

Strategic Interaction between General Practitioners and Specialists - implications for gatekeeping

Catherine Schaumans *

TILEC, CentER, Tilburg University

November 2009

Abstract

Competition and complementarities between firms can occur simultaneously. To flexibly identify the nature of strategic interaction between GPs and specialist types in Belgium, we present a sequential equilibrium entry game of incomplete information. The results indicate that some specialists are strategic complements (gynecologists, TNE-specialists) and some are strategic substitutes in the entry decision of GPs (dermatologists, ophthalmologists, psychiatrists). With free choice of physician, this is indicative for patients' choice behavior: for the latter group of specialists, patients often wrongly self-refer. Although introducing mandatory referral schemes would correct this inefficiency, it would generate sustainability problems for the current body of specialists.

Keywords: entry, strategic interaction, GPs, specialists, gatekeeping
JEL-codes: I11, L10

*Contact: catherine.schaumans@uvt.nl

This paper originates from chapter four of my 2008 dissertation at K.U.Leuven. I thank Frank Verboven, Pedro Pita Barros, Hans Degryse, Michael Mazzeo, Erik Schokkaert, Patrick Van Cayseele, Xavier Boutin, Geert Dhaene, Stijn Ferrari and various seminar participants at CEPR Applied IO School 2008, 6th Annual IIOC, NIE 2008, EARIE 2008, Tilburg University, RWTH Aachen, KULeuven, Kellogg School of Management and Antwerp University for helpful comments. Furthermore, I am grateful for the hospitality of Kellogg School of Management at Northwestern University and to Dendrite International Belgium and RIZIV/INAMI for data provision. I am also grateful to the Flemish Science Foundation for financial support (FWO, Grant G.0089.04) and to EARIE08 (Young Economist Essay Award 2008) and VVE (VVE-prijs 2009) for awarding this paper.

1 Introduction

The education system delivers a variety of physicians to society. There is the general practitioner (GP), or family doctor, who is trained to have a very broad knowledge on all current medical problems and to understand the wider background of his patientele. On the other hand, there is a long list of fields of expertise in which physicians can be specialist, such as dermatologic or pediatric care. Although their initial education is broad, these specialists are trained to be experts in a specific field and are thus capable to diagnose and treat more complex and specialized cases. Given this education structure, the intention of complementarity in their services is clear: GPs treat regular cases and more complex or specialized cases are handled by specialists.

The reality is however not that clear-cut. In Belgium, as in almost half of Western-European countries and under several insurance contracts in the United States, patients have a free choice to contact any physician they like, GP or specialist. This complicates things considerably: a specialist is now not just a welcomed help in treating difficult cases, but also becomes a competitor for the GP (Newhouse 1990).¹ It is therefore a priori not clear whether GP services and specialist services are to be considered as complementary or as an example of product differentiation in the care market. Furthermore, it is likely that the nature of the interactions between the health professionals differs according to the field of specialty.

This article aims to empirically test the nature of the interactions between Belgian GPs and specialists of different fields of expertise. We investigate whether GPs benefit or are harmed by the presence of specialists in the market. We argue that in case GPs benefit from the presence of specialists, the services provided by these health professionals can be considered as complementary. When GPs are harmed by the presence of specialists, competition for patients seems to dominate the interaction between the health providers.

Due to data availability constraints, we suggest evaluating the strategic interaction in the entry decisions between specialists and GPs. More precisely, by examining the choice of GPs and specialists to be active in different geographic markets, we infer the impact of the market presence of different kinds of specialists on GP payoffs. We model the entry decisions of physicians as a strategic entry game in the tradition of Bresnahan and Reiss (1991a,b) and Mazzeo (2002). Our research question is however different from the existing literature in the sense that it is a priori not clear how the strategic interaction effects are characterized.^{2,3} We argue

¹Newhouse (1990): "In reality, however, there is a certain amount of competition among specialties; this is perhaps most apparent between a general (or family) practitioner, on the one hand, and a general internist (or general pediatrician) on the other hand, but almost all specialists perform some services or procedures that other specialists also perform." (p.211)

²A working paper by Vitorino (2008) addresses a similar research question in the setting of agglomeration effects in shopping centers.

³The literature provides a wide range of applications of entry models of product differentiation such as on the competition between airlines (Berry 1992, Ciliberto and Tamer 2004), between motels (Mazzeo 2002) and between banks (Cohen and Mazzeo 2007). There are also some examples that cover positive strategic interaction effects, i.e. strategic complementarity (Sweeting 2007, Schaumans and Verboven 2008).

that in the event of strategic interaction effects being asymmetric in sign, complete information games in pure equilibrium suffer from the non-existence of pure-strategy equilibria. To avoid the typical restrictions on the underlying payoffs with respect to the effects of other-type physicians, this article proposes the use of a sequential incomplete information game in the spirit of Einav (2009). It is shown that under this set of assumptions, the entry model has the appropriate flexibility to identify the nature of the strategic interaction effects, while allowing for sufficient heterogeneity and while remaining computationally tractable. We apply the structural entry model to the Belgian physician markets, which are characterized by free choice of physician and a fee-for-service system.

The complementarity or substitutability of GP and specialist services is primarily driven by patients' choice behavior in their decision to contact a GP or a specialist. With free choice of health provider, patients may choose to visit the specialist although the GP, if given the chance, would prefer to handle this patient him- or herself. When patients exhibit this 'wrongly self-referring' behavior, GPs lose income and are thus harmed by the presence of specialists. On the other hand, when patients with complicated health problems go to the GP, the possibility to refer these patients to a specialist is beneficial to the GP. In sum, the extent to which GPs are affected by the presence of a specialist crucially depends on the choice behavior of patients.

We argue that identifying the interaction between GPs and specialists can indicate the extent to which patients wrongly self-refer.⁴ This can in turn be viewed as a measure of the efficiency of the use of specialist care. Although specialists often welcome the additional business, patients who wrongly self-refer are medically not better off, whereas they pay a higher price for it (i.e. the health insurer or society pays). Furthermore, the demand for specialist care is artificially higher, which results in training a higher than optimal number of specialists. Health care is thus inefficiently used when patients wrongly self-refer.

Insights in the choice behavior of patients furthermore contain valuable input for the debate of introducing gatekeeping.⁵ That is, implementation of mandatory referral schemes, where GPs decide on the access of patients to specialist care, would eliminate these inefficiencies: wrong self-referrals are no longer possible. However, other inefficiencies can be generated in the form of additional transaction costs: when patients are correctly self-referring to specialists, this policy change would generate additional and unnecessary GP contacts, whereas the number of contacts with specialists does not reduce. Furthermore, by altering the organization of the health care markets, the regulator would affect the market opportunities of specialists.

⁴Alternative ways to quantifying the extent to which patients wrongly self-refer to specialists is hard. Constructing a direct measure would require detailed patient-level and/or specialist-level data, with an objective measure of the necessity of secondary care. This data is not available.

⁵Gatekeeping is present in a health care system if the following three criteria are fulfilled: Enrolment of patients with a specified GP for a fixed period of time; payment for GPs is mainly by capitation per enrolled patient; and specialist care is usually only granted following referral by a GP (De Maeseneer et al 1999). This paper focuses on the mandatory referral scheme (element 3) in the discussion on gatekeeping.

That is, when patients are wrongly self-referring, mandatory referral schemes lead the decrease in the patientele of specialists (i.e. efficiency gain). If this drop is important, this can lead to a decrease in the number of specialists that is sustained in the market.⁶ Given that these specialists are high-skilled workers and trained using public funding (and that still specialists are being trained), the drop in their sustainability can generate high welfare losses.

Based on the findings of the nature of the strategic interaction between GPs and specialists, we discuss the implications of introducing mandatory referral schemes in the Belgian health care market.⁷ There is a large literature that evaluates the efficiency gains and the quality or budget effects of the presence of a gatekeeper in health care systems (Kulu-Glasgow et al 1998, Delnoij et al 2000, Gerdtham and Jönsson 2000, Ferris et al 2001, Brekke et al 2007, Barros 1998). Instead of descriptive ex-post analysis of the effects of gatekeeping, we investigate a non-gatekeeping situation to get an insight in the efficiency of the current use of medical professionals and on potential transition costs associated to introducing mandatory referral schemes. Note though that we do not perform a full welfare analysis of the implementation of gatekeeping nor do we take a stance of the importance of other arguments in favor or against gatekeeping.

Our estimation results for the Belgian physician markets indicate that the effect of specialists on GP payoffs depends on the specialization field. The entry decisions of gynecologists and ear, nose and throat-specialists (ENT) are estimated to be strategic complements to the entry decision of GPs. The presence of dermatologists, ophthalmologists and psychiatrists on the other hand is found to have a negative impact on GP payoffs. These specialist types thus attract a lot of patients for whom GP care would suffice. Finally, our results are not conclusive for pediatric and physiologic care. We conclude that the main inefficiencies in the current health care system originate from the unnecessary use of dermatologic, ophthalmologic and psychiatric care.

With respect to the impact of introducing mandatory referral schemes in the Belgian care system, our findings indicate that efficiency gains can be realized on the activities of subset of specialists, whereas mandatory referral schemes could introduce some inefficiencies with respect to the use of other specialist care. At the same time, considerable transition costs are to be expected as the drop in the demand for specialist services translates in viability problems for the current body of dermatologists, ophthalmologists and psychiatrists. Simulation results indicate that a realistic drop in the demand for specialist services due to mandatory referrals would imply that up to 25% of the current specialists would be forced to exit the market.

⁶Survey results from Germany indicate that specialists report to fear financial losses due to gatekeeping (Gress et al 2004).

⁷Throughout the paper, we assume that only GPs will be assigned as gatekeepers. Gynecologists and pediatricians are thus not allowed to act as the primary care doctor for certain population groups. A US study by Kirk et al (1998) indicates that only a minority of gynecologists identify themselves as primary care providers.

The article is organized as follows. We start by discussing in more detail the relation between general practitioners and specialists in a market in which patients have free choice of medical provider and relate this to the identification strategy. In Section 3, we introduce the application and thus the characteristics of the organization of health care markets in Belgium. Section 4 then presents the entry model to determine the strategic interaction effects and discusses the particular strengths of the model given the research question. Section 5 follows with the data description and the empirical implementation of the equilibrium model to the Belgian physician markets. The results of the analysis are presented and discussed in Section 6 and Section 7 concludes.

2 The interaction between specialists and GPs

When a patient visits a physician, the physician incurs some costs and receives some benefits. The benefits are the fee the physician gets for his/her work, but can also include the satisfaction of treating patients or the intellectual challenge of solving a difficult case. The costs are associated to the material and the time used for talking to the patient, diagnosing the problem and possibly treatment. As in the absence of mandatory referral schemes (e.g. Belgium) patients can either go to a GP or directly to a specialist, we distinguish between four cases:

1. A patient with a regular health concern visits a GP.

It is worthwhile for the GP to treat the patient when the anticipated benefits of diagnosing and treatment outweigh the costs. We assume that the fee for GPs is set in such a way that this condition is satisfied for the average health problem. When this is not the case, we assume that the ethical and intellectual satisfaction are sufficiently large for GPs to have positive payoffs of treating patients with regular health concerns.

2. A patient in need of specialist care visits a GP.

It is worthwhile for the GP to refer patients to specialists when the anticipated costs of diagnosing and treatment outweigh the benefits. The education system designs and supports this complementary between GPs and specialists. That is, specialists are trained in specialized fields and thus have lower marginal costs of treating patients with health issues related to their specialties. As these cases are generally more complicated, the specialists are also remunerated for the higher costs they incur. For patients that need specialist care, we assume that the GP visit has zero net payoffs for the GP. That is, we assume that the costs of taking the first diagnostic measures are exactly covered by its benefits.⁸

⁸Remark that this implies that for these patients, GPs are indifferent between patients contacting them first and being

3. A patient with a regular health concern visits a specialist.

In this scenario the patient will be worse off. That is, in the event that he gets the same treatment, he will have to pay more for it compared to contacting a GP. Furthermore, there also exists the risk that the patient is not diagnosed or misdiagnosed, when the patient chooses the wrong specialist type. Also the GP is worse off because if given the chance, the GP would have opted to treat the patient. That is, the GP's costs of managing this patient are lower than the associated benefits. We will refer to this case as a *wrong self-referral*, as the GP would not refer in this case.

