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Nibene H Somé

Rose Anne Devlin

Nirav Mehta

Greg Zaric

Lihua Li

See next page for additional authors

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N. H. Somé,[1,2] R. A. Devlin,[4] N. Mehta,[3] G. Zaric,[1,5] L. Li,[2] S. Shariff,[2] B. Belhadji,[6] A. Thind,[1,2] A. Garg,[1,2] S. Sarma*[1,2]

[1]Department of Epidemiology & Biostatistics, University of Western Ontario, London, ON
[2]Institute for Clinical Evaluative Sciences, Toronto, ON
[3]Department of Economics, University of Western Ontario, London, ON
[4]Department of Economics, University of Ottawa, Ottawa, ON
[5]Richard Ivey School of Business, University of Western Ontario, London, ON
[6]Strategic Policy Branch, Health Canada, Ottawa, ON

E-mails:

N. H. Somé: nsome@uwo.ca
R. A. Devlin: radevlin@uottawa.ca
N. Mehta: nmehta22@uwo.ca
G. Zaric: gzaric@ivey.uwo.ca
L. Li : lihua.li@ices.on.ca
S. Shariff: Salimah.Shariff@lhsc.on.ca
B. Belhadji: bachir.belhadji@canada.ca
A. Thind: athind2@uwo.ca
A. Garg: Amit.Garg@lhsc.on.ca
S. Sarma: ssarma2@uwo.ca

*Corresponding Author
Address: Department of Epidemiology & Biostatistics
Schulich School of Medicine & Dentistry
University of Western Ontario
London Ontario
CANADA N6A 5C1
Tel: (519) 661-2111 x87583
E-mail: ssarma2@uwo.ca

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Conflict of interest statement

None of the authors have any conflicts of interest to declare.

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Abstract

We examine family physicians' responses to financial incentives for medical services in Ontario, Canada. We use administrative data covering 2003-2008, a period during which family physicians could choose between the traditional fee-for-service (FFS) and blended FFS known as the Family Health Group (FHG) model. Under FHG, FFS physicians are incentivized to provide comprehensive care and after-hours services. A two-stage estimation strategy teases out the impact of switching from FFS to FHG on service production. We account for the selection into FHG using a propensity score matching model, then use panel-data regression models to account for observed and unobserved heterogeneity. Our results reveal that switching from FFS to FHG increases comprehensive care, after-hours and non-incentivized services by 3%, 15% and 4% per annum. We also find that blended FFS physicians provide more services by working additional total days as well as the number of days during holidays and weekends. Our results are robust to a variety of specifications and alternative matching methods. We conclude that switching from FFS to blended FFS improves patients' access to after-hours care, but the incentive to nudge service production at the intensive margin is somewhat limited.

Keywords:
Physician remuneration; financial incentives; medical services; comprehensive care, after-hours services; access to care

JEL classification: I10; I12; I18; C23; C33

1. Introduction

Like elsewhere, access to family physicians was a concern to a large number of residents of Ontario, Canada in the early 2000s. During this period, approximately 57% of Ontarians could not see their primary care physician the same or following day when sick and 52% found it difficult to access care in the evenings or weekends (Ministry of Health and Long-Term Care (MOHLTC), 2015). Consequently, the government of Ontario introduced primary care reform, offering new compensation systems and financial incentives aimed at influencing physicians' service production. Prior to 2000, most family physicians in Ontario were paid using a fee-for-service (FFS) system, receiving a fixed fee for each service in accordance with defined schedule of benefits. In July 2003, the government of Ontario introduced a blended FFS model (the Family Health Group (FHG)), in which physicians would continue to receive all of their FFS payments plus incentives to provide comprehensive care (e.g., health assessment, preventive care services such as immunizations and cancer screenings) and some services outside of regular office hours, like evenings, weekends and holidays.

Many researchers have focused on comparing physicians' output across different remuneration systems (Campbell et al., 2007; Devlin and Sarma, 2008; Glazier et al., 2009; Kantarevic et al., 2011; Kralj and Kantarevic, 2013; Li et al., 2014; Sarma et al., 2010; Sutton et al., 2010), but the literature to date has not determined the extent to which financial incentives affect the mix of "incentivized" and "non-incentivized" services within the FFS environment. We fill this gap by studying the complete set of services that a physician can provide following the introduction of the FHG in Ontario.

We use Ontario health administrative data to evaluate the impact of physicians switching from FFS to FHG on total, comprehensive care, after-hours and non-incentivized services. To date, relatively little is known about the relationship between physicians' compensation schemes and access to both after-hours and comprehensive care. Recent studies on Australian physicians shed some light on those providing after-hours services (Broadway et al., 2016; Pham and McRae, 2015). Pham and McRae (2015) found that physicians who were employees rather than partners in a practice, female, older or lived in urban areas were less likely to provide after-hours services, whereas those in solo practices or who were partners in the practice were more likely to provide after-hours services. After-hours services increased if earnings increased but Australian physicians already with high earnings were unlikely to provide after-hours services (Broadway et al., 2016).

Our empirical strategy has two stages: the first stage accounts for the observed differences between switchers and non-switchers using a propensity score matching (PSM) technique to render switcher and non-switcher groups comparable. The second stage estimates the impact of switching from FFS to FHG using panel-data regression models. We allow for unobserved physician-specific effects and a physician-specific time trend using a high-dimensional fixed-effects model (Balazsi et al., 2018). Censored regression models are applied where appropriate.

Physicians respond to financial incentives embodied in the blended FFS by increasing the quantity of services: on average, physicians who switched to FHGs produce more incentivized services than those who remained in FFS. Specifically, comprehensive care services increased by 2.8% and after-hours services increased by 14.9%. Non-incentivized services increased by 4.4%, suggesting a positive spill-over effect from switchers increasing their total days worked and the number of days worked during holidays and weekends. FHG physicians, on average, produced an additional $1,713 worth of comprehensive care services, $21,316 of after-hours services and $3,850 of additional non-incentivized services per year. The estimated cost to the government of implementing comprehensive care and after-hours care premiums in the FHG model is, on average, $26,952 per year per switcher (in 2003 Canadian dollars).

2. Institutional Context

In Canada, provinces and territories have the primary responsibility for organizing and delivering health care services. The federal government ensures that each provincial/territorial health care system meets the national standards (Marchildon, 2013). Medically necessary physician and hospital services are publicly funded through taxes and privately delivered. As in other Canadian provinces, the fees for medical services in Ontario negotiated between the provincial medical association (the Ontario Medical Association) and the government of Ontario and are administrated by the Ontario Health Insurance Plan (OHIP) (Marchildon and Hutchison, 2016). The fees are listed in the *Schedule of Benefits and Fees.* OHIP compensates physicians for a wide range of services; patients do not pay out-of-pocket for these services. Fees are service-specific and account for the skills and time intensiveness of each service. Family physicians are responsible for acquiring office space, purchasing equipment, hiring office staff and incurring other practice-related expenses.

In 2000, 95% of family physicians in Ontario were paid predominantly by FFS (Sweetman and Buckley, 2014). As of April 1, 2016, 62% had opted for a reformed model (Office of the Auditor General of Ontario, 2016) with Family Health Groups and Family Health Organizations (FHO) accounting for 87% of the 8,800 family physicians in the reformed models, servicing 92% of the 10.6 million enrolled patients (Office of the Auditor General of Ontario, 2016). This paper studies physicians who switched from FFS to FHG between 2003 and 2008. The FHG was introduced in July 2003 and the decision to join FHG belonged solely to the physician. The FHG participation rate went from zero in 2002/03 to 39% in 2007/08 (Table 1). The percentage of FFS physicians dropped from 97% in 2002/03 to 35% in 2007/08 and participation in other models (including FHO, Family Health Network, Comprehensive care model, Community Health Group, Health Services Organization) went from 3% in 2002/03 to 26% in 2007/8 (Table 1).

Under FFS, physicians receive a fixed fee for each service; under FHG they receive FFS payments plus additional financial incentives for comprehensive care and after-hours services to enrolled patients. The comprehensive care premium (CCP) is 10% of the FFS fee. The after-hours premium was initially 10% of the FFS fee, increasing to 15% in April 2005, then to 20% in April 2006 (MOHLTC Bulletin 11020). As per the FHG agreement, physicians are required to provide after-hours services of at least one three hour-block per physician in the group per week unless exempted by the Ministry (MOHLTC). In addition, FHG physicians receive a comprehensive care capitation fee for each enrolled patient as well as other small incentives beginning in 2006 (Kantarevic et al., 2011; Sweetman and Buckley, 2014).

Physicians in the FHG model must enroll patients and provide them with both after-hours and comprehensive care services to receive premiums. Enrolment is voluntary on the part of the patient, but involves the seeking of treatment from the enrolling physician, except in emergency situations. The physician agrees to provide health care services to enrolled patients, establishing a formal one-to-one relationship between the patient and the physician (Sweetman and Buckley, 2014). FHG physicians can choose the size of their patient roster. In FFS there is no formal enrolment requirement and therefore no commitment between the physician and the patient. Table 2 compares the key features of the FFS and FHG models in Ontario.

3. Data, Variables and Decision to Switch to FHG

3.1. Data Sources

The data come from family physicians in Ontario between April 1st 2003 and March 31st, 2008. We use health administrative databases held at the Institute for Clinical Evaluative Sciences (ICES) in Ontario. ICES Physician Database (IPDB) contains physicians' demographic and practice characteristics; the Corporate Provider Database (CPDB) provides information on each physician's compensation model and effective date of eligibility for billing under the Ontario Health Insurance Plan (OHIP).

From the OHIP database we construct aggregated comprehensive care services, aggregated after-hours services, and the aggregated quantity of all non-incentivized services. The OHIP database provides the fee codes, fees paid, and the number of services performed by physicians. Fee codes include the comprehensive care services eligible for the CCP premium under FHG listed in Table A2.1 in appendix A2; Table A2.2, appendix A2, lists the fee codes eligible for the after-hours premium under FHG. We restrict after-hours services to those provided during weekends and holidays; services by FFS physicians after 5 pm on regular working days cannot be captured with the OHIP data. This restricted after-hours services measure allows for comparison between FFS and FHG physicians. Other OHIP fee codes submitted by family physicians are grouped as non-incentivized services.

Patient characteristics are from Ontario's Registered Persons Database (RPDB) and the Client Agency Program Enrollment (CAPE) database. The CAPE allows us to match enrolled patients with physicians and provides information on each physician's model type. Physicians can switch at any time between the available practice models; few actually switch on April 1st, resulting in at least two model affiliations in the switching year. For patients in FFS, we virtually enrolled them to physicians based on the highest billing from 18 core primary care fee codes submitted in the previous two years. We obtained each patient's residential postal code, age and sex from the RPDB.

3.2. Variables

The introduction of the FHG in 2003 led to three types of services: (i) comprehensive care *(j=1)*, (ii) after-hours *(j=2)* and (iii) non-incentivized services *(j=3)*. Each is identified by the OHIP fee codes listed in Tables A2.1-A2.2. To render our quantity measures meaningful, we aggregated the services using a formula similar to the one employed by Dumont et al. (2008) to calculate the quantity of type *j (j=1,2,3)* service by physician *i* at year *t*: $Q_{ijt} = \sum_{k=1}^{N_j} q_{ikt}p_{k,2003}$, where $p_{k,2003}$ is the fee for service k in 2003, q_{ikt} is the number of service k performed by physician *i* at year t=*2003-2008* and N_j is the number of fee codes or services of type *j*. The aggregated service *j* for each physician each period, Q_j , is given by the quantity of services of type *j*, weighted by the 2003 prices, allowing us to account for differences in time and skills associated with each service. For example, summing physician services with OHIP fee codes A001 (minor assessment) and A007 (intermediate assessment) assumes that there is no difference in time and expertise to perform minor and intermediate assessments. Using the fees paid for those services in 2003 ($21.70 for A001 and $33.70 for A007) as weights allows that intermediate assessment requires more time and skills than a minor assessment. The price of the aggregated service *j* was aggregated into indices. The price index for services provided within type *j*, denoted $\mathfrak{p}_j$, was calculated as a Laspeyres price index, where service *j* at year *t* is $\mathfrak{p}_{jt} = \frac{\sum_{k=1}^{N_j} p_{k,t}q_{k,2003}}{\sum_{k=1}^{N_j} p_{k,2003}q_{k,2003}}$, with $p_{k,t}$ the fee for service *k* (of type *j*) in year *t* and $q_{k,2003}$ the number of service *k* (of type *j*) in 2003. This price index represents the fees paid for aggregated service *j* under FFS. We use the number of each service of type *j=1,2,3* in the base year as weights, so the quantity variations due to switching to FHG are excluded from the price index. Total services aggregates comprehensive care services, Q_1, after-hours services, Q_2, and non-incentivized services, Q_3, weighted by the corresponding price indices. For each physician *i* at year *t,* total services is given by $Q_{it} = \mathfrak{p}_{1t}Q_{i1t} + \mathfrak{p}_{2t}Q_{i2t} + \mathfrak{p}_{3t}Q_{i3t.}$ Our weighted quantity variable captures the ability of the physician to produce medical services at different relative prices.

