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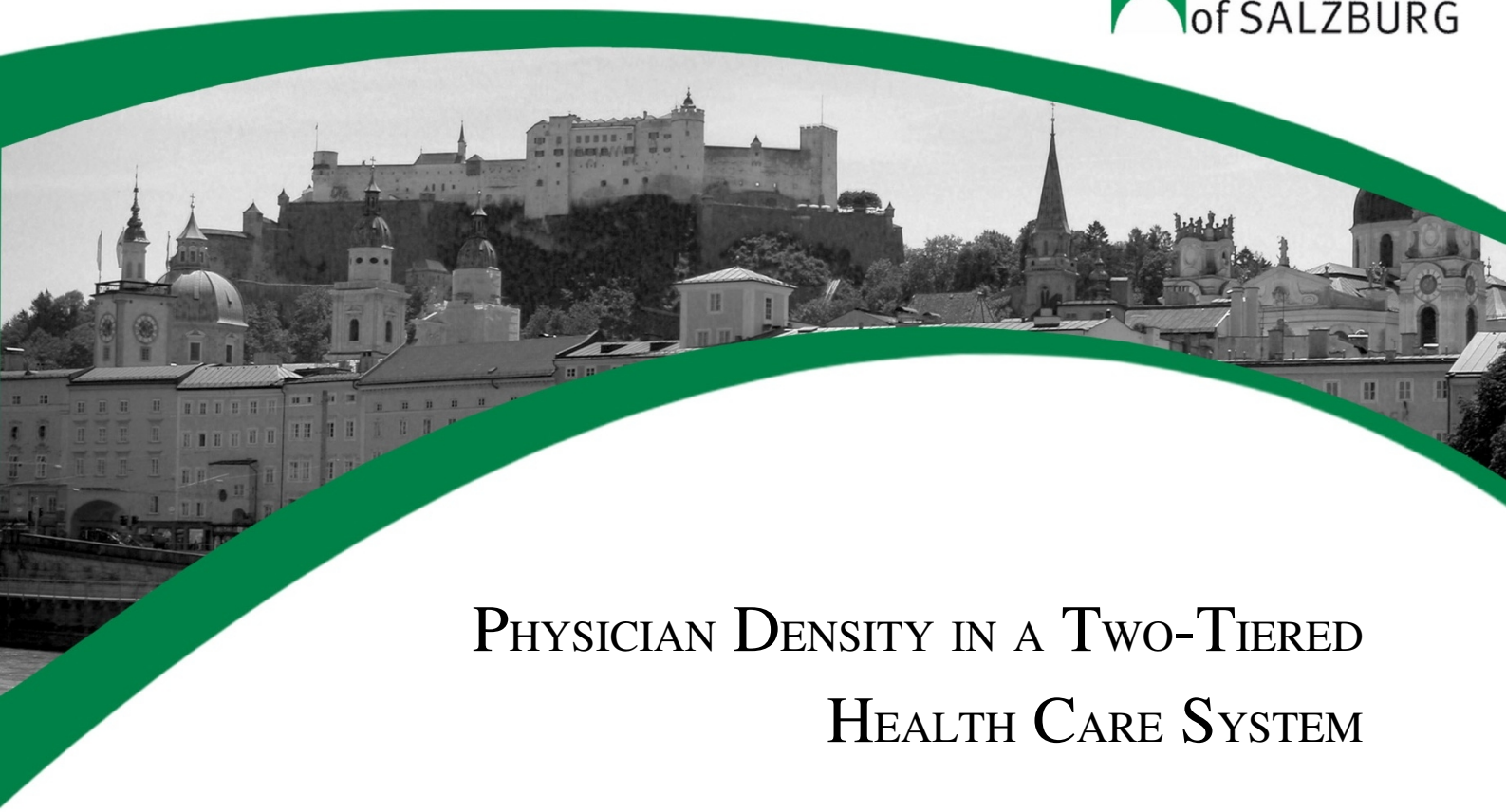

Physician Density in a Two-Tiered Health Care System

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Physician Density in a Two-Tiered Health Care System*

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Abstract

We investigate the density of private physicians in a two-tiered health care system, i.e., one with co-existing public and private health care providers. In particular, we analyze how the densities of private and public suppliers of outpatient health care (general practitioners and specialists) are related to each other. Using a panel of 121 Austrian districts between 2002 and 2008, we find that the density of private specialists is positively associated with the density of private general practitioners, but negatively related to the density of public general practitioners. We also observe a negative relationship between the densities of private and public general practitioners and the ones of private and public specialists, indicating competitive forces between the private and the public sector of the outpatient health care provision in Austria.

JEL classification: I11, I18, L23, C23
Keywords: Competition in health care markets; physician location; panel econometrics

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1 Introduction

In many countries, disparities in the distribution of health care capacities are a major concern for health care policy at least for two reasons. First, health care services are typically associated with categorical goods, implying the often held claim that every citizen should have equal access to an agreed minimum standard of health care. Second, a maldistribution of health care capacities may cause inefficiencies. In particular, an over-provision of health care capacities in socioeconomic attractive areas might lead to supplier induced demand (see Gaynor and Haas-Wilson 1999). Concerns about such disparities apply to nearly all facilities of health care provision, and especially to outpatient care. There is a vivid and ongoing discussion in health sciences, particularly in health economics, whether market based physician location policies cause the mentioned maldistribution, and to which extent the state should regulate or stipulate entry to regional physician markets (see, e.g., Detsky 1978, Davis and Marshall 1979, Scheffler *et al.* 1979, Fruen and Cantwell 1982, Newhouse *et al.* 1982, Noether 1986, Foster and Gorr 1992, Bolduc *et al.* 1996, Nocera and Wanzenzried 2002, Rosenthal *et al.* 2005).

There are two broad lines of research explaining spatial differences in physician densities. The first strand of literature primarily focuses on the individual location decision. The 'prior contact theory', for instance, stresses that physicians are more likely to practice in locations where they received their medical education or hold an affiliation to a hospital (see, e.g., Earickson 1970, Kaplan and Leinhard 1973). Other authors, focusing on interviews of physicians, emphasize that individual characteristics of physicians such as the family background play a decisive role in the decision where to locate a practice (see, e.g., Leonardson, Lapierre and Hollingsworth 1985, Hurley 1989, Kristiansen and Forde 1992, Morrisey, Klethe and Marder 1991, or Lin, Rosentahl and Horwitz 1997). Further, there is an eminent line of research in industrial organization focusing on the individual market entry and exit decisions of physicians and its impact on competition in the health care sector (see, e.g., Bresnahan and Reiss 1988, 1990, 1991, Abraham, Gaynor and Vogt 2007, Schaumans and Verboven 2008, Capps, Dranove and Lindrooth 2009).