4. A patient in need of specialist care visits a specialist.

By going to the (correct) specialist directly, the patient avoids paying for a GP visit in which he will be referred anyway. As the GP would decide to refer, we label this case as a *correct self-referral*. The patient will thus be better off because of the reduced transaction costs, whereas the GP is indifferent as the costs and benefits of this visit would perfectly outweigh each other (by assumption). The specialist is now the first contact of the patient with his health concern. In such, all initial tests and diagnostic efforts will have to be carried by the specialist. The specialist thus prefers these patients to be referred by a GP.

Given this set-up, consider the impact of the presence of a specialist on the payoff of a GP. The presence of a specialist implies that the GP is able to refer patients: he/she will refer those patients for who the expected costs for treatment outweigh the expected benefits. In such, the average marginal cost of treatment for the GP reduces. As a 'referral visit' yields GPs no net benefits, payoffs are higher when specialists are present in the market. We label this positive impact on GP payoffs of the presence of specialists as the *referral effect*.

On the other hand though, to some extent GPs and specialists deliver the same services and specialists are thus competing for patients with GPs. That is, patients now have the option to go to the specialist instead of to the GP. To the extent that patients correctly self-refer, this does not harm the GP. But when patients wrongly self-refer, the GP foregoes the opportunity to increase his payoffs. This negative impact on GP payoffs of the presence of specialists is labeled as the *competition effect*.⁹

referred to a specialist and patients contacting the specialist directly. When GPs take their job seriously and don't just refer all patients to specialists to limit their workload, this is a realistic assumption.

⁹Remark that the interpretation of the signs of the strategic interaction effects in terms of the incidence of wrong referrals is driven by the assumption that GPs are not losing income in case patients correctly self-refer. For Belgium, we believe this assumption is justified as the workload of the average GP is rather high (there are often claims of a shortage of GPs). Therefore, they have a high opportunity cost of time.

The interaction between GPs and specialist

The positive referral effect and negative competition effect occur at the same time, so that it is a priori not clear whether a GP will benefit or will be harmed by the presence of specialists in the market. It is ultimately an empirical question. The answer hinges on the extent to which patients correctly and wrongly self-refer to specialists. That is, when most of the patients wrongly self-refer to a specialist, the competition effect is large so that the GP is likely to be harmed by the presence of the specialist. When most of the patients correctly self-refer to a specialist or when most of the patients continue to visit the GP first, positive referral effects can result from the presence of the specialist.

By estimating the impact of the presence of specialists on GP payoffs, we can therefore evaluate the incidence of wrong self-refer. That is, when the presence of a specialist negatively impacts the payoffs of GPs, the competition effect outweighs the referral effect. This is the case when many patients wrongly self-refer. When the presence of a specialist on the other hand positively impacts GP payoffs, the competition effect is dominated by the referral effect. Therefore, not too many patients wrongly self-refer or the benefits from referring are large (the GP refers a lot or the value of referring is high).¹⁰

The impact of introducing mandatory referral schemes

As gatekeeping is believed to contribute to efficiency and cost containment, policy makers in countries without gatekeeping are increasingly interested in the adoption of a mandatory referral scheme: patients can access secondary care only following a referral from their GP. However, introducing mandatory referral schemes also changes the entire organization of the health care markets and forces patients to change their choice behavior with respect to contacting a GP or a specialist.

To the extent that patients wrongly self-refer, the obliged GP visit yields efficiency gains: GPs treat patients with regular health problems instead of the more expensive specialist services being used. But when the majority of patients correctly self-refer to specialists, the new system would introduce additional transaction costs and inefficiencies compared to the system of free choice. That is, it generates additional and unnecessary GP contacts, whereas the number of contacts with specialists does not reduce. Furthermore, although efficiency gains might realize, important transition costs accompany the introduction of mandatory referral schemes. That is, when patients are wrongly self-referring, the increased efficiency will go together with a decrease in the patientele of specialists. These changing market opportunities can lead to a decrease in the number of specialists that is sustained in the market and thus to welfare losses.

¹⁰We want to remark that one could also try to interpret the impact of GPs on specialist payoffs: when there is a GP, there might be less self-referrals, which could negatively impact specialists' payoffs. We choose not to look at this effect, because there are many GPs per market: how would we interpret the change in payoffs due to an increase in the number of GPs from 15 to 16 GPs. Furthermore, many arguments with respect to positive or negative impacts of wrong self-referral on specialist payoffs can be told.

3 Organization of the Belgian Health care Markets

Before looking at the entry model to estimate the nature of the strategic interaction between GPs and specialists, we introduce the characteristics and the organization of the primary and secondary health care provision in Belgium. We focus on the entry requirements, the conduct and the interaction between physician types as these determine the set-up of the model.

The delivery of health care in Belgium, a social health insurance country, is mainly private and based on the principles of independent medical practice. Belgium is known for having a high GP density: for 2005, we account for the presence of one GP per 859 inhabitants. Furthermore, for a total population of about ten million there are close to 40,000 active physicians (GPs and specialists), which makes Belgium the second most physician dense country of Europe, after Greece (OECD Health Data). The high availability of medical care is also associated with a high consumption level of care services: Belgians on average have 4.6 contacts with a GP and 2.3 contacts with specialists per year (WIV 2006).

Entry requirements

Entry into the medical professions is conditional on minimum educational standards (licensing). Medical students start with a six-year program, which covers the basics for all physician types, followed by a one-year introduction to the preferred specialization field, which mostly consists of internships. After this initial period of seven years, medical students start their study of a specialty to obtain a license to practice: such fields of specialization include e.g. general medicine, gynecology and dermatology. These further studies consist of two years of internships and seminars for GPs and on average 5 years of study and internships for the different specialist types. Note that there is a restriction on the number of students that can start in each specialization field and that retraining to another specialization field is very rare: also retraining from a specialist type to a GP requires additional study. Apart from these educational requirements and some administration, entry in the Belgian physician markets is free. That is, a licensed and registered physician of any type can choose to locate an office anywhere in Belgium.¹¹ Note that the industry and governmental institutions also provide employment opportunities for licensed physicians of different types, which gives potential physicians the option to not entering the physician market. A recent study by KCE indicates that 20% of the licensed GPs never practice the profession and that there is an exit rate amongst starters of 15% over a 10-year period (KCE 2008).

Conduct

¹¹This is in contrast to the regulation in some neighboring countries. In The Netherlands and Germany, there is regulation on the number of physicians per local market. Belgium has similar regulation for the pharmacy market. Adjustments to the entry model for these entry restrictions are demonstrated in Schaumans and Verboven (2008).

Most GPs operate solo, frequently without any staff except perhaps a medical secretary.¹² They typically perform a combination of open office hours, appointments and home visits. Furthermore, most GPs are enrolled in a local system of night and weekend duty to ensure the availability of primary care. Specialists are on the other hand often associated to hospitals. However, some fields of specializations do not necessarily require the hospital environment, which results in system where specialists are active in multiple offices: one within the hospital and a private practice. Studies show that patients often visit especially dermatologists, pediatricians, ophthalmologists and gynecologists outside the hospital (about 50% of all specialist contacts, WIV 2006). In this context, specialists typically operate solo and perform consultations on appointment.

In general, both GPs and specialists (in hospitals and in private practice) are remunerated through fee-for-service payment where fees are set at the national level by the Convention Committee of the health insurers and physicians¹³. As a result, a drop in workload directly translates into a decrease of income. The fee-for-service system furthermore prevents price competition amongst physicians of the same type. A consultation with a specialist is however substantially more expensive than a GP contact: in January 2005, patients' copayment for a consultation was 3.29€ with a GP, whereas the patient pays on average more than 10€ for a specialist contact. Although there is no price competition and furthermore self-regulation traditionally prevented physicians to compete through advertising, physicians do have a wide range of other instruments they can use to compete with: quality of treatment, time spend on a consultation, availability, home visits (for GPs), waiting time and so on.

Interaction between health providers

The Belgian health care system does not include any gatekeeping role for GPs. Neither referral nor enrolment system is in place. There is thus free choice of physician and because the functions and roles of most health care personnel have not been clearly defined, specialists often form the first point of contact. WIV (2006) reports that on average 55% of all new contacts with specialists are initiated by the patient rather than by a GP. There are significant differences however according to gender and age in the self-referring behavior. For example, females and young adults tend to self-refer more often.

Containment of health expenditure has been on the political agenda since the eighties and in 1993, some initiatives were launched to serve this purpose: amongst others there was a significant increase of copayment. But with the challenges of ageing and the development of expensive new medical techniques, initiatives on

¹²75% of the population indicates visiting a GP that operates solo (WIV 2006). The percentage of GPs working solo is expected to be a bit higher than this. The number of centers operating as a multidisciplinary team (integrated health care practices) is growing, but there is still only a small minority of people affiliated to them. Our dataset does not allow us to identify them.

¹³In principle, only health professionals associated to university hospitals do not work (solely) on a fee-for-service basis, but are salaried. We will exclude the markets with university hospitals from the analysis below.

cost containment and efficiency remain important. In 1999, the Belgian authorities started with financial incentives for patients to participate in a system of enrolment with a preferred GP. Over the first five years, more than 30% of the population already enrolled. Moreover, in 2004, 95% of the population indicates having a regular GP (WIV 2006) and a 2001-survey of one of the Belgian health insurers indicates that 75% of the patientele of a GP is loyal.¹⁴ This indicates that the majority of patients seem not to be shopping around as far as GP care is concerned. Secondly, as of February 1st, 2007 a specialist contact that is not initiated by a GP referral has become more expensive for the patient, although the price difference of 5€ is only valid for one contact per year.¹⁵ When these cost containment measures would have full impact, they would mimic the situation under a mandatory referral scheme: patients register with a preferred GP and due to financial incentives, they visit the GP first. It should be noted though that the financial incentives, as they are today, are not (very) effective, in the sense that they are too small to significantly alter the choice behavior of patients. Nonetheless, the Belgium regulator has put into place the first steps towards a gatekeeping system.

4 Entry Model

In this section, we present a static entry model to flexibly estimate the strategic interaction effects between specialist types and GPs to evaluate whether GPs especially benefit (referral effect) or are especially harmed (competition effect) by the presence of specialists. Our method thus focuses on identifying the signs of the strategic interaction effects of different specialist types on GP payoffs entering the market.

The characteristics of the Belgian health care markets, as described in section 3, motivate the basic properties of our entry model. First, because of the educational requirements in the physician markets, each physician knows its specialty (i.e. GP, dermatologist, etc.) before the entry game starts. Entrants therefore make no specialty choice. Furthermore, although licensing limits the total number of potential physician entrants, the lack of restrictions on the number of entrants in a local market implies that the pool of entrants for a specific local market is large.¹⁶ Finally, because the majority of GPs still operate in a solo-practice and also specialists work for their own account, we can treat all entry decisions as individual decisions.

We propose to model the entry decisions of physicians as a sequential game of incomplete information.

¹⁴Loyalty is here defined as not having any contacts with any other GP throughout the year. (Socialistische Mutualiteit, 'Flits' Oktober 2001).

¹⁵De Artsenkrant, No. 87 (31/01/2007). Note that because we are working on data prior to the introduction of the fee-differential related to a referral, the model is able to capture the way specialists and GPs interact in the absence of gatekeeping.

