Management and Business Administration Doctoral School

THESIS EXTRACT

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Networks in health care

Ph.D. Dissertation

Supervisor:

Lublóy Ágnes, Ph.D.

Associate professor

Budapest, 2016

Department of Finance

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1. LITERATURE REVIEW AND RESEARCH OBJECTIVES

In my thesis I analyze and describe the nature and functioning of the professional networks developed among general practitioners and specialist as a result of ties established between doctors and patient while provisioning medical services. My research focuses on the impact of the strength of ties between general practitioners and specialists developed in the practice of shared care on the health status of the patient and the costs of medication.

The significance of the present thesis may lie in investigating the way general practitioner-specialist professional networks actually operate and its economic policy implications. By understanding these networks, healthcare economists and politicians might be able to strengthen those relationships which enhance the probability of providing for lower pharmacy costs at comparable or improved health care quality standards. Therefore, understanding these relationships ought to be seen as serving important social objectives.

The strength of this research lies in the data utilized. I defined the strength of ties between doctors in accordance with the number of patients receiving care by the same two doctors. These professional ties were analyzed on the basis of prescription data recorded. Due to the unique data, all ties between physicians included in the database can be mapped with great accuracy.

In my empirical research I first address the question whether general practitioners and specialists maintaining close professional ties with each other - at comparable patient health levels as a minimum - are successful in reducing pharmacy costs. Should it be concluded that the pharmacy costs - at least when assuming comparable levels of patient health status – are significantly lower in strong general practitioner-specialist ties; then obviously the creation and maintenance of such ties serve the best interests of all parties concerned. In accordance with the foregoing deliberations, it appears that the simultaneous exploration of two hypotheses is required as presented below:

H1: The health status of patients treated in strong general practitioner-specialist relationships tends to be better.

H2: The pharmacy costs carried by patients treated in strong general practitioner-specialist relationships tend to be lower.

The novelty of my research is not only evidenced by the fact that no similar studies have been pursued and published in reliance on quantitative methods but also that no attempt has been

made so far in the professional literature of the field to provide a simultaneous and interdependent presentation of the above two hypotheses.

As regards to the first hypothesis, certain research projects have been conducted on the field in the United States of America. In particular, Barnett et al [2012] and Pollack et al [2013] concluded that in an environment where one doctor provides treatment for a patient with the collaborative care of a small number of other doctors, such collaboration will result in an improved patient health status - probably on account of a more efficient exchange of professional information and the better management of the health care process. These findings are supported by the systematic literature reviews of Lemieux et al [2006] and Bosch et al [2009] where the authors conclude that close ties among doctors providing shared care result in enhanced clinical performance and a better health status for the patient. In summary, it can be stated that similar research projects have only been conducted outside Europe and even those have fell short of addressing the health care systems of other countries. The research performed by Pollack et al [2013] stand closest to my thesis. It is important to note, that the results of research carried out outside Europe are not applicable or transferable to Hungary due to substantial differences between the health care systems. Nonetheless, the methodology employed in previous research projects may well provide a useful background for this research.

The second hypothesis relies on the assumption that in cases where doctors share the treatment of a large number of patients, pharmacy costs will be reduced. Examining the treatment of diabetes Walraven et al [2010] have pointed out in their systematic literature review that improved coordination of medical care results in a decrease in the usage of health care services; especially in the area of inpatient care and emergency care. Barnett et al [2012] and Pollack et al [2013] have shown that the cost of care provisioning for those patients whose doctors work with a number of other patients in a shared care environment are lower when compared to other settings, probably due to more efficient collaboration among the physicians involved. The reduction of pharmacy costs is an important objective considering the fact that within the expenditures laid out for medical services - in treating diabetes as an example - the share of pharmacy costs exceeds more than 20% of the total costs (Pollack et al [2013]).

Should we find that the health status of patients treated in strong general practitioner-specialist relationships is better or at least equal to those treated in weak general practitioner-specialist relationship then it is important to understand the reasons of such improved

performance. Such understanding may help developing strategic recommendations for healthcare strategists seeking to create and strengthen efficient ties between general practitioners and specialists.

