

Labour supply, service intensity, and contracts: Theory and evidence on physicians

Bernard Fortin, Nicolas Jacquemet, Bruce Shearer

▶ **To cite this version:**

Bernard Fortin, Nicolas Jacquemet, Bruce Shearer. Labour supply, service intensity, and contracts: Theory and evidence on physicians. Journal of Applied Econometrics, 2021, 36 (6), pp.686-702. 10.1002/jae.2840 . hal-03426996

HAL Id: hal-03426996
https://hal.science/hal-03426996

Submitted on 12 Nov 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Labour Supply, Service Intensity, and Contracts: Theory and Evidence on Physicians*

Bernard Fortin† Nicolas Jacquemet‡ Bruce Shearer§

March 2021

Abstract

Based on linked administrative and survey panel data, we analyze the labour supply behaviour of physicians who could adopt either a standard fee-for-service contract or a mixed remuneration (MR) contract. Under MR, physicians received a *per diem* and a reduced fee for services provided. We present estimates of a structural discrete choice model that incorporates service intensity (services provided per hour) and contract choice into a labour supply framework. We use our estimates to predict (*ex ante*) the effects of contracts on physician behaviour and welfare, as measured by average equivalent variations. The supply of services is reduced under a MR contract, suggesting incentives matter. Hours spent seeing patients is less sensitive to incentives than the supply of services. Our results suggest that a reform forcing all physicians to adopt the MR system would have substantially larger effects on physician behaviour than were measured under the observed reform. A pure salary (*per diem*) reform would sharply reduce services but would increase time spent seeing patients.

Keywords: Practice Patterns of Physicians, Labour Supply, Service Intensity, Fee-for-Service Contract, Mixed Remuneration Contract, Discrete Choice Models.

JEL codes: C25, J22, J33, I10, J44.

*The authors thank the *Collège des médecins du Québec* for making its survey data available and the *Régie de l'assurance-maladie du Québec* and Marc-André Fournier for the construction of the database. This article was partly written while Fortin and Shearer were visiting the University Paris 1 Panthéon-Sorbonne. We thank participants at the Maurice Marchand Meeting in Health Economics (Lyon), the ADRES workshop on the Econometric Evaluation of Public Policies (Paris), the Canadian Economics Association (Montréal), the European Workshop on Econometrics and Health Economics (Thessalonique), the European Economic Association (Vienna) and the Econometric Society Winter Meeting. We also thank seminar participants at CREST, the Free University of Amsterdam and Paris-Dauphine University. We are grateful to Michel Truchon as well as Bruno Crépon, Arnaud Dellis, Brigitte Dormont, Pierre-Yves Geoffard, Guy Laroque, Pierre-Thomas Léger, Pierre-Carl Michaud, Marie-Claire Villeval, and three referees for useful discussions or comments. We acknowledge research support from the Canadian Institute of Health Research (CIHR), le Fonds de recherche du Québec en société et culture (FRQSC), the Canada Research Chair in Social Policies and Human Resources at the Université Laval, and the program "Investissements d'Avenir" from the french National Research Agency (ANR-10–LABX-93-0).

†Département d'économique, Université Laval, CRREP and CIRANO. Bernard.Fortin@ecn.ulaval.ca.

‡Paris School of Economics and University Paris I Panthéon-Sorbonne. Nicolas.Jacquemet@univ-paris1.fr.

§Département d'économique, Université Laval, CRREP and CIRANO. Bruce.Shearer@ecn.ulaval.ca.

1 Introduction

In the face of ageing population and rising demand for healthcare, improving knowledge of physicians' labour supply is a crucial research issue for policy makers and economists. While the literature on this topic has grown rapidly in recent years (see the survey by Lee et al., 2019), a number of important issues are still to be addressed. Physicians can affect their output at work through two basic margins (see McGuire, 2000): their hours spent seeing patients and their volume of services provided per hour (or service intensity). Yet, empirical studies of physicians' labour supply typically concentrate on either hours of work (Showalter et al., 1997; Baltagi et al., 2005; Andreassen et al., 2013; Kalb et al., 2018) or the volume of services (Delvin and Sarma, 2008; Kantarevic et al. 2008; Clemens and Gottlieb, 2014) . Generalized models, which simultaneously analyze decisions over hours and service intensity permit a more complete portrait of physician behaviour and allow for a richer policy evaluation environment.

Physicians' decisions on these margins will typically depend on the nature of their payment contract. Under a fee-for-service (FFS) system, a physician receives a fee for each service competed, providing strong incentives to supply services. The same physician paid per hour worked under a salary (SA) contract is likely to supply more hours of work, but fewer services per hour. These incentive effects are important determinants of the aggregate supply of health care. A mixed remuneration (MR) contract, which combines elements from both FFS and a SA contracts, will affect the physician' decisions over the supply of hours and services, depending on the relative payment for services and hours completed. These contracts can also generate important selection effects, attracting physicians with different productivity characteristics and preferences. The total effect of any contract on the supply of health care will therefore depend on its incentive and selection effects and whether or not contracts are chosen by physicians or are mandatory.

The contributions of this paper are threefold. First, we develop and estimate a structural labour-supply model of physicians that analyses decisions over both hours worked and services per hour. Second, we incorporate physician choices over contracts, creating a natural setting within which to study selection and incentives. Third, our structural model allows us to simulate the impact of counterfactual reforms of payment systems on physicians' labour supply behaviour (e.g., free

MR system, mandatory MR or SA systems, variable or constant cost reforms). We use our model to analyze physician labour supply behaviour under different payment systems. We also provide evaluation of some reforms in terms of physicians' welfare, as measured by Average Equivalent Variation (EV) and applied to a discrete choice model.

We apply our model to a sample of specialist physicians (pediatricians) working in the Province of Quebec (Canada) between the years 1996-2002. Our unique data set links administrative and survey data. It contains information on physician labour supply (weekly hours spent seeing patients, and weeks worked per year) as well as the number of services provided by each physician per year and their payments. This sample period also spans an important reform in physician compensation which we exploit to identify our model. Prior to 1999, most specialist physicians in Quebec (92%) worked in the public sector and were paid FFS contracts. In 1999, the government introduced a non-mandatory MR scheme, under which physicians received a (half) *per diem*, paid for 3.5 hours worked, and a reduced fee per service.

To account for the endogenous choice of a compensation system by physicians, we derive the efficient budget constraint that maximizes physician income for each possible combination of hours and services supplied. We pay careful attention to the institutional constraints imposed on contracts within the Quebec Healthcare System (for instance, income ceilings, regionally differentiated remuneration, and constraints on the choice of the compensation system at the individual level). These features give rise to a non-linear efficient budget constraint. We therefore discretize the choice set available to physicians (Zabalza et al., 1980; van Soest, 1995) .

We estimate the model by solving for the utility function parameters that generate the observed practice patterns as optimal choices. To account for selection we allow for heterogeneity in preferences, estimating a mixed-logit model (McFadden and Train, 2000). The voluntary nature of the reform further complicates estimation. The decision to adopt MR was not individual specific, but determined by a vote at the department level. Consequently, individual physicians could be constrained in their choice of a compensation system. Accounting for constraints on choice leads to a mixture of likelihoods wherein the probability of being constrained is estimated along with the other parameters.

Estimating utility-function parameters permits the simulation of physician behaviour under different compensation systems. Our results suggest the changes in incentives brought about by the 1999 reform significantly affected physician behaviour. Services completed decreased by 5.2%. What is more, service intensity decreased by 5.1% (implying fewer services were completed per clinical hour). A mandatory reform, forcing all physicians to work under MR, would have reduced services by 12.0%. The reform was also costly, increasing payments to physicians by 11.3%. This is due to the large *per diem* that physicians were paid for working under MR. We therefore investigate the effects of a constant-cost reform, under mandatory participation in MR. Under such circumstances, services provided would decrease relative to the FFS contract by 9.5%, the hours worked would increase by 2.9% and service intensity would decrease by 9.5%. Finally, we provide an analysis of the impact of replacing a FFS contract by a cost-preserving pure salary (half *per diem*) scheme. Our model predicts that such a reform would increase physicians' hours of work by 7.3% and would reduce total services by 20.2%. Service intensity (*i.e.*, services per hour) would decrease by 23.7%. This suggests that the reform would induce doctors to spend much more time with their patients.

2 Institutions: Physician Remuneration in Quebec

Physicians in Quebec have traditionally been paid FFS contracts. Under this system, physicians receive a fee for each service provided. The fees are service specific, accounting for the difficulty and time intensiveness of the service provided. Our empirical work will account for these differences by constructing index numbers of services and prices. We use p to denote the aggregate price for services and S to denote the aggregate service.

In 1999, the government introduced an MR scheme for specialist physicians. Under MR contracts, physicians receive a wage (or *per diem*) for time spent at work in hospitals. *Per diems* are paid for blocks of $\overline{d} = 3.5$ hours of work, paying $\mathcal{D} = 300\$$ each.[1] During these periods a physician is allowed to perform certain activities, including seeing patients, administrative services, and teaching. Research activities are not covered. A physician can claim up to 28 *per diems* over a two-week period. Services provided under a *per diem* period are classified as billable or non-billable. Billable

[1] All dollar figures presented in the text are measured in Canadian dollars.

services are remunerated at a reduced fee per service, αp, with $0 < \alpha \leq 1$.[2] Non-billable services (mostly physicians' follow-up visits) are not remunerated under a *per diem* period: $\alpha = 0$.

MR physicians do not necessarily spend all of their time under the *per diem*. Clinical services (billable and non-billable) provided outside of the *per diem* are paid at the same rate as for FFS physicians, p. Let θ denote the proportion of time spent (and services provided) under the *per diem* by MR physicians. If $\mathcal{N}$ denotes the average number of *per diems* claimed per week throughout the year, and $\mathcal{W}$, the number of weeks worked during the year, then a physician who supplies S^B total billable services and S^{NB} total non-billable services will have annual income

$$\widehat{X}^{MR} = \mathcal{W}\mathcal{N}\mathcal{D} + (1-\theta)pS^{\mathrm{NB}} + \theta\alpha pS^{\mathrm{B}} + (1-\theta)pS^{\mathrm{B}}. \tag{1}$$

Under FFS contracts physicians are remunerated for both billable and non-billable services. Annual income is given by

$$\widehat{X}^{FFS} = p(S^{\mathrm{B}} + S^{\mathrm{NB}}). \tag{2}$$

An important determinant of relative potential earnings under FFS and MR contracts is θ. In our empirical work we estimate its value from the proportion of total time worked spent under the *per diem*. Details are given in (Fortin, Jacquemet, and Shearer, 2021, Section B).[3]

3 Data and Summary Statistics

Our data contain information on the labour supply behaviour and individual characteristics of physicians practising in Quebec between 1996 and 2002. These data come from two sources: a time-use survey conducted annually by the Quebec College of Physicians and the administrative records of the Health Insurance Organization of Quebec (RAMQ). The time survey provides information on the average number of hours per week physicians spent seeing patients, as well as hours spent performing teaching and administrative duties. Since the MR reform occurred in the last quarter

[2] The value of α is specialty and service specific. Its average over all billable services in our sample is approximately 0.3.