¹⁶To the extent that there are too few licensed physicians to cover the different geographic markets, the model changes in the constant term: the positive payoffs condition to trigger entry is then replaced by the condition of payoffs higher than the best alternative. This is just a matter of normalization of the outside option.

To be more precise, we assume that physicians that are trained in the same specialty are homogenous and have complete information about each others' payoffs. However, physicians have incomplete information on the payoffs of physicians that are trained in another specialty. It is thus assumed that physicians receive some additional information about their payoffs in a market while they are trained in their specialty field. As the private information in this model thus stems from the different medical specialties, we refer to physician types. It is furthermore assumed that types make their entry decisions in a pre-specified order.

We start this section by introducing the model set-up, firm behavior and the equilibrium of the game. This is followed by a discussion on the choice of the modeling assumptions.

Set-up and payoffs

Let the set of players in market m be grouped in T types of physicians, with \mathcal{F}_t potential physicians of type t ($t \in [1, T]$). The action space of all players of all types consists of entering or not entering the market. Physicians know their type before the entry decision is made and physicians of the same type are assumed homogenous: we denote GPs as physicians of type 1 and the different specialist types are assigned type 2 to type T .¹⁷ With payoffs of not entering the market normalized to zero, we represent payoffs of a physician of type t entering market m by the following reduced form:

$$\begin{aligned} \pi_t^m &= \bar{\pi}_t(\mathbf{X}^m, n_1^m, \dots, n_t^m) - \varepsilon_t^m \\ &= \beta_t \mathbf{X}^m + \alpha_t n_t^m + \sum_{\substack{j=1 \\ j \neq t}}^T \gamma_{tj} n_j^m - \varepsilon_t^m \end{aligned} \quad (1)$$

The observed component of physician payoffs ($\bar{\pi}$) depends on market characteristics (\mathbf{X}^m , such as the number of inhabitants) and the entry decisions of all physicians. Type-specific coefficients allow for payoffs to vary across types. Furthermore, payoffs vary across physician types because of type-specific characteristics. These type-specific characteristics are assumed to be unobserved by both the researcher and other physician types (ε_t^m), although the distribution of the random variable of which the private information is drawn is known by all players (G). Because physicians of the same type are homogenous, the exact identity of the entrants is irrelevant for payoffs. Instead, payoffs are affected by the realization of the number of entrants of the different types in the market (n_1^m, \dots, n_T^m).¹⁸

To be perfectly clear, remark that payoffs is type-specific but not firm-specific: our model is one of incomplete information not because of firm-level heterogeneity, but due to type-specific market unobservables.

¹⁷This is in contrast with for example Mazzeo (2002), where firms make both an entry decision and a type decision. In his setting, all firms are ex ante homogenous.

¹⁸Throughout the paper, we denote the realization of the random variable N_t in market m as n_t^m .

Put differently, we present a model with complete information within type (market level error term), but with incomplete information between types.

Consistent with the existing literature, same-type physicians are strategic substitutes. That is, payoffs are assumed to be decreasing in the number of physicians of the own type: $\alpha_t < 0$. Furthermore, to reduce the computational burden of the model, we make the following simplifying assumption with respect to the effect on payoffs of the number of entrants of other types:

$$\gamma_{tj} = 0 \quad \forall t \neq 1, j \neq 1$$

That is, it is assumed that payoffs of all specialist types - all physician types but the GPs ($t \neq 1$) - are affected only by the number of own-type rivals and by the number of GPs in the market. In other words, entry decisions of specialists of different types are independent from each other, at least in first order: there remain some indirect effects between specialist types through their simultaneous effect on the GP market. Given the characteristics of the application, this assumption is not strong: for the types we will focus on, specialists rarely refer patients directly to other specialist types.¹⁹ Importantly, GP payoffs (type 1) are affected by the number of physicians of all types.

In contrast to the traditional empirical entry literature, we make *no* assumptions on the signs of the strategic interaction effects. Instead, estimation of the model will yield insights on this. A negative effect ($\gamma_{tj} < 0$) indicates that the entry decisions of type- j physicians are strategic substitutes to the entry decision of physicians of type t : the entry of a type- j physician in the market yields an additional competitive effect. A positive effect ($\gamma_{tj} > 0$) on the contrary implies strategic complementarity in the entry decisions for physicians of type t as payoffs of entering a market increase in the number of other-type physicians. Furthermore, the strategic interaction effects between any two types of physicians are allowed to be asymmetric, both in magnitude ($\gamma_{12} \neq \gamma_{21}$) and in sign (i.e. $\gamma_{12} < 0$ and $\gamma_{21} > 0$). The latter is a particular strength of the incomplete information game and important to allow for in our application. That is, whereas specialists are probably positively affected by the entry decision of GPs, the competitive effect can dominate the strategic effect of a specialist type on GP payoffs.

With physicians' payoffs of entering market m at hand, we model their entry decisions as a strategic three-stage game.

Stage 1: all potential entrants of type 1 simultaneously make their entry decisions.

¹⁹The restriction is more severe within the context of a hospital in which specialists do 'refer' to each other. As our dataset does not allow us to identify which specialists are associated to which hospital, we can however not control for this. The number of hospital beds will however be taken up as an explanatory variable in the estimation of the model, to partly control for this.

Stage 2: type-2 to type- T players simultaneously decide on entry.

Stage 3: all physicians that have entered market m interact and payoffs are realized (π_t^m).

Two remarks are in place. First, the assumption that GPs make their entry choice first is motivated by the consideration that a GP's patientele is mainly trust-based and very local whereas this is rather reputation-based in the specialists' markets. As such, GPs' sunk costs of entering a specific local market is higher. This implies that GPs are more strongly committed to ex-post follow through their entry decision.²⁰ Second, because of the assumption on the strategic independence of specialist types, the simultaneous entry stage for all specialist types (stage 2) yields the exact same market equilibrium as a game in which the different types would enter sequentially in a pre-specified order (see Einav 2009²¹).

Firm behavior and Equilibrium

Physicians decide on entering the market according to a pre-specified order of play: GPs (type 1) move first whereas the specialist types simultaneously decide in the second stage of the game. As a result, the model can be solved backwardly for its perfect Bayesian equilibrium (Einav 2009). As physicians of the same type are assumed homogenous, we solve for the equilibrium number of entrants per type in the market. As physicians enter when they deem it to be profitable, the long run perfect Bayesian Nash equilibrium market structure in market m consists of the maximum number of physicians that is viable, given their product differentiation.

We start by looking at the entry decisions in the second stage of the game, where the specialist types decide on entry. Importantly, although the information on the GP-specific error term is unknown to all potential specialist entrants, they do observe the total number of GP entrants per market as a result of the realization of the GP-specific error term. This is because GPs decide on entry first (sequentiality assumption). Therefore, all payoff-relevant information in the second stage of the game is disclosed when specialist types decide on entry.

We continue by discussing the entry decision by GPs in the first stage of the game. Potential entrants of type 1 observe all market characteristics and the private realization of the GP-specific unobservable. As the realization of the unobservables of other physician types is not known, GPs conjecture on the actions of all

²⁰This is in contrast with the general argument that material investments to enter a market as a specialist are higher. Note though that these costs are not market-specific. The current sequence of entry decisions is furthermore convenient as it reduces computational burden in the presence of more than two types. Finally, note that instead of making an assumption on the sequence of entry, Einav (2003) allows to estimate the likelihood of the different orders of play. This however requires that the dataset is very rich.

²¹In his timing game, Einav (2009) demonstrates the development of an equilibrium market structure in case there is strategic dependence between all types. That is, in a $(T + 1)$ -game where the order of play is clearly determined, all but the last mover anticipate on the behavior of some types and all but the first mover condition their expectations on other firms' choices.

other physician types. Physicians of type 1 thus decide whether or not to enter the local market m based on their expected payoffs of entering.

Together, the equilibrium entry strategy of all physician types results in the perfect Bayesian Nash equilibrium market structure for market m

Second stage

In the second stage of the game, type-1 physicians have already made their entry decisions. Now, the \mathcal{F}_t potential entrants of the specialist types ($t \in [2, T]$) simultaneously decide on entry in market m . They use all available information and thus condition their choice behavior on the observed number of type-1 entrants ($N_1 = n_1^m$). Furthermore, the entry decisions are independent across types by assumption. With the realization of the type-specific error term being common knowledge within type, all determinants of type- t physician payoffs are observed. Physicians of type 2 to type T thus base their entry decisions on the following conditional payoffs of entering market m :

$$\begin{aligned} \pi_t^m | N_1^m = n_1^m &= \bar{\pi}_t(\mathbf{X}^m, n_1^m, N_t) - \varepsilon_t^m \\ &= \beta_t \mathbf{X}^m + \alpha_t N_t + \gamma_{t1} n_1^m - \varepsilon_t^m \end{aligned} \quad (2)$$

Each individual type- t physician enters the market when the observed payoff shock allows profitable entry, given the observed number of GP entrants in the market. As the type-specific payoff shock is common knowledge, all potential entrants can perfectly anticipate on the number of entrants of the own type, i.e. the maximum number for which all entrants are expected to be profitable. Following Bresnahan and Reiss (1991), for any realization of the number of type-1 physicians ($N_1 = n_1^m$), the probability that in the Nash equilibrium, n_t physicians of type t ($t \in [2, T]$) enter market m is given by:

$$\begin{aligned} \Pr(N_t = n_t^m | N_1 = n_1^m) &= \Pr(\bar{\pi}_t(\mathbf{X}^m, n_1^m, n_t^m) \geq \varepsilon_t^m > \bar{\pi}_t(\mathbf{X}^m, n_1^m, n_t^m + 1)) \\ &= G(\bar{\pi}_t(\mathbf{X}^m, n_1^m, n_t^m)) - G(\bar{\pi}_t(\mathbf{X}^m, n_1^m, n_t^m + 1)) \end{aligned} \quad (3)$$

First stage

Potential entrants of type 1 make their entry decisions first and decide based on their expected payoffs of entering market m . In contrast to the second movers, type-1 physicians conjecture on the choice behavior of the physicians of all other types. As physicians of type 1 are homogenous and have the same information, their conjectures on the actions of the physicians of the other types are the same in equilibrium. The expected

payoffs of entering market m can be written as

$$\begin{aligned}
E(\pi_1^m) &= E(\bar{\pi}_1(\mathbf{X}^m, N_1, N_2, \dots, N_T)) - \varepsilon_1^m \\
&= \beta_1 \mathbf{X}^m + \alpha_1 E(N_1) + \sum_{\substack{j=1 \\ j \neq t}}^T \gamma_{1j} E(N_j) - \varepsilon_1^m
\end{aligned} \tag{4}$$

As GPs have some information on the payoffs of physicians of other types, the potential entrants of type 1 can anticipate on the choice behavior of type- t physicians. Based on the equilibrium behavior of specialist types and the distribution of the type-specific unobservables (G), GPs deduce the probability of observing a specific number of entrants of a specialist type. This is given by equation (3), where it is important to note that the expected number of type-2 to type- T entrants depends on the realization of the number of entrants of type 1. The expectation of physicians of type 1 over the number of physicians of type 2 to type T in market m can thus be updated by integrating out over the probability of observing n_t^m specialists of type t entering the market, conditional on the number of type-1 physicians:

$$E(N_t) = \sum_{n_t^m \in \mathcal{F}_t} \Pr(N_t = n_t^m | N_1) \cdot n_t^m \quad \forall t \neq 1 \tag{5}$$

