Competition and physician behaviour: Does the competitive environment affect the propensity to issue sickness certificates?*

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Abstract

Competition among physicians is widespread, but compelling empirical evidence on its impact on service provision is limited, mainly due to endogeneity issues. In this paper we exploit that many GPs, in addition to own practice, work in local emergency centres, where the matching of patients to GPs is random. The same GP is observed both with competition (own practice) and without (emergency centre). Using high-dimensional fixed-effect models, we find that GPs with a fee-for-service (fixed-salary) contract are 12 (8) percentage points more likely to certify sick leave at own practice than at the emergency centre. Thus, competition has a positive impact on GPs' sicklisting that is strongly reinforced by financial incentives.

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1 Introduction

Competition among physicians is widespread. Almost every country has a market-based allocation of physician services, though the scope for competition may vary according to government regulations. In particular, the extent to which prices of physician services are set administratively or determined in the market differs across public and private health care systems. In this paper we study the effect of non-price competition among physicians on their service provision in a National Health Service (NHS), and how this relationship depends on the financial incentives provided by the physicians' remuneration schemes.

Despite the widespread presence of competition in physician markets, the empirical evidence on its impact on physicians' service provision is surprisingly scarce.[1] There are only a few papers, which we discuss below, that provide compelling evidence on the causal relationship between competition and physician behaviour. A main reason for this is that market structure is endogenous, which makes it hard to obtain plausible exogenous variation in the degree of competition. A standard regression analysis of market concentration on physicians' service provision, as used by most of the existing literature on physician markets, will yield biased estimates. While instrumental variable approaches could be employed to deal with the endogeneity problem, the lack of data in physician markets has made this difficult.[2]

In this paper we propose a novel approach to identify the impact of competition on physicians' service provision. More precisely, we take advantage of the fact that many General Practitioners (GPs), in addition to their regular office practice, work in local primary care emergency centres (PCECs). At the PCECs, the physician-patient matching is random, implying that the GPs face exogenous demand and thus no competition for patients. However, at the GPs' own practice, the matching is a result of patient choice and the GPs should realise that their treatment decisions will affect both the probability that the patient chooses to remain on the GPs' list in the future, and also, through reputation effects, the probability that new patients will choose to be listed with the GP. Since the data allows us to observe the same GP in different competitive environments, being exposed (in own practice) or not (in emergency centre) to competition, we are in principle able to isolate the effect on competition on GP behaviour in a way that allows

[1] See the review by Gaynor and Town (2011).

[2] For more details, see Gaynor and Town (2011).

us to make causal inferences.

A key advantage of our approach is that it allows us to control for selection issues related to GPs' choice of location and type of remuneration. GPs' choice of location may potentially depend on the degree of competition in the local market. If particular GPs tend to a larger extent to locate in more competitive geographical areas, then estimations that base identification on cross-sectional variation in the degree of competition in local markets will yield biased results. In a similar way, the allocation of GPs across remuneration schemes is obviously not random, but an endogenous choice made by the GP. Given that there is selection of GPs into different reimbursement schemes, using cross-sectional variation across GPs' remuneration yields biased results. By focusing on the same GP in two different environments, our approach accounts for these kinds of selection issues, enabling us to identify causal effects of competition on GPs' behaviour, here measured according to their propensity to certify sickness absence for their patients.

An important issue, though, is to control for other factors (than competition) that may influence physician behaviour in the two competitive environments. To do so, we exploit rich administrative data with detailed patient-level information in Norway from 2006 to 2014. From these data, which basically cover the whole population in Norway, we select the ten most frequent acute diagnoses treated by GPs. As outcome variable, we use certification of (paid) sick leave, which is a highly frequent and standardised 'treatment choice' made by GPs for acute diagnoses. The detailed data allow us to estimate high-dimensional fixed-effect models using only within patient and GP variation. This implies that we control for all time-invariant unobserved (and observed) patient and GP heterogeneity. We also include diagnosis fixed-effects and control for time trend, as well as a wide set of potentially time-varying patient and GP characteristics.

Our key finding is that GPs are more likely to issue sick leave to patients that visit them at their own practice than at the emergency centre. We also find that, when exposed to competition, GPs with an activity-based (fee-for-service and capitation) contract are much more likely to offer sick leave than GPs with a fixed-salary contract. These results are economically significant. In our most preferred model, GPs with an activity-based contract are 12 percentage points more likely to offer a sick leave at their own practice than at the emergency centre, whereas the equivalent figure for GPs on fixed-salary contracts is 8 percentage points. These findings are (in qualitative terms) highly robust across a large set of specifications and sensitivity tests. We therefore conclude that competition does influence physician behaviour, and that this effect is strongly reinforced by financial incentives (i.e., activity-based remuneration of physician services).

To develop economic intuition for the results, we construct a dynamic model of GPs' choices of sick-listing practice styles when patients differ in illness severity and thus the need for a sick leave. In the model patients always (weakly) prefer a sick leave certificate irrespective of illness severity, as it is optional to make use of it. This implies that, under competition, GPs can increase future demand by adopting a more lenient sick-listing practice style. Assuming GPs are semi-altruistic and that deviating from medical sick-listing guidelines (i.e., being too lenient) is costly for the GP, we show that the effect of exposing GPs to competition crucially depends on the GPs' remuneration scheme. For GPs with an activity-based (fee-for-service or capitation) contract, competition always induces the GPs to be more lenient in terms of sick listing. For GPs with a fixed-salary contract, the effect of competition is *a priori* ambiguous. If GPs are mainly profit motivated, competition induces the GPs to adopt a stricter practice style in order to avoid (rather than attract) patients. However, the reverse is true if GPs are sufficiently altruistic and thus put a larger weight on patients' benefit from obtaining a sick leave relative to the costs of being too lenient.

The rest of the paper is organised as follows. In the next section we review the relevant literature. In Section 3 we present the Norwegian primary care market. In Section 4 we develop a dynamic model for GPs' sick listing practice and derive predictions for the empirical analysis. In Section 5 we present our data and provide some descriptive statistics. In Section 6 we explain our empirical strategy and in Section 7 we present our empirical results. In Section 8 we present several robustness checks and extensions in order to validate our results and empirical strategy. Section 9 concludes the paper.

2 Related literature

The economic literature on the market for physician services is extensive. A majority of work is on 'physician agency' that focuses on the role of asymmetric information in the relationship between patients and physicians and physician-induced demand.[3] There is also a large and related literature on physician incentives and payment schemes that studies the effects of fee changes on physicians' supply of medical services.[4] However, the literature on competition *per se* in physician markets is surprisingly sparse despite its widespread presence.[5]

There exists an early literature on the effects of competition on *pricing* of physician services. Most of this literature tends to use the number of physicians per capita within a geographic area as measure of competition, and exploit across-area variation to estimate the effect of competition on service prices.[6] More recent papers use instead measures of market concentration, such as the Herfindahl-Hirschman Index (HHI), to estimate the impact on service prices.[7] A key problem is that these measures of competition are endogenous and thus yield biased results. A recent paper by Dunn and Shapiro (2014) deal with this problem by using predicted (rather than actual) fixed-travel-time HHI, as used by Kessler and McClellan (2000) for competition in hospital markets. Linking these concentration measures to health insurance claims in the US, they find that physicians in more concentrated markets charge higher service prices. Another paper is Gravelle et al. (2016) who study the impact of competition on consultation prices charged by GPs in Australia. The degree of competition is measured by distance between GPs, and they use within area (rather than across area) variation to identify the effects of competition on GPs' consultation prices. They argue that the areas are sufficiently small to account for the fact that GPs' locational decisions are endogenous. They find that GPs with more distant competitors charge higher prices and a smaller proportion of their patients make no out-of-pocket payment. Our paper differs from this strand of literature in that we focus on the impact on non-price competition variables (i.e., sick listing) and take a different approach to obtain exogenous variation in the degree of competition (i.e., within GP variation in competition and service provision).

The number of studies on the impact of competition on physicians' service provision is much

[3] See, for instance, the review by McGuire (2000) and the recent paper by Jacobson et al. (2013).

[4] See, for instance, the seminal work by Gruber and Owings (1996) and the more recent work by Devlin and Sarma (2008), Clemens and Gottlieb (2014) and Brekke et al. (2017).

[5] For a review, see Gaynor and Town (2011).

[6] See, for instance, the seminal work by Pauly and Satterthwaite (1981) who use data on 92 US metropolitan areas. They find that areas with more physicians per capita have lower prices.

[7] See, for instance, Schneider et al. (2008) who find that physician market concentration in California, measured by HHI, is associated with higher prices.

more limited than the above-mentioned literature on physician pricing. A recent paper by Santos et al. (2017) provide evidence from the UK that patients respond to quality differences among GPs and are willing to travel further to higher quality practices. While this is not a direct test of the effects of competition, the study shows that GPs face higher demand if they improve their quality. There are a few papers that use 'shortage of patients' as competition measure, where shortage of patients is defined by whether the GP has open vacancies on their patient lists. The idea is simply that patients with closed list are competing less than those with open lists. For instance, Iversen and Lurås (2000) and Iversen (2004) show that Norwegian GPs who experience shortage of patients provide more services and thus obtain higher income per patient than their colleagues with full patient lists. A similar approach is taken by Iversen and Ma (2011) who find that more intense competition, measured either by whether the GPs' patient list is open or by the GPs' desired list size, leads to more diagnostic radiology referrals. Finally, Godager et al. (2015a) find that increased competition, measured either by the number of open primary physician practices or HHI, has negligible or small positive effects on referrals overall. Although it might seem plausible that GPs compete less aggressively in local markets with few open lists, the competition measure is clearly endogenous and thus likely to suffer from the same endogeneity problem as the use of market concentration measures, such as the HHI. Our paper differs from this strand of literature in that we do not consider the relationship between primary and secondary care and the gatekeeping role of GPs.[8] More importantly, we propose a different approach to identifying the effect of competition on GPs' service provision, using within GP variation rather than across GP or local market variation.

Finally, we should mention a closely related study by Markussen and Røed (2017). They study, as we do, the GPs' propensity to issue sickness certificates to patients using Norwegian administrative data. Their study consists of three separate parts. First, they identify each GPs' degree of 'gatekeeper leniency' at each point in time by using worker (patient) fixed effects, which is identified by worker movements between GPs and between sick leave and work. Second, they examine the extent to which workers choose GPs that are more lenient by estimating a conditional logit model, where the choice set is identified by the observed GP choices among

[8] Besides the above-mentioned studies, there are several papers that adress the role of GPs as gatekeepers for specialist care; see, for instance, Dusheiko et al. (2006), Brekke et al. (2007), and Gonzalez (2010).

other workers in the same local area. Third, they examine whether GPs adjust their gatekeeper leniency in response to fluctuations in demand or in costs of losing patients. This is done using a fixed effect model where the effects are identified on the basis of changes in the local competitive environment or in the GP's remuneration structure. Their results show that patients tend to choose GPs that have a more lenient sick-listing practice and GPs tend to become more lenient in local markets with stronger competition. While this study reports similar results as we do, they use conventional measures of (local) competition, such as the number or share of GPs with open lists (vacancies), the number of GPs per capita in an area, or the share of patients with a recent GP switch. A well-known problem with these measures is that they are market outcomes possibly affected by the GPs' service provision, including in our case their sick listing practice.

Our contribution is to propose a different approach to identify the causal impact of competition by examining the same (within) GP's sick listing practice in two different competitive environments, i.e., with competition (own practice) and without competition (emergency centre). As GPs are obliged to also work at emergency centres, this gives plausible exogenous variation in the exposure to competition, which allows us to make causal inference about the impact of competition on GPs' sick listing. Using GPs on fixed-wage contracts as baseline, Markussen and Røed estimate that competition (along with fee-for-service) increases sick listing by around 4 percent. This finding is also consistent with our results, where we show that fee-for-service GPs respond more strongly to competition than fixed-salary GPs. An advantage of our approach is that we can disentangle the impact of competition from remuneration, while the two effects are non-separable in their study. Finally, our analysis on the impact of competition on GPs' sick listing accounts for (unobserved) patient heterogeneity by including patient fixed effects, which is not done by Markussen and Røed, though they explicitly model patient heterogeneity in their analysis of patients' choice of GP.

3 Institutional background

In the Norwegian National Health Service (NHS), primary care provision is the responsibility of the municipalities, although funding and regulation are to a large extent made by the central government. Since the implementation of the Regular General Practitioner Scheme (*Fastlegere-*

formen in Norwegian) in 2001, each inhabitant of Norway has the right to be listed with a GP.[9] Patients are free to choose their GP (if the GP has vacant patient slots), and can switch GP (without stating any particular reason) at most twice per year.[10] The rate of patient-induced changes of regular GP is relatively small but far from negligible. According to numbers obtained from the Norwegian Directorate of Health, 6.4 percent of the patients initiated a change of regular GP in each of the years 2009 and 2013.[11]

In contrast, the GPs are not allowed to select their patients. GPs are free to choose their preferred patient list size in the interval between 500 and 2500 patients, but must accept any patient who wishes to be listed with the GP as long as there are available slots on the GP's list. Table A.1 in the Appendix shows the variation in *preferred* and *actual* list size during our period of analysis, which is 2007 to 2014. Although the variation is larger across GPs, as one would probably expect, there is also considerable variation for each GP over time, particularly with respect to actual list size. This variation is obviously partly driven by patients who change their regular GP.