To control for patient complexity, we used patients' characteristics as covariates: average age, proportion of male patients in physician's practice, proportion of patients living in rural areas, and average comorbidity score based on the Johns Hopkins Aggregated Diagnosis Groups (ADGs). We derived the ADG for each patient from their diagnosis codes from all ICES health administrative databases using the Johns Hopkins ACG® System Version 10 case-mix adjustment system (The Johns Hopkins University, 2011), a well-used measure of patients' comorbidity status in the health services literature (Glazier et al., 2008). As the ADGs comprise 32 diagnosis groups, each patient has 32 indicator variables representing the presence or absence of each diagnosis group. We summed up ADGs for each patient, yielding an ADG score per patient up to 32; the average score was defined as the average of ADG scores of physician's patients. We used patient postal codes from the RPDB and Statistics Canada's postal code conversion file to obtain rural/urban location of patients. Individuals living in communities with less than 1,000 people is defined as rural areas (Statistics Canada, 2017).

When considering whether to switch, a FFS physician can estimate expected gross revenue under FHG based on the actual services provided to patients in the year 2002/03. This represents the revenue that a FFS physician would have gained in 2002 if paid under FHG practice rates based on the type and quantity of services provided to patients in 2002/03. We calculate this expected gain using the MOHLTC algorithm used to advise FFS physicians interested in switching to the FHG model.

Detailed practice level expenses are not available. Some research suggests that practice expenses are in the neighbourhood of 30% of gross revenues (Collier, 2015; Office of the Auditor General of Ontario, 2016; Petch et al., 2012). Given the fixed expenses associated with FFS and FHG practices, physicians are likely to switch only if their expected gross revenues exceed the expected costs of switching to FHG *ceteris paribus*. This is another reason to include the gain in income variable in the switching decision.

3.3. FFS physicians' switching decision to FHG

To understand the effect of physician switching from FFS to FHG, we develop a theoretical model of physician labour supply in a multitasking environment (see Appendix A1). In the model, physicians choose the total hours of work and allocate them to comprehensive care, afters-hours care and non-incentivized services. The model generates gross revenue functions (representing the total production of services) that depend on total hours, number of enrolled or rostered patients, and a wage index capturing the marginal return to an hour worked (the details are presented in the Appendix A1). The gross revenue functions predict the mix of services under FFS and FHG models, allowing us to derive a FHG participation decision rule by comparing the revenues under both models.

A utility-maximizing physician choses the model which maximizes revenue given the constraint on total hours worked (budget). Figure 1 illustrates the relationship between the number of enrolled patients and income or consumption conditional on h_i^* (the optimal hours worked under FFS). Derivations of the budget equations and the participation decision are presented in Appendix A1.

The budget line is horizontal under FFS as there is no incentive for physicians to enroll patients. The budget curve FHG illustrates the relationship between the number of enrolled patients and income under FHG, holding total working hours fixed at h_i^*. n_i^* represents the number of enrolled patients that renders physicians indifferent between FFS and FHG conditional on the total hours worked. The provision of after-hours care under FHG will increase costs for the physician. FHG will be attractive if the sum of the comprehensive care premium, $\tau_1 \mathrm{p}_1 Q_{i1}$, and net income from providing after-hours care, $(1+\tau_2)\mathrm{p}_2 Q_{i2}$, offsets the costs of providing after-hours care. This sum is an increasing function of the number of enrolled patients, n_i. For low values of n_i (below n_i^*) the sum of the benefits received under FHG is not sufficient to cover the additional costs of switching to FHG, hence the physician will choose FFS if $n_i \leq n_i^*$, and switch to FHG only if $n_i > n_i^*$. Physicians who can enroll more patients (such as physicians with indifference curves at E_1 in Figure 1) will tend to choose FHG moving from E_1 to E_2 and increase the production of services. FHG physicians will have to enroll patients and agree to provide them with both after-hours and comprehensive care services to receive additional premiums and bonuses. Therefore, switchers will be those with the ability to enroll and retain a sufficiently large number of patients, and able to provide comprehensive care and after-hours services to them. While physicians who have difficulties enrolling and retaining patients (such as physician E_0 in Figure 1) will remain in FFS. A direct comparison of physicians' production of services across FFS and FHG models without accounting for selection will potentially confound the effects of switching to FHG on service production. In our empirical analysis, we use propensity score matching to render switchers and non-switchers similar in terms of observed characteristics.

4. Methods

To evaluate the effect of switching from FFS to FHG on the mix of services, we started with all physicians who were paid under these models during 2003-2008, covering one year before and five years after the introduction of the FHG. Physicians not practicing in all of these years and those who switched back to FFS (362 physicians from 2004 to 2008) were excluded. This ensures that all physicians had the option of choosing the FHG model. The switcher group is defined as those who switched from FFS to FHG in any year between 2004 and 2008 and remained thereafter in FHG. The non-switcher group are those who remained in FFS throughout the study period. After excluding observations with missing data, we have 3,020 switchers (FHG physicians) and 1,150 non-switchers (FFS physicians). The mean and standard deviation of each continuous variable and the percentages for the dichotomous variables from 2003 to 2008, are presented in Table 3.

Before the FHG model was available, switchers, on average, produced more of all services compared to non-switchers. Physicians who switch to FHG seem to respond to both the comprehensive care and after-hours premium by producing more of these incentivized services. Switchers increased non-incentivized services for which they received the same fee as in the FFS model – perhaps explained by the fact that switchers increased total days worked per annum as well as the number of days worked during holidays and weekends compared to non-switchers (middle of Table 3). Switchers seem to respond to the incentives embedded in the FHG model.

Table 3 also highlights differences in the production of services, physicians' characteristics, and patients' characteristics. Before FHG, the switchers group provided 22% more services, worked 12% more days, and worked 14% more during holidays and weekends than non-switchers. When we evaluate the actual services produced by physicians in the fiscal year 2002/03 using the FHG system (the expected gain in income), switchers would have earned on average $206,720 and non-switchers $150,700. A proportion of this difference is the expected income gain (i.e. after accounting for the additional costs of providing after-hour services).

Table 3 shows that before the introduction of the FHG model, switchers had 21% more female physicians, 27% fewer patients living in the rural areas, and younger patients than non-switchers. Switchers were relatively younger than non-switchers (48 vs 52 years on average). These differences suggest that estimating the average treatment effects on the treated requires addressing the selection issue. We use three matching techniques (kernel-based propensity score matching (PSM), the covariate balancing propensity score (CBPS) and the entropy balancing (EB)) to render switcher and non-switcher groups comparable in terms of observable characteristics. The details of the matching procedures are presented in Appendix A0 and the results are reported in Figures 2 to 4 and Table 4.

4.1 Estimating Average Treatment Effects on the Treated

After accounting for baseline differences in observable characteristics between switchers and non-switchers using PSM, CBPS and EB, we employed panel-data regression models to account for physicians-specific unobserved factors affecting outcomes. We begin with a basic panel-data model:

$$lnQ_{it} = \theta_t + c_i + X_{it}\beta + \varphi FHG_{it} + u_{it}, \quad (1)$$

where lnQ_{it} represents the natural logarithm of services (total services, comprehensive care services and non-incentivized services) produced by physician i at year t, the parameter θ_t is a time-varying intercept (including the time trend and its square), the parameter c_i is physician unobserved heterogeneity, and, X_{it} is a set of physicians' observables characteristics (age, age squared, number of working holidays and weekends, sex (female), international medical graduate (IMG), 14 local health integration network (LHIN) indicators capturing regional variations; patient characteristics (average ADG score, average age, proportion in rural areas, and proportion of males); and the price indices of each type of service). The regressor of interest, FHG_{it}, takes the value one if physician i at year t was practicing in a FHG, takes on a fraction in the first year of switching (the fraction of time in FHG), and zero if the physician remained in FFS. Finally, u_{it} is the error term. Equation (1) is estimated using the fixed effects (FE) transformation or within transformation to eliminate physician-specific time-invariant unobserved heterogeneity c_i. In doing so, we assume that prior to reform switchers and non-switchers had the same θ_t (parallel trends assumption).

We then relax the parallel trends assumption by allowing each physician to follow his/her own time trend, adding another fixed effect to c_i, the interactions between year and individual physicians. The model becomes

$$lnQ_{it} = c_i + g_i\theta_t + X_{it}\beta + \varphi FHG_{it} + u_{it}, \quad (2)$$

with g_i the physician-specific time trend coefficient. Unlike in FE method, we cannot transform equation (2) to eliminate both c_i and g_i. We rely on a high-dimensional fixed-effects (HDFE) estimator, an iterative approach to estimating models with many levels of fixed effects (Guimarães and Portugal, 2010). User written HDFE program in STATA "reghdfe" estimates φ and each c_i

and g_i per physician (Correia, 2016). Controlling for both time-invariant heterogeneity and physician-specific trend helps ascertain the robustness of our results.

The after-hours services variable is left-censored at zero (31.5% of the sample) because some physicians choose not to work during weekends and holidays. Applying a linear regression model will lead to inconsistency since theoretically $E(y_{it}|FHG_{it}, X_{it})$ is non-linear in (FHG_{it}, X_{it}) when $y_{it} > 0$ (Wooldridge, 2010) (p.524). We use the Tobit model to estimate the average treatment effects of switching from FFS to FHG model on after-hours services. We first apply a pooled Tobit procedure, then, we use a random-effects (RE) Tobit model to take advantage of the panel data. To decide between the panel and pooled estimators we use a likelihood-ratio test where the null hypothesis is that the default model is pooled Tobit. We estimate two versions of the model: without and with physician-specific unobserved effects, c_i. To control for the unobserved effect in a Tobit model, we use Chamberlain-Mundlak device: $c_i = a + b\bar{Z}_i + v_i$ with $\bar{Z}_i = \frac{1}{6}\sum_{t=1}^{6} Z_{it}$, a and b are coefficients to be estimated, Z_{it} is the set of explanatory variables in equation (1) and v_i is an error term (Chamberlain, 1982; Mundlak, 1978).

5 Estimated Results

We start by estimating equation (1) using ordinary least squares (OLS) for comparison only, since OLS estimates may be biased because the physician fixed-effects c_i are potentially correlated with the decision to switch FHG_{it} leading to $E(c_i|FHG_{it} = 1) \neq 0$. We then estimate FE (equation (1)) and HDFE (equation (2)) models for total services, comprehensive care services and non-incentivized services. For after-hours services, we use pooled Tobit model and random-effects (RE) Tobit model with and without physician's unobserved heterogeneity. Note that the likelihood-ratio test rejected the pooled Tobit model for random-effects Tobit model. For all models we present inverse probability weighted regressions results, where the weights come from the PSM in the first stage. The average impacts of switching from FFS to FHG on switchers are reported in Table 5. The full sets of estimates are presented in Table A2.5 and A2.6. The results for the corresponding unweighted version of the regressions are reported in Table A2.7.

The results from the inverse probability weighted HDFE (FE) model (second panel) indicate that, on average, physicians who switched to the FHG model increase the production of total, comprehensive care, and non-incentivized services by 8.7% (7.4%), 2.8% (4.9%), and 4.4% (5.4%) respectively. Conditional on providing after-hours care, RE Tobit model with (without) unobserved effects show that switchers increased their production of after-hours services by 14.9% (16.8%). FHG physicians also produce more non-incentivized services. Ignoring the panel dimension of our data and unobservable heterogeneity leads to biased estimates. For comparison, we present in Table 5 (first panel) the results for the number of services which are qualitatively similar to those in the second panel, but different in magnitude. Results of the unweighted regressions in Table A2.7 indicate that, on average, switching to the FHG model has a significantly positive impact on switchers; estimates of the impact on switchers' services production from pooled OLS and Tobit models are greater in magnitude than those from the inverse probability weighted versions of these models. The results from the weighted and unweighted HDFE and FE models are not dramatically different, suggesting that accounting for unobservable heterogeneity is crucial in identifying the average treatment effects on the treated.