The second line of research addresses directly the spatial distribution of physician densities and tries to identify factors explaining differences in the physician workforce over urban and rural areas. Obviously, physician densities not only reflect entry decisions but also migration and market exits of physicians. The resulting disparities are typically explained by demand-driven factors, like a region's demographic, socioeconomic and technological background, as well as the specific characteristics of a region's health care system (i.e., the availability of health care facilities acting as substitutes or complements to the outpatient physician workforce), including the corresponding legal environment which is important for a patient's access to health care (e.g., differences in cost sharing schedules between regions). This translates into a framework where the physician density at a given location is regressed on a set of a region's demographic, geographical, socioeconomic and

institutional variables (see, e.g., Noether 1986, Brasure *et al.* 1999, Nocera and Wanzenried 2002, or Jiang and Begun 2002).

This paper contributes to the research on regional disparities in physician density and is, thereby, related to the second strand of literature mentioned above. Rather than treating the physician workforce as a homogeneous group, as in previous papers on this field of research, we focus on location decisions of physicians acting in two-tiered health care systems. For this purpose, we refer to the Austrian health care system, where physicians with and without a contract with the public social insurance system co-exist (henceforth, we refer to the former ones as *public* and to the latter ones as *private physicians*). While market entry for public physicians is strongly regulated by public agencies, private physicians are free to choose a location. They are also less restricted in pricing policies and service provision. For these reasons, we restrict our attention to the location decisions of private physicians. Further, we distinguish between general practitioners (GPs) and specialists (SPs), leaving with four different types of physicians: private and public general practitioners ($PGPs$ and $CGPs$) as well as private and public specialists ($PSPs$ and $CSPs$). To study how the corresponding physician densities are related to each other, we exploit information from 121 Austrian districts over the time period 2002 to 2008. We estimate the local density of one type of private physicians ($PGPs$ or $PSPs$) as a function of the densities of public physicians ($CGPs$ and $CSPs$) and the remaining density of private physicians, among other factors such as a region's hospital facilities, educational level or aggregate income. This, in turn, allows to draw conclusions about the existence and intensity of competition between these types of physicians in a two-tiered health care system.

The remainder of the paper is organized as follows. Section 2 describes the institutional background of the Austrian health care system, giving particular emphasis on health care provision of private and public physicians. From this, we elaborate three testable hypotheses regarding the relationship between private and public physicians. Section 3 provides a brief overview over the data, elaborates the econometric framework to analyze interrelations between densities of different types of physicians, and discusses our empirical findings. Finally, Section 4 concludes.

2 Institutional Background and Main Hypotheses

From a demand and financing perspective, the public health insurance system represents the first tier of outpatient care in the Austrian health care system. Membership in this system is obligatory both for wage earners in the public and the private sector, but also for self-employed persons (including farmers). Individuals with family ties to obligatory insured persons and without own coverage obtain free health coverage. Overall, the public health insurance covers around 98.5 percent of the whole population, excluding only marginal groups from public health insurance. It is mainly financed by income related

contributions. Private health insurance and out-of-pocket payments constitute the second tier of the Austrian health care system. Roughly 35 percent of the population have signed contracts with private health insurance companies, which predominantly offer additional coverage to the first tier services and/or increase provider choices within the system.

Health care services are supplied by public physicians and by their private counterparts. Both groups are self-employed and are mainly working in single practices (see Hofmarcher and Rack 2006: 118). The spatial distribution of public physicians is based on a location plan agreed between the public health insurance companies and the Chamber of Physicians. It specifies the regional distribution of the physician workforce derived from the basic health needs of the relevant population. It also has to ensure a sufficient provision of medical services based on the existing state of medical standards. A public physician's contract relies on bilateral agreements negotiated between the public health insurance companies and the Chamber of Physicians. It determines important dimensions of physician services, such as the practice style (e.g., office hours, treatment guidelines or restrictions of additional occupations) or the physician payment scheme. The assignment of a contract is based on criteria like waiting time or professional experience. Once concluded, the contract is not limited in time.

Public physicians generate income from fee-for-service and lump-sum payments. The latter can be claimed for initial contacts and for the provision of basic services. The share of lump-sum payments to total physician earnings varies widely over different fields of specialization. At an aggregate level, it amounts to about 68 percent for $CGPs$ and around 34 percent for $CSPs$ (see Theurl and Winner 2010). The fee-for-service component of remuneration includes earning caps, inducing decreasing marginal revenues per patient and treatment. Public physicians are also allowed to earn extra money by providing additional services beyond the contract (e.g., school services). The scale of these activities, however, is strictly regulated by the physician contract (e.g., via upper limits of working time in such occupations). In contrast to public physicians, their private counterparts are free to choose their practice location. Their remuneration is mainly based on a fee-for-service system. The corresponding fees are agreed between the physician and the patients, albeit there exists a recommendation for the physician pricing policy by the Chamber of Physicians. Further, they are allowed to earn extra money without any restrictions (e.g., by working in a private or public hospital).

Patients with public health insurance coverage are basically free to consult a public or a private physician. However, the associated costs are considerably different. While utilization of public outpatient health care is based on a benefit-in-kind scheme with only negligible cost-sharing elements, treatment costs in the private sector are paid (i) out of the individual pocket, (ii) by the private health insurances, and/or (iii) by the public health insurance. The latter only reimburses parts of a private physician's invoice. The

maximum amount refunded is fixed at 80 percent of the amount a public physician would receive, but only if the private physician's services are included in the public benefit catalogue. Further, since prices of such services are well above the ones of public physicians in most cases, the cost sharing rate is usually much higher than 20 percent.[1] As a consequence, we would expect that services of private physicians are only demanded if the additional costs are at least covered by the expected benefits, as compared to the ones of consuming services from public physicians (e.g., shorter waiting times or higher treatment quality; see Propper 2000, for a more general approach to derive the demand for health care). In this case, public and private physicians are competing for more or less the same population of patients, especially when providing very similar health services. In other words, services of private and public physicians can be viewed as substitutes, suggesting a negative relationship between the corresponding physician densities (in the following, we refer to this as *'competition effect'*). This competitive relationship between physicians is summarized in the solid dark arrows of Figure 1.

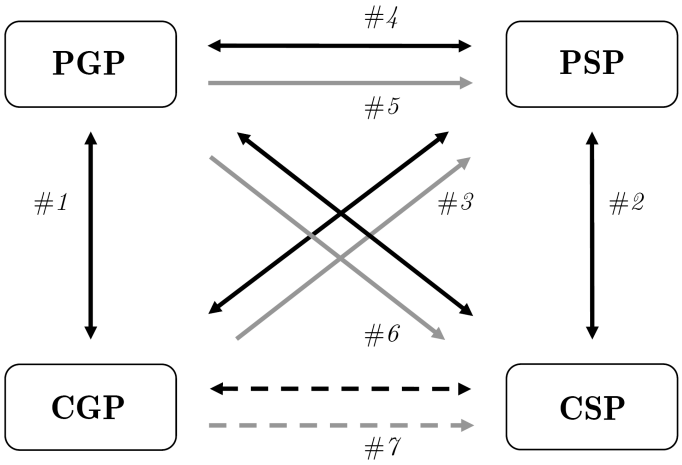

Figure 1: Competition and referral between private and public physicians

Notes: Competition between physicians is represented by the dark arrows, referrals from one type of physicians to other ones are indicated by the grey shaded arrows. Dashed arrows indicate relationships between physicians that are not addressed in the empirical analysis below.