In order to understand better the relationship among doctors participating in shared care arrangements, it is important to investigate whether such relationships are dominantly created between general practitioners and specialists of similar professional characteristics. The findings of the previous research are contradictory. Landon et al [2012] concludes that the homophyly is present in these relationships; physicians tend to share patients with other physicians with similar physician-level and patient-panel characteristics. On the other hand, Barnett et al [2012] concludes that the homophyly cannot be observed in their sample.

H3: Doctors having strong ties to one another share many similarities (homophyly).

Due to the contradictory previous findings I will investigate the collaborations among doctors based on the two definitions (the characteristics of doctors with concentrated vs. dispersed referral structures; and the characteristics of doctors being preferred versus non-preferred, the detailed definitions can be found in section 2.1). I expect to find substantial differences in the nature and quality of the various sets of relationships between general practitioners, on the one hand, and specialists on the other. Such recognized differences would enable drawing policy recommendations aiming at an enhanced level of collaboration between general practitioners and specialists assuming that enhanced collaboration results in lower pharmacy costs. Following this argumentation, the following hypotheses have to be tested:

H4a: Based on their characteristics, general practitioners maintaining a concentrated referral structure can be differentiated from those maintaining a dispersed referral structure.

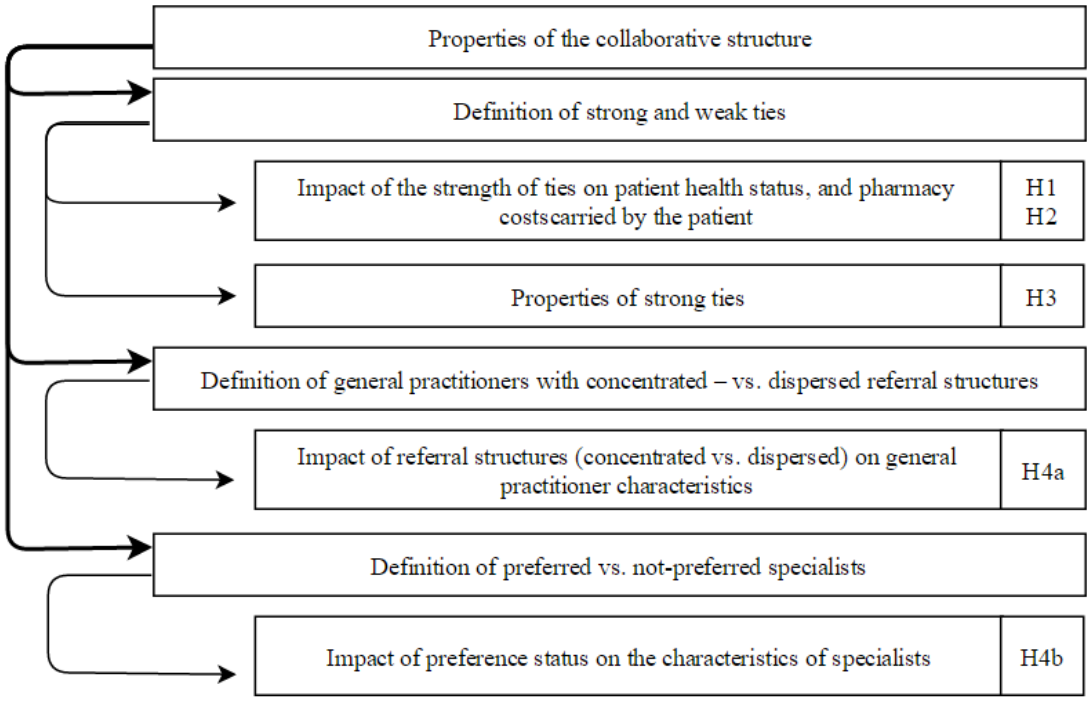
H4b: Based on their characteristics, preferred specialists can be differentiated from those defined as non-preferred.

2. METHODOLOGY

2.1. Collaborations

The research process is summarised in Figure 1.

