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Old Boys' Network in General Practitioner's Referral Behavior?*

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Abstract

We analyzed the impact of social networks on general practitioners' (GPs) referral behavior based on administrative panel data from 2,684,273 referrals to resident specialists made between 1998 and 2007. To construct estimated social networks, we used information on the doctors' place and time of study and their hospital work history. We found that GPs referred more patients to specialists within their social networks and that patients referred within a social network had fewer follow-up consultations and were healthier as measured by the number of inpatient days. Consequently, referrals within social networks tended to decrease healthcare costs by overcoming information asymmetry with respect to specialists' abilities. This is supported by evidence suggesting that within a social network, better specialists receive more referrals than worse specialists in the same network.

Keywords: Referral behavior, general practitioners, information asymmetry, social networks

JEL Classification Numbers: I1, I11

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1 Introduction

In most health-care systems, general practitioners (GPs) serve as gatekeepers who coordinate access to health-care services provided by resident medical specialists, out-patient departments, and hospitals. Though institutional settings differ between countries and health-care systems, primary care providers can either diagnose and treat patients themselves or refer the patients to medical specialists.[1] Patient referrals from GPs to specialist care (resident doctors or hospitals) are of particular importance in health policy. (i) Quantitative evidence has shown that follow-up health-care costs vary substantially depending on GPs' referral behavior.[2] (ii) A quality-cost tradeoff for patients' health may exist depending on whether they are being referred on to further specialists or receive treatment from the GP. (iii) Finally, the introduction of managed care in national health systems has changed the responsibility and flexibility of GPs in their referring behavior by limiting the number of consultants that patients are allowed to be referred to, and by shifting control over health-care delivery from doctors' judgment toward predetermined bureaucratic mechanisms such as referral guidelines. Regardless of whether referral rates are high or low, the policy-relevant question is whether referrals are medically and economically appropriate or not. Obviously, from a medical point of view, the referral behavior of GPs should be based on medical criteria. Apart from that, economic considerations influence the referral behavior of GPs due to scarcity of resources in health-care systems.

Under the traditional view of microeconomics, interactions between economic agents take place via markets and their signals (Manski, 2000; Soetevent, 2006). However, in a regulated health-care sector where costs for medical services are covered by social insurance, the price mechanism does not function as normal. This is particularly true in Bismarckian fee-for-service (FFS) health-care systems. As a result, we propose that social interaction plays an important role in doctors' referral behavior. In this paper, we analyze the referral

[1] In a strict gatekeeping system, GP referrals are compulsory for patients to utilize medical specialists.

[2] For example, Crombie and Fleming (1988) found a 10-fold difference in hospital expenditures for GP practice populations associated with the lowest and highest rate of referrals to hospitals.

behavior of GPs who refer patients to resident specialists for further diagnosis and treatment. Based on comprehensive administrative panel data for the Austrian province of Upper Austria for the period of 1998-2007, we identified the determinants of GPs' referral rates and analyzed the role played by social networks. Further, we assessed the referrals' appropriateness by estimating the effects of social networks on the timeliness and destination of a referrals as well as the health status and outpatient expenditures of the referred patients. Finally, we tested whether social networks contributed to overcoming information asymmetries with respect to specialists' quality.

We found that doctors' networks formed at the teaching hospital played an important role in their referral behavior. The number of referrals from a GP to a medical specialist increased, ceteris paribus, if both doctors had worked in the same teaching hospital, and additionally, if they had worked there at the same time. Moreover, patients referred within a social network had fewer follow-up consultations with another specialist in the same medical field, and compared to patients referred outside the social network spent fewer subsequent days in the hospital; they also lost less work time due to illness. A network referral increased the waiting time of patients slightly, though we did not find any differences in outpatient expenditures or subsequent re-referrals to specialists from other medical fields. From this, we conclude that referrals within doctor's social networks were more appropriate as they neither adversely affect patients' health nor increase health-care costs. Further empirical evidence showed that within hospital and co-worker networks, higher-quality doctors received more referrals than lower-quality doctors compared to referrals outside of the network. This supports our hypothesis that social networks help to reduce information asymmetry with respect to specialists' abilities.

Previous studies focused on the following determinants of referral behavior: (i) patient characteristics, (ii) GP characteristics, (iii) practice characteristics, and (iv) the availability of specialist care.

Patient characteristics: O'Donnell (2000) reported in her comprehensive literature survey that age and gender may explain approximately 10 percent of the variation observed in referral rates. Salam-Schaatz et al. (1994) showed that controlling for patient characteristics (age, gender, and case-mix) decreased the variation in primary care doctors' referral profiles by more than 50 percent.

GP characteristics: The empirical evidence on the most important GP characteristics, namely their age and years of experience, was inconclusive. Whereas several UK studies did not identify any significant impact of age or experience on a GP's referral rate (Cummins et al., 1981; Wilkin and Smith, 1987), one Finnish study (Vehvilainen et al., 1996) and another UK study (Rashid and Jagger, 1990) reported higher referral rates for younger and relatively inexperienced primary care providers.

Practice characteristics: O'Donnell (2000) reported similar conflicting evidence of the impact of practice characteristics on variation in referral rates. Whereas several authors found a positive association between high referral rates and single-handed practices (Hippisley-Cox et al., 1997a), others reported no relationship between referral rates and the number of doctors in a practice (Christensen et al., 1989). Conversely, Verhaak (1993) found an increase in referral rates with the number of GPs in the practice. A series of empirical studies stressed the importance of the availability of specialist care in explaining referral rates (Jones, 1987; Noone et al., 1989; Roland and Morris, 1988). Madeley et al. (1990) found that urban GP's have higher referral rates than their rural counterparts.

O'Donnell (2000) concluded that patient characteristics together with practice and GP characteristics cannot explain more than 50 percent of the variation in referral rates. Qualitative empirical evidence suggests that "having a personal relationship with the consultant" is one of the most important determinants of referral decisions in a fee-for-service (FSS) environment (Shortell, 1973) and indicates that GPs also rely on consultants' professional reputations in their referral decision-making (Ludke, 1982). Similarly, Whynes et al. (1998) suggested that GPs' choice of referral destination is dominated by their knowledge of and confidence in the hospital consultants and by their physical proximity. Anthony (2003) argued that in addition to personal and professional relationships, FFS referrals rely on direct communication between the providers and on the opportunities to monitor one another in the referral process.

Referral processes based on social networks may work well as they facilitate the flow of information and control (Grembowski et al., 1998). For example, network participants may gain information on others' reliability and reputation, either through past experience or via third party connections. This corresponds with the economists' notion of statistical discrimination, under which rational agents may favor or disadvantage different social groups (Arrow, 1973; Phelps, 1972). The term "statistical discrimination" means that a group affiliation is used as a decision criterion if the productivity signals of the agents (the medical ability of specialists) are differently informative within and outside of the network.[3] Consequently, GPs may refer patients to specialists within their network because it is easier to assess the strength and ability of these specialists. Another important argument is that social relationships allow social control and increase the conformity to rules and norms (Horne, 2001). Social and professional relationships in referral processes do not, however, guarantee per se a high quality of health-care. "Referral relationships based in social ties may be stuck in old-boy networks, or based on friendship or inertia, resulting in referrals to known, but not necessarily high-quality providers" (Anthony, 2003, p. 2035). Schaffer and Holloman (1985) found that GPs selected their consultants from a group of colleagues with whom they shared a background, interests, or training. However, the authors did not offer a strategy for normative statements about the patients' welfare or the health-care system. Neither the size of referral rates nor their determinants allow a clear judgment whether referrals are appropriate or not.

Coulter (1998) specifies a referral as appropriate if it is necessary for the patient, effective in achieving its objectives, timely in the course of the dis-

[3] Note that the literature on statistical discrimination distinguishes two cases (for a broader survey, see for instance Fang and Moro (2011)): Let us assume that GPs are interested in the specialists' quality q. In the first case the group identity is used as the signal for different group averages of the quality. The second case assumes identical distributions of q for the two groups, but the signals on q for the two groups are differently informative. In this second case, a rational agent decides in favor of the group in which quality can better be assessed. Throughout the paper, we refer to the second case when discussing statistical discrimination.

ease, and cost effective.[4] Similarly, Foot et al. (2010) argued that there is no commonly agreed-upon definition of "high-quality" referrals. Based on their literature review, they evaluated the quality of a referral along the dimensions "necessity, timeliness, destination, and process."[5] Most available qualitative studies on the appropriateness of referrals have included joint reviews of the sending and receiving doctors for a series of referrals. The available evidence is mixed, with some hospital consultants being critical of GPs' referrals, and other studies suggesting that GPs in general do refer appropriately.[6]

This paper extends the literature in several ways: (i) we used a unique comprehensive panel dataset that allowed the estimation of gravity models for pairs of sending and receiving doctors including GP and specialist fixed effects, (ii) the match of this panel dataset with doctor characteristics provided by the Medical Chamber allowed for a good representation of doctor's personal networks, (iii) we provide evidence for the determinants of referrals with particular emphasis on the role of social networks, and (iv) we estimated the appropriateness of referrals within social networks using various patient outcomes. (v) Finally, we provide evidence suggesting that social networks are suitable to overcome information asymmetries between GPs and specialists. The role of social networks in patients' referrals in particular (including an analysis of patient outcomes) has not, to our knowledge, been quantitatively analyzed before now.

The rest of the paper is organized as follows: Section 2 presents the institutional setting in the Austrian outpatient health-care sector. Section 3 describes the data; descriptive statistics are shown in Section 4. Section 5 presents the empirical strategy, the results of which are presented in Section 6. Robustness Checks are discussed in Section 7 and Section 8 concludes the paper.