The competition effect implies that private and public physicians of the same type provide substitutive services, so that we would expect that $PSPs$ and $PGPs$ tend to

[1]Rough calculations for the period 2000 to 2004 show that the cost sharing percentage of the submitted physician bills amounts to about 40 to 70 percent, with huge differences among specialties. Public insurance officials argue that only 50 percent of the public insured patients submit their physician bill for reimbursement. Thus, we presume that the overall percentage of cost-sharing to utilize private physician services is even higher than the share mentioned above. In addition, our data show that the public health insurance system spends around 10 percent of its expenditure for outpatient care to reimburse the costs of private physicians. Finally, the costs of private physicians are not reimbursed if the patient further contacts a public physician of the same type within the same accounting period.

avoid markets with a higher number of $CSPs$ and $CGPs$, respectively. This is captured in #1 and #2 of Figure 1. Our first hypothesis with regard to the relationship between private and public physicians is as follows:

> **Hypothesis 1:** The density of $PGPs$ ($PSPs$) should be negatively related to the density of $CGPs$ ($CSPs$).

On the other hand, $CGPs$ typically represent the first contact in the health care system and are, therefore, able to influence patient flows to other physicians via their referral behavior, indicated as grey shaded arrows in Figure 1. Although referrals are not obligatory,[2] they enable public physicians to alleviate treatment maximizing strategies intended to compensate for decreasing returns per patient and treatment, resulting from the above mentioned remuneration scheme. From this, it is generally plausible to assume a positive relationship between the density of $CGPs$ and $PSPs$ (henceforth *'referral effect'*, #3 in Figure 1). It should be noticed, however, that referrals from the public to the private sector are rather unusual in Austria. $CGPs$ usually refer to $CSPs$ (#7 in the figure), and thus, we do not expect that a PSP benefits strongly from a CGP located in the same area.[3] Therefore, we are able to derive a second hypothesis:

> **Hypothesis 2:** Since $PSPs$ and $CGPs$ partly provide the same services and referrals from the public to the private sector are uncommon, the density of $PSPs$ should be negatively associated with the density of $CGPs$.

By way of contrast, the referral effect should be stronger for $PGPs$ if treatments are cumbersome or time consuming (see Schaumans and Verboven 2008). Then, the density of $PSPs$ would be higher in locations with a higher PGP density, and vice versa (i.e., $PGPs$ benefit from presence of $PSPs$ as they create referral opportunities, see #5 in Figure 1).[4] Further, private physicians are more exposed to competition as they are not 'protected' by a physician location plan. Baumgartner (1988) has shown that physicians tend to cooperate or build up networks under such conditions, which might be especially the case

[2] This would be the case if several specialists are consulted within one accounting period or if hospital stays and/or treatments in hospital outpatient departments are required (see Hofmarcher and Rack 2006, for details). For some specific services (e.g., computer tomography or magnetic resonance), however, referral is compulsory.

[3] Interestingly, the literature on the physicians' referral behavior is relatively scarce. One exception is Atella and Deb (2008), who analyze doctor visits in Italy at the individual level. Among other things, they observe that public and private specialist visits are negatively affected by primary care physician visits, indicating a competitive relationship between primary care physicians and specialists. However, the corresponding coefficient on private specialists is much higher than the one on public specialists, which, in turn, seems to confirm our observation from Austria that $CGPs$ typically prefer $CSPs$ over $PSPs$ when referring to specialists.

[4] Similarly, Atella and Deb (2008) find that visits to primary care physicians, public specialists and private specialists are all positively related to unobserved heterogeneity. While we are not able to draw such a conclusion due to a lack of individual data, this result also suggests a positive relationship among private physicians, as they will tend to locate in attractive markets where the demand for health care is high, i.e., where people are already consuming a high amount of health care services.

between private GPs and SPs. Although the substitutive effect might also play a role between $PGPs$ and $PSPs$ (#4 in the figure), we would presume that it is outweighed by a relatively strong impact of referral and network effects. This leads to our final hypothesis:

> **Hypothesis 3:** Due to referrals, the density of $PSPs$ should be positively related to the density of $PGPs$. Further, since $PGPs$ benefit from cooperation with $PSPs$ if treatments are cumbersome or time consuming, the impact of PSP density on the density of $PGPs$ should be positive.

Notice that also $CSPs$ benefit from referrals of $CGPs$ (#7 in in Figure 1) and, to a lesser extent, of $PGPs$ (arrow #6). However, as the location of public physicians follows a fixed location plan by the Austrian public health insurance, it is reasonable to assume that the densities of $CGPs$ and $CSPs$ are not seriously influenced by private resources of outpatient health care. After all, our description of the Austrian health care system shows that the density of each particular type of physicians is affected by the density of the other types of physicians. Below, we propose a specific empirical framework to address these interrelations.

3 Empirical Analysis

3.1 Data and Descriptives

To test the above mentioned interrelations among private and public physicians empirically, we employ a data set from 121 Austrian districts between 2002 and 2008.[5] Data from physicians and their specialties are available from Göschl CD MED, *Handbuch für die Sanitätsberufe Österreichs* (years 2002 to 2008). As shown in Table 1, our sample includes about 14,569 (private and public) physicians, on average. Over the whole sample period, about 56 percent of all self-employed physicians have signed a contract with the public health insurance system, approximately 48 percent of them are $CSPs$. The share of $PSPs$ is somewhat higher (around 70 percent) in the group of private physicians. Further, we can see a substantial increase (about 27 percent) in private physicians over the course of the years, which is the result of increased medical graduates and stable capacity plans for public physicians. Finally, we also observe enough variation the number of private physicians over time (the average annual change is around five percent for private physicians, but much lower for public physicians), rendering panel data (fixed effects) estimation possible.

Based on the physicians' locations, we are able calculate the number of physicians per district and specialty. In addition, we use information on regional supply and demand for health services, in our case a districts's aggregate income, its average educational level

[5] At the sub-national level, Austria is organized in nine federal states, 121 regional districts (including 23 districts of Vienna) and 2,357 local jurisdictions (communities and cities).