Figure 1. Research design



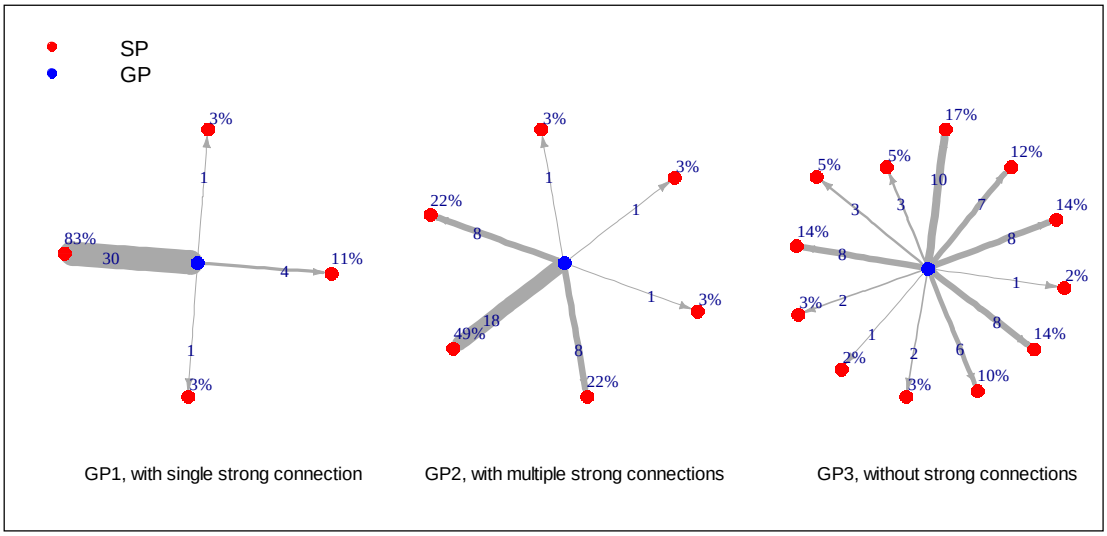
The number of specialists collaborating with particular general practitioners varies widely. In addition, the number of patients treated jointly in any particular relationship also varies significantly. For these reasons, the definition of the different types of collaboration is not straightforward. In relationships where shared care is provided for a higher number of patients the ties are presumably stronger since it can be assumed that professional interaction takes place more frequently among the doctors. The distribution of the strength of general practitioner-specialist relationships is skewed and their relationship is not linear as inferred by Pollack et al [2013]. On the basis of previous research and due to the differences in the number of patients treated jointly by collaborating doctors, we need a relative threshold rather than an absolute one, such as the number of patients would be, for the definition of the strength of ties. The two decisive factors in defining the threshold values are the number of patients receiving shared care and the distribution of patients among specialists.

In my research I employed three different definitions for collaboration (Fig 1.).

The definition of strong and weak ties

In my dissertation, I first allocated patients to general practitioner-specialist relationships. If a patient consulted several specialists during the observation period, then I allocated the patient to a number of general practitioner-specialist relationships simultaneously, in the following manner. I first defined the ratio of pharmaceuticals prescribed for one patient as suggested by one particular specialist over all pharmaceuticals prescribed for that patient as suggested by specialists. This ratio was then allocated as a weight to the patient of the relevant specialist. Next, I arranged the 6323 general practitioner-specialist relationships according to patient ratios in diminishing order. I qualified the relationship as strong in cases which fall into the uppermost quintile of collaborative ties. This criterion was met, for the purposes of my research, in cases where one general practitioner referred more than 19.2% of his/her patients to one particular specialist. In contrast, a particular general practitioner-specialist relationship was qualified as weak if that relationship fell into the lowest quintile of the cases studied. In this category, a particular general practitioner provides shared care for less than 2.3% of his/her patients in collaboration with one particular specialist (Fig 2.).

Figure 2. Strong and weak ties in the example of three general practitioners



Data source: DoktorInfo database.

The definition of general practitioners having concentrated vs. dispersed referral structures

Following the definition of strong vs. weak ties, for a more thorough analysis it is necessary to provide a definition of concentrated vs. dispersed referral structures characterizing general practitioners.

For determining the concentration of referral structures, I used the most widely accepted measure, the Herfindahl-Hirschman index as applied to individual general practitioners (Rhoades [1993]),

$$HHI = \sum_{i=1}^{n} s_i^2, \text{ where}$$

$$s_i = \frac{number\ of\ patients\ referred\ to\ one\ SP\ by\ one\ particular\ GP}{all\ patient\ of\ one\ particular\ GP}$$

I defined the HHI index for each general practitioner and, subsequently, I sorted the 794 general practitioners in a sequential order. Based on this sequence, I placed general practitioners into categories as characterized by concentrated vs. dispersed referral structures. This means that I applied a relative indicator: I defined the referral structure of a particular general practitioner as concentrated when his/her practice fell into the uppermost quintile of the cases studied. Both the uppermost and the lowest quintiles contained 158 practices.

