WU Vienna University of Economics and Business

Health Economics and Policy Group

Master's Thesis

Regional Variation of Health Care Expenditures in Austria

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Abstract

Over the last decades, the notion of widespread differences in health care expenditures across regions has been firmly established and critically reviewed in the literature in terms of their causes and consequences. In Austria, too, health care expenditures show clear regional disparities. In 2016, there was regional variation in health care expenditures at the district level which ranged from 50% below to 30% above the average of 1,844.15€ per inhabitant. When looking at the factors associated with the level of health care expenditures per inhabitant, patient characteristics, especially demographic and socioeconomic factors, can explain some of the regional disparities within the expenditures of the Austrian health care system. This is in line with the theory which states that in universal and publicly financed health care systems, such as the Austrian, regional disparities will arise through the demand side. The analyses also find a positive relationship between health care expenditures of different health care sectors and specialities, namely between expenditures of the inpatient and the outpatient sector. The results have implications for evidence-based health policies regarding inequalities as a good health care system should deliver quality health services to all people when and where they need them.

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LIST OF ABBREVIATIONS

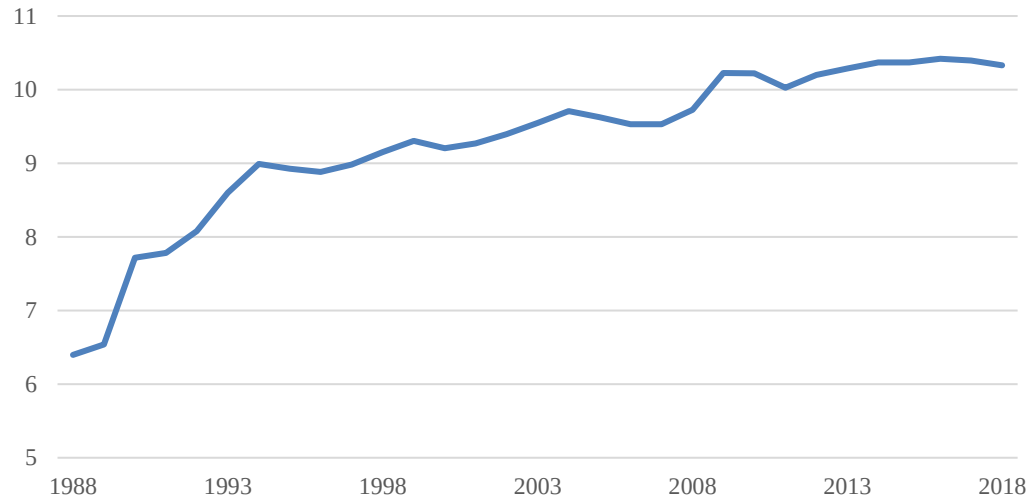
AIC	Akaike information criterion
BIC	Bayesian information criterion
BMSGPK	*Bundesministerium für Soziales, Gesundheit, Pflege und Konsumentenschutz,* Federal Ministry of Social Affairs, Health, Care and Consumer Protection
COPD	chronic obstructive pulmonary diseases
CoV	coefficient of variation
CT	computer tomography
DRG	diagnosis-related groups
DVSV	*Dachverband der österreichischen Sozialversicherungsträger*, Main Association of Austrian Social Security Institutions
e.g.	*exempli gratia,* for example
EU	European Union
GDP	gross domestic product
ger.	German
GP	general practitioner
HRR	hospital referral regions
ibid.	*ibidem*, in the same place
i.a.	*inter altri*, among others
i.e.	*id est*, that is
LDF	*leistungsorientierte Diagnosefallgruppen,* procedure-oriented diagnosis-related case groups
OECD	Organisation for Economic Co-operation and Development
OLS	ordinary least squares
ÖÄK	*Österreichische Ärztekammer,* Austrian Medical Chamber
SD	standard deviation
SUR	seemingly unrelated regression
US	United States of America
VIF	variance inflator factor
WHO	World Health Organisation
€	Euro
%	per cent

1 INTRODUCTION

"A good health [care] system delivers quality services to all people when and where they need them." (WHO, 2020)

The Austrian health care system is deemed to be one of the best in the world and access to medical services can be considered exemplary in international terms. As such, Austria's residents report the lowest level of unmet needs for medical care across the European Union (EU) and virtually the whole population is covered by social health insurance while enjoying a broad benefit basket (Bachner et al., 2018). This, however, goes hand in hand with relatively high health expenditures which are also steadily increasing: Over the last three decades, health expenditures as share of the gross domestic product (GDP) in Austria have risen from 6.40% in 1988 to 10.33% in 2018 (see Figure 1) (OECD, 2020).

Figure 1: Health expenditures as share of GDP (in %), Austria, 1988-2018



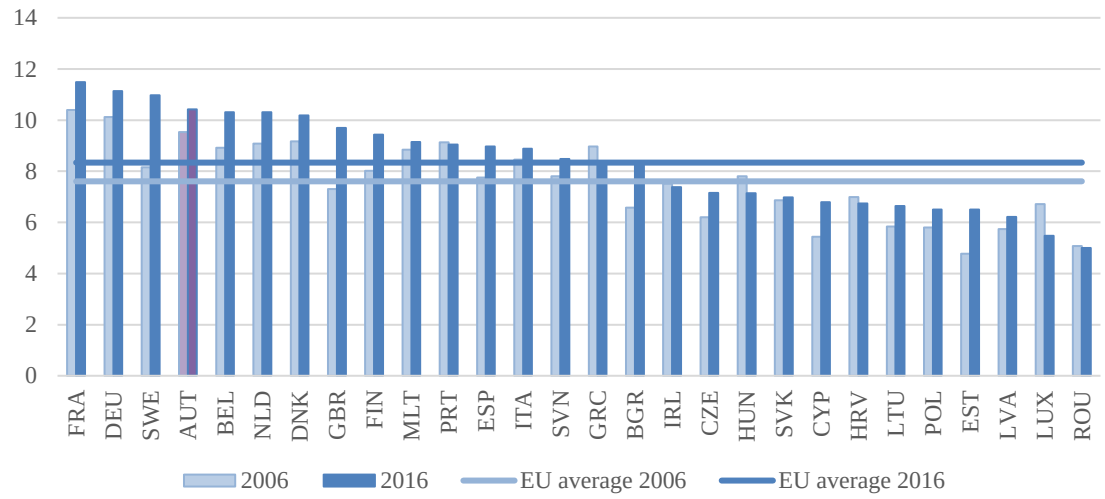
Data source: OECD (2020)

This phenomenon can also be observed for other countries of the European Union in recent years. As shown in Figure 2, health expenditures as share of GDP have increased in almost all EU countries from 2006 to 2016 (OECD, 2020).[1] However, there are also some exceptions where expenditures have decreased, namely countries affected most by the austerity policies following the European debt crisis as well as Eastern European countries. Compared to the EU average, health expenditures as share of GDP in Austria

[1] This time period was chosen in order to account for effects of the financial crisis of 2008/09 as well as the fact that health expenditures of the year 2016 will be the focus of this thesis.

(9.5% in 2006 and 10.4% in 2016) have been well above the average of 7.6% in 2006 and 8.4% in 2016 (OECD, 2020).

Figure 2: Health expenditures as share of GDP (in %), EU countries, 2006 and 2016



Data source: OECD (2020)

The fact that health expenditures as a share of GDP have been increasing over recent years is an important observation since they have also been growing faster than the gross domestic product itself. Between 2006 and 2016, health expenditures in EU countries have, on average, increased by 1.68% while the average growth rate of GDP was 1.11% (The World Bank, 2020). For Austria, this finding also holds as the average growth rate of current health expenditures was at 1.98% while that of GDP was at 1.28% (ibid.).

From a health economic perspective, these circumstances raise questions about the efficiency and the efficacy of a health care system. In general, rising expenditures could either increase the quality of health services as more resources are devoted to health or they could reduce the quality and the amount of medical services provided due to initial budget restrictions. In publicly financed systems, however, the latter argument seems to prevail which is why disproportionally increasing health expenditures can thus conflict with their aim to offer all insured the same (high) level of services, regardless of when and where they need them. Rising health expenditures are therefore also associated with a number of (in-)equality aspects as neither demographic, socioeconomic and social factors nor the place of residence of the insured should influence the quality, provision and utilisation of health care services. Within this framework, regional disparities play

an important role as the presence of such regional variation in health care expenditures warrant specific health policies which can support a needs-based and equal care for all insured. Research shows that regional variation in health care expenditures can be due to supply-driven or demand-side factors with the latter being predominant in universal and publicly funded health care systems (e.g. de Vries et al., 2018; Lavergne et al., 2016; Skinner, 2012).

From a health policy perspective, disproportionally increasing health expenditures also constitute a challenge if medical services are not provided on the basis of medical need. One way to establish whether the provision of services is needs-based is to look at the relationship between different health care sectors and the associated expenditures as a higher medical need will lead to higher health expenditures in all care sectors in a publicly-funded health care system.

The aim of this thesis is therefore twofold: First, it will be established whether there is regional variation in health care expenditures in Austria. If so, the determinants of health expenditures will also be studied. Second, it will be examined whether there is a relationship between health care expenditures of different health care sectors and specialities such that their levels influence each other. If so, it will also be studied whether the determinants of health expenditures in different care sectors and specialities differ from each other. These analyses will be carried out for claims data of selected social health insurance funds for the year 2016.

The ensuing hypotheses are that there is regional variation in health care expenditures in Austria which can be associated with heterogeneity in patient characteristics. Regional disparities will therefore be related to demand-side factors as the Austrian health care system is publicly funded. Furthermore, it is expected that there is a relationship between health expenditures of different health care sectors and specialities as higher medical needs will lead to higher expenditures in all care sectors.

The following thesis is structured thusly: Section 2 provides an overview of the literature concerning the determinants of health care expenditures as well as the relationship between expenditures of different health care sectors while section 3 reviews the Austrian health care system. Section 4 introduces the data basis and the variables used in the analysis as well as discusses the applied research methodologies. Section 5 then describes the results while sections 6 and 7 discuss and conclude.

2 THEORETICAL BACKGROUND

Over the last decades, the notion of widespread differences in health care expenditures across regions has been firmly established and critically reviewed in the literature. Most of the existing research comes from the United States (US) and centres around the seminal paper of Wennberg and Gittelsohn (1973) as well as follow-up studies of the Medicare[2] population (i.a. Corallo et al., 2014; Cutler et al., 2019; Fisher et al., 2003a, 2003b, 2004; Paul-Shaheen et al., 1987; Wennberg, 2002; Wennberg et al., 2002). Recently, however, the analysis of marked variations in the health care systems has also been carried out in other countries, including Canada (Lavergne et al., 2016), Germany (e.g. Göpffarth, Kopetsch, & Schmitz, 2016), Italy (Giannoni & Hitiris, 2002), the Netherlands (de Vries et al., 2018), Spain (Prieto & Lago-Peñas, 2012) and Switzerland (Reich, Weins, Schusterschitz, & Thöni, 2012). Due to the different structure and the size of the welfare state of the respective health care systems, US-based results regarding the causes and consequences of regional variations cannot be directly applied to the Austrian case, despite offering possible explanatory approaches, while those from the other aforementioned OECD countries are more suited to do so. For Austria, there exists only very little empirical evidence regarding small area variations in health care spending so far. One recently published study (Hofmarcher & Molnárová, 2018) however states that there are striking differences in health care spending as well as health status between the nine Austrian provinces even though this is not examined in more detail.