[3] Since most physicians in our sample period have a yearly income implying the highest marginal (provincial + federal) tax rate, the latter is likely to be constant for most physicians. Thus we ignore income taxes in our analysis.

of 1999, we eliminated 1999 and 2000 from our empirical analysis, as these years correspond to a period of transition to the reform. Also, we assume that annual weeks worked are exogenous and set equal to their average over the period ($W = 46$) for each individual. Weeks worked exhibits very little variation in our data, and its inclusion had no effect on previous versions of the estimated model (Fortin, Jacquemet, and Shearer, 2010). Moreover, this allows us to include 2001 in our sample, a year for which the time-survey does not provide information on weeks worked. The survey also includes information on the personal characteristics of each physician, including age and gender.

The RAMQ is a public organization, responsible for paying physicians in Quebec. It has administrative records containing the billing information on each physician working in the province, including the number of services provided, the prices paid for those services and income. These data are available on a quarterly basis. Data from these two sources were matched (anonymously) on the basis of physician billing numbers.

Physicians provide a variety of different services, each remunerated at different rates. To keep our estimation problem tractable, we aggregated services to form a quantity index of services provided, distinguishing only between billable and non-billable services. We weighted the different types of services by the fee received for that service. This provides a control for the difficulty in providing the service. The way the partial observability of non-billable services is treated when a physician is under MR is discussed in Section 4.3.

Price variation is excluded from the index by holding price weights constant at the base year levels. These weights are the base-year prices paid to FFS physicians; they are the same for both billable and non-billable services. The price data for different services was also aggregated into indexes for billable and non-billable services, under FFS and MR. The price index for services provided under FFS, denoted p, was calculated as a Laspeyres price index. The average number of each type of service provided in the base year served as the weight for the price of that service. The index for services provided under MR, denoted αp, was similarly calculated by aggregating the fees paid for individual services under MR. Here we also used the average quantities of each service provided among FFS in the base year as weights. In this way, the MR price index excludes

quantity variations due to MR switching. The precise calculations underlying all indexes are given in Fortin, Jacquemet, and Shearer (2021, Section A).

The empirical model that we estimate is numerically intensive, involving multidimensional integrals. In order to limit computational time we restricted the sample to one specialty: pediatrics. This specialty provides high variability in the participation in MR (58% of pediatricians opted for MR in the year 2001) and in the marginal incentives to perform services. The MR system was popular among pediatricians due to the fact that medical services generally take longer to complete in pediatrics, penalizing them under FFS. Focusing on one specialty also reduces the problem of heterogeneity in the nature of services provided.

Summary statistics for the sample period are provided in Table 1. We divide the sample into Before MR Reform (1996 to 1998) and After MR Reform (2001-2002) and on the basis of physicians who remain under FFS or switch to MR (the panel is unbalanced due to flows in and out of the population of physicians over the period). A physician is considered to have switched to MR if he is paid (at least in part) under the MR system during the sample period. Note that patients are not informed about the compensation scheme that applies to the physician they see. Moreover, waiting lists were very long in Quebec during the sample period. As a result, it is unlikely that the changes in practice patterns that are observed upon the adoption of MR are due to changes in the patient mix that physicians face.

The top part of the table provides information on the professional practice behaviour of the physicians in our sample, disaggregated into the four categories considered. We define the following variables:

$$
\begin{aligned}
X &\quad \text{Annual income, measured in thousands of (1996) Canadian dollars,} \\
h^c &\quad \text{Weekly clinical hours (seeing patients),} \\
h^o &\quad \text{Weekly non-clinical hours (administrative work and teaching),} \\
S^{\mathrm{B}} &\quad \text{Volume of billable services supplied throughout the year,} \\
S^{\mathrm{NB}} &\quad \text{Volume of non-billable services supplied throughout the year.}
\end{aligned}
\tag{3}
$$

Table 1: Summary Statistics on Sampled Physicians

	FFS physicians		MR physicians	
	Before	After	Before	After
	Observed practice			
Weekly Total Hours	43.09	41.92	48.64	46.73
	[13.01]	[12.83]	[12.67]	[10.62]
____ clinical (h^c)	38.69	38.85	41.38	39.02
	[12.79]	[11.62]	[13.73]	[12.62]
____ non-clinical (h^o)	4.40	3.07	7.26	7.71
	[8.36]	[8.20]	[9.62]	[10.33]
Total Services[a]	167.00	167.94	141.81	122.19
	[66.83]	[72.88]	[56.16]	[72.24]
____ Non-billable (S^{NB})	71.85	73.22	60.94	55.19[b]
	[47.02]	[57.50]	[36.20]	[46.62]
____ Billable (S^B)	95.15	94.73	80.88	67.00
	[55.47]	[57.44]	[49.21]	[46.07]
Service intensity $\left(=\frac{S^{NB}+S^B}{h^c * W}\right)$	96.01	89.28	74.51	62.79
	[101.69]	[38.01]	[34.91]	[34.18]
Annual income[a] (X)	157.60	163.40	138.95	160.53
	[62.30]	[67.99]	[52.76]	[53.58]
	Sample characteristics			
Number of physicians	139	123	111	99
Number of observations	355	206	267	175
Gender (Male = 1)	0.66	0.65	0.52	0.55
	[0.47]	[0.48]	[0.50]	[0.50]
Age	49.89	52.70	43.07	47.26
	[11.17]	[11.04]	[10.04]	[10.03]

[a] In thousands of (1996) Can. Dollars.
[b] Lower bound for MR physicians after the reform.
Note. The upper part provides the average practice behaviour of Quebec pediatricians included in our sample, split according to their choice of compensation scheme—FFS physicians are those who never adopt MR during the observation period, MR physicians are those who switch to MR—and the period—before (1996-1998) and after (2001-2002) the reform. The bottom part of the Table summarizes individual characteristics. Standard deviations appear in brackets.
Definitions of Variables: h^c Clinical hours (seeing patients); h^o Non-clinical hours (administration and teaching); S^{NB} Non-billable Services; S^B Billable Services; W average number of weeks worked; X Income.

Service intensity, s, is measured as the number of services completed per clinical hour worked, that is, $s = (S^B + S^{NB})/(h^c * W)$, and is thus a function of these variables. We present the average and standard deviation of each variable. The bottom part of the table presents summary statistics on the demographic characteristics of physicians in each of the different categories.

Changes in behaviour are suggested from the Before and After columns among the MR physicians. The average volume of services supplied by MR physicians decreased after switching to MR from 142 to 122. This change, in the order of 13.8%, is suggestive of a substantial reaction to incen-

tives among those treated by the reform.[4] Notice that this is composed of changes in both billable and non-billable services. The table shows that the supply of both types of services decreased after the introduction of the reform, although one must bear in mind that non-billable services are only partially observed after the reform. There is a 17.0% decrease in billable services, from 81 to 67.

Other behavioural changes are also suggested by the table. MR physicians sharply decreased their service intensity from 83 to 70 , a decrease of 15.7%. This decrease in services performed per hour is largely due to the change in services provided—weekly clinical hours worked changes relatively little with the reform (from 41 to 39, a decrease in the order of 5%). The increase in income among the FFS physicians that is observed after the introduction of MR is due to the government increasing the fees paid per service.[5] MR physicians' earnings increased much more (in percentage) than those of FSS physicians (15.5% *vs* 3.7%). This suggests that the introduction of the *per diem* offset any loss of earnings due to a reduction of services provided and hours worked. The standard deviation of earnings is also higher (post reform) under FFS contracts (80) than under MR (62). This reflects the absence of the per diem and higher fee-for-service payments under FFS contracts.

Table 1 also points to potentially important selection effects in the data. There are notable differences between MR and FFS physicians prior to the reform, both in terms of hours worked (MR physicians provided 6.9% more clinical hours and 65.0% more non-clinical hours of work than FFS physicians) and in terms of service intensity (MR physicians provided 15% fewer total services before the reform than FFS physicians). The difference in services leads to a substantial difference in annual income. Pre-reform, MR physicians earned approximately 13.4% less income.

One important part of the explanation for these results is likely to be selection on observables (in particular, gender and age). Table 1 shows that before reform, 66% of FFS physicians were male, while only 52% of MR physicians were male. This indicates that the proportion of females who switched to MR (59%) is larger than that of males (39%). This is perhaps unsurprising since the female physicians work fewer hours and provide fewer services than do the male physicians in our sample. Thus female physicians had more incentive to adhere to the MR system. Also, before

[4]This is a similar order of magnitude to the treatment effect (on the treated) calculated by Dumont et al. (2008) among pediatricians (12.8%) using difference-in-differences techniques.

[5]The reaction of FFS physicians to this increase is studied extensively in Shearer, Somé, and Fortin (2019).

reform, MR physicians are younger (43 years on average) than physicians who remained under FFS (50 years on average). This may partly be explained by the presence of preference habits that are likely to be stronger for older physicians.

While Table 1 provides a number of interesting statistics, more sophisticated econometric approaches are needed to isolate the effect of the reform on behaviour. As well, taking account of unobserved heterogeneity will allow us to control for the selection on unobservables as well as to control for exogenous observable variables. Finally, structural estimation will allow us to evaluate the effects of other payment systems, not observed in the sample period.

4 Empirical Model

We specify preferences as a function of annual consumption, leisure and services

$$u = u(X, h^o, l, S^{\mathrm{B}}, S^{\mathrm{NB}}), \tag{4}$$

where the variable definitions are as in (3). We allow for two types of services: billable, denoted S^{B}, and non-billable, denoted S^{NB}. Recall that non-billable services are not remunerated under MR. We assume that they enter directly in the physicians' utility function (ensuring they will be supplied). This can be due to physicians gaining utility from patient health (Arrow, 1963; Evans, 1974), or to these services being complements in the production of billable services. We also assume that time spent on administrative and teaching services enter utility directly as a form of on-the-job leisure, h^o. For example, performing teaching tasks may increase influence and prestige. We denote the total weekly hours by h^t (with $h^t = h^c + h^o$). Pure leisure is denoted by l. The weekly time constraint is given by $l = T - h^c - h^o$, where $T = 168$, the maximum amount of time available in a week. We allow for differences in the marginal utility (or disutility) of billable and non-billable services to capture possibly different service intensity levels to complete these tasks.