The average estimates of the physician-specific time trend for both switchers and non-switchers from the HDFE model are presented in appendix A2 (Figures A2.1-6) by sex and age. These figures suggest that male and female physicians, older (over 55 years) and younger (55 years or below) physicians, switchers and non-switchers have different time trend slopes. Overall, female and male physicians have positive time trend slopes in services production, except for comprehensive care services (Figure A2.3) for both female and male non-switchers. We also see from Figures A2.4-6 that older non-switchers tend to decrease the production of services over time (negative time trend slopes), while older switchers tend to increase the production of services overt time.

Our estimates suggest that physicians respond to incentives brought about by the FHG reform in a predictable manner. On average, physicians who switched to the FHG model produced more services than those who remained in the FFS: comprehensive care services increased by 2.8%; after-hours services increased by 14.9% and even non-incentivized services increased by 4.4%, suggesting some type of spill-over effects arising from the provision of more incentivized services to enrolled patients. To gain insights into this latter result, we report the switchers' production of non-incentivized services by type of patients over time in Table A2.8. It appears that the positive effect on non-incentivized services came from two complementary sources. After the first two years, switchers supplied most of the non-incentivized services to non-enrolled patients (more than 90% and 60% in 2003 and 2004). Then, switchers gradually increased the proportion of non-incentivized services provided to enrolled patients reaching 88% in 2008, reducing the provision to non-enrolled patients to 12%. This transition may be explained by the time lag in the enrolment process, reflecting the time needed to respond to the incentives embedded in the FHG model.

The quantity-increasing response can partly be explained by incentive effects that encourage physicians to work more days per year. On average, switchers increase their total days worked per year by 1% and the number of days worked during holidays and weekends by 2% (Table 6).

Based on the preferred HDFE and RE Tobit with unobserved effects specification, we calculate the value of the additional services produced by switchers relative to non-switchers. A switcher facing a 10% increase in payment for comprehensive care services produces, on average, additional comprehensive care worth $1,713 per year relative to a non-switcher. A switcher facing a more than 10% increase in the payment for after-hours services produces, on average, $21,316 worth more after-hours services per year than a non-switcher, conditional on providing after-hours care. Regarding non-incentivized services, the spill-over effects generates an additional $3,850 per year of non-incentivized services for switchers relative to non-switchers. In terms of total services, switching to FHG adds extra services valued at $42,673 per year per FHG physician (based on HDFE model), representing 1.16 FFS equivalent services. Also, implementing the FHG model creates additional costs to the government that we capture using the premiums paid to physicians for providing comprehensive and after-hours care. We use the preferred models (HDFE and RE Tobit with unobserved effects) to predict the adjusted costs, noting that each switcher received, on average, $20,085 and $6,788 per year for providing comprehensive care and after-hours care respectively. The total cost to the government is estimated at $26,952/year per switcher. In other words, in order to produce additional services valued at $42,673 per year per switcher, the corresponding premiums costs to the government is valued at $26,952.

5.1 Robustness Checks

Previous results were based on the inverse probability weighting technique with PSM matching. Using weights from the CBPS and EB matching methods produce qualitatively similar results to Table 5 (see Table A2.9). Across all models, switching to FHG compensation system increases total, comprehensive care, after-hours and non-incentivized services.

5.2 Heterogeneous Impact

Table 7 reports the impact of switching from FFS to FHG by sex (first panel), graduation cohort (second panel), practice location (third panel) and the switching year (fourth panel). On average, the impact of switching from FFS to FHG is greater for male physicians, suggesting that they are more responsive to financial incentives than females. The experienced physicians' cohort (graduated before 1970) is more sensitive to comprehensive care incentives than other graduation cohorts; less experienced physicians (graduated after 1990) are more responsive to after-hours incentives. The third panel shows some heterogeneous responses based on practice location. Finally, early switchers (switched before 2005) are more responsive to incentives than the late switchers except for after-hours incentives. Overall, across all sub-groups considered, the impact of switching to the FHG is positive: financial incentives encourage the production of incentivized medical services with a positive spillover effect on non-incentivized services.

6 Discussion and Conclusions

We provide a unifying framework to study incentivized and non-incentivized medical services within the FFS environment using Ontario's natural experiment. After accounting for selection bias using matching methods, we found that physicians who switched from FFS to a blended FFS (FHG) increased total service production of 3% to 15%: comprehensive care medical services increased by 2.8%, after-hours services by 14.9%, and non-incentivized services by 4.4%. Previous studies on the impact of physician payments focused solely on patient visits to physicians' office (Gaynor and Gertler, 1995; Gaynor and Pauly, 1990; Kantarevic et al., 2011; Li et al., 2014; Sarma et al., 2010). Our paper highlights the importance of multitasking in understanding the incentive effects on services production, especially when studying pure FFS and blended FFS models.

The quantity-increasing response from physicians who switched to FHG model may be partly due to increasing total days worked as well as the number of days worked during holidays and weekends. Thus, policy makers can rely on financial incentives to nudge the supply of targeted physician services. Altering the number of physicians is generally expensive and time consuming given the extensive medical training; the ability to use financial incentives to increase the supply of services at the intensive margin can help alleviate supply shortfalls, at least in the short run. There is a limit to the quantity of medical services that can be produced with existing physicians. Our results show that the FHG physicians yielded 1.16 more services than comparable FFS physicians. The government of Ontario incurred $26,952 additional yearly premium costs per switcher to produce additional services valued at $42,673 per year per switcher. The responses to these financial incentives is quite inelastic: a 10% increase in incentives leads to a 3% increase in comprehensive care services; a 15% increase in incentives leads to about a 15% increase in after-hours services.

This inelastic response imposes limits rather quickly on the role of financial incentives as a mechanism to increase physician services. Our results clearly suggest that financial incentives may be more effective in targeting the production of specific medical services or to deal with a temporary increase in demand for medical services rather than as a permanent solution to a supply shortfall. Moreover, financial incentives may lead to other savings in the health care system by improving after-hours care and reducing, say, costly emergency department visits (Mehta et al., 2017). Our results are robust to alternative matching approaches but rely on the assumption that the propensity score matching equation in the first stage is reasonable, which may not hold if unobservable factors also influence selection into FHG. We believe that our second-stage regressions and alternative matching procedures are reasonable specifications in identifying the effect of switching to FHG.

There are some limitations of the study. First, our results might not generalize to the entire FFS physician population of Ontario, holding only for switchers. Second, practice level workforce data are not readily available, limiting additional insights into the type of physicians likely to switch to FHG. Third, practice cost-sharing information of physicians may influence their decision to switch but these data are not available. Finally, services provided after 5 pm during regular working days were unavailable with OHIP data; our analysis of after-hours is restricted to services provided during the weekends and holidays, thereby underestimating the true impact of switching to blended FFS on after-hours services. Nevertheless, our paper clearly finds that switching from FFS to blended FFS improves patients' access to care during weekends and holidays and increases the provision of comprehensive care to patients.

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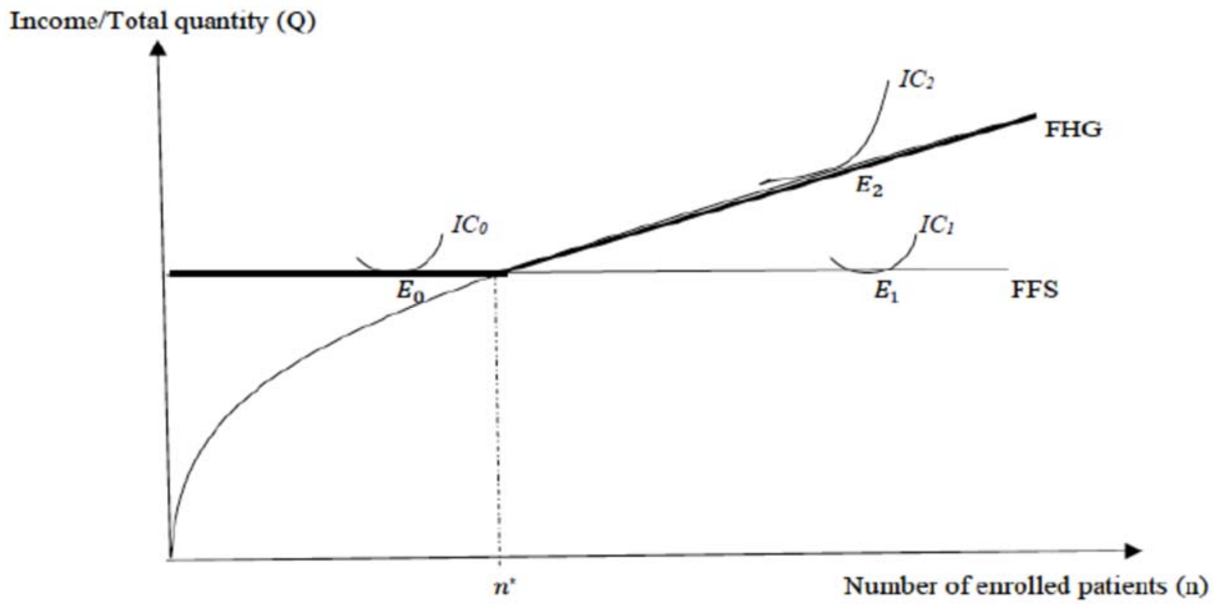
Figure 1: Optimal Choice along the efficient Budget Constraint



Legend: IC: Indifference Curve; FFS: Fee-For-Service; FHG: Family Health Group

Figure 2: Distribution of the propensity scores (kernel matching)

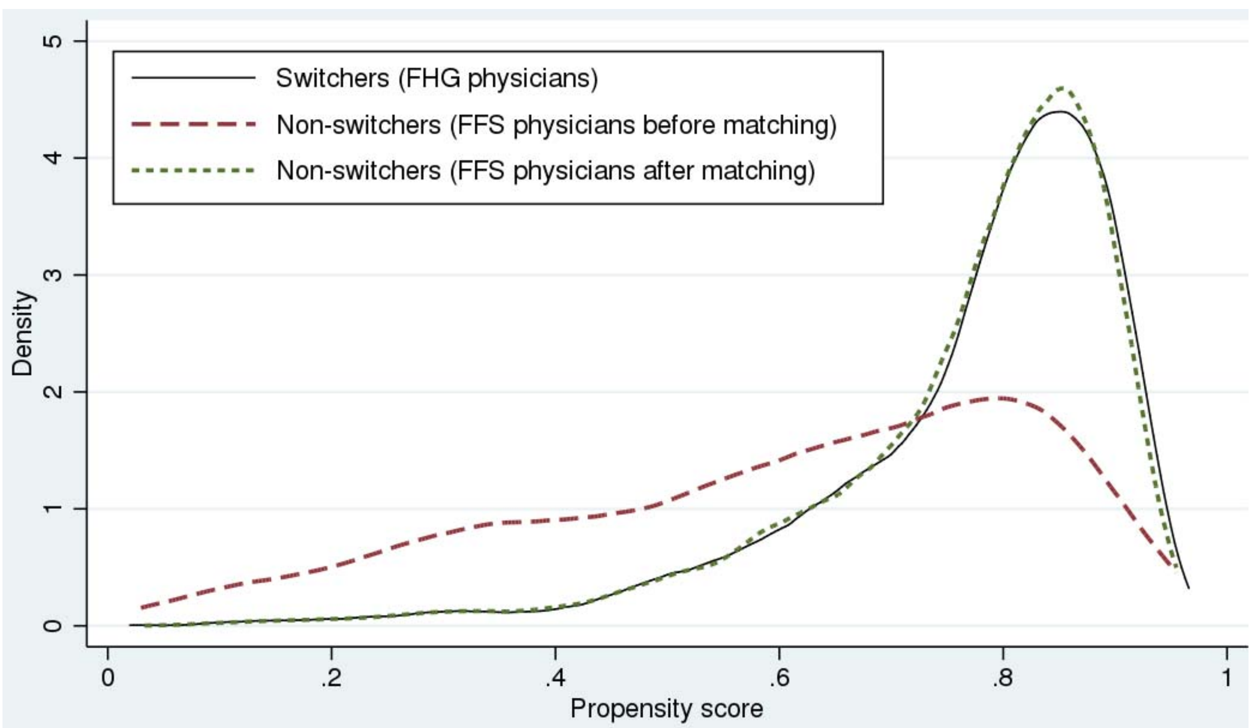


Figure 3: Distribution of the propensity scores (CBPS)