Given the steady increase in health care expenditures over recent years, researchers have also looked into the relationship between health expenditures of different health care sectors and specialities (e.g. Adhikari, 2012; Atella and Deb, 2008; Büyükdurmus et al., 2017; Fortney et al., 2005; Kopetsch, 2007). This relationship can either be positive, negative or non-existent and may imply necessary structural reforms of the health care system (Fortney et al., 2005). For Austria, there is no empirical evidence of the interdependence between health expenditures of different care sectors so far.

The following literature survey therefore discusses the theoretical causes of regional variation (section 2.1) as well as providing empirical evidence of regional disparities in

[2] Medicare is a federal government program in the US which provides health care coverage (health insurance) for people over the age of 65 as well as for younger people with end-stage renal diseases and those receiving disability benefits. Benefits include inpatient as well as outpatient (medical) coverage with optional prescription drug coverage. (Medicare Interactive, 2019)

health expenditures (section 2.1). Finally, a quick overview of the relationship between the health expenditures of different health care sectors and specialities is given (section 2.3).

2.1 Theoretical causes of regional variation: determinants of health care expenditure

Economic theory suggests that there are two potential causes of regional variations in health care: demand-side and supply-driven factors. Demand-side factors reflect medical need and patient preferences for care as well as access barriers to health care (Skinner, 2012). This also includes patient heterogeneity between regions in terms of income, age, gender, education, health status and the prevalence of (chronic) diseases and multimorbidities (de Vries et al., 2018; Skinner, 2012). Hence if there is heterogeneity on the demand side because patients are sicker, prefer specific treatments or do not have access to specific medical services, regions will also vary with respect to health care expenditures. Crucial within this perspective is the so-called social gradient which describes the phenomenon whereby people who are less advantaged in terms of their socioeconomic position have worse health outcomes than those who are more advantaged and are thus also in need for more health care, causing higher expenditures (Donkin, 2014). Studies have therefore examined how strongly socioeconomic inequalities influence health outcomes such as life expectancy and, as a consequence, health care expenditures of people living in different regions (Kibele, Klüsener, & Scholz, 2016; Sundmacher, Kimmerle, Latzitis, & Busse, 2011). In the United States, for instance, geographic disparities in life expectancy are large and amounted to as much as 20 years in 2014 (Dwyer-Lindgren et al., 2017). The fact that 74% of this variation can be explained by a combination of socioeconomic (e.g. income, educational attainment or occupation) and race/ethnicity factors, behavioural and metabolic risk factors (e.g. prevalence of diabetes mellitus, hypertension or obesity) as well as health care factors points to the importance of non-medical determinants as predictors of mortality and therefore also the level of health expenditures (Dwyer-Lindgren et al., 2017; Lavergne et al., 2016). This branch of research is hence closely related to the analysis of health inequalities, i.e. avoidable differences in health between groups of people within and between countries and their societies, but with a spatial component (World Health Organization, 2019).

On the supply side, factors such as provider financial incentives, capacity constraints, physician beliefs and practice norms play an important role (Skinner, 2012). One feature within this context is the so-called supplier-induced demand where a health care provider shifts a patient's demand curve beyond the level of care that the fully informed patient would otherwise want, i.e. doctors and hospitals create their own demand by carrying out too many medically unnecessary treatments in order to maximize their profits (Cutler et al., 2019; J. E. Wennberg, Barnes, & Zubkoff, 1982). If the variation in supply-side factors is spatially correlated, for example if physicians with more intensive treatment styles hire other physicians with similar beliefs and practice norms, the resulting regional differences on the provider side could explain regional variations in health care expenditure (Cutler et al., 2019).

Apart from that, system factors such as (insurance) regulation, price setting or payment, and, in publicly-funded systems, the general economic conditions also influence the dynamics of demand and supply (de Vries et al., 2018; Eibich & Ziebarth, 2015). While demand factors are generally considered justifiable causes of variation in health care spending, regional variation as a result of supply factors is deemed to be undesirable as regional variation in health care spending not caused by differences in medical need is said to indicate inefficiency (de Vries et al., 2018). The latter especially holds if higher health care expenditures are not associated with better health outcomes (Baicker & Chandra, 2004; Corallo et al., 2014; Fisher et al., 2003a, 2003b; Lavergne et al., 2016; Sirovich, Gottlieb, Welch, & Fisher, 2006; J. Wennberg & Gittelsohn, 1973).

Econometric models try to parse out whether demand, supply or other factors are the most important determinants in explaining regional variations in health care expenditure; the results differ depending on which countries are examined. However, caution should be exercised when interpreting the corresponding results as one very common problem within these analyses concerns the issue of reverse causality between health expenditures and health outcomes (Göpffarth et al., 2016; Skinner, 2012). In general, reverse causality refers to a direction of cause-and-effect contrary to a common presumption, i.e. if two variables X and Y are associated, it might be the case that Y is causing changes in X instead of the other, expected, way around (Woolridge, 2014). Applying this conjuncture to health expenditures and health outcomes, causality can therefore work in both directions: A high poor health outcome can either be the result of

high expenditures if their level is demand-side driven ("higher needs lead to poor outcomes and higher expenditures") or of low expenditures if the needs of patients are not met ("undetected needs lead to poor outcomes and lower expenditures as patients are not treated"). The interpretation of the results thus depends on the specific health care system and yields rather associative than causal conclusions (see section 6).

2.2 Empirical evidence of regional variation in health care expenditure

For decades, researchers have documented marked variation in health care spending across and within regions all over the world (i.a. Fisher et al., 2003a, 2003b; Göpffarth et al., 2016; Lavergne et al., 2016; Reich et al., 2012; Skinner, 2012; Wennberg and Gittelsohn, 1973; Zhang et al., 2012).

For the United States, research has shown that Medicare spending varies more than two-fold across hospital referral regions[3] (HRRs) as well as from state to state and from one hospital to another (The Dartmouth Institute for Health Policy & Clinical Practice, 2019). In 2016, price-adjusted Medicare reimbursements among the 306 HRRs in the US varied from about $7,400 per enrollee in the lowest spending region to more than $13,000 in the highest spending region (ibid.). Most of this variation is due to supply-side factors, especially physician organizational factors and physician beliefs about treatment (Cutler et al., 2019). In this context, there is also a profound body of empirical evidence documenting that these marked variations in health care expenditures are the result of inefficiencies as regions with higher spending and service use do not automatically display better health outcomes (Baicker & Chandra, 2004; Corallo et al., 2014; Fisher et al., 2003a, 2003b; Lavergne et al., 2016; Sirovich et al., 2006; J. Wennberg & Gittelsohn, 1973). Studies in line with this argumentation find that more than 50% of the variation in Medicare spending across regions cannot be explained, thus indicating inefficiencies (Fisher et al., 2003a, 2003b; Göpffarth, 2011; Institute of Medicine (IOM), 2013; Skinner, 2012). Over the recent years, however, this view has been critically reviewed (e.g. Sheiner, 2014; Song et al., 2010; Zuckerman et al., 2010). The main criticism relates to the fact that this conclusion is very often based on a correlation ra-

[3] Hospital referral regions (HRRs) represent regional health care markets for tertiary medical care that generally require a major referral centre, i.e. a hospital where patients are referred to for major cardiovascular surgical procedures and for neurosurgery. (The Dartmouth Institute for Health Policy & Clinical Practice, 2019; Zhang, Baik, Fendrick, & Baicker, 2012)

ther than a causal relationship (Eibich & Ziebarth, 2014; McWilliams et al., 2014). This opinion has been supported by Sheiner (2014) who claims that the relationship between spending and outcomes is not the result of inefficiencies but rather of omitted variables on the demand side which biases the conclusion.

The results for other OECD countries contrast quite strongly with studies from the US as there is only weak evidence for inefficiencies as a cause for regional variation even though there are pronounced regional disparities within the respective health care systems (Göpffarth et al., 2016). This might relate to the fact that many of these health care systems differ quite substantially from the US as prices, insurance coverage and the degree of cost sharing are invariant across the region, the legal context for medical practice is constant as well and results represent the entire population, including all age groups, fully insured (Lavergne et al., 2016). Therefore, many of the mechanisms driving regional variation observed in the United States are not relevant for other OECD countries, thus leading to very different results (Lavergne et al., 2016; Manning, Norton, & Wilk, 2012). The findings for these countries hence indicate that regional variation in health care expenditures is largely explained by demand-side factors, especially patient characteristics (de Vries et al., 2018; Eibich & Ziebarth, 2014; Giannoni & Hitiris, 2002; Göpffarth et al., 2016; Lavergne et al., 2016). In Canada, for example, unadjusted spending in the most expensive health region was 50% higher than in the least expensive (Lavergne et al., 2016). However, after adjustment for patient characteristics, including age, sex, recorded diagnoses and the residence of patients, only very little unexplained variation among health regions remains (ibid.). For Germany (Eibich & Ziebarth, 2014, 2015; Göpffarth, 2011, 2013, 2015; Göpffarth et al., 2016; Nolting, 2018), the Netherlands (de Vries et al., 2018) and Italy (Giannoni & Hitiris, 2002) similar conclusions can be made. This result is consistent with the conjuncture that in countries with centrally-provided and publicly-funded health care, a person's demand for care is not limited by supply factors such as price, private budgetary considerations or the ability to pay which is why regional variations should arise through differences on the demand-side (Pauly, 1986).

2.3 Relationship between health expenditures of different health care sectors and specialities

Generally speaking, different health care sectors or specialities and their corresponding health expenditures can either have a positive, a negative or no relationship at all. If sectors or specialities are positively related, health services and their expenditures are called complements as they are mutually dependent on each other. As such complementary health services are those that tend to be delivered or consumed together and therefore rise expenditures in all involved health care sectors (Fortney et al., 2005). A positive relationship between health expenditures of different sectors or specialities therefore implies, among other things, that patient characteristics and especially medical needs are important determinants of health care expenditures[4]. Substitutes, by contrast, are those health services and corresponding expenditures which exhibit a negative relationship between them and can be delivered or consumed instead of each other which rises expenditures in one health sector and decreases them in another.

