PHYSICIAN INDUCED DEMAND AND FINANCIAL INCENTIVES. EVIDENCE FROM LARGE-SCALE FEE CHANGES

Preliminary Version. Do not cite! *

Tamara Bischof** Jonas Meier †

October 23, 2020

Abstract

This paper analyzes how physicians adapt their provision of medical services when their financial incentives change. Exploiting a plausibly exogenous and large-scale reform to the reimbursement system, we find that physicians are not immune to monetary incentives. Conceptually, physicians may substitute across services or increase their aggregate supply in response to the new scheme. Our rich dataset allows us to isolate both channels carefully. We find that providers increase (decrease) the volume of services that became relatively more (less) attractive. The results vary considerably by the extent of the income loss. Further, physicians increase their service volumes and their number of patients if they lose a substantial share of their revenue. Finally, we evaluate the reform in light of the explicitly announced saving target and propose improvements for future policy interventions.

Keywords: physician behavior; supply-side incentives; fee-for-service

JEL: I11, I13, I18, J44

Word count: 11,309

***Acknowledgements:** We would like to thank Blaise Melly and Michael Gerfin for valuable comments and suggestions and Fabienne Töngi for the research assistance. We would also like to thank participants at the Brown Bag Seminar in Bern and the 12th World Congress of the Econometric Society for valuable comments. Moreover, we are grateful to Sasis AG (Oliver Grolimund and Sandra Wüthrich) for providing the data. We gratefully acknowledge financial support received from the Berne University Research Foundation (17/2018).

**Department of Economics, University of Bern, Schanzeneckstrasse 1, 3001 Bern, Switzerland. Mailto: tamara.bischof@vwi.unibe.ch.

†Department of Economics, University of Bern, Schanzeneckstrasse 1, 3001 Bern, Switzerland. Mailto: jonas.meier@vwi.unibe.ch.

1 INTRODUCTION

The cost for the health sector has dramatically risen in recent years for the OECD countries. For instance, over the years 2007 to 2017, and in terms of GDP, expenditures increased from 12.4 to 17.1% for the US and 9.7 to 12.3% for Switzerland (OECD, 2019). Many call for cost-containment measures on the supply side to complement existing measures on the demand side (e.g. deductibles, co-payments). Most prominently, fee-for-service (FFS) is often thought to drive costs (McClellan, 2011, for a recent overview). Policymakers share this view: For instance, reforms of Medicare are based on the assumption that physicians offset half of their revenue losses due to fee reductions by increasing volume.[1] The empirical evidence on this topic, however, is mixed.

The purpose of this paper is to study how financial incentives affect physician behavior in terms of volume and type of medical services. The paper aims to disentangle two response channels: the effect through changes in relative prices and the effect due to an income change.

We explore the effects of a plausibly exogenous and large-scale fee change in Switzerland using rich physician-and-service level data from mandatory health insurance. In this setting, providers of ambulatory care are reimbursed under a nationally uniform fee-for-service (FFS) schedule called *TARMED*. Using a flexible fixed effect regression approach, we identify the effect of fee changes on volumes of specific services and thus describe the way that financial incentives affect substitution across services. To the best of our knowledge, this paper provides the first attempt to address substitution patterns across the full set of medical services charged by a physician.

We find that physicians substitute across services; namely, they increase volumes for services that became relatively more attractive, and reduce the supply of services with above-average fee cuts. Specifically, a fee increase by 4% more than a physician's average increases the volume of this service by 1%. This behavior is consistent with profit-maximization.

Because the fee changes are unevenly distributed across medical specialties, we can additionally explore how the effect differs by the extent of the income loss. For example, radiologists lose a large chunk of their revenue (median of -13%), whereas other specialties are net winners. Indeed, the substitution pattern described above varies by how much revenue is at stake: We find little evidence for substitution for doctors who lose a large fraction of

[1] The Health Care Financing Administration, commissioned to implement Medicare, assumes a fifty percent volume offset in their calculations, so that physicians are expected to increase their service volume after a fee reduction to halve their revenue loss. (cf. Codespote et al., 1998; Congressional Budget Office, 2007). See also the discussion in Reinhardt (1999).

their revenue (and thus, income). Rather, this behavioral margin seems especially crucial for medical specialties that only experience moderate revenue losses or eventually benefit, such as general practitioners (GPs).

On the other hand, revenue-losers may react at a different margin, that is, by increasing their total service volume. Service expansion may occur along two lines: treating more patients or increasing service intensity per patient. We find evidence for such expansions that goes hand in hand with a less pronounced substitution behavior. For each additionally lost revenue percent, physicians who lose revenue increase consultations by up to 2.6% and total service volume by roughly 0.5%. These results imply that for physicians who encounter a substantial income loss, increasing overall supply is more important than substituting across services.

Our findings tie to a body of literature studying how physicians react to incentives besides patient needs. For instance, previous research provides convincing evidence that obstetricians perform more C-sections when fertility declines (Gruber and Owings, 1996; Gruber et al., 1999), and that cardiac surgeons intensify treatment when they lose revenue (Yip, 1998). Our paper most closely relates to the empirical literature studying the effect of variation in fees (Clemens and Gottlieb, 2014; Yip, 1998; Rice, 1983; Gruber et al., 1999; Brekke et al., 2017).[2] Recently, Clemens and Gottlieb (2014), leveraging a large geographic consolidation in Medicare fees, find that a 2% increase in reimbursement rates leads to a 3% increase in healthcare provision. Similarly, we address the issue of expanding aggregate supply and contribute by extending the scope of our analysis to a wide set of services and closely examining the ensuing substitution patterns.

This line of research closely links to the literature on physician induced demand (PID), pioneered by Evans (1974). Under the PID hypothesis, physicians influence demand for medical services *against* the best interest of their patients (McGuire, 2000). McGuire and Pauly (1991) provide a widely used theoretical framework to study the PID phenomenon in Fee-for-Service (FFS) systems.[3] In their model, providers react to fee reductions by substituting supply towards more favorable services (substitution effect), and by increasing their overall healthcare supply (income effect, only present when physicians seek an income target). An empirical investigation of the strength of the income effect then provides evidence regard-

[2]The earlier empirical literature mostly focused on variations in the physician density (Fuchs, 1978; Cromwell and Mitchell, 1986; Stano, 1985, subject to critique by Dranove and Wehner, 1994; Gruber and Owings, 1996). Recently, similar approaches are used to study the effect of market concentration and competition (Dunn and Shapiro, 2018). More recently, there is a focus on the variation in the information asymmetry between medical professional and patient (Johnson and Rehavi, 2016; Gottschalk et al., 2018; Currie et al., 2011; Domenighetti et al., 1993; Schmid, 2015). See McGuire (2000); Chandra et al. (2011) for overviews.

[3]Other theoretical models are developed in Fuchs (1978); Zweifel et al. (1997).

ing the presence of PID versus profit-maximizing agents. The interpretation of our results is loosely based on the theoretical model, and our methodology is similar to Yip (1998), who aims to account for the substitution and the income effect in studying how the provision of cardiac surgeons react to a large fee change in Medicare. She finds that physicians with the highest income reduction increase the volume of an intensive procedure the most. By extending her work, we aim to isolate the two effects. Our methodology improves on her approach by using a more diverse population, a wider set of services, and a richer dataset.

More broadly, the paper relates to the literature on agency. As already pointed out by Arrow (1963), physicians act as agents for their patients, who delegate treatment decisions to their doctors. If physicians act as perfect agents, monetary incentives should play no role in determining treatment, as physicians assist their patients in demanding the optimal quantity of services. However, if physicians react to financial incentives, say, by substituting highly reimbursed services for low-cost care, they no longer act as perfect agents. By studying how physicians react to a large reshuffling of their financial incentives, we add empirical evidence to this important literature. Our results may be informative to other settings with imperfect agents.

Finally, our results are of direct interest to policy makers. Reimbursement systems are periodically updated and should incorporate research insights to optimally construct fee structures that contain costs while maintaining quality.

The remainder of this paper is structured as follows. Section 2 discusses the institutional background and the payment reform of 2018. Our dataset is described in Section 3, and Section 4 provides descriptives. The empirical strategy is explained in Section 5, Section 6 presents and discusses the results. Section 7 concludes.

2 INSTITUTIONAL BACKGROUND

The Swiss healthcare system is characterized by mandatory healthcare insurance (MHI) that covers a comprehensive and standardized basket of medical services. MHI accounts for the bulk of healthcare expenditures in the ambulatory sector. Insurance is organized according to the principles of managed competition (Enthoven, 1978). Individuals may choose among a number of insurance plans offered by private insurance providers. The basic plan for adults features a deductible of CHF 300 (≈USD 300) and free physician choice. In return for a premium reduction, individuals may opt for a higher deductible or the inclusion of managed care features. Health plans may be changed during an annual open enrolment window in November.

Ambulatory care has traditionally been provided by independent single practices. Providers are reimbursed on a fee-for-service (FFS) basis (see Subsection 2.1). Most physicians are self-employed or work in small practices. In recent years, more group practices have emerged along with an increased importance of ambulatory clinics in hospitals that offer ambulatory services. Still, in 2014, 84% of ambulatory practitioners (co-)owned their current practice (Hostettler and Kraft, 2018). Despite the fact that most individuals enjoy free provider choice, the majority report having a regular GP (De Pietro et al., 2015).

2.1 Provider Reimbursement

Ambulatory services covered by mandatory health insurance are reimbursed under a universal fee-for-service (FFS) schedule.[4] Since 2004, fees are regulated on a national level in the *TARMED* fee schedule. The schedule contract is subject to collective negotiations involving the so-called *tariff parties*[5]. Fees for the roughly 4,500 services vary by physician specialty and region.

Similar to Medicare, medical services are ranked on a relative value scale (*Taxpunkte*) and conversed to a monetary value by multiplying with a geographic adjustment factor (*Taxpunktwert*).[6] Specifically, for service s, supplied in region r, a provider with specialty i may charge

[4]Note that exceptions prevail for patients insured with HMO plans. In these cases, insurance companies negotiate contracts with provider networks to arrange reimbursement of medical services. These contracts often include bonus payments or capitation mechanisms. Some physician networks may accept (partial) financial responsibility for the full clinical pathway of their patients (including inpatient care). Schmid et al. (2018) and De Pietro et al. (2015) offer further information. We abstract from individual contracts in this paper.

[5]Collective negotiations take place between the payer and the provider side. The supply side is represented by the Swiss Medical Association (FMH) and the Swiss Association of Hospitals (H+). The demand side is represented by two organizations representing the MHI insurance companies (santésuisse and curafutura).

[6]This factor varies by canton. Switzerland is a federal state consisting of 26 cantons. In 2017, these factors ranged from 0.82 (Schwyz, Zug) to 0.97 (Jura).

the following fee:

$$\text{fee(CHF)}_{s,i,r} = \text{relative value units}_{s,i} \times \text{geographic adjustment factor}_r \tag{1}$$

The relative value units of a service compensate the resources required for providing the service. First, medical work with the patient (*Medizinische Leistung*), and, second, the infrastructure, practice expenses, and overhead costs (*Technische Leistung*). The two components are explained in more detail in Appendix A.

2.2 2018 Reform

In our analysis, we make use of a large-scale change to the fee schedule that changed relative prices for all physicians in 2018. The Federal Council intervened because the regulations for the current schedule expired and the involved parties had failed to negotiate a new contract. This decision was relatively surprising and on a short notice. The new schedule, effective 1st of January 2018, was only officially announced in October 2017. Thus, the new fees took many physicians by surprise. Even more so since the revision included broad and large-scale changes, affecting different parameters of the fees. From the perspective of a given physician, the revision changed relative prices and, depending on the specialty, affected a substantial part of practice revenue. Figure 1 illustrates that fees decreased for the majority of services. Still, the valuation for some services increased after the reform. The most prominent examples in terms of aggregate revenue are services related to consultations[7]. The reform affects the remuneration of services by changing fees, changing the composition of the service (*compositional changes*), and retiring certain services. Overall, services making up for a share of 27% of total revenue are affected by compositional changes. These changes entail five broad categories[8], which are described in further detail in Appendix B.