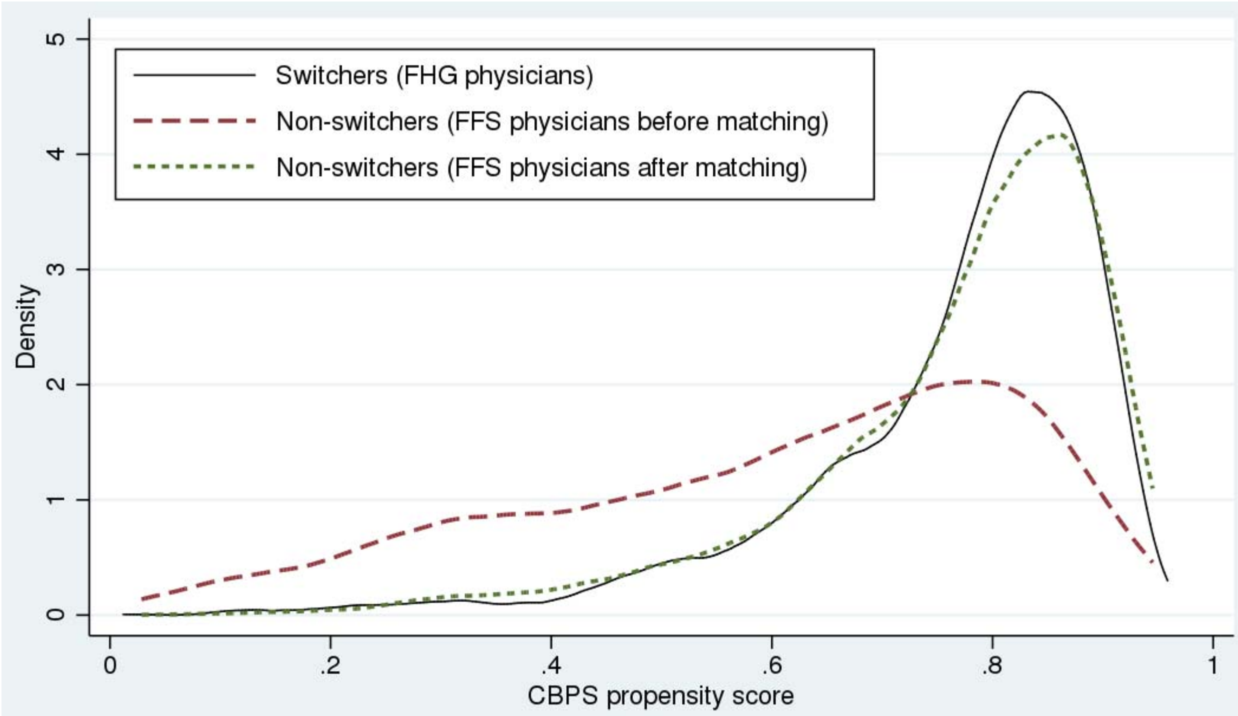


Figure 4: Distribution of the propensity scores (EB)

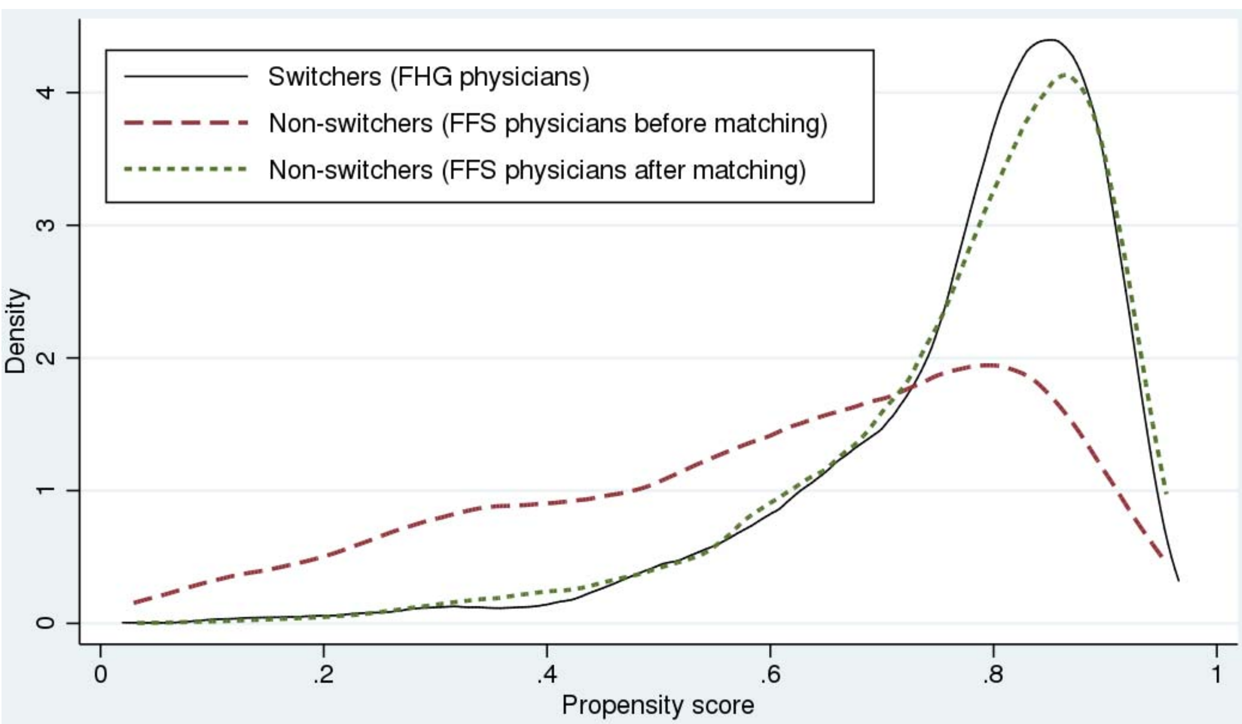


Table 1: Distribution of physicians in Ontario across FFS and FHG

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
Physicians in FFS	9,908	8,049	7,003	5,164	4,944	3,752
(%)	(97.3)	(78.4)	(67.1)	(49.1)	(46.6)	(35.1)
Physicians in FHG	0	1,847	2,870	3,976	3,886	4,184
(%)	(0.0)	(18.0)	(27.5)	(37.8)	(36.6)	(39.2)
Physicians in other model	277	374	568	1,372	1,780	2,748
(%)	(2.7)	(3.6)	(5.4)	(13.1)	(16.8)	(25.7)
Total	10,185	10,270	10,441	10,512	10,610	10,684
(%)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Source: Client Agency Program Enrollment database.
Note: Other model include CCM = Comprehensive Care Model, CHG = Community Health Group, CSA = Community Sponsored Agreement, FHN = Family Health Network, FHO = Family Health Organization, GHC = Group Health Center, HSO = Health Services Organization, PCG = Primary Care Group, RAN = Rural and Northern Group (PCN), SMO = South Eastern Area Medical Organization (SEAMO), and STJ = St. Joseph's Health Centre.

Table 2: Comparison of Ontario's FFS and FHG payment models

	FFS	FHG
Minimum Group size	1	At least 3
Patient enrollment requirement	No	No, but encouraged through incentives
After-hours requirement	No	At least one three hour-block
Services		
Comprehensive care services	Remunerated at price $\mathfrak{p}_1$	Remunerated at price $(1+\tau_1)\mathfrak{p}_1$
After hours services	Remunerated at price $\mathfrak{p}_2$	Remunerated at price $(1+\tau_2)\mathfrak{p}_2$
Non-incentivized services	Remunerated at price $\mathfrak{p}_3$	Remunerated at price $\mathfrak{p}_3$
Fixed payment	No fixed payment	(small) Comprehensive care capitation
Fixed bonuses payment	No bonuses	bonuses for preventive care (flu shots to seniors, pap smear, mammogram, childhood immunizations, and colorectal-cancer screening) were introduced in late 2006

Note: $\tau_1 = 10\%$ is the comprehensive care premium and $\tau_2 = 20\%$ the after-hours premium.

Table 3: Descriptive statistics: mean, percentages and standard deviation

	2003		2004		2005		2006		2007		2008	
	Switcher (FHG)	Non-switcher (FFS)	Switcher (FHG)	Non-switcher (FFS)	Switcher (FHG)	Non-switcher (FFS)	Switcher (FHG)	Non-switcher (FFS)	Switcher (FHG)	Non-switcher (FFS)	Switcher (FHG)	Non-switcher (FFS)
Outcomes												
Number of services (count) [a]												
Number of CC services	7053 (66.41) [3293]	5394 (64.86) [3885]	7133 (63.96) [3382]	5293 (64.13) [3898]	7243 (57.02) [3510]	5221 (62.5) [4025]	7041 (56.87) [3514]	5014 (62.72) [4080]	6714 (57.75) [3463]	4699 (63.84) [4045]	6637 (56.78) [3567]	4625 (59.72) [4196]
Number of AH services	616 (5.8) [910.1]	514.9 (6.19) [928.9]	918.4 (8.23) [1329]	498.9 (6.04) [932.9]	1364 (10.74) [1778]	480.7 (5.75) [928.2]	1585 (12.8) [2052]	475.1 (5.94) [961.2]	1553 (13.36) [2007]	437 (5.94) [916.1]	1540 (13.17) [2021]	851.7 (11.00) [1125]
Number of Non-incentivized services	2951 (27.78) [2707]	2407 (28.94) [2972]	3102 (27.81) [2943]	2462 (29.83) [3129]	4095 (32.24) [3351]	2651 (31.74) [3805]	3754 (30.32) [3222]	2505 (31.34) [3383]	3358 (28.88) [3296]	2224 (30.21) [2841]	3513 (30.05) [3572]	2268 (29.28) [2785]
Total number of services	10621 (100) [5115]	8316 (100) [5497]	11153 (100) [5622]	8254 (100) [5576]	12702 (100) [6663]	8353 (100) [6115]	12380 (100) [6784]	7994 (100) [6021]	11626 (100) [6684]	7361 (100) [5711]	11689 (100) [7038]	7745 (100) [6229]
Price index[b] *(base year=2003)*												
Price index for CC serv. (p_{1t})	1.00	1.00	1.02	1.02	1.08	1.08	1.12	1.12	1.19	1.19	1.20	1.20
Price index for AH serv. (p_{2t})	1.00	1.00	1.02	1.02	1.08	1.08	1.12	1.12	1.18	1.18	1.19	1.19
Price index for Non-incentivized services (p_{3t})	1.00	1.00	1.01	1.01	1.14	1.14	1.40	1.40	1.42	1.42	1.51	1.51
Quantity of services in thousands of 2003 Canadian dollars (i.e. Value of services)												
CC services (Q_{1t})[c]	187.5 (76.9) [82.81]	144 (72) [99.4]	190.5 (74.6) [85.59]	141.8 (71.5) [100.3]	194.2 (73.3) [89.49]	140.7 (71.2) [104.3]	190.7 (72.5) [90.52]	136.6 (72.3) [107.6]	182.7 (72.2) [89.81]	128.4 (72.4) [107.3]	181 (71.9) [92.7]	126.9 (67.3) [112.5]
AH services (Q_{2t})[c]	14 (5.8) [24.1]	14.4 (7.2) [25.5]	21 (8.2) [26.4]	14 (7) [25.4]	25.6 (9.7) [27.7]	13.6 (6.9) [25.6]	32.4 (12.3) [28.8]	13.6 (7.2) [26.8]	31.9 (12.6) [27.7]	12.6 (7.1) [25.7]	32.7 (13) [27.9]	25.7 (13.6) [31.9]
Non-incentivized services (Q_{3t})[c]	42.3 (17.3) [41.9]	41.6 (20.8) [61]	43.9 (17.2) [44.4]	42.5 (21.4) [63.5]	45.3 (17.1) [44.9]	43.4 (21.9) [68.8]	40 (15.2) [39.2]	38.7 (20.5) [63]	38.6 (15.2) [42.8]	36.4 (20.5) [60.4]	37.9 (15.1) [49]	36 (19.1) [57.9]