The existing literature on interdependences between health expenditures of different health care sectors or specialities is not very extensive and does not provide a clear picture of the relationship between care sectors. The latter could be due to the fact that in many countries the health care system is structured in a way that access to medical services is restricted by law which is enforced through a so-called Gatekeeper model (Büyükdurmus et al., 2017). In these models, the general practitioner (GP) has the task of piloting patients through the health care system, thereby authorising treatment by specialists in the outpatient sector or referring them to the inpatient sector (ibid.). This system therefore warrants a purely complementary relationship between different health care sectors and specialities as secondary care (specialists, inpatient services) can, in most cases, only be consumed after using primary care at the GP thus increasing health expenditures in all involved care sectors (ibid.). In health care systems where there is no such model in place, however, there is clear heterogeneity in the interdependences between different sectors. As such, the direction of the relationship strongly depends on

[4] There are also other possible mechanisms which warrant a positive relationship between health expenditures of different care sectors and specialities. These include regional clustering due to similar physician beliefs or spill-over effects in practice styles, e.g. if doctors work both in the in- and the outpatient sector. In both cases, health expenditures of different providers and sectors may develop in the same direction. However, these mechanisms are rather more relevant in non-public health care systems which is why they are not considered further in this analysis of a publicly funded system.

the medical speciality as well as on the specific setting and methods of the respective study in a way that some find a complementary relationship while others find a substitutive one for the same specific situation (Büyükdurmus et al., 2017).

Studies have been carried out, among others, for Germany (Büyükdurmus et al., 2017; Kopetsch, 2007), Italy (Atella & Deb, 2008) or the United States (i.a. Fortney et al., 2005) and, as mentioned before, report contradictory findings. However, they all establish a relationship between health expenditures of different sectors or specialities.

Best reviewed in the literature is the relationship between inpatient, outpatient and/or primary care services and their corresponding health expenditures (e.g. Adhikari, 2012; Atella and Deb, 2008; Büyükdurmus et al., 2017; Fortney et al., 2005; Kopetsch, 2007). Theory suggests that there are a number of possible mechanisms by which outpatient or primary care services can be a complement or substitute with inpatient services. Mechanisms for complementation are the utilisation of services that are truly supplemental or ancillary to each other (e.g. diagnostic laboratory tests), the detection of illnesses that cannot appropriately be treated in one health care sector, such as cancer, and the identification of acute episodes which require further treatment in another speciality or care sector like angina pectoris (Fortney et al., 2005). Substitution mechanisms, on the other hand, are the prevention, early detection or delay of illnesses in one health care sector which may avert treatment in another speciality or sector (Donaldson, Yordy, Lohr, & Vanselow, 1996; Starfield, 1994). However, there is also the possibility that substitution effects arise due to structural inefficiencies of health care system which lead patients to consume medical services not based on their medical need but rather due to misinformation ("use of the 'wrong' health care provider") or the distance to the nearest health care provider (Fortney et al., 2005; Göpffarth et al., 2016).

As mentioned above, there exists only limited evidence on small area regional variation of health care expenditures in Austria. This thesis therefore contributes to the literature in providing a first overview of eventual regional variations in health expenditures as well as in establishing potential determinants of these expenditures. In addition, it also adds in ascertaining an interdependence between health expenditures of different sectors or specialities as no such detailed examination has been carried out for Austria so far.

3 INSTITUTIONAL BACKGROUND[5]

As evidence suggests (see section 2.1), the institutional background plays an important role for the causes of regional variation in health care expenditures. Therefore, the Austrian health care system and its structure will be shortly reviewed in the following.

The Austrian health care system is based on the principles of solidarity, affordability and universality, with the most important guideline being that access to high-quality health care is provided equally to everyone in need regardless of the person's age, gender, origin, social status and income. It can thus be categorized as an universal health care system with health care expenditures as a share of GDP amounting to 10.3% in 2018, which is considerably higher than the EU average of 8.3% (OECD, 2020). More than 75% of total health care expenditure is financed from public sources, about 18% is made out-of-pocket by the patients and the rest is financed via voluntary private health insurance which plays only a minor role in the system. In total, public health expenditures constitute 16% of government expenses which are financed by a mix of general tax revenues (40%) and compulsory social health insurance contributions (60%) (OECD, 2019).

Health care is based on a social insurance model founded on compulsory insurance so that 99.9% of the population in Austria are covered. All of the insured people have a legal right to services, which are financed via contributions on the basis of solidarity, and they enjoy a broad benefit basket as well as good access to health care. The level of contributions in the social insurance system is independent of the individual health risk of the insured and is rather an income-related amount. For the majority of those covered by health insurance, the contribution is 7.65% of their gross wage, up to a maximum level of gross income of 5,130€ in 2018. In total, contributions are paid in almost equal parts by the employer and the employee. At the moment, there are five social insurance funds[6] which are responsible for health, pension and accident insurance; enrolment in one of the funds takes place according to the occupational status as well as the place where people live or work. Even though health insurance is thus generally linked to employment, coverage is extended to co-insured persons, such as spouses and depend-

[5] If not stated otherwise, this section is based on Bachner et al., (2018) and Federal Ministry for Labour, Social Affairs, Health and Consumer Protection (2019).

[6] Up to January 1st 2020, there were 21 social insurance funds – 19 of which were social health insurance funds - which were reduced to five during the latest structural reform.

ents, pensioners, students, people with disabilities and those receiving unemployment benefits.

There are a large range of health care services available to the population and as such, Austria's residents report the lowest level of unmet needs for medical care across Europe (OECD/EU, 2018). Provision of health services in Austria is characterized by relatively unrestricted access to all levels of care including general practitioners (GPs), specialists and hospitals, i.e. there is a free choice of doctors and no Gatekeeper model in place. This implies that, apart from a few exemptions (e.g. CT examination), there is no obligation to obtain the consent of the health insurance institution before using the services of contracted doctors, outpatient clinics and general practitioners. In the outpatient sector, patients also have the choice between contracted physicians (45%) and those without contract (55%), for using the latter one exists the possibility of partial reimbursement from the social health insurance funds. The Austrian health care system has, however, a strong focus on inpatient care which becomes visible by a high hospital utilisation given by, for example, the hospital bed density for which Austria shows the second highest number compared to other EU countries (OECD/EU, 2018).

In terms of organisation and governance, the Austrian health care system is quite complex and fragmented: Not only are the responsibilities shared between the federal and the regional (*Bundesländer*) level, but some of them are also delegated to self-governing bodies such as social insurance and professional bodies of health service providers. This in turn leads to a mixed health care financing between the state (federal and regional level) and the social health insurance funds who contribute to different parts of the budget. Several reform attempts over the recent years have aimed at improving cooperation and coordination in the health care system, but some crucial challenges still remain.

4 DATA AND METHODOLOGICAL APPROACH

In the following, the database (section 4.1) and the methodological approach (section 4.2) used for the analysis of the regional variation of health care expenditures in Austria as well as for the examination of the relationship between health expenditures of different health care sectors and specialities is described in detail.

4.1 Data

The empirical analysis of this thesis is performed for the year 2016 and expands on data from four different sources: Firstly, and most importantly, it uses claims data from the Main Association of Austrian Social Security Institutions (ger. *Dachverband der österreichischen Sozialversicherungsträger, DVSV*) for the key variable "health care expenditures". Secondly, it draws upon administrative data from the Federal Ministry of Social Affairs, Health, Care and Consumer Protection (ger. *Bundesministerium für Soziales, Gesundheit, Pflege und Konsumentenschutz, BMSGPK*), the Austrian statistical bureau (ger. *Statistik Austria*) and the Austrian Medical Chamber (ger. *Österreichische Ärztekammer, ÖÄK*) for the covariates of the empirical analysis. All datasets are merged at district level which is also the unit of observation. As of 2020, there were 116 districts in Austria which is therefore the maximum number of observations in the sample.

In order to ensure comparability at district level, the statistical examination of health care expenditures is carried out per inhabitant according to the so-called residence principle. This means that the indicators are evaluated by source, i.e. on the basis of the residence of the beneficiaries and not on the location of the service providers. All health care expenditures are district-level average values, for nationwide representations, the size of the districts is also taken into account in order to avoid demographically induced distortions.

4.1.1 Health care expenditures

The analysis of the regional variation of health care expenditures as well as the examination of the relationship between health care expenditures of different health care sectors takes both the inpatient as well as the outpatient sector into account.

For the inpatient sector, health care expenditures are calculated by drawing on the diagnosis-related groups (DRG) system which is a nationwide uniform model for the billing

of inpatient hospital stays. As such, inpatient hospital stays are grouped into procedure-oriented diagnosis-related case flat rates (LDFs) on the basis of the data collected in hospitals (Hagenbichler, 2010). For the analysis, the sum of LDFs in each district are provided by the Main Association of Austrian Social Security Institutions and expenditures for the inpatient sector were calculated retrospectively using a point value[7] which reflects the public health care expenditures.

For the outpatient sector, claims data from the Main Association of Austrian Social Security Institutions are used to examine health care expenditures. In doing so, the monetarily quantified value of all medical and similar services which is billed with and paid out by the social health insurance funds are considered. The figures are aggregated at the district level and the study cohort includes health services provided to patients of the 13 biggest social health insurance funds in the year 2016[8]. Health care expenditures in the outpatient sector include expenditures for medical services (general practitioners, specialists, other health care providers and dentists), medicines, aids and appliances (ger. *Heilbehelfe und Hilfsmittel*) as well as for transport. Specialists include doctors of all specialties except general and dental medicine, other health care providers encompass health professionals such as therapists or rehabilitation facilities.

The analysis of the regional variation of health care expenditures draws upon the variable "total expenditure" which consists of expenditures in the inpatient and outpatient sectors. For the examination of the relationship between health care expenditures of different care sectors, however, health care expenditures of the different sectors (inpatient and outpatient sector) and specialities (general practitioners and specialists) were evaluated separately. Table 1 presents descriptive statistics of the health care expenditures in the sample. Note that the various sectors and specialities cannot be summed up as the data query considers every patient only once, e.g. in order to be taken into account for the variable “total expenditure”, one has to take up services in either the inpa-

[7] In general, the point value describes inpatient expenditures, while the implicit value adjusts these expenditures for private expenditures and therefore reflects the real public expenditures. This implicit point value was provided by the Institute for Advanced Studies (IHS). In 2016, the implicit point value was 1.34, i.e. one LDF corresponded to 1.34€.

[8] As of 2016, there were 19 social health insurance funds, the 13 included in the analysis are the nine regional health insurance funds (ger. *Gebietskrankenkassen, GKK*), the public servants social insurance fund (ger. *Versicherungsanstalt öffentlich Bediensteter, BVA*), the social insurance fund for commerce and industry (ger. *Sozialversicherung der gewerblichen Wirtschaft, SVA*) as well as for farmers (ger. *Sozialversicherungsanstalt der Bauern, SVB*) and the railways social insurance fund (ger. *Versicherungsanstalt für Eisenbahnen und Bergbau, VAEB*).

tient or the outpatient sector or in both. However, if a patient is included in the variable "total expenditures", this does not imply that he/she will also be included in the other expenditure variables as here it does depend on the specific sector of utilisation. It is for this reason that the variables "inpatient sector" and "outpatient sector" cannot be summed up to the variable "total expenditures" even though they contain, in theory, the same information. The same applies to the variable "outpatient sector" or the variables "general practitioners" and "specialists", respectively.