The definition of preferred vs. non-preferred specialists

By definition, a specialist maintains strong ties with a general practitioner if he/she is one of the preferred specialist of that particular general practitioner. A specialist qualifies as being a preferred partner of a general practitioner if the latter refers at least 30% of his/her patients, or a minimum of nine patients, to that particular specialist. One general practitioner may have more than one preferred specialist. Preferred specialists receive patients with referrals from five general practitioners or more.

2.2. Databases

In my dissertation, I have relied on two main and three additional databases. Prescription data have been provided for research purposes by the DoktorInfo Ltd. Nearly 900 general practitioners insert prescription data into the Doktorinfo databases on a daily basis. The another main sources of data used in this research is the Health Centre of Registry and Training database (hereinafter referred to as HCRT database). By relying on the HCRT database, I have downloaded socio-demographic and workplace-related characteristics for general practitioners and specialists (HCRT [2015]). I have used three additional databases in my research. The Price Subsidy Department of the National Health Insurance Fund of Hungary (NHIFH) regularly issues a Public Pharmacy Register (PUHA), which is a public

database on subsidized pharmaceuticals (NHIFH [2014]). Moreover, I used a database containing 2011 pharmacy prices to define the full prices of pharmaceutical products. Finally, the 2011 Annal of the Designation Register of Populated Areas published by the Hungarian Central Statistical Office (HCSO) contains in its database the population figures of all inhabited settlements which enabled me to categorize all towns examined in this research by their size (HCSO) [2011]). Using Google Maps, I was able to calculate public road distances between health care practices.

2.3. Patient population

The selection of patients with type 2 diabetes offers a promising approach to the investigation of collaborative practices between general practitioners and specialists for three reasons. First, patients suffering from this chronic disease constitute the largest patient population receiving shared care provided jointly by general practitioners and specialists. Secondly, this area of health services produces the largest number of general practitioner prescriptions issued on the recommendation of specialists. Thirdly, medication applied in the treatment of diabetes can only be prescribed by a well-defined group of licensed specialists comprising internists and endocrinologists. (Ministerial Decree 44/2004. - IV. 28. - ESzCsM - Ministry of Health, Social and Family Care). As a result, I was able to delineate and analyze the largest possible subset in terms of the number of prescriptions written.

2.4. Output variables

In this section, I discuss the definitions of the health status of patients, on the one hand, and pharmacy costs, on the other. These variables are referred to as output variables. In my dissertation, I use approximate indices on the health status of patients based on diagnosed and treated comorbidities.

In my research, I employed four different comorbidity indices:

• *Charlson comorbidity index (Charlson et al [1987]):*

The Charlson comorbidity index offers predictions as to the 10 year survival probability of the patient using a weighted scoring system which evaluates the presence or the absence of 19 different diseases. (Charlson et al [1987]).

• *Quan-modified Charlson comorbidity index (Quan et al [2011]):*

Considering the fact that since the first publication of the Charlson comorbidity index in 1984 several medical innovations affected the mortality rates related to particular diseases it could be argued that the application of this rating system may require adjustments. Therefore, I also define the relevant index values on the basis of the Quan-modified Charlson comorbidity rating method: I revise the mortality rate scores assigned to particular diseases while the list of diseases remains unchanged (Quan et al [2011]).

• *Elixhauser measure (Elixhauser et al [1998]):*

The Elixhauser measure examines the occurrence of 30 carefully selected diseases expressing their aggregate frequency of occurrence.

• *ATC-based comorbidity count:*

The fourth comorbidity rating technique applied in my research is an alternative index referred as the number of prescription drugs dispensed in the relevant literature (e.g., Lix et al [2016]). This alternative index relies on the ATC codes entered on the prescriptions. My objective in using this alternative index was the rectification of potential mistakes occurring in the ICD codes. With the help of the comorbidity indices based on the ATC codes, I took account of the occurrences of diseases with respect to which the patient received at least one prescription in each quarter year analyzed.