Table 1: Private and public physicians in Austria

	Number of physicians				
Year	*PSP*	*PGP*	*CSP*	*CGP*	*Sum*
2002	3,675	1,560	3,940	4,289	*13,464*
2003	4,013	1,730	3,924	4,258	*13,925*
2004	4,200	1,792	3,925	4,261	*14,178*
2005	4,612	2,015	3,932	4,246	*14,805*
2006	4,875	2,046	3,925	4,217	*15,063*
2007	5,025	2,088	3,918	4,194	*15,225*
2008	5,139	2,115	3,896	4,165	*15,315*
Average	*4,506*	*1,907*	*3,923*	*4,233*	*14,569*
Change 2002-08 (in percent)	*28.49*	*26.24*	*-1.12*	*-2.98*	*12.09*
Average annual change (in percent)	*5.79*	*5.30*	*-0.19*	*-0.49*	*2.18*

Notes: PSP ... private specialist, *PGP* ... private general practitioner, *CSP* ... public specialist, *CGP* ... public general practitioner.

(measured by an index between zero and five)[6], living area, and the facilities of private and public inpatient facilities as measured by a district's total number of beds in private and public hospitals. The corresponding data are covered in the Austrian Population Census 2001 (*Statistik Austria 2001*); a district's income is taken from the Austrian Wage Tax Statistics (2004-06), published by Statistik Austria; information on the number of available beds in public and private hospitals is taken from the *Krankenanstaltenverzeichnis 2008*, published by the Austrian Ministry of Health (BMG 2008).

Table 2 provides a descriptive overview of the dataset, along with a correlation matrix of our variables included in the empirical analysis below. Overall, our sample includes 847 observations, i.e., 121 districts over seven years. On average, we observe 37 (around 32) $PSPs$ ($CSPs$) in a district, with a minimum of zero (one) and a maximum of 275 (227) physicians. The corresponding figures for GPs are much lower, with mean values of around 16 ($PGPs$) and 35 ($CGPs$). The lower block of Table 2 shows that the average density of $PSPs$, defined as the number of $PSPs$ in a district over the population size in 1,000 inhabitants, is 0.68. The maximum is around 10.1. For public specialists, we observe a mean (maximum) value of around 0.5 (4.4), and for (private and public) general

[6]Specifically, we consider five main groups of educational levels. From these, we calculate an average level of education multiplying the numbers of persons in each group with the corresponding level of education, and dividing the sum of the subgroups by the population above 15 years, i.e.,

$$E = \frac{\sum_{L=1}^{5} POP_L \cdot L}{POP_{15}}.$$

L corresponds to the level of education, POP_L indicates the population in each subgroup, and POP_{15} is the overall population above 15 years. The educational levels considered are (1) compulsory school, (2) apprenticeship or secondary education, (3) higher school certificate (general qualification for university entrance), (4) an additional education after this school-leaving certificate (e.g., a polytechnic education or a college) excluding university education, and (5) a university degree or equivalent. Thus, we obtain an index measuring the average educational level ranging from 1 to 5 within regions, where increasing values indicate a higher level of education.

Table 2: Descriptive statistics (847 observations)

Variable		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Number of PSP	(1)	1.00								
Number of PGP	(2)	0.88	1.00							
Number of CSP	(3)	0.77	0.73	1.00						
Number of CGP	(4)	0.43	0.56	0.68	1.00					
Private hospital beds[a)]	(5)	0.48	0.51	0.52	0.63	1.00				
Public hospital beds[a)]	(6)	0.67	0.66	0.76	0.57	0.47	1.00			
Average income[b)]	(7)	0.68	0.60	0.50	0.11	0.13	0.25	1.00		
Education	(8)	0.71	0.58	0.57	0.07	0.18	0.30	0.89	1.00	
Living area (100 km^2)	(9)	-0.30	-0.18	-0.45	0.06	0.01	-0.23	-0.40	-0.51	1.00
Mean		37.24	15.75	32.42	34.98	1.23	4.00	17.41	1.70	2.69
Standard deviation		47.46	15.05	33.13	20.58	2.11	5.77	2.23	0.25	2.37
Minimum		0.00	0.00	0.00	1.00	0.00	0.00	14.70	1.43	0.01
Maximum		274.00	93.00	227.00	161.00	15.72	36.05	28.51	2.65	11.09
Densities of health care providers[c)]										
Mean		0.68	0.27	0.54	0.53	1.77	6.11	–	–	–
Standard deviation		1.16	0.30	0.55	0.07	2.63	7.77	–	–	–
Minimum		0.00	0.00	0.00	0.33	0.00	0.00	–	–	–
Maximum		10.14	2.87	4.39	0.76	13.38	53.87	–	–	–

Notes: [a)] Number of hospital beds in a district, in 100. [b)] Income in 1,000 Euro per person. [c)] Calculated as the total number of physicians/hospital beds in a district over 1,000 inhabitants. PSP ... public specialist, PGP ... private general practitioner, CSP ... private specialist, CGP ... public general practitioner.

practitioners we have much lower entries of around 0.3 and 0.5 (2.9 and 0.8), respectively.

Average annual income (net of taxes), measured by a district's total income to population size, amounts to about 17,400 Euro (the minimum is about 14,700 Euro and the maximum amounts to 28,500 Euro). The largest district in our sample is around 1,100 km^2, with an average value of 270 km^2. Further, we observe an average of around 123 (400) hospital beds in the private (public) inpatient sector. The corresponding maxima lie around 1,572 and 3,605 beds. Finally, the correlation matrix at the top of the table reveals that there is a close relationship between all suppliers of the health care system, which is not surprising given the above-mentioned interrelations among public and private physicians and hospital facilities.

Table 3 summarizes the distribution of physicians over 14 specialties; the upper table block refers to private, and the lower one to public physicians. Within the group of private physicians, the main specializations are represented by internists (around 22.5 percent of all specialists), surgeons (21.7 percent), neurologists (14.3 percent) and gynecologists (12.7 percent). These are also the largest specializations among public physicians. There, our sample includes about 17.4 percent internists, 8.7 percent surgeons, 12.5 percent neurologists and 14.3 percent gynecologists. Looking at the maximum entries, we observe some specializations with rather low representations in both groups of physicians, which is especially the case for lung doctors, urologists, laboratory diagnostics and radiologists. In the empirical analysis below, we account for the composition of specializations by (i) analyzing the whole group of SPs, and (ii) by focusing on specializations with relatively strong

representations in our sample of private physicians, i.e., internists, surgeons, neurologists and gynecologists.