Table 1: Descriptive statistics of health care expenditures

	obs.	average expenditure/ inhabitant	SD	minimum	maximum
Total expenditures	115	1,844.15€	184.61€	925.56€	2,245.58€
Inpatient sector	115	951.45€	126.44€	441.84€	1,347.91€
Outpatient sector	115	889.56€	114.75€	394.09€	1,114.16€
General practitioners	115	121.80€	21.78€	66.58€	173.04€
Specialists	115	195.25€	37.78€	93.84€	275.38€

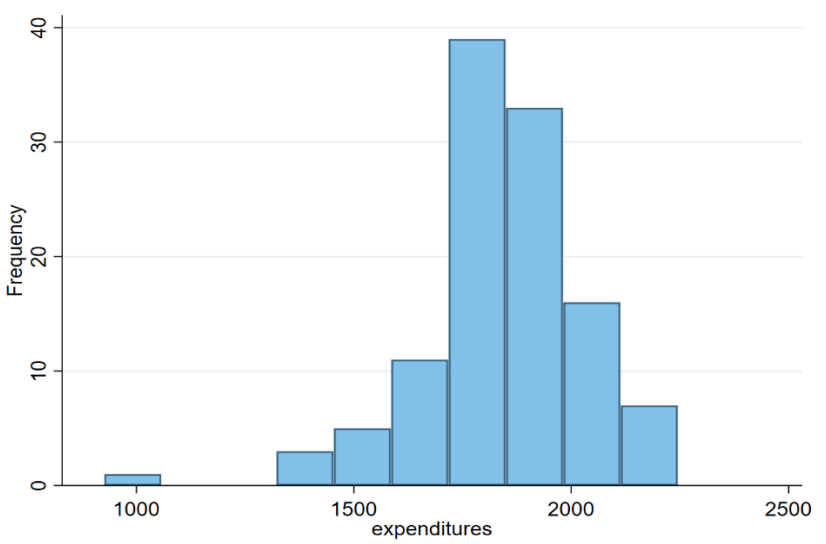
Note: obs.= observations, SD= standard deviation

Data source: Main Association of Austrian Social Security Institutions

In 2016, total health care expenditures reached a total of 16,044,930,265.54€ and there were 8,700,471 Austrian inhabitants. The average total expenditure per district amounted to 1,844.15€ per inhabitant whereby it ranged from 925.56€ to 2,245.58€ (see Table 1). This distribution can also be seen in Figure 3 which displays the district-level frequency of average total expenditures per inhabitant by means of a histogram as well as in Figure 4 which shows a boxplot of average total expenditures per inhabitant at the district level.[9]

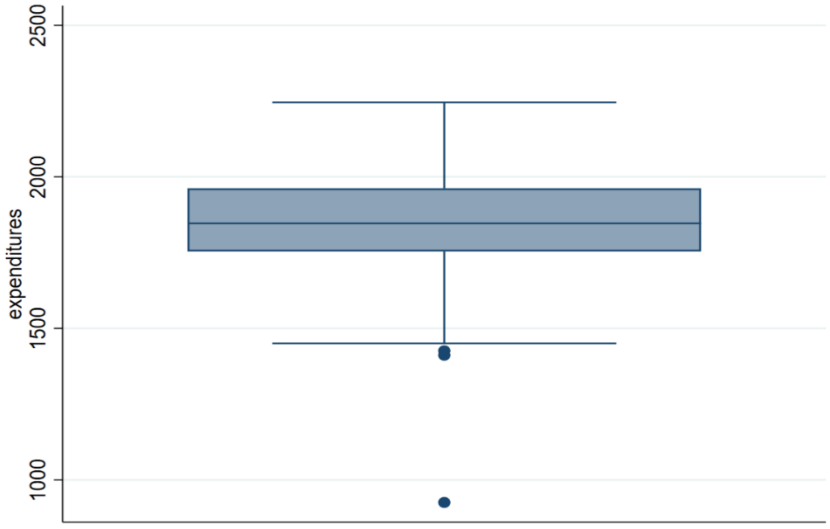
[9] The histograms and boxplots of the other variables (inpatient sector, outpatient sector, GPs and specialists) can be found in the appendix.

Figure 3: Histogram of district-level total expenditures per inhabitant in €



Data source: Main Association of Austrian Social Security Institutions

Figure 4: Boxplot of district-level total expenditures per inhabitant in €



Data source: Main Association of Austrian Social Security Institutions

As can be seen from both figures above, there is one main outlier within the sample, i.e. there is one district where average total expenditures per inhabitant were a lot lower compared to the other districts in 2016. However, due to the fact that it cannot be ascertained whether this is due to a systematic error in the data or due to other reasons, the outlier was not removed from the sample.

Table 1 also indicates that, compared with the outpatient sector, health care expenditures at the district level in the inpatient sector were slightly higher and averaged 951.45€ per inhabitant in 2016 while those in the outpatient sector reached 889.56€. Looking solely at general practitioners and specialists in the outpatient sector, it be-

comes apparent that district-level average health care expenditures were accordingly lower and amounted to 121.80€ per inhabitant for GPs and 195.25€ per inhabitant for specialists in 2016.

4.1.2 Covariates

The analysis also draws upon further variables which are likely to be determinants of health care expenditures in Austria and which are therefore also used in the empirical analysis. In line with the theory (see for example Göpffarth et al., 2016), these covariates include supply-side as well as demand-side factors. As such, information about the supply of physicians for the supply side and data on selected health outcomes as well as socioeconomic and demographic variables are considered for the demand side.

Information about the supply of physicians is made available by the Austrian Medical Chamber and consists of the density of physicians per 1,000 inhabitants. Thereby, both the inpatient and the outpatient sector as well as all specialities, with the exception of dental medicine, are considered.

Data on selected health outcomes is provided by the Federal Ministry of Social Affairs, Health, Care and Consumer Protection as well as the Austrian statistical bureau. The health outcomes are selected on the basis of their significance for the morbidity and mortality burden in Austria so that both chronic diseases and the two most frequent causes of death - cardiovascular diseases and cancer - are taken into account (Statistik Austria, 2020). As a result, the number of deaths due to cardiovascular diseases and malignant neoplasms (cancer) on the one hand and the number of hospital stays with the main diagnoses "diabetes" and “chronic obstructive pulmonary diseases (COPD)” as approximate values for chronic diseases on the other hand are considered. All health outcomes are extrapolated to 1,000 inhabitants.

Socioeconomic and demographic variables are supplied by the Austrian statistical bureau and include general life expectancy, age and gender distribution, education level and net annual income of the population as well as the unemployment rate in the district. For the age distribution, the respective shares of six different age groups (0-14, 15-29, 30-44, 45-59, 60-74, 75+) were used, for the gender distribution the shares of women and men respectively. The level of education is approximated by the share of persons with only compulsory schooling; a district average is used for the net annual income.

The descriptive analysis of the covariates, depicted in Table 2, yields the following results: In 2016, the average density of physicians was 7.25 doctors per 1,000 inhabitants. On the demand side, the average mortality for cardiovascular diseases was 4.06 persons per 1,000 inhabitants while the one for cancer was lower with 2.41 persons. The average morbidity of the population, which is being approximated by the number of hospital stays with the most prominent chronic diseases being the main diagnoses, was 2.19 persons per 1,000 inhabitants for diabetes and 2.37 persons for COPD. Looking at demographic and socioeconomic variables, it becomes apparent that, in 2016, on average, the life expectancy was 81.61 years, there were slightly more women than men (50.85% vs. 49.15%), the biggest age group consisted of people aged 45 to 59 years, 9.12% of the population finished compulsory schooling only, the annual net income was 22,404.11€ and the unemployment rate was 7.12%. A more detailed summary of the descriptive statistics of the covariates can be found in Table 2 below[10].

[10] Note that the means presented in Table 2 refer to unweighted average values, i.e., contrary to the health care expenditures, the size of the individual districts is not accounted for.

Table 2: Descriptive statistics of covariates

	obs.	mean	SD	minimum	maximum
Supply-side factors					
Physicians: density	116	7.25 pp	8.88 pp	1.35 pp	72.98 pp*
Demand-side factors					
Mortality: cardiovascular diseases	116	4.06 pp	1.44 pp	1.90 pp	11.66 pp
Mortality: cancer	116	2.41 pp	0.85 pp	1.09 pp	8.60 pp
Morbidity: diabetes	115	2.19 pp	0.92 pp	0.93 pp	7.16 pp
Morbidity: COPD	116	2.37 pp	0.93 pp	0.91 pp	6.51 pp
Life expectancy	116	81.61 years	1.04 years	77.69 years	83.64 years
Sex: male	116	49.15%	0.80%	46.31%	50.73%
Sex: female	116	50.85%	0.80%	49.27%	53.69%
Age: 0-14	116	14.06%	1.42%	9.98%	16.57%
Age: 15-29	116	18.17%	2.49%	13.50%	26.77%
Age: 30-44	116	19.91%	1.93%	16.78%	26.18%
Age: 45-59	116	23.20%	1.61%	18.40%	26.42%
Age: 60-74	116	15.42%	1.56%	12.46%	20.59%
Age: 75+	116	9.25%	1.75%	5.64%	14.02%
Education: compulsory schooling	116	9.12%	3.11%	2.83%	19.88%
Net income	116	22,404.11€	2,330.45€	17,528€	34,748€
Unemployment rate	116	7.21%	3.48%	2.15%	18.00%

Note: obs.= observations, SD= standard deviation, pp= persons (physicians) per 1,000 inhabitants

* In this case. the maximum density of physicians per 1,000 inhabitants can be considered as an outlier as the corresponding district is the one where Austria's biggest hospital, the Vienna General Hospital (ger. *Allgemeines Krankenhaus Wien, AKH*), is located. However, it is still included in the analysis in order to get the whole picture.

Data source: DVSV, BMSGPK, ÖÄK and Statistik Austria

4.2 Methodological approach

The empirical analysis is divided into two parts: While part one focuses on the regional variation of total health care expenditures in Austria, part two emphasises the relationship between health expenditures in different health care sectors and specialities as well as their determinants. Each part uses a different methodological approach which is described in detail in the following.

4.2.1 Regional variation of health care expenditures

The statistical examination in part one is carried out using a two-step approach. At first, the data is thoroughly descriptively analysed in order to establish whether there is regional variation in total health care expenditures in Austria at all. This is done, on the one hand, by looking at the deviation from the mean and, on the other hand, by calculating the coefficient of variation. The deviation from the mean is presented in percentages

per district while the coefficient of variation (CoV) is calculated as ratio of the standard deviation and the mean (Woolridge, 2014). As a result, it can be shown that there is regional variation at the district level if the deviation from the mean is unequal to zero and if the CoV is greater than zero.