As a result, expected payoffs can be written to only depend on the realization of the number of entrants of the own type. Note that although the market level payoff shock in the GP market is common knowledge for all GPs, the potential entrants are not capable to perfectly predict the number of GPs that can be profitable in the market due to the interaction effects with the predicted state of the specialist markets. They decide on entry based on expected payoffs. The probability that a market structure with n_1^m physicians of type 1 is a Nash equilibrium, is given by the probability of type-1 physicians being profitable in the presence of n_1^m rivals, but unprofitable with an additional entrant in the market:

$$\begin{aligned}
\Pr(N_1 = n_1^m) &= \Pr(E(\bar{\pi}_1(\mathbf{X}^m, n_1^m)) \geq \varepsilon_1^m > E(\bar{\pi}_1(\mathbf{X}^m, n_1^m + 1))) \\
&= G(E(\bar{\pi}_1(\mathbf{X}^m, n_1^m))) - G(E(\bar{\pi}_1(\mathbf{X}^m, n_1^m + 1)))
\end{aligned} \tag{6}$$

Perfect Bayesian Nash Equilibrium

For the presented entry game with incomplete information between physician types and a pre-specified orders of moves, the equilibrium probability of observing market structure (n_1, n_2, \dots, n_T) in market m is described

by:

$$\begin{aligned} \Pr (N_1 = n_1^m, N_2 = n_2^m, \dots, N_T = n_T^m) \\ = \Pr(N_1 = n_1^m) \cdot \Pr(N_2 = n_2^m | N_1 = n_1^m) \cdot \dots \cdot \Pr (N_T = n_T^m | N_1 = n_1^m) \end{aligned}$$

When the distributions of the type-specific market unobservables (ε_t^m) have full support, this equation gives the equilibrium probabilities of observing any possible market structure. Remark already that the realizations of the type-specific market unobservables are assumed independent across types and across markets. Given a specification for the reduced form payoffs for the physician types and an assumption on the distribution of the error terms, the estimation proceeds through the maximization of a likelihood function, where every market is treated as an independent game. With n_t^{m*} the observed number of entrants of type t in market m , the likelihood function is given by:

$$L(\beta_t, \alpha_t, \gamma_{tj}) = \prod_{m=1}^M \Pr(N_1 = n_1^{m*}, N_2 = n_2^{m*}, \dots, N_T = n_T^{m*}) \quad (7)$$

Discussion

The empirical model to tackle our research question is closest related to the incomplete information game in Einav (2009). In a study to explain the observed demand patterns in the movie industry, Einav presents a sequential game of incomplete information to explain the timing decision of movie distributors. In our setting firms make decisions to enter geographic markets, i.e. the unit of observation is a local market as opposed to a point in time. But more importantly, the setting of Einav concerns few potential entrants with observable heterogeneity, for which he considers the timing decision separately. We instead group firms into homogenous types and look at the aggregate decision of each physician type. We thus study the equilibrium number of entrants per type, which increases the dimensionality of the model.

Our modeling assumptions are used explicitly to meet the requirements of the research question at hand. First, we intend to identify the sign of the strategic interaction effects between different physician types. Second, we cannot exclude the possibility that the strategic interaction effects between GPs and a specialist type are asymmetric in sign.²² And third, as there exist a lot of physician types - GPs, dermatologists, pediatricians, gynecologists, psychiatrists, and so on - we want to allow for sufficient type heterogeneity.

The model presented is one of incomplete information due to the required flexibility of the strategic interaction effects. Although recent estimation techniques for games of complete information, such as the

²²That is, GPs' payoffs might decrease in the number of a specialist type, while this specialist type benefits from the presence of GPs in the market.

bounds approach (e.g. Ciliberto and Tamer 2004) or the method of inequality conditions (e.g. Andrews et al 2004), allow for some more flexibility, they still require that the strategic interaction effects are symmetric in sign due to the completeness of the information set. We demonstrate this point in panel A of Figure I, where we display a complete information game between two firms (for expositional reasons) where the strategic interaction effects are asymmetric in sign. That is, the presence of firm 2 positively affects payoffs of firm 1, whereas the presence of firm 1 negatively impact payoffs of firm 2. It is clear that for medium-valued realizations of the error terms, no pure-strategy equilibrium strategy can be found. As a result, there exists no well-defined likelihood function for the probability of observing the different market outcomes. Even though advanced techniques might allow a researcher to estimate the model, the results cannot be trusted as the underlying mapping of unobservables to market structures is non-existing. As such, complete information games require the knowledge of or an assumption on the nature of the strategic interaction effects (strategic complements or strategic substitutes) to define the likelihood function.

<Insert Figure 1 here>

Modeling and estimating firm conduct while allowing for more flexible strategic interactions between firm types requires the researcher to abandon either the pure-strategy equilibrium assumption (Bajari et al 2007, Aradillas-Lopez 2007) or the assumption of complete information. In this article, we adjust the assumption on the characteristics of the information set and work under the incomplete information assumption. In incomplete information games firms decide based on expected payoffs so that the decision to enter does not depend directly on the realization of the error terms of the other type firms. This is demonstrated in panel B of Figure I for our model of incomplete information and pre-specified order of moves.²³ Furthermore, the incompleteness of the information structure implies that the empirical model is invariant to the nature of the strategic interaction effects.²⁴ Therefore, we can use simple estimation techniques without further assumptions on the underlying payoffs. Although the recent literature increasingly uses the assumption of an incomplete information set, its potential to deal with flexible interactions has not been fully recognized.

The choice for incomplete information games is often made based on considerations of computational burden. Recent developments in the literature however allow for estimating a higher degree of firm heterogeneity in complete information games, but identification is here reduced to the set of models for which the data is consistent (Ciliberto and Tamer 2004²⁵). Instead, an incomplete information setting retains point

²³Note that you can easily show the same with a game of incomplete information and simultaneous choices.

²⁴This refers to the fact that the use of standard maximum likelihood based on well-defined areas of integration is not possible for games of complete information without determining the sign of the strategic interaction effects (the mapping differs according to the assumption, see Schaumans and Verboven, 2008)

²⁵The methodology proposed in Ciliberto and Tamer (2004) also allow for a flexible estimation of the underlying payoffs while dealing with the issue of multiple equilibria. This method implies that the data itself will be used to determine how the areas of error term realizations connected to a certain market structure are defined. Computational burden however increases fast when the binary model is extended to estimating the number of firms of a type entering the market. Furthermore, although type

identification while being less computationally intensive. A drawback of the incomplete information model however remains the presence of ex-post regret. Note though that the sequentiality assumption and the fact that the error terms are type- and not firm-specific imply that only the first mover is subject to ex-post regret (Einav 2009). In other words, only the GPs can regret having entered or not entered the market.

Contrary to most of the incomplete information games that assume the same equilibrium is played in all markets, we solve the multiplicity problem in the game by assuming that types enter the market in a pre-defined order and thus solve the game for the unique Bayesian Nash equilibrium (Einav 2009). This assumption helps us to reduce the computational burden of allowing for a high degree of firm heterogeneity in the model.²⁶

The computational complexity of our model is also considerably reduced by assuming that private information is type-specific instead of firm-specific: in the latter case, firms would be heterogeneous and the equilibrium market structure would be driven by expectations on the choice behavior of firms of the same type, which requires solving for a fixed-point equilibrium entry probability in all the substages of the game (Seim 2006).^{27,28}

5 Empirical Implementation

To implement the empirical entry model to explain the characteristics of the Belgian physician markets, it remains to specify the reduced form payoff functions for the physician types and to make an assumption on the distribution of market and type-specific unobservables. In this section, we discuss further implementation and identification issues, after which the data on the Belgian health care markets is introduced.

specific variables and exclusion restrictions are not per se needed, they help reduce the bounds of the parameter set. Finally, an extension of the model is needed to allow for mixed equilibria when the strategic interaction effects do not have the same sign. Apart from these technical drawbacks in the empirical implementation, this methodology however does allow for a flexible estimation of the strategic interactions and correlation in the unobservables.

²⁶Einav (2009) argues that the equilibrium calculus is linear in the number of players in the market, and thus has the benefit over simultaneous incomplete information games, which rely on numerical search algorithms.

²⁷Computational burden is further increased as in our model, the equilibrium probabilities would be unique, but might be unstable. Searching for the equilibrium expectations under instability of the probability mapping is very time consuming. Using the Nested Pseudo-likelihood method presented by Aguirregabiria and Mira (2002) could be a feasible alternative.

²⁸A recent working paper by Vitorino (2008) addresses a related issue using a simultaneous game of incomplete information. She studies the presence of agglomeration effects of shopping centers and also uses the property of the incomplete information game of allowing for the effect of same type stores to be either positive (agglomeration dominates) or negative (competition dominates). The setting is quite different though. She considers a limited number of potential entrants (3) with firm-specific characteristics of a limited number of potential types (3) to choose to enter a shopping mall. Instead of assuming sequential entry, it is assumed that the same equilibrium is picked in similar markets. As a result, her estimation approach is more complex to solve for the equilibrium, but it is manageable because the number of potential entrants is limited.

Model implementation and Identification

To estimate the entry model, we use the payoff specification as introduced in equation (1). We allow for asymmetries, both in magnitude and in sign, in the strategic interaction effects by estimating type-specific coefficients. Standard t-tests suffice to infer the nature of strategic interactions between Belgian physicians of different types. Note that the numbers of physicians of all types enter linearly. We thus assume that an extra entrant always has the same impact on payoffs, irrespective of the number of entrants that is already present in the market. This choice is solely based on computational issues and is consistent with the literature.²⁹

We treat the model’s unobservables (ε_t^m) as realizations of a standard logistic distribution.³⁰ With this assumption the model is completed so that we can take the likelihood function as given in equation (7) to the data. For computation, it should be noted though that GPs decide based on expected payoffs: calculating these expected payoffs implies computing the probability of observing any number of specialists of any type conditional on any possible number of GP entrants.³¹ For estimation, we reduce the dimensionality of the problem by limiting the number of GPs and specialists to a maximum of 30 ($\mathcal{F}_t = 30$). With 88.5% of our markets containing less than 30 GPs and virtually all municipalities having less than 30 specialists of a specific type, this assumption is not restrictive.

Estimation of the model identifies the coefficients related to the market characteristics (β_t) and the coefficients related to the number of physicians of the own and the other types (α_t, γ_{tj}). All these coefficients are identified up to the scale of the error term. Furthermore, the effects of the other-type physicians are not separately identified from possible correlation in the unobservables, because the realization of the error terms are assumed independent across types. Consequently, the finding of a positive (negative) interaction effect can be due to real complementarities (substitutability) in the entry decisions of the professionals, but can also originate from a positive (negative) correlation in the market unobservables. We share this property with other models of incomplete information (Seim 2006, Einav 2009, Dutta et al 2007).³²

Furthermore, our data consists of neither panel data nor good instruments for the presence of the different specialist types in GP payoffs to solve for the separate identification of the correlation and the strategic interaction effects. As we are primarily interested in the effect of different specialist types on the entry decision

²⁹Theoretically one can estimate a more realistic pattern of effects, with e.g. fixed effects for all market structures. However, our dataset restricts the extent to which we can identify such parameters: we have few markets with few GP entrants and many markets with no specialist entrants. Note that our assumption furthermore contains the number of parameters to estimate.

³⁰We can also estimate the model under the assumption that the unobservables are distributed according to a standard normal. Our conclusions are robust against the distributional assumption.

³¹The computational benefit of assuming GPs to move first lays here. If the different specialist types were to decide first, each of them would anticipate on the choice behavior of the GPs, which condition on the entry decisions of all specialist types. As a result, one specialist type now has to take into account the choice behavior of all other specialist types.

³²Note that models of complete information in general do not alleviate this problem: whereas they do allow for correlation in strategic interaction effects, separate identification of the correlation coefficient from these effects is not straightforward and requires good instrumentation in the payoffs of all types (Athey and Stern, 2003).

of GPs, our instruments should affect the presence of a specific specialist type while having no impact on the profitability of GPs. Two issues arise: first, we need at least as many instruments as we have specialist types. Second, none of the market characteristics presented above (nor other possible characteristics we considered) pass the second requirement. For example, the percentage toddlers is clearly very important for the pediatrician payoffs, but this age category also provides extra demand for GPs, especially as pediatricians do not perform home visits and only work on the regular office hours.