Table 3: Private and public physicians per specialty

	Mean	**Std.Dev.**	**Min.**	**Max.**	**Hosp.**[a)]
Private physicians					
General Practitioners	15.76	15.04	0	93	11.63
Specialists	37.24	47.46	0	274	51.37
Ophthalmologists	1.42	2.68	0	17	56.73
Dermatologists	1.47	2.51	0	16	43.50
Gynecologists	4.71	5.04	0	29	57.02
Otolaryngologist	1.13	1.88	0	14	63.19
Pediatricians	1.75	2.44	0	13	45.50
Lung doctors	0.46	1.03	0	7	60.00
Neurologists	5.33	8.07	0	41	45.41
Orthopedists	2.24	3.01	0	20	52.98
Urologists	0.96	1.56	0	8	53.72
Laboratory diagnostics	0.40	0.88	0	6	61.70
Radiologists	0.93	1.52	0	11	49.55
Surgeons	8.07	12.27	0	81	67.64
Internists	8.38	10.82	0	70	58.00
Other specialists	2.50	3.70	0	31	54.84
Public physicians					
General Practitioners	34.98	20.58	1	161	7.89
Specialists	32.42	33.13	0	227	19.66
Ophthalmologists	3.08	3.03	0	23	24.60
Dermatologists	2.32	2.47	0	17	26.41
Gynecologists	4.64	5.00	0	38	20.00
Otolaryngologist	2.03	2.14	0	16	40.73
Pediatricians	2.58	2.60	0	20	18.71
Lung doctors	1.25	1.46	0	10	18.95
Neurologists	4.04	4.21	0	32	37.30
Orthopedists	2.31	2.53	0	13	33.81
Urologists	3.53	3.63	0	21	36.47
Laboratory diagnostics	0.39	0.75	0	5	72.92
Radiologists	1.81	1.75	0	10	44.69
Surgeons	2.82	3.83	0	22	48.26
Internists	5.64	6.27	0	46	29.84
Other specialists	0.89	1.56	0	10	45.37

Notes: [a)] Share of physicians working in public and private hospitals.

The last column of Table 3 reports the share of physicians working in a public or private hospital in addition to the activities in their practices. In this regard, we can see that there are large differences between GPs and SPs on the one hand, and between private and public specialists on the other one. On average, more than 50 percent of all private specialists take up such outside activities, a share that varies between 18 (pediatricians) and 68 percent (surgeons).

Table 4 describes how (private and public) SPs and GPs are distributed over the Austrian districts. For example, we can see that there are seven districts in Austria with less than five $PSPs$ located within the district. The lion's share of the Austrian districts sustain more than five and less than 25 private physicians, especially in the group of

PSPs. With regard to public physicians, we observe the main group of representation in the classes of more than 5 and less than 25 and of more than 25 and less than 50 physicians. Generally, we have relatively few districts with a low representation in our sample, so that it seems enough variation over districts rendering regression analysis possible.

Table 4: Number of physicians per district (year 2008)

Number of physicians	**PSP**	**PGP**	**CSP**	**CGP**
Less than 5	7	19	13	2
More than 5 and less than 25	56	79	54	39
More than 25 and less than 50	30	18	32	61
More than 50	28	5	22	19
Sum	*121*	*121*	*121*	*121*

Notes: PSP ... private specialist, *PGP* ... private general practitioner, *CSP* ... public specialist, *CGP* ... public general practitioner.

Finally, we provide four figures in the Appendix depicting the spatial distribution of *PSPs* (Figure 2), *PGPs* (Figure 3), *CSPs* (Figure 4) and *CGPs* (Figure 5), where the borders represent the districts as our observational units (all entries in the figures relate to 2005). Each entry in these figures indicates a physician's location. Comparing the figures for (private and public) *SPs* with the ones of *GPs* we can see that the former are more located in agglomerations (i.e., the larger cities), while the latter are more uniformly distributed over both rural and urban areas. This pattern is less pronounced for private physicians.

3.2 Specification and Estimation

We are interested to explain the densities of (i) *PSPs* and (ii) *PGPs* as a function of (public and the remaining private) physicians and other demand- and supply-related covariates of a district. Our sample includes 121 Austrian districts over seven years, so that we can rely on a balanced panel. We estimate two separate regressions, which read as

$$PSP_{it} = \alpha_1 PGP_{it} + \alpha_2 CSP_{it} + \alpha_3 CGP_{it} + \mathbf{X}_i\boldsymbol{\delta} + \lambda_i + \nu_{it}, \quad (1)$$

$$PGP_{it} = \beta_1 PSP_{it} + \beta_2 CSP_{it} + \beta_3 CGP_{it} + \mathbf{X}_i\boldsymbol{\gamma} + \mu_i + \varepsilon_{it}, \quad (2)$$

where i indicates the i^{th} district, $i = 1, ..., n$. t is a time index, $t = 1, ..., T$. *PSP*, *CSP*, *PGP* and *CGP* represent time-variant densities of private and public specialists as well as private and public general practitioners. As mentioned above, physician density is measured as the number of a group of physicians within a district per 1,000 inhabitants. $\mathbf{X}_i$ contains a matrix of independent variables including a district's availability of hospital beds in the public and private sector, average income, an index of its educational level (see footnote 6), and living area. Living area and the number of beds in private and public hospitals are time invariant as well as all of the remaining variables in $\mathbf{X}$ as they refer to

the year 2001 (the year where the actual population census has been carried out). λ_i and μ_i represent unobserved i-specific effects, ν_{it} and ε_{it} are idiosyncratic error terms.

From the discussion of Figure 1 and also the correlation matrix in Table 2 it is obvious that the right-hand-side densities of private physicians are probably endogenous. Further, we should also account for endogeneity of (time-invariant) density of hospital beds in the private sector. For instance, it might be true that the PSP density in eq.(1) is influenced by a district's PGP density, but causation might also run in the opposite direction if the presence of $PSPs$ raises a district's attractiveness for $PGPs$ due to increased referral opportunities. Similarly, it is reasonable that private hospitals are located in areas where the availability of private physicians is high. Such endogeneity issues also apply to eq.(2). We assume that these interrelations are i-specific, so that the density of $PGPs$ is correlated with λ_i in eq.(1) and orthogonal to ν_{it}, and the one of $PSPs$ is correlated with μ_i and orthogonal to ε_{it} in eq.(2). Further, we assume that the right-hand-side densities of both public physicians and public hospital beds are exogenous, which might be justified by the fact that they are determined by the physician capacity and hospital plans.