Granted that the analysis in the first step reveals that there is regional variation in total health care expenditures in Austria, the determinants of these heath care expenditures will be examined in more detail as a second step. To explore the per-inhabitant health expenditures per district, a multiple linear regression model[11] in which the total expenditures are regressed on different control variables will be estimated. The unit of observation is the district (N = 115) and the following model is used:

$$y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \varepsilon_i \quad (1)$$

where
- i stands for the relevant district
- y = total (health care) expenditures per inhabitant
- X_1 = vector of supply of health services
- X_2 = vector of demand of health services
- ε = stochastic error term

The regression analysis consists of two estimations whereby a restricted form of the model as well as the full model will be estimated. As such, the restricted-form model accommodates the supply of physicians for the supply side as well as the morbidity and mortality of the population for the demand side while the full model expands on these covariates and also includes demographic and socioeconomic characteristics of the population as demand-side factors. This approach is used in order to disentangle the effect of medical need on health expenditures due to the disease burden on the one hand and patient characteristics on the other hand.

Following the model estimations, regression diagnostics will be carried out in order to ascertain whether the results are unbiased and consistent as well as to determine the goodness of fit. In doing so, standard testing for common inefficiencies, namely heteroscedasticity and multicollinearity, as well as for model specification will be applied. In econometrics, heteroscedasticity means that the variance of the error term, given the explanatory variables, is not constant which renders the estimator biased (Woolridge,

[11] The multiple linear regression model uses the standard ordinary-least-squares (OLS) method.

2014). In order to test for heteroscedasticity, the so-called Breusch-Pagan test, which regresses the squared residuals on the explanatory variables in the model, will be used (Woolridge, 2014). As the Breusch-Pagan test operates with the null hypothesis that the errors have a constant variance, also called homoscedasticity, it will be significant if there exists heteroscedasticity within the error terms. One possible way to deal with heteroscedasticity is to use the OLS estimator but to apply robust standard errors which allow for the presence of heteroscedasticity and leads therefore to an unbiased estimator (Woolridge, 2014). Multicollinearity on the other hand refers to correlation among the explanatory variables which leads to unstable coefficients with wildly inflated standard errors (Woolridge, 2014). One way to test for multicollinearity is to look at the so-called variance inflator factor (VIF). The VIF is the term in the sampling variance affected by correlation among the explanatory variables and quantifies as such the severity of multicollinearity in a multiple regression model (Woolridge, 2014). It is calculated as the ratio of the variance in a model with multiple explanatory variables and the variance of a model with only one explanatory variable (Woolridge, 2014). A VIF with a value greater than 10 points to the conjuncture that there is perfect multicollinearity in the model which in turn leads to inconsistent estimators. In order to avoid multicollinearity, one of the variables which are near perfect linear combinations of each other should be excluded from the model. Finally, the regression diagnostics also include testing for the goodness-of-fit of the model, i.e. how well the model fits the observations. This is done by looking at the so-called R^2 which is the ratio of the explained variation compared to the total variation, thus it is the proportion of the sample variation in the dependent variable explained by the independent variables (Woolridge, 2014). The R^2 ranges from 0 to 1 whereby a low value points to omitted variables and a greater value indicates a better fit. However, as the R^2 automatically increases with the number of independent variables in a model without adding any information about the goodness of fit, it is recommendable to also look at the adjusted R^2. The adjusted R^2 is similar to the R^2 but it further imposes a penalty for adding additional independent variables to the model by using degrees-of-freedom[12] adjustment in estimating the error variance (Woolridge, 2014). Other goodness-of-fit measures include the so-called Akaike information criterion (AIC) and the Bayesian information criterion (BIC). Both are used for model selection

[12] In a multiple regression model, the degrees of freedom are the number of observations minus the number of estimated parameters (Woolridge, 2014).

and deal with the trade-off between the goodness-of-fit and the simplicity of the model (Davidson & MacKinnon, 1993). As such, when comparing two models, the one with the lower value of the AIC/BIC should be chosen. If the goodness-of-fit measures indicate that the model is not correctly specified, it needs to be specified differently, e.g. by including more relevant variables.

To sum up, the estimation strategy in part one aims at establishing whether there is regional variation of health care expenditures at the district level in Austria. If this is the case, the determinants of health expenditures will also be studied using multiple regression models for which regression diagnostics will be performed after the estimations.

4.2.2 Relationship between health expenditures in different health care sectors and specialities

The empirical analysis in part two is also conducted in two steps. As a first step, it will be established whether there is any relationship between health expenditures in different health care sectors and specialities. This is done by looking at the correlation coefficient which is a measure of linear dependence between two random variables that does not depend on units of measurement and is bounded between -1 and 1 (Woolridge, 2014). Thus, a correlation coefficient of zero means that there is no empirical relationship between two variables, a positive value describes a positive relationship between the variables ("the higher, the higher") while a negative coefficient indicates an inverse relationship ("the higher, the lower"). For this reason, variables that have a positive relationship are called complements and those that have an inverse relationship are called substitutes (Woolridge, 2014). In terms of the respective health expenditures, this means that health care sectors and specialities with a complementary relationship are mutually dependent on each other and their expenditures develop in the same direction, while those with a substitutive relationship can be used as "replacement" for each other.

If such a relationship between different health care sectors or specialities can be determined, this linear dependence will be analysed in more detail in a second step. For that, a seemingly-unrelated regression (SUR) model will be estimated as this will allow not only to ascertain the determinants of health care expenditures but also to determine the relationship between the health expenditures of different health care sectors or specialities. A SUR model is a generalisation of a linear regression model consisting of several

regression equations, each having its own dependent variable and possibly the same set of independent variables, whose error terms are allowed to correlate (Davidson & MacKinnon, 1993; Zellner, 1962).

Thus, to explain the per-inhabitant health expenditures in different health care sectors or specialities per district, a SUR model in which the health expenditures are regressed on different control variables and in which the error terms are assumed to be correlated across the equations will be estimated. The unit of observation is the district (N = 115) and the following model is used:

$$y_{i,j} = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \varepsilon_{i,j} \quad (2)$$

where
- i stands for the relevant district
- j stands for the relevant health care sector/speciality
- y = health care expenditures per inhabitant
- X_1 = vector of supply of health services
- X_2 = vector of demand of health services
- ε = stochastic error term

The regression analysis uses the same covariates as the one performed in part one, however, it consists of four separate equations, one for each health care sector (inpatient and outpatient sector) or speciality (general practitioners and specialists) and two estimations: In the first estimation, a SUR model will be performed in order to find out whether there is a relationship between health expenditures of different health care sectors while the second estimation applies this issue to different specialities in the outpatient sector. When interpreting the results of these estimations, the covariance matrices as measures of linear dependence between two random variables will also be closely examined. To that end, a Breusch-Pagan test, which tests for independent equations, will be performed. The statistical test will be significant if the equations, and the variables, are dependent on each other, i.e. if the disturbance covariance matrix is not diagonal (Stata, 2020).

All in all, the methodological approach in part two aims at establishing a relationship between health expenditures of different health care sectors and specialities as well as at looking at the determinants of these expenditures. To that end, a correlation analysis as well as SUR models will be used.

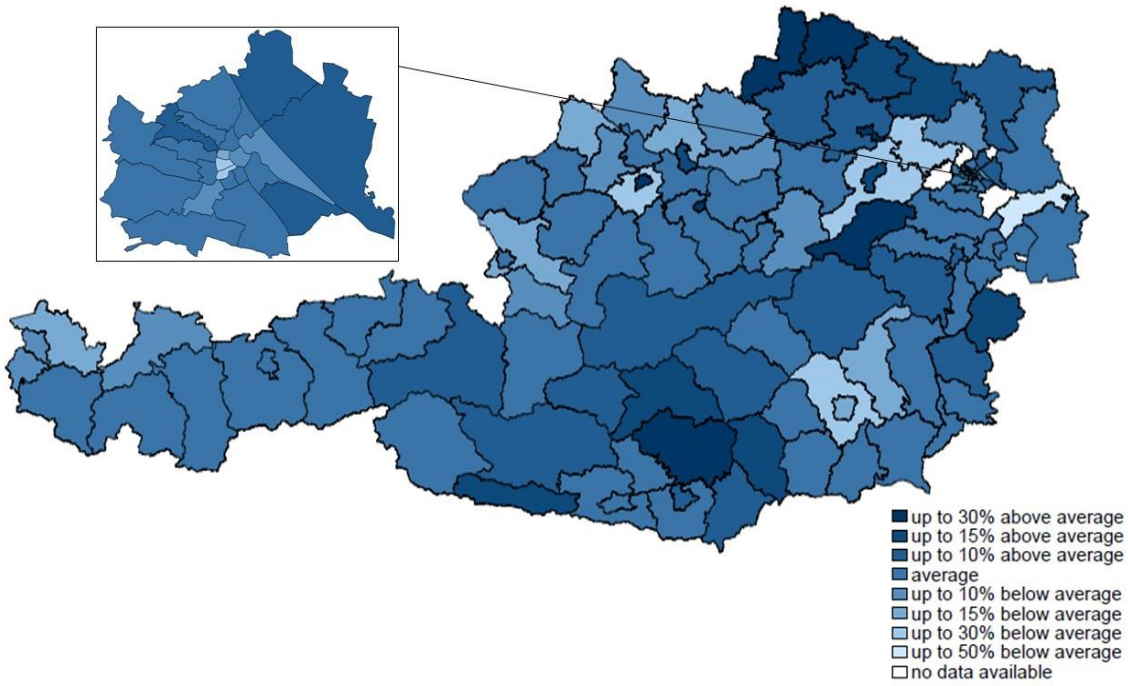
5 RESULTS

Applying the empirical strategy to the data, the following results could be achieved and are further presented in section 5.1 (regional variation of health care expenditures) and section 5.2 (relationship between health expenditures in different health care sectors and specialities).

5.1 Regional variation of health care expenditures

The results of the descriptive analysis of regional disparities show that in 2016, there was indeed regional variation of health care expenditures in Austria. Figure 5 displays the regional variation of total expenditures as deviation from the mean whereby lighter colours stand for below-average and darker ones for above-average health care expenditures.

Figure 5: Regional variation of total (health care) expenditures per inhabitant



Note: In addition to the district excluded from the analysis for data protection reasons, the district "*Wien-Umgebung*" is also highlighted in white, as this district was dissolved in the course of a district reform in 2017.

Data source: Main Association of Austrian Social Security Institutions

In 2016, total expenditures varied between 50% below and 30% above the Austrian average of 1,844.15€ per inhabitant at the district-level (see Figure 5). Even though no clear pattern can be discerned when looking at the map, some individual districts exhibited particularly high or low health expenditures. The existence of regional disparities in

health care expenditures can also be confirmed by the coefficient of variation which was 0.10 and points therefore clearly to regional variation of health expenditures in Austria.

As a second step, the determinants of health care expenditures were estimated using a multiple linear regression model in order to explore the different district-level health care expenditures per inhabitant. The regression results are displayed in Table 3. Note that model 1 is a restricted model and includes the supply of physicians for the supply side as well as the morbidity and mortality of the population for the demand side. Models 2 and 3 then expand on these covariates and also include the demographic and socioeconomic characteristics of the population as demand-side factors. They differ, however, in their standard errors so that model 3 incorporates robust standard errors.