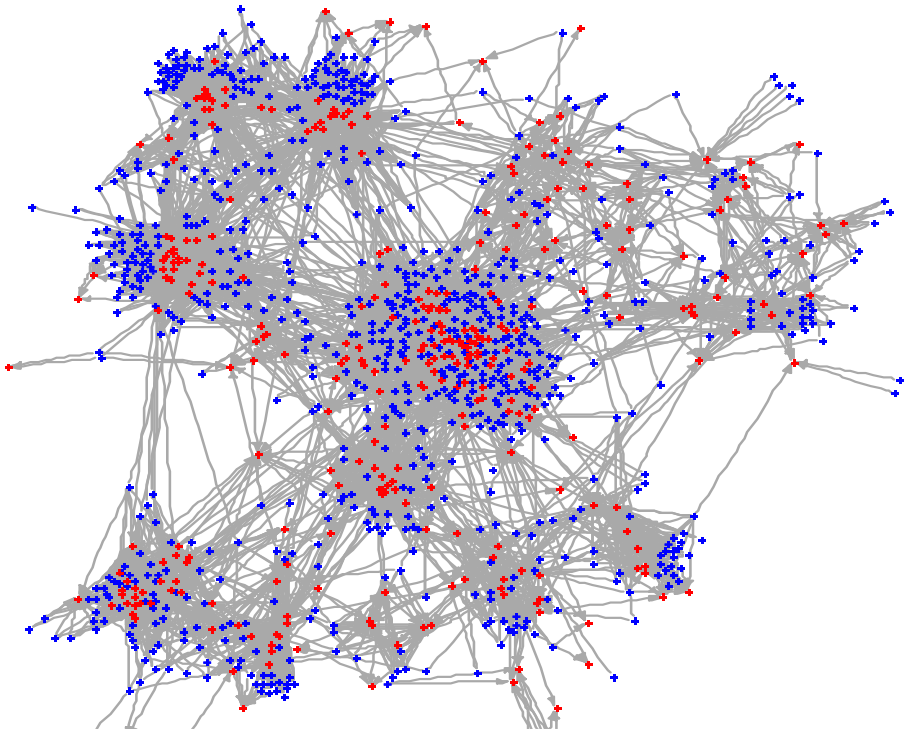
In defining pharmacy costs, I calculated the aggregate cost of medication, without subsidies, prescribed by the general practitioner for every single patient throughout the years 2010 and 2011 using information retrieved from the NHIFH database. It is important to stress that, in the course of this research, I was not using medication expenditures carried by the patient when calculating pharmacy cost. Instead, I used the full prices which would be payable for the pharmaceuticals in the pharmacy shops by the patient complemented by government subsidies. As a result, I was able to take into account the pharmacy cost for the whole society.

3. RESULTS

3.1. Characteristics of the collaboration structure

In my empirical research, I explore the characteristics of relationships between general practitioners and specialist which emerge in the process of providing care jointly for patients with type 2 diabetes (Fig. 3.).

Figure 3. The network structure of general practitioners and specialists



Data source: DoktorInfo database.

In the sample, both the number and the distribution of patients treated by particular general practitioners show large variation. On average, a general practitioner collaborates with eight specialists - nonetheless, the standard deviation of this factor in the sample is fairly high. The structure of collaboration between doctors is rather fragmented. The number of patients receiving shared care in any particular general practitioner-specialist relationship may substantially differ from case to case. Also, the number of specialists collaborating with one particular general practitioner may show large variations. Therefore, in the analysis of relationships I used a relative threshold.

3.2. Health status of patients and pharmacy costs

In this subsection, I take a close look at the health status of patients and the pharmacy costs of patients treated in strong general practitioner-specialist relationships as opposed to those receiving care in weak relationships.

Table 1 shows the test results calculated for the first two hypotheses. All four comorbidity indices support the conclusion that patient health status is not influenced by the nature of general practitioner-specialist relationships, be the respective ties classified as either strong or weak. The health status of patient, regardless of the comorbidity indices used, are very much the same and do not appear to be influenced by the strength of specialist-general practitioners relationships. This implies that I have to reject my first hypothesis.