Total services as a sum: $Q_{1t} + Q_{2t} + Q_{3t}$	243.8 (100) [102.3]	200.1 (100) [119.8]	255.4 (100) [109.9]	198.3 (100) [120.9]	265.1 (100) [118.1]	197.7 (100) [128]	263.1 (100) [122.8]	188.9 (100) [132.1]	253.2 (100) [124.1]	177.4 (100) [131.7]	251.7 (100) [130.3]	188.5 (100) [148.2]
Total services (Q_t) as weighted sum of the three types of services: $Q_t = \mathfrak{p}_{1t}Q_{1t} + \mathfrak{p}_{2t}Q_{2t} + \mathfrak{p}_{3t}Q_{3t.}$	243.8 [102.3]	200.1 [119.8]	259.9 [111.9]	201.7 [123]	289.2 [128.8]	216.3 [140]	305.8 [142.3]	222.3 [155.3]	309.5 [151.9]	219.1 [162.2]	313.6 [163.9]	237.2 [184.5]
<u>Physicians' characteristics</u>												
Expected gain in income (thousands of 2003 C$)	206.72	150.70	-	-	-	-	-	-	-	-	-	-
	[99.75]	[108.4]	-	-	-	-	-	-	-	-	-	-
Working holidays and weekends	62.86	55.06	61.3	53.09	63.87	52.29	62.49	51.1	60.42	49.25	58.69	47.4
	[22.86]	[25.5]	[23.13]	[25.76]	[22.58]	[25.99]	[22.86]	[27.27]	[23.34]	[27.39]	[22.88]	[27.54]
Total days worked	251.71	223.9	248.92	219.51	255.92	218.37	249.7	213.24	244.84	205.91	246.02	203.25
	[49.68]	[63.1]	[49.94]	[63.76]	[48.53]	[63.87]	[48.21]	[66.93]	[49.95]	[70.07]	[51.94]	[75.54]
Age	48.53	52.21	49.53	53.21	50.53	54.21	51.53	55.21	52.53	56.21	53.53	57.21
	[9.49]	[11.8]	[9.49]	[11.81]	[9.49]	[11.81]	[9.49]	[11.81]	[9.49]	[11.81]	[9.49]	[11.81]
IMG	15%	19%	15%	19%	15%	19%	15%	19%	15%	19%	15%	19%
Female	35%	29%	35%	29%	35%	29%	35%	29%	35%	29%	35%	29%
<u>Patients' characteristics</u>												
Av. ADG score	3.47	3.43	3.38	3.4	3.36	3.46	3.32	3.49	3.29	3.44	3.22	3.4
	[0.52]	[0.93]	[0.5]	[0.92]	[0.49]	[1.01]	[0.48]	[1.07]	[0.47]	[1.05]	[0.46]	[1.06]
Av. Age of patients	38.91	40.88	39.16	41.7	39.31	42.49	39.26	43.35	39.64	44.12	40.08	44.67
	[6.8]	[11.3]	[6.73]	[11.82]	[6.58]	[12.25]	[6.44]	[12.66]	[6.41]	[13.19]	[6.42]	[13.42]
% of male patients	0.45	0.48	0.46	0.48	0.46	0.48	0.47	0.48	0.47	0.48	0.47	0.48
	[0.13]	[0.14]	[0.13]	[0.15]	[0.13]	[0.15]	[0.13]	[0.15]	[0.13]	[0.15]	[0.12]	[0.16]
% of pat. in rural areas	0.08	0.11	0.07	0.1	0.07	0.1	0.07	0.1	0.07	0.1	0.07	0.1
	[0.18]	[0.24]	[0.17]	[0.23]	[0.17]	[0.23]	[0.17]	[0.23]	[0.17]	[0.23]	[0.17]	[0.23]

Note: Percentage in parentheses and standard deviations in squared brackets.

Legend: [a] represents the average of the sum of the number of services $\sum_{k=1}^{N_j} q_{ikt}$, where q_{ikt} is the number of service *k* performed by physician *i* at year *t* and N_j is the number of fee codes or services of type *j*. [b] Laspeyres price indices computed with the FFS price of services as reported in the OHIP Schedule of Benefits and Fees. [c]The (weighted) quantity of services are computed using the formula describes in section 3: $Q_{ijt} = \sum_{k=1}^{N_j} q_{ikt} p_{k,2003}$.

Table 4: Mean and Standardized Bias before and after matching

	Mean and standardized Bias before matching				Mean and standardized Bias after matching				
	Switcher (FHG)	Non-switcher (FFS)	P-value of t-test before matching	% of bias	Switcher (FHG)	Non-switcher (FFS)	P-value of t-test after matching	% of bias	% reduction of |bias|
Total services in 2003 (thousand C$)	243.82	200.1	0.000	39.2	243.82	247.23	0.206	-3.1	92.2
Age	48.52	52.21	0.000	-34.4	48.52	48.54	0.964	-0.1	99.0
Female	0.35	0.28	0.000	14.0	0.35	0.34	0.237	3.1	77.7
FTE	1.15	0.98	0.000	45.9	1.15	1.15	0.682	-0.9	98.0
Expected gain in income (thousand C$)	206.72	150.70	0.000	53.9	206.72	208.56	0.478	-0.7	96.7
LHIN01 = Erie St. Clair	0.04	0.04	0.946	-0.2	0.04	0.05	0.095	-4.5	-1823.3
LHIN02 = South West	0.06	0.05	0.839	0.70	0.06	0.05	0.252	2.9	-308.2
LHIN03 = Waterloo Wellington	0.01	0.04	0.000	-23.5	0.01	0.01	0.747	0.4	98.1
LHIN04 = Hamilton Niagara Haldimand Brant	0.08	0.09	0.462	-2.5	0.08	0.09	0.315	-2.6	-2.3
LHIN06 = Mississauga Halton	0.09	0.08	0.222	4.3	0.09	0.09	0.854	0.5	88.7
LHIN07 = Toronto Central	0.16	0.22	0.000	-15.7	0.16	0.16	0.811	-0.6	96.3
LHIN08 = Central	0.17	0.12	0.000	15.0	0.17	0.18	0.484	-1.9	87.0
LHIN09 = Central East	0.13	0.10	0.004	10.4	0.13	0.14	0.418	-2.2	78.5
LHIN10 = South East	0.02	0.03	0.144	-4.9	0.02	0.02	0.930	-0.2	95.7
LHIN11 = Champlain	0.13	0.13	0.619	-1.7	0.13	0.13	0.924	-0.2	85.7
LHIN12 = North Simcoe Muskoka	0.01	0.02	0.016	-7.7	0.01	0.01	0.247	2.2	71.0
LHIN13 = North East	0.03	0.03	0.843	0.7	0.03	0.02	0.086	4.2	-507.2
LHIN14 = North West	0.01	0.02	0.124	-5.1	0.01	0.01	0.532	1.4	73.1
Average ADG score	3.46	3.43	0.141	4.4	3.46	3.44	0.063	3.9	11.9
Av. Age of patients	38.90	40.88	0.000	-21.1	38.90	38.60	0.122	3.3	84.5
Prop. of patients in rural areas	0.07	0.11	0.000	-16.7	0.07	0.07	0.554	1.3	92.0
Higher-order terms									
Age squared	2444.6	2864.9	0.000	-37.4	2444.6	2449.0	0.859	-0.4	99.0
Total services in 2003 squared	69917	54378	0.000	25.9	69917	72446	0.094	-4.2	83.7
Expected gain in income squared	52514	34483	0.000	39.8	52514	53967	0.229	-3.2	91.9

Note: CC = Comprehensive care, AH = After-hours, FFS = Fee For service, FHG = Family Health Group

Table 5: Impact of switching from FFS to FHG on service production using inverse probability weighted regressions (PSM)

Outcomes	Number of services: Pooled OLS	FE	HDFE	RE Tobit with UE	Weighted quantity of services (in 2003 dollars): Pooled OLS	FE	HDFE	RE Tobit with UE
Log Total services	0.087***	0.085***	0.076***	-	0.044***	0.074***	0.087***	-
	(0.018)	(0.009)	(0.005)	-	(0.016)	(0.009)	(0.005)	-
Log CC services	0.027	0.050***	0.028***	-	0.037*	0.049***	0.028***	-
	(0.022)	(0.013)	(0.007)	-	(0.021)	(0.012)	(0.007)	-
Log AH services	¶0.014	-	†0.167***	0.151***	¶0.034***	-	†0.168***	0.149***
	(0.010)	-	(0.005)	(0.005)	(0.010)	-	(0.005)	(0.006)
Log non-incentivized services	0.377***	0.098***	0.065***	-	0.411***	0.054***	0.044***	-
	(0.035)	(0.015)	(0.008)	-	(0.037)	(0.017)	(0.008)	-
Observations	24,964	24,964	24,961	24,964	24,964	24,964	24,961	24,964
Physicians	4,164	4,164	4,161	4,164	4,164	4,164	4,161	4,164

Legend: Significance level: * p<0.10; **p<0.05; *** p<0.01. Robust standard errors in parentheses. ¶ Pooled Tobit estimates. †Random Effect Tobit without unobserved effects. RE Tobit with UE= Random Effect Tobit with unobserved effect.

Note: HDFE: High-dimensional fixed-effects, FE: Fixed effects, RE: Random-effects, FFS=Fee For service, FHG= Family Health Group. OLS regressions include prices of the different services, time trend and its squared, age, age squared, number of working holidays and weekends, gender (female), IMG, average ADG score, average age of patients, % of patients in rural areas, % of male patients, 14 geographic indicators for regional health areas (LHINs) (LHIN number one: Erie St. Clair is used as reference), and an intercept. Fixed Effects regressions include the same explanatory variables as in OLS except IMG and age. High-dimensional Fixed effects regressions include the same explanatory variables as in Fixed Effects regressions except time trend, time trend squared and age squared. Tobit model is applied to AH services which contain 31.5% of zero-observations. The RE Tobit models include time trend, time trend squared, IMG, gender (female), 14 geographic indicators for regional health areas (LHINs), (FTE>=0.5), number of working holidays and weekends, age, prices of different services, average age of patients, % of patients in rural areas, and, % of male patients with or without time average variables (unobserved characteristics). The Pooled Tobit model includes the same explanatory variables as in RE Tobit model plus age squared.

Table 6: Impact of switching on days worked

	Log total days worked.	Log working holidays and weekends
FHG	0.00969***	0.0188***
	(0.00371)	(0.00615)
AH services price index	0.184***	0.220**
	(0.0613)	(0.108)
Non-incentivized services price index	0.0208	0.132***
	(0.0294)	(0.0457)
CC services price index	-0.181	0.389*
	(0.141)	(0.220)
Av. ADG score	0.00748	-0.00842
	(0.0156)	(0.0187)
Av. Age of patients	-0.000986	-0.000992
	(0.00209)	(0.00269)
Prop. of male patients	0.127	0.203
	(0.126)	(0.182)
Prop. of patients in rural areas	-0.170	-0.267
	(0.112)	(0.168)
LHIN02 = South West	0.00978	-0.0803
	(0.0981)	(0.121)
LHIN03 = Waterloo Wellington	0.158	0.359
	(0.181)	(0.270)
LHIN04 = Hamilton Niagara Haldimand Brant	0.0752	0.0606
	(0.118)	(0.141)
LHIN05 = Central west	0.106	0.0849
	(0.108)	(0.124)
LHIN06 = Mississauga Halton	0.0912	0.141
	(0.106)	(0.119)
LHIN07 = Toronto Central	0.00560	0.0642
	(0.131)	(0.131)
LHIN08 = Central	-0.00347	0.0572
	(0.113)	(0.121)
LHIN09 = Central East	0.0612	0.151
	(0.118)	(0.137)
LHIN10 = South East	0.286	-0.313
	(0.229)	(0.378)
LHIN11 = Champlain	0.510	0.260
	(0.338)	(0.275)
LHIN12 = North Simcoe Muskoka	0.0566	0.0353
	(0.0924)	(0.118)
LHIN13 = North East	0.373	0.382
	(0.258)	(0.251)
LHIN14 = North West	0.229	-0.0129

	(0.231)	(0.317)

Legend: Significance level: * p<0.10; **p<0.05; *** p<0.01. Robust standard errors in parentheses.

