | |
| Age | 0.011*** | 0.006*** | 0.004*** |
| | (0.000) | (0.000) | (0.001) |
| Self-employed | -0.012*** | -0.010*** | -0.013 |
| | (0.004) | (0.002) | (0.018) |
| Part-time worker | -0.029*** | -0.021*** | -0.035*** |
| | (0.001) | (0.001) | (0.008) |
| Unemployed | 0.005 | 0.001 | 0.004 |
| | (0.003) | (0.002) | (0.013) |
| Pensioner | -0.016*** | -0.009*** | -0.036*** |
| | (0.004) | (0.002) | (0.013) |
| Student | -0.001 | -0.004** | -0.015 |
| | (0.004) | (0.002) | (0.023) |
| Employed | 0.007** | 0.003* | 0.007 |
| | (0.003) | (0.002) | (0.012) |
| Carer | -0.010*** | -0.004** | -0.026* |
| | (0.004) | (0.002) | (0.015) |
| Health status | | | |
| Stroke | 0.200*** | 0.081*** | 0.119*** |
| | (0.005) | (0.002) | (0.006) |
| Cardiac infarction | 0.477*** | 0.050*** | 0.263*** |
| | (0.009) | (0.002) | (0.007) |
| Other diseases of the circulatory system | 1.216*** | 0.820*** | 0.195*** |
| | (0.002) | (0.001) | (0.002) |
| Invasive neoplasms | 0.203*** | 0.072*** | 0.137*** |
| | (0.002) | (0.001) | (0.004) |
| Diseases of the digestive system | 0.388*** | 0.240*** | 0.154*** |
| | (0.001) | (0.001) | (0.002) |
| Diabetes | 0.445*** | 0.220*** | 0.185*** |
| | (0.005) | (0.001) | (0.005) |
| Death | -0.012*** | -0.021*** | -0.004 |
| | (0.002) | (0.001) | (0.008) |
| Observations | 13,445,390 | 13,445,390 | 1,511,631 |

Table A5: The effects of density of medical practitioners on individual hospitalizations:Fixed-effects models