2.2.1 Descriptives of Fee Changes

Figure 1 gives an overview of the pre-reform fees (left panel) and how they changed (right panel). Before the reform, the average fee for a service is CHF 400 (log fee 5.12). On average, fees were reduced by CHF 86 (-0.14), which translates approximately to a 14%-cutback. The right panel illustrates that not all fees were reduced. In fact, for approximately 30% of all

[7] Fee IDs 00.0010, 00.0020 and 00.0030.

[8] First, splitting services into a finer set of services that are very similar to the old ones. These services are included in our models as they are tractable over time. Second, similarly, services were split into new services which are not comparable to the old service. Third, changes in the billable time of services with a *Minutage* (i.e. 5-minute intervals replacing 15-minute intervals). Fourth, introduction of *Minutage* for services. Fifth, changing the restrictions on the combination and repeated charges for a single service within a period of time (i.e. a maximum of four times per day).

services (accounting for 54% of total revenue in 2017) fees increased, mostly for consultation-related services. This increase is mostly due to the harmonization of the scaling factor that compensates for the duration of medical training. It is important to note that the figure does not account for the importance of a service in terms of, say, revenue. Rather, all services are weighted equally to get a comprehensive picture of the fee changes.

– Insert Figure 1 about here –

2.2.2 Exogeneity of the Fee Changes

We argue that the fee change was exogenously determined. There are several justifications to this. First of all, Figure 2 shows that the fee changes do not correlate with the lagged changes in service volumes. Thus, the federal government did not systematically reduce the fees for services that grew in size. Several technicalities of the revision process further support this claim. Physicians were not directly involved in the process determining the new fees. Thus, they had no opportunity to guard important services strategically from fee cuts. Moreover, the revision consists of several different interventions such that physicians could not perfectly anticipate how their practice would be affected. Finally, the original *TARMED* fee schedule is based on pricing models that are intellectual property of the physicians' association. The federal government was not granted access to them.[9] Therefore, the new fees are not based on the same observables that determined the previous fees in the first place. We conclude that the fee changes are plausibly exogenous from the perspective of individual physicians.

– Insert Figure 2 about here –

3 DATA

We use billing data from MHI in Switzerland for the period from 2015 to 2018.[10] The data, based on individual insurance claims, is aggregated on a physician-and-service level. It covers all physicians working in the outpatient sector who bill for MHI, excluding staffed physicians in hospitals.[11] We further aggregate all information on a quarterly frequency to achieve

[9] FOPH (2017, p. 10)

[10] We additionally have access to data for the year 2014. We exclude these data points from the analysis because of an earlier revision in October 2014. This reform aimed at redistributing revenue from specialists to GPs. We thus start our sample period in the last quarter of 2015. The quantities of 2014Q1 to 2015Q3 are only used to predict future quantities for the quantity counterfactuals introduced in the identification section.

[11] Outpatient services provided by hospital staff account for roughly 35% of total ambulatory costs under MHI. We exclude the hospital sector because information is not available on an individual physician level. Rather, the

a physician-service level panel dataset. Using quarterly intervals is attractive because it reduces both noise and the computational burden. Further, there are fewer seasonal patterns. The dataset is best described by starting with the main variables: the quantities and the fees. Volumes are measured by how often a physician billed a service in a given quarter. Additionally, we observe how many patients a physician sees per quarter. The data distinguishes 42 medical specialties that were diversely affected by the fee changes. In the analysis, we will separately estimate the effects for the 12 largest specialties in terms of revenue[12] to account for potential heterogeneity. Taken together, they account for more than 80% of total revenue. An attractive characteristic of the data at hand is that it covers patients of virtually all health insurance companies in Switzerland.

In order to increase the reliability of our analysis, we limit our sample to continuously practicing physicians[13] (excluding 17.5% of total revenue from 2015 to 2018) and exclude potentially erroneous data points. This includes services charged at highly unreasonable prices[14] (0.5%). Further, we restrict our analysis to services that can clearly be tracked across the different versions of the fee schedule. As discussed in Section 2 and Appendix B, a number of services underwent major changes that render before-and-after comparisons unfeasible. We exclude these *compositional changes* (10.8%)[15] and retired services (0.2%). We will refer to the remaining data as estimation sample.

4 Descriptive Statistics and Graphical Evidence

This section provides descriptive statistics for the estimation sample used in the ensuing causal analysis. These are complemented by first graphical evidence of the reform in Subsection 4.1.

Table I provides summary statistics and some additional characteristics of our estimation sample from 2015 to 2018. In 2017, the last year before the reform, the sample consists of 13,051 physicians and 2,105 different services. It is important to point out that individual

information in our data reflects an aggregate measure of decisions by several staffed doctors. Including them would thus conflate our estimates of individual behavior.

[12]In terms of revenue, the 12 largest specialty groups are GPs, psychiatrists, group practices, ophthalmologists, OB-GYNs, radiologists, pediatricians, medical practitioners, cardiologists, dermatologists, gastroenterologists and otorhinolaryngologists (ordered by revenue).

[13]We exclude physician-quarters if the revenue of the current or the preceding quarter lies below CHF 20,000 (25% of average quarterly revenue). Further, we excluded all observations of a physician if she had four or more quarters with total revenue below CHF 20,000. Finally, all observations of a physician were left out if she experienced extreme changes of her revenue in two or more quarters.

[14]In practice, we exclude physicians whose average prices deviate more than 10% from the official fees, or who deviate more than 50% from the fee at least once.

[15]Note that this value is lower than in Section 2 as the largest category of services affected by compositional changes is tractable over time and is thus still included in our models.

service composition is much narrower in scope: the average physician charges only 36 distinct services in a quarter. Notably, this number varies considerably across specialties, ranging from as few as six different services for psychiatrists to as many as 82 for radiologists. The average physician in our data charges a volume of 4,667 services and gains a revenue of CHF 90,239 per quarter. On average, a physician has 769 consultations per quarter.

A first descriptive analysis confirms the observation that costs rise over the years, which is consistent with an underlying trend of increasing healthcare expenditures OECD (2019). Quarterly revenue per physician increases from CHF 85,656 in 2015 to 90,239 in 2017 (see Table I). In aggregate, this corresponds to a cost increase of 14% (from CHF Mio. 1,031 per quarter in 2015). The empirical analysis will have to account for this positive trend. We discuss the cost evolution in more detail in Subsection 4.1.

– Insert Table I about here –

4.1 Graphical Evidence

This subsection provides first descriptive evidence of the effects of the policy change. For this purpose, we momentarily extend the scope of our analysis to the entire ambulatory sector covered by MHI, therefore going beyond our estimation sample described above. Specifically, the following discussion includes hospital staff and physicians who may have stopped or just started practicing over the course of our observation period. We describe how aggregate costs evolve and compare them to the announced policy target of saving 0.47 billion.[16]

We start by discussing how costs in the ambulatory sector evolve. Figure 3 plots total outpatient costs reimbursed by MHI for the years 2014 to 2019 (solid red line). Mirroring the previous discussion of Table I, Figure 3 shows that overall medical costs grow over time. Ignoring this positive time trend would bias the estimated effects of the policy intervention.

Additionally, it is evident from Figure 3 that the data is cyclical: Ambulatory costs usually peak in the first quarter, followed by a through in the third quarter. This variation reflects an underlying seasonality in the prevalence of diseases such as the flu, which is amplified by missing visits during summer vacations.[17] We will account for such cycles by including

[16] For the sake of completeness, Figure 7 in Appendix G shows the same figure based on our estimation sample only. The general idea is comparable.

[17] A vast literature in public health and epidemiology shows increased mortality in winter months (e.g. Anderson and Bell, 2009; Wilkinson et al., 2004). It is natural to assume that this excess mortality coincides with increased utilization of medical services in the same period. Further, a literature in epidemiology shows that the incidence of several (infectious) diseases is highly seasonal. For example, in the northern hemisphere the seasonal flu occurs in the winter time (Dowell and Ho, 2004) and Chickenpox in spring (London and Yorke, 1973), thus a large share of both disease falling to the first quarter. Further, cold weather increases respiratory and heart problems, leading to increased utilization of primary care (Moineddin et al., 2008), and icy conditions increase the number of falls and accidents.

physician-quarter fixed effects.

– Insert Figure 3 about here –

In the next step, we get a first notion of the policy's effect. To account for the high degree of cyclicality and the trend present in the data, we first build a simple counterfactual. We predict physician-specific service volumes based on pre-reform data under the assumption that quantities grow at the same rate for all physicians in the same specialty.[18] Multiplying by the pre-reform fees and aggregating over all physicians yields a notion of how medical costs would have evolved without the reform (dashed blue line). Comparing realized costs (solid red) to our counterfactual suggests that medical costs dropped considerably after the reform.

We suggest that part of this cost reduction is due to adjustments in physician behavior after the reform. Of course, part of the cost reduction is purely mechanical. After all, the reform reduced the average fee. In fact, the mechanical reduction only accounts for a relatively small share of the reduction: Multiplying counterfactual volumes by the *new* fees gives an indication of how costs evolved had physician behavior remained at predicted levels (subject to time trends and cyclicality). These costs (dashed pale blue) lie above the realized cost, suggesting that the cost reduction is not purely mechanical but rather an additional reduction in costs due to behavioral changes.[19] This finding is somewhat puzzling. For instance, our interpretations runs contrary to the Medicare prediction of volume extension after fee cuts.

Did the policy attain the target of saving 0.47 billion? A back-of-the-envelope calculation suggests so. Actual costs lie below those predicted by a counterfactual that exactly achieves the saving target (dashed orange line), thus saving at least the announced target sum. To sum up, Figure 3 suggests that physicians responded to the reform beyond the purely mechanical effect. We will analyze their behavior empirically in the following sections.

5 EMPIRICAL STRATEGY

The empirical analysis aims to identify how physicians react to the exogenous fee changes presented in Section 2.2. As mentioned earlier, there are at least two potential channels for physicians' response to fee changes: The so-called substitution effect and the income effect. The former is a volume increase (decrease) for services that became relatively more (less) attractive, and the latter is a volume increase of *all* services to achieve a targeted income. The

[18] Details on the predictions can be found in Appendix C.

[19] Interestingly, the discrepancy is most substantial in the first quarter of 2018, which could indicate that physicians need some time to adapt to the new fees optimally.

remainder of this section explains how we isolate and analyze the two channels.

Measuring the bite of the reform. To analyze either channel, it is crucial to first measure how physicians are affected by the revision. Similar to Yip (1998)[20], we define a reform *BITE* variable for each physician - measuring the expected revenue loss related to the reform[21]:

$$\text{BITE}_{i,t} = \frac{\sum_s^S (P_{i,s,18} Q_{i,s,17t} - P_{i,s,17} Q_{i,s,17t})}{\sum_s^S (P_{i,s,17} Q_{i,s,17t})}. \tag{2}$$

For physician i in quarter t:, $Q_{i,s,y,t}$ represents the volume of service s in year y at fee $P_{i,s,y}$. *BITE* measures the expected percentage change in practice revenue based on pre-reform volume for each physician and quarter. A negative value thus indicates an (expected) income loss. In our view, our measure improves on earlier work by precisely estimating how revenue would change if quantities remained fixed. According to theoretical considerations in McGuire and Pauly (1991), physicians targeting a level of income would expand their total supply when they lose revenue in order to maintain their target income. In our setting, this prediction translates to a volume expansion when $BITE$ gets increasingly negative.

BITE ranges from -0.47 to 0.35, which highlights how widely the reform's impact on revenue varies between physicians. Absent any adaptions in behavior, physicians can expect a reduction of revenue by 47% while others would expect a 35%-gain in revenue. For the largest 12 specialties (in terms of revenue), the average (0.014) lies below the median (0.034), which implies that there are fewer losers than winners, and that losers are more strongly affected in absolute terms. Tables VI and VII in Appendix F show summary statistics for the variable by medical specialty.