Table 7: Heterogeneity of responses

	Observations	Outcome Variables			
	[Physicians]	Log (total services)	Log (CC services)	Log (AH services) †	Log (non-incentivized services)
Gender					
Males	16,671	0.087***	0.031***	0.181***	0.035***
	[2,779]	(0.007)	(0.008)	(0.008)	(0.011)
Females	8,290	0.073***	0.023**	0.139***	0.042***
	[1,382]	(0.009)	(0.011)	(0.011)	(0.015)
Graduation cohort					
Grad. year < 1970	4,336	0.093***	0.072***	0.182***	0.061*
	[723]	(0.015)	(0.026)	(0.018)	(0.024)
Grad. year 1970-1980	7,355	0.085***	0.019	0.163***	0.042**
	[1,226]	(0.012)	(0.012)	(0.012)	(0.018)
Grad. year 1980 -1990	8,292	0.075***	0.014	0.139**	0.039***
	[1,382]	(0.008)	(0.008)	(0.011)	(0.013)
Grad. year > 1990	4,980	0.089***	0.026*	0.206***	0.030
	[830]	(0.012)	(0.014)	(0.016)	(0.019)
Location					
South West Ontario	4,880	0.063***	0.0002	0.129***	0.006
	[823]	(0.014)	(0.056)	(0.017)	(0.020)
Central Ontario	14,938	0.083***	0.018*	0.167***	0.044***
	[2,505]	(0.007)	(0.009)	(0.009)	(0.011)
South East Ontario	3,816	0.111***	0.078***	0.166***	0.071***
	[642]	(0.012)	(0.013)	(0.017)	(0.020)
Northern Ontario	1,295	0.072***	0.063*	0.456***	-0.014
	[221]	(0.023)	(0.036)	(0.036)	(0.748)
Year of switching					
Switched before 2005	11,728	0.112***	0.044***	0.082***	0.069***
	[1,955]	(0.009)	(0.010)	(0.012)	(0.014)
Switched in 2005 or after	20,125	0.064***	0.016*	0.097***	0.011
	[3,358]	(0.007)	(0.009)	(0.008)	(0.011)

Legend: Significance level: * p<0.10; **p<0.05; *** p<0.01. Robust standard errors in parentheses. †Marginal effects from Random-effects Tobit with unobserved effects estimation.

Note: FFS=Fee For service, FHG= Family Health Group. We use weighted High Dimensional Fixed Effects regressions controlling for the prices of the different services, number of working holidays and weekends, average ADG score, average age of patients, % of patients in rural areas, % of male patients, and an intercept. For AH services we compute the marginal effect of switching after estimating a RE Tobit model with unobserved physician-effects controlling for the prices, age, number of working holidays and weekends, time trend, time trend squared, IMG, average age of patients, % of patients in rural areas, % of male patients and the average across time of all explanatory variables.

Online Appendix

Appendix A0: Matching Strategies

To deal with the systematic differences between switchers and non-switchers, we rely on propensity score matching (PSM) (Rosenbaum and Rubin, 1983) to ensure that the two groups are comparable in terms of observed characteristics. We first estimate the propensity score (i.e., the probability that an individual physician will switch from FFS to FHG) using the Dehejia and Wahba (2002) algorithm along with the 'hit or miss' method (Heckman et al., 1997). The hit or miss method allows us to select the additional variables that might affect the participation decision, for example higher-order terms of covariates. We retain the set of pre-reform variables which provides an estimated propensity score that ensures covariate balancing between switcher and non-switcher physicians.

The PSM method may give rise to a biased estimated average treatment effect if the propensity score model is mis-specified (Kang and Schafer, 2007; Smith and Todd, 2005). Also, the choice of the balancing test could affect the set of covariates used to estimate the propensity scores (Lee, 2013). Concerns about these potential sources of bias motivate us to use methods that ensure the balance of covariates even when the propensity score model is not correctly specified. We use the covariate balancing propensity score (CBPS) method (Imai and Ratkovic, 2014) and the entropy balancing (EB) method (Hainmueller, 2012) as alternatives to the PSM. These directly incorporate covariate balance in the estimation procedure. CBPS uses a generalized method of moment estimator which combines score conditions (equivalent to fitting a logistic regression model) and covariate balancing moment conditions (ensuring the covariate balancing). The EB method provides the optimal weights under some pre-specified covariate balancing constraints on first and second moments. EB may be seen as a generalization of the PSM (Hainmueller, 2012).

Matching Results

Propensity scores are estimated using both logit and CBPS methods. As summarized in Table A2.4, our specification ensures covariate balancing between the two groups. The logistic regression results reported in Table A2.3 show that expected gain in income, total services in 2003, full-time equivalent (FTE), gender (female), and patients' average age are positively correlated with the probability of switching. Average ADG scores, the proportion of patients in rural areas, age squared, and seven of the 14 geographic indicators for regional health areas, the Local Health Integration Networks (LHINs), are negatively correlated with the probability of switching (with LHIN05 as reference).

We include all the variables listed in Table A2.3 in the model even though they were not statistically significant because they either increased the prediction rate (hit-or miss) or ensured overall covariate balancing. We use the same covariates to estimate the propensity score model with CBPS. The results (in the second column of Table A2.3) are qualitatively similar to the results of the logistic regression. However, CBPS reduces the standard errors of the covariates.

Figures 2 to 4 summarize the distribution of the estimated propensity scores for switchers and non-switchers before and after PSM, CBPS and EB. The before matching distribution of propensity scores for switchers and non-switchers were very different: the Kolmogorov-Smirnov (KS) test for equality of propensity score distributions reject the equality of the distributions of propensity scores across two groups. The figures reveal that the estimated common support or overlapping region of the two distributions is large enough to perform matching (Heckman et al., 1999). Six observations in the switcher group were dropped from the analysis due to the lack of common support. The after-matching distribution of propensity scores for switchers and non-switchers are very similar – the solid and the dashed lines largely coincide (Figure 2-4), suggesting a large reduction of covariate imbalance after-matching. The after-matching KS test p-values are 0.134, 0.103 and 0.233 for kernel matching, CBPS, and EB methods, respectively, suggesting that the equality of the distributions for switchers and non-switchers cannot be rejected at the standard level of significance (1%, 5% and 10%).

The second panel of Table 4 shows the after-matching summary statistics for both groups including p-value of t-test of equality of groups' means and standardized bias[1]. The notable differences in the covariates between switchers and non-switchers in the original sample (first panel of Table 4) have disappeared in the matched or reweighted sample. The standardized bias for covariates went from a maximum value of 53.9% (in absolute value) before matching to 4.5% after matching. The p-values of t-test of equality of groups' means are greater than 10% after matching, except in four variables out of 24. For those four variables the equality of means between switcher and non-switcher groups cannot be rejected at 5% of significance level. Also, the regression-based balancing test results, according to Smith and Todd (2005), reported in Table A2.4 show that the statistical significance of the covariates is largely unaffected by the participation in the FHG model: the p-values for each covariate is greater than 5%, except for age and age squared. We cannot reject the hypothesis that the participation in the FHG model

[1] Standardized bias is defined as the difference of the sample means in these two groups as a percentage of the square root of the average of the sample variances in the two groups (switcher and non-switcher).

does not provide information on the covariates. The three matching methods employed seem to achieve balancing between the switcher and non-switcher groups.

We match and reweight 3,014 switchers to 1,150 non-switchers. Our final panel dataset to estimate the average treatment effect on the treated of FHG reform contains 24,984 physician-year observations on 4,164 physicians practicing in Ontario between the years 2003-2008.

Appendix A1: The Theoretical Model

3.1 FFS physician problem

A FFS physician receives a fixed fee for each service. Let the production of service j provided by family physician i be a function of the hours devoted to produce j, h_{ij}, the physician's personal characteristics (age, gender, year of graduation, whether or not they graduated from an international medical school, and practice location), and patients' characteristics (average comorbidity score, average age, proportion of male patients, proportion of patients living in rural areas) denoted by the vector X_i, and a production shock ε_{ij}. The production shock captures random elements that affect the time spent per service, including the complexity of a particular service, specific to each physician. The quantity of service j provided by the physician i is specified as

$$Q_{ij} = \mathscr{b}(X_i)h_{ij}^{\delta}\varepsilon_{ij}, \;\; \varepsilon_{ij} > 0, \mathscr{b}(X_i) > 0, \qquad j = 1,2,3 \qquad (31)$$

where δ is the marginal return to time spent by the physician to produce a service. We assume that δ is between zero and one, which generates positive and decreasing returns to hours spent in providing services guaranteeing a finite interior solution for hours worked. We also assume common shocks across services ($\varepsilon_{ij} = \varepsilon_i, j = 1,2,3$) meaning that the productivity of a physician is affected in the same way by any new technologies, procedures or recommended treatment guidelines.

The physician has a constant elasticity of substitution (CES) utility function defined over consumption, C and leisure, L. This functional form is general enough to permit unrestricted responses to incentives, yet parsimonious in parameters, allowing for a simple and direct interpretation of the results. We assume equal share parameters for simplicity in our CES utility function. Solving the model with different share parameters will complicate the analysis somewhat without changing our conclusions. Physician $i's$ preferences are given by

$$U(C_i, L_i) = \left(C_i^{\rho} + L_i^{\rho}\right)^{\frac{1}{\rho}}, \qquad \rho < 1,$$ (4~~2~~)

where ρ determines the elasticity of substitution between consumption and leisure, $L_i = T - h_i$, where h_i is total working hours and T is total amount of time available. The time allocated by the physician to produce the services is $h_i = h_{i1} + h_{i2} + h_{i3}$. Under the FFS payment model, physician i's budget constraint is

$$C_i = \mathfrak{p}_1 Q_{i1} + \mathfrak{p}_2 Q_{i2} + \mathfrak{p}_3 Q_{i3} + y,$$ (5~~3~~)

where $\mathfrak{p}_j$ is the price of service $j = 1,2,3$ and y represents non-labour income. The prices of services are exogenous for each physician, as is the case with the publicly funded healthcare system in Ontario.

The timing of the model is as follows:

i. For each service j and each physician i, nature chooses ε_{ij};
ii. The physician observes ε_i, knows $\mathscr{b}(X_i)$ and the price of services before he/she chooses h_{ij} conditional on the total working hours, h_i;
iii. The physician chooses h_i and receives his/her payment from the MOHLTC.

We assume that the physician has complete information and his/her utility maximization problem is solved in two steps: for a given total hours worked, the optimal time spent on each service h_{ij}, is determined (denoted as $h_{ij}^*(h_i)$); this is then substituted into the utility function to obtain an indirect utility function that depends on total hours worked, which we maximize for optimal hours.

Rewriting the utility function taking into account the budget constraint, the time constraint and the technology of production, gives us:

$$U(h_{i1}, h_{i2}, h_{i3}) = \left(\left(\mathscr{b}(X_i)(\mathfrak{p}_1 h_{i1}^{\delta}\varepsilon_i + \mathfrak{p}_2 h_{i2}^{\delta}\varepsilon_i + \mathfrak{p}_3 h_{i3}^{\delta}\varepsilon_i) + y\right)^{\rho} + (T - h_{i1} - h_{i2} - h_{i3})^{\rho}\right)^{\frac{1}{\rho}}.$$ (6~~4~~)

The first-order condition for h_{ij}, $j = 1,2,3$ is

$$\delta \mathfrak{p}_j h_{ij}^{\delta-1} \mathscr{b}(X_i)\varepsilon_i\left(\mathscr{b}(X_i)(\mathfrak{p}_1 h_{i1}^{\delta}\varepsilon_i + \mathfrak{p}_2 h_{i2}^{\delta}\varepsilon_i + \mathfrak{p}_3 h_{i3}^{\delta}\varepsilon_i) + y\right)^{\rho-1} - (T - h_{i1} - h_{i2} - h_{i3})^{\rho-1} = 0.$$

Solving for time devoted to each service gives:

$$\begin{cases} h_{i1}^{*}(h_i) = \dfrac{p_1}{p_1 + p_2 + p_3} h_i \\ h_{i2}^{*}(h_i) = \dfrac{p_2}{p_1 + p_2 + p_3} h_i \\ h_{i3}^{*}(h_i) = \dfrac{p_3}{p_1 + p_2 + p_3} h_i \end{cases} \qquad (75)$$

where $p_j = (\mathfrak{p}_j)^{\frac{1}{1-\delta}}$. Substituting these optimal solutions back into the utility function gives the indirect utility:

$$V(h_i) = \left(\left(\mathscr{b}(X_i) w_{FFS} h_i^{\delta} \varepsilon_i + y \right)^{\rho} + (T - h_i)^{\rho} \right)^{\frac{1}{\rho}}, \qquad (86)$$

where $w_{FFS} = (p_1 + p_2 + p_3)^{1-\delta}$ determines the marginal return to an hour worked when that hour is optimally allocated across services.