4.1 Endogenous Compensation System Choice

We model the choice of a compensation system by constructing the *efficient budget constraint*, that maximizes physician income for any hours and services combination. To proceed we assume the marginal utility of income is U_X is positive and that preferences are (directly) independent of the compensation system. This implies that a rational physician will always select the compensation system that maximizes income for a given hours and services combination. We therefore proceed in two steps: first we determine the efficient budget constraint, the upper envelope of income, X, attainable from each value of $(h^c, h^o, S^{\text{NB}}, S^{\text{B}})$. Let $\boldsymbol{S} = (S^{\text{NB}}, S^{\text{B}})'$ and $\boldsymbol{h} = (h^c, h^o)$ denote vectors. Then the efficient budget constraint is given by

$$X(\boldsymbol{h}, \boldsymbol{S}; w, p, \alpha) = \underset{D \in \{0,1\}}{\text{Max}} [(1 - D)X^{FFS}(\boldsymbol{h}, \boldsymbol{S}; w, p) + DX^{MR}(\boldsymbol{h}, \boldsymbol{S}; w, p, \alpha)], \tag{5}$$

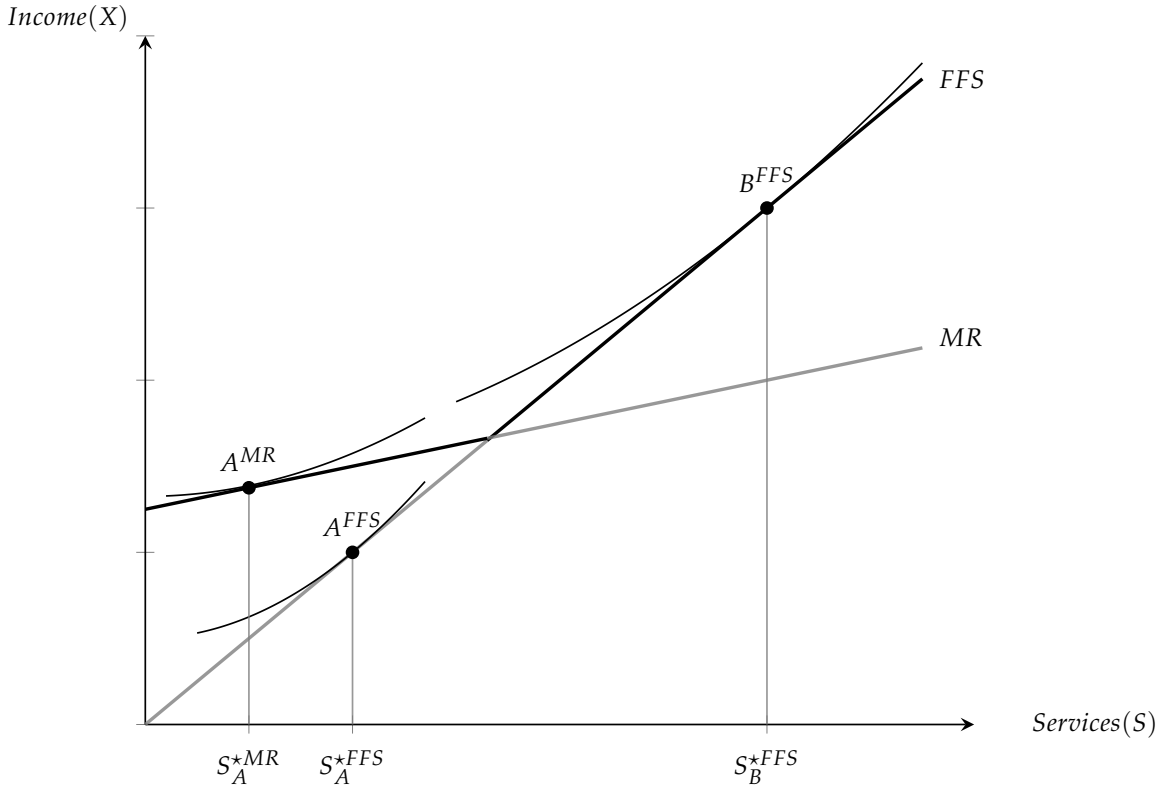
The complete details of how $X^{MR}(\boldsymbol{h}, \boldsymbol{S}; w, p, \alpha)$ is calculated is given in Fortin, Jacquemet, and Shearer (2021, Section B). Second, the physician chooses the $(X^\star, \boldsymbol{h}^\star, \boldsymbol{S}^\star)$ combination that maximizes his utility subject to $X = X(\boldsymbol{h}, \boldsymbol{S}; w, p, \alpha)$. The choice of a compensation system is then given by

$$D(\boldsymbol{h}^\star, \boldsymbol{S}^\star; w, p, \alpha) = \underset{D \in \{0,1\}}{\arg\,\text{Max}} [(1 - D)X^{FFS}(\boldsymbol{h}^\star, \boldsymbol{S}^\star; w, p) + D(X^{MR}(\boldsymbol{h}^\star, \boldsymbol{S}^\star; w, p, \alpha)]. \tag{6}$$

This is illustrated in Figure 1 which considers the tradeoff between services (assumed unidimensional) and consumption (income), conditional on $h^\star_{FFS}$, the optimal hours under the FFS system. For simplicity, it is assumed that a physician under MR is never under FFS. The budget line FFS has slope p, the marginal monetary return to completing services under FFS. It passes through the origin because hours are not remunerated under FFS. The values of (S, X) chosen under FFS correspond to the optimal values $S^\star_{FFS}$ and $X^\star_{FFS}$. The line MR illustrates the tradeoff between services and income under MR, holding hours fixed at $h^\star_{FFS}$. It cuts the y-axis at $wh^\star_{FFS}$ and has slope equal to αp, reflecting the reduced FFS payments received under MR. The efficient budget constraint associated with the transformed program is given by the bold line. It is piece-wise linear and non-convex. This raises well-known problems for optimization and labour supply estimation (Hausman, 1985).

Figure 1 also illustrates potential problems of self-selection. Workers who have a preference for

Figure 1: Optimal Choices Along the Efficient Budget Constraint



Note. The Figure illustrates the endogenous selection into compensation schemes based on physicians preferences. Clinical hours are held constant.

low service intensity levels (such as worker A, who chooses $S_A^{\star FFS}$ under FFS) will tend to choose MR, while those who have a preference for high service intensity levels (such as worker B, who chooses $S_B^{\star FFS}$ under FFS) will tend to choose FFS.

A few important remarks are in order concerning our model. First, we omit the quality of services from the utility function. We acknowledge that this is a strong assumption, but it is necessary in the absence of data on quality. We cannot identify the structural effect of quality on health without data on health outcomes. Second, by incorporating services (rather than unobservable effort) and hours (both of which are observable) directly into the utility function, we ignore agency problems and moral hazard. Third, we assume that the physicians have complete control over their practice variables—freely choosing both their hours of work and their clinical services. This rules out constraints to supply or any demand shocks that might affect a physician's practice, allowing us

to concentrate on the supply side of the medical market. We also assume that the group of services that physicians provide is exogenously fixed, which allows us to ignore corner solutions. Finally, our model ignores physicians' risk preferences, which potentially affect their behaviour and their choice of contracts (Dohmen and Falk, 2011). However, given the high level of excess demand for medical services in Quebec, risk is unlikely to be of first-order importance to physician behaviour. Below, we develop a generalized version of our model that takes into account voting constraints on contract choices, to explain why physicians are sometimes observed working under suboptimal contracts. Another reason why we ignore risk preferences is that it would likely be difficult to separately identify the effects of voting constraints from risk preferences, without extraneous information on physician wealth (Ackerberg and Botticini, 2002) or preference-revealing lotteries (Holt and Laury, 2002; Bellemare and Shearer, 2013).

4.2 Discrete Alternatives Choice Probabilities and the Utility Function

Given the non-linearities in the efficient budget constraint after the MR reform, we follow van Soest (1995) and Hoynes (1996) and discretize the physicians' choice set. We allow for $N_c = 4$ levels of clinical hours of work, $N_o = 4$ levels of non-clinical hours of work, $N_{S^{\text{B}}} = 5$ levels of billable services, and $N_{S^{\text{NB}}} = 5$ levels of non-billable services. The complete choice set of practice variables involves $dim(J) = N_c \times N_o \times N_{S^{\text{B}}} \times N_{S^{\text{NB}}} = 400$ alternatives. A single alternative, corresponding to one particular practice possibility, is a set of values: $j = \{c_j, o_j, S_j^{\text{B}}, S_j^{\text{NB}}\}$ respectively pointing to the ${c_j}^{th}$ level of discretized clinical hours of work, $c_j \in \{1, ..., N_c\}$, the ${o_j}^{th}$ level of discretized non-clinical hours of work, *etc*. The consumption under each alternative is computed through the efficient budget constraint along which the physician maximizes utility.

Let V_{ijt} stand for the annual utility of physician i in alternative j in year t. Following McFadden (1974), we decompose V_{ijt} into a deterministic component, u_{ijt}, and a random term, ϵ_{ijt}, which is independent across alternatives: $V_{ijt} = u_{ijt} + \epsilon_{ijt}$, where $\epsilon_{ijt} \sim$ i.i.d. Gumbel.

The deterministic component of utility is specified as a quadratic function, which constitutes a

flexible function in the sense of Diewert (1971):

$$u_{ijt} = \boldsymbol{\gamma}'\mathbf{z}_{ijt} + \mathbf{z}'_{ijt}\boldsymbol{\beta}\mathbf{z}_{ijt} + \gamma_{S^{\text{NB}}}S^{\text{NB}}_{ijt} + \boldsymbol{b}'_{S^{\text{NB}}}\mathbf{z}_{ijt}S^{\text{NB}}_{ijt} + \beta_{S^{\text{NB}}}(S^{\text{NB}}_{ijt})^2. \tag{7}$$

where the practice characteristics that are fully observable are denoted by $\boldsymbol{z} = (h^o,\ T - h^o - h^c,\ S^{\text{B}},\ X)'$, those for which we observe a lower bound to the actual number performed, S^{NB}_j, and where

$$\boldsymbol{\beta} = \begin{pmatrix} \beta_o & \beta^l_o & \beta^{S^{\text{B}}}_o & \beta^y_o \\ \beta^l_o & \beta_l & \beta^{S^{\text{B}}}_l & \beta^X_l \\ \beta^{S^{\text{B}}}_o & \beta^{S^{\text{B}}}_l & \beta_{S^{\text{B}}} & \beta^X_{S^{\text{B}}} \\ \beta^y_o & \beta^X_l & \beta^X_{S^{\text{B}}} & \beta_x \end{pmatrix}; \boldsymbol{\gamma} = \begin{pmatrix} \gamma_o \\ \gamma_l \\ \gamma_{S^{\text{B}}} \\ \gamma_X \end{pmatrix}; \boldsymbol{b}_{S^{\text{NB}}} = \begin{pmatrix} \beta^{S^{\text{NB}}}_o \\ \beta^{S^{\text{NB}}}_l \\ \beta^{S^{\text{B}}}_{S^{\text{NB}}} \\ \beta^X_{S^{\text{NB}}} \end{pmatrix}.$$

4.3 Estimation

To begin, we consider the case for which S^{NB} is fully observable.[6] A physician chooses alternative j if: $V_{ij} \geq V_{ik},\ \forall k \neq j$. The individual contribution to the likelihood function is the probability of this event occurring, that is

$$\mathcal{L}_{ij} = P\left[V_{ij} \geq V_{ik},\ \forall k \neq j\right] = P\left[\epsilon_{ij} \geq u_k - u_j + \epsilon_{ik},\ \forall k \neq j\right] = \frac{exp(u_j)}{\sum_{k=1}^{J} exp(u_k)}. \tag{8}$$

Several features of our data set necessitate modifications to the standard estimation methodology and likelihood function. First, to account for the partial observability of non-billable services when a physician is under MR, we assume that the non-billable services are supplied under the *per diem* and outside of the *per diem* in proportion to the time spent under the *per diem*, θ. Let S^{NB}_{NPD} denote the observable number of non-billable services supplied outside of the *per diem* while under MR. Similarly, let S^{NB}_{PD} denote the unobservable number of non-billable services supplied while on the *per diem* under MR and let S^{NB}_{Total} denote total number of non-billable services supplied. Then $S^{\text{NB}}_{Total} = S^{\text{NB}}_{NPD}/(1-\theta)$ and $S^{\text{NB}}_{PD} = \theta S^{\text{NB}}_{Total} = \theta/(1-\theta)S^{\text{NB}}_{NPD}$.