All GPs need to have a contract with a municipality to set up a practice and serve patients within the NHS, irrespective of remuneration scheme. This contract regulates opening hours, list size, and office location. The vast majority (around 95 percent) of GPs are self-employed and run their own private practice, receiving a mix of capitation and fee-for-service, where the latter amounts to around 70 percent of their income.[12] The capitation part is covered by the municipality, whereas the fee-for-service part is covered by the public social security agency and (to some degree) patient co-payments.[13] The remaining (5 percent) of the GPs are employed by the municipality and receive a fixed salary.[14] The (level of) GP remuneration is determined in

[9] In the following, 'GP' refers to primary care doctors that are contracted or employed by the municipalities, i.e., GPs within the NHS.

[10] When choosing a GP, patients are not restricted to GPs located in their own municipalities. In practice, though, the share of patients listed with GPs outside their own municipalities is very low.

[11] In absolute numbers, these changes involved 311,000 patients in 2009 and 325,000 patients in 2013.

[12] Some municipalities also offer contracts where the municipality provides premises, equipment and/or staff for the private practice. In return, the municipality keeps the capitation fee while the GP receives the fee-for-service income.

[13] There are in principle significant co-payments assocciated with primary care services, but an annual cap of approx. €200 for individual health expenditures followed by 100 percent coverage from social insurance, implies in practice a very low share of de facto patient co-payments.

[14] The work week for GPs with a fixed salary contract is 37.5 hours. In addition, the GPs, irrespective of remuneration scheme, are obliged, according to their contract with the municipality, to spend a given number of hours at the PCEC. The municipality may also require the GPs to spend some hours at nursing homes, health clinics, prisons, etc. This is also independent of remuneration scheme.

annual negotiations between the medical association and the associations representing central and local governments.

Municipalities are also responsible for the emergency primary health care for their inhabitants (and visitors). These services are offered either at a GP's office or at PCECs, which often serve several municipalities. During evenings, nights and weekends, all emergency contacts are directed to these centres. In larger municipalities, PCECs also offer services during daytime. During ordinary opening hours, all GPs are obliged to accept and assess patients in need of emergency care in their own practice. In principle, if they are below the age of 60, GPs are also obliged to provide emergency care at PCECs, though it is possible to apply for exemption based on health or social reasons. In practice, more than 50 percent of the GPs work at PCECs.

Approximately half of the consultations taking place at PCECs are with a regular GP and the rest are covered by locums and junior doctors from hospitals. When working in an emergency centre during daytime or in the evenings, the vast majority of GPs are paid according to the same fee-for-service schedule as the one used for contracted GPs in their regular practice (Godager et al., 2015b). The PCECs are mainly visited by patients with infections, musculoskeletal problems, injuries and other physical disorder, though approximately 5 percent is related to mental health problems. Epidemiological research has found that, compared to many other countries, primary care emergency services are frequently used in Norway, and often in relation to conditions that could just as well have been treated by the patient's regular GP. The reason for this pattern appears to be relatively poor access to the GP during daytime (Sandvik et al., 2012). A key feature of the consultations taking place at the emergency centres is that patients are randomly matched with doctors, which we exploit as an identification strategy in our empirical analysis. The implications of this will be further discussed in Section 6, where we describe our empirical strategy.

An important function that GPs are entrusted with is gatekeeping to the Norwegian sickness benefit system, in which workers are entitled to a 100 percent replacement rate up to a maximum threshold (approximately €61,000 or $64,700) from the first day of sick leave and until one year for the same sickness spell. The first 16 days of sick leave are paid by the employer, while sickness benefit beyond the first 16 days is covered by the public social security agency.[15] Self-certification

[15] The change of payer after 16 days might affect incentives for sickness absence, in the sense that it might be

can be used for the first three or eight days of an absence spell depending on employer.[16] Beyond that period, eligibility for sickness benefit requires certification from a GP who must assess the ability to work (full or part time) and make a decision about sickness certification based on this evaluation. The Norwegian Health Directorate has issued sickness certification guidelines in order to help standardise the certification practice across GPs.[17] Sickness certificates can be issued both at a regular GP practice and at a PCEC and the procedures for issuing such certificates are identical in both cases.

4 A dynamic model of GP practice styles

In this section we develop a dynamic model of GPs' choices of sick-listing practice styles, where we make sure that the model is sufficiently rich to incorporate the key institutional details of the Norwegian primary care market. The model is used to make theoretical predictions about how competition is likely to affect sick-listing rates, and how this relationship is likely to depend on GP payment schemes.

A total mass of 1 infinitely lived workers are uniformly distributed on $L = [0, 1]$. In every period t, each worker falls (temporarily) sick with illness severity s, which is perfectly negatively correlated with work ability, and which is drawn (independently in each period) from a uniform distribution with support $[0, 1]$. Each time a worker falls sick, he can visit a GP who might issue a sickness certificate. The GP can correctly observe patients' illness severity and will issue a sickness certificate if the severity is above a threshold level $\widehat{s}_i := \sigma - \beta_i$, where $\sigma \in (0, 1)$ is the threshold level for issuing sickness certificates according to official guidelines and $\beta_i = \sigma - \widehat{s}_i$ represents GP i's departure from these guidelines. Thus, β_i reflects GP i's chosen *practice style* for issuing sickness certificates, where a higher value of β_i implies a more lenient practice style.[18]

Excluding travelling costs associated with a GP visit, the utility of a patient with severity

in the interest of the employer, in some cases, to prolong sickness certification once the first 16 days have passed (see, e.g., Fevang et al., 2014).

[16] There is no administrative registration of self-certified sickness absence in Norway. However, survey data collected by Statistics Norway indicate that self-certified sickness absence rates have been stable at a level just below 1 percent during the last 20 years (see https://www.ssb.no/arbeid-og-lonn/artikler-og-publikasjoner/stabilt-sykefravaer–371775 for exact figures).

[17] These guidelines are available at https://helsedirektoratet.no/retningslinjer/sykmelderveileder.

[18] A sickness certificate is valid for a certain period of time, which is decided by the GP. However, we abstract from this dimension of the certification decision and consider only the decision of whether or not to issue a sickness certificate.

s who attends a GP is $a(s)$ if he does not obtain a sickness certificate and $b(s)$ if he a obtains such a certificate, where $a'(s) < 0$, $b'(s) < 0$ and $b(s) > a(s)$ for all s. Thus, higher illness severity implies lower patient utility, but, for a given severity level, a patient always prefers to get a sickness certificate.[19]

There are two GPs in the market, one located at each endpoint of L. Including travelling costs, expected utility for a worker located at z and visiting GP i, located at z_i, is[20]

$$U^i(z) = \int_0^{\widehat{s}_i} a(s)\, ds + \int_{\widehat{s}_i}^1 b(s)\, ds - \tau |z - z_i|, \tag{1}$$

where $\tau > 0$ is the marginal travelling cost. With little loss of generality, we parameterise the sub-utility functions as follows: $a(s) = \eta - s$ and $b(s) = 1 - s$, where $\eta \in (0,1)$. We assume that $U^i(z) > 0$ for all z and β_i, which implies full market coverage; i.e., that every worker who falls sick always prefers to visit a GP.[21]

Suppose that, at each point on the line, a share λ of workers can choose which GP to attend, whereas each of the remaining share $1-\lambda$ is randomly allocated to one of the GPs each time they fall sick. If all workers are able to correctly observe the practice style of each GP, the worker who is indifferent between GP i and GP j is located at $\widehat{x}$, which is implicitly defined by $U^i(\widehat{x}) = U^j(\widehat{x})$, and explicitly given by

$$\widehat{x} = \frac{1}{2} + \frac{(1-\eta)\left(\beta_i - \beta_j\right)}{2\tau}. \tag{2}$$

The location of the indifferent worker thus depends crucially on two factors: (i) the difference in GP practice styles $(\beta_i - \beta_j)$, and (ii) the utility gain of obtaining a sickness certificate $(1-\eta)$.

The *potential demand* for GP i from the segment of patients who make a choice of GP is then given by $\lambda\widehat{x}$. However, since practice style is difficult to observe *ex ante*, it is unrealistic to assume that a GP who chooses a particular practice style will immediately realise his potential demand. We assume instead that patients' beliefs about the practice styles of the two GPs

[19] If a sick worker prefers to work, he can always refrain from using the sickness certificate. Thus, a worker who has already visited a GP can never be worse off by obtaining a sickness certificate. This means that the results of the model would be qualitatively unaffected by assuming that some workers would be better off without a sick leave.

[20] For simplicity, we assume that patient co-payments are zero. Positive patient copayments would not affect the analysis in any way, as long as these copayments are exogenous and equal for both GPs in the market.

[21] This requires $\tau < \frac{1}{2} - \sigma(1-\eta)$ and $\sigma < \frac{1}{2(1-\eta)}$.

evolve sluggishly over time through repeated interactions and reputation. More specifically, at each point in time, only a fraction $\gamma \in (0,1)$ of patients become aware of changes in GP practice styles. This implies that only a fraction γ of any potential change in demand is realised at each point in time.

Let actual demand of GP i at time t be given by

$$Q_i(t) = \frac{1-\lambda}{2} + \lambda x(t) \tag{3}$$

whereas potential demand is given by

$$\widehat{Q}_i(t) = \frac{1-\lambda}{2} + \lambda \widehat{x}(t), \tag{4}$$

where $\widehat{x}$ is given by (2). Analytically, the law of motion of actual demand is given by

$$\frac{dQ_i(t)}{dt} := \dot{Q}_i(t) = \gamma \left(\widehat{Q}_i(t) - Q_i(t) \right), \tag{5}$$

which is equivalent to

$$\frac{dx(t)}{dt} := \dot{x}_i(t) = \gamma \left(\widehat{x}(t) - x(t) \right). \tag{6}$$

The net income of GP i at time t is a linear combination of fixed-salary income and fee-for-service income, given by

$$\pi_i(t) = \theta w + (1-\theta) p Q_i(t), \tag{7}$$

where w is a fixed wage and p is the consultation fee net of monetary costs per consultation, which for simplicity are assumed to be constant.[22]

In addition to net income, we also assume that each GP cares, to some extent, about patient utility; that there is a (non-monetary) effort cost of patient consultations; and that GPs suffer a

[22] As described in Section 3, the payment scheme for self-employed GPs in Norway is a combination of capitation and fee-for-service, and there is also a separate (but very low) fee for issuing a sickness certificate. In our theoretical model, the assumption that all workers fall sick once per period implies that the net consultation fee p can be interpreted as including capitation payment. It is straightforward to extend the model by (i) introducing a distinction between capitation and fee-for-service payment (by assuming that each worker falls sick only with a certain probability in each period), and (ii) introducing a separate fee for issuing a sickness certificate. However, this would only complicate the exposition without qualitatively affecting any of the results, since all these fees would affect GP incentives in the same way (further details available upon request). Thus, for expositional purposes, we represent the fee-for-service payment scheme only by a single parameter, namely the net consultation fee p.

disutility from deviating from the official sick-listing guidelines. The aggregate utility of patients attending GP i at time t is given by

$$V_i(t) = \lambda \int_0^{x(t)} \left(\frac{1}{2} - (1-\eta)\widehat{s}_i(t) - \tau z\right) dz + \frac{(1-\lambda)}{2} \int_0^1 \left(\frac{1}{2} - (1-\eta)\widehat{s}_i(t) - \tau z\right) dz. \quad (8)$$

The payoff of GP i at time t is then assumed to be given by

$$\Omega_i(t) = \pi_i(t) + \alpha V_i(t) - cQ_i(t) - \frac{k}{2}(\sigma - \widehat{s}_i(t))^2, \quad (9)$$

where α measures the degree of altruism towards the patients, c is the (constant) marginal cost of consultation effort, and where the last term reflects the GP's disutility of adopting a practice style that deviates from the official guidelines. In order to make sure that the GP's participation constraint is satisfied for all $\theta \in [0, 1]$, we assume that $p > c$.