Although we can therefore not correct for the possible correlation in market unobservables (i.e. no exclusion restrictions), we are able to limit the related concerns: first, we correct for a lot of market characteristics, as to reduce the magnitude of the unobservables and second, we estimate the model while allowing for a high degree of firm heterogeneity in the market, which reduces the possible bias on the individual interaction effects in GP payoffs. That is, the bias is reduced to only the correlation between the GP error term and the specialist type error term, conditional on the number of other specialist types. Nonetheless, there can remain an upward bias in the estimates of the strategic interaction effects, which we will keep in mind in the interpretation of our results.

Finally, we would ideally want to estimate a specification with a payoff function for all physician types separately. However, despite the assumptions to reduce the computational burden of the model, we are still confronted with optimization problems. We therefore use the classes of specialists to reduce the number of physician types in the empirical model (see section 5). With our primary interest in the effect on GP payoffs of specialists of classes 1 and 2, we estimate the model twice. First, we focus on the strategic interaction of the entry decisions of GPs and specialist types of class 1, while grouping the other specialist types by class. That is, we specify payoffs for seven physician types: GPs, dermatologists, gynecologists, pediatricians, ophthalmologists, class-2 specialists and class-3 specialists. The second estimation does the same but then considers the specialist types of class 2. Payoffs are defined for six types: GPs, psychiatrists, ENT-specialists, physiologists, class-1 specialists and class-3 specialists. Note that the entry behavior of class-3 specialists is always included as an endogenous control variable.³³

Data on Belgian health care markets

In this section, we present the dataset for the study on Belgian GPs and specialists. The first step consists of defining the relevant geographic market. There is however little guidance on this: unlike in the US, antitrust offices have not (yet) addressed any cases of merging physician offices, because this phenomenon is marginal

³³Remark that we make the simplifying assumption that all specialist types of the same class are homogeneous. This implies that the entry of e.g. an internist has the same impact on internists' payoffs as the entry of a surgeon does. As we are not primarily interested in this group, we allow for this stringent assumption to lighten further computational burden.

in Belgium and prices are fixed. We nonetheless know that physicians cannot engage in advertising or other promotional selling activities. Therefore, patient choice is largely guided by local information. Furthermore, 95% of the Belgian population indicates having a regular GP which is conveniently located close to their home. The town might thus be as far as the sphere of influence for a GP reaches. For specialists on the other hand, it is generally believed that patients are willing to travel further, making the relevant geographic market of specialists larger (Ettinger 1998). In this article, we define the municipality as relevant geographic market for all physician types. Belgium is made up of towns that are grouped into 586 municipalities, where the average municipality counts 17,590 inhabitants.³⁴ Allowing for differences in relevant market definition is subject of future research.

For the empirical implementation of the model, we do not include municipalities with more than 100,000 inhabitants to reduce the heterogeneity in the number of practitioners. Furthermore, municipalities that have a university hospital are dropped to avoid potential problems with the market definition (their good reputation attract patients from all over the country) and potential problems due the different reimbursement scheme and objective function for practitioners within university hospitals. This selection reduces our sample to 564 municipalities. Note though that our results are robust against the inclusion of these markets.

Health providers

Privacy concerns limit the data availability on health care professionals to a location measure (= zip code). For general practitioners, we rely on a dataset of the Belgian Institute for Sickness and Invalidity Insurance (RIZIV/INAMI). From this dataset, we select those GPs that are truly active and available to the public (outside of hospitals) based on their performance. As selection criterion we use a recent regulation (July 1st, 2006) which states that GPs will only remain certified if they have more than 500 contacts in one of the last five years. From dialogue with RIZIV/INAMI, we add the restriction that GPs should have at least 50 patients in one of the last five years.³⁵ We used data on the number of contacts of all registered GPs from 2000 until 2004 to deduce the number of active GPs in the beginning of 2005. This procedure results in the identification of 11,842 GPs. These GPs have on average 3,794.27 contacts per year (s.d. 3,464) and each serves on average 591.55 patients (s.d. 408).³⁶

For specialists, a dataset from Dendrite Belgium gives the number of active specialists in Belgian zip

³⁴The relevant geographic market of a GP can be smaller than this, whereas the relevant geographic market of some specialist types can be larger. Working on an intermediate level (municipality) seems to be a good compromise. This definition is also in line with the empirical work on physicians in for example Baumgardner (1988) that works on US county level and Newhouse (1990) that uses the US towns as market definition.

³⁵The basic selection rule corrects for non-specialists uniquely associated to a company and retired GPs that still treat their own family. As they are not open to the public, their impact on other GPs or specialists can be assumed away. The limitation with respect to the number of patients aims to filter out those GPs that only perform guard duty. They are excluded as they do not work within the same time frame as the genuine GPs, so that they cannot be considered genuine competitors.

³⁶An official report of RIZIV/INAMI (03/07) indicates the presence of 11,799 active GPs in 2005. We do not have the appropriate data to simulate their criteria exactly, although we are pretty close.

codes according to their self-reported field of specialization in April 2005.³⁷ We opt to work with every location where a specialist is active. That is, we are not able to distinguish between the locations in terms of the time a specialist spends at certain offices. However, even if the specialist is only active in a local market for a small time period, he/she will still be available to patients and can thus be considered to interact with other health care providers.³⁸ We furthermore aggregate specialties as to come to a manageable and more or less homogenous group of specialist types and define three classes of specialists. First, there are those who are claiming a role in the first line care (WIV 2006). In this class, we identify dermatologists (*der*), gynecologists (*gyn*), pediatricians (*ped*) and ophthalmologists (*oph*). The second class of specialists are in principle concerned with second or third line care, but often have a private office outside the hospital. This class consists of psychiatrists (*psych*), ear, nose and throat-specialists (*ENT*) and physiotherapists (*phys*).³⁹ A third class of medical specialists is especially active in hospitals. Whereas internists (*int*) and surgeons (*sur*) are also available for private consultations, there is no direct access to the remainder of the specialists. We consider them as one group which we name the ‘hospital specialists’ (*hos*). Our focus lies on the first and second class of specialists.

A count of the Belgian physicians according to their type in the sampled municipalities is presented in the first column of Table 1: e.g. we identify 608 dermatologists’ and 1,140 gynecologists’ offices in Belgium. The average number of physicians per type on municipality level is given in the second column of the table. There are on average 16 GPs active in the selected municipalities, whereas the average number of specialists is a lot lower at between 1 and 3 specialists of each type per market.⁴⁰ It is clear from the data that there is a strong positive correlation between the numbers of physicians of each type in a market. For example, the number of GPs has the highest correlation with the number of dermatologists, with a correlation coefficient of 0.84 and the correlation between specialist types averages around 86%. The question at hand is whether this is due to demand or cost characteristics of municipalities or rather due to the strategic interaction between physician types.

<Insert Table 1 here>

³⁷There can be some difference between the official field of specialization, by their RIZIV-number or by the hospital they might work for, and the self-reported field of expertise. We choose to work with the self-reported fields as they probably capture the specialists’ activities best. Furthermore, we do not use the field of ‘general medicine’, as it overlaps with the GP dataset. Note finally, that the RIZIV/INAMI dataset could not be used for specialists, as the home address is reported instead of the working address.

³⁸An alternative is to work based on the preferred address of the specialist. We believe that this understates the availability of specialists as well as the effect its presence has on other physicians in the same markets. We furthermore restrict the sample of specialists to those who have finished their degree completely. In other words, we do not take up assistants, which however do treat people. As they are always connected to a specialist, we regard the entire work staff of the specialist as one. The presence of assistants however helps to justify the use of all the working addresses of specialists.

³⁹Note that some of the specialist groups we use, are a groups of different specialists. For example, physiotherapists comprise both the specialists in sports health and in physiotherapy.

⁴⁰Many municipalities lack specific specialists: on average 58% of all municipalities does not hold a specialist type. However, only 19% of all municipalities have no specialist of any type.

Market characteristics

To control for demand and cost characteristics in the different municipalities, we add a dataset with market characteristics for which the descriptive statistics are presented in Table 2. According to studies on health status and morbidity, the age, gender and ethnic composition together with the socioeconomic status of the service population are important indicators for the demand of GP care (Boerma 2003). We have information from the National Institute of Statistics (NIS) on the number of inhabitants (S) and the population density ($dens$).⁴¹ The dataset moreover includes variables indicating the age composition of the local population. We opt to work with seven age groups; ‘ $age0_4$ ’ gives the percentage population under the age of 5, ‘ $age5_14$ ’, ‘ $age15_29$ ’, ‘ $age30_44$ ’, ‘ $age45_59$ ’ and ‘ $age60_75$ ’ give the percentage population in the respective age groups and finally ‘ $age75+$ ’ gives the percentage elderly, defined as over the age of 75. Further market characteristics are the percentage female population ($female$), the mean income level measured in ten thousand euros ($income$), the unemployment rate ($unempl$) and the percentage of foreign population ($foreign$). We additionally include a dummy variable for the Belgian region in which the market is located, to identify common profitability shocks (or value of the outside option) across municipalities in the same area.

We furthermore collected data for the presence and the size of hospitals and constructed a variable indicating the number of hospital beds ($beds_hosp$). This variable can indicate agglomeration effects in physician payoffs and controls for the presence of alternative care. A further correction for alternative supply of health care comes with the inclusion of the number of beds in retirement homes ($beds_rest$).

<Insert Table 2 here>

6 Estimation Results

Table 3 present the results of the estimation of the empirical entry model in which we focus on the first class of specialists, whereas the estimated coefficients for the specification with class-2 specialists are given in Table 4. The different columns of the tables give the estimated coefficients for the different physician types of the simultaneous estimation.

<Insert Table 3 here>

<Insert Table 4 here>

As a goodness-of-fit measure, we simulate the number of entrants of all types given the market characteristics: for 1,000 random draws for the error terms (from a logistic distribution), we calculate the equilibrium

⁴¹To enable a policy experiment below, we specify the number of inhabitants of a market S^m to enter physician payoffs log-linearly.

number of entrants in each market. We are able to predict the number of entrants per market rather accurately as the observed number of entrants systematically lies well within the confidence bounds of the simulated equilibrium number of entrants. Following Berry and Waldfogel (1999), we compute the correlation of the predicted and the actual number of entrants per type to construct a R^2 for the regression. For the model with the class-1 (class-2) specialists, our estimation results in a R^2 of 0.79 (0.76).

The choice behavior of patients

Consider the estimated coefficients for the strategic interaction effects in upper panel of Tables 3 and 4. The results indicate that the effect of the number of physicians of the own type is always negative. The higher the number of same-type rivals, the lower payoffs of entering the market. This is both consistent with economic theory and required by the equilibrium model we put forward. For the effect of the number of physicians of the other types, the results are mixed. First, the number of GPs in the market mostly positively affects payoffs of specialist types. This can be explained by the potential presence of agglomeration effects or by a lower workload of referred contacts compared to self-referrals.⁴²

Second, the strategic interaction effects in GP payoffs have varying signs.⁴³ GP payoffs are positively affected by the number of gynecologists, pediatricians, ENT-specialists and physiologists in the market. In other words, the benefits for GPs from the ability to refer outweigh the costs associated with the free access to these specialist types. This implies that patients that require the care of these specialist types thus mainly access secondary care through the GP (high referral effect) or correctly self-refer (low competition effect). The number of dermatologists, ophthalmologists and psychiatrists however has a negative impact on GPs' probability of entry: the costs due to the competition for patients here outweigh the referral benefits. An important part of the patients that use these types of secondary care services thus wrongly self-refer (high competition effect).

Although we limit the issue of correlation in the type-specific market shocks through simultaneous estimation, we test for the likelihood of an upward bias in our estimated strategic interaction effects. That is, using the model estimates, we retrieve the (average) value of the error terms and calculate correlation coefficients. We find that the correlation between GP and specialist shocks lies between 0.02 and 0.04 for all specialist types, except for pediatricians and physiologists. For these specialist types, we find values of 0.15

⁴²Remember though that there can be an upward bias in these strategic interaction effects (possible positive correlation in the error terms). We therefore do not stress this finding.