[4] An extended welfare economic perspective might focus on the net benefits of referrals; this would, however, require the economic (monetary) evaluation of health benefits.

[5] See also Blundell et al. (2010).

[6] See O'Donnell (2000, p. 467) for a brief review of this literature.

2 Institutional setting

In Austria, every resident is covered by mandatory health insurance administered through 25 (regional) "sickness funds". Residents cannot freely choose among these funds; they are assigned to a fund depending on their occupation and place of residence. The sickness funds cover all costs associated with maternity and illness. Since deductibles and copayments are small in general, access to the health-care system is not limited by financial constraints. The majority of ambulatory care is provided by resident doctors including GPs and medical specialists.[7] Although patients can freely select among all available GPs, they usually consult a GP located close to their primary residence. In fact, we observed that 73.7 percent of patients' home zip codes were the same as the zip code of their GPs' practice.[8] Note that for a substantial number of patients, the nearest doctor might reside in a neighboring community with a different zip code. The GP is expected to coordinate patient care and serves as the recommended first point of contact in non-emergency cases. This gatekeeping function is justified by the fact that doctors can better decide on appropriate treatment than patients. Based on their diagnoses, GPs have to decide whether the further services of medical specialists are necessary. However, in the Austrian health-care system, the GP does not receive any fee for referring patients and is not responsible for the costs of specialist care. If the GP decides that specialist care is necessary, he or she refers the patient to a specialist in that particular field. The patient is then eligible to consult one doctor in this field per calendar quarter. GPs are free in their decision to select a suitable specialist.

[7]These two groups of providers account for 78.9 percent of total ambulatory expenditures in Austria, or 5.8 bn Euro in 2010. Source: OECD System of Health Accounts: http://www.statistik.at/web_de/statistiken/gesundheit/gesundheitsausgaben/index.html. Accessed May 5, 2012.

[8]Based on survey results, Salisbury (1989) showed that most people chose the nearest doctor, and that patients—in general—did not have much information on the doctor's practice. We found no indication that patients had enough information to select their GPs according to the GPs' social networks.

3 Data

For our empirical analysis, we used administrative data from the *Upper Austrian Sickness Fund*. This database includes detailed information on the health-care service utilization of approximately 1.1 million private employees and their dependents; this represents 75 percent of the provincial population. The data comprise health-care services provided by 957 doctors, including information on medical appointments, drug prescriptions, approvals for sick leave, and referrals from GPs to medical specialists. The referral data-set includes 2,684,273 referrals from 575 GPs to 382 medical specialists between 1998 and 2007.[9]

For each referral, we recorded the referring GP, the receiving medical specialist, the referred patient, and the specialist's revenues generated by this consultation during the quarter of the referral.[10] From these data, we compiled a yearly panel data-set for each potential GP-specialist pair. On average, 95 percent of a GP's referrals were made to only 35 different specialists. Consequently, 85.3 percent of all GP-specialist pairs did not include any referrals. For each year and pair, we identified the number of referrals and the specialist's revenues as outcomes. We matched this file with data from the Upper-Austrian Medical Chamber to obtain the doctors' socio-economic characteristics such as gender, age, medical field (for specialists), place and time of study, job history, and the zip code of their medical practice. The information on the zip code of their practice allows us to compute the geographic distance between GPs and medical specialists.

4 Descriptive statistics

Table 1 illustrates the development of the average GP referral rate over the observation period, and demonstrates that the percentage of referred patients

[9]We included all doctors who held a contract with the sickness fund for at least one year. The majority of these doctors (75 percent) can be observed in each year.

[10]Revenues paid to specialists in a subsequent quarter were not considered, as it was unclear whether these follow-up treatments were initiated by the GP. This approach might underestimate the true volume of revenue; however, the short time period examined guarantees a conservative approach that does not over-emphasize the GPs' importance.

increased slightly from 15.1 percent in 1998 to 16.6 percent in 2004. However, the referral rate began a sharp decrease in 2005; referral rates were close to 9 percent in 2006 and 2007. This drop can be explained by the introduction of the electronic insurance card in 2005. This card, used for electronic invoicing of medical services, allows patients to see certain medical specialists without a referral slip issued by the primary care provider, as was necessary before 2005. As a result, an increasing number of patients consulted resident specialists without being referred by their GP.[11]

Table 2 shows the number of GPs and specialists per medical field available in our data. The average number of patients treated per year lies between 1,015 (neurology and psychiatry) and 6,795 (radiology). On average, a GP refers 14.7 percent of his or her patients to medical specialists. Column 4 displays the proportions of specialists' patients referred by GPs: Whereas only 3.11 percent of patients treated by pediatricians were referred by GPs, the rate of referred patients was highest for neurologists and psychiatrists (65.12 percent), followed by radiologists (43.84 percent) and surgeons (42.88 percent). This pattern is mirrored by the percentages of revenue generated by referred patients. Neurologists and psychiatrists earn more than 63 percent of their revenue from referred patients, followed by radiologists and surgeons. The revenue per referred patient was highest for internists followed by pulmonary specialists, surgeons, and orthopedists, with internists earning nearly 100 Euro per referred patient per year. Moreover, Table 2 shows that the proportion of female resident doctors is below 10 percent in the fields of urology, surgery, internal medicine, and orthopedics, whereas they represent 32 percent in neurology and psychiatry, 33 percent in dermatology, and 43 percent in pediatrics. The last column indicates that the variation in mean age of doctors is low across medical specialties.

Table 3 includes information on the number of different specialists to whom the average GP refers patients (Panel A) and on the number of GPs from whom the average medical specialist receives patient referrals (Panel B). The average

[11] In the subsequent regression analysis of referral rates, we use period dummies to control for time effects. Moreover, we have no reason to assume that this structural break due to changes in the accounting system correlates with the research question in this paper (the determinants of referral behavior and the role of social networks).

GP referred 21.40 percent of all referred patients to one single specialist and another 11.12 percent to a second. The column of cumulative percentages illustrates that, on average, a GP refers almost 50 percent of all referred patients to only 4 specialists. Similarly, as can be seen in Panel B, the average specialist receives 10.05 percent of referred patients from one single GP, and another 7 percent from a second GP. The cumulative percentages indicate that the average specialist receives 50 percent of referred patients from 10 different GPs.

5 Estimation strategy

Following the standard approach to analyze the determinants of referral behavior, this section presents our empirical strategy to identify the impact of social networks on GPs' specialist referrals.

5.1 Determinants of referral rates: The standard approach

Quantitative research into referral behavior argues that the variation in referral rates of GP i is basically explained by GP-, practice- and patient characteristics. In accordance with this literature (see the Introduction), we present regressions for referral rates of Upper Austrian GPs to resident specialists that controlled for these groups of determinants. In contrast to previous studies, we also tested whether social networks influenced the referral rates. The GP referral rate is estimated by this equation:

$$rate_{it} = \theta\, GP_{it} + \lambda\, practice_{it} + \nu\, patient_{it} + \pi\, network_{it} + \rho_t + \xi_{it} \qquad (1)$$

The dependent variable $rate_{it}$ denotes the referral rate of a GP in period t, and is defined as the fraction of patients per year who are referred to specialist care (referred patients divided by all patients who consulted the GP per year). GP_{it} denotes GP characteristics including experience (the doctor's current age minus his or her age in the year of graduation from university), experience squared, gender, dummies for marital status, dummies for the university of graduation, and the teaching hospital. Characteristics of a GP's practice were captured by $practice_{it}$ including a city dummy,[12] practice size (measured in cases treated per year), the number of GPs, and the number of specialists in the same zip code area. Moreover, we included patient characteristics ($patient_{it}$) including the proportion of female patients, the average age of the patient group, and patients' labor market status. The vector $network_{it}$ denotes the network variables measured as the share of specialists who belonged to the GP's network divided by the total number of specialists within a 50 km radius of the GP's practice. We constructed the following networks: (i) the share of specialists who graduated from the same *university* as the GP at different points in time, (ii) the share of specialists who were *fellow students* of the GP, (iii) the share of specialists who worked at the same *hospital* as the GP at different points in time, (iv) the share of specialists who were *co-workers* of the GP at the same teaching hospital, (v) the share of specialists of the same gender as the GP, and (vi) the share of specialists in the same age group as the GP. ρ_t are period dummies, and ξ_{it} denotes the error term. We used repeated cross-section ordinary least squares (OLS) estimations.

5.2 The impact of social networks on referral behavior

The aforementioned model, however, only measures the impact of the size of social networks on the GP's overall referral rate; it does not analyze whether GPs prefer specialists within their social network to outsiders for a given referral rate. To examine the distribution of referrals, we observed annual patient flows between each pair of GP and specialist and estimated the following gravity model[13]

[12] The *City* dummy is equal to 1 for the cities of Linz, Wels, and Steyr, that have 191,107, 58,717, and 38,248 inhabitants, respectively. These are the three largest cities that comprise about 20.33 percent of the Upper Austrian population in 2012.

[13] This model is called a "gravity model" due to its resemblance to models of the economics of trade. In this gravity model, the exporting country is represented by the GP and the importing country is represented by the medical specialist. The trade

$$y_{ijt} = \alpha \cdot x_{ijt} + \beta \cdot z_{it} + \mu \cdot r_{jt} + \gamma_i + \eta_j + \delta_t + \epsilon_{ijt} \quad (2)$$

The major difference between equations 2 and 1 is that the unit of observation is no longer the GP, but the GP-specialist pair.[14] In this equation, y_{ijt} denotes either the number of patients referred from GP i to specialist j in year t (referred to as referrals) or the resulting *revenues* of specialist j from the referrals of GP i. Summary statistics for these and the other variables are presented in Table 4.