Let X^d_{jt} denote income associated with compensation system $d \in \{MR, FFS\}$ and choice variables: $h^o_j,\ T - h^o_j - h^c_o,\ S^{\text{B}}_j,\ S^{\text{NB}}_j$. Further, let $\tilde{X}_{ijt} = \max\{X^{MR}_{ijt}, X^{FFS}_{ijt}\}$ denote the maximum income

[6] For notational simplicity, we ignore the index t, except when needed for clarity.

available for choice j. We define the following vectors of observable characteristics associated with alternative $j \in \{1, 2, \dots J\}$

$$z_{jt}^d = (h_j^o,\ T - h_j^o - h_o^c,\ S_j^{\text{B}},\ S_j^{\text{NB}},\ X_{jt}^d)' \tag{9}$$

$$\tilde{\boldsymbol{z}}_{jt} = (h_j^o,\ T - h_j^o - h_o^c,\ S_j^{\text{B}},\ S_j^{\text{NB}},\ \tilde{X}_{jt})'. \tag{10}$$

We use $u_i(\boldsymbol{z}_{jt})$ to denote observable utility as a function of $\boldsymbol{z}$. Discretizing the choice set allows us to estimate the model without imposing quasi-concavity, but does require the marginal utility of consumption to be positive at all chosen points along the budget constraint (van Soest, 1995). The quadratic utility function does not impose positive marginal utility. We will therefore check whether it is satisfied at the optimum for each individual and each period in our sample. Using flexible function forms also entails some disadvantages. In particular, the model loses parsimony and we are unable to interpret the parameters directly in terms of economic fundamentals.

4.3.1 Heterogeneity in Preferences

To account for observable heterogeneity in preferences, we allow the coefficients of (7) to depend on age and a dummy variable indicating male physicians:

$$\gamma_i^k = \gamma_0^k + \gamma_1^k \times Age_i + \gamma_2^k \times DMale_i \quad k = \{o, l, L, S^{\text{B}}, S^{\text{NB}}, X\}, \tag{11}$$

$$\beta_i^k = \beta_0^k + \beta_1^k \times Age_i + \beta_2^k \times DMale_i \quad k = \{o, l, L, S^{\text{B}}, S^{\text{NB}}, X\}. \tag{12}$$

We allow for unobservable heterogeneity by adding error terms to the functions in (11). These terms are individual specific and randomly distributed across the population. Define $\widetilde{\boldsymbol{\gamma}}_{\boldsymbol{i}} = (\widetilde{\gamma}_i^o, \widetilde{\gamma}_i^l, \widetilde{\gamma}_i^{\text{B}})$ to be the vector of random coefficients, where

$$\widetilde{\gamma}_i^{k'} = \gamma_0^{k'} + \gamma_1^{k'} \times Age_i + \gamma_2^{k'} \times DMale_i + \eta_i^{k'} \quad k' = o, l, S^{\text{B}}.$$

We assume that $\eta_i^{k'} \sim N(0, \sigma_{k'})$ and that the η's are mutually independent, and independent of ϵ_j, $\forall j$. We define D_t as a dummy variable equal to one in all years post reform, and zero otherwise. Conditional on η_i, the probability of a sequence of choices by physician i who maximizes his utility

is

$$l_{ij}(\eta_i) = \prod_{t=1}^{T} \left(\frac{exp^{u_i(z_{jt}^{FFS})}}{\sum_{k=1}^{J^C} exp^{u_i(z_{kt}^{FFS})}} \right)^{1-D_t} \left(\frac{exp^{u_i(\tilde{\mathbf{z}}_{jt})}}{\sum_{k=1}^{J^C} exp^{u_i(\tilde{\mathbf{z}}_{kt})}} \right)^{D_t}, \tag{13}$$

which reflects the fact that pre-reform, all physicians were paid under FFS. We impose the efficient budget constraint post-reform, reflecting that physicians will select the compensation system that maximizes their income.

The contribution to the likelihood is the unconditional (mixed logit) probability

$$\mathcal{L}_{ij} = \int_{\eta} l_{ij}(\eta_i) f(\eta) d\eta \tag{14}$$

We estimate the model using simulation methods, averaging each observation over a vector of independent draws of η. Following Train (2009), we account for the panel dimension of our data by evaluating all observations on physician i at the same vector of simulated ηs. We identify the utility-function parameters by restricting the observed decisions to be optimal choices. This requires calculating the utility associated with each alternative available to a physician; that is, each $j \in J$.

4.3.2 Constrained Choice

The actual choice of a compensation system was not individual specific. Rather, members of specialist departments within each hospital determined the compensation system by vote, only adopting the MR system if the vote was unanimously in favour. This raises the possibility that some physicians may be constrained in their choice of a compensation system and, hence, not be located on the efficient budget constraint.[7] However only those physicians who prefer MR are potentially constrained; those who prefer FFS are ensured their unconstrained choice since the voting rule is unanimous. This implies that physicians who are observed on sections of the efficient budget constraint under MR are not constrained. Physicians observed under FFS can be divided into two groups: those who are observed in an alternative j for which $X_j^{MR} > X_j^{FFS}$ are constrained. Those who select alternatives for which $X_j^{MR} < X_j^{FFS}$ are potentially constrained.

[7] We do see a number of physicians (30 in 2002) who are paid FFS contracts when they would earn higher income under MR, for the same practice variables.

To account for constraints on choices, let $\psi_i(\mathbf{x}_i)$ denote the probability that a physician is constrained from attaining the efficient budget constraint. We allow this probability to depend on physician characteristics: gender, age and the region of Quebec in which he/she practices, contained in $\mathbf{x}$. We then define the following observed regimes:

$\mathcal{R}_1$ the physician is observed FFS when only FFS is available (that is, pre-reform observations);

$\mathcal{R}_2$ the physician is observed MR when MR dominates;

$\mathcal{R}_3$ the physician is observed FFS when MR dominates;

$\mathcal{R}_4$ the physician is observed FFS when FFS dominates.

We disregard the case of physicians observed MR while FFS dominates which is ruled out by assumption.[8] Given the constraint only applies post reform, we replace the second term of the likelihood function with

$$\left[[1-\psi_i(\mathbf{x}_i)] \frac{exp^{u_i(\tilde{\mathbf{z}}_{jt})}}{\sum_{k=1}^{J^C} exp^{u_i(\tilde{\mathbf{z}}_{kt})}} \right]^{D_{it2}} \times \left[\psi_i(\mathbf{x}_i) \frac{exp^{u_i(z_{jt}^{FFS})}}{\sum_{k=1}^{J^C} exp^{u_i(z_{kt}^{FFS})}} \right]^{D_{it3}} \times \left[\psi_i(\mathbf{x}_i) \frac{exp^{u_i(z_{jt}^{FFS})}}{\sum_{k=1}^{J^C} exp^{u_i(z_{kt}^{FFS})}} + [1-\psi_i(\mathbf{x}_i)] \frac{exp^{u_i(\tilde{\mathbf{z}}_{jt})}}{\sum_{k=1}^{J^C} exp^{u_i(\tilde{\mathbf{z}}_{kt})}} \right]^{D_{it4}}, \tag{15}$$

where D_{itj} indicates the presence of physician i in regime $\mathcal{R}_j, \forall j \in \{2,3,4\}$. A constrained physician selects his optimal labour supply alternative along the FFS budget constraint rather than the efficient budget constraint. Some caution is warranted in interpreting the parameter ψ. In particular, ψ provides flexibility, allowing the model to explain observations for which a physician is seen to make a seemingly suboptimal choice: selecting FFS when MR would give higher income. Risk preferences can also provide such flexibility. For example, a risk-loving physician may prefer FFS, even

[8] There are only 10 observations that fall into this category; they are classified in $\mathcal{R}_2$. One interpretation of this case is that these physicians make optimization errors.

if MR provided higher income, enjoying the risk that FFS provides. The reader should therefore be aware that ψ may be capturing unobservables other than constraints, such as risk preferences of physicians.

The likelihood function reflects the fact that the constraints on behaviour only apply to regimes $\mathcal{R}_2$—$\mathcal{R}_4$ since $\mathcal{R}_1$ occurs before the reform. Physicians in regime $\mathcal{R}_2$ are unconstrained which occurs with probability $(1-\psi)$. The physicians in regime $\mathcal{R}_3$ are constrained which occurs with probability ψ. The physicians in regime $\mathcal{R}_4$ can be either constrained or unconstrained.

5 Results

5.1 Parameter Estimates, Elasticities and Model Fit

We estimated two versions of the model. The first includes observed and unobserved heterogeneity on utility parameters while the probability of being constrained, ψ, is restricted to be constant. The second (and our preferred) specification allows ψ to depend on observable parameters: gender, age, and regional dummies (indicating metropolitan with university, metropolitan without university and non-metropolitan regions). The results are presented in Fortin, Jacquemet, and Shearer (2021, Table A). The proportion of observations with a negative marginal utility of income is 6.8% in our preferred specification. The average probability of being constrained is equal to 0.54, suggesting that a large proportion of the physicians were constrained in their choice of a compensation system.

We used our estimates to simulate the elasticities of labour supply variables. These suggest modest (negative) hours elasticities with respect to wages and non-labour income and important (negative) income effects in determining the service response with respect to changes in the fees paid for services. See Fortin, Jacquemet, and Shearer (2021, Table B) for the complete results. To analyze the performance of our model we estimated it on a subsample of observations, up to and including 2001. We then used the resulting estimates to predict physician behaviour in 2002. Table 2 compares these predictions with observed outcomes for the year 2002. The last column of the table gives the percent difference between the predicted and observed values. On the whole, the model's fit is very good. For example, predicted weekly hours is within 4.9% of its observed counterpart,

Table 2: Model Fit

	Observed Total	Predicted 2002	Observed 2002	Percent Difference
Weekly Total Hours	44.77	46.05	43.88	4.94
_____ clinical (h^c)	39.50	39.80	38.78	2.63
_____ non clinical (h^o)	5.27	6.25	5.10	22.54
Total Services[a]	147.42	145.06	144.38	0.47
_____ Non-billable (S^{NB})	64.27	61.33	63.59	-3.55
_____ Billable (S^B)	83.15	83.73	80.78	3.65
Service intensity $\left(=\frac{S^{NB}+S^B}{h^c * W}\right)$	74.64	72.89	74.47	-2.12
Annual income[a] (X)	143.71	144.75	142.76	1.39

[a] Thousands of (1996) Can. Dollars.
Note. The cells display the average practice behaviour (in terms of practice variables) observed over the whole sample period (*first column*) and in 2002 (*last column*). The *second column* reports the average practice behaviour predicted by the model estimated on a subsample of observations, that is, up to and including 2001.

total services is within 0.5%, billable services is within 3.6%, and annual income is within 1.4%. The model has more trouble predicting non-clinical hours worked (a difference of 22.5%). Recall, there is no monetary reward for providing non-clinical hours, which may explain the model's difficulty in predicting their value.

We also used our parameter estimates to replicate the data in Table 1. To do so we simulated behaviour separately on the subsamples of physicians who are observed to switch to MR and those who stay under FFS for the whole observation period. Behaviour is simulated along the FFS budget constraint in both subsamples for the 1996-1999 period ('Before') as well as for FFS physicians for the 2001-2002 period ('After'), and along the MR budget constraint for MR physicians for the 2001-2002 period (this budget constraint is the same as the one used for 'Mandatory MR' in Table 4 below). The results are given in Table 3. The simulations replicate the data very well in terms of hours worked. The model captures the reduction in total services amongst MR physicians (although the simulated decrease in billable services is notably smaller than the observed decrease in Table 1). The model also captures the lack of any change in services among FFS physicians (although the level is somewhat underpredicted). Income is underpredicted by the model.