5.1 Substitution Across Services

How does the (relative) provision of different services respond to changes in their relative prices? We identify the substitution pattern by comparing relative changes in service quantities *within* a physician and quarter. Formally, this relative change is modeled by including a physician-quarter fixed effect in the regression model. The underlying rationale is that fee changes for the same service may have different consequences for physicians who differ in their practice style, even if they practice in the same specialty. In turn, the analysis abstracts

[20] Yip (1998) proposes a weighted average of the fee changes. The weights are computed as the average quantities right before and after the treatment. In fact, our measure in (2) highly correlates with an alternative specification in the style of Yip (1998) (correlation coefficient 0.71).

[21] Note that we want to build a comprehensive measure of how physicians are affected. Therefore, we also include services affected by compositional changes to build this variable.

from explicitly modeling the effect of fee changes on a physician's overall service volume.[22] Our baseline specification of the model is as follows:

$$\Delta \ln Q_{i,s,t} = \beta_0 + \beta_1 \Delta \ln P_{i,s,t} + \gamma_s + \delta_{i,t} + \epsilon_{i,s,t}, \tag{3}$$

where $Q_{i,s,t}$ is the volume of service s provided by physician i in quarter t, $P_{i,s,t}$ represents the corresponding fee, and Δ denotes the difference to the prior-year quarter. Using the first difference of the logarithms of the outcome as well as our main regressor is attractive for two main reasons. First, the log-transformation facilitates comparison despite the large variance across services and physicians. Second, comparing to the prior-year quarter nets out quarter effects. We further include two fixed effects in our baseline specification: A service fixed effect (γ_s) that takes care of service-specific trends, and, as already motivated above, a physician-quarter fixed effect ($\delta_{i,t}$) that allows for comparing relative changes within a physician and quarter. Note that the physician-quarter fixed effect ($\delta_{i,t}$) picks up the *BITE* variable and thus helps to isolate the substitution effect. Our coefficient of interest, β_1, will (for small changes) approximate the percentage point change in service volume when the relative fee changes by one percentage point.[23] This baseline model is appealing as it is the only way to isolate the substitution effect neatly.[24] To the best of our knowledge, our paper is the first to draw conclusions about the substitution pattern shutting other response channels. Another attractive property is that the coefficient of interest, β_1, has the flavor of an elasticity.[25] Finally, the estimation model presented in equation (3) ties to the previous literature (e.g. Yip, 1998), thus ensuring comparisons. To the best of our knowledge, no previous paper has modeled substitution effects across such a broad range of service, and for such a heterogeneous group of physicians. We thus contribute novel evidence to the literature.

To ensure that we capture the appropriate effect of the fee variable ($\Delta \ln P_{i,s,t}$), we additionally consider more flexible specifications such as introducing polynomials of the fee (up

[22] In fact, our preferred specification does not allow for the concurrent modeling of both, as average changes are picked up in the physician-by-quarter fixed effect.

[23] To be precise, $\beta_1$measures how a change in the log gross growth rate of $P_{i,s,t}$ affects the log gross growth rate of $Q_{i,s,t}$. For small changes of $Q_{i,s,t}$ and $P_{i,s,t}$, the coefficient approximates net growth rates. Recall that the gross growth rate of $Q_{i,s,t}$ with respect to the prior-year quarter is $\frac{Q_{i,s,t}}{Q_{i,s,t-4}}$ whereas the net growth rate subtracts 1 from the gross growth rate.

[24] The physician-quarter effect makes it a model of relative fee changes for each physician, which we ultimately want to estimate. In principle, the effect of $\Delta \ln P_{i,s,t}$ and $BITE_i$ could be estimated in one regression by dropping the physician-quarter fixed effect. However, the same value of $\Delta \ln P_{i,s,t}$ could have very different implications, say, because for a physician all other fees may have increased or decreased.

[25]

$$\beta_1 = \frac{\partial \Delta lnQ}{\partial \Delta lnP} = \frac{\partial ln\left(\frac{Q_t}{Q_{t-4}}\right)}{\partial ln\left(\frac{P_t}{P_{t-4}}\right)} = \frac{\frac{Q_t}{Q_{t-4}}}{\frac{P_t}{P_{t-4}}} \cdot \frac{\partial \frac{Q_t}{Q_{t-4}}}{\partial \frac{P_t}{P_{t-4}}}$$

to order five) and interacting with an indicator for a fee decrease. We use the physician-and-service-specific revenue of the prior-year quarter as weights for all regression models. More precisely, we use the logarithm of the revenue to be consistent with our main outcome and treatment variables. All standard errors are clustered on the physician-quarter level.

As discussed in the first part of this section and illustrated by Tables VI and VII in Appendix F, the bite of the fee reform varies considerably across medical specialties. Thus, in the next step, we consider if, in turn, heterogeneous substitution patterns arise. Formally, we let β_1 in equation (3) vary for the 12 largest specialties and group the results by the specialty's median *BITE*.[26] Generally speaking, the incentives and possibilities to substitute may depend on a number of factors. Most importantly, we expect physicians who have lost a large share of their revenue to respond more strongly for two reasons. First, markedly lower fees imply a decrease in revenue. Because this increases the marginal utility of revenue under a range of utility functions,[27] physicians have ample incentives to expand the volume of services with a higher financial return. Such behavior manifests in substitution from "losing" to "winning" services in terms of the relative fee. Second, experiencing a severe reduction in revenue is correlated with a higher variance of the fee changes[28], which means that relative prices, and thus incentives, have changed more strongly.

Besides the possibly amplifying effect of the income $BITE$, there are constraints on how physicians can optimize their service mix. An apparent one is the number of distinct services a physician uses: Having fewer distinct services limits the substitution possibilities. Further, the fee schedule limits how often certain services can be charged per patient and consultation. It seems likely that expanding service quantities is harder when such limitations restrict a larger part of a physician's practice.[29] We use the revenue-share of limited services as a rough proxy for the ease of substituting. Because the variable is constant for each physician and quarter, the physician–quarter fixed effect ($\delta_{i,t}$) in equation (3) picks it up.

5.2 Total Healthcare Supply

The analysis would be far from complete by only examining substitution behavior. Several earlier studies (e.g. McGuire and Pauly, 1991; Yip, 1998) found that physicians with the

[26] Taken together, these physicians account for more than 83% of all revenue. The included specialties are GPs, psychiatrists, group practices, ophthalmologists, OB-GYNs, radiologists, pediatricians, medical practitioners, cardiologists, dermatologists, gastroenterologists, and otorhinolaryngologists (ordered by revenue).

[27] This claim holds for standard utility functions as outlined in McGuire and Pauly (1991).

[28] Figure 8 in Appendix G provides evidence for this claim.

[29] Figure 10 in Appendix G summarizes the number of services, the fraction of revenue restricted by limitations, and the median value of BITE for the largest specialties.

sharpest income decline show the most pronounced reactions. Thus in a second analysis, we examine how a physician's *total* healthcare supply responds to income changes. This is a non-trivial exercise for two reasons. First, the raw quantities of the services are not directly comparable across services and physicians. Thus, they cannot simply be summed up to get a measure of total supply. Second, services exhibit different time trends, which renders the analysis of any aggregate delicate, as it remains unclear how these trends should be averaged. We tackle these issues by proposing two complementary identification strategies.

In a first step, we argue that the number of office visits constitute an appropriate measure of a physician's healthcare supply. Thus, we regress the change in consultations in a given quarter on the individual, quarterly $BITE_{i,t}$, and a physician fixed effect. We let the coefficient vary for medical specialties with a median revenue loss (negative BITE), indexed by $m \in M$.

$$\Delta \ln C_{i,t} = \beta_0 + \beta_1 BITE_{i,t} + \sum_{m \in M} \beta_{1,m} I_m \times BITE_{i,t} + \delta_i + \epsilon_{i,t}. \tag{4}$$

We expect only the physicians affected by a substantial revenue reduction to exhibit income-targeting behavior. Besides, consultations have been growing at different rates for these specialties. Thus, it is important to estimate a fully saturated model. Comparing to the baseline model in (3), it is apparent that the model in equation (4) builds on fewer observations because the unit of observation is the provider instead of provider-and-services.

Unfortunately, the model in (4) encounters an endogeneity problem for some physician specialties. For psychiatrists, gynaecologists, and medical practitioners, pre-reform growth rates of consultations seem to correlate with the value of $BITE$. Figure 9 in Appendix G illustrates this dependence. This undermines the identification of β_1 in (4) and makes the estimation of the model for these specialties infeasible.

The second approach is motivated by a prediction of the PID hypothesis (McGuire and Pauly, 1991). The PID states that physicians fully offset any income loss by increasing service volume. For this purpose, we will decompose the observed revenue change from 2017 to 2018 into two parts: First, a *mechanical change* that measures by how much revenue changes due to the fee adjustments, holding the supply level fixed. Second, a *behavioral change* measuring how revenue changes because the provision of services adapts (holding prices fixed). Note that individual physicians can not influence the first part. They may react, however, by, say, performing additional examinations, which the second part would pick up. Relating the two measures provides an estimate as to how much physicians offset lost income. Thus, the PID prediction (coefficient of -1) will be testable. In practice, we will base the measures on cost predictions that account for specialty-specific trends and cyclicality. More precisely, we use specialty-specific quantity predictions $\hat{Q}_{i,s,18}$ for 2018 to account for different trends in volumes.

$$\begin{aligned}\Delta\ln R_i = & \underbrace{\ln\left(\sum_s^S P_{i,s,18}\cdot Q_{i,s,18}\right) - \ln\left(\sum_s^S P_{i,s,18}\cdot \hat{Q}_{i,s,18}\right)}_{\text{behavioral change}_i} \\ & + \underbrace{\ln\left(\sum_s^S P_{i,s,18}\cdot \hat{Q}_{i,s,18}\right) - \ln\left(\sum_s^S P_{i,s,17}\cdot \hat{Q}_{i,s,18}\right)}_{\text{mechanical change}_i}. \end{aligned} \quad (5)$$

$\ln\Delta R_i$ measures how the revenue in 2018 compares to what was expected for a physician based on previous quantities (levels and trends) and the old fees. The first term of the decomposition identifies how much of $\ln\Delta R_i$ is due to a change in service volume (*behavioral change*). Similar to the $BITE$ variable, the second term (*mechanical change*) captures how revenue (mechanically) changes due to changing prices. Compared to the $BITE$, the *mechanical change* additionally accounts for specialty-specific trends in service volumes. Again, the variable further improves on the original definition of $BITE$ by Yip (1998) by using quantity predictions that are unaffected by physicians' responses to the reform. The predictions for the quantities in 2018 are based on the assumption that service-specific growth rates are constant across all physicians of the same specialty. Further, owing to the data's high cyclicality, we use average quarterly differences[30] and not linear trends for the predictions. Appendix C describes the predictions in further detail. Applying these counterfactuals allows linking revenue changes directly to changes in prices or quantities. If physicians target an income level, they would choose their quantities in a way that fully offsets the revenue loss due to the fee changes and, in turn, effectively reduce the change in revenue to zero. Thus, regressing *behavioral change* on *mechanical change* provides an answer to whether this is the case or not. As this analysis is conducted on the physician level, we perform a median regression to ensure that the results are robust to outliers (Hao and Naiman, 2007).

[30] Average change in quantity for all first, second, third, and fourth quarters.

6 RESULTS AND DISCUSSION

6.1 Substitution across Services

Table II shows our baseline estimates of the causal effect of relative fee changes on changes in relative service volume. The magnitude of the effect is sizeable, with a coefficient of 0.253. In other words, when the fee of a service increases by 2% more than the average, its volume will increase by around 0.5%. Figure 4 illustrates the result. The figure plots the predicted change in service volume based on equation (3) in brown. The results show that physicians expand (reduce) the quantity of services for which the fee has become relatively more (less) attractive. Here, losing or gaining attractiveness is measured relative to the weighted[31] average fee change for every physician since we include physician-quarter fixed effects.