Our network effects are covered by the vector of pair-variables x_{ijt}, defined as dummy variables equal to one if the respective attribute of GP i and specialist j corresponds, and zero otherwise. For the identification of social networks, we used information on the doctors' place and time of study and their work history.[15] We constructed (i) a dummy equal to one if GP i and specialist j graduated from the same *university* at different points in time, (ii) a dummy equal to one if both were *fellow students*, (iii) a dummy equal to one if both worked at the same *hospital* at different points in time, and (iv) a dummy equal to one if both were *co-workers* at the same *hospital*. For (i) and (iii), we expected that both doctors might know each other indirectly via third party connections. For (ii) and (iv), however, it is reasonable to assume that the doctors knew each other directly. Note that an affiliation with the same social network does not ensure that two doctors know each other; the pair variables rather served as proxies to capture a higher probability of being acquainted with one another. Thus, we expected stronger effects for the networks of *co-workers* and *hospital* than for *university* and *fellow students*.

The variables discussed so far tested whether GPs referred more or fewer patients to specialists with whom they had a personal connection. We refer to these networks as "personal networks." In their comprehensive literature review, McPherson et al. (2001) showed that similar individuals are more likely to interact than dissimilar ones. This phenomenon has been demonstrated

flows are typified by the number of referred patients and the resulting revenues of the specialist.

[14] Each GP is paired with all specialists.

[15] Similar strategies for the construction of networks are used in Cohen et al. (2008) and Gompers et al. (2012).

in a wide range of social settings, e.g, friendship, school, marriage, or work. Therefore, we tested whether similarities in doctors also enhanced collaboration, although they did not reflect a potential personal connection. For this purpose, we constructed (v) another dummy equal to one if the GP and the specialist were of the *same gender*. Similarly, (vi) the dummy for *same age group* was one if the GP and the specialist belonged to the same age group (below/above median age). We used these two variables because this information is rather easily accessible for GPs. This is particularly true for the specialists' gender because only information on his or her first name is required. We called these social interactions "affinity-based networks."[16]. As additional pair variables we included the traveling distance between GP i and specialist j measured in minutes.

It is important to note that the attributes used to construct the pair variables were time-invariant at the doctor level, but varied over doctor pairs. This is because GP i was paired with different specialists j, and vice versa. Thus, it was possible to include both GP and specialist fixed effects denoted by γ_i and η_j, although we used time-invariant information of the individual doctors. The doctor fixed effects account for time-invariant heterogeneity such as education effects influenced by universities or hospitals, and time-invariant ability. Consequently, the pair variables captured the network effects but no idiosyncratic effects based on doctor-specific attributes.[17]

We also included time-varying characteristics of the GP (z_{it}) and the specialist (r_{jt}) such as experience (current age minus age in the year of graduation from university) and each doctor's total annual number of patients. In order to prevent reverse causality, we subtracted any referrals and revenues that had occurred between this pair. To control for changes in referral behavior over time, we included period dummies δ_t. Finally, ϵ_{ijt} denotes the error term.

[16] Obviously, we cannot exclude the possibility that doctors within affinity-based networks know each other personally; this will certainly be true for some of the doctor-pairs within those networks. Nevertheless, we presume that there is a lower probability that doctors know each other within affinity-based networks as compared to personal networks.

[17] For analogous empirical work in trade see Egger and Pfaffermayr (2003) or Silva and Tenreyro (2006).

6 Empirical results

Section 6 presents the main empirical results. Subsection 6.1 starts with a discussion of the determinants of the GPs' referral rate. Subsection 6.2 shows the results for the gravity model and Subsection 6.3 analyzes the effects of social networks on patient outcomes.

6.1 The determinants of GPs' referral rates

The regression results for the determinants of the referral rate are depicted in Table 5. In specification (1), we present the characteristics that were analyzed in previous studies including GP, practice, and patient characteristics. In addition to the existing literature, we also analyze in specification (2) whether network characteristics also influence the referral rate.

As can be seen in column (1), the GP's experience entered the regression inverse by U-shaped with a positive impact of experience on the referral rate for professional experience less than 30 years, and negative impact thereafter. Gender and family status of the GP was not found to be a significant determinant of the referral rate. Single and divorced primary care providers were not significantly different from married doctors (the base category). Similarly, the location of the university from which the GP graduated did not have an effect: The referral pattern of GPs who studied at the medical schools in Graz and Vienna was similar to that of those who studied in Innsbruck (the base category).[18]

The dummy variable city showed a strong and significant impact on a GP's referral rate. The percentage of referred patients increased by 3.80 points if the GP's practice was located in an urban versus a rural area. Another positive influence was observed for practice size, representing the number of patients who consulted the GP per year. Two further supply-side impacts showed the expected signs: The number of specialists in a GP's zip code was an indicator of the availability of complementary good specialist care. As can be seen, an additional specialist in the GP's zip code area increased the referral rate

[18] The regressions also controlled for hospital fixed effects (the hospital where the GP did his or her medical internship after graduation from university) and for period fixed effects.

by 0.17 percentage points. Obviously, GPs were more inclined to refer their patients if the specialists were located in the vicinity of patients' residences. This result is in line with empirical evidence that both a shorter distance between a GP's practice and specialist care and the availability of consultants increased referral rates, as presented in the literature review. Finally, we found a significantly negative influence of the number of GPs in the same zip code area: another GP practice decreased the referral rate of a GP in a zip code area by 0.19 percentage points. This is evidence for substitution.

The GPs' referral rates depended significantly on their patients' age and labor market status. One additional year of mean age increased the referral rate by 0.24 percentage points. This can be explained by the fact that patients' health status deteriorates with age, and that a worsened state of health increases the need for referrals. Moreover, the GPs' referral rate decreased significantly with the share of unemployed, retired, and other patients.[19] A one-percentage-point higher unemployment rate among a GP's patients reduced the referral rate by 0.52 percentage points. The same increase in the share of retired or other patients decreased the referral rate by 0.35 and 0.12 percentage points, respectively. These results support the findings of Sorensen et al. (2009), who showed that persons with low socio-economic status are referred less to practicing specialists and more to hospitals. The influence of the *female share* of patients remained insignificant.

A comparison of column (1) and column (2) reveals that the coefficients remained almost unchanged qualitatively and quantitatively, if we additionally controlled for network characteristics. Among these characteristics, we found statistically significant effects for the *same-gender* and *co-workers* networks, but these effects were of minor quantitative importance. This evidence would suggest that the size of social networks did not substantially influence the GPs' overall referral rate. Nothing is said, however, about the preferential treatment of doctors within the social network. In the next section, we analyze whether increased referrals and revenues to doctors within the GPs' social networks can be observed.

[19] The category "other patients" included mothers on maternity leave, conscripts, individuals on rehabilitation and co-insured children.

6.2 A gravity model of referral behavior

Table 6 provides a first descriptive picture of mean comparison tests for the number of referred patients (referrals) and revenues based on referred patients measured in 2007 Euro (revenues). The social groups according to different network criteria are listed in the rows. Columns (2) and (5) show the means for referrals within the network; columns (1) and (4) list the respective means for referrals outside the networks. The p-values in columns (3) and (6) indicate that the differences in means for all social groups were statistically significant. We found that, on average, more patients were referred within a social network as compared to outside the network and that revenues were higher for referrals to specialists in the network.

These descriptive results are supported by the data in Table 7, which presents the OLS regression results on the determinants of this referral behavior for the gravity model (2). The dependent variables are the annual number of referrals (left panel) and annual revenue from these referrals (right panel). The four different columns (No FE, GP FE, Specialist FE, Both FE) indicate different model specifications with respect to the inclusion of fixed effects.

We found some evidence that GPs refer more patients to specialists who graduated from the *same university* at different points in time. However, when we controlled for GP and specialist fixed effects simultaneously, the significant effects disappeared for both referrals and revenues. For the *fellow-students* network, we found significant (at the 10 percent level) negative effects only in the specifications that controlled for GP fixed effects. In the most comprehensive models with fixed effects for GPs and specialists, the *same gender* variable remained statistically significant at the 10 percent level in explaining the number of referrals (left panel). Our results revealed that having worked in the same *hospital* and having worked there at the same time contrasted with our other network variables over all specifications as stable indicators for higher patient referrals and higher revenue. Given the unconditional sample mean of 1.82 referred patients and 93.64 Euro revenue, the increase of 1.21 patients (or 60.60 Euro) for having worked in the same hospital and additional 1.08 patients (72.82 Euro) for having been *co-workers* is substantial.

Networks formed at the teaching hospital therefore seemed to be more influential than university networks. Obviously, we cannot directly measure whether two doctors knew each other personally; rather, our variables indicate the probability that they might have interacted. Given the structure of Austrian medical schools and hospitals, this probability is likely lower in a university setting compared to the normal operations of a hospital. Other controls showed the expected signs: specialists with a medical practice closer to the GP and with a larger number of patients (higher reputation) received more referrals. Whereas the experience of a GP had no influence on the referral behavior, younger specialists received on average more patients and higher revenues. GPs with a high number of patients also referred more patients.

6.3 Social networks and patients' outcomes

The identification of significant social network effects on the doctors' referral behavior per se did not allow an appraisal of the welfare implications of the referral practice. Unfortunately, data on patients' benefits were not available, so we cannot offer a rigorous welfare analysis. However, we present empirical evidence on the appropriateness of referrals based on indicators that clearly corresponded with the patients' well-being. Although the literature lacks a commonly agreed-upon definition of high-quality referrals, different multi-dimensional criteria for the appropriateness of referrals exist. Blundell et al. (2010) and Foot et al. (2010) list the following criteria: (i) "Necessity" asks whether the referral of a patient is necessary from a medical point of view; (ii) "timeliness" identifies whether the referral takes place without avoidable delay. (iii) According to "destination," the question is whether the patients are referred to the most appropriate destination. (iv) The criterion "process" focuses on the quality of the referral process per se (e.g., Is there a referral letter? Are the patients' preferences considered in the selection process?). We offer two further criteria in addition to these criteria discussed in the literature: (v) the "competency" of the specialist in solving the patient's medical problem, and (vi) an assessment of the effects on "outpatient expenditures" within the health system.