Table 3: Simulated Before-After Comparison

	FFS physicians		MR physicians	
	Before	After	Before	After
	Simulated practice			
Weekly Total Hours	45.73	45.21	46.52	47.24
	(1.418)	(1.192)	(1.844)	(1.541)
____ clinical (h^c)	40.04	39.75	40.33	40.27
	(1.106)	(0.985)	(1.387)	(1.205)
____ non-clinical (h^o)	5.69	5.46	6.20	6.97
	(0.735)	(0.693)	(0.835)	(0.809)
Total Services[a]	155.86	153.17	149.58	135.50
	(4.771)	(4.663)	(4.521)	(5.553)
____ Non-billable[b] (S^{NB})	69.22	67.87	64.83	53.93
	(3.573)	(3.646)	(3.832)	(4.029)
____ Billable (S^B)	86.63	85.30	84.75	81.57
	(3.565)	(3.259)	(3.612)	(3.404)
Service intensity $\left(=\frac{S^{NB}+S^B}{h^c * W}\right)$	77.86	77.07	74.19	67.30
	(1.966)	(1.985)	(2.427)	(2.795)
Annual income[a] (X)	144.53	136.40	141.76	149.83
	(4.175)	(4.114)	(4.153)	(4.914)

[a] Thousands of (1996) Can. Dollars.
Note. The cells display the average practice behaviour (in terms of practice variables) simulated by the model on periods before (1996-1999) and after (2001-2002) on the sub-samples of physicians who never choose the MR system (FFS physicians) and those who switch to MR after (MR physicians). Behaviours are simulated using the FFS budget constraint for FFS physicians, and the mandatory MR budget constraint for MR physicians.

5.2 Policy simulations

Different compensation policies imply different budget constraints, which in turn affect the probabilities of selecting different practice alternatives. Given estimates of the preference parameters we can calculate the (expected) predicted behaviour under different compensation systems by changing the budget constraint. We compute bootstrapped standard errors of this predicted behavior, obtained by repeated random draws of the model parameters from their estimated distributions and by recalculating predicted behavior for each draw.

5.2.1 The Observed Reform

We begin our analysis of different reforms by simulating the effects of the observed policy—the introduction of the MR system as a constrained choice on the part of physicians. We compare predicted behaviour under FFS (the first column of Table 4) to that under the MR system, taking account of the probability of being constrained. The budget constraint under MR is then the mixture

Table 4: Treatment Effects of MR

	FFS	Group Free MR		Individual Free MR		Mandatory MR	
		Practice	Variation	Practice	Variation	Practice	Variation
Weekly Total Hours	45.46	46.05	1.31 %	46.80	2.96 %	46.96	3.31 %
	(1.26)	(1.233)	(0.004)	(1.339)	(0.024)	(1.347)	(0.026)
_____ clinical (h^c)	39.84	39.80	-0.09 %	39.52	-0.79 %	39.66	-0.44 %
	(0.95)	(0.937)	(0.006)	(1.013)	(0.035)	(1.017)	(0.037)
_____ non clinical (h^o)	5.62	6.25	11.24 %	7.28	29.57 %	7.30	29.89 %
	(0.81)	(0.815)	(0.450)	(1.209)	(3.383)	(1.232)	(3.484)
Total Services[a]	152.95	145.06	-5.16 %	135.10	-11.67 %	134.75	-11.90 %
	(5.28)	(5.377)	(0.016)	(6.850)	(0.099)	(7.234)	(0.112)
_____ Non-billable (S^{NB})	67.40	61.33	-9.01 %	53.74	-20.27 %	53.47	-20.67 %
	(3.43)	(3.426)	(0.044)	(4.647)	(0.253)	(4.951)	(0.300)
_____ Billable (S^B)	85.54	83.73	-2.13 %	81.36	-4.89 %	81.28	-4.99 %
	(3.61)	(3.439)	(0.005)	(3.397)	(0.038)	(3.432)	(0.041)
Service intensity $\left(=\frac{S^{NB}+S^B}{h^c * W}\right)$	76.78	72.89	-5.07 %	68.36	-10.96 %	67.94	-11.51 %
	(2.10)	(2.302)	(0.022)	(3.239)	(0.112)	(3.527)	(0.138)
Annual income[a] (X)	135.03	144.75	7.20 %	153.87	13.95 %	150.28	11.29 %
	(4.64)	(4.727)	(0.012)	(5.073)	(0.040)	(5.081)	(0.044)

[a] Thousands of (1996) Can. Dollars.
Note. Average practice behaviour predicted by the model in 2002 depending on whether physicians are paid according to: a mandatory FFS (*first column*) ; the MR scheme chosen conditionally on group agreement (*second column*) ; an MR system freely chosen on an individual basis (*third column*) ; or a mandatory MR (*last column*). The percentage variation provided for each compensation scheme takes FFS as a benchmark. Bootstrapped standard errors (in % variations) appear in parentheses.

of the constrained budget constraint and the unconstrained (efficient) budget constraint. The results are given in the second column of Table 4, labelled "Group Free MR". These results are instructive in many ways. First, notice the reform increased the number of weekly hours worked very slightly, by 1.3%. Moreover, this is entirely due to increases in non-clinical hours which rose by 11.2%; clinical hours in fact decreased by 0.1%. This suggests that the *per diem* incorporated into the MR payment system did induce physicians to spend more time on administrative and teaching activities. The reform also had important effects on the volume of services provided. Physicians reduced their supply of services in the order of 5.2%. This reflects physicians responding to monetary incentives.

Services are more sensitive than hours devoted to seeing patients. The MR compensation system reduced the marginal payment for services received by physicians (on average by 30%) and hence the marginal benefit to their completion. This substitution effect is accentuated by the negative income effect on the volume of services associated with the higher annual income received by MR physicians. Indeed, the physician annual income increased on average by 7.2%. This reflects the large *per diem* payments that MR physicians received, independent of the number of services

provided. The fact that the reform was expensive also raises the question as to whether or not it could have been enacted at a lower cost. We return to this point below in Section 5.2.4. Our results show that service intensity decreased (by 5.1%) with the reform which suggests that physicians spent more time with their patients under MR.

5.2.2 Mandatory MR Reform

Given the voluntary nature of the observed reform, a natural question is how a mandatory MR reform would affect behaviour. We address this within the context of our model by simulating optimal choices along the MR budget constraint. We then compare the resulting predicted behaviour to that under FFS. The results are presented in the fourth column of Table 4. They suggest that a mandatory reform would have had considerable effects on services provided (a decrease of 12.0% relative to FFS) and non-clinical hours (an increase of 29.9% relative to FFS); these are much larger than under the observed reform. Physicians would also spend more time with patients – services per hour worked seeing patients would decrease by 11.5% relative to FFS. The cost of the program would also be significantly affected (average physician income would increase by 11.3% relative to FFS).

The mandatory reform changes two things vis-à-vis the observed reform: first, it removes the choice of the compensation system (eliminating any selection due to differences in unobservable preferences) and second it removes constraints on an individual's choice of the MR system. To decompose the overall effect into its component parts, we simulated the observed voluntary reform, removing the constraint on choice. We set $\psi = 0$, allowing physicians to choose their compensation system individually along the efficient budget constraint. The subsequent predicted behaviour is compared to behaviour under FFS. The results are given in the third column of Table 4, labelled "Individual Free MR." They are close to the results from the mandatory reform though average physician income increases by a higher percentage in the former reform (14%) than in the latter one (11.3%) relative to FFS. This suggests that constraints on choice are the most important factor in explaining the difference between the actual and mandatory reforms. Even though workers who switched to MR were low-productivity physicians, many high-productivity physicians—who

Table 5: Average Equivalent Variations (EV)

	N	Group Free MR	Ind Free MR
Overall	192	17,680.36 (13,574)	34,544.55 (13,785)
Male	120	21,125.60 (11,683)	37,710.32 (5,777)
Female	72	11,938.29 (14,607)	29,268.26 (20,252)
Young	88	16,277.04 (12,488)	38,892.51 (7,653)
Mature	82	20,839.96 (14,216)	33,168.22 (14,911)

Note. Average Equivalent Variations (EV) computed in 2002 are the average minimum amount of yearly income (in 1996 Can. Dollars) physicians in the sample would accept to stay under a fee-for-service compensation scheme rather than switching to the Group Free MR or and Individual Free MR system. 50 iterations on the $J \times 1$ vectors of random variable draws for each physician have been used to compute the average physicians' EVs. Empirical standard errors are provided in parenthesis.

would have reacted strongly to the change in compensation system— would have switched to MR if they had not been constrained in their choice. Physicians who are currently observed under FFS could (on average) find a practice pattern under MR that provides them with higher income and that they prefer, but they are constrained from choosing it. Geometrically, this suggests that the line *MR* in Figure 1 should be shifted upward so that a large number of pediatricians would choose the MR system if they were free to do so.[9] The similarity between the results of the "Individual Free" and "Mandatory" reforms also suggests that unobservable selection, due to preference differences between MR and FFS physicians, is not an important factor in determining our results.

5.2.3 The impact of reforms on physicians' welfare

To evaluate the welfare effects of a reform on physicians, we calculated, for each doctor, his Equivalent Variation (EV), that is, the minimum payment he would be willing to accept to forego the reform. Our calculations are based on simulation procedures, first suggested in McFadden (1999), and applied in several papers on discrete choice (see, *e.g.*, Herriges and Kling, 1999; Creedy, Hérault, and Kalb, 2011; von Haefen and Domanski, 2018). Of course, these welfare measures are partial as they do not provide information on the impact of a reform neither on patients' welfare (*i.e.*, quality

[9] This is consistent with the fact that pediatricians strongly advocated for the government to introduce the MR system.

Table 6: Practice Under a Cost-Preserving Mandatory MR

	FFS	Constant cost	% Var.	Variable cost	% Var.
Weekly Total Hours	45.46	46.77	2.88%	46.96	3.31%
____clinical (h^c)	39.84	39.86	0.06%	39.66	-0.44%
____non clinical (h^o)	5.62	6.90	22.90%	7.30	29.89%
Total Services[a]	152.95	138.42	-9.50%	134.75	-11.90%
____Non-billable (S^{NB})	67.40	56.00	-16.92%	53.47	-20.67%
____Billable (S^B)	85.54	82.42	-3.65%	81.28	-4.99%
Service intensity $\left(=\frac{S^{NB}+S^B}{h^c * W}\right)$	76.78	69.45	-9.55%	67.94	-11.51%
Annual income[a] (X)	135.03	135.10	0.05%	150.28	11.29%
Per Diem (3.5 hours)	–	234.09 $		300 $	

[a] Thousands of (1996) Can. Dollars.
Note. Average practice behaviour predicted by specification 3 of the model (accounting for observed and partially unobserved heterogeneity) in 2002 depending on whether physicians are paid according to: a mandatory FFS (*first column*), the Mandatory MR scheme, associated to a *per diem* that maintain healthcare costs at a constant level (*second* and *third* columns), and the Mandatory MR scheme, associated to the actual *per diem* (*fourth* and *fifth* columns).The *third* and *fifth* columns provide the percentage variation in practice induced by the change.

of services) nor on tax payers' welfare.

Table 5 presents the results on the Average EVs of the observed reform and the Individual Free MR reform for various groups of physicians. All calculated Average EVs are positive and larger than the effect of the reform on income. This is expected as these reforms both increased physicians' income and reduced their intensity of services. As well, the welfare effect of the actual reform is smaller ($17,680) than that of the Individual Free MR reform ($34,544). The latter imposes no constraint on a physician's choice of a compensation system. Interestingly, the welfare impact of the actual reform and the Individual Free reform are smaller for male and young physicians than for female and mature physicians. This is also expected as the latter tend to spend more time with their patients.