We estimate two additional models that allow for potentially different substitution responses for services with above- and below-average fee changes. The results, pictured in orange (kink) and red (quadratic fit), suggest that physicians respond more strongly to above-average fee changes, implying that they rather increase financially favorable services than reduce unattractive ones. We conclude that it is sensible to estimate a flexible model and thus will only present results from the quadratic fit in the remainder of this section. The estimates are robust to a range of more flexible specifications discussed in Section 5.[32]

In terms of the direction of the effects, our results confirm earlier findings, but are slightly smaller in magnitude (Gruber et al., 1999). Comparisons need to be taken with a grain of salt since earlier studies estimated substitution effects between two different markets (Yip, 1998) or for only two different services (Gruber et al., 1999) and are thus not directly comparable. Nevertheless, the described substitution pattern is in line with theoretical models (McGuire and Pauly, 1991). The results present compelling evidence that physicians behave rationally and maximize their revenue. Potentially, physicians may maximize profits against the best interests of their patients and thus cause a welfare loss, for example by providing excessive care beyond the medically optimal level. However, the model does not allow a welfare statement, since the optimal level of care remains unobserved.

– Insert Figure 4 about here –

Heterogeneity. We next analyze how substitution patterns vary between different medical specialties whose revenue is differently affected by the reform. We thus interact the fee

[31] The observations are weighted by their prior-year quarter log revenue.

[32] Estimation of specifications with higher-order polynomials yield qualitatively similar results. The remainder of the paper thus focusses on models including terms up to second-order polynomials.

variables in (3) with a dummy for each of the 12 largest specialties. The results using the quadratic fit are illustrated in Figure 5 (and Table III). To increase readability, the plot groups specialties by how strongly their revenue is affected. Specifically, we distinguish three groups based on the median *BITE*: *negative bite* (radiologists, cardiologists, gastroenterologists)[33], *no bite* (psychiatrists, group practices, otorhinolaryngologists, OB-GYNs, dermatologists), and *positive bite* (GPs, pediatricians, medical practitioners, ophthalmologists). The broad implication of the preceding model remains: physicians increase the quantity of services in cases where the fee has relatively increased. This is particularly true for providers who benefit from the reform (right part of the figure). However, the other two subfigures reveal that the specialties differ regarding the strength of the substitution effect.

In the (largely) non-affected group (middle panel), the general picture still holds. However, psychiatrists show an opposite pattern, reflecting a seemingly irrational substitution pattern, with volume increases of relatively less attractive services. Possibly, this puzzling result arises due to constraints: psychiatrists only choose from six distinct services in the first place, and nearly all of them are limited (accounting for 98% of revenue). Further, none of the relevant services charged by psychiatrists seem to be substitutes.[34] Being virtually unable to substitute, psychiatrists could potentially respond by expanding their aggregate supply of healthcare. Subsection 6.2 will tackle this issue.

Lastly, we turn to the group that loses revenue due to the reform (left subfigure). Cardiologists respond with a pronounced substitution behavior. This result is in line with our expectation that physicians react more strongly when they lose a larger share of their revenue. Further, Figure 5 illustrates that service volumes of radiologists and gastroenterologists are much less sensitive to fee changes, and therefore exhibit a less pronounced substitution response. The stark contrast of this result to the previous discussion raises the question if physicians who lose a large chunk of their income respond differently. It is possible that once a certain threshold is met, physicians care much less about relative prices but rather expand volumes across all services, irrespective of the fee changes. If this is the case, our results will

[33] Bite takes on the lowest median values for radiologists (-0.130), cardiologists (-0.094), and gastroenterologists (-0.099).

[34] Two services generate about 90% of psychiatrist revenue: 02.0020 and 02.0210, (both charging for therapy in five-minute intervals). While these positions are similar in scope, they differ in the practitioner. By law, MHI does not reimburse psychotherapists (without a medical degree) in independent practices. In order to be eligible for reimbursement, they need to be employed by a psychiatrist who files the claims on their behalf and supervises them. This regulation directly concerns the substitution possibilities for the two positions mentioned above. Specifically, 02.0210 can only be charged by employed psychotherapists (without a medical degree). Hence, the two positions are prescribed by two different medical professionals. This makes substitution across services difficult. A psychiatrist can only increase the volume of 02.0210 by shifting his workload to employees (or employing new psychotherapists). While this substitution is, of course, possible in reality, modeling substitution *across* suppliers lies outside the scope of this paper.

not pick it up. Therefore, we relate volume and *BITE* directly in the following section.[35]

– Insert Figure 5 about here –

6.2 Total Healthcare Supply

The previous subsection established that physicians who suffer a financial loss substitute the least. Likely, the second channel is more important: an overall supply expansion. Among the heavily affected group, only cardiologists substitute weakly according to the expected pattern. However, radiologists, cardiologists, gastroenterologists and potentially psychiatrists may respond by increasing their *total* supply. Generally, volume can be expanded along two margins: Increasing the number of consultations or charging more services per visit. Based on theoretical considerations in McGuire and Pauly (1991), we expect only physicians whose income is substantially reduced to increase their aggregate supply. Further, and in an extension to the theoretical model, we expect a volume increase by psychiatrists. As mentioned above, they constitute a group with very limited substitution possibilities so that their only margin is a supply change. In the following, we show and discuss estimation results for the aforementioned groups (negative median BITE and psychiatrists[36]) and compare them to a benchmark group consisting of all other medical specialties.[37]

– Insert Figure 6 about here –

Figure 6 presents point estimates and standard errors for the main coefficients from the two models laid out in Subsection 5.2: The coefficient of *BITE* in the consultation model in equation (4) in dark blue, and the coefficient of *mechanical change* from the aggregate supply model based on equation (5) in light blue. A negative coefficient indicates that large revenue losses are (partially) offset by an increase in consultations or aggregate supply and thus provides evidence for income targeting. Note that the standard errors are larger in the counterfactual model due to fewer observations (only one observation per physician). The full set of results is shown in Tables IV and V.[38]

[35] Similar to psychiatrists, radiologists are restricted in their choices by facing numerous limitations (97% of their revenue). Cardiologists and gastroenterologists face almost no restrictions (26% and 13% of their revenue, respectively) and charge a moderate number of distinct services (25 and 34). Thus, these reasons may only partly explain the weak substitution response.

[36] Note that for psychiatrists, the consultation model is not run due to the endogeneity concerns discussed in Subsection 5.2.

[37] As mentioned in Section 5, psychiatrists, medical practitioners, and OB-GYNs are excluded because of endogeneity concerns.

[38] Robustness and sensitivity checks of those models include a set of regressions where we control for covariates. Specifically, we include quarterly physician data on the number of distinct services, the cantonal physician density, and the revenue share of services that face some limitations. Further, we account for differences in the patient groups by including the revenue shares of the following groups: women, young (below age 36), morbid (hospital stay in the

First of all, Figure 6 points out that physicians respond differently depending on whether they gained or lost due to the reform. We first discuss the benchmark group with an unaffected or even increased revenue. For physicians in this group, $BITE$ takes on a median value of about 0.03. These physicians increase consultations in response to the revenue gain. The estimated coefficient corresponds to a 1.09% increase in consultations when the expected revenue (measured by $BITE$) increases by one percentage point. Considering the counterfactual exercise, the *mechanical change* is not affecting aggregate supply for these physicians. These results speak against the literal target income hypothesis. Not a surprising finding, since the (literal) income-targeting hypothesis is generally deemed unlikely to hold for physicians who gain revenue (McGuire and Pauly, 1991).[39] Rather, the observed pattern may be explained by two competing explanations. On the one hand, the pattern is consistent with revenue maximization, as the increased fees increase the marginal return to labor, which would manifest in a positive coefficient of *BITE* in the consultation model. This is exactly what we observe for physicians in the benchmark category. On the other hand, the pattern may result from substitution. Because the reform increased consultation fees[40], office visits gained attractiveness relative to other services. Therefore what we see in Figure 6, i.e. seeing more patients but not expanding aggregate supply, may reflect a substitution behavior. .

Next, we turn to the group with a negative *BITE*. Revenue losses induce cardiologists and gastroenterologists to expand both their number of patients and their total supply. The coefficients of the consultation model translate to an increase of up to 2.6% in the number of patients when *BITE* decreases by 1%-point. Aggregate supply measured by *behavioral change* is less responsive but increases by 0.51% and 0.83%, respectively, if *mechanical change* decreases by 1%. This result provides evidence for income-targeting behavior. In contrast, radiologists do not increase their service volumes. A possible reason for this difference is that a radiologist's practice mostly relies on referrals by other providers. Thus, radiologists have fewer options to increase their supply. Another explanation could be that they have one of the highest quarterly revenues among all physicians in which case a standard utility function implies that the marginal benefit of revenue is lower.[41] Thus, a comparable reduction in revenue does not lead to the same response as revenue matters less for overall utility. However, radiologists

previous year), low deductible (CHF 300). The qualitative implications for both models remain the same. However, for the counterfactual model, the inclusion of the covariates alters the statistical significance as the estimation model only includes one observation per physician.

[39] In principle, physicians who benefit from the reform (positive *BITE*) could reduce their supply. This behavior is consistent with the literal target income hypothesis of McGuire and Pauly (1991). However, this behavior is generally regarded as highly unlikely even by the authors. Thus, we do not expect a negative coefficient for physicians with a positive $BITE$.

[40] Service IDs: 00.0010, 00.0015, 00.0020.

[41] The median quarterly revenue of radiologists is about CHF 380,000. Among the largest 12 specialties, the second highest value is CHF 225,000 for group practices.

increase the number of patients they see, which likely corresponds to an increase in labor supply. Therefore, similarly to psychiatrists regarding their substitution possibilities, radiologists may be constrained with respect to the services they charge *per patient*.

Finally, psychiatrists expand the quantities of their services (coefficient of the counterfactual model -1.08). As described in Subsection 6.1, psychiatrists exhibit a puzzling substitution pattern that favors less attractive services. Taken together, the results suggest that psychiatrists provide more healthcare and consequently partially offset their revenue loss. Again, this observation is consistent with the income-targeting hypothesis and thus with physician-induced demand.

Taking together, we observe three results. First, in response to a large-scale fee change, physicians substitute across services to optimize their revenue. Second, physicians respond differently depending on whether they gained or lost revenue. Being hit harder by the reform, most physicians tend to increase their aggregate supply rather than to substitute between services. Finally, the ability to substitute may depend on other factors such as the number of services a physician regularly charges, and whether these services are close-enough substitutes.

6.3 Limitations

Our results are subject to a number of limitations. Most importantly, the dataset does not allow conclusions regarding patient health. Consequently, we form no statement if and how patient health is affected by the changes in the service mix described in Subsection 6.1 or by the changes in treatment intensity described in Subsection 6.2. Further, as in any empirical study of physician behavior, the optimal level of care remains fundamentally unobserved.

Moreover, we need to exclude a subset of medical services due to data constraints. These services, mostly affected by compositional changes are not directly comparable to pre-reform services. Therefore, the substitution analysis in Subsection 6.1 does not include the full variety of available services. However, the excluded services only make up around 10.8% of total revenue, and we therefore do not expect a large impact on the estimated results. Excluding the services potentially biases our results if they are systematically differently substituted, which we do not expect. Similarly, we observe physician behavior within the scope of MHI. For the ambulatory sector, MHI accounts for the vast majority of health expenditures. Still, services not covered by MHI may be alternative substitution options that remain unobserved to us.[42]

[42] In multipayer markets, fee changes may also spill over to both prices and volumes of other payers (e.g. Clemens

6.4 Policy Implications

Our results provide compelling evidence that financial incentives affect treatment decisions. First, we find substitution across the board. Second, the response varies considerably by the extent of revenue at risk. These findings have important implications for the optimal design of remuneration systems. Health policy is frequently confronted with the task of finding better ways to contain ever-growing healthcare costs while maintaining quality. Most regulators mandate regular updates of the provider payment systems, which offer frequent opportunities to incorporate new evidence on the provision of medical services. We argue that these periodic updates should also consider economic insights into the responses to financial incentives. Our findings suggest that aggregate supply increases if a sizeable part of revenue is lost. We thus conclude that gradual fee changes are preferable since strong and costly responses due to the income loss can be avoided.