In the following section, we analyze the appropriateness of referrals based on indicator variables for the criteria (ii)-(vi).[20] To estimate the effects of social networks on these indicators we used the identical econometric framework as presented in equation (2). In this section, however, we changed the dependent variable and used the respective indicators as discussed below. With the exception of "timeliness" we measured the indicators q quarters—with $q \subseteq \{1, 2, 3, 4\}$—after the initial referral from GP i to specialist j and presented the results including fixed effects for both doctor types. As the effects of referrals within social networks on patient outcomes can only be estimated for doctor pairs with referrals greater than zero, the number of observations decreased from 1,502,333 to 220,698 annual GP-specialist pairs.[21]

6.3.1 Destination

We used two different variables for the criterion destination: (i) "Follow-up consultations" measured how many patients consulted another specialist in the same medical field after the initial referral from GP i to specialist j. A follow-up consultation may indicate that the initial referral was inappropriate, and that the patient was not satisfied with the specialist's treatment. Consequently, the patient consults a new specialist. Apart from the potential harm to the patients, follow-up consultations result in additional expenditures for the health-care system. (ii) "Subsequent referrals" measured how many patients have been re-referred to a specialist in another medical field by the original specialist to whom the patient was referred. A subsequent referral may indicate that the GP made an error and selected the wrong medical field. Obviously, both events might regularly occur in daily medical practice without any negative connotation (for example, if a patient moves to another area and therefore has to consult another specialist, or when specialists refer their patients to radiologists for further tests).[22] In both cases, however, we should not

[20] We cannot deliver evidence on the criteria (i) necessity. The data used did not include any information on this.

[21] We also estimated the determinants of referral behavior (Table 7) with the restricted sample. The results (not shown in this paper) depicted qualitatively identical results, however, with a somewhat reduced statistical significance.

[22] We presume that subsequent referrals happen more often in daily medical practice, whereas follow-up consultations would be more typical for dissatisfied patients and are therefore a better predictor of patients' well-being. Thus, we interpreted

expect differences for referrals within and outside of social networks. Hence, a statistically significant difference for the number of follow-up consultations and subsequent referrals for referrals within and outside of social networks allows an assessment of the appropriateness of referral behavior.

Our results on the determinants of follow-up consultations and subsequent referrals within one, two, three, and four quarters after the initial referral based on OLS estimations are presented in Tables 8 and 9. A significant negative sign for our pair variables x_{ijt} would indicate fewer follow-up consultations for specialists in the same field, and fewer subsequent referrals to specialists in a different field for referrals within the social network. Table 8 shows statistically significant negative signs for follow-up consultations in quarters 3 and 4 for the *fellow students* and *hospital* social networks. Moreover, we observed negative and highly significant coefficients for *co-workers* at the same hospital for all quarters. These figures are also economically significant as, for example, the coefficient of -0.266 in quarter 4 corresponded to a decrease in follow-up consultations by 15 percent (see the mean of 1.694 follow-up consultations in Table 8). In contrast, the coefficients of social networks explaining the number of subsequent referrals to specialists in other medical fields (see Table 9) are lower in value and statistical confidence. Only in quarters 1 and 2 did we observe a lower number of subsequent referrals within the *co-workers* social group.[23] Hence, we did not find detrimental effects for patients referred within the social network with regard to destination. On the contrary, the results supported the view that patients were more satisfied with referrals within the GPs' social network, so that the number of follow-up consultations with other specialists decreased.

6.3.2 Process & competency

With regard to the criteria "process" and "competency," we offer two different variables targeting the quality of the referral and the specialist's medical

follow-up consultations compared to subsequent referrals as a stronger indicator of the inappropriateness of referrals.

[23]Given the volatile results for the coefficient of *fellow students* over time, we did not want to over-interpret the statistical artifact of a positive coefficient of *fellow students* in the second quarter at the 90 percent confidence level.

performance. A first best approach would compare the patient's health status before and after a referral within and outside of social networks. Since we could not observe the patient's health status directly, we used the days of hospitalization and the days of sick leave (only for employed persons) as proxies for health status. We utilized the econometric framework of equation 2 with the number of hospital days and the number of days of sick leave as the dependent variables; tables 10 and 11 list the empirical results. For the subsequent hospital days, we found significant negative effects for the *fellow students* network in the quarters 2, 3, and 4. This suggests an improvement of the patients' health. For the subsequent days of sick leave, no significant network effects were discerned. In summary, neither hospital days nor days of sick leave increased after a referral within a network, implying that increased referrals within a doctor's social networks had no detrimental effects on the patients' health status.

6.3.3 Timeliness

According to the criterion "timeliness," the period between the referral and the consultation with the specialist should be as short as possible. Unfortunately, the exact dates of patients' consultations were not included in our data. We were only provided data for the quarter during which the doctors balanced their accounts with the sickness fund for the medical services provided. Hence, for each referral we counted the number of quarters between the billing for the GP visit and the specialist consultation.[24] Subsequently, we computed the mean waiting period for each GP-specialist pair per year and used this mean as the dependent variable. The empirical results are presented in Table 12. The only significant effect was discerned for the *hospital* network, indicating that patients referred between doctors who worked at the same hospital had a longer period to wait for the appointment with a specialist.[25] This suggests

[24] Doctors are required to settle their accounts with the sickness fund as soon as possible.

[25] We observed a 7.960 percent increase in wait time for the *hospital* network. Given the average referral duration of 0.04 quarters (=3.6 days), the additional statistical waiting time for referrals in the social network was 6.9 hours on average. Note that we underestimated the waiting periods as we could only observe the quarter during which the referral and the actual consultation took place: In short waiting periods, the queue time for many of the patients fell within the same quarter and was thus

a fundamental trade-off involved in the doctors' referral behavior: Within the *hospital* social network, patients may be referred to better specialists (see the results on indicators for "destination" and "process & competency") but they have to accept longer waiting periods. Although we had no data on the welfare implications of this trade-off, we interpreted the result in favor of the quality of referrals within networks. Since the additional waiting period is relatively small, we believe that the quality aspects of the referral decision prevail.

6.3.4 Outpatient expenditures

Finally, we present results concerning the cost implications for the outpatient health-care system. For each referred patient, we calculated the total outpatient expenditures for each of the four quarters following the consultation with the specialist. To estimate the effects of social networks on the subsequent outpatient expenditures, we used equation 2 and calculated the annual mean expenditures over all patients for each doctor pair as the dependent variable. The empirical results in Table 13 demonstrate that we did not observe any statistical significance for our social network variables. Apparently, referrals within personal networks did not increase outpatient expenditures. We found only cost-reducing effects for the *same gender* network in the first quarter after the referral. In general, however, savings from a reduced number of follow-up consultations were too small to significantly impact outpatient expenditures. As far as other controls are concerned, we found lower outpatient expenditures with an increase in the GP's and the specialist's experience, suggesting that the more practiced GPs and specialists incurred lower outpatient expenditures in treating their patients (note that the effect was larger for specialists). The significant negative sign of distance may be the result of lower health-care utilization by patients in rural areas that typically exhibit lower densities of doctors.

unobservable by us. Observable differences in the waiting periods between the two groups were only generated by the subgroup of those patients whose longer queue time extended into the following quarter. As our coefficients represent the mean effect for all patients within the social network, our results represent a lower limit of the true waiting period for all patients if we do not assume a very unequal distribution of waiting times for which there was no evidence in the data.

7 Personal networks versus affinity-based networks

It is clear that social networks influenced the doctors' referral behavior. Our results on personal networks can be summarized as follows: GPs referred more patients to specialists if both had previously worked at the same hospital. The effect intensified for those doctors who had worked in the hospital at the same time. Fewer follow-up consultations, fewer subsequent referrals, and fewer subsequent days in hospital suggest that referrals within this type of network are more appropriate. For affinity-based networks, we also observed improved patient outcomes, but—as opposed to personal networks—the effects were substantially lower.

Various motives can be provided for GPs' preference for specialists within their own network. These motives range from explicit discrimination to statistical discrimination or even rent-seeking motives in which GPs might shift rents to doctors within their social network (also referred to as the "old boys network") instead of searching for an objectively ideal specialist for the patient. Although we cannot directly or empirically test the full breadth of motives for referrals within networks, we exploited the typical characteristics of personal networks to validate the importance of positive statistical discrimination within them. In personal networks, doctors are acquainted at a substantially higher probability compared to affinity-based networks constructed solely on the basis of the doctors' similarity. Hence, the two types of networks differ, as in the affinity-based networks, GPs do not refer patients to specialists because they know them, but because they share similar characteristics. Based on acquaintance via personal networks, GPs are better informed regarding the specialists' particular skills and can make make better decisions because it is easier to assess the ability and strength of the specialists. According to statistical discrimination, specialists from the own personal network are chosen because their quality is more precisely known.

Our results on patient outcomes support this hypothesis of statistical discrimination. We observed better health outcomes for patients referred within personal networks as compared to referrals outside the network. Further, the health outcomes for referrals within personal networks were better than for referrals within affinity-based networks. To provide further evidence of the existence of statistical discrimination in personal networks, we tested whether the information asymmetry on specialists' quality could be reduced (Section 7.1) and whether the improvements in patient outcomes were influenced by the selection of healthier patients (Section 7.2).