5.2.4 Constant Cost Reform

One striking feature of the reform is the cost of the MR contract. The large *per diem* paid to physicians caused incomes to increase by over 7% in all versions of the reform investigated in Table 4. It is therefore of interest to investigate whether alternative contracts could achieve similar results at lower costs. To do so we concentrate on constant-cost contracts, which keep annual payments to

Table 7: Practice Under a Cost-Preserving Pure Salary (Per Diem) scheme

	FFS	Constant cost salary	
		Practice	Variation
Weekly Total Hours	45.46	48.79	7.33 %
	(5.20)	(6.264)	(0.096)
____ clinical (h^c)	39.84	41.65	4.53 %
	(3.05)	(2.634)	(0.161)
____ non-clinical (h^o)	5.62	7.14	27.16 %
	(3.68)	(4.886)	(3.938)
Total Services[a]	152.95	122.06	-20.20 %
	(9.29)	(25.557)	(2.336)
____ Non-billable (S^{NB})	67.40	45.53	-32.45 %
	(5.74)	(13.559)	(3.828)
____ Billable (S^B)	85.54	76.52	-10.55 %
	(9.13)	(15.178)	(1.888)
Service intensity $\left(=\frac{S^{NB}+S^B}{h^c * W}\right)$	76.78	58.61	-23.66 %
	(7.43)	(15.565)	(1.908)
Annual income[a] (X)	135.03	133.58	-1.08 %
	(8.37)	(16.260)	(1.250)

[a] Thousands of (1996) Can. Dollars.
Note. Average practice behaviour predicted by specification 3 of the model (accounting for observed and partially unobserved heterogeneity) in 2002 depending on whether physicians are paid according to: a mandatory FFS (*first column*), or a salary scheme based solely on an hourly wage (the rate of which is chosen so as to maintain income constant; *second* column). The *third* column column provides the percentage variation in practice induced by the change. Bootstrapped standard errors (in % variations) appear in parentheses.

physicians equal to those observed pre-reform (under FFS). We restrict attention to a mandatory reform, forcing all physicians to work under MR. To proceed, we fix the FFS paid under MR at the levels observed in the actual MR contract, but allow the *per diem* to be determined endogenously to keep expected earnings at the level of the FFS contract.

The results are given in Table 6 (we replicate the simulation results of the (variable-cost) mandatory MR from the last two columns of Table 4 for ease of comparison). The *per diem* paid to physicians in this case would be $234.09, compared to $300 in the observed contract, a reduction of 22.0%. By construction, physicians' annual income growth would be zero relative to FFS under a constant-cost reform as compared to 17.7% under the variable cost scheme. Moreover, total services would decrease by 9.5% rather than 12.0% under the variable cost contract. This reflects the presence of a smaller income effect. Service intensity would be almost identical to the variable cost reform. These results suggest that the MR reform could have been enacted at a lower *per diem*, reducing government expenditures on physicians, while increasing the supply of services.

Finally, we consider the effect of a fixed *per diem* contract (pure SA scheme), containing no fee-for-service and the observed reform's *per diem*. Again, we consider the effect of a mandatory reform to eliminate selection. The results are shown in Table 7. Here, services would decrease by 20.2% relative to the FFS contract, showing a high powered incentive effect as the fee paid for services falls to zero. Yet, hours would increase by 7.3% as the physicians would increase hours worked to receive more *per diems* (low powered incentive effect). Service intensity would decrease by 23.7%, suggesting that physicians would spend much more time with each patient.

6 Conclusion

We have developed and estimated a structural labour supply model that incorporates service intensity into the standard consumption/leisure tradeoff and allows for choice among alternative contracts. We have applied our model to analyze the response of physicians to changes in their compensation system.

We have used our estimates to simulate the effects of alternative policies and compensation systems. Our results suggest that incentives significantly affect physicians' service intensity and the volume of services provided. The MR reform led to a 5.2% reduction in the volume of services provided and to a 5.1% decrease in the service intensity. The effect on weekly hours was much less pronounced : hours spent at work increased by 1.3%. The impact of this reform on physicians' welfare as measured by their Average Equivalent Variation, is larger than its positive effect on their average income, as it also reduces service intensity. A mandatory MR reform would have a substantially larger effect on behaviour: services would decrease by 12.0% and service intensity would decrease by 11.5%. The cost per physician would increase by 11.3%, largely due to the large *per diem* offered to physicians, $300 per 3.5 hours. A constant-cost (mandatory) reform, setting the *per diem* to $234.09 per 3.5 hours would generate a substantially smaller reduction in physician behaviour: services would decrease by 9.5%, and service intensity would decrease by 9.5%. Also, when controlling for gender and age, our analysis provides little support for selection on unobservables.

One limitation of our model is that it uses a static approach. A dynamic model would allow for a richer treatment of the effects of compensation on physician productivity. For example, pro-

ductivity may increase with experience as physicians learn to make diagnoses. We also ignore the quality of services as measured, for example, by indicators of patients' health. This makes it difficult to draw definitive conclusions about the total welfare impact of the compensation reform. Moreover, our paper raises some modeling issues for physician labour supply and measuring treatment effects. In developing our model we have assumed that physicians exercise complete control over their practice environment, choosing both the number of services to supply and hours to work, given exogenously determined prices. This makes sense within the context of publicly provided healthcare systems. Yet in market based systems the number of services provided and their prices are subject to market forces. Extending the model to account for demand-side factors would allow applications in market-oriented healthcare systems. Finally, we ignore general-equilibrium effects in our model. General-equilibrium effects would occur if, for example, there is a transfer of activities between physicians who chose MR and those who remained on FFS. We leave these extensions for future research.

References

ACKERBERG, D. A., AND M. BOTTICINI (2002): "Endogenous Matching and the Empirical Determinants of Contract Form," *Journal of Political Economy*, 110(3), 564–591.

ANDREASSEN, L., M. DI TOMMASO, AND S. STROM (2013): "Do medical doctors respond to economic incentives?," *Journal of Health Economics*, 32(2), 392–409.

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

BALTAGI, B. H., E. BRATBERG, AND T. H. HOLMAS (2005): "A panel data study of physicians' labor supply: the case of Norway," *Health Economics*, 14(10), 1035–1045.

BELLEMARE, C., AND B. SHEARER (2013): "Multidimensional heterogeneity and the economics importance of risk and matching: evidence from contractual data and field experiments," *Rand Journal of Economics*, 44(2), 361–389.

CLEMENS, J., AND J. D. GOTTLIEB (2014): "Do Physicians' Financial Incentives Affect Medical Treatment and Patient Health?," *American Economic Review*, 104(4), 1320–49.

CREEDY, J., N. HÉRAULT, AND G. KALB (2011): "Measuring welfare changes in behavioural microsimulation modelling: accounting for the random utility component," *Journal of Applied Economics*, 14(1), 5–34.

DEVLIN, R.-A., AND S. SARMA (2008): "Do Physician Remuneration Schemes Matter? The Case of Canadian Family Physicians," *Journal of Health Economics*, 25(7), 1168–1181.

DIEWERT, W. (1971): "An Application of the Shephard Duality Theorem: A Generalized Leontief Production Function," *Journal of Political Economy*, 79(3), 481–507.

DOHMEN, T., AND A. FALK (2011): "Performance pay and multidimensional sorting: Productivity, preferences, and gender," *American Economic Review*, 101(2), 556–590.

DUMONT, E., B. FORTIN, N. JACQUEMET, AND B. SHEARER (2008): "Physicians' multitasking and incentives: Empirical evidence from a natural experiment," *Journal of Health Economics*, 27(6), 1436–1450.

EVANS, R. (1974): "Modeling the economic objectives of the physician," in *Health economics symposium, Proceedings of the First Canadian Conference 4-6 Sept.*, ed. by R. Fraser, pp. 33–46. Queen's University Industrial Relations Centre, Kingston (Ont.).

FORTIN, B., N. JACQUEMET, AND B. SHEARER (2010): "Labour Supply, Work Effort and Contract Choice: Theory and Evidence on Physicians," IZA Discussion Paper No. 5188.

——— (2021): "Online Supporting Information for 'Labour Supply, Work Effort and Contract Choice: Theory and Evidence on Physicians'," *Journal of Applied Econometrics*.

HAUSMAN, J. A. (1985): "The Econometrics of Nonlinear Budget Sets," *Econometrica*, 53(6), 1255–1282.

HERRIGES, J. A., AND C. L. KLING (1999): "Nonlinear income effects in random utility models," *Review of Economics and Statistics*, 81(1), 62–72.

HOLT, C., AND S. LAURY (2002): "Risk Aversion and Incentive Effects," *American Economic Review*, 92, 1644–1655.

HOYNES, H. W. (1996): "Welfare Transfers in Two-Parent Families: Labor Supply and Welfare Participation Under the AFDC-UP Program," *Econometrica*, 64(2), 295–332.

KALB, G., D. KUEHNLE, A. SCOTT, T. C. CHENG, AND S.-H. JEON (2018): "What factors affect physicians' labour supply: Comparing structural discrete choice and reduced-form approaches," *Health Economics*, 27(2), e101–e119.

KANTAREVIC, J., B. KRALJ, AND D. WEINKAUF (2008): "Income Effects and Physician Labour Supply: Evidence from the Threshold System in Ontario," *The Canadian Journal of Economics / Revue canadienne d'Economique*, 41(4), 1262–1284.

LEE, T., C. PROPPER, AND G. STOYE (2019): "Medical Labour Supply and the Production of Healthcare," *Fiscal Studies*, 40(4), 621–661.

MCFADDEN, D. (1974): "Conditional Logit Analysis of Qualitative Choice Behavior," in *Frontiers in Econometrics*, ed. by P. Zarembka, pp. 105–142. New York Academic Press, New York.

MCFADDEN, D. (1999): "Computing Willingness-to-pay in Random Utility Models," in *Trade, Theory and Econometrics*, ed. by J. Melvin, J. Moore, and R. Riezman, pp. 253–272. Routledge.

MCFADDEN, D., AND K. TRAIN (2000): "Mixed MNL models for discrete response," *Journal of Applied Econometrics*, 15(5), 447–470.

MCGUIRE, T. G. (2000): "Physician Agency," in *Handbook of Health Economics*, ed. by A. J. Culyer, and J. P. Newhouse, vol. 1A, pp. 461–536. North-Holland, Amsterdam.

SHEARER, B., N. H. SOMÉ, AND B. FORTIN (2019): "Measuring Physicians' Response to Incentives: Labour Supply, Multitasking, and Earnings," CRREP Working Paper 2019-03.

SHOWALTER, M. H., AND N. K. THURSTON (1997): "Taxes and labor supply of high-income physicians," *Journal of Public Economics*, 66(1), 73–97.

TRAIN, K. E. (2009): *Discrete Choice Methods with Simulation*. Cambridge University Press, 2nd edn.

VAN SOEST, A. (1995): "Structural Models of Family Labor Supply: A Discrete Choice Approach," *Journal of Human Resources*, 30(1), 63–88.

VON HAEFEN, R. H., AND A. DOMANSKI (2018): "Estimation and welfare analysis from mixed logit models with large choice sets," *Journal of Environmental Economics and Management*, 90, 101 – 118.