We consider a dynamic game where the two GPs simultaneously (and independently) choose their practice styles (i.e., β_i and β_j) at each point in (continuous) time over an infinite time horizon. This is a 2-player differential game with practice style as the control variable and demand as the state variable. For analytical convenience, we choose the open-loop solution as our game-theoretic solution concept. Here it is assumed that each GP knows the initial state of the system but cannot observe the other GP's practice style, and thus potential demand, in subsequent periods. This implies that each GP computes his optimal plan (i.e., a sequence of practice styles over time) at the beginning of the game and then sticks to it forever. Thus, the optimal choice depends only on time, time-invariant parameters and initial conditions.[23]

The open-loop equilibrium solution is explicitly derived in Appendix A1. In the symmetric steady state of this solution, the practice style of each GP is given by

$$\beta^* = (1-\eta)\frac{\lambda\gamma((1-\theta)p - c) + \alpha(\tau(\gamma+\rho) + \lambda\gamma\phi)}{2k\tau(\gamma+\rho) - \alpha\lambda\gamma(1-\eta)^2}, \quad (10)$$

where ρ is the rate of time preference, and where $\phi := \frac{1}{2} - (1-\eta)\sigma - \frac{\tau}{2} > 0$ (by the assumption of full market coverage). Restricting our attention to the steady-state outcome, we ask two related questions: (i) How does the degree of competition affect GP practice styles? (ii) How

[23] See Brekke et al. (2012) for a similar approach to quality competition more generally.

does the effect in (i) depend on the GP payment scheme?

Using the share of patients who choose GP as the measure of competition, the benchmark case of *no competition* is given by $\lambda = 0$. In this case, the steady-state GP practice style is given by[24]

$$\beta^*_{\lambda=0} = \frac{\alpha(1-\eta)}{2k}. \tag{11}$$

When GPs cannot affect demand through their choice of practice style, there exists only one incentive for GPs to adopt a practice style that deviates from the official guidelines, namely altruistic concern for patient utility at the *intensive* margin. A more lenient practice style ($\beta > 0$) implies that the expected utility of patients who are allocated to the GP increases, and a semi-altruistic GP derives some benefits from this. These marginal benefits are optimally traded off against the marginal disutility of deviating from the official guidelines. Thus, semi-altruistic GPs will choose a strictly positive value of β, whereas purely profit-oriented GPs will set $\beta = 0$. Furthermore, in the absence of competition, GP practice styles do not depend on the payment scheme for GPs.

The case of free patient choice, which implies *competition* between the GPs, is characterised by $\lambda = 1$. The effect of competition on GP practice styles in the steady state is then given by

$$\Delta\beta^* := \beta^*_{\lambda=1} - \beta^*_{\lambda=0} = \gamma(1-\eta)\frac{2k((1-\theta)p-c) + \alpha\left(\alpha(1-\eta)^2 + 2k\phi\right)}{2k\left(2k\tau(\gamma+\rho) - \alpha\gamma(1-\eta)^2\right)}. \tag{12}$$

The sign of this expression – which is *a priori* ambiguous – depends on the sign of the numerator, which consists of two terms. The first and second term capture the effect of competition on, respectively, the GPs' *financial* and *altruistic* incentives for the choice of practice style.

We can isolate the *financial incentives* by considering the case of purely profit-oriented GPs (i.e., $\alpha = 0$). In this case, we see that the sign of $\Delta\beta^*$ depends crucially on the GP payment scheme. The effect of competition on the GPs' propensity to issue sickness certificates is negative ($\Delta\beta^* < 0$) under fixed-salary contracts ($\theta = 1$) and positive ($\Delta\beta^* > 0$) under fee-for-service contracts ($\theta = 0$). More generally, competition leads to a more lenient GP practice style if the financial incentives for attracting more patients are sufficiently high-powered (i.e., if θ is

[24] If $\lambda = 0$, there is no dynamic competition over time. Each GP will choose the steady-state value of β at $t = 0$ and stick to it forever.

sufficiently low). If these incentives do not exist, which is the case under fixed-salary contracts, a purely profit-oriented GP will choose a practice style in the steady state that is stricter than the official guidelines (i.e., $\beta^* < 0$) in an attempt to reduce demand and thereby save consultation effort costs.[25]

The effect of GP *altruism* is captured by the second term in the numerator of (12) and contributes unambiguously positively. The reason is that competition allows for patient utility effects of GP practice styles at the *extensive* margin. By adopting a more lenient practice style, a GP can attract more patients and thereby increase the total utility of the patients treated. Under fee-for-service payment ($\theta = 0$), this effect will reinforce the positive relationship between competition and the propensity to issue sickness certificates. Under fixed-salary contracts ($\theta = 1$), GP altruism introduces a counteracting effect. If the altruistic gain of increased patient utility at the extensive margin is higher than the marginal consultation cost, competition leads to a more lenient GP practice style ($\Delta\beta^* > 0$) also for GPs on fixed-salary contracts.

Finally, notice that the *magnitude* of the competition effect on GP practice styles depends on the size of the *potential* demand response to a more lenient practice style (measured by $(1 - \eta)$) and by how fast *actual* demand adjusts to such a change in practice style (measured by γ).

The above described results are summarised as follows:

Proposition 1 *(i) Under fee-for-service contracts, competition always leads to a more lenient GP practice style. (ii) Under fixed-salary contracts, competition leads to a more lenient (stricter) GP practice style if the degree of altruism is sufficiently strong (weak). (iii) When facing competition, a GP on fee-for-service contract is always more lenient than a GP on fixed-salary contract.*

5 Data and descriptive statistics

Data on GPs and their patients are derived from the Norwegian Health Economics Administration (HELFO), which is responsible for the Norwegian primary care patient list scheme.[26]

[25] Since total demand is fixed, each GP always has the same demand in the symmetric steady-state equilibrium, regardless of the competitive environment. However, when patients are free to choose their preferred GP, each GP has a unilateral incentive to increase (decrease) demand if the marginal net benefit of doing so is positive (negative).

[26] HELFO is a subordinate institution directly linked to the Norwegian Directorate of Health.

For each patient contact (consultation), whether at the GP's regular office or at an emergency centre, the GP sends an invoice to HELFO. The register includes information on patients' age and gender, date and time of contact, diagnosis according to the ICPC-2-diagnosis code and codes from a detailed tariff scheme for type of contact (including a tariff for issuing sickness certificates). Notably, each invoice also states whether the GP is remunerated by fee-for service or fixed salary. The register includes the same type of information regardless of where the consultation takes place (at the GP's own practice or in an emergency centre). HELFO also holds a register of the regular GPs, including their age, gender, medical specialist status and the personal identifiers of the patients on the list. From HELFO we have obtained data from 2006-2014.

Data from HELFO do not include information on patient characteristics like education and income. This information is derived from the FD-Trygd database, which links administrative information from the National Insurance Administration, Statistics Norway and the Directorate of Labour. The database covers all Norwegians from 1992 onwards. Besides detailed information on work activity, income and social security (sick leave, disability, retirement pension, etc.), the database also includes extensive background information such as education, marital status and number of children.

5.1 Sample

We restrict attention to the 10 most frequent diagnoses among employed patients attending PCECs in the period 2007-2014.[27] These are listed in Table 1, which also contains information on the total number of visits at emergency centres per diagnosis.

[Table 1 here]

From HELFO we have extracted information on all consultations, whether at a regular GP practice or at an emergency centre, where the patient was diagnosed with one of these 10 diagnoses. This amounts to a total of 6,036,580 visits over the period 2007-2014. The sample that we use in our analysis is a subset of these visits, where sample selection is based on a number of different considerations, which we carefully explain below.

[27] The explanatory variable 'visits last year' is based on data for the period 2006-2013, therefore consultations in 2006 cannot be included in the sample.

Since we focus on GPs' sick-listing practice we only include patients who were employed at the time of consultation, which reduces the total number of visits by approximately 25 percent. Furthermore, we exclude from the sample visits to physicians not registered as a regular GP[28] and visits (at a GP office) to another regular GP than the one the patient is listed with.[29] These two categories constitute roughly 26 and 30 percent, respectively, of all visits.[30]

Another potential problem is related to visits which result in emergency hospital admissions. In these cases, the sickness certificate might be issued at the hospital. In order to exclude such cases we link our data on primary care visits to data from the Norwegian Patient Register (NPR), which contains (weekly) information on all admissions to secondary care in Norway. Based on this information, we have excluded visits from patients who are registered with a hospital stay in the same week as the primary care consultation.

In a few cases, a GP is registered both with fee-for-service and salary in a given month. If more than 5 percent of the GP's consultations are remunerated differently from the dominant consultation type, we exclude the GP's consultations for the relevant month. This could for instance happen if the GP changes practice during a month. It concerns less than a half percent of all consultations.

Less than 3 percent of all PCEC consultations take place during the night, and these consultations are excluded from our sample. This exclusion is an attempt to reduce unobservable patient and GP heterogeneity across consultation types. On the patient side, consultations at emergency centres during the night is likely to involve more high-severity patients, while on the GP side, excluding night-time consultations will exclude most of the PCEC consultations where GPs are paid a fixed salary, ensuring a more homogeneous remuneration scheme (fee-for-service) for the remaining PCEC consultations in the sample.[31] Furthermore, we exclude consultations where the GP is matched with one of his own list patients at an emergency centre, since it is

[28] These include locums, interns, junior doctors from hospitals working in emergency centres, etc.

[29] A patient might be seen by another GP than the one she is listed with if the patient's regular GP is unavailable for some reason. This is particularly frequent in GP group practices.

[30] Notice that these two categories are not mutually exclusive. The intersection consists of all consultations outside emergency centres where the pasient visits a GP different from the one she is listed with, and this GP is not registered as a regular GP.

[31] It should be noted that, according to our theory model, the renumeration scheme has no impact on GP behaviour in a situation with exogenous demand, as is the case for emergency centre consultations. We have also estimated our empirical models on a sample where we include night-time PCEC consultations and the results (which are available upon request) are practically identical.

reasonable to assume the GP has incentives to behave differently in such cases.[32]

Our empirical strategy for identifying the effects of competition on GP behaviour, which is explained in detail in Section 6, relies on an assumption that consultations at PCECs are random and isolated matches between GPs and patients – who do not know each other – with a low probability of future interactions. This is a plausible assumption in municipalities with a sufficiently large number of GPs, where the probability of seeing a particular GP when going to a PCEC is very low. However, this assumption is less plausible in small municipalities, with a limited number of GPs. Even if we exclude consultations where GPs are matched with their own list patients at PCECs, the degree of familiarity between patients and GPs is generally much larger in small municipalities, making the distinction between regular GP consultations and PCEC consultations more blurry. We therefore exclude consultations that take place in relatively small municipalities, with less than 10 GPs.

[Table 2 here]

Finally, we have also dropped a small number of patients with missing observations on some explanatory variables. Table 2 contains information on the relative size of each of the excluded consultation categories for each of the ten diagnoses considered.[33] Our final sample contains almost 2 million consultations.

5.2 Variables

In line with our empirical strategy (to be further explained in the next section), we classify all consultations in our final sample into three different categories: (i) consultations where the patient visits her own regular GP and this GP is self-employed and paid by capitation and fee-for-service, (ii) consultations where the patient visits her own regular GP and this GP is employed on a fixed-salary contract, and (iii) consultations which takes place at a municipal emergency centre. These categories constitute approximately 89 percent, 1 percent and 10 percent, respectively, of the total number of consultations. For each consultation we also know

[32] We use this excluded category of consultations in a placebo test of our identification strategy in Section 8, along with several other robustness checks.

[33] Notice that, since these categories are not mutually exclusive, the number of visits in the final sample cannot be directly calculated from the total number of visits by using the shares of excluded visits given in Table 2.

whether a sickness certificate has been issued and whether the consultation is a prolonged one.[34]

[Figures 1a and 1b here]

Figure 1a shows the frequency of each diagnosis in each category of primary care consultations. For many diagnoses, their frequency is quite similar across consultation categories. Within this set of diagnoses, we see that *upper respiratory infection* is the most common diagnosis at GP offices and almost equally frequent at emergency centres. On the other hand, *laceration/cut* is much more common at emergency centres. These patient sample differences will be taken care of in the empirical analysis where we control for diagnosis. Notice, however, that the descriptive statistics on the rate of sick listing across the three categories of consultations, as depicted in Figure 1b, show a very consistent pattern. For every single diagnosis, the sick-listing rate is highest in consultations with a regular GP on fee-for-service payment and lowest in consultations at emergency centres.

We also include a relatively large set of GP and patient characteristics as control variables. All variables are listed and defined in Table A.2 in the Appendix. In Table 3 we report the mean values of all variables (summed over all diagnoses) for each of the three consultation categories. Patients at the emergency center had a lower number of visits to a GP or an emergency centre the previous year, but they are also somewhat younger than the average patient at the GP office. For most of the other variables, the descriptive statistics show relatively small and non-systematic differences across consultation categories. As expected, since regular GPs above the age of 60 are automatically exempted from the obligation to work at emergency centres, the average GP age is somewhat lower for consultations taking place there.