7.1 A test for statistical discrimination

Given that the observed pattern is caused by statistical discrimination, one would expect that high-quality specialists within the network would receive more referrals than low-quality specialists. Therefore, we tested whether the referrals within a network were more concentrated on high-quality specialists. As previously mentioned, a GP referral is not mandatory to access specialist care. Based on this, we provided two measures specialist quality: (i) The percentage of a specialist's patients who worked in a hospital and who had not been referred by a GP, and (ii) the percentage of a specialist's patients who hold an academic degree and who had not been referred by a GP. For this purpose, we computed the number of hospital staff patients divided by their total number of patients, and the number of university graduate patients divided by their total number of patients in each year and for each specialist. It is reasonable to assume that both patient groups possess more information on the quality of a specialist. Individuals working in a hospital can be expected to gather information on doctors through their occupational experience and networks, and university graduates are more likely to form networks with doctors during their shared time at the university. Moreover, following the Grossman model, university graduates are more efficient in health production and, in particular, in processing information in health-care markets. Therefore, these patient proportions should be positively correlated with the specialist's quality.

We constructed three dummy variables for each of these cardinally measured factors indicating low-quality, mid-quality, and high-quality specialists by dividing the observations into tertiles. We used the identical econometric framework as before, but added the dummy variables mid- and high-quality and generated interaction terms between these dummies and each network variable. Significant and positive coefficients for the interaction terms would imply that high-and mid-quality specialists within a network received more referrals, and that social networks reduced information asymmetry. The within variation of each indicator, however, was not sufficient to simultaneously control for specialist fixed effects. Because we expected that both indicators correlated with regional characteristics that also influenced the number of referrals, we additionally controlled for either a city dummy or zip code fixed effects. The empirical results are presented in Tables 14 and 15.[26]

Table 14 shows the results for the quality indicator hospital staff. High-quality specialists receive 1.557 fewer referrals in the base specification, 1.346 fewer referrals in the city specification, and 0.908 fewer referrals in the zip code fixed effect specification. A similar pattern was observed for mid-quality specialists, but the effect was not statistically significant in the zip code fixed effect specification; they received between 0.311 and 0.217 fewer referrals. Although these results seem to be contradictory, it is important to note that these coefficients show the effects of high-quality compared to low quality-specialists. High quality specialists have limited patient capacity and thus accept significantly fewer patients referred by GPs. These specialists may be hospital employees themselves who work part-time in the outpatient sector or have a large number of private patients. This was confirmed in our data, where we found that mid- and high-quality doctors had fewer consulting days per week, worked fewer days over the year, and had higher workloads in terms of patients seen per work day.

For mid-quality specialists in the *same gender* network, we observed negative effects across all specifications ranging from -0.324 to -0.169. We discerned an identical pattern in the high-quality doctors of the same network, but the effects were larger in magnitude, falling between -0.471 in the zip code fixed

[26] The tables only present the coefficients for the quality indicators and the interaction terms. The remaining coefficients are almost identical to the estimation results presented in Table 7.

effects specification and -0.446 in the base specification. The only significant effect among the *university* and *fellow students* networks was observed for mid-quality doctors in the city specification. We observed stronger effects in terms of quantitative and statistical significance for the *hospital* and *co-workers* networks for both quality measures. Mid-quality doctors of the *hospital* network received 1.617 more patients in the base specification, 1.574 more patients in the city dummy specification, and 1.410 more patients in the zip code fixed effects specification. For the high-quality category, the effects decreased but were still significant. In the *co-workers* network, the effect for the mid-quality category was more than twice as large as compared to the *hospital* network: the effects ranged from 4.011 in the zip code fixed effects specification to 4.313 in the base specification. For the high-quality category, we again observed a decrease in magnitude. Doctors from this category received between 1.514 and 1.809 more referrals than low-quality doctors in the same network.

Table 15 presents the results for the quality indicator share of university graduates. The first column shows that the high-quality specialists received 0.358 fewer referrals than the low-quality specialists. However, the sign changed if regional controls were included. High-quality specialists received 0.308 more referrals in the city specification and 0.728 in the zip code fixed effects specification. In the last specification, we observed that mid-quality specialists from the *same gender* network received on average 0.137 less referrals. Mid-quality specialists belonging to the *hospital* network received more referrals (1.321–1.359). The effect for mid-quality specialists from the *co-workers* network was even stronger, and ranged from 2.417 to 2.492 additional referrals.

The combination of findings from both quality indicators reveals that higher-quality doctors within the *hospital* and *co-workers* networks received more referrals than lower-quality doctors in the same networks. These results support the hypothesis that statistical discrimination can explain the quality-improved referrals within personal networks. In this way, GPs can better acquire information specialists' skills within the personal social network compared to doctors outside the network, thus enabling the GP to refer patients more appropriately within the social network. We would not expect such a concentration of referrals to high-quality doctors within social networks under pure rent-seeking motivation toward increasing revenue.

7.2 Potential selection effects

One counter-argument against our results on positive statistical discrimination is the existence of selection effects. Healthier patients may be referred within the doctor's social network and thus influence our results. As shown in Table 5, GPs did not refer more patients if the surrounding specialists belonged to their network, except for the *same gender* network. This provides primary evidence against the hypothesis that the results for *hospital* and *co-workers* networks were caused by the selection of healthier patients. Moreover, we performed a falsification test that analyzed whether patients referred in social networks were healthier before the referral. In doing so, we compared the health status of individuals approximated by their number of days spent in the hospital and days of sick leave in the quarter prior to the referral. Table 16 demonstrates that patients referred within personal networks were not healthier than patients referred outside the network. For affinity-based networks, however, Table 16 demonstrates that GPs referred healthier patients within the *same gender* network, at least according to the sick leave criterion.

7.3 A synthesis of results on personal versus affinity-based networks

According to our results, the *co-workers* and *hospital* personal networks were apparently used to reduce information asymmetries concerning the specialists' quality, which in turn improved the appropriateness of referrals (see Tables 8 and 9 as well as Subsection 7.1). However, the test showed opposite effects for the *same gender* network. This confirms that the selection strategy of specialists within this affinity-based network was indeed different. GPs did not use this network to acquire information on the specialists' quality, but they did choose a specialist based on their affinity toward the specialist. This hypothesis was supported by our empirical findings: (i) An increase in the share of surrounding specialists of the same gender increased the referral rate (Table 5) suggesting that GPs refer more patients. This might imply that some patients were referred even if no specialist care was absolutely necessary, in contrast to the results of the other network variables. (ii) The gravity model (Table 7) shows that the number of referrals to doctors with the same gender increased. (iii) We found evidence that the number of follow-up consultations (Table 8) and amount of outpatient expenditures (Table 13) tended to be slightly lower. However, we observed a higher concentration of referrals to low-quality specialists, and fewer referrals to mid- and high-quality doctors (see Tables 14 and 15) in this network. To summarize this evidence, we conclude that rent-seeking motives rather than positive statistical discrimination seemed to be the driving force behind the additional referrals within the *same-gender* affinity-based network.[27] This result is in line with Gompers et al. (2012) who showed that affinity-based networks perform worse than ability-based networks for the venture capital market. Note, however, that our results on the *same-gender* affinity-based network are based on weaker statistical evidence compared to the statistical discrimination phenomenon within the *hospital* or *co-workers* networks. Since we observed neither statistically significant detrimental effects for patients nor cost increases for the health-care system, it is important not to overvalue this result.

8 Conclusions

Based on comprehensive health-care service utilization data from Austria, we examined the determinants of GPs' referral behavior with a particular focus on social networks. We analyzed the effects of social networks on the referral rate — the decision of a GP to refer patients to specialist care—and on the distribution of the referred patients among different specialists. Moreover, we tested the appropriateness of within-network referrals using various indicators

[27]Regarding gender differences, we observed more (fewer) re-referrals and higher (lower) outpatient expenditures for male (female) pairs. At the same time, we found evidence of increased (decreased) referrals to low-quality doctors for male (female) GP-specialist pairs. Thus, if there exists a rent-seeking motive in referral behavior, it is a male phenomenon ("old boys' network"). It must be noted, however, that the number of observed female GP-specialist pairs was substantially lower than the number of male GP-specialist pairs.

correlated with patients' well-being, such as the timeliness of the referral, the destination, proxies for the health status of patients, and outpatient expenditures. Finally we analyze whether the observed network effects were the result of information asymmetries concerning the quality and ability of specialists. To our knowledge, this paper is the first to use rich administrative data to assess the appropriateness of referrals.

Our results on the determinants of the referral rate are in line with previous studies. We found that referral rates varied substantially across GPs, and that rates were influenced by GP-, practice-, and patient characteristics. Extending previous quantitative studies, we analyzed the role of social networks and differentiated between personal and affinity-based networks. In general, we found that GPs did not refer more patients if the surrounding specialists belonged to their social network.

However, the evidence from the pairwise regressions demonstrates that social networks changed the distribution of the referrals. GPs who had worked in the same hospital at different times (third-party links) and at the same time (direct links) as the specialists referred more patients to those specialists. Moreover, we provide empirical evidence that this type of personal network reduced information asymmetry on the specialists' abilities as GPs selected specialists from higher-quality categories within these networks. This evidence supports statistical discrimination: GPs used their personal networks in order to acquire information on the quality of specialists and therefore improve the appropriateness of their referrals.

For the affinity-based *same gender* network, a different empirical pattern emerges. In addition to the focus on lower-quality doctors within this type of network, we observed—in contrast to all the other networks—an increasing referral rate if more specialists of the same gender practiced in the vicinity of the GP. Furthermore, we found evidence of better health outcomes for patients referred within this network. We demonstrated, however, that several of these patients were slightly healthier (in terms of days of sick leave) in the quarter prior to the referral, suggesting that the results in this network were driven by a selection effect rather than the quality of the network. We found some statistical evidence that affinity-based networks performed worse in comparison to personal networks. Based on this, we conclude that affinity-based networks, as opposed to personal networks, decreased the appropriateness of referrals. Social networks that reduced information asymmetry, however, improved the appropriateness of referrals.