ZABALZA, A., C. PISSARIDES, AND M. BARTON (1980): "Social security and the choice between full-time work, part-time work and retirement," *Journal of Public Economics*, 14(2), 245–276.

View publication stats

Author Manuscript

Online Supporting Information for "Labour Supply, Service Intensity, and Contracts: Theory and Evidence on Physicians"

Bernard Fortin[1] Nicolas Jacquemet[2] Bruce Shearer[3]

February 2021

A Indexes

Quantities: Let p_a^t stand for the price of the service a at time t and $S_{a,i}^t$ for the number of a-type services a physician i provided at time t. The annual level of services S_i^t is then measured as:

$$\begin{cases} S_i^t = \sum_a S_{a,i}^t \, p_a^{1996} & \text{if } 1996 \leq t < 2000, \\ S_i^t = \sum_a (S_{a,i}^t \, p_a^{2000}) \, \dfrac{\sum_a S_{a,i}^{2000} \, p_a^{1996}}{\sum_a S_{a,i}^{2000} \, p_a^{2000}} & \text{if } 2000 \leq t \leq 2002. \end{cases} \tag{16}$$

The same price are used for weighting billable and non-billable services. The variable S_i^t in (16) then stands for either non-billable services, $S_i^t = S_i^{\text{NB}t}$, or billable ones, $S_i^t = S_i^{\text{B}t}$, aggregated using the same price levels.

Prices: For the same reasons, the weights used for price indexes are the average level of services provided by FFS physicians. This avoids incorporating into price measures the effect of the variations in services due to switching to MR. Let $\overline{S}_a^t$ denote the average level of billable services of type a provided by all the FFS physicians belonging to the specialty considered. The price index of services is then given by:

$$\begin{cases} p^t = \dfrac{\sum_a \overline{S}_a^{1996} \, p_a^t}{\sum_a \overline{S}_a^{1996} \, p_a^{1996}} & \text{if } 1996 \leq t < 2000, \\ p^t = \dfrac{\sum_a \overline{S}_a^{2000} \, p_a^t}{\sum_a \overline{S}_a^{2000} \, p_a^{2000}} \, \dfrac{\sum_a \overline{S}_a^{1996} \, p_a^{2000}}{\sum_a \overline{S}_a^{2000} \, p_a^{2000}} & \text{if } 2000 \leq t \leq 2002. \end{cases} \tag{17}$$

Once again, we hold constant the weights used for measuring the price index under MR, PF^t, since it is calculated using the average billable services provided by FFS physicians, at MR reduced prices.

[1]Département d'économique, Université Laval, CRREP and CIRANO. Bernard.Fortin@ecn.ulaval.ca.
[2]Paris School of Economics and University Paris I Panthéon-Sorbonne. Nicolas.Jacquemet@univ-paris1.fr.
[3]Département d'économique, Université Laval, CRREP and CIRANO. Bruce.Shearer@ecn.ulaval.ca.

This article is protected by copyright. All rights reserved.

Author Manuscript

B Calculation of MR earnings

A number of issues arise in calculating gross income under the MR system (see eq. (1)). First, a physician's income depends on the number of *per diems* claimed. As this is unknown, we must approximate it. To do so, we assume that each MR physician works the maximum number of *per diems* possible for a given number of hours worked, the remainder of his time is then allocated to FFS.

We estimate the number of (half) *per diems* worked during a week by

$$\widehat{\mathcal{N}} = \frac{\min\left\{floor\left(\frac{2\times(h^c+h^o)}{\bar{d}}\right), 28\right\}}{2}, \tag{18}$$

where $\bar{d}$ is the number of hours per *per diem* and 28 represents the maximum number of (half) *per diems* that a physician can claim over a two-week period.

Second, recall that we distinguish between billable services provided under the *per diem*, denoted S^{B}_{FFS}, for which the physician is paid a discounted fee, αp, and those provided outside of the *per diem*, denoted S^{B}_{MR}, for which the physician is paid the regular fee, p. Given that we do not observe whether or not a given service was remunerated under the *per diem*, we use θS^{B} and $(1-\theta)S^{\mathrm{B}}$ to estimate S^{B}_{MR} and S^{B}_{FFS}, respectively. Here θ is the proportion of time spent under the *per diem*, estimated as the share of total hours worked in a week under the *per diem* and given by

$$\hat{\theta} = \frac{\bar{d}\,\widehat{\mathcal{N}}}{h^c + h^o}. \tag{19}$$

Hence we attribute billable services to MR and FFS in the same proportion as we attribute hours worked to MR and FFS.

Consumption in alternative j, in year t, under MR is then given by

$$X^{MR}_{j,t} = 46\widehat{\mathcal{N}}_j\mathcal{D}_t + (1-\hat{\theta}_j)p_t S^{\mathrm{NB}}_j + \hat{\theta}_j\alpha p_t S^{\mathrm{B}}_j + (1-\hat{\theta}_j)p_t S^{\mathrm{B}}_j, \tag{20}$$

where $\widehat{\mathcal{N}}_j$ is the number of (half) *per diems* worked in alternative j, $\mathcal{D}_t$ is the payment per (half) *per diem* in year t, and $\hat{\theta}_j$ is the estimated share of total hours worked in a week in alternative j attributed to the *per diem*. The variable S^{NB}_j is the total non-billable services (both under and outside of the *per diem* periods), as approximated by $(S^{\mathrm{NB}}_{NP})_j/(1-\hat{\theta}_j)$, where $(S^{\mathrm{NB}}_{NP})_j$ is the (observable) non-billable services under the non *per diem* period. We accounted for government imposed income ceilings and regional income differentials. The actual provisions governing regional remuneration rate calculations involve a wide variety of individual characteristics—such as city of practice – not included in the data set. However, our data contains each physician's quarterly income before and after the correction for the regionally differentiated remuneration rate. We therefore approximate the actual regionally differentiated remuneration rate facing physician i, and denoted τ_i, as the ratio of the two reported levels of income over the whole sample period.

The actual level of income ceilings during the period is publicly available from government authorities in charge of physician compensation. However, these ceilings depend on the establishment in which the services were provided, information that is not available to us. To take account of

This article is protected by copyright. All rights reserved.

these exceptions in a tractable manner we calculate the average percentage of time that pediatricians spent in establishments where income ceilings were applied. The relevant ceiling for physician i, is then taken to be the actual income ceiling adjusted for the average percentage of time spent in establishments where the cap applies.

The actual consumption in each alternative is predicted based on equations (2) and (20). To convert consumption into real terms we deflate actual (nominal) consumption in each alternative using the price index provided by *Statistics Canada*. The average inflation rate for the whole period is 1.92%. Overall, our strategy for approximating consumption in each alternative proved to be a precise predictor of the observed income of physicians included in our sample.

C Estimates and Elasticities

The parameter estimates are presented in Table A. The utility function parameters are generally statistically significant. In the constraint function ψ, only the regional dummy variables are significant. Physicians in a metropolitan area have a higher probability of being constrained than do those in non-metropolitan areas. Neither gender nor male has any effect on the probability of being constrained.

The likelihood function increases significantly with the inclusion of observable characteristics in the constraint, from -4352.14 to -4291.60, we therefore use this specification to conduct our policy analysis. The proportion of observations with a negative marginal utility of income also decreases from 8.47% to 6.78%. The probability of being constrained ψ is the logit transformation of the estimated parameters. Its average value is equal to 0.542 in specification 2, suggesting that a large proportion of the physicians were constrained in their choice of a compensation system. This suggests that introducing a reform allowing physicians to choose their compensation system individually will have a strong effect on their behaviour.

Table B provides results on the elasticities of practice variables with respect to non-labour income, hourly wage rate, and fee per service.[4] The second column provides our benchmark; it is computed as the average practice choice simulated from the estimated model against a simplified budget constraint, broadly representative of the prevailing case before the reform. We assume an hourly wage rate equal to \$10, the full fee under FFS on all clinical services, and an exogenous non-labour income equal to \$10,000.[5] We remove all the other parameters that may affect a physician's budget constraint (for instance, income ceilings and regionally differentiated remuneration). The physician's budget is thus linear in (w, p, y) with all arguments strictly positive. As the MR reform involved substantial changes in the fee per service and wage parameters, for comparison-sake, we also performed our elasticity simulations based on large (50%) percentage changes in each of these parameters. Similarly, the computation of the income elasticity, $\varepsilon_{k/y}$, for each practice variable, k, is based on the variation in practice induced by a 50% increase in non-labour income. Also, we use Slutsky decompositions of uncompensated elasticities into compensated and total income elasticities: $\varepsilon_{k/w} = \widetilde{\varepsilon}_{k/w} + wh^t \frac{\mathcal{W}}{y}\varepsilon_{k/y}$ and $\varepsilon_{k/p} = \widetilde{\varepsilon}_{k/p} + \frac{pS}{y}\varepsilon_{k/y}$, and where $\mathcal{W}$ is set at 45 weeks of work, to

[4] The reader should bear in mind that an important difference between the elasticity simulations and the actual reform is that, under the actual reform, the *per diem* (hourly wage) simultaneously becomes positive.

[5] We add small positive hourly wage and non-labour income to the observed FFS contract in order to allow us to simulate elasticities at the benchmark.

This article is protected by copyright. All rights reserved.