⁴³The signs of the strategic interaction effects are robust for changing payoffs specifications, although the effect of pediatricians and psychiatrists is not always significant. We have tested the robustness of the signs and significances of the strategic interaction effects by estimating the model using more, less and other groupings of explanatory variables (e.g. province dummies instead of one region dummy), using different groupings of specialists into classes, using a refined definition of the number of hospital beds (splitting according to the type of care, e.g. geriatric beds, pediatric beds) and using alternative definitions for the strategic interaction terms (adding presence of specialists in the GP payoff function).

and 0.64 respectively. We thus should be cautious in interpreting the positive interaction effects for these specialist types.

For Belgium, we can thus conclude that the use of gynecologists' and ENT-specialists' services can be considered as complementary to GP services, whereas the use of dermatologists', ophthalmologists' and psychiatrists' services are mainly substitutes to GP services. As the competition effect dominates the referral effect for this group of specialists, we find that a lot of patients must be wrongly self-referring for these types of specialist care.

Consider for completeness the estimation results of the effects of market characteristics on the entry probabilities of the physician types in Tables 3 and 4. Caution is to be advised in the interpretation of these results: our controls for market demand, costs and outside option are aggregate and exhibit a strong collinearity. Furthermore, by allowing for a lot of strategic interaction effects in the GP equation, we lose a lot of the explanatory power of demographic characteristics. For GPs, we find that payoffs of entering a market are positively affected by population size: the bigger the potential market, the more profitable and thus probable is entry of a GP. For specialist types, market size (population) and the presence and size of hospitals are important indicators for the profitability of any specialist: the higher the number of inhabitants and the higher the number of hospital beds, the higher the probability of observing more specialists of any type. Also the percentage of young adults (15–29 age group), the percentage females and the average income level tend to have a positive impact on the number of specialists of the different types. This indicates that young adults, females and higher income people use specialist care more frequently. On the other hand, the unemployment rate of the population negatively affects most specialist types and specialist payoffs are lower in the Flanders region. The latter can be explained by a higher value of the outside option for specialists in the Flanders region.

Implications for Gatekeeping

The findings on the nature of the strategic interaction effects have further relevance for policy makers in the debate on the introduction of gatekeeping in Belgium (or the price difference between referrals and self-referrals for specialist contacts when these are sufficient to induce a comparable change in patient behavior). As discussed in section 3, the presence of mandatory referral schemes would change the entire organization of health care provision. Inefficiencies can result when patients are currently correctly self-referring, whereas the sustainability of specialists is threatened to extent to which patients are currently wrongly self-referring. Both mechanisms have a negative impact on the cost-benefit analysis of the introduction of mandatory

referrals and are thus relevant to the policy debate. Although we are not able to quantify these effects, we can contribute to the discussion on gatekeeping by indicating for which specialist types these problems are likely to occur. Although our discussion can be seen as an argument against the implementation of gatekeeping, it should be clear that we are not evaluating the desirability of introducing mandatory referral schemes in the Belgium health care system. We do at most a partial analysis of welfare effects which is only intended to provide some supporting information on the functioning of the physician markets as they are regulated today.

First, we find that an important part of the gynecologists' and ENT-specialists' contacts are referrals or correct self-referrals. For those patients who already get referred to the specialist, nothing changes due to the introduction of mandatory referral schemes. But the system would entail an obligatory first visit to the GP for those patients who correctly self-refer. This GP contact is unnecessary and thus inefficient. Furthermore, other efficiency benefits will not materialize as the number of specialist visits will not be reduced. In sum, introducing mandatory referrals in the gynecologists' and ENT-specialists' care is not likely to result in efficiency gains as the majority of the patients naturally exhibit the desired behavior. Note though that even when all patients would correctly self-refer to these specialist types, the society might benefit from having one GP centralizing all medical information on the patients.

Second, the estimation results indicate that the activities of dermatologists, ophthalmologists and psychiatrists negatively impact GP payoffs. This implies that these specialists realize a substantial part of their business (income) from patients that wrongly self-refer. The introduction of mandatory referral schemes for these types of medical care can thus result in important efficiency gains.

At the same time though, the market opportunities of specialist types change when mandatory referral schemes trigger substantial drops in the demand for their services. This is most likely the case for specialist types that currently attract a lot of wrong self-referrals: the majority of the wrongly self-referred patients will not end up in their office once mandatory referrals are in place (i.e. the GP will choose to treat these patients). Therefore, an important viability threat is expected for the active and future dermatologists, ophthalmologists and psychiatrists. Note that whereas dermatologists, ophthalmologists and psychiatrists are expected to experience the largest drop in market demand, the viability of the other specialist types will also be affected by the introduction of mandatory referral schemes. That is, we identify only the net effect of the presence of specialist types on GP payoffs. Therefore, the finding of a positive effect only implies that the referral effect dominates the competition effect. It can thus be the case that the competition effect is very big, but that the referral effect is slightly more important. As a result, a substantial impact of the introduction of gatekeeping is to be expected as well. We thus identify the lower bound of the effect.

To quantify the viability threat due to the introduction of gatekeeping, we simulate changes in the equilibrium market structure due to a drop in demand in the specialists' markets. Under the assumption that variable profits are proportional to the market size (i.e. inhabitants with the same characteristics visit physicians the same number of times), this policy experiment is analogous to studying the impact of a decrease in the total number of inhabitants of the market. Therefore, the drop in demand is modeled as a percentage decrease in the number of inhabitants in the market (ϕ), with the market composition remaining constant (through $\ln S$, see Schaumans and Verboven 2008). Given their equilibrium entry behavior (as estimated), we consider the total number of specialist entrants of all types under four alternative situations: we compare the status-quo entry behavior (under the current demand conditions: $\phi = 1$) to the entry patterns following a percentage decrease in market population with factors $\phi = 0.75, 0.5$ and 0.25 .⁴⁴ The simulation results in Table 5 give the average equilibrium number of entrants in each market given changes in the total number of inhabitants in the market ($\phi \cdot S$) for 1,000 random draws for the error terms (from a logistic distribution). We find for example that, whereas the current demand conditions allow for the presence of 677 (865) dermatologists (gynecologists) to operate profitably, a drop in demand by 25% ($\phi = 0.75$) reduces the total number of entrants to 508 (652). When demand halves, 336 (428) dermatologists (gynecologists) can be sustained, whereas a further reduction in demand to only a quarter of the original demand level ($\phi = 0.25$) results in a total number of 126 (202) dermatologist (gynecologist) entrants. Class-2 specialists seem to be less sensitive to demand drops.

Depending on how substantial the drop in demand for the specialists will be, considerable transition costs will realize: a lot of specialists will no longer be profitable in the market and will have to exit. As dermatologists, ophthalmologists and psychiatrists are currently competing for patients with GPs, the drop in the demand for their services is expected to be the largest. For gynecologists and ENT-specialists (and for pediatricians and physiologists), the drop in demand will be more moderate. Assuming a 25% decrease in demand for the latter group of specialists and a 50% drop for the specialist types whose entry decisions are strategic substitutes for GPs' entry decisions, we find that a total of 1,491 medical specialists will experience viability problems in case the Belgian policy makers continue the introduction of elements of gatekeeping into the care system. Note that this amounts to 25.8% of the total body of currently active specialists of class 1 and class 2, which are all high-skilled workers with very specific and expensive training.

⁴⁴The demand for GP services is likely to change as well. We do not consider any changes in the GP market, i.e. we assume the demand for GPs remains constant. Similar results originate from simulations in which we neglect the strategic interaction effects ($\gamma_{tj} = 0$).

7 Conclusion

This article studies whether general practitioners (GPs) benefit from the presence of a specialist due to the option of referral or whether their interaction is rather dominated by the competition for patients. The entry literature lends itself nicely for studying these health care markets, as data availability is often an issue. However, whereas the entry literature traditionally focused on questions of product differentiation, this article demonstrates the use of entry models to tackle a different type of research question. That is, we study the precise nature of the strategic interactions between different types of physicians. Although the entry literature has boomed in the last years, not much attention has been given to this problem. Because of the tradition of studying problems of product differentiation, the assumption of types being strategic substitutes in the entry decision is ubiquitous. Often the strategic interactions between firms are however not this simple: even though the competition effect is most obvious, at least some positive effect from the presence of other-type firms is likely (think of e.g. agglomeration effects, Vitorino 2008, Dutta et al 2007). When modeling the strategic interactions between firm types, it is therefore advisable to allow for the possibility that a positive effect is present and may be dominating the negative effect. Modeling and estimating firm conduct while allowing for these more flexible interactions requires the researcher to abandon either the pure-strategy equilibrium assumption or the assumption of complete information. We apply the latter strategy in this article.

We put forward a sequential incomplete information entry game that has the flexibility to identify the sign of the strategic interaction effects between different types of firms. The model is designed to avoid restrictions on the underlying payoffs with respect to the effect of other-type firms and to avoid issues of non-existence of pure-strategy equilibria in case the strategic interaction effects are asymmetric in sign. At the same time, the model remains computationally tractable and allows for sufficient firm heterogeneity. We use this game to study the strategic interactions in the Belgian physician markets, in which there is no gatekeeping role for GPs.

For the Belgian physician markets, the results indicate that we can group specialists into two categories. First, the decisions of certain specialist types are strategic complements to the entry decision of GPs. This category includes gynecologists and ear, nose and throat-specialists (ENT). As GP payoffs are increasing in the number of specialists of these types, we find that the competition effect (patients instead go to the specialist) is dominated by the referral effect (GPs' average cost of treatment drops). The majority of the patients is thus either referred to these specialist types or correctly self-refer. A second group of specialists consists of dermatologists, ophthalmologists and psychiatrists, whose entry decisions are found to be strategic substitutes in the entry decision of GPs. These specialist types mainly compete for patients with GPs. We

therefore find that self-referred contacts make up a significant part of the income of these specialists and often concern health issues that do not require specialist care (wrong self-referrals). Our results are not conclusive for pediatric and physiologic care. We conclude that there is inefficient use of specialist care mostly for dermatologic, ophthalmologic and psychiatric care.⁴⁵ This induces unnecessary costs on society, both because of the higher unit cost of the treatment and because of the high(er) cost in training these specialists.

Recent developments in Western-Europe indicate that the introduction of mandatory referral schemes is strongly being considered. France introduced a system of non-compulsory coordinated care pathways for patients in January 2005, which includes the reduction of patients' freedom of choice through financial incentives (HealthPolicyMonitor). Also Belgium and Germany recently introduced price differences between referred specialist contacts and self-referrals.⁴⁶

Our findings on the choice behavior of patients are furthermore instructive for this debate. First, our analysis shows that some efficiency gains and cost savings can be realized by introducing mandatory referral schemes. As we find that an important part of the use of dermatologic, ophthalmological and psychiatric services is unnecessary (inefficient), direct benefits would realize from a drop in the use of this expensive specialized care. Our results therefore indicate that the price increase for self-referred specialist contacts, as recently been introduced in the Belgian health care system (and provided that the incentives are strong enough) will yield cost savings and efficiency gains from the reduced use of dermatologic, ophthalmological and psychiatric care. However, this strategy seems not appropriate for the other specialist types: as the majority of the population correctly self-refers to these specialist types or already gets referred by the GP, the incentives to visit the GP especially results in additional transaction costs, i.e. unnecessary GP contacts. The strategy by the French government to limit the price increases for self-referrals to a particular group of specialists is therefore more appropriate: for Belgium, our results suggest that efficiency gains can be realized from setting substantial price differences between referrals and self-referrals for dermatologists, ophthalmologists and psychiatrists.⁴⁷

Second, the same results are informative for the transition costs of implementing gatekeeping associ-

⁴⁵Unfortunately, we cannot find any corroborating evidence for our findings as no quantitative or qualitative analysis on the number of wrong self-referrals per specialist type is available.