The physician's optimal choice of hours worked, h_i^*, is derived from the indirect utility function, but does not have a closed-form solution. Note that h_i^* is the unique solution from the maximization of the indirect utility function. The optimal quantity of services produced is given by

$$Q_{ij}^{*} = \mathscr{b}(X_i) \left(\frac{p_j}{p_1 + p_2 + p_3} \right)^{\delta} h_i^{*\delta} \varepsilon_i, \qquad j = 1,2,3.$$

3.2 FHG physician problem

A FHG physician receives the FFS payment and extra incentives for selected services provided to enrolled patients. Our model allows the FHG physician to choose the number of patients to enroll, denoted by n. For each enrolled patient, the comprehensive care service is remunerated at $(1 + \tau_1)\mathfrak{p}_1$, where $0 < \tau_1 < 1$ is the comprehensive care premium; and after-hours care service is remunerated at $(1 + \tau_2)\mathfrak{p}_2$, where $0 < \tau_2 < 1$ is the after-hours premium. For each non-enrolled patients, $1 - n$, all the services are remunerated at their FFS fee, $\mathfrak{p}_3$. Note that the number of patients is normalized to one. Since FHG physician i can enroll patients, we allow the technology of production of medical services to depend on n_i (Woodward and Warren-Boulton, 1984)

$$Q_{ij} = \begin{cases} \mathscr{b}(X_i) h_{ij}^{\delta} n_i^{\gamma} \varepsilon_{ij}, & j = 1,2, \\ \mathscr{b}(X_i) h_{ij}^{\delta} (1 - n_i)^{\gamma} \varepsilon_{ij}, & j = 3 \end{cases}$$

where δ represents the marginal return to time spent by the physician to produce a service and γ represents the marginal return for a physician to enroll a patient. We assume that δ and γ are between zero and one to ensure finite interior solutions for both time spent for each service and the number of enrolled/non-enrolled patients.

The FHG physician budget constraint is

$$C_i = (1+\tau_1)\mathfrak{p}_1 Q_{i1} + (1+\tau_2)\mathfrak{p}_2 Q_{i2} + \mathfrak{p}_3 Q_{i3} + y.$$

Maximizing the physician's utility function keeping total hours worked h_i fixed. The number of enrolled patients n_i fixed, and under the common shocks assumption gives the optimal time devoted to each service as a function on h_i and n, denoted $\hat{h}_{ij}(h_i, n_i), j = 1,2,3$

$$\begin{cases} \hat{h}_{i1}(h_i, n_i) = \dfrac{n_i^{\frac{\gamma}{1-\delta}} P_1}{n_i^{\frac{\gamma}{1-\delta}} P_1 + n_i^{\frac{\gamma}{1-\delta}} P_2 + (1-n_i)^{\frac{\gamma}{1-\delta}} P_3} h_i, \\ \hat{h}_{i2}(h_i, n_i) = \dfrac{n_i^{\frac{\gamma}{1-\delta}} P_2}{n_i^{\frac{\gamma}{1-\delta}} P_1 + n_i^{\frac{\gamma}{1-\delta}} P_2 + (1-n_i)^{\frac{\gamma}{1-\delta}} P_3} h_i, \\ \hat{h}_{i3}(h_i, n_i) = \dfrac{(1-n)^{\frac{\gamma}{1-\delta}} P_3}{n_i^{\frac{\gamma}{1-\delta}} P_1 + n_i^{\frac{\gamma}{1-\delta}} P_2 + (1-n_i)^{\frac{\gamma}{1-\delta}} P_3} h_i, \end{cases}$$

where $P_j = \left(\left(1+\tau_j\right)\mathfrak{p}_j\right)^{\frac{1}{1-\delta}}, j = 1,2;\ P_3 = (\mathfrak{p}_3)^{\frac{1}{1-\delta}}$. Substituting back the optimal time devoted to each service into the utility function gives an indirect utility function which depends on (h_i, n_i). Maximizing this function with respect to (h_i, n_i) gives an explicit form of $\hat{n}_i$

$$\hat{n}_i = \frac{P^{\frac{1-\delta}{\gamma+\delta-1}}}{1 + P^{\frac{1-\delta}{\gamma+\delta-1}}}, \text{with } \gamma + \delta \neq 1$$

Where $P = \frac{P_3}{P_1 + P_2}$ represents the price of non-incentivized services relative to incentivized-services. Again there is no closed-form solution for the optimal $\hat{h}_i$. The optimal quantity of each type of service produced is given by

$$\hat{Q}_{ij} = \begin{cases} \mathscr{b}(X_i)\hat{h}_{ij}^{\delta}\hat{n}_i^{\gamma}\varepsilon_{ij}, & j = 1,2, \\ \mathscr{b}(X_i)\hat{h}_{ij}^{\delta}(1-\hat{n}_i)^{\gamma}\varepsilon_{ij}, & j = 3. \end{cases}$$

We derive the budget constraint equations of physicians under the different models as the total quantity of services provided which reflects physicians' gross earnings or consumption. Under FFS payment model, the total quantity of services provided by the physician i (denoted by C_i^{FFS}) is

$$C_i^{FFS} = \mathfrak{p}_1 Q_{i1}^* + \mathfrak{p}_2 Q_{i2}^* + \mathfrak{p}_3 Q_{i3}^* = b(X_i) w_{FFS} h_i^{*\delta} \varepsilon_i \qquad (9~~8~~)$$

where $w_{FFS} = (p_1 + p_2 + p_3)^{1-\delta}$ represents the marginal return to an hour when that hour is optimally allocated across services, and $p_j = (\mathfrak{p}_j)^{\frac{1}{1-\delta}}$. w_{FFS} is the wage index under FFS compensation system. While, under FHG payment model, the predicted total quantity of services provided (denoted by C_i^{FHG}) by the physician i is

$$C_i^{FHG} = (1+\tau_1)\mathfrak{p}_1 \hat{Q}_{i1} + (1+\tau_2)\mathfrak{p}_2 \hat{Q}_{i2} + \mathfrak{p}_3 \hat{Q}_{i3} = b(X_i) w_{FHG} \hat{h}_i^{\delta} \hat{n}_i^{\gamma} \varepsilon_i \qquad (10~~9~~)$$

where $w_{FHG} = \left(P_1 + P_2 + P^{\frac{-\gamma}{\gamma+\delta-1}} P_3\right)^{1-\delta}$ represents the marginal return to an hour worked when that hour is optimally allocated across services – the wage index under FHG payment model, and $P_j = \left((1+\tau_j)\mathfrak{p}_j\right)^{\frac{1}{1-\delta}}, j = 1,2;\ P_3 = (\mathfrak{p}_3)^{\frac{1}{1-\delta}}$.

Equations (8) and (9) represent the budget line for a FFS physician and the budget curve for a FHG physician, respectively, as drawn in Figure 1.

Comparing the total production of services (gross earnings) under the two different payment models, at h_i^* (optimal hours worked under FFS), gives rise to a participation to FHG decision which is: the physician i s witches to FHG, if and only if $w_{FHG} \hat{n}_i^{\gamma} > w_{FFS}$. The physician will switch to FHG if the wage index of FHG payment model after enrolling $\hat{n}_i$ patients is greater than the wage index of FFS payment model. With this decision rule we can derive the minimum number of enrolled patients, n^*, that renders switching profitable for the physician $\hat{n}_i > \left(\frac{w_{FFS}}{w_{FHG}}\right)^{\frac{1}{\gamma}} = n^*$.

Appendix A2: Figures and Tables

Figure A2.1: Estimated physician-specific time trend from HDFE model for total services by male and female physicians

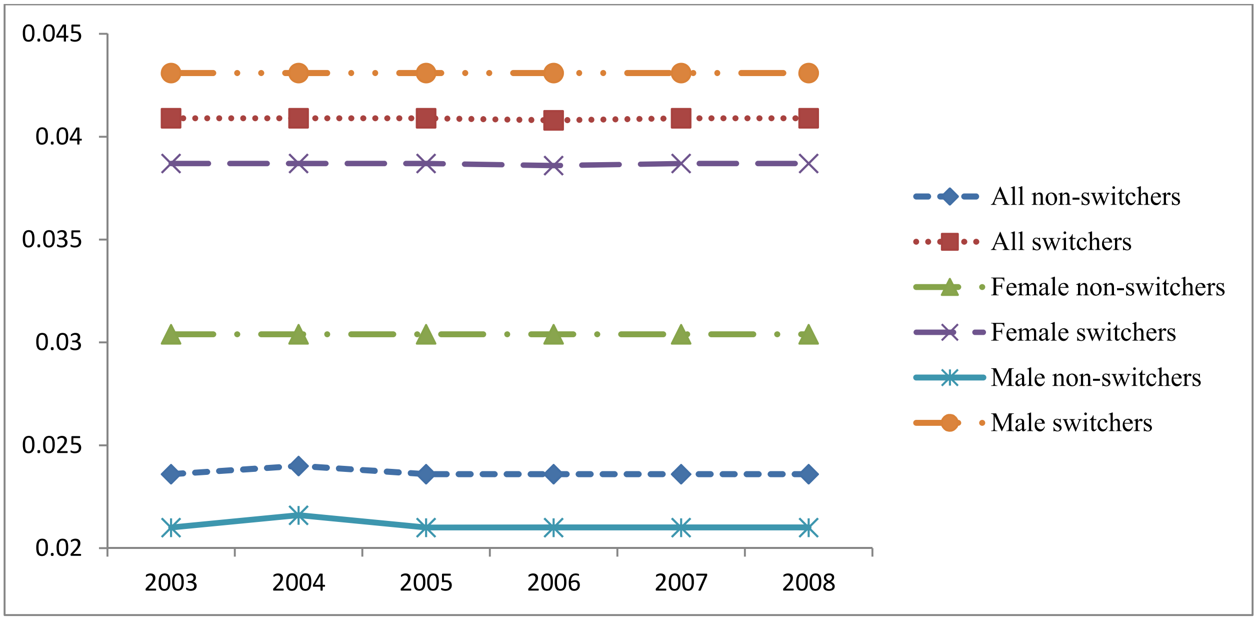


Figure A2.2: Estimated physician-specific time trend from HDFE model for non-incentivized services by male and female physicians

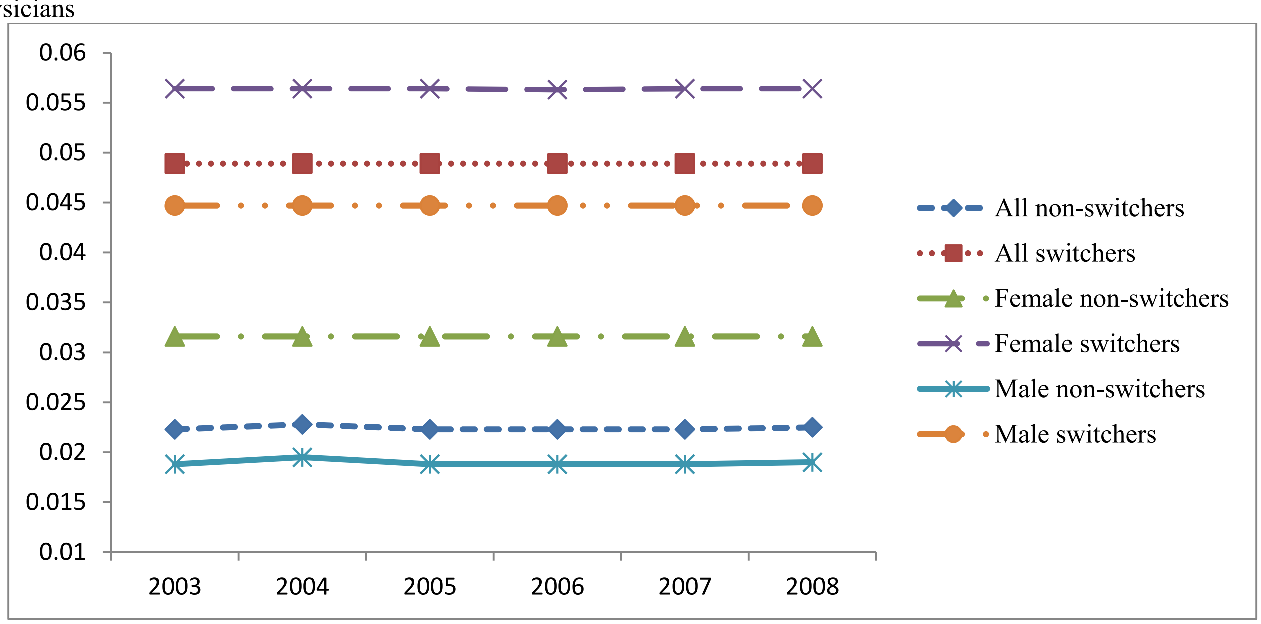


Figure A2.3: Estimated physician-specific time trend from HDFE model for comprehensive care services by male and female physicians