[Table 3 here]

To complete the picture, we also report the mean values of the patient-level variables for a different partition of the data, where all consultations are categorised according to whether or not a sickness certificate was issued. These descriptive statistics, reported in Table A.3 in the Appendix, show that patients who receive a sickness certificate are, on average, slightly younger, with a slightly lower income, and are somewhat more likely to have low education. Overall,

[34] The standard time for a consultation is 20 minutes, but the consultation can be prolonged by the physician.

though, the differences between these two groups of patients, along observable dimensions, are not very pronounced.[35]

6 Empirical strategy

The (twofold) aim of our empirical analysis is (i) to estimate the causal relationship between the degree of competition a GP is exposed to and his propensity to issue sickness certificates to his patients, and (ii) to assess how this relationship depends on the GP payment scheme (fixed salary versus fee-for-service). Our theoretical analysis predicts that more competition will lead to a higher sick-listing rate if GP payment is based on fee-for-service. On the other hand, the effect of competition on the sick-listing rate of fixed-salary GPs is positive (negative) if the degree of GP altruism is sufficiently strong (weak), but always smaller than the effect on the sick-listing rate of fee-for-service GPs.

The key challenge for empirical identification is to create an exogenous measure of competition intensity. Our strategy here is to exploit the fact that the consultation-specific matching of patients to physicians is based on patient choice at regular GP practices, whereas it is completely random at emergency centres. This difference in 'matching technology' has clear implications for the nature of the competitive environment the GPs find themselves in when they work in their own practice or in an emergency centre. When patient-physician matching is random, as is the case in an emergency centre, the GP cannot influence his future demand, which is exogenous. This implies that the GP is not exposed to any competition for patients and is equivalent to the case of $\lambda = 0$ in the theory model.

On the other hand, when working in his own practice, where physician-patient matching is a result of patient choice, the GP should realise that his treatment decisions (or 'practice style') will affect both the probability that the patient chooses to remain on the GP's list in the future, and also, through reputation effects, the probability that new patients will choose to be listed with the GP. This implies that the GP is exposed to competition for patients and is equivalent to the case of $\lambda = 1$ in the theory model.[36] Since the data allow us to observe

[35] Because of multiple visits (to a regular GP or a PCEC), with some visits resulting in a sickness certificate and others not, the same patient might be represented in both categories of consultations in Table A.3.

[36] The indications of significant variation in actual patient list size over time, as shown in Table A.1, suggest that most regular GPs are indeed exposed to competition for patients.

the same GP in different competitive environments, being exposed (in own practice) or not (in emergency centre) to competition, we are in principle able to isolate the effect of competition on GP behaviour in a way that allows us to make causal inferences.[37]

Obviously, the above-described empirical strategy implicitly relies on the basic assumption that the degree of GP leniency with respect to sick-listing is indeed a strategic competition variable for GPs when working in their regular practices. Given that patients tend to value a more lenient practice style, it seems *a priori* reasonable to assume that changes in the degree of leniency will affect GP demand over time, mainly via reputation effects, as postulated in our theoretical model. This assumption is also convincingly backed up by empirical evidence reported by Markussen and Røed (2017). Based on a conditional logit model using Norwegian data, they show that differences in GP leniency with respect to sick-listing have strong effects on workers' choice of regular GP.

In order to estimate the effect of competition on physician behaviour, we employ the following high-dimensional fixed effect model where we control for all time-invariant characteristics of patients and physicians using the Stata module *reghdfe* (Correia, 2014):

$$y_{ijt} = \xi * Type_{ijt} + \kappa * X_{ijt} + \psi_i + \delta_j + \omega_t + \varepsilon_{ijt}, \tag{13}$$

where the dependent variable y_{ijt} is equal to 1 if GP j issues a sickness certificate to patient i at time t, and equal to zero otherwise. According to (13), we have the following distinct sources of variation in the dependent variable:

1. Type of consultation ($Type_{ijt}$) according to the three previously defined categories.

2. Observed time-varying exogenous characteristics of patients and physicians (X_{ijt}).

3. Time-invariant patient heterogeneity (ψ_i).

4. Time-invariant physician heterogeneity (δ_j).

[37] One could imagine that a patient decides to change her regular GP based on a visit at the emergency centre, thereby creating a link between a GPs behaviour at PCEC consultations and the demand for consultations at his regular practice. However, a significant demand effect of this kind arguably requires a certain degree of repeated GP-patient interaction, which we largely rule out by excluding smaller municipalities from our sample. Thus, we believe that such an effect is likely to be negligible in larger municipalities, where the probability of seeing a particular GP at a PCEC is very small.

5. Period-specific effects (dummy variables for year, month, day of week and hour) common to all patients and physicians (ω_t).

6. Unexplained random variation (ε_{ijt}).

Our explanatory variable of main interest is type of consultation. In the analysis we use visits to emergency centres as the baseline category, which implies that the estimated parameter vector ξ measures the effect of exposure to competition on physicians' propensity to issue sickness certificates, with separate parameter estimates depending on whether physicians have fixed salaries or fee-for-service payments in the environment where they are exposed to competition. GPs working at emergency centres may well differ systematically from GPs who do not on unobservable characteristics. However, GP fixed effects capture differences between GPs regarding their motivation for working at emergency centers, their attitudes towards the gatekeeper role and to the usefulness of sickness absence in a therapeutic context, their degree of altruism, and so on. Patient fixed effects, in turn, capture factors such as genetic predispositions, initial health status including chronic disease, attitudes towards illness and work, and degree of risk aversion regarding change of Regular GP.

A remaining potential estimation problem, though, is that patients visiting an emergency centre might differ from patients visiting a regular GP. Even in a regression model where we include patient, GP and time fixed effects, and where we also control for a large set of time-varying patient and physician characteristics, the dependent variable is likely to be correlated with the error term due to unobserved patient characteristics. However, the interpretation of the estimation results is greatly enhanced by the fact that, although it is hard to know the size of the patient selection bias, it is arguably easier to make conjectures about the *direction* of the bias. Controlled for observable patient characteristics, it seems reasonable and intuitive to assume that the average patient severity level is at least as high for PCEC consultations as for regular GP consultations. Although we cannot directly observe patient severity, this conjecture is backed by the observation that, for every diagnosis considered, the share of patients who are sent to hospital after a primary care consultation is considerably higher for emergency centre consultations than for regular GP consultations.[38] We will return to this issue when discussing

[38] These figures are calculated using the data and procedure previously described in Section 5 and are reported in Table A.4. in the Appendix.

the robustness of our empirical results presented in the next section.

Eq. (13) is our preferred model, but we also report results from estimations of OLS models with time-fixed and diagnoses-fixed effects, as well as from models adding GP or patient fixed effects. When estimating GP and/or patient fixed effects specifications, we follow Correia (2015) and drop singleton observations (i.e., GPs or patients for whom there is only one observation) in order to ensure proper inference and improve computational efficiency in our fixed-effect regressions. In all specifications, we cluster the standard errors at GP level.

7 Results

Our main regression results are presented in Table 4, which displays results from the estimation of four different versions of (13). As a benchmark for comparison, estimates based on pooled ordinary least squares (OLS) are reported in Column 1 of Table 4. If we compare OLS results with raw data sickness certification rates (Table 3), the differences in sick-listing propensity across consultation categories are much less when we control for observable GP and patient characteristics as well as time fixed effects. In particular, controlling for diagnosis is important, as could be expected from the descriptive statistics (Figures 1a and 1b).

Columns 2 and 3 in Table 4 show the estimates from models with physician fixed effects and patient fixed effects, respectively. In the model with physician fixed effects, identification of the competition effect is based on observations of the same physician both in his own practice and at an emergency centre. On the other hand, in the model with patient fixed effects, identification is based on observations of the same patient visiting her regular GP and visiting an emergency centre. Finally, in Column 4 we report estimates from our preferred empirical model with two-way (physician and patient) fixed effects, as specified in (13).

[Table 4 here]

For our independent variables of interest, the point estimates are qualitatively similar in all four models. When a physician works in a more competitive environment (i.e., in his own practice instead of at an emergency centre), the physician's propensity to issue sickness certificates is significantly higher. Furthermore, this effect is significantly stronger if the physician has financial incentives to compete for patients (i.e., if the physician's income in his own practice is based on capitation and fee-for-service rather than a fixed salary). These effects are estimated with a great deal of precision. In our most preferred model, exposure to competition increases the probability of sick listing by approximately 8 percentage points if the GP is on a fixed-salary contract, and by almost 12 percentage points if the GP is on a fee-for-service contract.[39] The estimated coefficients for the other covariates are all relatively small in magnitude.[40]

In qualitative terms, the estimated effects of competition on sick-listing rates are similar across the four different models displayed in Table 4. However, the magnitudes of the effects are somewhat sensitive to the inclusion of patient and physician fixed effects. This suggests that there are unobserved and time-invariant patient and physician heterogeneities which are relevant for the sick-listing rates. All else equal, some physicians might be more lenient than others in their sick-listing practice, whereas the demand for sickness certification might be higher from some patients than from others. Compared with the OLS estimates, the inclusion of physician fixed effects tends to increase the magnitude of the estimated coefficients, particularly for salaried physicians. On the other hand, the inclusion of patient fixed effects tends to reduce the estimated effects of competition. This suggests that more lenient physicians are overrepresented in PCEC consultations, whereas patients with higher demand for sickness certification are overrepresented in regular GP consultations.

The estimated effect of competition on the sick-listing practice of fee-for-service GPs, who have financial incentives to attract patients, serves as a strong confirmation of the prediction from our theoretical model. The finding of a considerably stronger effect for these GPs than for fixed-salary GPs is also in accordance with the theoretical analysis. However, our theory predicts that the sign of the competition effect is *a priori* ambiguous for fixed-salary GPs, with a positive (negative) effect if the degree of altruism is sufficiently strong (weak). The empirical finding of a significantly positive effect also for this group of GPs suggests, in light of the theory, that the degree of altruism among fixed-salary GPs is relatively high. This might be partly

[39] Using an F-test, we confirm that the effects of competition on physicians' sick-listing practice are siginificantly different (in all four models) for the two types of GPs (fixed salary vs. fee-for-service).

[40] In Table A.5 in the Appendix we report separate estimates of (13) for each of the ten diagnoses given in Table 1. The effect of competition on sick-listing rates is significantly positive for most of the diagnoses, particularly for GPs on fee-for-service contracts, although the results across diagnoses are not perfectly consistent, which is fairly expected, given the considerably reduced number of observations on which each estimation is based.

explained by a selection effect that is not fully accounted for in our empirical models. When the Regular General Practitioner Scheme was introduced in 2001, the GPs who were already on a fixed-salary contract were given the right to keep their position as employed GPs earning a fixed salary. Thus, the type of GP (fee-for-service vs. fixed salary) is to some extent a result of the GPs' own choice and we cannot rule out the possibility that the two types of GPs differ along some unobservable dimension. One possible self-selection criterion, which seems intuitively plausible, is that the more profit-oriented GPs opted for a self-employment contract (capitation and fee-for-service) whereas the more altruistic ones opted to remain on a fixed-salary contract.

8 Robustness and extensions

In this section we assess the validity of our results in three different ways. First, we address some potential selection biases in our main analysis and check whether our results are robust to different sample selection criteria that help correcting for these biases. Second, we explore whether our identifying strategy produces heterogeneous effects along dimensions that are likely to affect the *scope for competition*. If the effects are stronger in contexts where the scope for competition is larger, this provides confirmation that our empirical strategy is really capturing a competition effect. Finally, we design a placebo test where we compare GPs' practice styles at their own GP practices with the practice style towards *their own list patients* at the emergency centres, which is a way to eliminate the competition effect which, we claim, is explaining our main results (Table 4). All results in this section are derived from our preferred empirical model with two-way (GP and patient) fixed effects.

8.1 Selection bias

As mentioned in Section 6, our results might be affected by patient selection bias due to unobserved systematic differences between patients who visit an emergency centre and patients who visit their regular GP. However, as previously argued, such a bias – if it still remains after controlling for both time-varying and time-invariant heterogeneity – is likely to be in the direction of sicker patients attending emergency centres, which implies that, absent the competition effect, the rate of sick listing should be higher at emergency centres than at regular GP practices. Thus, the fact that we find significantly *lower* sick-listing rates at emergency centres suggests that we are, if anything, *underestimating* the positive effect of competition on physicians' propensity to issue sickness certificates.

However, we can also identify several other potential biases that might work in the opposite direction. In Table 5 we present a series of results (in Columns 2-6) where we aim to correct for each of these biases by different sample selection criteria. For ease of comparison, we also reproduce our main results based on the full sample (from Table 4) in the first column of Table 5. All results in Table 5 are estimated using our preferred empirical specification with both patient and GP fixed-effects.