Table 1. Description of strong and weak general practitioner-specialist relationships in the function of various outcome measures

Outcome measures	Strong ties (uppermost quintile, mean value)	Weak ties (lowest quintile, mean value)	p-value
Patient health status (excluding diabetes)			
Charlson comorbidity index	0.93	0.91	43.64
Quan-modified Charlson comorbidity index	0.60	0.60	82.66
Elixhauser measure (based on ICD-10 codes)	1.98	1.95	42.33
ATC-based comorbidity count (based on third-level ATC codes)	8.01	7.98	83.93
Pharmacy costs (based on retail prices as of January 2010; thousand HUF - Hungarian Forint)	612.18	721.41	0.00

Data source: DoktorInfo and the NHIFH databases.

On the other hand, as shown in Table 1, the strength of ties between doctors certainly influences the size of the pharmacy costs. Patients treated in strong general practitioner-specialist relationships carry pharmacy costs which are 15.14% smaller than those carried by

patients treated in weak relationships. The difference is significant, thus, my second hypothesis has to be accepted.

For a better understanding of the differences in pharmacy costs, in addition to the by-variate analyses I have also performed a multivariate regression analyses. This multivariate regression analyses might help explaining the observed differences in pharmacy costs. I found that the strength of ties, similarly to many patient characteristics (gender, age, severity of diabetes condition) bear a significant impact on pharmacy costs, alongside with the type of therapy applied (insulin based vs non-insulin based) (Table 2).

Table 2. Multivariate regression applied to the pharmacy costs carried by patients

Independent variables	Standardized Coefficients	Sig.
	Beta	
Strong and weak ties between general practitioners and specialists (0 - for weak; 1 - for strong)	0.011	0.030
Quan-modified Charlson comorbidity index	-0.009	0.113
Patient's gender (0-female, 1-male)	-0.024	0.000
Diabetes severity (0- without complication, 1-with complications)	0.014	0.007
Type of therapy (0-no insulin, 1-insulin based)	0.202	0.000
The number of prescriptions per patient (units)	0.570	0.000
The number of consultations per patient (with the specialist, generating new recommendations for prescription medicines)	0.062	0.000
Patients' age	0.174	0.001
Patients' age squared	-0.272	0.000

Data source: DoktorInfo and the NHIFH databases.

In summary, it can be argued that the strength of ties exerts no impact on the health status of patients. This result is in line with previous research (O'Connor et al [2008], Craven and Bland [2006], Smith et al [2007]).

The finding that the pharmacy costs of patients treated in strong general practitioners-specialist relationships are significantly higher than the pharmacy cost of patients treated in weak general practitioners-specialist relationships, is in line with previous research. In particular, Barnett et al [2012], Landon et al [2012] and Pollack et al [2013] have also found that those relationships which provide shared care for a larger number of patients generate comparatively lower pharmacy costs.

3.3. Characteristics of strong vs. weak ties

Having evaluated hypotheses H1 and H2, the question arises: if the reduction of health care costs at the level of the whole society is found to be attributable to strong general practitioner-specialist ties, as demonstrated, then can we identify those characteristics of collaborating doctors which might support the development of such relationships?

My empirical research did not find support for the third hypothesis (H3) related to the emergence of homophyly in strong general practitioner-specialist relationships. It has been demonstrated that in strong relationships doctors have a long record in collaborating with their partners in shared care, and that their practices are geographically close to each other. The impact of homophyly is limited, and it can only be detected in the number of specialites acquired. General practitioners tend to refer their patients to specialists they know well and with whom they have a long standing collaborative partnership. This result is consistent with the findings of Barnett et al. [2012], who also argued that homophyly cannot be detected in all categories of doctor characteristics.

Subsequently, I investigated the possible differences in the characteristics of general practitioners maintaining a concentrated referral structure as opposed to those working with a dispersed referral structure (H4a), and whether preferred specialists differ in their characteristics from their non-preferred colleagues (H4b).

My results show that general practitioners maintaining concentrated referral structures mostly work in minor municipalities, and that graduation from the same medical school probably impacts the development of strong ties. It may well be that general practitioners working in minor municipalities are constrained in their choice of selecting a specialist. In comparing preferred as opposed to non-preferred specialists, I came to the conclusion that preferred specialists are usually older, have more professional experience, the period spent in their current practices is usually longer, they work mostly in small municipalities, fill senior management positions in their respective medical institutions and have a relatively small number of colleagues of the same specialisation working in the neighbourhood. Accordingly, it can be concluded that professional experience is an important consideration in the choice of a specialist made by either the general practitioner or the patient, similarly to the professional recognition and acclaim accorded to the specialist also assuming that professional reputation is probably a consequence of more experience.