⁴⁶European countries are public insurance countries such that the policy is national wide. This is contrary to the US case where the organization of health provision depends on the insurance contract you buy. About 70% of the insured Americans are enrolled in some form of managed care plan (Glied 2000), where several of the HMOs practice gatekeeping. The dynamics in the US are furthermore different. Recently, some HMOs have relaxed the restrictions on access to specialists (Ferris et al 2001). We also see this tendency in Sweden.

⁴⁷Remark that in France, patients do not pay more when they self-refer to ophthalmologists, gynecologists, psychiatrists or pediatrician. For gynecologists and pediatrician, Belgian data suggests that there indeed is no need to give patients incentives to change their behavior. The psychiatrist and the ophthalmologists on the other hand are especially competing for patients with GPs in Belgium. There should thus be a higher price for self-referrals. Note though that we can not generalize our results to the French situation, as patient behavior and other institutional details may differ.

ated to the viability of the body of specialists. As the mandatory referral scheme excludes the possibility for patients to self-refer to a specialist, our findings suggest that mainly dermatologists, ophthalmologists and psychiatrists will experience viability problems following the introduction of gatekeeping. Given these findings, policy makers might decide to further restrict the number of students specializing in the field of dermatology, ophthalmology and psychiatry, anticipating on the lower demand for these services in case they pursue the introduction of mandatory referral schemes.

The viability threats for the body of specialists are especially problematic when gatekeeping is gradually introduced as in Belgium and neighboring countries. That is, in case a mandatory referral scheme is implemented without the accompanying capitation system, the income level of specialists is directly affected. Furthermore, as a result specialists have incentives to (start to) induce more demand for their services as to maintain their income level. The anticipated benefits in terms of cost containment would then not materialize. In case the mandatory referral scheme is combined with a capitation system, comparable problems emerge. To ensure viability, the fixed fee per patient enrolled with a specialist will have to be set high, both in absolute terms and compared to the capitation for the GP, as the number of patients per specialist will be relatively low. From a budget perspective, this will not be maintainable. In case the regulator sets more realistic fixed fees for specialists, a proportion of the health professionals will experience viability problems and the transition costs will materialize. Note that only when GPs do not get the correct incentives, i.e. in case GPs minimize their effort level and always refer patients to specialists, the current body of specialists can be sustained.

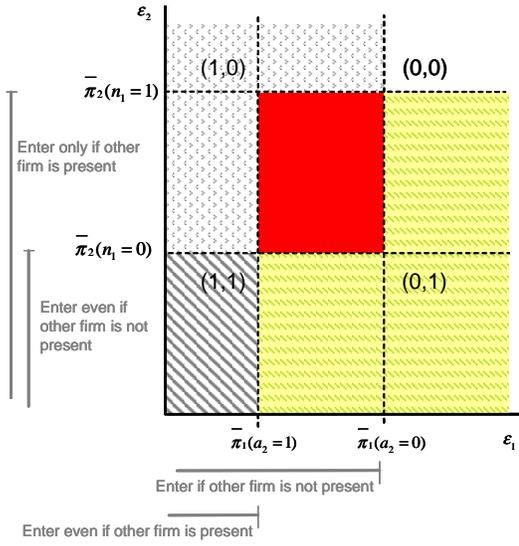
Finally, we want to stress that our conclusions are hard to generalize to other countries. All results crucially depend on the habits of the patients and the behavior of the professionals, which are the result of all incentives in the health system but also of culture. It would therefore be interesting to repeat our exercise for other countries in search of more general patterns. The care system in France before the 2005 reform is most comparable to the Belgian care organization (although the consumption of medical care is very different). The application of our methodology could shed light on the appropriateness of the French policy choice of the differential introduction of mandatory referrals. The United States is also an interesting case as both gatekeeping and free choice exist next to each other as a result of their private insurance system. To the extent that physicians can be attributed to be active in one of the systems (e.g. is he/she an HMO physician), a comparison of the size of the specialized workforce and workload could be instructive for the differences in demand for specialist care between a gatekeeping system and a non-gatekeeping system.

References

- AGUIRREGABIRIA V. and MIRA P. "Swapping the nested fixed point algorithm: A class of estimators for Markov decision models," *Econometrica*, 70 (2002), pp. 1519-1543.
- ARADILLAS-LOPEZ A. *Semiparametric Estimation of a Simultaneous Game with Incomplete Information*. Working Paper, Princeton University, 2007.
- ATHEY S. and STERN S. *An Empirical Framework for Testing Theories about Complementarity in Organizational Design*. NBER Working Paper no. 6600, 2003.
- BAJARI P., HONG H., KRAINER J. and NEKIPELOV D. *Estimating Static Models of Strategic Interactions*. Working Paper, 2007.
- BARROS P.P. "The black-box of health care expenditure growth determinants". *Health Economics*, Vol 7 (1998), pp 533-544.
- BAUMGARDNER J.R. "Physicians' Services and the Division of Labor Across Local Markets". *The Journal of Political Economy*, Vol. 96 (1988), pp 948-982.
- BERRY S.T. "Estimation of a Model of Entry in the Airline Industry." *Econometrica*, Vol. 60 (1992), pp. 889-917.
- BERRY S.T. and WALDFOGEL J. "Free entry and social inefficiency in radio broadcasting." *RAND Journal of Economics*, Vol 30 (1999), pp. 397-420.
- BREKKE K.R., NUSCHELER R. and STRAUME O.R. "Gatekeeping in health care". *Journal of Health Economics*, Vol 26 (2007), pp. 149-170.
- BRESNAHAN T.F. and REISS P.C. "Entry and Competition in Concentrated Markets." *Journal of Political Economy*, Vol. 99 (1991a), pp. 977-1009.
- BRESNAHAN T.F. and REISS P.C. "Empirical Models of Discrete Games." *Journal of Econometrics*, Vol. 48 (1991b), pp. 57-81.
- CILIBERTO F. and TAMER E. *Market Structure and Equilibria in Airline Markets*. Working paper, Northwestern University, 2004.
- COHEN A. and MAZZEO M. *Investment Strategies and Market Structure: An Empirical Analysis of Bank Branching Decisions*. Working Paper, 2007.
- DE MAESENEER J., BOGAERT K., DE PRINS L. and GROENEWEGEN P. "A literature review". In: Brown S, eds., *Physician funding and health care systems - an international perspective*, The Royal College of General Practitioners, London, pp 17-32, 1999.
- DELNOIJ D., VAN MERODE G., PAULUS A. and GROENEWEGEN P. "Does general practitioner gatekeeping curb health care expenditure?", *Journal of Health Services Research and Policy*, Vol. 5 (2000), pp. 22-26.
- DUTTA S., SUDHIR K. and TALUKDAR D. *A Structural Model of Entry and Location Choice: The Differentiation-Agglomeration Trade-Off*. Working Paper, 2007.
- ETTINGER D. JD. "The truth about antitrust". *Family Practice Management*, Vol. 5 (1998).
- EINAV L. "Not All rivals Look Alike: Estimating an Equilibrium Model of The Release Date Timing Game". *Economic Inquiry*, forthcoming 2009.
- FERRIS T.G., CHANG Y., BLUMENTHAL D. and PEARSON S.D. "Leaving gatekeeping behind - Effects of opening access to specialists for adults in a Health Maintenance Organization". *New England Journal Of Medicine*, Vol 345 (2001), pp. 1312-1317.
- GERDTHAM U-G. and JÖNSSON B. "International Comparisons of Health Expenditure: Theory, Data and Econometric Analysis". In: A.J. Culyer and J.P. Newhouse, eds., *Handbook of Health Economics* Vol. 1, Chapter 1, 2000.
- GRESS S., HESSEL F., SCHULZE S. and WASEM J. "Prospects of gatekeeping in German social health insurance", *Journal of Public Health*, Vol 12 (2004), pp. 250-258.
- GLIED S. "Managed Care." In: A.J. Culyer and J.P. Newhouse, eds., *Handbook of Health Economics* Vol.1, Chapter 13, 2000.

- KENNISCENTRUM VOOR DE GEZONDHEIDSZORG (KCE), “Huisartsgeneeskunde: aantrekkingskracht en beroepstrouw bevorderen.” *KCE Reports* Vol. 90A, 2008.
- KIRK E.P., SANTA J., HECKLER T. and COLLINS, M. “Obstetrician-gynecologists as primary care physicians: The Oregon experience—Early perceptions regarding the effects of legislative action”, *American Journal of Obstetrics & Gynecology*, Vol 178 (1998), pp 1222-1228.
- KULU-GLASGOW I., DELNOIJ D. and DE BAKKER D. “Self-referral in a gatekeeping system: patients’ reasons for skipping the general-practitioner”. *Health Policy*, Vol. 45 (1998), pp 221-238.
- MAZZEO M.J. “Product Choice and Oligopoly Market Structure.” *RAND Journal of Economics*, Vol 33 (2002), pp. 221-242.
- NEWHOUSE J.P. “Geographic Access to Physician Services”. *Annual Review of Public Health*, Vol 11 (1990), pp 207-230.
- SCHAUMANS C. and VERBOVEN F. “Entry and regulation: evidence from health care professions”. *RAND Journal of Economics*, Vol. 39 (2008), pp. 949-972.
- SEIM K. “An Empirical Model of Firm Entry with Endogenous Product-Type Choices.” *RAND Journal of Economics*, Vol. 37 (2006), pp. 619-640.
- SWEETING A. *Coordination Games, Multiple Equilibria and the Timing of Radio Commercials*. Working Paper, Department of Economics, Duke University, 2007.
- VITORINO M.A. *Empirical Entry Games with Complementarities: An Application to the Shopping Center Industry*, Working Paper, Graduate School of Business, University of Chicago, 2008.
- WETENSCHAPPELIJK INSTITUUT VOLKSGEZONDHEID (WIV). “Gezondheidsenquête door middel van Interview, België, 2004.” *Nationaal Instituut voor de Statistiek*, IPH/EPI REPORTS N 2006 - 035, 2006.

A. Complete information game



B. Incomplete information game

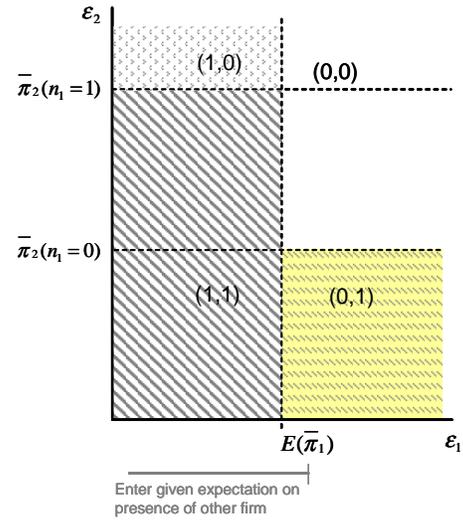


Figure 1. Entry games with strategic interaction effect that are asymmetric in sign

Table 1: Total and average number of physicians per municipality in Belgium, according to physician type for the sampled markets (nobs=564)

Physician type	Total number of physicians	Average per market mean	(s.d.)
<i>GP</i>	9,014	15.98	(14.10)
<i>der</i>	608	1.08	(2.42)
<i>gyn</i>	1,140	2.02	(6.15)
<i>ped</i>	820	1.45	(3.68)
<i>opht</i>	828	1.47	(2.87)
<i>psych</i>	1,472	2.61	(6.54)
<i>ENT</i>	542	0.96	(2.40)
<i>phys</i>	718	1.27	(2.26)
<i>int</i>	2,558	4.54	(11.65)
<i>sur</i>	1,976	3.50	(8.90)
<i>hos</i>	4,145	7.35	(17.68)

Source: own calculations based on RIZIV (2005) and Dendrite (2005).