Applying a fixed effects (FE) estimator under these conditions would remove the time invariant $\mathbf{X}_i$-variables, but still provides consistent estimates of α_1 and β_1 as well as of α_2, α_3, β_2 and β_3 (see, e.g., Greene 2008: 337). To estimate the parameters $\boldsymbol{\delta}$ and $\boldsymbol{\gamma}$, we apply a random effects model as developed by Hausman and Taylor (1981). Hausman and Taylor (1981) propose to assess the effects of time-invariant variables in panels by generalized least squares (GLS) applying an instrumental variable estimator to treat possibly endogenous regressors. In our case, this approach is useful to address the potential endogeneity of the right-hand-side densities of private physicians and private hospital beds. Basically, the HT-estimator starts with the consistent FE-estimates, takes the within residuals of this regression, say $\hat{e}_{it}$, and, in a second step, regresses $\hat{e}_{it}$ on $\mathbf{X}_i$ using the time-variant exogenous variables as instruments (in our case, the densities of public physicians). From this, we obtain estimates of $\hat{\boldsymbol{\delta}}$ and $\hat{\boldsymbol{\gamma}}$, which, along with the estimates of the α's and β's from the within regression, can be used to estimate the variance components $\hat{\sigma}^2_\lambda$ ($\hat{\sigma}^2_\mu$) and $\hat{\sigma}^2_\nu$ ($\hat{\sigma}^2_\varepsilon$) in eq.(1) [eq.(2)]. The estimated variance components can be used to apply a GLS transformation on each variable in the model.[7] Denoting the GLS transform of each variable with '$*$', we finally obtain the HT-estimator from the regressions

$$PSP^*_{it} = \alpha_1 PGP^*_{it} + \alpha_2 CSP^*_{it} + \alpha_3 CGP^*_{it} + \mathbf{X}^*_i\boldsymbol{\delta} + \lambda^*_i + \nu^*_{it}, \tag{3}$$

using the within average $\bar{y}_{it}$, $\bar{\bar{y}}_{it} = y_{it} - \bar{y}_{it}$ and the level of the time-invariant but exogenous $\mathbf{X}_i$-variables as instruments, where $y \in \{PGP, CSP, SGP\}$. Similarly, the HT-estimator of eq. (2) is exploited from

[7] Denoting each variable in our model with w, the GLS transform is given by $w^*_{it} = w_{it} - \theta\bar{w}_{it}$, where $\theta = 1 - \left(\frac{\hat{\sigma}^2_\nu}{\hat{\sigma}^2_\nu + T_i\hat{\sigma}^2_\lambda}\right)^{\frac{1}{2}}$ in eq.(1) (see Greene 2008: 338). Similar applies to eq.(2).

$$PGP_{it}^{*} = \beta_1 PSP_{it}^{*} + \beta_2 CSP_{it}^{*} + \beta_3 CGP_{it}^{*} + \mathbf{X}_i^{*}\boldsymbol{\gamma} + \mu_i^{*} + \varepsilon_{it}^{*}, \tag{4}$$

using $\bar{z}_{it}$, $\bar{\bar{z}}_{it} = z_{it} - \bar{z}_{it}$ and the level of the time-invariant but exogenous $\mathbf{X}_i$-variables as instruments, where $z \in \{PSP, CSP, SGP\}$. According to Amemiya and MaCurdy (1986), we further assume that the densities of CSP and CGP are orthogonal to λ_i (μ_i) in eq.(1) [eq.(2)], imposing a stricter requirement on the instruments than the original HT-estimator.

To test the HT-model against its FE counterpart we apply a Sargan test on over-identification (see Hayashi 2000: 227). The corresponding test statistic is distributed as χ^2 with T times the number of exogenous time-varying variables minus the number of endogenous time-invariant variables as degrees of freedom. If the test statistic is insignificant, the model is consistent and more efficient than its fixed effects counterpart. If not, one should prefer the FE-estimates. Finally, we take the logarithm of all variables in our empirical models to account for the fact that especially the dependent variables (densities of $PSPs$ and $PGPs$) are not normally distributed but log-normally. We further tested the linear against the logarithmic model applying a J-Test as proposed by Davidson and MacKinnon (1993), indicating that the logarithmic specification outperforms the one without logarithms.[8]

3.3 Estimation results

Table 5 summarizes our estimation results. The Sargan test in the last line of the table is insignificant for both specifications, indicating that our instruments are valid and, therefore, the HT-estimates should be preferred over the ones of the FE-model (not reported in the table). With regard to the time-invariant covariates, we observe insignificant effects of private hospital beds, which might be explained by the fact that this variable is not varying over time and not much over districts. The density of public hospital beds is significantly positive for $PSPs$ and significantly negative for $PGPs$, suggesting that $PSPs$ ($PGPs$) tend to seek (avoid) markets with public inpatient facilities. Education enters positively, but is insignificant in the PGP equation. Income and living area exhibit insignificant effects in both the PSP and PGP equations. Generally, one should interpret the corresponding (negative and positive) parameter estimates cautiously as there is a close correlation between both variables (see Table 2).

Regarding our relationship of interest, we are not able to confirm the competition effect between $CSPs$ and $PSPs$ (*Hypothesis 1*), as the density of $CSPs$ does not appear significant in the PSP equation. However, this might be due to the choice of the dependent variable, as the effects between different specialties might cancel out each other, leading to a non-significant coefficient for $CPSs$. For instance, it is reasonable that otolaryngologists

[8] Below, we do not report the results of FE-estimation and also the ones without logarithms for the sake of brevity. They are available from the authors upon request.

or gynecologists do not compete with dermatologists in a region. Below, we account for this measurement issue distinguishing between different specialties in our regressions. In contrast, *Hypothesis 1* is confirmed for $PGPs$, where we observe a significantly negative impact of CGP density, indicating a dominance of the competition effect over the referral effect.

Table 5: Estimation results

	PSP	PGP
Density of PSP	–	0.371^{***}
		(0.038)
Density of PGP	0.679^{***}	–
	(0.118)	
Density of CSP	-0.036	-0.060
	(0.167)	(0.091)
Density of CGP	$-0.376^{\#}$	-0.396^{***}
	(0.254)	(0.127)
Density of private hospital beds	-0.017	0.003
	(0.077)	(0.025)
Density of public hospital beds	0.070^{***}	-0.022^{**}
	(0.026)	(0.010)
Average income	0.340	-0.181
	(0.327)	(0.191)
Education	1.656^{**}	0.342
	(0.591)	(0.255)
Living area	0.010	-0.011
	(0.028)	(0.012)
Observations	847	847
Overidentification: $\chi^2(13)$	13.953	10.727

Notes: PSP ... private specialist, PGP ... private general practitioner, CSP ... public specialist, CGP ... public general practitioner. Bootstrapped standard errors in parentheses (50 replications). ***, **, * and $^{\#}$ denote significance at 1, 5, and 10 and 15 percent levels.

With respect to *Hypothesis 2*, we find a weakly significant negative impact of CGP density on the density of $PSPs$, indicating that the competition effect dominates the referral effect for this type of physicians. Thus, $CGPs$ appear to be substitutes rather than complements to private specialists. One obvious explanation might be that $CGPs$ act as profit maximizers and prefer longer treatment processes instead of referring to $PSPs$. As mentioned above, this is due to the institutional design of the Austrian health care system, where GPs are able to refer to a specialist when necessary, although it is not compulsory in most cases. Further, the negative coefficient might reflect that $CGPs$ prefer $CSPs$ rather than $PSPs$ when referring to a specialist.