[Table 5 here]

(i) One potential bias is related to the fact that the degree of *familiarity between physician and patient* is likely to be higher in a regular GP consultation, at least on average. This might have two different effects on the physician's decision of whether or not to issue a sickness certificate. First, higher familiarity is likely to improve diagnostic accuracy; i.e., the better the GP knows the patient, the more likely he is to observe the true severity level of the patient. However, there is no particular reason to believe that this will create a bias in our analysis. For any given GP practice style (i.e., sick-listing threshold), the inability to diagnose accurately can create two types of mistakes: the GP issues sickness certificates to patients who should not have been sick listed, and patients who should have been sick listed do not obtain a sickness certificate. Improved diagnosis accuracy will reduce both types of mistakes and there is no *a priori* reason to believe that the net effect is systematically different from zero. However, higher familiarity between physician and patient might also make the physician more prone to give the patient a sickness certificate in borderline cases. A GP might simply find it more difficult to deny patients he knows well a sickness certificate. In the context of our theoretical model, this effect could be interpreted as the GP acting more altruistic towards patients when there is higher familiarity between physician and patient, as would be the case in the context of patient choice ($\lambda = 1$).

All else equal, the 'familiarity effect' might create a bias in the direction of lower sick-listing rates at emergency centres, counteracting the aforementioned patient selection bias. Notice, however, that the potential bias due to familiarity between physician and patient is in principle the same for both types of GPs (fixed salary and fee-for-service). The fact that we find a considerably stronger response to competition for fee-for-service GPs than for fixed-salary GPs suggests, in light of our theoretical model, that our results cannot be fully explained by such a bias.

However, we can address this issue more closely by restricting our sample to consultations involving only GPs with new practices, which we define as practices that have been run by the GP for at most 12 months. Since the number of GP practices within the NHS is regulated, these 'new practices' are mainly existing practices that have been taken over by another GP when the GP previously running the practice retired, moved, or for other reasons decided to give up the practice. In these cases, the GP who takes over the practice inherits the patient list of the previous GP. At least for the first few months, the degree of GP-patient familiarity in new practices should be very low. Thus, by restricting the sample to consultations involving GPs with new practices, it is reasonable to assume that we reduce any potential familiarity bias to the point where it becomes negligible.[41] Descriptive statistics of this sample are presented in Table A.6 in the Appendix.

The results from the estimation of (13), using the above described sample, are reported in Column 2 of Table 5. We see that the effect of competition on GPs with fee-for-service contracts is still highly significant and very similar in magnitude compared with the result from the main analysis (Column 1). In contrast, the point estimate for fixed-salary GPs is close to zero and also loses its statistical significance. These results suggest that, at least for GPs on fee-for-service contracts, our main results are not biased by any differences in GP-patient familiarity between GPs working in their own practice and in PCECs. If there is such a bias, it seems to affect almost exclusively the fixed-salary GPs, although the loss of precision in the estimate might be explained by the relatively low number of observations.

(ii) Another potential bias is related to *renewals of sickness certificates*. Since these are issued with a certain time limit, which can often be quite restricted, a certain share of the

[41] One potential caveat with this strategy is that GPs with new practices might have stronger incentives (than GPs with older practices) to adopt a more lenient sick-listing practice in order to prevent exits from the patient list. This might be the case if the switching cost of a patient is an increasing function of the time the patient has been on the GP's list.

total patient mass, in particular those with a more long-term disease, might visit a GP simply to have their sickness certificate renewed. If, for a given sickness episode, the probability of having a sickness certificate renewed is higher than the probability of obtaining the first sickness certificate, and if renewals of sickness certificates mainly take place at a regular GP practice, this could create a bias in the direction of higher sick listing by regular GPs, implying that our competition effects might be overestimated.

We correct for this potential bias by excluding consultations involving patients who were already on sick leave at the time of the consultation. The corresponding results are reported in Column 3 of Table 5, which reveal that the estimated coefficients are somewhat reduced in magnitude, suggesting that our main results might be slightly biased by including patients already on sick leave. Still, though, the effects of exposure to competition are relatively large, very precisely estimated, and significantly larger for fee-for-service GPs than for fixed-salary GPs.

(iii) A third potential bias stems from the possibility that given illness episode might involve *multiple ordered visits*, with a regular GP visit subsequent to a PCEC visit. We can think of two different sources of such an 'ordering bias'. First, there might be cases where a GP at an emergency centre asks the patient to visit the regular GP in order to get a sickness certificate. Such cases might potentially arise if the sickness certification decision is a borderline one, where the emergency centre GP is more comfortable leaving this decision to the patient's own GP. Second, a patient might visit an emergency centre at the start of an illness period and then, subsequently, go to the regular GP to obtain a sickness certificate only at the end of the self-certification period. In both cases, the ordering bias might contribute to our competition effects being overestimated.

We address the potential ordering bias by excluding consultations where the same patient visits a regular GP within a short period (eight days) of visiting an emergency centre.[42] The results from estimations of (13) with this sample restrictions are given in Column 4 of Table 5. The point estimates are highly significant and very similar in magnitude to the ones obtained

[42] Given the acute nature of the diagnoses considered, a window of eight days should be more than enough to exclude cases related to the first potential source of the ordering bias. Furthermore, since this window corresponds to the maximum length of the self-certification period, cases related to the second potential source of this bias is, by definition, also excluded.

from the main sample, which suggests that this bias is negligible.

(iv) A fourth potential bias is related to *sickness during vacations*. All else equal, the probability of attending an emergency centre instead of the regular GP is arguably higher during vacations, since patients are more likely to be away from home in these periods. If the demand for sickness certificates is also lower during vacations, this could create a bias that, once more, leads to overestimation of the competition effect. It should be stressed, though, that it is far from clear that the demand for sickness certificates is much lower during vacations. The reason is that employees in Norway are, under certain conditions, entitled to having their vacation postponed when becoming ill during vacation. For most of the period of our analysis, the conditions for having the vacation postponed are that the sickness certification is 'ungraded' (i.e., with a 100 percent replacement rate) and that the duration of the sickness spell is at least 6 working days.[43]

Nevertheless, we can address any concerns about a potential 'vacation bias' more directly by excluding consultations taking place in June/July and during Christmas and Easter, which are the main vacation periods in Norway. The results are given in Column 5 of Table 5 and we see that the estimated coefficients are practically unaffected by these exclusions, providing reassuring evidence that our main results are not affected by a potential vacation bias.

Finally, we also perform a different test for potential selection bias related to patient severity. There are several possible reasons why a patient might choose to attend a PCEC instead of attending her regular GP. One reason might be that the GP is temporarily unavailable. By including only daytime PCEC consultations on weekdays in which the patient's regular GP is not at the office, we can construct a subsample of consultations in which PCEC visits are, on average, more likely to be motivated by lack of regular GP availability.[44] This subsample is arguably less likely to suffer from selection bias related to patient severity, since the availability of a GP on a given weekday is clearly uncorrelated with the average severity level of the patients who happen to fall ill on that particular day. The estimated effects of competition, using this subsample, are presented in the sixth and final column of Table 5. Once more, the point estimates are quite similar to the estimates based on the main sample (Column 1), particularly for fee-

[43] The latter condition was abolished on July 1, 2014.

[44] In our sample we have 25,741 PCEC visits taking place during the normal opening hours of regular GPs. Around 55 percent of these visits took place on days in which the patient's regular GP did not work, which suggest that GP unavailability is an important reason why patients choose to attend PCECs.

for-service GPs. This serves as a further indication that our main results are not particularly affected by selection bias.

8.2 Heterogeneous effects

Our empirical strategy is based on the assumption that the main difference between emergency centre consultations and regular GP consultations, that is not controlled for in our empirical model, is the difference in GP-patient 'matching technology' for the two types of consultations, which implies that GPs are exposed to competition when they work in their own practice but not when they work at an emergency centre. If this assumption is correct, we would expect to find stronger effects of competition in situations where the *scope for competition* is larger. We assess the validity of our key identifying assumption by estimating our preferred empirical model on various subsamples that differ with respect to the scope for competition.

We start out by exploring the role of relative scarcity of GP supply. All else equal, it is reasonable to assume that the scope for competition is inversely related to GP scarcity, which prompts us to use the number of GPs per patients (in a given municipality) as a measure of the scope for competition. Notice that the number of GP practices in each municipality is set by a national regulator and is therefore exogenous to GP behaviour, which allows us to obtain exogenous variation in the scope for competition across different municipalities. After ranking all municipalities (with at least 10 GPs) according to the number of GPs per patient, we create three equally sized categories of municipalities and estimate (13) on each of these three subsamples separately. The results, reported in Table 6, show that the magnitude of the estimated competition effect is clearly correlated with the scope for competition (inversely measured by GP scarcity), and where the sign of this correlation has the expected sign. This applies particularly to fee-for-service GPs, where the estimated competition effect in municipalities with the lowest GP scarcity is, on average, 65 percent larger than the equivalent effect in municipalities with the highest GP scarcity. We take this as reassuring confirmation of the validity of our key identifying assumption.

[Table 6 here]

Another potential measure of the scope for competition is based on individual GP practice characteristics, more precisely whether the GP's patient list is full or not. As illustrated by our theoretical model, if competition leads to higher sick-listing rates, as we find in our empirical analysis, this result is driven by each GP's desire to attract more patients. Since it is only possible for GPs with open patient lists to attract new patients, we would expect that the effect of competition is primarily driven by the behaviour of these GPs.[45] However, a naïve comparison of competition effects for GPs with open versus closed patient lists is susceptible to an obvious endogeneity problem, since a closed patient list might be a result of high demand because of a lenient sick-listing practice. We can deal with this endogeneity by once more considering only GPs with new practices, whose current demand does not depend on previous behaviour (by the same GP).

[Table 7 here]

In Table 7 we report the results from estimating (13) on two sub-samples of GPs with new practices, defined according to whether or not the patient list is open. The results are clearly in line with our initial conjectures. Regardless of whether we consider only GPs with closed lists or only GPs with open lists, the competition effect is significantly stronger for fee-for-service GPs than for fixed-salary GPs. Furthermore, whether we consider only fee-for-service GPs or only fixed-salary GPs, the competition effect is significantly stronger for GPs with open lists than for GPs with closed lists. Interestingly, though the estimate is based on relatively few observations, fixed-salary GPs with closed patient lists respond to competition by adopting a significantly *stricter* sicklisting practice. Once more, we take these results as confirmation of the validity of our empirical strategy for identification.

8.3 A placebo test

Our empirical identification strategy is based on the assumption that GPs have incentives to behave differently when GP-patient matching is based on patient choice than when it is random. In other words, GPs have incentives to adopt a different practice style towards patients in their own practice than towards randomly matched patients at an emergency centre. However, this

[45] This does not mean GPs with closed patient lists are unaffected by competition, since GP behaviour might also be motivated by the desire to avoid losing existing patients. However, it seems entirely plausible that competition has a *lower* impact on the behaviour of GPs that are capacity constrained.

logic does not apply in cases where a randomly matched patient at an emergency centre happens to be one of the GP's own list patients. In these cases, it is reasonable to assume that the GP's behaviour might affect the patient's decision to remain on the GP's list, and that the GP takes this into account in the sick-listing decision. Thus, all else equal, we would not expect GPs' behaviour towards their own list patients to depend on the physical premises in which the consultations takes place (own GP practice versus emergency centre), which is why consultations with the GP's own list patients at emergency centres were excluded from the main sample.

In order to test the above logic, we restrict our sample such that consultations at emergency centres *only* include the GPs' own list patients and re-estimate (13) using this restricted sample. As argued above, this sample restriction should in principle eliminate the competition effect and we can therefore interpret it as a placebo test of our identification strategy. If, by using this restricted sample, we obtain results similar to the ones reported in Table 4, then our main results must be explained by some other (unobserved) differences between the two consultation types that are not related to competition.[46]

[Table 8 here]

Estimation results from the restricted sample (using both GP and patient fixed effects) are presented in Table 8. We see that the difference in sick-listing probabilities for the two consultation types vanishes for fixed-salary GPs and is dramatically reduced (from 12 to 4 percentage points) for fee-for-service GPs. These results serve as added confirmation that our identification strategy is capturing a competition effect with a fairly high degree of precision. It is also quite plausible that the remaining difference (of 4 percentage points) in sick-listing rates between GP practice consultations and PCEC consultations can be explained by the fact that a GP working at an emergency centre might not always recognise his own list patients when they are randomly allocated to him. A failure to recognise own list patients should be particularly likely for GPs with relatively large patient lists. We explore this hypothesis by splitting the sample of consultations (from which the results in Table 8 are derived) according to whether the GPs' actual list size is above or below the average list size (1350 patients). The estimated results from these two sub-samples are presented in the second and third columns of Table 8 and

[46] Notice that our results in Section 8.1 (Table 5) rule out 'familiarity bias' as a potential explanation of our main results.

show that, although the estimated coefficient is (weakly) significant for fee-for-service GPs in both subsamples, the magnitude of the coefficient is smaller for GPs with shorter patient lists, which serves as partial confirmation of our hypothesis.