Table 2: Descriptive statistics of market characteristics (nobs=564)

Variable		Mean	(s.d.)
<i>S</i>	number of inhabitants (x1,000)	14.15	(11.87)
<i>dens</i>	population density (x1,000)	0.48	(0.80)
<i>age0_4</i>	percentage under age of 5	0.06	(0.01)
<i>age5_14</i>	percentage in age category 5 – 14	0.13	(0.01)
<i>age15_29</i>	percentage in age category 15 – 29	0.18	(0.01)
<i>age30_44</i>	percentage in age category 30 – 44	0.23	(0.01)
<i>age45_59</i>	percentage in age category 45 – 59	0.20	(0.01)
<i>age60_75</i>	percentage in age category 60 – 75	0.14	(0.02)
<i>age75+</i>	percentage over age of 75	0.07	(0.01)
<i>female</i>	percentage female	0.51	(0.01)
<i>foreign</i>	percentage foreigners	0.05	(0.06)
<i>income</i>	mean income level (x10,000)	2.51	(0.36)
<i>unempl</i>	unemployment rate	0.05	(0.03)
<i>beds_hosp</i>	number of hospital beds (x100)	0.70	(1.81)
<i>beds_rest</i>	number of beds in retirement homes (x100)	1.73	(1.96)
<i>Fla</i>	region dummy for Flanders	0.53	(0.50)

Source: NIS (2001), RIZIV (2005). See text for the definitions of the variables.

Table 3: Estimation results on the market characteristics of the empirical model with seven types: GPs, dermatologists (der), gynecologists (gyn), pediatricians (ped), ophthalmologist (oph), class-2 specialists (class2) and class-3 specialists (class3)* - nobs = 564 - ll-value=-5534.0059

	GP		der	gyn	ped	oph	class2	class3						
<i>GP</i>	-1.06	(0.09)	-0.01	(0.04)	0.04	(0.02)	-0.05	(0.03)	0.01	(0.02)	0.07	(0.03)	0.09	(0.04)
<i>der</i>	-9.32	(5.61)	-0.97	(0.08)	-	-	-	-	-	-	-	-	-	-
<i>gyn</i>	22.58	(6.61)	-	(0.04)	-0.58	(0.04)	-	-	-	-	-	-	-	-
<i>ped</i>	10.61	(5.18)	-	-	-	(0.06)	-	-	-	-	-	-	-	-
<i>oph</i>	-21.18	(9.25)	-	-	-	-	-0.87	(0.06)	-	-	-	-	-	-
<i>class2</i>	-1.44	(0.78)	-	-	-	-	-	-	-	-	-0.51	(0.03)	-	-
<i>class3</i>	0.14	(0.12)	-	-	-	-	-	-	-	-	-	-	-0.21	(0.01)
<i>lnS</i>	3.07	(0.88)	2.83	(0.56)	2.14	(0.29)	2.29	(0.38)	2.72	(0.42)	0.78	(0.43)	1.17	(0.57)
<i>dens</i>	-1.38	(0.79)	0.22	(0.21)	0.04	(0.14)	0.62	(0.14)	0.16	(0.20)	0.80	(0.30)	0.29	(0.41)
<i>age0_4</i>	13.87	(41.94)	-13.16	(30.23)	-34.59	(15.79)	-18.54	(21.70)	-48.31	(23.23)	-31.85	(24.06)	6.32	(32.81)
<i>age15_29</i>	-6.13	(31.22)	46.83	(14.39)	31.30	(7.17)	50.82	(10.71)	47.52	(11.36)	47.69	(13.75)	27.33	(19.14)
<i>age30_44</i>	18.94	(24.06)	28.35	(14.45)	8.47	(7.04)	0.05	(9.83)	1.94	(9.44)	23.61	(13.28)	12.76	(15.70)
<i>age45_59</i>	13.73	(21.18)	2.52	(13.03)	-17.58	(6.95)	-0.55	(9.81)	-27.91	(9.91)	5.36	(12.33)	4.36	(16.01)
<i>age60_75</i>	-7.39	(23.12)	21.48	(14.24)	10.82	(7.51)	13.26	(10.34)	15.67	(11.57)	-2.83	(13.26)	12.20	(16.82)
<i>age75+</i>	-12.96	(25.59)	21.82	(18.05)	19.84	(8.98)	20.16	(11.67)	27.47	(13.18)	30.04	(15.39)	24.58	(19.93)
<i>female</i>	-9.32	(34.69)	47.53	(19.29)	24.41	(10.75)	34.11	(15.39)	29.35	(14.85)	28.39	(19.22)	40.27	(26.48)
<i>foreign</i>	-0.56	(4.19)	0.31	(1.99)	-0.96	(1.20)	-1.11	(1.50)	-1.70	(1.72)	-0.58	(2.62)	-2.26	(3.80)
<i>income</i>	0.57	(1.03)	0.94	(0.49)	0.98	(0.27)	1.48	(0.35)	1.66	(0.41)	0.88	(0.48)	0.26	(0.66)
<i>unempl</i>	13.46	(12.63)	-25.42	(8.19)	-2.42	(4.52)	-14.72	(6.00)	0.89	(5.82)	-20.57	(7.51)	-10.04	(9.97)
<i>beds_hosp</i>	1.82	(1.18)	0.44	(0.08)	0.39	(0.05)	0.58	(0.08)	0.64	(0.07)	1.55	(0.11)	1.59	(0.12)
<i>beds_rest</i>	-0.01	(0.32)	0.16	(0.08)	-0.01	(0.06)	0.15	(0.08)	-0.02	(0.08)	0.16	(0.10)	0.03	(0.16)
<i>fla</i>	0.36	(0.90)	-2.62	(0.51)	-1.20	(0.29)	-2.12	(0.35)	-1.57	(0.37)	-1.71	(0.42)	-1.32	(0.55)
<i>constant</i>	-24.58	(29.60)	-69.93	(15.84)	-39.86	(7.80)	-51.76	(11.04)	-48.80	(11.02)	-37.70	(13.77)	-44.12	(19.08)

* Each column gives the estimated coefficients of the strategic interaction effects and the market characteristics (rows) on payoffs of a physician type. Standard errors are reported within brackets. Class-2 groups all psychiatrists, ENT-specialists and physiologists together, while class-3 groups internists, surgeons and hospital specialists.

Table 4: Estimation results on the market characteristics of the empirical model with 6 types: GPs, psychiatrists (psych), ear, nose and throat specialists (ENT), physiologists (phys), class 1 specialists (class1) and class 3 specialists (class3)* - nobs = 564 - ll-value=-5201.1537

	GP	psych	TNE	phys	class1	class3
<i>GP</i>	-1.20 (0.11)	<i>0.04</i> (0.02)	0.02 (0.03)	0.06 (0.02)	0.03 (0.03)	0.09 (0.04)
<i>psych</i>	-3.35 (1.04)	-0.59 (0.03)	-	-	-	-
<i>ENT</i>	4.04 (1.50)	-	-0.87 (0.07)	-	-	-
<i>phys</i>	15.13 (4.37)	-	-	-0.94 (0.05)	-	-
<i>class1</i>	-0.86 (0.61)	-	-	-	-0.37 (0.02)	-
<i>class3</i>	0.09 (0.11)	-	-	-	-	-0.21 (0.01)
<i>lnS</i>	2.80 (1.65)	0.84 (0.37)	1.67 (0.57)	1.05 (0.23)	2.19 (0.49)	1.17 (0.55)
<i>dens</i>	-1.86 (1.13)	0.44 (0.21)	0.28 (0.23)	<i>0.23</i> (0.14)	0.36 (0.27)	0.30 (0.38)
<i>age0_4</i>	9.52 (66.8)	<i>-36.74</i> (21.4)	-40.30 (33.8)	-14.36 (11.9)	-33.50 (31.5)	4.35 (33.1)
<i>age15_29</i>	-0.38 (42.1)	28.00 (11.7)	<i>27.84</i> (15.0)	14.59 (5.58)	51.72 (16.2)	27.67 (19.8)
<i>age30_44</i>	-10.45 (40.2)	28.50 (11.9)	7.80 (13.2)	<i>9.68</i> (5.16)	12.67 (15.2)	12.42 (16.1)
<i>age45_59</i>	-6.49 (33.4)	-3.41 (12.0)	-8.82 (14.2)	-0.90 (5.84)	-12.68 (14.2)	4.71 (16.0)
<i>age60_75</i>	-14.17 (34.6)	-5.03 (11.2)	-18.98 (16.7)	4.99 (5.42)	11.50 (15.3)	11.03 (16.6)
<i>age75+</i>	15.79 (46.9)	<i>24.69</i> (14.4)	17.71 (18.0)	8.05 (6.76)	17.81 (18.1)	24.48 (20.5)
<i>female</i>	28.30 (54.4)	28.16 (17.6)	65.45 (22.7)	8.66 (9.66)	72.83 (24.2)	41.27 (26.5)
<i>foreign</i>	1.69 (4.69)	2.92 (2.32)	0.98 (2.66)	-0.32 (0.94)	-1.02 (2.75)	-2.14 (3.54)
<i>income</i>	1.80 (1.62)	<i>0.73</i> (0.41)	1.10 (0.51)	0.27 (0.21)	<i>0.91</i> (0.53)	0.23 (0.53)
<i>unempl</i>	20.59 (24.1)	-20.96 (6.58)	<i>-13.35</i> (8.04)	-7.95 (3.46)	-22.16 (8.59)	-10.92 (9.93)
<i>beds_hosp</i>	0.04 (1.25)	1.27 (0.09)	0.50 (0.10)	0.44 (0.07)	0.92 (0.10)	1.60 (0.13)
<i>beds_rest</i>	0.06 (0.49)	0.10 (0.08)	<i>0.16</i> (0.10)	0.02 (0.05)	0.20 (0.13)	0.05 (0.16)
<i>fla</i>	-0.08 (1.28)	-1.64 (0.35)	-1.74 (0.51)	-0.70 (0.22)	-2.20 (0.51)	-1.37 (0.54)
<i>constant</i>	-34.63 (35.2)	-33.18 (12.0)	-52.76 (16.4)	-19.46 (6.45)	-68.41 (17.6)	-44.25 (19.5)

* Each column gives the estimated coefficients of the strategic interaction effects and the market characteristics (rows) on payoffs of a physician type. Standard errors are reported within brackets. Class-1 groups all dermatologists, gynecologists, pediatricians and ophthalmologists together, while class-3 groups internists, surgeons and hospital specialists.

Table 5: Simulation results on the equilibrium number of specialist entrants of all types for varying drops in the demand for their services

	$\phi=1$	$\phi=0.75$	$\phi=0.5$	$\phi=0.25$
<i>der</i>	676.60 (26.04)	508.22 (23.08)	335.84 (18.87)	162.30 (13.42)
<i>gyn</i>	865.05 (42.74)	652.01 (37.42)	428.38 (31.16)	201.87 (21.97)
<i>ped</i>	886.80 (30.46)	716.00 (27.45)	527.35 (23.40)	311.83 (17.87)
<i>opht</i>	819.56 (28.55)	627.12 (25.18)	424.35 (20.54)	212.97 (14.67)
<i>psych</i>	1296.02 (41.83)	1179.12 (39.40)	1123.38 (38.19)	837.75 (32.46)
<i>ENT</i>	532.05 (25.70)	436.17 (23.26)	392.73 (21.57)	201.26 (16.19)
<i>phys</i>	704.94 (34.33)	601.97 (32.34)	539.44 (26.61)	310.75 (24.58)

* The simulations are based on the results of the full estimation of the model, as presented in Tables 3 and 4 (1,000 simulations). The different columns give the equilibrium number of entrants under varying drops in the demand for specialist services: the number of inhabitants (S) changes by factor ϕ . Standard errors are reported within brackets.