The empirical evidence presented in this paper has two potential implications for the organization of referrals between health-care providers: (i) Health-care organizations should not only collect information on the referrals themselves, but also on variables that allow for assessment of the quality and the necessity of the referrals. A combination of a variety of indicators of the quality of referral behavior would facilitate a better identification of important patterns; such an evaluation might enable more effective control of health-care resources. (ii) The central finding of the paper (that GPs use their personal networks in order to gather information on specialists' abilities) demonstrates the consequences of information asymmetry in this health-care market. Different mechanisms—such as an information system—that could reduce these information asymmetries increase the appropriateness of referrals and could in turn improve patient outcomes and decrease health-care costs.

9 Tables

Table 1: Average referral rate, 1998-2007

Year	Average number of patients per GP	Average number of referrals per GP	Referral rate
1998	3,145	483	15.10
1999	3,482	545	15.29
2000	3,564	549	15.10
2001	3,660	587	15.91
2002	3,801	639	16.46
2003	3,907	644	16.11
2004	3,997	682	16.60
2005	4,195	597	14.01
2006	4,292	379	8.69
2007	4,345	396	9.01

Note: This table provides the number of patients, referrals, and the resulting referral rate in percentages for the average GP per year.

Table 2: Sample composition

	# of doctors	Average # of patients	Average # of referrals	Share of referred patients (in %)	Total revenues	Total revenues from referred patients per specialist (abs.)	Total revenues from referred patients per specialist (in %)	Revenues per referred patient and specialist (absolute)	Revenues per referred patient and specialist (in %)	Female share	Mean age of specialists
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
GP	575	3,249	477	14.68	120,644	-	-	-	36.90	11	53.94
Eye specialist	45	4,156	682	16.41	176,227	27,612	15.67	35.24	35.97	33	53.93
Surgery	16	1,110	476	42.88	134,768	56,523	41.94	58.78	66.97	1	56.24
Dermatologist	32	4,855	959	19.75	185,874	38,187	20.54	34.72	32.17	33	53.62
Gynecologist	69	3,218	474	14.73	164,329	23,840	14.51	42.40	41.67	9	56.10
Internists	44	1,426	422	29.59	168,012	55,129	32.81	99.55	84.93	3	55.77
Pediatricians	36	2,253	70	3.11	175,535	5,480	3.12	55.02	52.78	43	54.71
ENT specialist	29	2,852	742	26.02	177,484	47,593	26.82	49.52	46.22	13	52.34
Pulmonary specialist	22	2,530	931	36.80	185,727	68,156	36.70	64.93	64.17	10	55.75
Neurology & psychiatry	29	1,015	661	65.12	134,363	84,948	63.22	54.81	61.79	32	55.79
Orthopedics	27	3,050	869	28.49	207,553	55,026	26.51	59.01	63.91	4	54.09
Radiology	18	6,795	2,979	43.84	493,937	207,495	42.01	50.48	55.31	14	56.50
Urology	15	2,658	867	32.62	159,103	41,869	26.32	39.93	53.15	1	57.31

Note: This table provides summary statistics for the doctors included in the estimation sample covering the period from 1998 to 2007. Column (1) shows the number of doctors per medical field. In total, we observed 382 medical specialists. The annual average number of patients and referrals are shown in columns (2) and (3). Column (4) shows the share of specialists' patients referred by GPs. The first entry in this column represents referrals by the GP; for the specialists, these numbers denote the referrals received. The total annual average revenues from medical consultations are shown in column (5). Column (6) shows the specialists' revenues from referred patients; the corresponding percentage is shown in column (7). The revenues per referred and non-referred patient are shown in columns (8) and (9). Finally, columns (10) and (11) depict the percentage of female doctors and the average age per medical field. All monetary values are expressed in 2007 Euros.

Table 3: Patients referred between GPs and specialists

		Panel A				
Ranking of specialist[a]	# of GPs	Mean	SD	Min	Max	Cumulative
1	606	21.14	11.35	5.36	96.43	21.14
2	606	11.12	5.44	2.04	50.00	32.26
3	604	8.27	2.89	1.02	20.05	40.53
4	603	6.80	2.21	0.51	15.79	47.33
...						
11	593	2.49	0.81	0.24	4.79	74.80
...						
24	558	0.64	0.39	0.02	1.76	90.37
...						
35	513	0.34	0.23	0.01	0.97	95.33
...						
		Panel B				
Ranking of GP[b]	# of Spec.	Mean	SD	Min	Max	Cumulative
1	387	10.05	7.61	2.47	100.00	10.05
2	386	7.24	3.29	1.98	20.54	17.29
3	386	6.03	2.55	1.83	17.86	23.32
...						
10	382	2.95	0.86	1.13	5.35	51.00
...						
23	375	1.24	0.43	0.07	2.33	75.59
...						
44	346	0.39	0.24	0.01	0.96	90.13
...						
61	307	0.23	0.18	0.00	0.63	95.08
...						

Note: Panel A shows the number of different specialists to whom a GP referred patients. Panel B shows the number of different GPs from whom a specialist received patients.

[a] The number of specialists to whom a GP refers patients in descending order by respective referral share.

[b] The number of GPs from whom a specialist received patients in descending order by respective referral share.

Table 4: Summary statistics of variables used in pairwise regressions

Variable	Mean	SD	Min	Max
Referrals	1.82	11.66	0	1086
Revenues	93.64	623.85	0	90496.43
University	0.39		0	1
Fellow students	0.11		0	1
Hospital	0.08		0	1
Co-workers	0.02		0	1
Same age group	0.51		0	1
Same gender	0.76		0	1
Distance[b]	65.08	30.30	0	205.75
GP's experience	22.17	5.62	5	43
Specialist's experience	23.41	5.82	10	48
GP's patients[a]	3.907	1.409	0.276	10.7
Specialist's patients[a]	3.826	2.413	0.001	25.001
Number of GPs			575	
Number of specialists			382	
Observations			1,502,333	
Non-zero observations			220,698	

Note: This table provides summary statistics for the variables used in the subsequent regressions. The number of GPs and specialists represents all doctors included in the estimation sample. The sample comprises 1,502,333 observations; however, referrals between a doctor pair in only 220,698 observations. The figures of the summary statistics are based on all observations, including the zeros. [a] Measured in thousands of patients. [b] Measured in minutes.

Table 5: Determinants of the referral rate

	(1)	(2)
GP characteristics		
Experience	0.423***	0.391**
	(0.153)	(0.158)
Experience squared	−0.007*	−0.006
	(0.004)	(0.004)
Female	0.966	1.098
	(0.931)	(0.928)
Single	2.200	2.270
	(1.669)	(1.633)
Divorced	−0.471	−0.468
	(0.823)	(0.816)
Widowed	1.379	1.275
	(1.701)	(1.655)
Graz[a]	0.494	0.096
	(0.673)	(1.071)
Vienna[a]	0.247	0.306
	(0.471)	(0.502)
Practice characteristics		
City	3.814***	3.621***
	(0.800)	(0.783)
Practice size[b]	0.530***	0.516***
	(0.171)	(0.170)
Number of GPs	−0.186**	−0.178**
	(0.078)	(0.077)
Number of specialists	0.166***	0.159***
	(0.058)	(0.057)
Observations	4,823	4,823
R^2	0.39	0.40
Mean	14.12	14.12

(to be continued)

Table 5 continued	(1)	(2)
Patient characteristics		
Share of females	0.013	0.016
	(0.065)	(0.065)
Mean age of patients	0.236***	0.261***
	(0.074)	(0.075)
Share of unemployed patients	−0.524***	−0.507***
	(0.166)	(0.166)
Share of retired patients	−0.353***	−0.364***
	(0.064)	(0.064)
Share of other patients[c]	−0.116**	−0.118**
	(0.049)	(0.049)
Shares of network specialists		
Same gender		0.148***
		(0.048)
Same age group		−0.037
		(0.028)
University		−0.029
		(0.025)
Fellow students		0.024
		(0.036)
Hospital		0.000
		(0.021)
Co-workers		0.083*
		(0.043)
Observations	4,823	4,823
R^2	0.39	0.40
Mean	14.12	14.12

Note: This table summarizes estimation results of GP, practice, and patient characteristics, and the share of network specialists on the referral rate (annual number of referrals divided by annual number of patients expressed as a percentage) in a repeated cross-section with GPs as observation units. The results are based on OLS estimation; standard errors (in parentheses) are robust to clustering at the GP level and to heteroskedasticity of unknown form. *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. Each estimation also controlled for hospital and period fixed effects. [a] In comparison to GPs who studied at the medical university of Innsbruck. [b] Measured in thousands of patients. [c] Mothers on maternity leave, conscripts, persons on rehabilitation, and co-insured children.

Table 6: Mean comparison tests for referrals and referred revenues

	Referrals			Revenues		
	No	Yes	p-value	No	Yes	p-value
	(1)	(2)	(3)	(4)	(5)	(6)
University	1.536	1.916	0.000	73.380	100.121	0.000
Fellow students	1.761	1.923	0.000	89.146	100.711	0.000
Hospital	1.802	1.994	0.000	92.409	103.265	0.000
Co-workers	1.577	4.518	0.000	80.715	234.599	0.000
Same age group	1.735	6.269	0.000	88.749	338.471	0.000
Same gender	1.782	1.865	0.000	91.321	95.907	0.000
Mean[a]		1.820			93.640	
Observations		1,502,333			1,502,333	

Note: This table shows mean comparison tests of referrals and revenues for each network variable. Columns (2) and (5) show the means within the network and (1) and (4) outside the network. The p-values indicate whether the differences in means are statistically significant.
[a] Refers to the unconditional sample mean.