Changes in relative fees may lead to potentially undesirable substitution between services. In principle, the regulator could shut down the substitution effect. Reducing all fees by the same factor keeps relative prices unchanged. Careful considerations may additionally keep the supply extension at a minimum by keeping the income effect small. Of course, this is a rather technical argument, because in practice, many other factors influence the decision on fee adjustments. Perhaps a more realistic approach in this direction is trying to identify a medical specialty's most relevant set of services and keep their relative fees relatively constant.

Further, in a long-term perspective, many countries discuss more large-scale reforms of the payment *system*, for example by abandoning FFS or by combining it with other models, like capitation. In this context, our findings suggest that the regulator could make use of the described substitution pattern. Instead of setting prices purely based on the cost of providing a service, the regulator could increase fees for high-value services and thus incentivize physicians to provide more of them. Equivalently, fees for services that are of low medical value could be reduced (see Schwartz et al., 2014; Chernew et al., 2007; Chandra et al., 2011). Implementing such policies is in line with the recent wave of educational campaigns that propose a reduction of clinically unnecessary medical tests, treatments, and procedures.[43] Thus, implementing a reformed system that exploits the substitution responses described in our analysis is a promising avenue to reduce inefficiencies in healthcare provision.

and Gottlieb, 2017, for the US). Our setting features a single payer so that no outside option persists.

[43] `www.choosingwisely.org`. Similar campaigns have been launched in Canada, the Netherlands, England, Japan, Australia, New Zealand, Germany, Italy, Switzerland, Wales and Denmark.

7 CONCLUSION

This paper addresses physician responses to an exogenous and large-scale revision of medical service reimbursement. As shown in previous work, there are two potential types of responses: shifts in aggregate healthcare supply and substitutions between services. The present analysis is able to isolate the two channels and provides evidence on the relevance of both. More precisely, our results contribute in three ways. First, they suggest that physicians increase their supply when their aggregate revenue drops, thereby confirming existing findings. Further, physicians substitute from relatively less to more attractive services. Finally, substituting between services seems relevant only for physicians whose revenue was not reduced substantially. In cases with a marked revenue loss, physicians increase aggregate supply and thus are likely to seek an income target. This behavior is consistent with physician-induced demand.

Concerning the policy itself, our calculations suggest that the saving target of 0.47 billion was achieved in the first post-reform year. Our results on the substitution behavior suggest that adapting the fee structure may have (unintended) consequences for the service mix provided by physicians. Potentially, such effects may be adverse, for instance, when patients are undertreated or receive adverse overtreatment. Understanding the role of limitations posed on specific services constitutes a promising avenue for further research.

Bibliography

Anderson, Brooke G. and Michelle L. Bell, "Weather-related mortality: how heat, cold, and heat waves affect mortality in the United States," *Epidemiology (Cambridge, Mass.)*, 2009, *20* (2), 205.

Arrow, Kenneth J., "Uncertainty and the Welfare Economics of Medical Care," *The American Economic Review*, 1963, *53* (5), 941–973.

Brekke, Kurt R., Tor Helge Holmås, Karin Monstad, and Odd Rune Straume, "Do treatment decisions depend on physicians' financial incentives?," *Journal of Public Economics*, 2017, *155*, 74–92.

Chandra, Amitabh, David Cutler, and Zirui Song, "Chapter Six - Who Ordered That? The Economics of Treatment Choices in Medical Care," in Mark V. Pauly, Thomas G. Mcguire, and Pedro P. Barros, eds., *Handbook of Health Economics*, Vol. 2 of *Handbook of Health Economics*, Elsevier, 2011, pp. 397 – 432.

Chernew, Michael E., Allison B. Rosen, and A. Mark Fendrick, "Value-Based Insurance Design: By abandoning the archaic principle that all services must cost the same for all patients, we can move to a high-value health system.," *Health Affairs*, 2007, *26* (Suppl2), w195–w203.

Clemens, Jeffrey and Joshua D Gottlieb, "Do physicians' financial incentives affect medical treatment and patient health?," *American Economic Review*, 2014, *104* (4), 1320–49.

_ **and Joshua D. Gottlieb**, "In the shadow of a giant: Medicare's influence on private physician payments," *Journal of Political Economy*, 2017, *125* (1), 1–39.

Codespote, Suzanne M., William J. London, and John D. Shatto, ""Physician Volume & Intensity Response," Memorandum to Richard S. Foster, Office of the Actuary," *Health Care Financing Administration August*, 1998, *13.*

Congressional Budget Office, "Factors Underlying the Growth in Medicare's Spending for Physicians' Services," Background Paper 2597, The Congress of the United States 2007.

Cromwell, Jerry and Janet B Mitchell, "Physician-induced demand for surgery," *Journal of health economics*, 1986, *5* (4), 293–313.

Currie, Janet, Wanchuan Lin, and Wei Zhang, "Patient knowledge and antibiotic abuse: Evidence from an audit study in China," *Journal of Health Economics*, 2011, *30* (5), 933 – 949.

Domenighetti, Gianfranco, Antoine Casabianca, Felix Gutzwiller, and Sebastiano Martinoli, "Revisiting the most informed consumer of surgical services: the physician-patient," *International journal of technology assessment in health care*, 1993, *9* (4), 505–513.

Dowell, Scott F. and Mei Shang Ho, "Seasonality of infectious diseases and severe acute respiratory syndrome–what we don't know can hurt us," *The Lancet Infectious Diseases*, 2004, *4* (11), 704 – 708.

Dranove, David and Paul Wehner, "Physician-induced demand for childbirths," *Journal of health economics*, 1994, *13* (1), 61–73.

Dunn, Abe and Adam Hale Shapiro, "Physician competition and the provision of care: evidence from heart attacks," *American Journal of Health Economics*, 2018, *4* (2), 226–261.

Enthoven, A., "Consumer-Choice Health Plan," *New England Journal of Medicine*, 1978, *298*, 650–658, 709–720.

Evans, Robert G, "Supplier-induced demand: some empirical evidence and implications," in "The economics of health and medical care," Springer, 1974, pp. 162–173.

FOPH, *Inhalt der Änderung und Kommentar Verordnung über die Festlegung und die Anpassung von Tarifstrukturen in der Krankenversicherung* Federal Office of Public Health 2017.

Fuchs, Victor R., "The Supply of Surgeons and the Demand for Operations," *The Journal of Human Resources*, 1978, *13*, 35–56.

Gottschalk, Felix, Wanda Mimra, and Christian Waibel, "Health services as credence goods: A field experiment," 2018.

Gruber, Jon, John Kim, and Dina Mayzlin, "Physician Fees and Procedure Intensity: The Case of Cesarean Delivery," *Journal of Health Economics*, 1999, *18* (4), 473–490.

Gruber, Jonathan and Maria Owings, "Physician Financial Incentives and Cesarean Section Delivery," *Rand Journal of Economics*, Spring 1996, *27* (1), 99–123.

Hao, Lingxin and Daniel Naiman, *Quantile Regression*, SAGE Publications, Inc., 2007.

Hostettler, Stefanie and Esther Kraft, "FMH-Ärztestatistik 2017 – aktuelle Zahlen," *Schweizerische Ärztezeitung*, 2018, *99* (1314), 408–413.

Johnson, Erin M. and M. Marit Rehavi, "Physicians treating physicians: Information and incentives in childbirth," *American Economic Journal: Economic Policy*, 2016, *8* (1), 115–41.

London, Wayne P. and James A. Yorke, "Recurrent outbreaks of measles, chickenpox and mumps: I. Seasonal variation in contact rates," *American journal of epidemiology*, 1973, *98* (6), 453–468.

McClellan, Mark, "Reforming payments to healthcare providers: The key to slowing healthcare cost growth while improving quality?," *Journal of Economic Perspectives*, 2011, *25* (2), 69–92.

McGuire, Thomas G, "Physician agency," *Handbook of health economics*, 2000, *1*, 461–536.

_ **and Mark V Pauly**, "Physician response to fee changes with multiple payers," *Journal of health economics*, 1991, *10* (4), 385–410.

Moineddin, Rahim, Jason X. Nie, Gabrielle Domb, Alan M. Leong, and Ross E. G. Upshur, "Seasonality of primary care utilization for respiratory diseases in Ontario: a time-series analysis," *BMC Health Services Research*, 2008, *8* (1), 160.

OECD, "System of Health Accounts 1997-2017," Online 2019.

Pietro, Carlo De, Paul Camenzind, Isabelle Sturny, Luca Crivelli, Suzanne Edwards-Garavoglia, Anne Spranger, Friedrich Wittenbecher, and Wilm Quentin, "Switzerland: health system review.," *Health Systems in Transition*, 2015, *17* (4), 1–288.

Reinhardt, Uwe E., "The Economist's Model of Physician Behavior," *JAMA*, 02 1999, *281* (5), 462–465.

Rice, Thomas H., "The impact of changing Medicare reimbursement rates on physician-induced demand," *Medical care*, 1983, pp. 803–815.

Schmid, Christian, "Consumer Health Information and the Demand for Physician Visits," *Health Economics*, 2015, *24* (12), 1619–1631.

Schmid, Christian P. R., Konstantin Beck, and Lukas Kauer, "Health Plan Payment in Switzerland," in Thomas G. McGuire and Richard C. van Kleef, eds., *Risk Adjustment, Risk Sharing and Premium Regulation in Health Insurance Markets*, Academic Press, 2018, chapter 16, pp. 453–489.

Schwartz, Aaron L., Bruce E. Landon, Adam G. Elshaug, Michael E. Chernew, and J. Michael McWilliams, "Measuring low-value care in Medicare," *JAMA internal medicine*, 2014, *174* (7), 1067–1076.

Stano, Miron, "An analysis of the evidence on competition in the physician services markets," *Journal of Health Economics*, 1985, *4* (3), 197 – 211.

Wilkinson, Paul, Sam Pattenden, Ben Armstrong, Astrid Fletcher, R. Sari Kovats, Punam Mangtani, and Anthony J. McMichael, "Vulnerability to winter mortality in elderly people in Britain: population based study," *BMJ: British Medical Journal*, 2004, *329* (7467), 647.

Yip, Winnie C., "Physician response to Medicare fee reductions: changes in the volume of coronary artery bypass graft (CABG) surgeries in the Medicare and private sectors," *Journal of Health Economics*, dec 1998, *17* (6), 675–699.

Zweifel, Peter, Friedrich Breyer, and Mathias Kifmann, "Health economics," *Berlin/Heidelberg*, 1997, *22009.*

Appendix

A Calculation of Relative Value Units

This section describes the calculation of the *TARMED*'s relative value units in more detail. The relative value units of a service are the sum of two components that account for the medical and the technical component of providing a service. Equation (6) illustrates this. The two components are described in the following.

$$\text{relative value units}_{s,i} = \text{MS}_{s,i} + \text{TS}_{s,i} \tag{6}$$

Medical component of relative value unit. The medical component MS_s reimburses medical work with the patient. The relative value units for the medical component is determined by six parameters.

$$MS_s = \frac{reference\ income \times dignity\ factor_i}{annual\ work\ load \times productivity_s} \times Scaling_i \times Minutage_s^M + (assistance_s) \tag{7}$$

- reference income = CHF 207,000
- dignity factor 0.905-2.2625 (pre-reform), 0.985 (post-reform), reimburses education and qualification, depends on specialty
- annual workload = 115,200 minutes
- productivity 45%-100%, depends on service (more specifically on the functional unit, *Sparte*, e.g. doctors office, types of OP).[44] The parameter measures the share of billable time. Basically: the time spent with patients as a percentage of total annual work time. Example: 0.85 for consultations.
- Scaling Factor. Adjusts for the different training durations. Scaling factor of 1 for all specialties except 0.93 for medical practitioner (*praktischer Arzt*). (Before 2018: 1 for all specialties) (shorter).
- medical assistance: only where applicable, depends on service
- Minutage is the (normative) time necessary to provide the service. Calculations based on cost models (GRAT, KOREG, ROKO for physician practices, INFRA for hospitals)

[44] A functional unit is an area of a practice where a certain bundle of services is provided. Each unit is characterized by a specific infrastructure (space, fixed and mobile equipment) and by a certain number of non-medical staff.