After each estimation, regression diagnostics[13] were carried out in order to determine the validity of each model. This yielded the following results: Model 1 exhibits no common inefficiencies such as heteroscedasticity and multicollinearity, but shows that relevant covariates are missing in the model. For that reason, the full model (model 2) including more demand-side variables was estimated in a second step. This corrected for the omitted variables, but led to heteroscedasticity in the error terms. Model 3 therefore uses the full set of covariates as well as robust standard errors which amends for inefficiencies such as heteroscedasticity as well as for the omitted variables in model 1. Looking at the goodness-of-fit measures and model selection criteria of the individual models, the full model (models 2 and 3) fares better than the restricted one at all levels: Both the R^2 (0.47 vs. 0.14) and the adjusted R^2 (0.39 vs. 0.10) are higher in models 2 and 3 than in model 1 while the AIC and BIC are lower (1,485.4 vs. 1,520.9 or 1,529.3 vs. 1,537.4). Altogether, the regression diagnostics point to model 3 to provide the most valid results of the estimations which is why those results will be examined in more detail in the following.

Table 3 displays the final regression results whereby the per-inhabitant health care expenditures per district are related to a number of covariates. Note that for the age and gender distributions, there is one reference category to which the other categories are compared to in order to avoid multicollinearity. For the age distribution, the reference

[13] A summary of the regression diagnostics as well as a graphical representation of the homo-/ heteroscedasticity can be found in the appendix.

group is the share of people aged 75 years or more while for the gender distribution, it is the share of men in the respective district.

Table 3: Regression results – determinants of health care expenditures

	(1)	(2)	(3)
Physician density	0.268	3.706	3.706
	(1.868)	(2.328)	(2.807)
Mortality cancer	-6.445	-9.343	-9.343
	(39.64)	(34.45)	(29.25)
Mortality CVD	49.96**	34.25	34.25
	(24.85)	(24.18)	(32.39)
Morbidity diabetes	13.82	1.824	1.824
	(23.86)	(20.96)	(16.02)
Morbidity COPD	-2.902	-10.06	-10.06
	(24.40)	(24.73)	(26.31)
Share of children		-6.300	-6.300
		(24.79)	(21.78)
Share of young adults		-19.16	-19.16
		(27.15)	(26.82)
Share of adults		-48.97**	-48.97***
		(19.46)	(18.52)
Share of adults 2		-26.01	-26.01
		(27.79)	(25.34)
Share of pensioners		-3.363	-3.363
		(36.43)	(27.87)
Share of females		41.32	41.32**
		(30.33)	(20.22)
Life expectancy		-13.59	-13.59
		(17.76)	(17.43)
Education		-7.224	-7.224
		(7.407)	(7.325)
Income		-0.0342***	-0.0342***
		(0.009)	(0.009)
Unemployment		14.26*	14.26**
		(7.551)	(5.987)
Observations	115	115	115
R-squared	0.135	0.466	0.466
Adjusted R-squared	0.095	0.385	0.385
AIC	1520.9	1485.4	1485.4
BIC	1537.4	1529.3	1529.3

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Data source: DVSV, BMSGPK, ÖÄK and Statistik Austria

The regression results indicate that demand-side factors, especially demographic and socioeconomic characteristics, were associated with the level of health care expenditures per inhabitant and district in Austria in 2016. As such, the share of people aged 30 to 44 years ("adults"), the share of females, the net annual income and the unemployment rate were significantly related to the level of total expenditures. However, these covariates were associated with health care expenditures in different ways: While the share of females and the unemployment rate were positively related to the district-level total expenditures per inhabitant, the share of people aged 30 to 44 years and the annual net income were negatively associated with them. In detail, this means that a one-percentage-point increase in the share of females was related with, ceteris paribus, an increase in total expenditures by 41.32€ while a one-percentage-point increase in the unemployment rate, ceteris paribus, to a rise in expenditures by 14.26€. On the other hand, a one-percentage-point increase in the share the 30-44-year-olds, was, compared to reference group and ceteris paribus, associated with a reduction in total expenditures by 48.97€ whereas an increase in the annual net income by one euro with a decrease by 0.03€. These effects can be explained by demand-side effects, especially the characteristics of the patients and the corresponding heterogeneity in the prevalence of (chronic) diseases. This becomes apparent by the circumstance that the significant effect of the mortality due to cardiovascular diseases on expenditures observed in the restricted model vanishes in the full model where demographic and socioeconomic characteristics are included. The results imply that the older (represented by age distribution and the share of females which exhibit a higher life expectancy than men) and socioeconomically worse off (revealed by a higher unemployment rate) the inhabitants of a district are, the sicker they are and the more health services they use which thus increases the total expenditures and vice versa.

The other covariates do not exert a significant influence on district-level health care expenditures per inhabitant, however, it is still interesting to look at the direction in which they were associated with total expenditures in 2016: On top of the aforementioned variables, the density of physicians, the mortality due to cardiovascular diseases and the morbidity associated with Diabetes were positively related to the per-inhabitant health expenditures per district while the mortality due to cancer, the morbidity associated with COPD, the shares of the population aged 0 to 14 years ("children"), 15 to 29 years ("young adults"), 45 to 59 years ("adults 2") and 60 to 74 years ("pensioners") as

well as the general life expectancy and the level of education was negatively affiliated with them.

A more detailed discussion of the results will be carried out in section 6.

5.2 Relationship between health expenditures in different health care sectors and specialities

The first step of the empirical analysis in part two revealed that there was indeed a relationship between district-level health expenditures per inhabitant in different health care sectors and specialities in Austria in the year 2016. This result was established in the correlation analysis which findings are displayed in Table 4.

Table 4: Results of correlation analysis

	Inpatient sector	Outpatient sector	General practitioners	Specialists
Inpatient sector	1.00			
Outpatient sector	0.25***	1.00		
General practitioners	-	-	1.00	
Specialists	-	-	-0.15	1.00

Note: *** p<0.01, ** p<0.05, * p<0.1
Data source: Main Association of Austrian Social Security Institutions

As can be seen from Table 4, there was a significant positive relationship between health expenditures in the inpatient and the outpatient sector as well as an insignificant negative one between the expenditures of general practitioners and specialists. The observed positive relationship (correlation coefficient: 0.25) can be interpreted as such that the inpatient and the outpatient sector act as complements to each other, i.e. that they mutually depend on each other and that their health expenditures develop in the same direction.

Consequently, a seemingly unrelated regression model was estimated whereby two separate estimations, each containing two equations, were carried out. The results are depicted in Table 5 and Table 6.

The SUR estimations find that the residuals of the individual estimations are positively correlated which means that the respective health expenditures in different sectors and of different specialities are associated with the same set of covariates. It can thus be said

that there is a relationship between health expenditures of different sectors and specialities. This interdependence is shown by the covariance matrices and the associated coefficients which take a value of 0.29 for the relationship between health expenditures in the inpatient and the outpatient sector and 0.42 for the one between general practitioners and specialists (see Table 5).

Table 5: SUR results – correlation of residuals

	Inpatient sector	Outpatient sector	General practitioners	Specialists
Inpatient sector	1.00			
Outpatient sector	0.29**	1.00		
General practitioners	-	-	1.00	
Specialists	-	-	0.42***	1.00

Note: *** p<0.01, ** p<0.05, * p<0.1
Data source: DVSV, BMSGPK, ÖÄK and Statistik Austria

Looking at the determinants of health expenditures (see Table 6) a similar picture as in section 5.1 emerges: The regression results indicate that demand-side factors, especially demographic and socioeconomic characteristics, were associated with the level of health expenditures per inhabitant and district in different health care sectors and specialities in Austria in 2016. In the inpatient sector, the share of people aged 30 to 44 years ("adults") as well as the annual net income were significantly negatively related to health expenditures. In the outpatient sector, the share of people aged 30 to 44 years and the general life expectancy were associated with a significant reduction in health expenditures while the unemployment rate in the district was significantly affiliated with an increase in them. The level of health expenditures of general practitioners was significantly negatively related to the respective share of people aged 15 to 29 years ("young adults"), 30 to 44 years and 60 to 74 years ("pensioners") as well as the life expectancy and the annual net income. By contrast, the share of females and the unemployment rate was significantly positively affiliated with expenditures of specialists while the general life expectancy was associated with a significant reduction of expenditures. The other covariates did not exhibit a significant association with district-level health care expenditures per inhabitant and can be, in terms of their effect, compared to the ones analysed above in the multiple linear regression model. It is however interesting to note that for many covariates, the direction of their effect is mirror-inverted for the two equations in

one estimation. This is, for example, the case for the morbidity associated with diabetes for expenditures in the inpatient sector (positive association) and the outpatient sector (negative association) or the mortality due to cardiovascular diseases for expenditures of GPs (positive relation) and specialists (negative relation).

Altogether, the results of the seemingly unrelated regression point to the fact that health expenditures of different health care sectors and specialities are positively related to each other. Also, heterogeneity in patients seem to play an important role in explaining the association between the level of health care expenditures per inhabitant in the inpatient and the outpatient sector as well as of GPs and specialists. Looking at what drives health care expenditures, it becomes apparent that they differ for different health care sectors and specialities: While age and income play an important role in the inpatient sector, the expenditures in the outpatient sector are strongly associated with the general life expectancy as well as the unemployment rate. The determinants of health expenditures for GPs are similar and include age, general life expectancy and income whereas gender and the unemployment drive expenditures for specialists. It can thus be assumed that a higher medical need resulting from patient characteristics leads to higher health expenditures in all health care sectors and specialities as a lot of diseases require a range of health services by several health care providers.