Table 7: Gravity model - Determinants of referral behavior

	Referrals				Revenues			
	No FE	GP FE	Specialist FE	Both FE	No FE	GP FE	Specialist FE	Both FE
University	0.120**	0.056	0.127**	0.021	9.876***	6.559**	9.161***	3.737
	(0.056)	(0.051)	(0.062)	(0.054)	(3.130)	(2.905)	(3.459)	(3.028)
Fellow students	−0.168	−0.189*	−0.052	−0.029	−8.949	−10.264*	−2.495	−1.489
	(0.103)	(0.096)	(0.106)	(0.092)	(5.648)	(5.374)	(5.749)	(5.103)
Hospital	1.615***	1.498***	1.572***	1.207***	80.121***	75.445***	77.826***	60.599***
	(0.209)	(0.202)	(0.224)	(0.201)	(10.692)	(10.370)	(11.446)	(10.353)
Co-workers	1.533***	1.455***	1.341***	1.081***	99.202***	94.475***	86.928***	72.820***
	(0.353)	(0.346)	(0.350)	(0.334)	(19.548)	(19.232)	(19.253)	(18.587)
Same age group	0.044	0.052	0.029	0.036	2.453	2.714	1.702	1.914
	(0.044)	(0.045)	(0.043)	(0.043)	(2.466)	(2.492)	(2.406)	(2.380)
Same gender	0.458***	0.541***	0.259	0.104*	30.327***	36.739***	11.680	3.767
	(0.077)	(0.052)	(0.168)	(0.062)	(4.043)	(2.700)	(8.538)	(3.071)
GP's experience	0.046***	0.132	0.050***	0.209	2.435***	6.079	2.666***	9.884
	(0.012)	(0.160)	(0.015)	(0.189)	(0.602)	(5.770)	(0.765)	(17.577)
Specialist's experience	0.001	−0.009	−0.074**	−0.153***	−0.094	−0.619**	−5.980***	−10.037***
	(0.005)	(0.006)	(0.035)	(0.030)	(0.281)	(0.288)	(1.799)	(1.609)
Distance	−0.074***	−0.116***	−0.098***	−0.191***	−3.846***	−6.067***	−5.038***	−9.895***
	(0.003)	(0.003)	(0.005)	(0.007)	(0.148)	(0.185)	(0.240)	(0.363)
GP's patients	0.245***	0.236***	0.162***	0.227***	11.744***	10.861***	7.858***	10.382***
	(0.045)	(0.036)	(0.054)	(0.035)	(2.375)	(2.246)	(1.489)	(1.492)
Specialist's patients	0.611***	0.574***	0.426***	0.427***	24.791***	22.857***	17.676***	17.704***
	(0.043)	(0.043)	(0.028)	(0.029)	(2.261)	(2.246)	(1.489)	(1.492)
Mean	1.82	1.82	1.82	1.82	93.64	93.64	93.64	93.64
Observations	1,502,333	1,502,333	1,502,333	1,502,333	1,502,333	1,502,333	1,502,333	1,502,333

Note: This table summarizes the results on the determinants of referral behavior based on Ordinary Least Squares (OLS) in pooled cross-section data. Referral behavior was either measured as the annual number of referrals for each doctor pair (left panel) or as the annual specialists' referred revenues (measured in 2007 Euro) for each doctor pair (right panel). Standard errors are robust to clustering at the GP level and to heteroskedasticity of unknown form. *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. The estimations also control for period fixed effects. The model specifications vary with respect to the inclusion of doctor fixed effects.

Table 8: Determinants of follow-up consultations

	Q1	Q2	Q3	Q4
University	0.003	0.006	0.033	0.003
	(0.037)	(0.044)	(0.049)	(0.052)
Fellow students	−0.059	−0.071	−0.107*	−0.119*
	(0.049)	(0.056)	(0.064)	(0.067)
Hospital	−0.094	−0.116	−0.151*	−0.176**
	(0.060)	(0.072)	(0.081)	(0.083)
Co-workers	−0.134*	−0.177**	−0.257***	−0.266***
	(0.071)	(0.080)	(0.088)	(0.093)
Identical age group	0.044	0.028	0.062	0.062
	(0.032)	(0.037)	(0.040)	(0.042)
Same gender	−0.140**	−0.145*	−0.121	−0.127
	(0.067)	(0.081)	(0.085)	(0.089)
GPs' experience	0.018***	0.024***	0.024***	0.011*
	(0.005)	(0.005)	(0.006)	(0.006)
Specialists' experience	−0.020	−0.043	−0.034	−0.026
	(0.028)	(0.035)	(0.038)	(0.040)
Distance	0.014***	0.020***	0.025***	0.028***
	(0.002)	(0.002)	(0.002)	(0.003)
GPs' patients	0.070	0.042	0.052	0.043
	(0.047)	(0.054)	(0.064)	(0.066)
Specialists' patients	0.042*	0.087***	0.124***	0.138***
	(0.025)	(0.032)	(0.035)	(0.037)
Mean	0.857	1.237	1.511	1.694
Observations	220,698	220,698	220,698	220,698

Note: This table summarizes the results on the determinants of follow-up consultations conducted at a different specialist in the same medical field 1, 2, 3, and 4 quarters after the initial referral based on Ordinary Least Squares (OLS). Standard errors are robust to clustering at the GP level and to heteroskedasticity of unknown form. *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. Since the follow-up consultations could only be determined for doctor-pairs with positive referrals, these figures are based on 220,698 observations.

Table 9: Determinants of subsequent referrals

	Q1	Q2	Q3	Q4
University	0.030	−0.023	0.018	0.005
	(0.043)	(0.032)	(0.030)	(0.032)
Fellow students	−0.104	0.092*	0.054	0.029
	(0.065)	(0.048)	(0.046)	(0.048)
Hospital	0.010	0.052	0.017	0.040
	(0.068)	(0.050)	(0.049)	(0.052)
Co-workers	−0.166*	−0.123*	−0.092	−0.026
	(0.099)	(0.071)	(0.071)	(0.071)
Identical age group	0.060	−0.022	−0.037	−0.028
	(0.037)	(0.026)	(0.024)	(0.027)
Same gender	−0.025	−0.059	−0.022	0.061
	(0.070)	(0.051)	(0.043)	(0.061)
GPs' experience	0.028***	−0.033***	−0.016***	0.037***
	(0.006)	(0.004)	(0.004)	(0.005)
Specialists' experience	−0.009	−0.066***	−0.058***	−0.062***
	(0.041)	(0.023)	(0.021)	(0.017)
Distance	−0.004***	−0.003**	−0.002**	−0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
GPs' patients	0.121**	−0.043	0.042	0.067*
	(0.047)	(0.037)	(0.032)	(0.037)
Specialists' patients	−0.030*	−0.023*	0.007	−0.004
	(0.018)	(0.013)	(0.012)	(0.013)
Mean	1.238	0.673	0.633	0.778
Observations	220,698	220,698	220,698	220,698

Note: This table summarizes the results on the determinants of subsequent referrals to a specialist in another medical field 1, 2, 3, and 4 quarters after the initial referral based on Ordinary Least Squares (OLS). Standard errors are robust to clustering at the GP level and to heteroskedasticity of unknown form. *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. Since the subsequent referrals could only be determined for doctor-pairs with positive referrals, these figures are based on 220,698 observations.

Table 10: Determinants of subsequent hospital days

	Q1	Q2	Q3	Q4
University	0.007	0.008	0.011	0.016
	(0.017)	(0.021)	(0.025)	(0.026)
Fellow students	−0.023	−0.045*	−0.059*	−0.072**
	(0.020)	(0.026)	(0.030)	(0.033)
Hospital	0.008	−0.008	−0.034	−0.040
	(0.023)	(0.031)	(0.035)	(0.036)
Co-workers	−0.030	0.028	0.031	0.018
	(0.032)	(0.055)	(0.057)	(0.059)
Same age group	−0.003	0.012	0.017	0.013
	(0.013)	(0.017)	(0.019)	(0.020)
Same gender	0.048	0.004	−0.010	−0.012
	(0.037)	(0.041)	(0.045)	(0.047)
GP's experience	0.034***	0.029***	0.027***	0.026***
	(0.002)	(0.002)	(0.003)	(0.003)
Specialist's experience	−0.011	−0.013	−0.019*	−0.024**
	(0.008)	(0.010)	(0.011)	(0.012)
Distance	−0.001	−0.001	−0.000	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
GP's patients	0.017	0.024	0.041	0.047*
	(0.019)	(0.022)	(0.025)	(0.028)
Specialist's patients	−0.008	−0.001	−0.003	−0.003
	(0.008)	(0.010)	(0.012)	(0.013)
Mean	0.457	0.659	0.792	0.894
Observations	215,174	215,174	215,174	215,174

Note: This table summarizes the results on the determinants of subsequent hospital days within 1, 2, 3, and 4 quarters after the initial referral based on Ordinary Least Squares (OLS). Standard errors are robust to clustering at the GP level and to heteroskedasticity of unknown form. *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. Since the subsequent hospital days could only be determined for doctor-pairs with positive referrals, these figures are based on 215,174 observations.