9 Concluding remarks

In this paper we study the impact of competition among physicians on their service provision, and how this relationship depends on financial incentives. Despite the fact that almost every country has a market-based allocation of physician services, compelling empirical evidence on the effects of competition is sparse. A key challenge is to obtain exogenous variation in the degree of competition in physician markets. In this paper we address this challenge by exploiting the fact that many GPs, in addition to their regular practice, work in primary care emergency centres. This allows us to observe the same GP in two different competitive environments: (i) with competition (regular practice) and (ii) without competition (emergency centre). Thus, our empirical strategy is to exploit within-GP variation in the degree of competition, using the GP's service provision at the emergency centre as a benchmark to identify the effect of competition.

From rich administrative data with detailed patient level information in Norway over nine years (2006 to 2016), we select a sample of the ten most frequent acute diagnoses treated by GPs. As the outcome variable we use the GPs' propensity to certify (paid) sick leave to patients, which is a highly frequent and standardised 'treatment' for acute diagnoses. Our main empirical finding is that GPs are more likely to issue sickness certificates to patients that visit them at their regular practice than at the emergency centre. The strength of this effect depends crucially on the GPs' financial incentives. Estimates from our preferred empirical model show that GPs with an activity-based (i.e., combination of fee-for-service and capitation) contract are 12 percentage points more likely to offer a sick leave to their patients in their regular practice than at the emergency centre. For GPs with fixed-salary contracts, the corresponding figure is only 8 percentage points. We therefore conclude that exposing GPs to competition has a positive impact on their propensity to sick list patients, which is strongly reinforced by high-powered activity-based financial incentives.

Although our empirical strategy allows us to identify exogenous variation in the degree of physician competition, a remaining challenge is to control for other factors (than competition) that may affect the GPs' service provision in the two competitive environments. The detail and richness of our data allow us to estimate a high-dimensional fixed effect model controlling for (observed and unobserved) time-invariant patient, GP and diagnosis heterogeneity, in addition to a wide set of observable patient and GP characteristics. In order to deal with potential estimation biases stemming from any remaining (time-variant) heterogeneity, we first establish the likely direction of the most obvious bias, namely that patient severity is likely to be higher at emergency centres than at GP practices, all else equal. This suggests that we *underestimate* the true effects of competition and therefore serves as a validation of the qualitative nature of our results. As a further validation, we carefully re-estimate our empirical model varying the sample selection criteria in order to account for any conceivable remaining biases caused by unobserved heterogeneity. Reassuringly, our main results hold up well when being exposed to such a falsification exercise.

Finally, we also validate our results and empirical strategy by testing if our results vary according to different measures of the *scope for competition*. In line with our predictions, we find that the effects of competition are considerably larger (i) in municipalities with more GPs (measured by the number of GPs per patient) and (ii) for GPs with spare capacity (i.e., GPs with open patient lists).

Our main results accord with the predictions from a dynamic model of semi-altruistic physicians who face demand that evolves over time depending on their chosen practice styles (i.e., their leniency towards issuing sickness certificates). A key insight from this model is that the response to competition from a salaried GP is *a priori* ambiguous and depends on the degree of altruism. Our finding of a positive effect of competition also for this type of GPs suggests that GP preferences are characterised by a sufficient degree of altruism.

Although our results are consistent with a scenario where GP preferences are similar across different payment schemes (which is the assumption in our theoretical model), the relatively small difference between the responses of the two GP types might also be partly explained by self-selection of more profit-oriented GPs into fee-for-service payment schemes. Compared with having a salaried position, being a self-employed GP (with fee-for-service and capitation payment) is potentially much more profitable but also entails much more risk. It might therefore be the case that more profit-oriented GPs tend to select themselves into self-employed practices, implying that the average degree of altruism is relatively higher among salaried GPs. However, absent any observable proxy for GP altruism, it is not possible to test this hypothesis directly.

The welfare effects and thus policy implications of our findings are not clear-cut. On the one hand, exposing GPs to (more) competition leads to more sick listing, which results in higher expenditures for the employer and the social insurance scheme. In addition, sickness absence has a direct negative impact on labour market productivity, all else equal. On the other hand, sick leave improves patients' utility by allowing them to not show up at work when ill and in most cases improving their recovery from illness. This may also have an indirect positive effect on labour market productivity given that their health condition is improved. While competition induces the GPs to become more lenient, we cannot say whether they are too lenient from a social welfare perspective. One could possibly argue that the treatment at emergency centres, where a GP's sick listing is not distorted by competition, defines a 'gold standard' given that GPs in this case act as perfect gatekeepers, balancing patient utility and societal expenditures. However, absence of competition may also involve adverse treatment effects, for instance due to low diagnosing efforts by GPs.

The above discussion illustrates a more general insight, namely that non-price competition can be excessive and lead to overutilisation of resources, from a social welfare perspective, when the costs of these resources are not fully internalised in the market. In the case of sick listing, the costs are not (fully) borne by either the physician or the patient. In general, the potential for competition-driven overutilisation of resources exists for any non-price dimension along which physicians compete. Our empirical results indicate that the effect of competition on physician behaviour is of sizeable magnitude. Furthermore, we show that these effects are significantly interlinked with the financial incentives inherent in different physician payment schemes. These results suggest that policies towards competition and patient choice in primary care markets should be seen in conjunction with the design of the physician payment schemes, and that the appropriate policy response to adverse competition effects might be to redesign payment schemes rather than to restrict patient choice.

A complete welfare analysis of the effect of physician competition requires a careful estimation on the effects on expenditures and patient utility (including health outcomes and labour market productivity). Unfortunately, our data do not allow for this, so we leave this issue for future research.

Appendix

Variation in regular GPs' patient list size

Table A.1 shows the variation in preferred and actual patient list size for regular GPs during the period 2007-2014.

[Table A.1 here]

The open-loop solution of the theory model in Section 4

Defining ρ as the rate of time preference, the dynamic optimisation problem of GP i is given by

$$\max_{\beta_i(t)} \int_0^{+\infty} \Omega_i(t) e^{-\rho t} dt, \tag{A1}$$

subject to the dynamic constraint[47]

$$\dot{x}(t) = \gamma\left(\widehat{x}(t) - x(t)\right) \tag{A2}$$

and the initial condition

$$x(0) = x_0 > 0. \tag{A3}$$

Let $\mu_i(t)$ denote the current-value co-state variable associated with the state equation (A2). The current-value Hamiltonian is then given by[48]

$$H_i = \pi_i + \alpha V_i - \frac{k}{2}\beta_i^2 + \mu_i \gamma\left(\frac{1}{2} + \frac{(1-\eta)\left(\beta_i - \beta_j\right)}{2\tau} - x\right). \tag{A4}$$

[47] Since total demand is fixed, both GPs face the same dynamic constraint; i.e., the demand dynamics for GP i automatically determine the demand for GP j.

[48] In order to save space, we henceforth drop the time indicator t.

The optimal solution must satisfy the following three conditions:

$$\frac{\partial H_i}{\partial \beta_i} = \frac{(1-\eta)\left(\alpha\tau\left(1-\lambda+2\lambda x\right)+\mu_i\gamma\right)}{2\tau} - k\beta_i = 0, \tag{A5}$$

$$\dot{\mu}_i = \rho\mu_i - \frac{\partial H_i}{\partial x} = (\rho+\gamma)\,\mu_i - \lambda\left(\left((1-\theta)\,p-c\right)+\alpha\left(\frac{1}{2}-\tau x-(1-\eta)\,\widehat{s}_i\right)\right), \tag{A6}$$

$$\dot{x} = \frac{\partial H_i}{\partial \mu_i} = \gamma\left(\frac{1}{2}+\frac{(1-\eta)\left(\beta_i-\beta_j\right)}{2\tau}-x\right), \tag{A7}$$

in addition to the transversality condition $\lim_{t\to+\infty} e^{-\rho t}\mu_i(t)\,x(t) = 0$. The second-order conditions are satisfied if the Hamiltonian is concave in its control and state variables, which requires $k > \frac{\alpha\lambda}{\tau}(1-\eta)^2$.

Time-differentiation of (A1) yields

$$(1-\eta)\left(\alpha\lambda\dot{x}+\frac{\gamma}{2\tau}\dot{\mu}_i\right) - k\dot{\beta}_i = 0. \tag{A8}$$

Substituting in (A8) for $\dot{\mu}_i$ from (A6), $\dot{x}$ from (A7) and using μ_i from (A5), we arrive at

$$\dot{\beta}_i = \frac{1}{4k\tau}\left(\begin{array}{c}(1-\eta)\left(\alpha\left(\lambda\gamma\left(2\sigma(1-\eta)-1\right)+2\tau\left(\lambda(2\gamma+\rho)-(\gamma+\rho)\right)\right)-2\lambda\gamma\left((1-\theta)\,p-c\right)\right)\\ +4k\tau(\gamma+\rho)\,\beta_i-2\alpha\lambda\gamma(1-\eta)^2\beta_j-2\alpha\lambda\tau(1-\eta)(3\gamma+2\rho)\,x\end{array}\right). \tag{A9}$$

which, together with (A7), describes the dynamics of the equilibrium.[49] The symmetric steady-state GP practice style, given by (10) in Section 4, is found by setting $\dot{\beta}_i = 0$, $\beta_i = \beta_j$ and $x = \frac{1}{2}$.

List of variables

The variables used in the estimation of (13) are listed and defined in Table A.2.

[Table A.2 here]

[49] It is straightforward to verify that the second-order condition $k > \frac{\alpha\lambda}{\tau}(1-\eta)^2$ is also sufficient to ensure saddle-point stability of the open-loop solution.

Characteristics of patients who receive (or not) a sickness certificate

In Table A.3 we report patient characteristics for two different categories of consultations, defined according to whether or not a sickness certificate is issued.

[Table A.3 here]

Share of consultations where patients are hospitalised

Table A.4 shows, for each diagnosis and for each consultation type, the share of consultations involving patients who are registered with a hospital stay in the same week as the primary care consultation.

[Table A.4 here]

Regression results per diagnosis

Table A.5 presents the results from separate estimations of (13) for each of the ten diagnoses listed in Table 1. For space-saving purposes, only the independent variables of interest are included in the table.

[Table A.5 here]

Descriptive statistics for GPs with new practices

Table A.6 displays descriptive statistics for the subset of consultations involving GPs with new ($\leq$ 12 months) practices.

[Table A.6 here]

References

[1] Brekke, K.R., Nuscheler, R., Straume, O.R., 2007. Gatekeeping in health care. Journal of Health Economics, 26, 149–170.

[2] Brekke, K.R., Cellini, R., Siciliani, L., Straume, O.R., 2012. Competition and quality in regulated markets with sluggish demand. Journal of Economics & Management Strategy, 21, 131–178.

[3] Brekke, K.R., Holmås, T.H., Monstad, K., Straume, O.R., 2017. Do treatment decisions depend on physicians' financial incentives? Journal of Public Economics, 155, 74–91.

[4] Clemens, J., Gottlieb, J.D., 2014. Do physicians' financial incentives affect medical treatment and patient health? American Economic Review, 104, 1320–1349.

[5] Correia, S., 2014. REGHDFE: Stata module to perform linear or instrumental-variable regression absorbing any number of high-dimensional fixed effects. Statistical Software Components S457874, Boston College Department of Economics.

[6] Correia, S., 2015. Singletons, cluster-robust standard errors and fixed effects: A bad mix. Duke University, mimeo.

[7] Devlin, R.A., Sarma, S., 2008. Do physician remuneration schemes matter? The case of Canadian family physicians. Journal of Health Economics, 27, 1168–1181.

[8] Dusheiko, M., Gravelle, H., Jacobs, R., Smith, P., 2006. The effect of financial incentives on gatekeeping doctors: evidence from a natural experiment. Journal of Health Economics, 25, 449–78.

[9] Dunn, A., Shapiro, A.H., 2014. Do physicians possess market power? Journal of Law and Economics, 57, 159–193.

[10] Fevang, E., Markussen, S., Røed, K., 2014. The sick pay trap. Journal of Labor Economics, 32, 305–336.

[11] Gaynor, M., Town, R., 2011. Competition in Health Care Markets. Chapter 9 in Pauly, M., McGuire, T., Barros, P.P., (eds.), Handbook of Health Economics, Vol. 2, pp. 439–637. Elsevier, Amsterdam.

[12] Godager, G., Iversen, T., Ma, C.A., 2015a. Competition, gatekeeping, and health care access. Journal of Health Economics, 39, 159–170.

[13] Godager, G., Iversen, T., Morken, T., Hunskår, S., 2015b. Fixed salary for doctors in emergency primary health care in Norway. Report No. 4-2015. Bergen: National Centre for Emergency Primary Health Care, Uni Research Health.

[14] Gonzalez, P., 2010. Gatekeeping versus direct-access when patient information matters. Health Economics, 19, 730–54.