Technical component of relative value unit. The technical component TS_s reimburses the infrastructure and practice expenses that are necessary for providing a certain service. Relative value units are based on two parameters.

$$TS_s = cost\ per\ minute_s \times Minutage_s^T \tag{8}$$

- Costs per minute account for direct and indirect costs for infrastructure, material, wages (non-medical staff) etc. per minute. The numbers are based on cost models (GRAT, KOREG, ROKO for physician practices, INFRA for hospitals). The costs per minute vary by functional unit (*Sparte*), e.g. operation, consultation in doctor's office etc.
- Minutage measures the necessary time to provide a service. Numbers are determined in the same cost models.

B Compositional Changes

The *TARMED* reform changed the composition of a number of services. We summarize these *compositional changes* by the five categories described below. Each type is illustrated by a specific example and by the respective revenue share.

(1) Splitting services into finer, comparable sets. This intervention splits a given service into a set of new services, targeted at a specific patient population (e.g. children, elderly). The most important service in this category is "*Konsultation, jede weiteren 5 Min.*" (service ID 00.0020). Starting from 2018Q1, physicians have to indicate the age group of their patient. This intervention forces physicians to report in more detail. As this is rather affecting the administrative burden and not the nature of the service it seems reasonable that these services are comparable over time. Thus, services falling into this category are included in our estimations. These services account for 14.1% of aggregate revenue between 2015Q4 and 2018Q4.

(2) Splitting services into finer, non-comparable sets. This category contains only one service, "*Glaskörperbiopsie für zytologische Diagnostik u/o intravitreale Injektion*" (service ID 08.3350). This service was divided into two new services both taking care of one part of the original biopsy. Thus, the sum of the new services cannot be compared to the old service. This category accounts for 0.5% of aggregate revenue between 2015Q4 and 2018Q4.

(3) Changing the Minutage. For a number of services, the *actual* time necessary to provide the service can be charged in fixed time intervals. One intervention changed the length of these intervals. Most prominently, this intervention affected the service "*Ärztliche Leistung in Abwesenheit des Patienten (inkl. Aktenstudium), pro 5 Min.*" (service ID 00.0140). This used to be a rather vague service compensating the time a physician worked in the absence of the patient. The federal government decided to split the service into 24 new, and finer, services, as well as to change the *Minutage* interval from five to one minute. As a result, physicians need to report more precisely. It is reasonable to assume that this change aims at holding the physicians (more) accountable for what they charge when patients are not present. The 24 new categories are hardly comparable to the old service. Thus, these types of services are excluded from the regressions. This category accounts for 6.4% of aggregate revenue between 2015Q4 and 2018Q4.

(4) Introduction of Minutage. This measure aimed at how services are charged. Starting from 2018Q1 physicians have to report how long it took them to provide the services affected by this change. Most prominently, this concerns "*Kleine Untersuchung durch den Facharzt für Grundversorgung*" (service ID 00.0410). (Additionally, this service was also split into a finer set. Therefore, it is also affected by the first type of changes, discussed above.) The introduction of *Minutage* changes the nature of the services and thus makes the comparability over time infeasible. These services account for 5.6% of aggregate revenue between 2015Q4 and 2018Q4.

(5) Changing restrictions. This category contains only one service, "*Instruktion von Selbstmessungen, Selbstbehandlungen durch den Facharzt, pro 5 Min.*" (service ID 00.0610). For this service, an additional limitation was introduced: The service can be charged at most three times per visit. Including this service into our estimation would result in biased estimates as physicians are potentially restricted regarding their substitution behavior, post-reform. (Additionally, this service was also split into a finer set. Therefore, it is also affected by the first type of changes, discussed above.) This category accounts for 0.6% of aggregate revenue between 2015Q4 and 2018Q4.

C Prediction for Individual Quantities

We predict physician-specific service volume based on pre-reform observations. In a first step, the aggregate average change in quantity was computed for service s and physician speciality g. In a second step, a percentage prediction for every service and physician speciality pair was computed. Finally, it is assumed that physicians within the same speciality share the same percentage changes of their quantities.

$$\text{Step 1:} \quad \overline{\Delta Q}_{g,s,j} = \frac{1}{T/4} \sum_{j}^{T/4} \Delta Q_{g,s,j+4k} \qquad j \in \{1,2,3,4\}$$

$$\text{Step 2:} \quad \%\hat{Q}_{g,s,j_{2018}} = \left(Q_{g,s,j_{2018}-4} + \overline{\Delta Q}_{g,s,j} \right) / \, Q_{g,s,j_{2018}-4}$$

$$\text{Step 3:} \quad \hat{Q}_{i,s,j_{2018}} = \left(1 + Q_{i,s,j_{2018}-4}\right) \%\hat{Q}_{g,s,j_{2018}}$$

D Tables

Table I: Descriptive Statistics, Quarterly Means

	2015	2016	2017	2018
Number of Quarters	1	4	4	4
Physician Statistics				
Revenue (CHF)	85,656	85.725	90,239	91,919
	(135,588)	(139,849)	(150,878)	(152,306)
Quantity	4,492	4,484	4,667	4,784
	(5,769)	(5,854)	(6,203)	(6,916)
Consultations	708	792	769	837
	(722)	(790)	(779)	(919)
BITE				0.010
				(0.044)
Distinct Services	36	36	36	36
Aggregate Statistics				
Cost (Million CHF)	1,031	1,074	1,178	1,198
Predicted Cost (Million CHF)				1,262
Number of Physicians	12,031	12,528	13,051	13,036
Distinct Services (overall)	2,112	2,109	2,105	2,170
Observations	432,739	1,784,300	1,862,569	1,879,592

Notes: Panel A of this table reports quarterly means for physicians in our estimation sample. Panel B reports aggregate statistics for the estimation sample. Standard deviations in parentheses.

Table II: Substitution Model: Regression Estimates

	Δ lnQ		
	(1) Linear	(2) Kink	(3) Quadratic
$\Delta \ln P$	0.253^{***}	0.979^{***}	0.368^{***}
	(0.013)	(0.031)	(0.020)
$1(\Delta lnP < 0)\Delta \ln P$		-0.894^{***}	
		(0.035)	
$(\Delta lnP)^2$			0.174^{***}
			(0.021)
R^2	0.095	0.090	0.095
adj. R^2	0.090	0.085	0.090
N Phys $\times$ Quarter	155,481	155,481	155,481
N	28,687,618	28,687,618	28,687,618

Notes: The table shows estimates for the substitution model. The outcome variable is $\Delta \ln Q$ in all columns. All models additionally include a constant, service fixed effects, and physician-by-quarter fixed effects. Observations are weighted with the prior-year quarter log revenue. Standard errors are clustered at the physician-and-quarter level in parentheses, *** $p < 0.001$ ** $p < 0.01$, * $p < 0.05$.

Table III: Substitution Model: Regression Estimates II

	(1)	
	$\Delta \ln Q$	
$\Delta \ln P$	0.452***	(0.048)
× Dermatologists	0.413***	(0.124)
× OB-GYN	−0.122	(0.072)
× Psychiatrists	−1.660***	(0.181)
× Ophthalmologists	0.133	(0.104)
× Oto-Rhino Laryngologists	−0.072	(0.154)
× Pediatricians	0.233*	(0.110)
× Radiologists	−0.498***	(0.115)
× GPs	0.149**	(0.058)
× Cardiologists	0.593***	(0.133)
× Gastroenterologists	−0.478***	(0.101)
× Medical Practitioners	−0.215	(0.126)
× Group practices	−0.130	(0.086)
$(\Delta \ln P)^2$	0.503***	(0.149)
× Dermatologists	2.305**	(0.847)
× OB-GYN	0.806	(0.469)
× Psychiatrists	−5.404**	(1.960)
× Ophthalmologists	−0.239	(0.162)
× Oto-Rhino Laryngologists	1.631	(1.055)
× Pediatricians	−1.047	(1.231)
× Radiologists	−0.401	(0.398)
× GPs	−0.085	(0.167)
× Cardiologists	1.354***	(0.405)
× Gastroenterologists	−0.617***	(0.170)
× Medical Practitioners	−0.487**	(0.177)
× Group practices	−0.440**	(0.169)
R^2	0.096	
adj. R^2	0.091	
N Phys × Quarter	155,481	
N	28,687,618	

Notes: The table shows estimates for the substitution model (quadratic fit) where the fee parameters vary for the twelve largest medical specialties. The outcome variable is $\Delta \ln Q$ in all columns. All models additionally include a constant, service fixed effects, and physician-by-quarter fixed effects. Observations are weighted with the prior-year quarter log revenue. Standard errors clustered at the physician-and-quarter level in parentheses,
*** $p < 0.001$ ** $p < 0.01$, * $p < 0.05$.

Table IV: Total Healthcare Supply: Regression Estimates (Consultations)

	Δ ln Consultation	
	(1)	(2)
	Baseline	Covariates
BITE (quarterly)	1.090***	0.935***
	(0.009)	(0.009)
BITE × Radiologists	−1.345***	−1.205***
	(0.028)	(0.027)
BITE × Cardiologists	−2.171***	−2.006***
	(0.022)	(0.022)
BITE × Gastroenterologists	−2.601***	−2.445***
	(0.027)	(0.026)
Covariates (Prior Year Quarter):		
Limited Services(Revenue Share)		−0.425***
		(0.013)
# Distinct Services		−0.005***
		(0.000)
Female (Revenue Share)		0.203***
		(0.013)
Young (Revenue Share)		−0.194***
		(0.007)
Morbid (Revenue Share)		−0.056***
		(0.010)
Low Deductible (Revenue Share)		−0.030***
		(0.005)
Physician Density		0.365***
		(0.007)
Constant	−0.005***	−0.421***
	(0.000)	(0.023)
R^2	0.254	0.267
adj. R^2	0.246	0.259
N Physician	9,973	9,973
N Physician × Quarter	870,354	870,354

Notes: The table shows estimates for the consultation model. Observations are weighted with the prior-year quarter log revenue. All models include physician fixed-effects. The covariates in column (2) measure prior-year-quarter levels of the number of distinct services, the cantonal physician density, and the revenue share of services that face some limitations. Further, we account for differences in the patient groups by including the revenue shares of the following groups: women, young (below age 36), morbid (hospital stay in the previous year), low deductible (CHF 300). Standard errors clustered at the physician-and-quarter level in parentheses, *** $p < 0.001$ ** $p < 0.01$, * $p < 0.05$.