By way of contrast, we find support for referrals from $PGPs$ to $PSPs$, entering positively in the PSP equation. This lend support to *Hypothesis 3* as it seems that private physicians (GPs and SPs) closely collaborate with each other and to some extent build up networks within their districts. Similarly, the coefficient of PSP density in the equation

for $PGPs$ is also positive and significant, implying a certain degree of network and cooperation effects, which might be the result of referrals among private physicians (*Hypothesis 3*). Similar to the PSP equation, we find no significant relationship between the densities of $CSPs$ and $PGPs$.

In sum, our estimation results from Table 5 reveal that $PSPs$ and $PGPs$ tend to establish networks or cooperations within their districts. The density of $CGPs$ enters significantly negative in both equations, indicating competition effects especially with $PGPs$ and a relatively low importance of referrals to $PSPs$. For $CSPs$, we are not able to identify any significant effects on the densities of $PGPs$ and $PSPs$. It should be noticed that the latter include a wide variety of very different specialities (see Table 3), which might explain the insignificant impact of $CSPs$, as discussed above. We account for this by re-estimating eq.(2) separately for the four largest groups of specialities reported in Table 3 (i.e., internal specialists, surgeons, neurologists and gynecologists), including the corresponding densities of $CSPs$ as the right-hand-side variable, among the other ones in eq.(2). The estimation results from this exercise are reported in Table 6. Again, we rely on the HT-estimates, which can be justified by the insignificant Sargan test statistics reported in the bottom line of the table.

Table 6: Estimation results for specific specialisations

	Physician density			
Variable	PSP^S	PSP^N	PSP^G	PSP^I
Density of PGP	0.164^{***}	0.150^{***}	0.134^{***}	0.164^{***}
	(0.050)	(0.056)	(0.044)	(0.039)
Density of $CSP^{a)}$	-0.473	-0.300^{*}	-0.555^{**}	-0.469^{**}
	(0.468)	(0.183)	(0.199)	(0.166)
Density of CGP	-0.322^{*}	0.054	-0.056	-0.200^{**}
	(0.168)	(0.085)	(0.137)	(0.092)
Density of private hospital beds	0.010	0.096^{*}	0.067^{*}	-0.020
	(0.043)	(0.050)	(0.038)	(0.050)
Density of public hospital beds	0.021^{*}	-0.003	0.014	0.015
	(0.012)	(0.014)	(0.014)	(0.016)
Average income	0.132	$0.354^{\#}$	$0.314^{\#}$	-0.143
	(0.198)	(0.244)	(0.202)	(0.265)
Education	0.671^{*}	0.280	0.104	1.290^{***}
	(0.362)	(0.302)	(0.286)	(0.290)
Living area	-0.002	-0.030^{**}	$-0.017^{\#}$	0.002
	(0.007)	(0.013)	(0.012)	(0.009)
Observations	847	847	847	847
Overidentification: $\chi^2(13)$	14.556	9.465	9.597	17.500

Notes: $^{a)}$ Public physician with identical specialty as the corresponding dependent variable. PSP^S ... private surgeons, PSP^N ... private neurologist, PSP^G ... private gynecologists, PSP^I ... private internists. Intercept not reported. Bootstrapped standard errors in parentheses (50 replications). ***, **, * and $^{\#}$ denote significance at 1, 5, and 10 and 15 percent levels.

Comparing the estimation results of Table 6 with the ones of Table 5, we firstly observe positive parameter estimates for the density of $PGPs$, which seems to confirm the above mentioned cooperation and network effects between private physicians according to *Hypothesis 3*. Further, and in line with *Hypothesis 2*, we find negative effects of CGP density again, indicating competition between $PSPs$ and $CGPs$. The exceptions are neurologists and gynecologists with insignificant parameter estimates, but significantly positive estimates for private facilities of inpatient care. This is not surprising as patients usually do not visit a GP when demanding services from these specialities. Most importantly however, we now find a significantly negative impact of CSP densities on the ones of private specialists in three out of four regressions (the exception is private surgeons in column 1 of Table 6), indicating that there is competition between private and public specialists within the same specialization. This result is consistent with *Hypothesis 1* and, to some extent, it also confirms Atella and Deb (2008), who find a substitutive individual health care utilization between public and private physicians using Italian data.

Overall, our estimation results suggest that referrals from $CGPs$ to $PSPs$ are obviously not strong enough to compensate competition forces between public and private physicians, which are inherently present in the two-tiered Austrian health care system. In contrast, we find a more pronounced referral behavior for $PGPs$, indicating cooperation and network effects within private physicians. Further, our results reveal that location decisions of $PSPs$ are negatively associated with the density of $CSPs$ (at least within the same specialty), suggesting that the market for outpatient health care of specialists reacts to competitive forces.

4 Conclusions

This paper assesses location decisions of physicians as measured by physician densities at the regional level. We extend the previous research relying on a two-tiered health care system with co-existing public (contracted) and private health care providers. Using data from 121 Austrian districts between 2002 and 2008 we focus on four groups of physicians: public general practitioners and specialists as well as their private counterparts. The latter are almost free to set prices for their services and, apart from that, are not restricted in their location choices. Therefore, we estimate the densities of (i) private specialists, and of (ii) private general practitioners as a function of the densities of public general practitioners and specialists and the remaining density of private physicians, along with other control variables such as the availability of private and public inpatient facilities within a district. Some of these variables are potentially endogenous, others are time-invariant (e.g., the availability of hospitals), suggesting to apply a Hausman-Taylor framework for panel data in our application.

Our findings might be summarized as follows. First, we find a positive association between the densities of private general practitioners and private specialists, indicating a

relatively strong referral effect between these groups of physicians. One reason might be strong collaboration or even the existence of medical networks among private physicians. Second, we observe a negative impact of the density of contracted specialists on the one of private physicians, indicating relatively strong competition forces among these physicians. Finally, we observe a negative impact of the density of public general practitioners on both private general practitioners and private specialists. While the former result might be explained by competition among (public and private) general practitioners, the latter might be a result of the referral behavior of public general practitioners, who tend to prefer public physicians when referring to specialists.

Our findings contribute to the ongoing debate whether services of private physicians should be considered in the capacity plans of public health care provision in Austria. Private resources of outpatient care are not included in the physician capacity plans so far. We observe a marked increase in the number of private physicians ($PSPs$ and $PGPs$) over the course of the years, while the number of public physicians strictly follows the capacity plans, and, therefore, remained nearly constant over the same time period. The relevance of the private health care sector might increase further given a high number of medical graduates from universities. Our evidence shows that private and public outpatient care is strongly substitutive, suggesting that a large share of the existing demand for health services is covered by private physicians. Considering these resources explicitly in the capacity plans might contribute substantially to improve the efficiency of the Austrian health care system.