[15] Gravelle, H., Scott, A., Sivey, P., Yong, J., 2016. Competition, prices and quality in the market for physician consultations. Journal of Industrial Economics, 64, 135–169.

[16] Gruber, J., Owings, M., 1996. Physician financial incentives and cesarean section delivery. RAND Journal of Economics, 27, 99–123.

[17] Iversen, T., 2004. The effects of patient shortage on general practitioners' future income and list of patients. Journal of Health Economics, 23, 673–694.

[18] Iversen, T., Lurås, H., 2000. Economic motives and professional norms: the case of general medical practice. Journal of Economic Behavior & Organization, 43, 447–470.

[19] Iversen, T., Ma, C.A., 2011. Market conditions and general practitioners' referrals. International Journal of Health Care Finance and Economics, 11, 245–265.

[20] Jacobson, M., Chang, T.Y., Newhouse, J.P., Earle, C.C., 2013. Physician agency and competition: evidence from a major change to Medicare chemotherapy reimbursement policy. NBER Working Paper 19247, National Bureau of Economic Research.

[21] Kessler, D., McClellan, M., 2000. Is hospital competition socially wasteful? Quarterly Journal of Economics, 115, 577–615.

[22] Markussen, S., Røed, K., 2017. The market for paid sick leave. Journal of Health Economics, 55, 244–261.

[23] McGuire, T.G., 2000. Physician agency. Chapter 9 in Culyer, A.J., Newhouse, J.P. (ed.), Handbook of Health Economics, Vol. 1, pp. 461–536, Elsevier, Amsterdam.

[24] Sandvik, H., Hunskår, S., Diaz, E., 2012. Use of emergency medical services by patients encompassed by the Regular GP scheme. Tidsskrift for den Norske laegeforening: tidsskrift for praktisk medicin, ny raekke, 132, 2272–2276.

[25] Santos, R., Gravelle, H., Propper, C., 2017. Does quality affect patients' choice of doctor? Evidence from England. Economic Journal, 600, 445–494.

[26] Schneider, J., Li, P., Klepser, D., Peterson, A., Brown. T., Scheffler, R., 2008. The effect of physician and health plan market concentration on prices in commercial health insurance markets. International Journal of Health Care Finance and Economics, 8, 13–26.

Tables

Table 1. The ten most frequent diagnoses at primary care emergency centres 2007-2014 (employed patients only).

ICPC-2	Diagosis	Number of visits
A11	Chest pain NOS[1]	61,255
D01	Abdominal pain/cramps general	134,012
L81	Injury musculoskeletal NOS	71,390
R05	Cough	56,930
R74	Upper respiratory infection acute	174,812
R75	Sinusitis acute/chronic	87,081
R76	Tonsillitis acute	56,763
R78	Acute bronchitis/bronchiolitis	57,819
S18	Laceration/cut	153,081
U71	Cystitis/urinary infection other	182,994

[1] NOS: not otherwise specified

Table 2. Visits excluded from the sample (as percentage of all visits to primary care physicians).

	All visits[1]	Patient not in work	Physician not regular GP	Patient visiting other GP[2]	Patient sent to hospital[3]	Inconsistent info on GP salary type[4]	Visits at night (11:00-08:00)	Patient's GP at emergency centre[5]	Small munici-palities[6]	Final sample
Chest pain	290,557	32.11	32.29	22.57	21.25	0.42	8.50	0.30	21.65	75,578
Abdominal pain/cramps	845,866	31.59	26.47	24.47	13.79	0.41	5.55	0.25	21.84	257,697
Injury musculoskeletal	349,593	23.02	22.77	23.79	19.39	0.67	3.24	0.36	27.72	107,475
Cough	682,527	26.96	24.33	35.40	0.009	0.41	0.96	0.20	24.65	228,285
Upper respiratory infection	1,268,854	18.16	25.82	35.75	0.008	0.36	1.02	0.24	20.35	479,105
Sinusitis acute/chronic	688,042	19.16	22.06	31.68	0.007	0.46	0.79	0.31	22.90	267,755
Tonsillitis acute	192,812	18.21	28.51	30.72	0.035	0.57	1.94	0.36	21.33	66,356
Acute bronchitis/bronchiolitis	562,904	26.37	19.11	28.93	0.010	0.34	1.13	0.35	23.89	206,722
Laceration/cut	321,922	27.40	40.07	23.14	0.061	0.49	11.40	0.57	27.54	68,461
Cystitis/urinary infection, other	833,483	30.32	29.54	31.98	0.019	0.48	2.86	0.33	22.48	235,916
All diagnoses	6,036,580	25.04	26.18	30.34	0.052	0.43	2.96	0.30	22.86	1,993,350

[1] Patients enlisted to a GP (99.6 % of the Norwegian population). [2] Visit to a GP other than the one the patient is enlisted to. [3] Emergency admission to hospital the same week as the visit to primary care physician. [4] Visit to a GP who is registered with both fee-for-service and fixed-salary contracts in the same month. [5] Visits where a patient meets her/his GP at the emergency ward. [6] Municipalities with less than 10 GPs.

Table 3. Descriptive statistics per consultation type (all diagnoses)

	Regular GP (fee-for-service)	Regular GP (fixed salary)	Emergency centre
Consultation characteristics			
Sickness certificate	0.365	0.269	0.140
Prolonged consultation	0.197	0.192	0.175
Patient characteristics			
Male	0.374	0.328	0.386
Age	41.188 (12.477)	36.045 (12.991)	37.722 (12.394)
Visits last year	2.482 (2.377)	2.182 (2.171)	2.135 (2.338)
Low education	0.212	0.180	0.218
Medium education	0.423	0.370	0.439
High education	0.368	0.450	0.342
Labour income	40.244 (25.013)	31.957 (20.640)	38.062 (25.124)
White collar	0.455	0.339	0.413
Married	0.451	0.355	0.404
Unmarried	0.399	0.544	0.473
Divorced	0.149	0.101	0.123
Children 0-5	0.210	0.181	0.246
Children 6-17	0.215	0.151	0.210
GP characteristics			
Male	0.688	0.500	0.774
Age	50.112 (9.661)	47.741 (11.944)	43.355 (8.811)
Specialist	0.687	0.567	0.495
Observations	1,771,724	24,352	197,274
Patients	788,355	14,965	169,413
GPs	3,786	175	2,652

Table 4. Effect of competition on GP sick listing.

	OLS (1)	Fixed effect GP (2)	Fixed effect Patient (3)	Fixed effect GP and patient (4)
Regular GP (fee-for-service)	0.1392***	0.1436***	0.1151***	0.1183***
	(0.0062)	(0.0045)	(0.0048)	(0.0044)
Regular GP (fixed salary)	0.0592***	0.1062***	0.0706***	0.0825***
	(0.0117)	(0.0152)	(0.0096)	(0.0131)
Prolonged consultation	-0.0033	-0.0108***	-0.0001	-0.0009
	(0.0022)	(0.0015)	(0.0018)	(0.0019)
Visits last year	0.0105***	0.0093***	-0.0020***	-0.0020***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Male	-0.0181***	-0.0182***		
	(0.0013)	(0.0011)		
Age	-0.0018***	-0.0015***		
	(0.0001)	(0.0001)		
Medium education	-0.0477***	-0.0376***		
	(0.0013)	(0.0012)		
High education	-0.0687***	-0.0613***		
	(0.0017)	(0.0014)		
Labour income	0.0001**	0.0000	0.0021***	0.0020***
	(0.0000)	(0.0000)	(0.0004)	(0.0004)
White collar	-0.0288***	-0.0299***		
	(0.0011)	(0.0010)		
Unmarried	0.0149***	0.0154***	0.0074	0.0068
	(0.0014)	(0.0011)	(0.0042)	(0.0042)
Divorced	0.0353***	0.0321***	0.0150***	0.0150***
	(0.0014)	(0.0013)	(0.0044)	(0.0044)
Children 0-5	-0.0240***	-0.0241***	-0.0302***	-0.0290***
	(0.0014)	(0.0012)	(0.0028)	(0.0028)
Children 6-17	-0.0050***	-0.0025*	-0.0117***	-0.0105***
	(0.0013)	(0.0011)	(0.0026)	(0.0026)
GP age	0.0001		0.0003*	
	(0.0002)		(0.0002)	
GP male	-0.0205***		-0.0172***	
	(0.0036)		(0.0025)	
GP specialist	0.0026	-0.0044	0.0011	-0.0033
	(0.0044)	(0.0028)	(0.0027)	(0.0036)
Observations	1,993,350	1,993,306	1,554,107	1,554,042
Dropped singleton observations	0	44	439,243	439,308
Patients	883,881	883,857	444,639	444,620
GPs	4,264	4,220	4,230	4,183
Time fixed effects[1]	Yes	Yes	Yes	Yes
Diagnoses fixed effects	Yes	Yes	Yes	Yes
Prob > F^2	0.000	0.012	0.000	0.005
R^2 adjusted	0.126	0.159	0.319	0.323
R^2 within	-	0.088	0.047	0.046

[1] Dummy variables for year, month, week and hour. [2] F-test: Reg. GP (fee-for-service) = Reg. GP (fixed salary)

***, **, *: significant at 0.1, 1 and 5 percent level. Standard errors clustered at the GP level.

Table 5. Effect of competition on GP sick listing: Sensitivity analyses.

	Main sample (1)	GPs with new practices (2)	Excluding patients already on sick leave (3)	Excluding emergency care visits with a subsequent GP visit (4)	Excluding visits in July/August and Easter/ Christmas (5)	Only daytime emergency care visits when patient's GP is unavailable (6)
Regular GP (fee-for-service)	0.1183***	0.1140***	0.0938***	0.1120***	0.1125***	0.1098***
	(0.0044)	(0.0233)	(0.0045)	(0.0044)	(0.0052)	(0.0071)
Regular GP (fixed salary)	0.0825***	-0.0027	0.0655***	0.0767***	0.0804***	0.0908***
	(0.0131)	(0.0685)	(0.0133)	(0.0131)	(0.0154)	(0.0242)
Observations	1,554,042	63,352	1,367,288	1,539,848	1,230,280	1,391,852
Dropped singleton obs.	439,308	85,907	441,392	440,888	420,308	401,220
Patients	444,620	24,520	413,718	442,170	373,293	402,742
GPs	4,183	1,536	4,176	4,180	4,144	3,970
Time fixed effects[1]	Yes	Yes	Yes	Yes	Yes	Yes
GP fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Patient fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Diagnoses fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Prob > F[2]	0.005	0.081	0.028	0.006	0.031	0.420
R^2 *adjusted*	0.323	0.379	0.324	0.324	0.327	0.324
R^2 *within*	0.046	0.034	0.053	0.047	0.047	0.046

[1] Dummy variables for year, month, week and hour. [2] F-test: Reg. GP (fee-for-service) = Reg. GP (fixed salary).

***, **, *: significant at 0.1, 1 and 5 percent level. Standard errors clustered at the GP level.

Table 6. Effect of competition on GP sick listing: Number of GPs per patients (in 1000).

	Less than 0.79 GPs per 1000 patients (1)	Between 0.79 and 0.87 GPs per 1000 patients (2)	More than 0.87 GPs per 1000 patients (3)
Regular GP (fee-for-service)	0.0943***	0.1386***	0.1561***
	(0.0066)	(0.0062)	(0.0096)
Regular GP (fixed salary)	0.0457	0.0970***	0.0866***
	(0.0280)	(0.0154)	(0.0294)
Observations	830,422	700,111	226,755
Dropped singleton observations	238,479	224,338	123,485
Patients	236,401	204,341	66,293
GPs	1,991	2,385	971
Time fixed effects[1]	Yes	Yes	Yes
GP fixed effects	Yes	Yes	Yes
Patient fixed effects	Yes	Yes	Yes
Diagnoses fixed effect	Yes	Yes	Yes
Prob > F[2]	0.078	0.004	0.014
R^2 *adjusted*	0.331	0.312	0.311
R^2 *within*	0.053	0.039	0.036

[1] Dummy variables for year, month, week and hour. [2] F-test: Reg. GP (fee-for-service) = Reg. GP (fixed salary).
***, **, *: significant at 0.1, 1 and 5 percent level. Standard errors clustered at the GP level.

Table 7. Effect of competition on GP sick listing: GPs with new practices; open vs. closed lists.

	Closed patient list (1)	Open patient list (2)
Regular GP (fee-for-service)	-0.2727	0.0907***
	(0.2969)	(0.0257)
Regular GP (fixed salary)	-0.7252**	0.0373
	(0.2478)	(0.0934)
Observations	10,134	51,041
Dropped singleton observations	15,361	72,723
Patients	4,039	19,735
GPs	291	1,255
Time fixed effects[1]	Yes	Yes
GP fixed effects	Yes	Yes
Patient fixed effects	Yes	Yes
Diagnoses fixed effect	Yes	Yes
Prob > F[2]	0.002	0.565
R^2 *adjusted*	0.363	0.384
R^2 *within*	0.029	0.034

[1] Dummy variables for year, month, week and hour. [2] F-test: Reg. GP (fee-for-service) = Reg. GP (fixed salary).
***, **, *: significant at 0.1, 1 and 5 percent level. Standard errors clustered at the GP level.