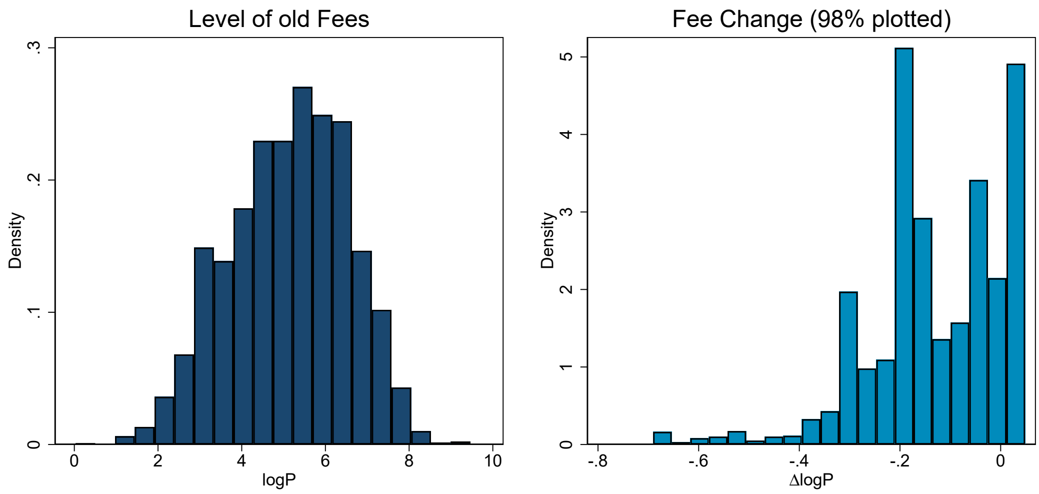
Table V: Total Health Care Supply: Regression Estimates (Counterfactual)

	Behavioral Change (1) Baseline	(2) Covariates
Mechanical Change	-0.008	-0.168^{***}
	(0.031)	(0.039)
Mechanical Change × Psychiatrists	-1.080^{***}	-1.284^{***}
	(0.282)	(0.295)
Mechanical Change × Radiologists	0.051	0.118
	(0.181)	(0.191)
Mechanical Change × Cardiologists	-0.511^{*}	-0.087
	(0.222)	(0.229)
Mechanical Change × Gastroenterologists	-0.831^{**}	-0.508
	(0.255)	(0.263)
Limited Services (Revenue Share)		-0.076^{***}
		(0.013)
# Distinct Services		-0.000
		(0.000)
Female (Revenue Share)		0.013
		(0.012)
Young (Revenue Share)		0.066^{***}
		(0.008)
Morbid (Revenue Share)		0.133^{**}
		(0.043)
Low Deductible (Revenue Share)		0.015
		(0.014)
Physician Density		0.009^{***}
		(0.001)
Psychiatrists	-0.034^{***}	-0.052^{***}
	(0.009)	(0.010)
Radiologists	0.013	0.030
	(0.024)	(0.025)
Cardiologists	-0.021	-0.009
	(0.024)	(0.025)
Gastroenterologists	-0.054	-0.047
	(0.030)	(0.031)
Constant	-0.036^{***}	-0.034
	(0.001)	(0.018)
N	13,881	13,771

Notes: The table shows median regression estimates for the counterfactual model. Observations are weighted with the prior-year log revenue. The covariates in column (2) measure prior-year levels of the number of distinct services, the cantonal physician density, and the revenue share of services that face some limitations. Further, we account for differences in the patient groups by including the revenue shares of the following groups: women, young (below age 36), morbid (hospital stay in the previous year), low deductible (CHF 300). Standard errors in parentheses, *** $p < 0.001$ ** $p < 0.01$, * $p < 0.05$.

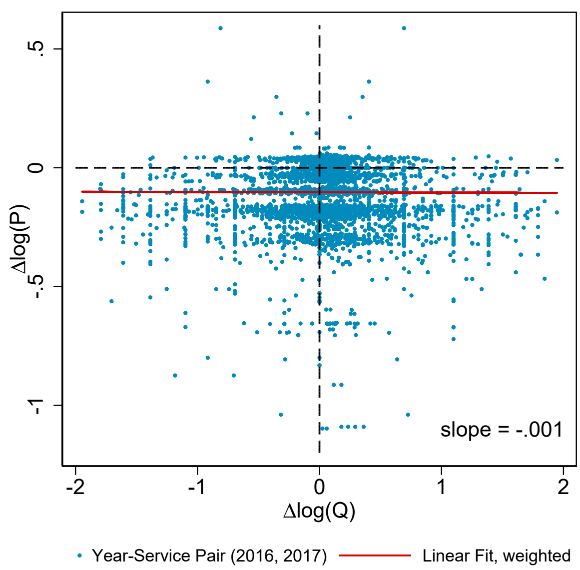
E Figures

Figure 1: Distribution of Pre-Reform Fees and Fee Changes



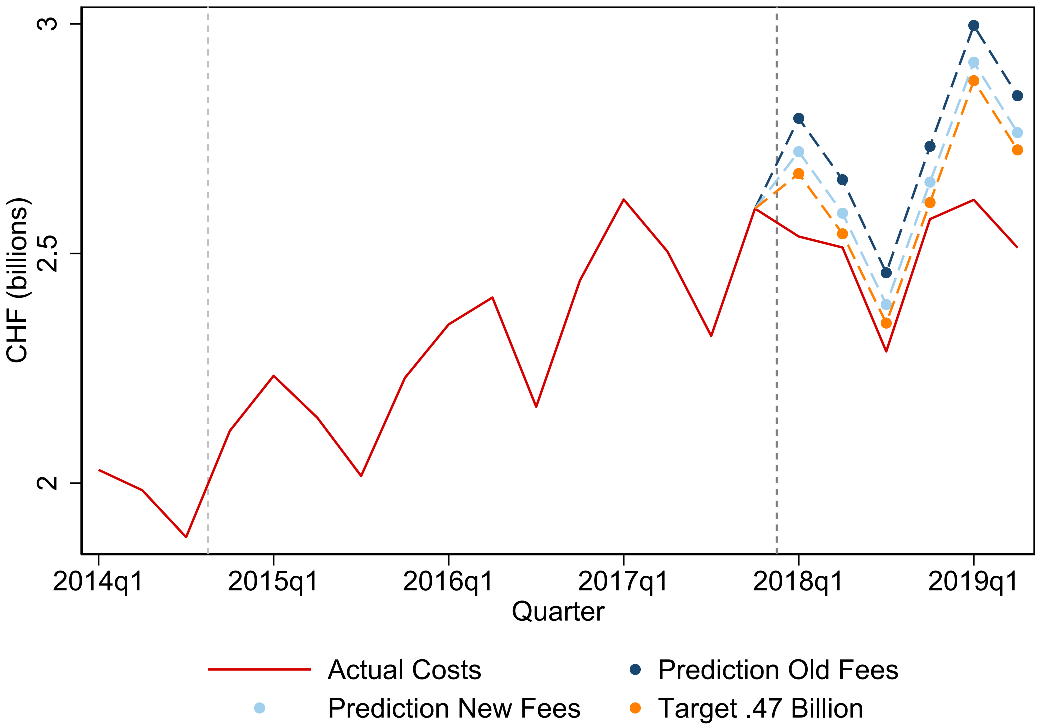
Note: Both figures are based on the estimation sample. To increase readability, the right panel excludes outliers (bottom and top percentile).

Figure 2: Pre-Treatment Changes in Service Volumes



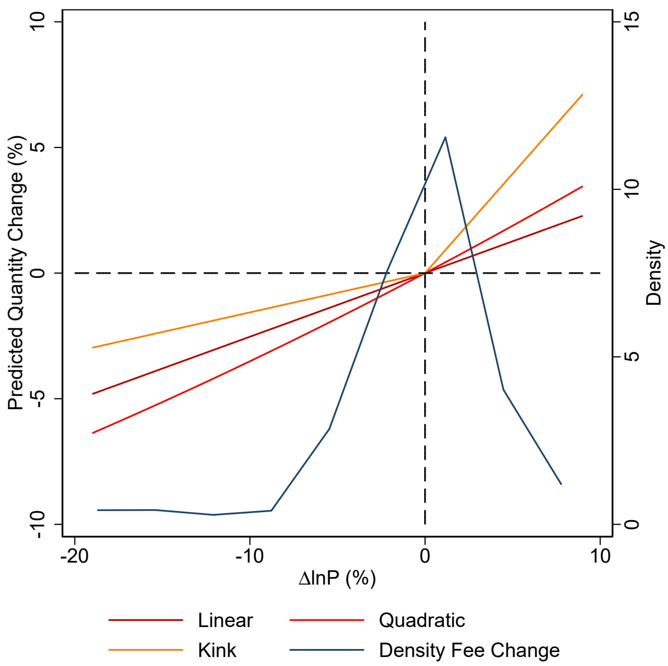
Note: The figure shows pre-reform changes in service volumes and relative fee changes for each service. The linear fit uses pre-year revenue weights.

Figure 3: Total and Predicted Costs (Quarterly)



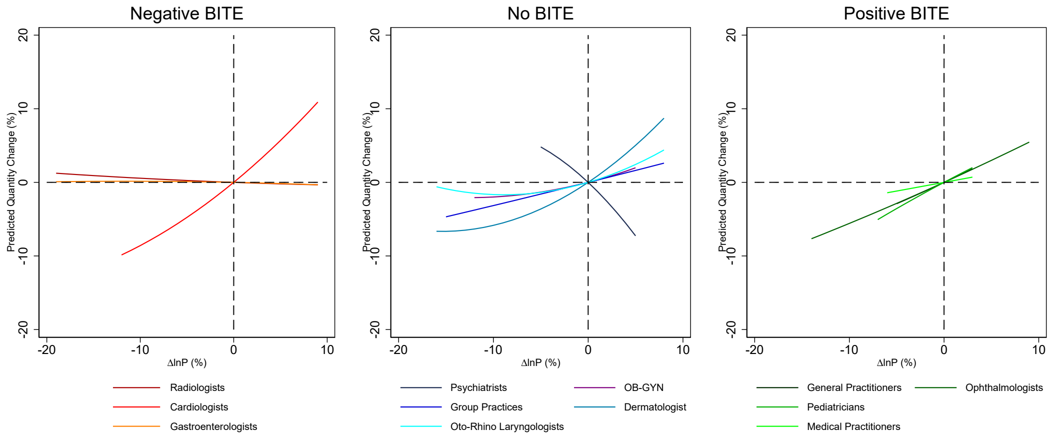
Note: The figure plots aggregate quarterly revenue for the outpatient sector covered by MHI. The figure is based on cleaned data including irregularly working physicians, hospitals and services affected by compositional changes.

Figure 4: Substitution Pattern



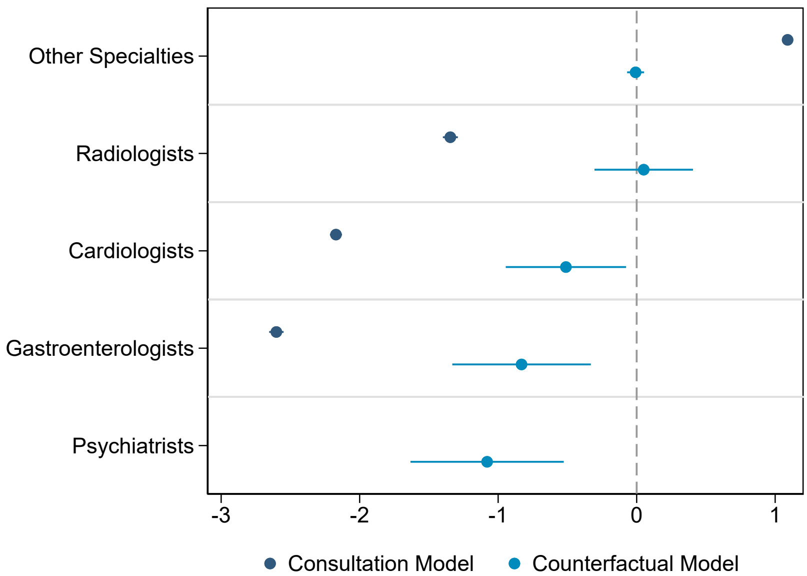
Note: The figure shows the predicted quantity change by fee change based on the estimated fee parameter(s) β_1 from three specifications: a linear term in the fee variable, complemented by an interaction of the fee with an indicator variable for a fee decrease (*kink*), or a quadratic term (*quadratic*). Observations are weighted with the prior-year quarter log revenue. The density represented in this graph is the pdf of the centered fee changes, weighted with the same weights used for the regression models.

Figure 5: Substitution Pattern by Physician Specialty



Note: The figure shows the predicted quantity change by fee change for the twelve largest specialties. Predictions are based on the quadratic specification from Figure 4: the model includes a quadratic term for $\Delta \ln P$ that also varies for the twelve largest specialties. Observations are weighted with the prior-year quarter log revenue. Higher order terms do not alter the interpretation. The substitution pattern is plotted for 90% of the fee changes within the physician specialty.