Author Manuscript

Author Manuscript

Table A: Preference Parameters

		Specification 1		Specification 2	
		Coef.	St.d.	Coef.	St.d.
γ^o		594.373*	(381.509)	589.548	(1061.209)
σ^o		145.722***	(22.940)	144.454***	(25.949)
	$\gamma^o \times Male$	358.852**	(198.886)	362.585*	(274.393)
	$\gamma^o \times Age$	-38.533	(98.138)	-38.158	(246.874)
γ^l		677.078**	(291.795)	659.293	(565.603)
σ^l		109.381***	(13.541)	109.124***	(13.755)
	$\gamma^l \times Male$	139.515	(149.366)	141.091	(202.723)
	$\gamma^l \times Age$	127.505**	(69.313)	131.546	(140.522)
$\gamma^{S^{NB}}$		-105.977**	(50.716)	-89.511	(95.056)
	$\gamma^{S^{NB}} \times Male$	4.910	(26.965)	3.958	(58.653)
	$\gamma^{S^{NB}} \times Age$	32.787***	(10.368)	28.845	(24.816)
γ^{S^B}		108.173*	(66.383)	126.988**	(66.560)
σ^{S^B}		93.618***	(10.595)	93.661***	(11.551)
	$\gamma^{S^B} \times Male$	61.609*	(44.873)	60.767	(91.427)
	$\gamma^{S^B} \times Age$	13.257	(17.781)	8.716	(18.572)
γ^x		40.379*	(27.768)	17.278	(64.908)
	$\gamma^x \times Male$	42.156***	(15.374)	43.683**	(24.602)
	$\gamma^x \times Age$	-6.445	(6.192)	-0.835	(11.800)
β^o_l		-1.985	(2.849)	-1.934	(5.970)
	$\beta^o_l \times Male$	-1.506	(1.510)	-1.530	(1.654)
	$\beta^o_l \times Age$	-0.269	(0.698)	-0.277	(1.393)
$\beta^o_{S^{NB}}$		1.898**	(0.906)	1.627**	(0.853)
	$\beta^o_{S^{NB}} \times Male$	0.187	(0.477)	0.202	(0.686)
	$\beta^o_{S^{NB}} \times Age$	-0.439***	(0.169)	-0.372**	(0.202)
$\beta^o_{S^B}$		-0.323	(0.799)	-0.606	(2.624)
	$\beta^o_{S^B} \times Male$	0.803**	(0.452)	0.813	(1.019)
	$\beta^o_{S^B} \times Age$	-0.383***	(0.156)	-0.313	(0.592)
β^o_x		-1.887***	(0.767)	-1.586*	(1.172)
	$\beta^o_x \times Male$	-0.245	(0.446)	-0.264	(0.644)
	$\beta^o_x \times Age$	0.404***	(0.141)	0.330*	(0.234)
$\beta^l_{S^{NB}}$		0.925***	(0.390)	0.951	(1.004)
	$\beta^l_{S^{NB}} \times Male$	-0.189	(0.202)	-0.193	(0.330)
	$\beta^l_{S^{NB}} \times Age$	-0.250***	(0.080)	-0.256	(0.228)
$\beta^l_{S^B}$		-0.011	(0.563)	0.003	(0.643)
	$\beta^l_{S^B} \times Male$	-0.694**	(0.367)	-0.693**	(0.339)
	$\beta^l_{S^B} \times Age$	-0.044	(0.131)	-0.047	(0.147)
$\beta^{S^{NB}}_{S^B}$		-0.078	(0.085)	-0.135	(0.162)
	$\beta^{S^{NB}}_{S^B} \times Male$	0.197***	(0.079)	0.204*	(0.155)
	$\beta^{S^{NB}}_{S^B} \times Age$	-0.009	(0.016)	0.004	(0.031)
β^o		-10.650***	(2.563)	-10.741**	(5.601)
	$\beta^o \times Male$	-3.731***	(1.531)	-3.738**	(1.959)
	$\beta^o \times Age$	1.611***	(0.635)	1.644*	(1.274)
β^l		-3.204***	(1.246)	-3.149*	(2.032)
	$\beta^l \times Male$	-0.190	(0.595)	-0.197	(0.787)
	$\beta^l \times Age$	-0.388*	(0.292)	-0.400	(0.504)
$\beta^{S^{NB}}$		-0.112*	(0.072)	-0.135	(0.188)
	$\beta^{S^{NB}} \times Male$	0.058*	(0.043)	0.063	(0.074)
	$\beta^{S^{NB}} \times Age$	-0.008	(0.014)	-0.003	(0.028)
β^{S^B}		-0.597***	(0.098)	-0.625***	(0.246)
	$\beta^{S^B} \times Male$	0.325***	(0.103)	0.327	(0.308)
	$\beta^{S^B} \times Age$	-0.079***	(0.027)	-0.073***	(0.021)
β^x		-0.100**	(0.056)	-0.067	(0.187)
	$\beta^x \times Male$	-0.115***	(0.041)	-0.119**	(0.069)
	$\beta^x \times Age$	0.021*	(0.014)	0.014	(0.032)
ψ		-178.079	(146.903)	3075.053**	(1377.607)
	$\psi \times Male$	—	—	489.569*	(371.394)
	$\psi \times Age$	—	—	135.731	(160.524)
	$\psi \times MetroUni$	—	—	-4329.354***	(1023.513)
	$\psi \times MetroNoUni$	—	—	-6138.808***	(1120.158)
LL		-4352.14		-4291.60	
Proportion UM negative		8.47%		6.78%	

Note. Estimated parameters of the utility function on the full sample in years 1996-1999, 2001 and 2002. Income and service parameters are associated with variables measured in Thousands of (1996) Can. Dollars. To ease readability of the table, all estimated parameters (and bootstrapped standard errors, in parentheses) are re-scaled by a factor $1e^4$.

This article is protected by copyright. All rights reserved.

Author Manuscript

Table B: Elasticity of Practice Variables

	Ref.	Non-labour income		Hourly wage rate				Service piece-rate			
		Δy	$\varepsilon_{k/y}$	ΔW	$\varepsilon_{k/w}$	$\widetilde{\varepsilon}_{k/w}$	$\frac{whW}{y}\varepsilon_{k/y}$	ΔIP	$\varepsilon_{k/IP}$	$\widetilde{\varepsilon}_{k/IP}$	$\frac{PA}{y}\varepsilon_{k/y}$
Weekly Total Hours	45.30	45.22	-3.470e-03	45.30	1.408e-04	6.076e-02	-0.061	44.65	-0.028	0.076	-0.104
	(5.29)	(5.33)	(9.266$e-06$)	(5.29)	(2.809$e-08$)	(2.190$e-03$)	(0.0022)	(5.98)	(0.0021)	(0.0030)	(0.0083)
____ clinical (h^c)	39.69	39.61	-3.898e-03	39.69	9.708e-05	6.820e-02	-0.068	39.11	-0.029	0.088	-0.117
	(3.02)	(3.00)	(7.702$e-06$)	(3.02)	(2.546$e-08$)	(2.774$e-03$)	(0.0028)	(2.96)	(0.0015)	(0.0042)	(0.0072)
____ non-clinical (h^o)	5.61	5.61	-4.420e-04	5.61	4.502e-04	8.174e-03	-0.008	5.54	-0.025	-0.012	-0.013
	(3.78)	(3.82)	(4.264$e-04$)	(3.78)	(9.663$e-07$)	(1.186$e-01$)	(0.1193)	(4.42)	(0.0623)	(0.1833)	(0.3932)
Total Services[a]	149.99	148.69	-1.731e-02	149.93	-7.426e-04	3.016e-01	-0.302	140.67	-0.124	0.395	-0.519
	(9.76)	(10.06)	(7.765$e-05$)	(9.77)	(1.465$e-07$)	(2.044$e-02$)	(0.0205)	(28.64)	(0.0993)	(0.0441)	(0.0698)
____ Non-billable (NBS)	65.06	64.04	-3.120e-02	65.01	-1.356e-03	5.438e-01	-0.545	58.24	-0.209	0.726	-0.935
	(6.22)	(6.54)	(3.622$e-04$)	(6.24)	(6.472$e-07$)	(8.999$e-02$)	(0.0905)	(20.95)	(0.2338)	(0.0931)	(0.3343)
____ Billable (BS)	84.93	84.65	-6.664e-03	84.92	-2.731e-04	1.162e-01	-0.116	82.43	-0.059	0.141	-0.200
	(9.31)	(9.39)	(2.969$e-05$)	(9.31)	(7.328$e-08$)	(1.244$e-02$)	(0.0125)	(13.08)	(0.0457)	(0.0706)	(0.0268)
Service intensity $\left(=\frac{NBS+BS}{h^c * W}\right)$	75.59	75.08	-1.343e-02	75.55	-8.398e-04	2.339e-01	-0.235	71.93	-0.097	0.306	-0.403
	(6.85)	(6.67)	(8.200$e-05$)	(6.85)	(1.645$e-07$)	(2.230$e-02$)	(0.0224)	(12.02)	(0.0990)	(0.0317)	(0.0767)
Annual income[a] (X)	142.19	145.14	4.150e-02	142.33	2.000e-03	-7.230e-01	0.725	196.73	0.767	-0.477	1.244
	(8.83)	(9.08)	(4.849$e-05$)	(8.85)	(2.412$e-07$)	(3.270$e-02$)	(0.0329)	(37.60)	(0.1914)	(0.0938)	(0.0567)

[a] Thousands of (1996) Can. Dollars.
Note. Elasticities of practice variables simulated from estimated preferences. In the reference situation, physicians are paid the full fee under FFS on all clinical services, an hourly wage rate equal to \$10 and an exogenous non-labour income equal to \$10,000. Elasticities are computed from a 50% change in each parameter of the resulting budget constraint—for each parameter, the first column displays predicted average behaviour from the updated budget constraint. Bootstrapped standard errors appear in parentheses.

compute the wage and fee per service compensated elasticities of each practice variable.[6]

Results from the second panel of Table B indicate that physicians' average clinical and non-clinical weekly hours of work, as well as the volume of (billable and non-billable) services are negatively affected (with $p < 0.01$) by an increase in non-labour income. Overall, the simulated elasticities are modest (in absolute value) though, ranging between -.003 for weekly hours of work and -0.017 for services. Moreover, physicians' service intensity, as measured by the volume of services provided (in 1996 Can. dollars) per clinical hour of work, decreases with non-labour income but very slightly, with an elasticity of -0.013 (with $p < 0.01$).

The third panel indicates that the uncompensated own wage elasticity of total weekly hours is close to zero. This suggests that physicians' labour supply curve for weekly hours is essentially vertical. The elasticity estimate is similar to that reported in Showalter and Thurston (1997) for employee physicians, but is lower than estimates from other studies. Baltagi, Bratberg, and Holmas (2005) and Showalter and Thurston (1997) reported a wage elasticity for hours worked of 0.34 and 0.27, respectively. Our estimate of the compensated own wage elasticity is positive, although quite small, being estimated at 0.068 (with $p < 0.01$). Our results also indicate that services and hours of work are net complements, as cross compensated wage elasticity of services is positive (= 0.335, with $p < 0.01$).

The last panel provides results regarding elasticities with respect to changes in the FFS. The own uncompensated service elasticity is negative and equal to -0.124, with $p < 0.01$. Thus, the labour supply curve for services is backward-bending. This concords with estimates reported in Shearer, Somé, and Fortin (2019) for broad-based price increases. Interestingly, the negative effect of an increase in the fee per service is much larger (in absolute value) on non-billable services ($= -0.209$) than on billable services ($= -0.059$). The compensated own service elasticity is positive as

[6] This is an approximation since the choice set is discrete and the variations in wage and fee per service are not infinitesimal.

This article is protected by copyright. All rights reserved.

Author Manuscript

expected and quite large and significant (= 0.395). Notice also that the compensated elasticity of weekly hours of work with respect to fee per service is positive but small (= 0.076). As expected, a compensated increase in the fee per service induces the physician to spend less time in non-clinical (teaching and administrative) activities and more time to perform clinical services, but again these effects are small (-0.012 and 0.088, respectively). These results suggest that compensated changes in the fee per service have a positive and significant impact on physicians' behaviour—especially on the volume of their services and their service intensity.

Our results on elasticities suggest that physicians (pediatricians) react to incentives in the directions predicted by the theory. The compensated own elasticities are all positive and the effects of non-labour income are all negative on weekly hours of work and on services. The small elasticities with respect to wage and the FFS on compensated and uncompensated weekly hours are consistent with studies focusing on hours of work supplied by physicians who are not self-employed: for example, Sloan (1975); Noether (1986) found that the wage elasticities are modest or non-significant in this context. Finally, we note that the incentive effects on services provided are generally much larger (in absolute value) than are those on hours worked.

References

BALTAGI, B. H., E. BRATBERG, AND T. H. HOLMAS (2005): "A panel data study of physicians' labor supply: the case of Norway," *Health Economics*, 14(10), 1035–1045.

NOETHER, M. (1986): "The Growing Supply of Physicians: Has the Market Become More Competitive?," *Journal of Labor Economics*, 4(4), 503–537.

SHEARER, B., N. H. SOMÉ, AND B. FORTIN (2019): "Measuring Physicians' Response to Incentives: Labour Supply, Multitasking, and Earnings," CRREP Working Paper 2019-03.

SHOWALTER, M. H., AND N. K. THURSTON (1997): "Taxes and labor supply of high-income physicians," *Journal of Public Economics*, 66(1), 73–97.

SLOAN, F. A. (1975): "Physician Supply Behavior in the Short Run," *Industrial and Labor Relations Review*, 28(4), 549–569.

This article is protected by copyright. All rights reserved.