Table 11: Determinants of subsequent days of sick leave

	Q1	Q2	Q3	Q4
University	0.020	0.037	0.059	0.054
	(0.035)	(0.043)	(0.048)	(0.051)
Fellow students	0.015	−0.036	−0.034	−0.023
	(0.044)	(0.054)	(0.058)	(0.064)
Hospital	−0.008	−0.031	0.018	0.021
	(0.065)	(0.072)	(0.079)	(0.083)
Co-workers	0.001	0.010	0.044	0.077
	(0.072)	(0.090)	(0.096)	(0.111)
Same age group	0.051*	0.033	0.028	0.016
	(0.028)	(0.036)	(0.038)	(0.041)
Same gender	−0.043	0.022	−0.007	0.001
	(0.067)	(0.093)	(0.103)	(0.108)
GP's experience	−0.006	0.006	0.003	0.003
	(0.012)	(0.015)	(0.016)	(0.018)
Specialist's experience	−0.103***	−0.131***	−0.148***	−0.166***
	(0.029)	(0.032)	(0.040)	(0.040)
Distance	−0.002	−0.002	−0.003	−0.004*
	(0.001)	(0.002)	(0.002)	(0.002)
GP's patients	−0.013	0.033	0.022	0.026
	(0.045)	(0.057)	(0.066)	(0.071)
Specialist's patients	−0.015	0.004	0.010	0.019
	(0.020)	(0.025)	(0.028)	(0.030)
Mean	0.910	1.315	1.594	1.815
Observations	171,788	171,788	171,788	171,788

Note: This table summarizes the results on the determinants of subsequent days of sick leave within 1, 2, 3, and 4 quarters after the initial referral based on Ordinary Least Squares (OLS). Standard errors are robust to clustering at the GP level and to heteroskedasticity of unknown form. *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. Since the subsequent days of sick leave could only be determined for doctor-pairs with positive referrals, these figures are based on 171,788 observations.

Table 12: Determinants of the referral duration

	In percent
University	0.398
	(2.593)
Fellow students	3.847
	(3.590)
Hospital	7.966**
	(3.861)
Co-workers	−2.976
	(4.836)
Same age group	−1.477
	(2.205)
Same gender	3.825
	(4.918)
GP's experience	−12.036***
	(2.149)
Specialist's experience	2.333
	(3.986)
Distance	0.496***
	(0.118)
GP's patients	−55.213***
	(10.920)
Specialist's patients	3.417**
	(1.408)
Mean	0.04*Quarter*
Observations	211,140

Note: This table summarizes the results on the determinants of the referral duration based on Ordinary Least Squares (OLS). Standard errors are robust to clustering at the GP level and to heteroskedasticity of unknown form. *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. Since the referral duration could only be determined for doctor-pairs with positive referrals, these figures are based on 211,140 observations.

Table 13: Determinants of subsequent outpatient expenditures

	Q1	Q2	Q3	Q4
University	2.327	1.980	2.399	2.577
	(3.178)	(3.402)	(3.466)	(3.501)
Fellow students	−5.908	−6.155	−6.737	−7.011
	(4.498)	(4.721)	(4.795)	(4.866)
Hospital	2.799	3.872	3.820	3.813
	(4.974)	(5.228)	(5.303)	(5.316)
Co-workers	−0.505	−1.488	−1.406	−1.306
	(7.149)	(7.688)	(7.810)	(7.854)
Same age group	−2.606	−2.597	−2.645	−2.462
	(2.628)	(2.754)	(2.786)	(2.809)
Same gender	−8.980*	−8.772	−8.611	−8.674
	(5.335)	(5.905)	(6.030)	(6.119)
GP's experience	−4.132***	−4.300***	−4.249***	−4.403***
	(0.364)	(0.373)	(0.381)	(0.383)
Specialist's experience	−8.846***	−10.257***	−10.998***	−11.408***
	(1.599)	(2.070)	(2.101)	(2.121)
Distance	−0.517***	−0.589***	−0.579***	−0.576***
	(0.163)	(0.169)	(0.171)	(0.172)
GP's patients	2.562	2.352	1.687	1.290
	(3.435)	(3.642)	(3.687)	(3.716)
Specialist's patients	1.877	1.606	1.463	1.348
	(1.633)	(1.753)	(1.796)	(1.803)
Mean	173.38	199.62	208.90	213.66
Observations	215,174	215,174	215,174	215,174

Note: This table summarizes the results on the determinants of subsequent outpatient expenditures within 1, 2, 3, and 4 quarters after the initial referral based on Ordinary Least Squares (OLS). Standard errors are robust to clustering at the GP level and to heteroskedasticity of unknown form. *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. Since the subsequent outpatient expenditures could only be determined for doctor-pairs with positive referrals, these figures are based on 215,174 observations.

Table 14: Test of information asymmetry (share of hospital staff)

	Base	City	Zip FE
Mid-quality	−0.311***	−0.217**	−0.039
	(0.111)	(0.108)	(0.107)
High-quality	−1.557***	−1.346***	−0.908***
	(0.173)	(0.173)	(0.171)
Same age group × mid-quality	0.007	0.017	0.028
	(0.080)	(0.081)	(0.080)
Same age group × high-quality	−0.062	−0.063	−0.043
	(0.078)	(0.078)	(0.079)
Same gender × mid-quality	−0.324***	−0.169*	−0.197**
	(0.101)	(0.099)	(0.091)
Same gender × high-quality	−0.446***	−0.451***	−0.471***
	(0.101)	(0.101)	(0.099)
University × mid-quality	0.123	0.104	0.068
	(0.111)	(0.111)	(0.113)
University × high-quality	0.048	0.059	0.069
	(0.096)	(0.096)	(0.098)
Fellow students × mid-quality	0.225	0.240*	0.144
	(0.139)	(0.139)	(0.138)
Fellow students × high-quality	0.077	0.133	0.112
	(0.146)	(0.146)	(0.144)
Hospital × mid-quality	1.617***	1.574***	1.410***
	(0.278)	(0.278)	(0.273)
Hospital × high-quality	0.691***	0.754***	0.479*
	(0.266)	(0.261)	(0.258)
Co-workers × mid-quality	4.313***	4.260***	4.011***
	(0.678)	(0.677)	(0.675)
Co-workers × high-quality	1.809***	1.691***	1.514***
	(0.479)	(0.477)	(0.467)
Mean	1.82	1.82	1.82
Observations	1,502,333	1,502,333	1,502,333

Note: This table summarizes the OLS results for the test of information asymmetry based on the specialist's share of hospital staff in all patients. The dependent variable is the annual number of referrals. The table only shows the effects of the quality indicators and their interaction terms with social network variables. Standard errors are robust to clustering at the GP level and to heteroskedasticity of unknown form. *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. In the base specification, we did not include regional controls. We controlled for a city dummy and for zip code fixed effects in the City and zip code fixed effects specification, respectively.

Table 15: Test of information asymmetry (share of university graduates)

	Base	City	Zip FE
Mid-quality	0.023	0.327***	0.435***
	(0.086)	(0.083)	(0.080)
High-quality	−0.358**	0.308*	0.728***
	(0.170)	(0.170)	(0.153)
Same age group × mid-quality	0.029	0.014	0.017
	(0.108)	(0.108)	(0.105)
Same age group × high-quality	0.023	0.003	0.018
	(0.119)	(0.116)	(0.112)
Same gender × mid-quality	−0.045	−0.120	−0.137*
	(0.076)	(0.076)	(0.077)
Same gender × high-quality	0.086	0.110	−0.000
	(0.153)	(0.152)	(0.141)
University × mid-quality	0.095	0.074	0.129
	(0.117)	(0.117)	(0.118)
University × high-quality	−0.102	−0.102	0.004
	(0.131)	(0.131)	(0.130)
Fellow students × mid-quality	0.124	0.156	0.037
	(0.182)	(0.182)	(0.186)
Fellow students × high-quality	0.126	0.154	0.078
	(0.200)	(0.199)	(0.198)
Hospital × mid-quality	1.355***	1.359***	1.321***
	(0.298)	(0.297)	(0.291)
Hospital × high-quality	0.463	0.467	0.379
	(0.396)	(0.395)	(0.377)
Co-workers × mid-quality	2.417***	2.475***	2.492***
	(0.624)	(0.623)	(0.616)
Co-workers × high-quality	1.050	1.119	0.863
	(0.776)	(0.776)	(0.760)
Mean	1.82	1.82	1.82
Observations	1,502,333	1,502,333	1,502,333

Note: This table summarizes the OLS results for the test of information asymmetry based on the specialist's share of university graduates in all patients. The dependent variable is the annual number of referrals. The table only shows the effects of the quality indicators and their interaction terms with social network variables. Standard errors are robust to clustering at the GP level and to heteroskedasticity of unknown form. *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. In the base specification, we did not include regional controls. We controlled for a city dummy and for zip code fixed effects in the City and zip code fixed effects specification, respectively.

Table 16: Falsification Test – Outcomes measured one quarter before the referral

	Hospital days	Days of sick leave
University	−0.002	0.007
	(0.015)	(0.035)
Fellow students	0.012	0.046
	(0.021)	(0.047)
Hospital	0.025	−0.083
	(0.027)	(0.055)
Co-workers	0.011	−0.024
	(0.028)	(0.080)
Same age group	−0.016	−0.042
	(0.013)	(0.028)
Same gender	−0.013	−0.119*
	(0.024)	(0.068)
GP's experience	0.002	0.061***
	(0.002)	(0.010)
Specialist's experience	−0.012*	−0.040*
	(0.006)	(0.024)
Distance	−0.000	0.001
	(0.001)	(0.001)
GP's patients	0.030	0.037
	(0.023)	(0.047)
Specialist's patients	0.005	0.002
	(0.007)	(0.016)
Mean	0.418	0.345
Observations	215,174	215,174

Note: This table summarizes the results on the determinants of subsequent hospitalized days and days of sick leave one quarter prior to the initial referral based on Ordinary Least Squares (OLS). Standard errors are robust to clustering at the GP level and to heteroskedasticity of unknown form. *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. Since the outcomes could only be determined for doctor-pairs with positive referrals, these figures are based on 220,698 observations.

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