Figure 6: Total Healthcare Supply



Note: This Figure plots the slope coefficients of the models outlined in Subsection 5.2 (point estimates and 95% confidence intervals). Observations are weighted with either the prior-year log revenue (counterfactual model) or the prior-year quarter log revenue (consultation model).

F Additional Tables

Table VI: Descriptive Statistics: Quarterly BITE by Medical Specialty (Top 12)

	Mean	SD	Median	IQR	Min	Max	N
Dermatologist	0.017	0.022	0.022	0.029	−0.099	0.045	1,422
OB-GYN	0.019	0.012	0.020	0.011	−0.097	0.046	3,882
Psychiatrists	−0.030	0.010	−0.036	0.014	−0.091	0.047	7,827
Ophthalmologists	0.005	0.076	0.034	0.008	−0.461	0.043	2,518
Oto-Rhino Laryngologists	0.024	0.018	0.030	0.016	−0.090	0.042	1,172
Pediatricians	0.040	0.013	0.043	0.006	−0.088	0.050	3,196
Radiologists	−0.109	0.059	−0.130	0.059	−0.209	0.018	495
GPs	0.043	0.011	0.046	0.005	−0.129	0.083	16,119
Cardiologists	−0.090	0.034	−0.094	0.047	−0.215	0.038	1,337
Gastroenterologists	−0.099	0.035	−0.099	0.035	−0.209	0.029	696
Medical Practitioners	0.031	0.011	0.032	0.011	−0.094	0.052	2,849
Group practices	0.009	0.058	0.029	0.032	−0.468	0.050	1,218
Total	0.014	0.046	0.034	0.058	−0.468	0.083	42,731

Notes: The table shows descriptive statistics for the quarterly BITE variable by medical specialty for the estimation sample. N is physicians × quarter.

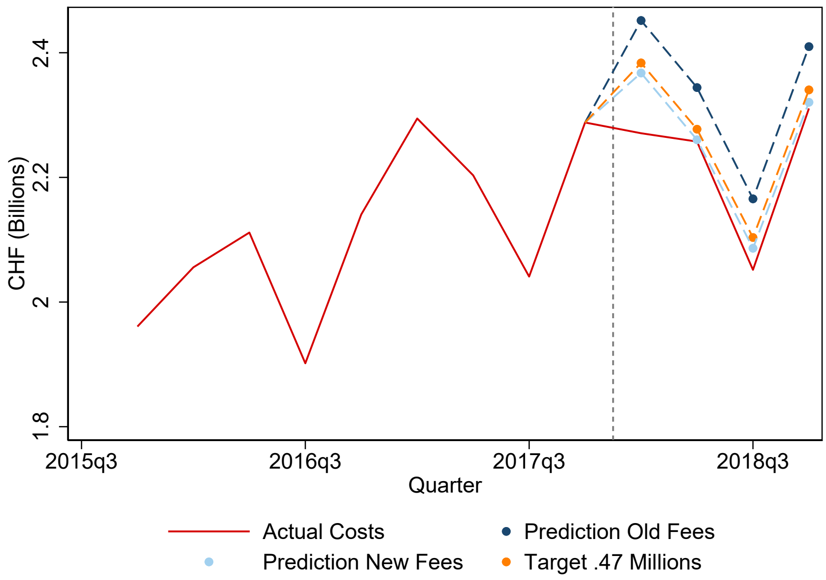
Table VII: Descriptive Statistics: BITE by Medical Specialty (Non-Top 12)

	Mean	SD	Median	IQR	Min	Max	N
Anaesthesiologists	−0.002	0.045	−0.004	0.068	−0.138	0.053	290
Surgeons	−0.006	0.043	−0.001	0.058	−0.139	0.242	740
Endocrinologists	−0.021	0.024	−0.019	0.032	−0.089	0.047	368
Pneumologists	−0.024	0.030	−0.025	0.037	−0.095	0.048	532
Neurosurgeons	−0.009	0.041	0.004	0.065	−0.144	0.049	189
Neurologists	−0.042	0.033	−0.044	0.050	−0.146	0.047	805
Child psychiatrists	−0.026	0.011	−0.027	0.018	−0.052	0.046	1,109
Orthopaedic Surgeons	0.013	0.033	0.023	0.032	−0.129	0.346	1,487
Urologists	−0.000	0.020	0.003	0.022	−0.097	0.036	662
Rheumatologists	−0.014	0.026	−0.018	0.035	−0.082	0.048	965
Angiologists	−0.035	0.012	−0.035	0.014	−0.069	−0.002	304
Hematologists	−0.001	0.032	0.002	0.047	−0.088	0.046	119
Physical Medicine and Rehabilitation	0.006	0.025	0.009	0.035	−0.055	0.043	179
Allergologists	−0.009	0.025	−0.009	0.029	−0.068	0.041	247
Medical Oncologists	−0.000	0.018	−0.002	0.021	−0.058	0.049	362
Nephrologists	0.004	0.024	0.007	0.019	−0.085	0.037	106
Pathologists	−0.031	0.015	−0.030	0.024	−0.083	−0.009	80
Plastic/Reconstructive Surgeons	−0.046	0.049	−0.056	0.077	−0.127	0.044	262
Other	−0.013	0.057	0.006	0.080	−0.174	0.051	293
Total	−0.013	0.036	−0.013	0.048	−0.174	0.346	9,099

Notes: The table shows descriptive statistics for the quarterly BITE variable by medical specialty for the estimation sample. "Other" contains specialties with 15 or fewer observations per quarter. N is physicians × quarter.

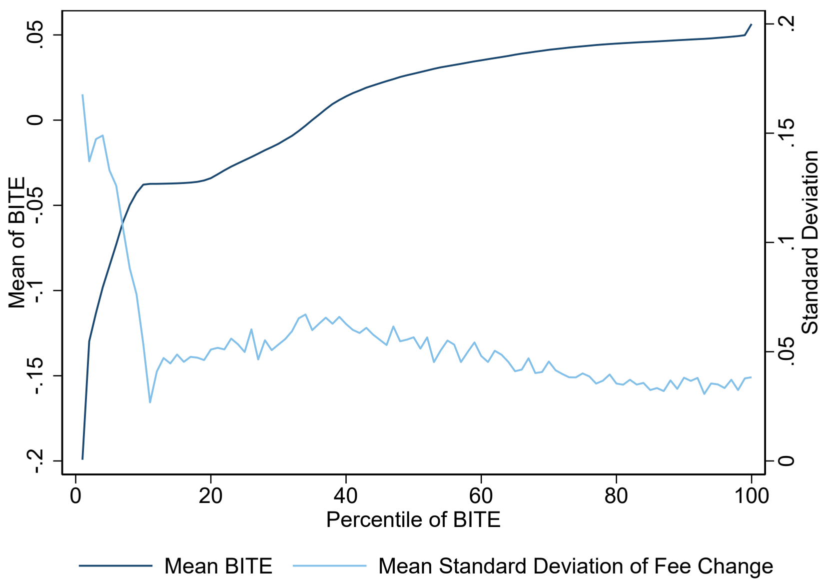
G Additional Figures

Figure 7: Total and Predicted Costs, Estimation Sample (Quarterly)



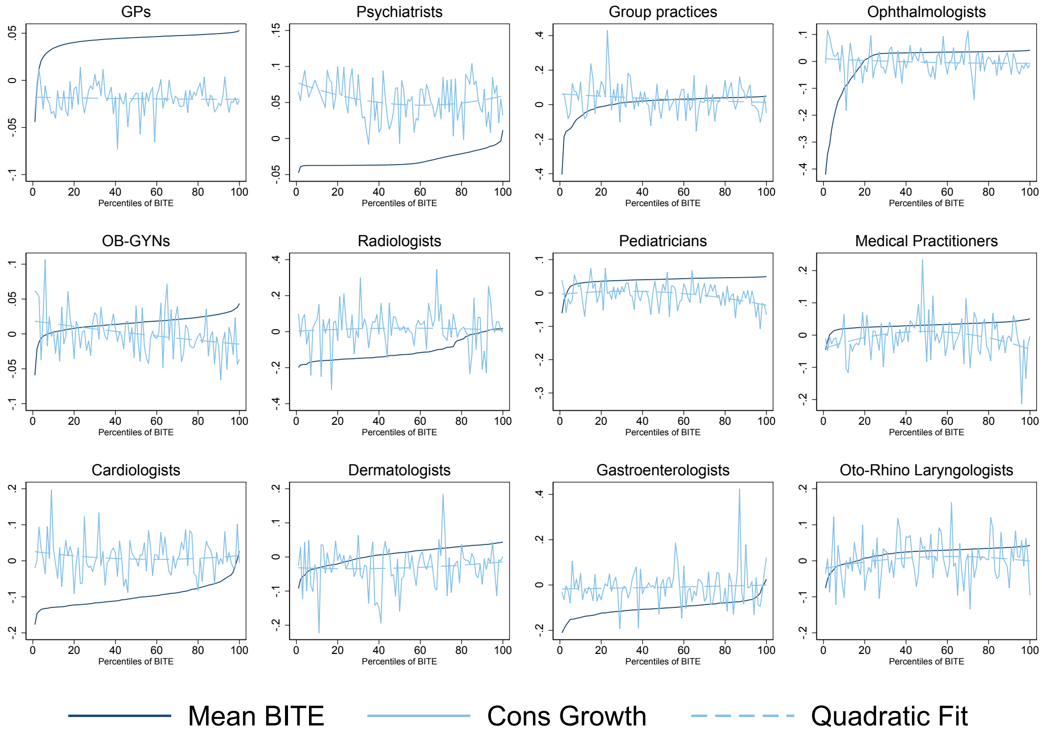
Note: The figure plots aggregate quarterly revenue for the outpatient sector covered by MHI. Data is based on the estimation sample.

Figure 8: Distribution and Standard Deviation of BITE



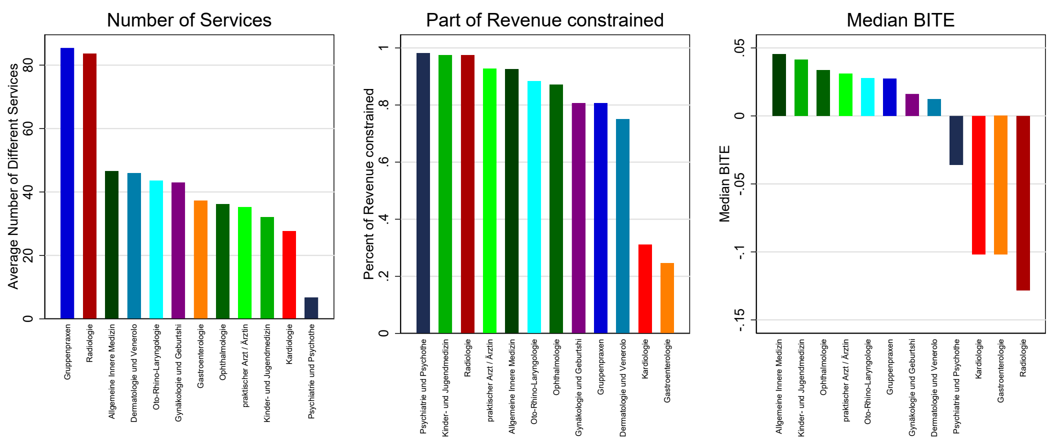
Note: The figure plots the average *BITE* by the percentiles of *BITE*. The light blue line plots the standard deviation of *BITE* within those percentiles.

Figure 9: Pre-reform Consultation Growth by BITE



Note: The figure plots average BITE, consultation growth and the quadratic fit by percentiles of BITE for the 12 largest specialties for the pre-reform period.

Figure 10: Statistics for the Top 12 specialties



Note: This figure is based on the estimation sample. The color coding is the same as in Figure 5