Table 8. Effect of competition on GP sick listing: GPs' own list-patients only.

	All GPs (1)	List length < 1350 patients (2)	List length >= 1350 patients (2)
Regular GP (fee-for-service)	0.0398***	0.0345*	0.0490**
	(0.0127)	(0.0176)	(0.0196)
Regular GP (fixed salary)	0.0163	0.0095	0.0343
	(0.0277)	(0.0449)	(0.0362)
Observations	1,403,467	645,459	708.092
Dropped singleton observations	398,929	231,725	217,120
Patients	404,315	196,389	205,232
GPs	3,900	2,898	1,507
Time fixed effects[1]	Yes	Yes	Yes
GP fixed effects	Yes	Yes	Yes
Patient fixed effects	Yes	Yes	Yes
Diagnoses fixed effect	Yes	Yes	Yes
Prob > F[2]	0.352	0.555	0.632
R^2 *adjusted*	0.324	0.328	0.331
R^2 *within*	0.046	0.045	0.042

[1] Dummy variables for year, month, week and hour. [2] F-test: Reg. GP (fee-for-service) = Reg. GP (fixed salary).
***, **, *: significant at 0.1, 1 and 5 percent level. Standard errors clustered at the GP level.

Table A.1. Variation in preferred and actual patient list size for regular GPs

	Mean	Std.Dev.
Regular GP (fee-for-service)		
Preferred list size	1288.6	
Between		351.1
Within		95.2
Actual list size	1231.0	
Between		386.6
Within		111.0
Regular GP (fixed salary)		
Preferred list size	974.1	
Between		304.6
Within		116.3
Actual list size	849.5	
Between		319.2
Within		126.7

Table A.2. Variable definitions

Consultation characteristics	
Regular GP (fee-for-service)	1 if visit to regular GP on fee-for-service contract
Regular GP (fixed salary)	1 if visit to regular GP on fixed-salary contract
Emergency centre	1 if visit at a primary care emergency center
Sickness certificate	1 if the physician issues a sickness certificate during consultation
Prolonged consultation	1 if the consultation is prolonged (beyond 20 minutes)
GP characteristics	
Male	1 if the GP is male
Age	Age of GP
Specialist	1 if the GP is specialist in general practice
Patient characteristics	
Male	1 if the patient is male
Age	Patient's age
Low education	1 if compulsory schooling
Medium education	1 if upper secondary education
High education	1 if higher education
Labour income	Patient's labour income (in 10,000 NOK)
Married	1 if the patient is married
Unmarried	1 if the patient is unmarried
Divorced	1 if the patient is divorced/widow/widower
Children 0-5	1 if the patient has children 0-5 years old
Children 6-17	1 if the patient has children 6-17 years old
Visits last year	Number of visits to GP or emergency centre last year

Table A.3. Descriptive statistics of patients in consultations with and without sickness certification

	Consultations with sickness certification	Consultations without sickness certification
Patient characteristics		
Male	0.383	0.371
Age	39.818 (12.070)	41,282 (12.732)
Visits last year	2.602 (2.331)	2.362 (2.391)
Low education	0.251	0.192
Medium education	0.423	0.422
High education	0.326	0.386
Labour income	38.794 (18.475)	40.514 (27.766)
White collar	0.409	0.471
Married	0.411	0.463
Unmarried	0.437	0.394
Divorced	0.152	0.143
Children 0-5	0.214	0.213
Children 6-17	0.209	0.217
Observations	680,462	1,312,888
Patients	379,340	714,941

Table A.4. Percentage of patients sent to hospital, by type of consultation.

	Emergency centre		Regular GP (fee-for-service)		Regular GP (fixed salary)	
	All visits	% sent to hospital	All visits	% sent to hospital	All visits	% sent to hospital
Chest pain	85,093	42.6	135,941	9.4	7,181	16.8
Abdominal pain/cramps	163,396	40.1	460,773	6.1	23,114	9.1
Injury musculoskeletal	72,097	45.7	188,101	9.9	10,840	16.9
Cough	63,020	2.2	368,441	0.7	18,991	0.9
Upper respiratory infection	170,970	1.8	632,020	0.6	28,116	0.7
Sinusitis acute/chronic	89,534	1.2	373,425	0.6	15,698	0.6
Tonsillitis acute	49,639	6.2	82,353	2.3	3,808	3.5
Acute bronchitis/bronchiolitis	66,856	2.4	356,515	0.8	11,782	1.1
Laceration/cut	160,273	7.2	83,762	4.8	8,182	5.3
Cystitis/urinary infection, other	200,590	3.3	356,515	1.4	21,616	1.5
All diagnoses	1,121,468	14.5	3,008,728	2.7	149,328	4.4

Table A.5. Effect of competition on GP sick listing, by diagnoses. GP, patient and time fixed effect models.

Diagnoses:	A11	D01	L81	R05	R74
Regular GP (fee-for-service)	0.0908	0.1065***	0.2194**	0.0827***	0.1612***
	(0.0620)	(0.0198)	(0.0705)	(0.0226)	(0.0139)
Regular GP (fixed salary)	-0.1941	0.1035*	0.3194***	0.1362	0.1543***
	(0.3125)	(0.0584)	(0.0911)	(0.1042)	(0.0423)
Observations	33,180	160,277	63,826	107,358	262,096
Dropped singleton observations	42,398	97,420	43,649	120,927	217,009
Patients	12,100	53,042	18,504	41,142	94,880
GPs	2,738	3,713	2,981	3,481	3,731
Prob>F	0.356	0.956	0.090	0.604	0.868
R^2 *adjusted*	0.407	0.377	0.350	0.324	0.320
R^2 *within*	0.002	0.003	0.003	0.002	0.004

Diagnoses:	R75	R76	R78	S18	U71
Regular GP (fee-for-service)	0.1099***	0.0647	0.1267***	0.1126***	0.0340***
	(0.0144)	(0.0568)	(0.0263)	(0.0338)	(0.0069)
Regular GP (fixed salary)	0.1228*	-0.2502	-0.0631	0.0704	0.0195
	(0.0610)	(0.2111)	(0.1371)	(0.1371)	(0.0211)
Observations	153,869	23,929	110,440	21,204	139,343
Dropped singleton observations	113,886	42,427	96,282	47,257	96,573
Patients	52,239	9,759	40,012	7,819	47,766
GPs	3,693	2,113	3,218	2,401	3,832
Prob> F	0.832	0.145	0.163	0.759	0.488
R^2 *adjusted*	0.304	0.204	0.304	0.262	0.212
R^2 *within*	0.003	0.004	0.002	0.006	0.007

***, **, *: significant at 0.1, 1 and 5 percent level.

Table A.6. Descriptive statistics per consultation type, GPs with new practices.

	Regular GP (fee-for-service)	Regular GP (fixed salary)	Emergency centre
Consultation characteristics			
Sickness certificate	0.351	0.268	0.131
Prolonged consultation	0.259	0.212	0.218
Patient characteristics			
Male	0.371	0.316	0.378
Age	39.722 (12.770)	34.277 (12.487)	37.611 (12.340)
Visits last year	2,541 (2.375)	2.307 (2.279)	2.155 (2.325)
Low education	0.223	0.182	0.221
Medium education	0.416	0.377	0.437
High education	0.361	0.441	0.343
Labour income	38.620 (23.821)	30.426 (19.943)	38.297 (24.672)
Married	0.417	0.320	0.403
Unmarried	0.441	0.592	0.472
Divorced	0.142	0.089	0.124
Children 0-5	0.213	0.181	0.251
Children 6-17	0.188	0.126	0.207
GP characteristics			
Male	0.582	0.476	0.738
Age	37.854 (7.060)	37.325 (6.511)	36.712 (6.586)
Closed patient list	0.229	0.134	0.121
Specialist	0.168	0.194	0.120
Observations	112,494	3,602	33,163
Patients	77,598	2,846	32,157
GPs	1,431	98	1,243

Figures

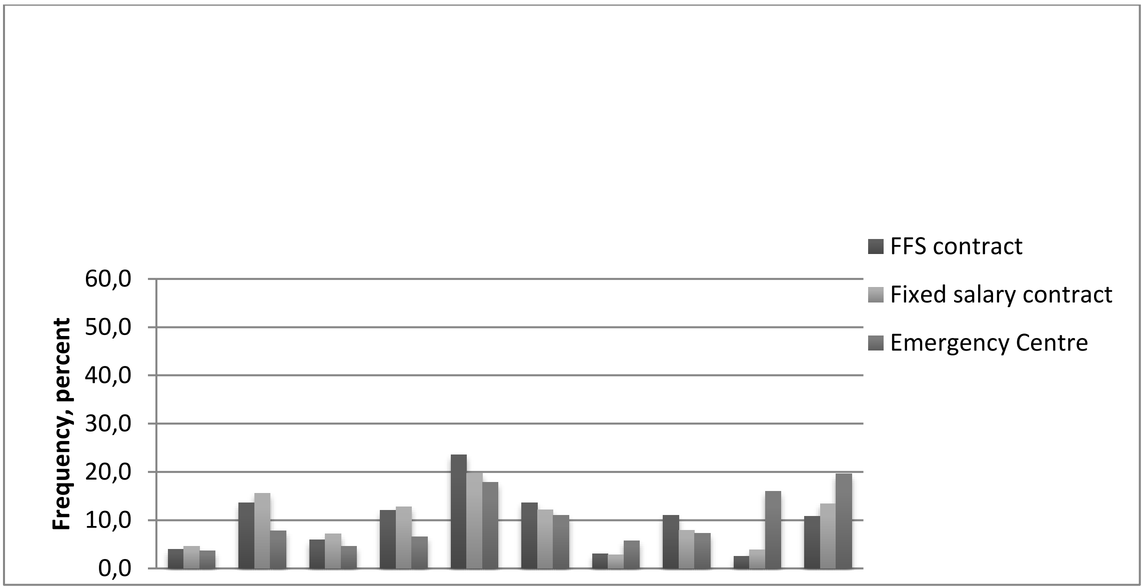

Figure 1a. Frequency of each diagnosis in each consultation category.

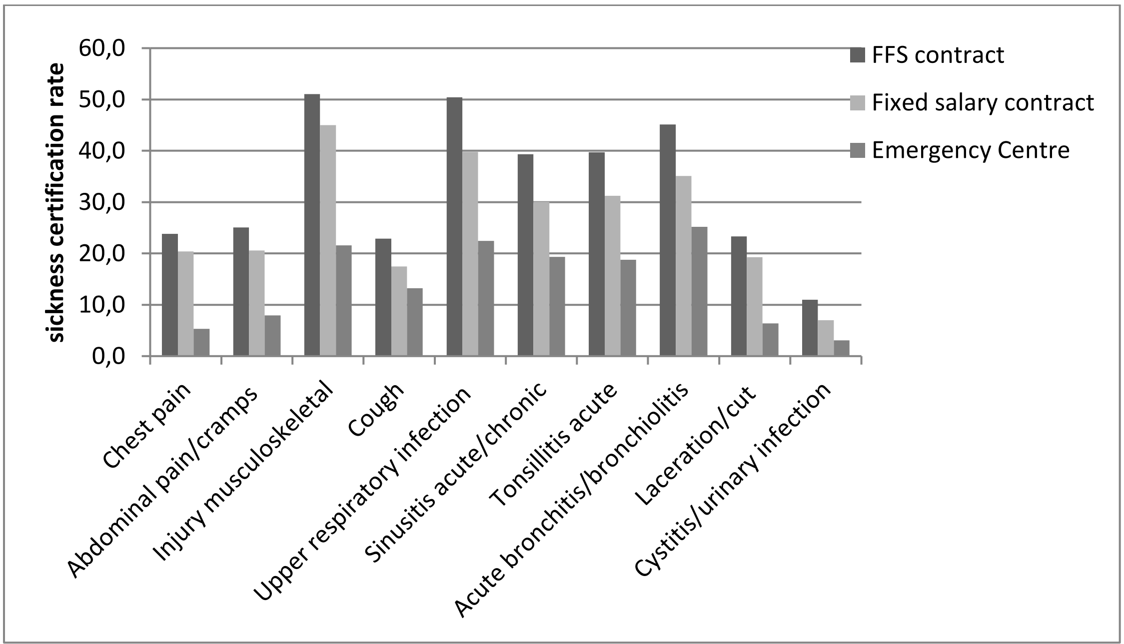

Figure 1b. Sickness certification rates for each diagnosis in each consultation category.