Table 6: SUR results – determinants of health care expenditures

	Sectors: Inpatient and Outpatient		Specialities: GP and Specialists	
Physician density	1.980	2.192	0.239	0.268
	(1.463)	(1.347)	(0.214)	(0.373)
Mortality cancer	-14.65	-3.438	0.389	7.844
	(21.65)	(19.93)	(3.171)	(5.517)
Mortality CVD	16.35	22.77	2.179	-2.279
	(15.19)	(13.98)	(2.225)	(3.871)
Morbidity diabetes	7.790	-8.323	-2.965	-3.386
	(13.17)	(12.12)	(1.929)	(3.356)
Morbidity COPD	3.588	-6.099	-0.355	-1.257
	(15.54)	(14.30)	(2.276)	(3.960)
Share of children	13.23	-19.31	-3.164	5.001
	(15.58)	(14.34)	(2.281)	(3.969)
Share of young adults	9.575	-25.60	-7.127***	3.274
	(17.06)	(15.70)	(2.499)	(4.347)
Share of adults	-34.66***	-19.57*	-5.023***	-0.349
	(12.23)	(11.25)	(1.791)	(3.115)
Share of adults 2	-4.704	-17.16	-3.300	1.067
	(17.46)	(16.07)	(2.557)	(4.449)
Share of pensioners	19.29	-30.28	-6.315*	3.841
	(22.89)	(21.07)	(3.353)	(5.834)
Share of females	25.64	22.53	-3.920	15.01***
	(19.06)	(17.54)	(2.792)	(4.857)
Life expectancy	13.62	-25.73**	-3.315**	-5.036*
	(11.16)	(10.27)	(1.634)	(2.843)
Education	-1.927	-5.831	-0.602	-0.717
	(4.654)	(4.284)	(0.682)	(1.186)
Income	-0.0286***	-0.00756	-0.00406***	0.000869
	(0.006)	(0.005)	(0.001)	(0.002)
Unemployment	0.380	14.83***	-0.533	5.585***
	(4.745)	(4.367)	(0.695)	(1.209)
Observations	115	115	115	115
R-squared	0.478	0.463	0.622	0.620

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Data source: DVSV, BMSGPK, ÖÄK and Statistik Austria

6 DISCUSSION

Health care expenditures in Austria show clear regional disparities. In 2016, there was regional variation in total health expenditures in Austria at the district level which ranged from 50% below to 30% above the average of 1,844.15€ per inhabitant. When looking at the factors associated with the level of health care expenditures per inhabitant, demand-side factors, especially demographic and socioeconomic factors, can explain some of the regional disparities within the expenditures of the Austrian health care system. As such, age, gender, the net annual income and the unemployment rate were related to a significant impact on the level of total expenditures. These effects can be explained by the characteristics of the patients, especially by the morbidity and mortality burden resulting from the demography and the socioeconomics of a district: The older and socio-economically worse off the inhabitants of a district are, the sicker they are and the more health services they use which thus increases the total expenditures and vice versa. The income effect on health expenditures, on the other hand, can be explained by the fact that there is also a private health care sector which tend to be used by socioeconomically better off patients, but is not included in this analysis. The other covariates (density of physicians, mortality due to cardiovascular diseases as well as to cancer, morbidity associated with Diabetes as well as with COPD, shares of the population aged 0 to 14 years, 15 to 29 years, 45 to 59 years and 60 to 74 years, general life expectancy and level of education) were not significantly associated with the level of health care expenditures.

It is important to note that even though the direction of the influence of some covariates might not always be intuitive at first, the effects can be explained, in most cases, by patient characteristics and the associated medical needs. Nevertheless, three covariates stand out, namely the mortality due to cancer, the morbidity associated with COPD and the general life expectancy. In theory, an increase in them should be, ceteris paribus, associated with an increase in health care expenditures as a higher medical need due to illnesses and age should also lead to higher total expenditures. The fact that they are negatively associated with expenditures in reality might be, on the one hand, due to the limited data available, and, on the other hand, due to the analysed one-year period. The latter is connected to the progression of the diseases and the circumstance that if a per-

son lives longer, it increases the expenditures in the long run, but decreases them in the considered year.

The analysis further showed that there exists a relationship between district-level health expenditures per inhabitant of different health care sectors and specialities. As such, a correlation analysis revealed that health expenditures in the inpatient and outpatient sector can be regarded as complements to each other which means that they mutually depend on each other and develop in the same direction. The seemingly unrelated regressions further implied that health expenditures of different sectors and specialities positively depend on the same set of covariates. However, in that context, it cannot be ascertained whether the different sectors and specialities can be regarded as complements or substitutes to each other.

In sum, the results point to the fact that the level of health care expenditures is strongly associated with patient characteristics and the corresponding state of health. This circumstance becomes obvious not only by the demand-side determinants of health care expenditures but also by the positive relationship between health expenditures of different health care sectors and specialities: A higher medical need resulting from patient characteristics leads to higher health expenditures in all health care sectors and specialities. This finding is in line with theory which suggests that in countries with an established welfare system, the level of health care expenditures should only be associated with patient characteristics and the associated medical need (de Vries et al., 2018; Lavergne et al., 2016; Pauly, 1986).

From a health policy point of view, the presence of regional variation in health care expenditures is an important aspect since knowledge about them allows a needs-based and equal care for all insured. However, seeing that the existing regional disparities in health care expenditures in Austria seem to a arise from the demand side, which is considered justified in the literature, this conjuncture does not constitute a violation of the principle of equal treatment. If this were not the case, i.e. if health care expenditures were supply-side driven, the existence of regional variation within a centrally-administered and publicly-funded health care system, such as the Austrian, would be quite concerning (Lavergne et al., 2016).

Due to the structure of the data, there are some limitations worth mentioning as they affect the interpretation of the results. First, the analysis of health care expenditures is

carried out from a system perspective which means that differences in the social health insurance funds are not considered. This, however, leads to an inherent distortion of health care expenditures since the various social health insurance funds differ quite considerably in their fee structure for the outpatient sector. This conjuncture is also reflected in the regional variation of their health expenditures which is why the results must be interpreted against this background. Second, for the inpatient sector, only inpatient stays are considered as for the hospital outpatient departments, there is no corresponding and clearly attributable expenditure data available. Furthermore, it should also be noted that the inpatient data set may also include patients not insured, but treated, in Austria. The analysis in the outpatient sector solely refers to health services provided by contracted physicians and therefore disregards the private health care sector. Third, for reasons of data protection, some variables only contain 115 observations as the number of cases was too small for one political district. In addition, some data points had to be excluded from the analysis because it was not possible to clearly assign health care expenditures to one specific political district. Overall, this affects, depending on the category of health expenditures, between 0.37% and 7.84% of all data points. Finally, it must also be noted that all other expenditures of the Austrian health system, such as the costs of prevention, health promotion and rehabilitation or administration, are not included in the variable "total expenditures".

Regarding the model specification, there are clearly endogeneity issues, most notably issues with reversed causality (Göpffarth et al., 2016). These affect both supply- and demand-side factors and may work through several channels (Göpffarth et al., 2016). In the case of the supply of health services, two possible effects could explain higher health expenditures in districts with a greater supply: On the one hand, increased supply in terms of a higher density of physicians could mean easier access to health services which would also be reflected in a higher utilisation and thus higher expenditures. On the other hand, increased supply is a sign of stronger competition among service providers which might lead to an increase in health services performed if physicians exploit the opportunities inherent in the health sector for inducing demand themselves (cue: supplier-induced demand) (Göpffarth et al., 2016; Kopetsch, 2007). Similar arguments apply to the demand of health services, especially to patient characteristics. Poorer health, reflected by morbidity and mortality as well as demographic and socioeconomic features of the population, in a given district will likely result in higher health care ex-

penditures while higher expenditures should, ceteris paribus, also lead to a better state of health. However, up-to-date, there are no credible instruments available to be used in an instrumental variables approach to fully overcome endogeneity problems due to reversed causality (Göpffarth et al., 2016). For this reason, causal interpretations of individual determinants of health care expenditures are beyond the scope of this thesis even though the detected correlations still offer some idea of what drives health care expenditures in Austria.

Another methodological issue concerns the possibility of a remaining omitted variable bias as there is still some variation left which cannot be explained and as the residuals in the SUR model exhibit a positive interdependence. This problem could, however, be solved by including further covariates in the model, especially supply-side variables such as the hospital bed density, the number of acute care beds or the density of pharmacies, but also expenditures for end-of-life care and a measure for patients' care preferences for the demand-side (Giannoni & Hitiris, 2002; Göpffarth et al., 2016; Prieto & Lago-Peñas, 2012; Reich et al., 2012).

Further research is therefore necessary in several areas: First, valid instrumental variables need to be worked out so that causal interpretations of individual determinants of health care expenditures are possible. Second, a broader range of covariates needs to be included in the regression analysis to rule out an omitted variable bias or rather reduce the degree of unexplained variation. And third, it would also be interesting to expand the analysis in order to account for spatial interdependencies as well as to incorporate a time series analysis as this would greatly contribute to the validity of the results.

7 CONCLUSION

The aim of this thesis was twofold: On the one hand, the extent of regional variation in health care expenditures in Austria as well as the determinants of health expenditures should be established. The resulting hypothesis that there is regional variation in health care expenditures in Austria which can be associated with heterogeneity in patient characteristics was supported. Furthermore, it was also established that regional disparities are related to demand-side factors which is in line with the theory for publicly-funded health care systems. On the other hand, the relationship between health care expenditures of different health care sectors and specialities should be examined. The corresponding hypothesis that there is a relationship between health expenditures of different health care sectors and specialities as higher medical needs will lead to higher expenditures in all care sectors was also endorsed. Present thesis therefore succeeds in contributing to the literature in two ways: For one thing, it offers an analysis and regional survey of health care expenditures in Austria in terms of their regional variation and their determinants, and, for another thing, it provides an overview of the interdependence of health expenditures in different health care sectors and specialities. Altogether, the results of the analyses carried out in this thesis point to the fact that the Austrian health care system is indeed a "good health [care] system that delivers quality services to all people when and where they need them" as defined by the World Health Organization.

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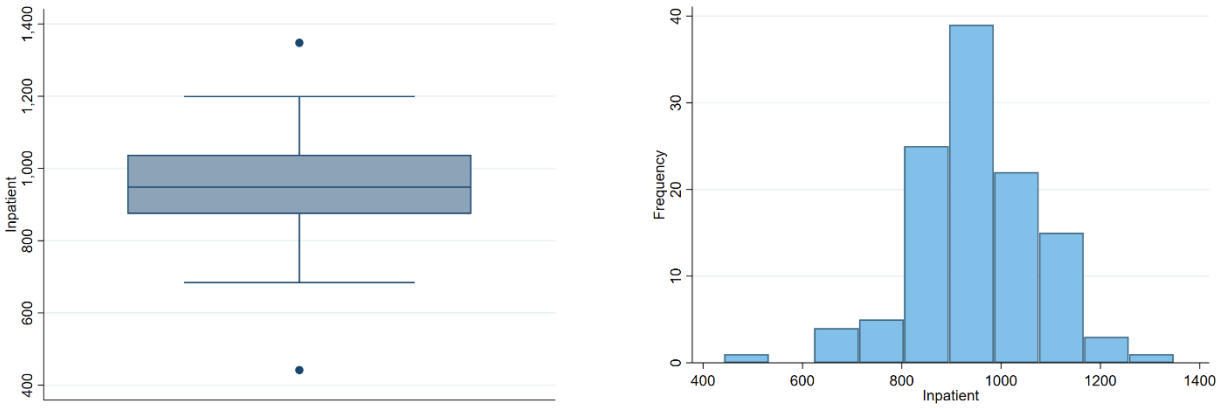
APPENDIX