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5 Appendix

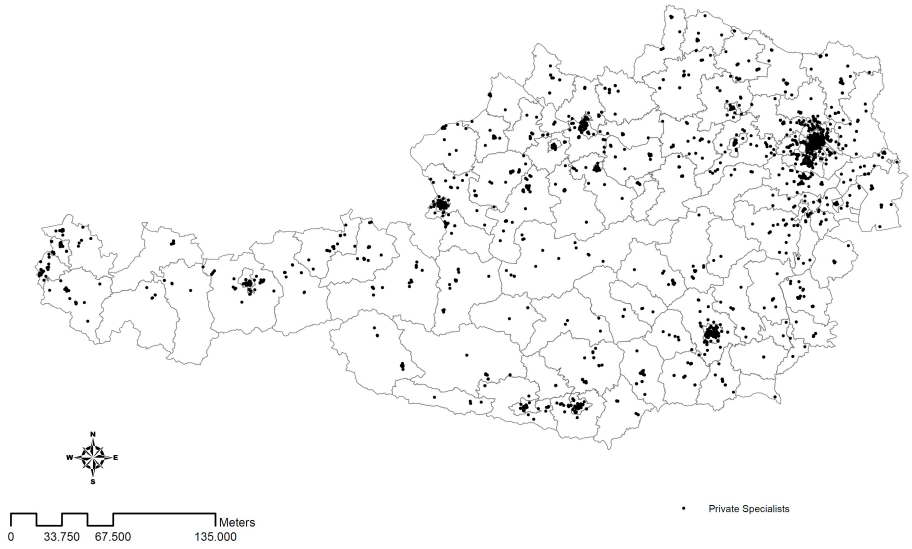

Figure 2: Spatial distribution of private specialists

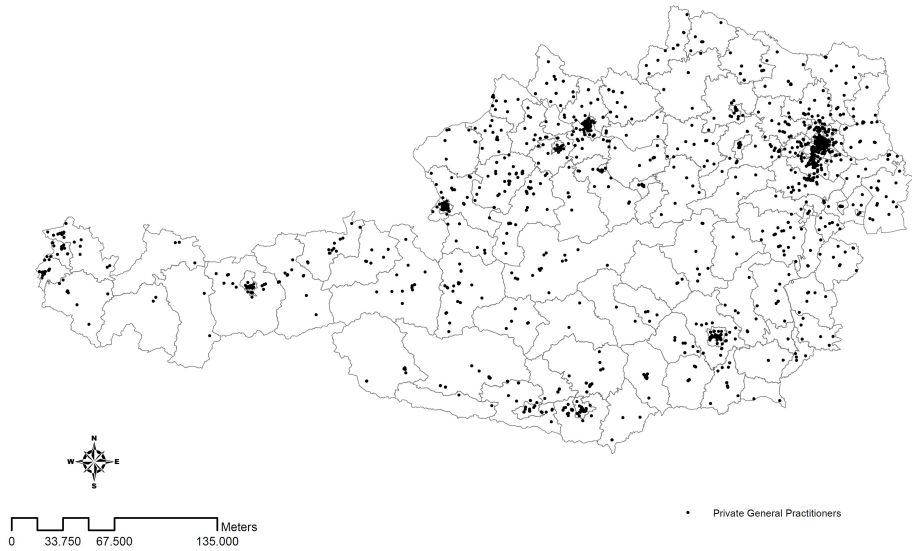

Figure 3: Spatial distribution of private general practitioners

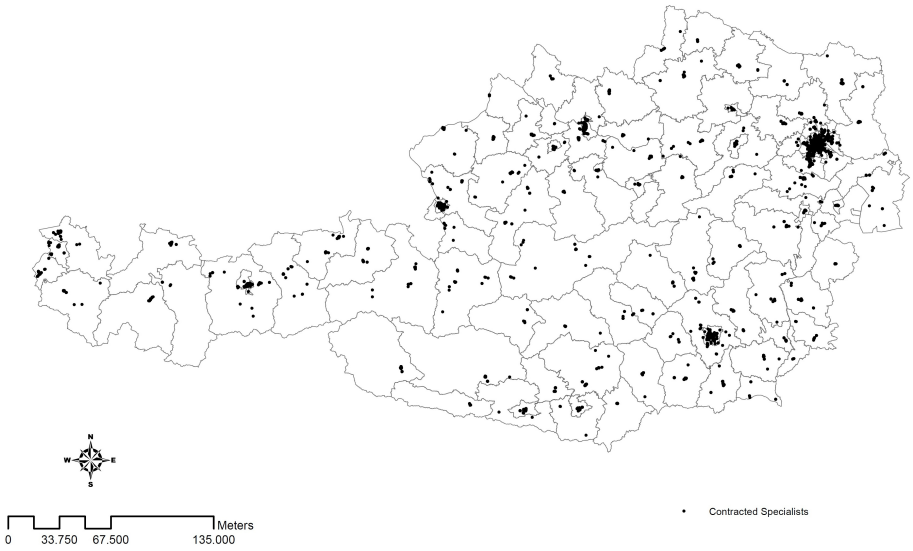

Figure 4: Spatial distribution of public specialists

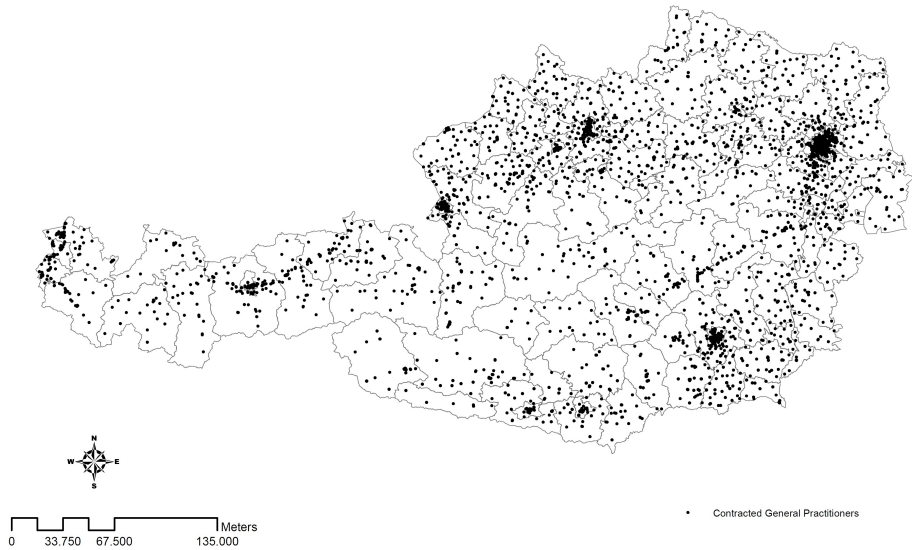

Figure 5: Spatial distribution of public general practitioners

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