The above findings are in line with my intuitions regarding the fact that the longer the period of joint collaboration the more intimate is the mutual understanding of the parties, the more extensive the familiarity with each other's therapeutic techniques and preferences, the greater the confidence of recommending each other as trusted professionals, and the more smooth is the communication developed with each other. The distance between the practices is highly important for the patient since, obviously, the majority of patients is either not willing, or is not capable of travelling large distances. The third major factor contributing to the emergence of strong ties between collaborating doctors is related to the obligation to provide healthcare services within particular geographic areas.

In weak relationships the ratio of distances of above 50 km between practices is fairly large (28.2%). Given the freedom of choosing physicians, in case of larger distances instead of the regionally assigned specialist, the patient is more likely to select a specialist of his/her own choice with whom he/she is already well acquainted; or one recommended by somebody else. In these cases it can be reasonably assumed that the general practitioner does not know the specialist personally, and therefore joint treatment is only a theoretical.

3.4. An analysis for the small and medium-sized municipalities

The obligation to provide healthcare services within particular geographic areas ought to be viewed as a critical factor in developing strong vs. weak ties: It may well be that the obligation to provide healthcare services within particular geographic areas predetermines the strength of ties in small communities. Therefore, I have investigated weather the health status and pharmacy costs of patients receiving care in strong general practitioner-specialist relationships is significantly different from the health status and pharmacy costs of patients receiving care in weak general practitioner-specialist relationships in small and medium-sized municipalities as well. In this analysis moderating coefficients were added to the model.

Having only small and medium-size municipalities in the sample, the results show that in geographic areas where the number of available specialists is low the chances for developing strong collaborative relationships are higher as compared to the whole sample (Table 3). Of the 794 general practitioners in the sample, 158 have concentrated referral structures and only six of the latter maintain practices in Budapest. In the case of general practitioners with dispersed referral structures these ratios show an inverse relationship.

Table 3. Description of strong and weak general practitioner-specialist relationships in the function of various outcome measures in small and medium-sized municipalities

Outcome measures	Strong ties (uppermost quintile, mean value)	Weak ties (lowest quintile, mean value)	p-value
Patient health status (excluding diabetes)			
Charlson comorbidity index	0.88	0.91	16.03
Quan-modified Charlson comorbidity index	0.59	0.60	58.15
Elixhauser measure (based on ICD-10 codes)	1.93	1.96	30.81
ATC-based comorbidity count (based on third-level ATC codes)	7.98	8.38	0.00
Pharmacy costs (based on retail prices as of January 2010; thousand HUF - Hungarian Forint)	591.89	696.60	0.00

Data source: DoktorInfo, HCSO and HCRT databases.

Patients treated by general practitioners working in small and medium-size municipalities and maintaining concentrated referral structures display no significant differences in terms of health status, while the pharmacy costs carried by the same patients are significantly lower. We might thus conclude that even in geographic areas where the number of available specialists is limited the finding remains valid: doctors working in strong collaborative ties contribute in a meaningful way to the reduction of pharmaceutical expenditures carried by society. The obligation to provide healthcare services within particular geographic areas is thus not the only factor responsible for the emergence of strong ties.

3.5. Policy recommendations

The most important policy implication of my dissertation pertaining to healthcare economics is related to the free choice of healthcare providers. Free choice of providers has been recently enacted in a number of developed countries, including the Netherlands and the United Kingdom. In an environment where patients can freely choose their specialists, the free choice may compel the general practitioners to expand the circle of collaborating specialist in the

provisioning of shared care. In my dissertation I have shown that the patients of those general practitioners who provide care in collaboration with a relatively larger number of specialists carry higher pharmacy costs. This might be achieved through offering patients limited rather than unrestricted choice-patients need excellent providers, in small numbers and close geographic proximity. Lower care fragmentation, coupled with enhanced medical education and technical infrastructure might benefit patients, by savings on travel times and costs, and the wider society, by savings on pharmacy costs. It appears beneficial to develop incentive schemes with the objective of encouraging general practitioners to enhance strong relationship with their specialist counterparts.

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