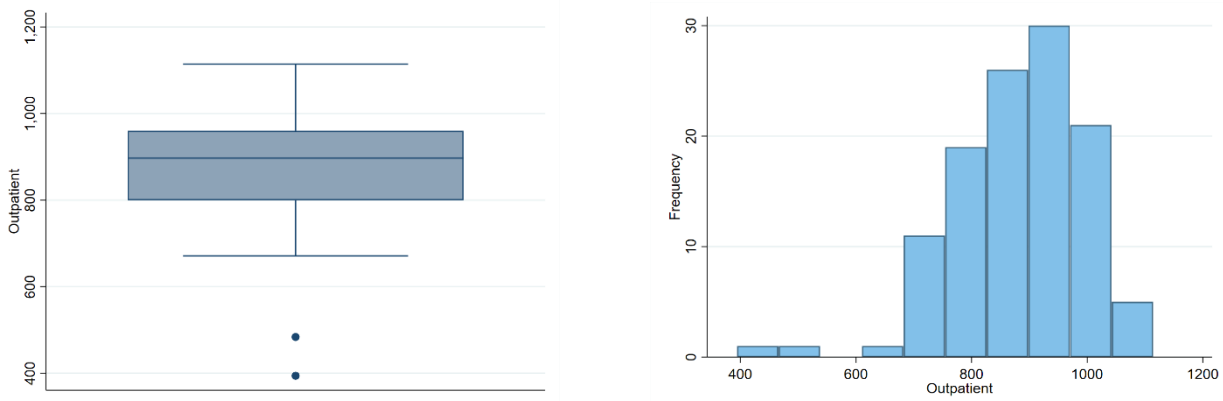
I. Descriptive analysis of health expenditures

Figure 6: Boxplot and histogram of district-level health expenditures per inhabitant in the inpatient sector (in €)



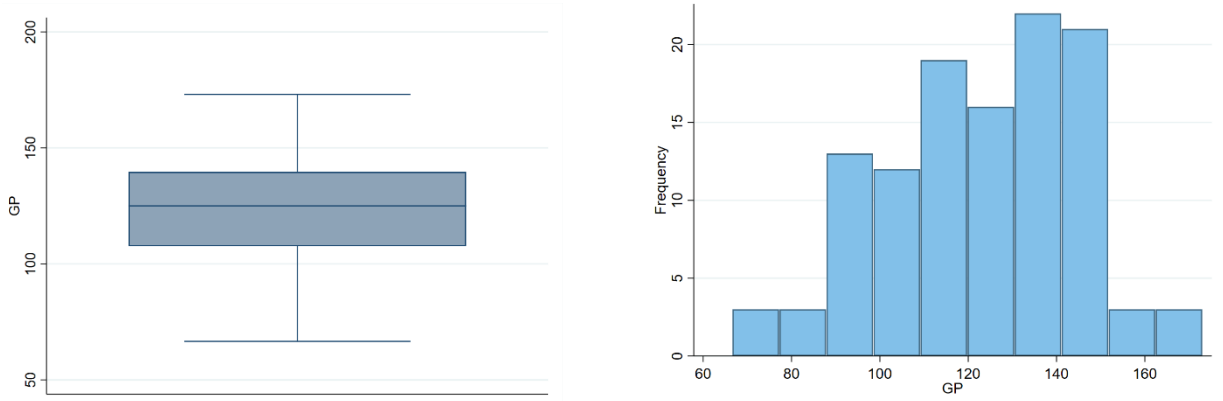
Data source: Main Association of Austrian Social Security Institutions

Figure 7: Boxplot and histogram of district-level health expenditures per inhabitant in the outpatient sector (in €)



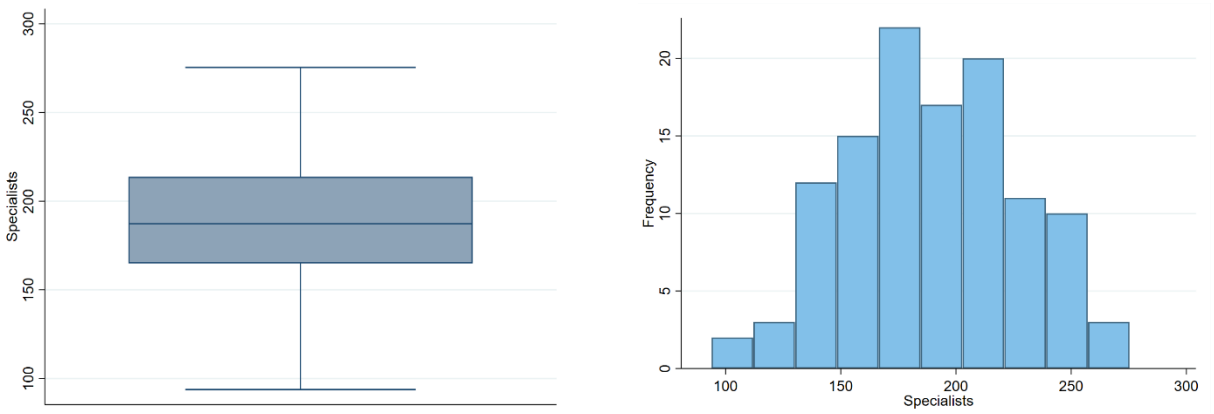
Data source: Main Association of Austrian Social Security Institutions

Figure 8: Boxplot and histogram of district-level health expenditures per inhabitant of GPs (in €)



Data source: Main Association of Austrian Social Security Institutions

Figure 9: Boxplot and histogram of district-level health expenditures per inhabitant of specialists (in €)



Data source: Main Association of Austrian Social Security Institutions

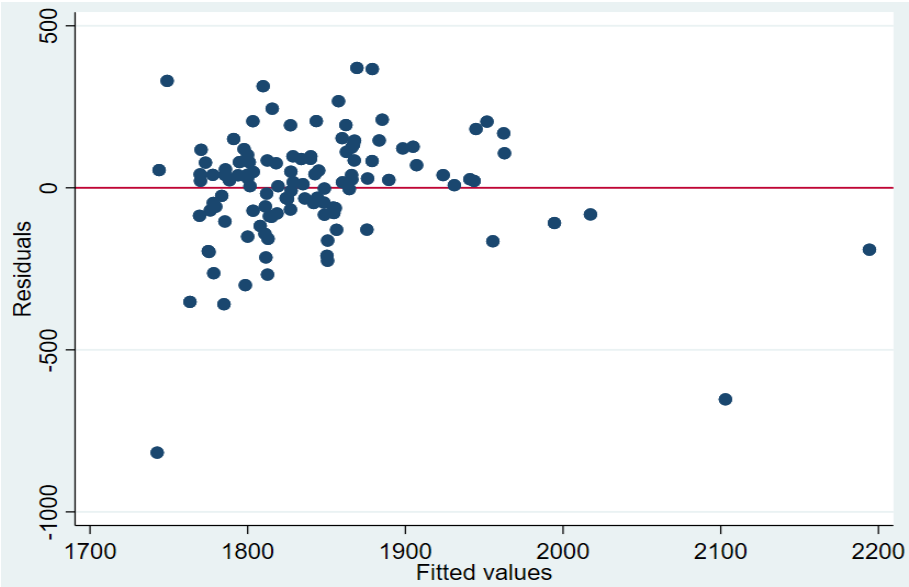
II. Results of regression diagnostics

Table 7: Results of regression diagnostics

	Model 1	Model 2	Model 3
Breusch-Pagan test for heteroscedasticity	p = 0.27	p = 0.02	-
VIF test for multicollinearity	VIF = 2.55	VIF = 6.55	VIF = 6.55

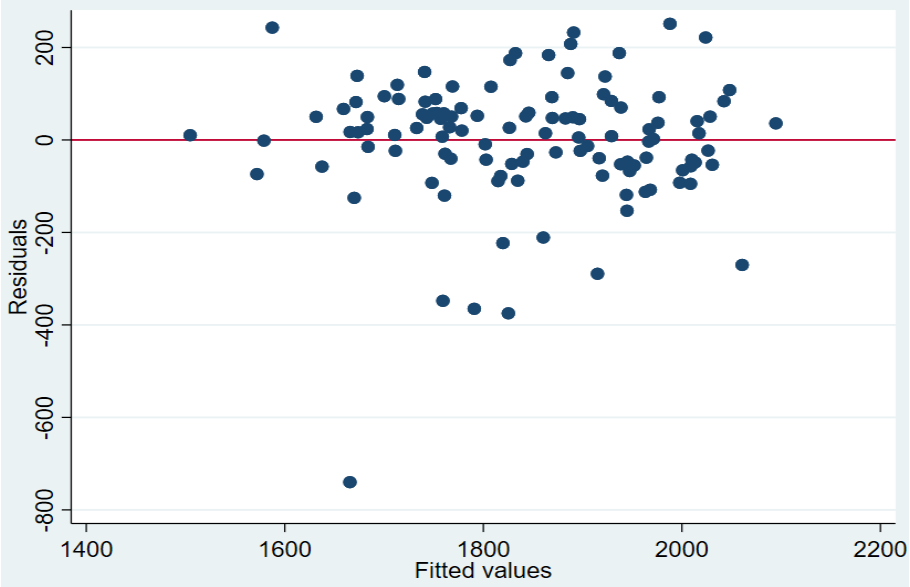
Data source: DVSV, BMSGPK, ÖÄK and Statistik Austria

Figure 10: Homoscedasticity – Model 1



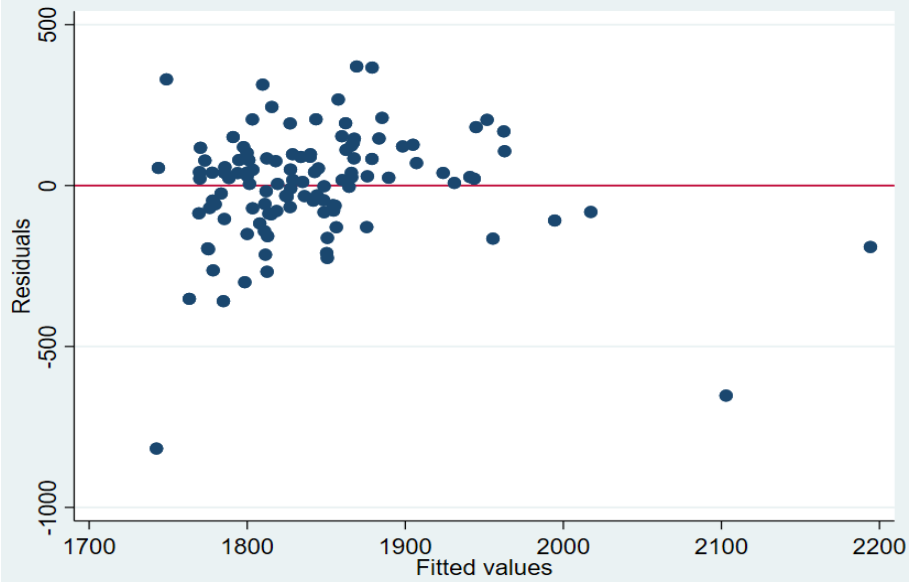
Data source: DVSV, BMSGPK, ÖÄK and Statistik Austria

Figure 11: Heteroscedasticity – Model 2



Data source: DVSV, BMSGPK, ÖÄK and Statistik Austria

Figure 12: Homoscedasticity – Model 3



Data source: DVSV, BMSGPK, ÖÄK and Statistik Austria

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