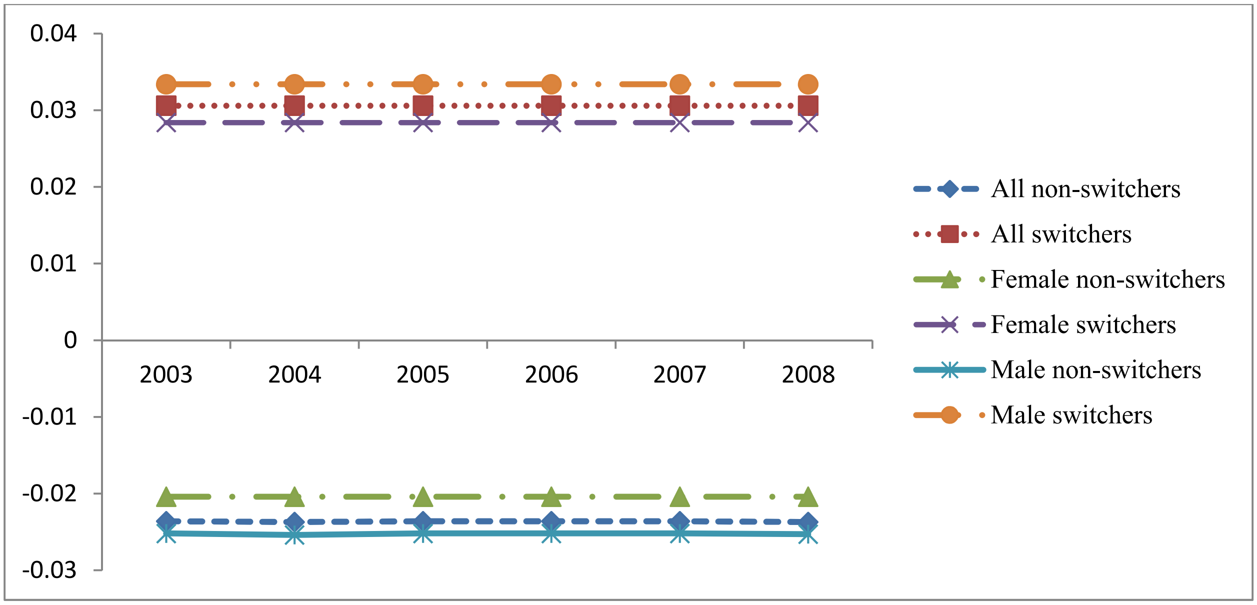


Figure A2.4: Estimated physician-specific time trend from HDFE model for total services by younger (≤ 55 years old) and older (> 55 years old) physicians

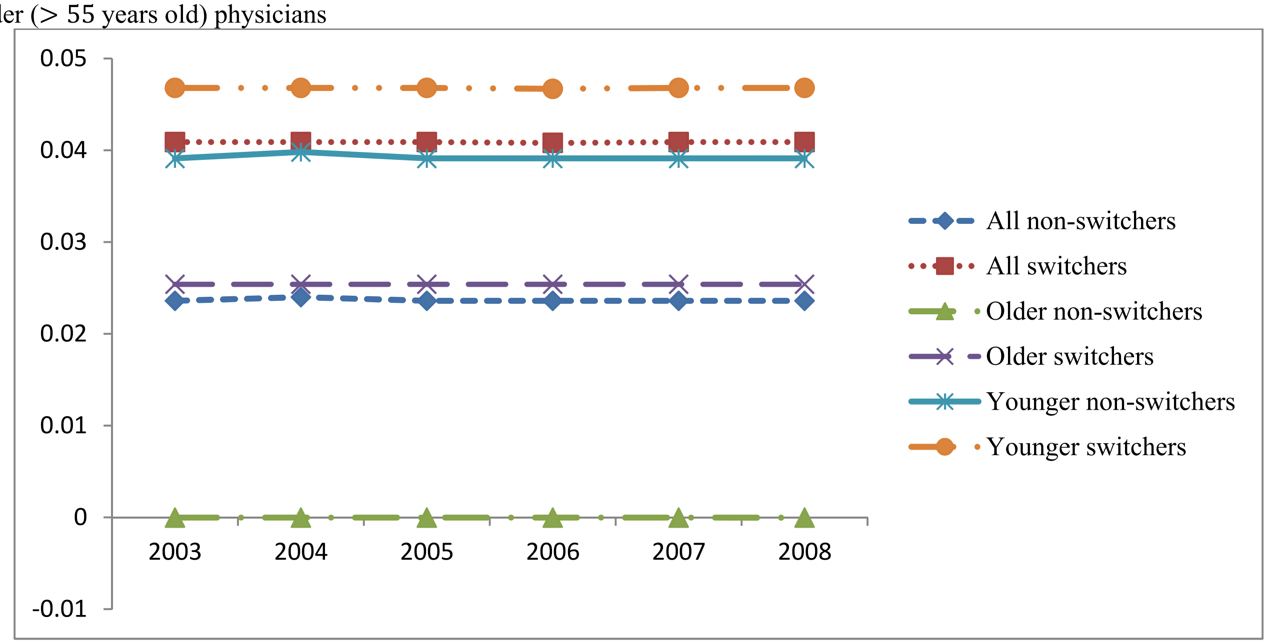


Figure A2.5: Estimated physician-specific time trend from HDFE model for non-incentivized services by younger (≤ 55 years old) and older (> 55 years old) physicians

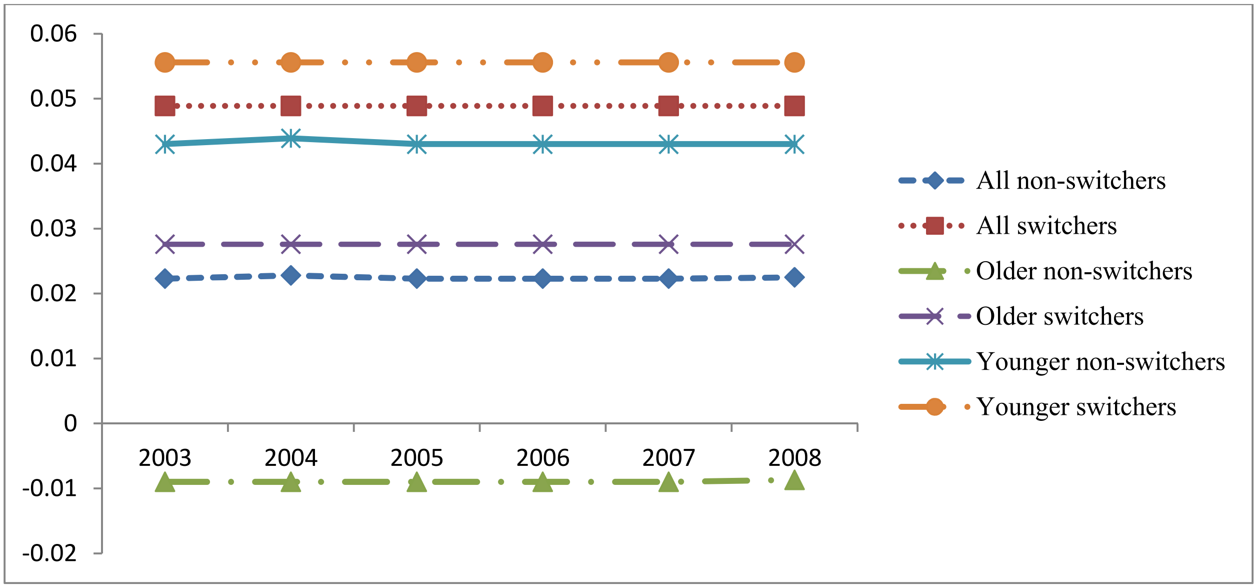


Figure A2.6: Estimated physician-specific time trend from HDFE model for comprehensive care services by younger (≤ 55 years old) and older (> 55 years old) physicians

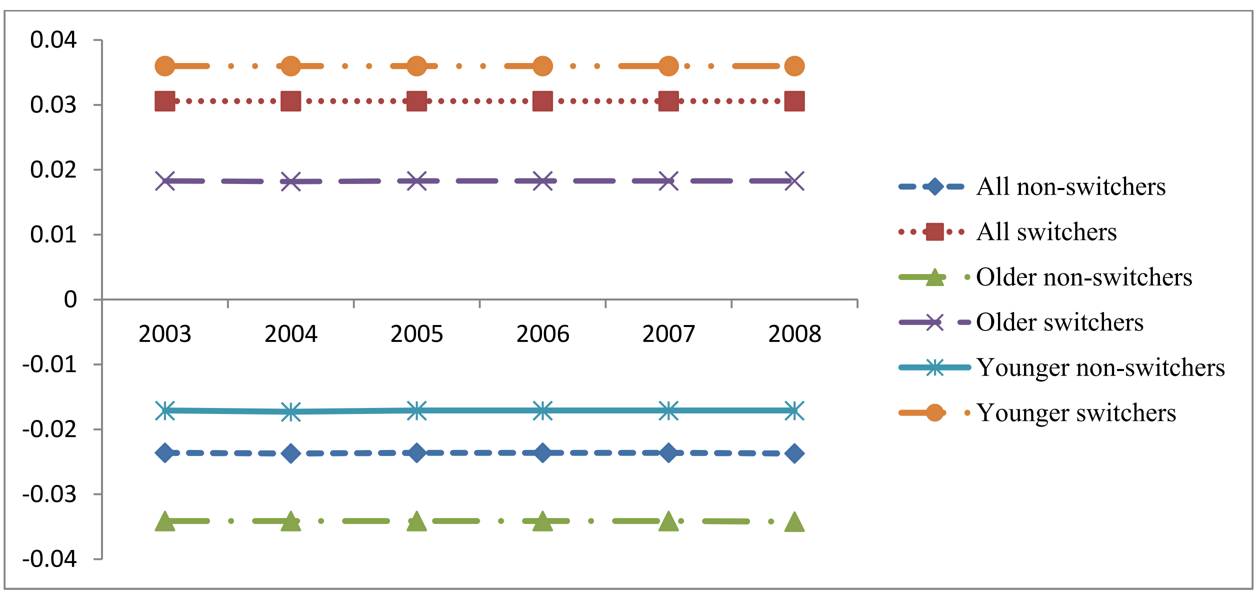


Table A2.1: Comprehensive care fee codes

OHIP fee Codes	Definition of the fee codes
A001	MINOR ASSESS.-F.P./G.P.
A003	GEN. ASSESS. -F.P./G.P.
A007	INTERMED.ASSESS/WELL BABY CARE-F.P./G.P./PAED.
A008	MINI ASSESSMENT-F.P./G.P.
A888	PARTIAL ASSESSMENT EM.DEPT EQUIVALENT
A901	GENERAL/FAMILY PRACTICE-HOUSECALL ASSESSMENT
A902	HOUSECALL ASSESS - PRONOUNCEMENT OF DEATH IN HOME
C010	SUPPORT CARE-F.P./G.P.-HOSP
C882	TERMINAL CARE IN HOSP.G.P/F.P
G365	D./T. PROC.-GYNAECOLOGY-PAPANICOLAOU SMEAR
G538	D&T IMMUNIZATION-WITH VISIT, EACH INJECT
G539	INJECTION OF UNSPECIFIED AGENT - SOLE REASON (FIRST INJECTION)
G590	INFLUENZA AGENT +VISIT
G591	INJECTION OF INFLUENZA AGENT - SOLE REASON
K005	INDIVIDUAL CARE PER 1/2 HR
K013	COUNSELLING-ONE OR MORE PEOPLE-PER 1/2HR.
K017	ANNUAL HEALTH EXAM-CHILD AFT. 2ND BIRTHDAY.
K022	HIV PRIM CARE INDIVID CARE 1/2 HR OR MAJOR PART
K023	PALLIAT CARE SUPPORT INDIVID CARE 1/2 HR OR MAJOR PART
K030	DIABETIC MANAGEMENT FEE

Table A2.2: After Hours care fee codes

OHIP fee Codes	Definition of the fee codes
A001	MINOR ASSESS.-F.P./G.P.
A003	GEN. ASSESS. -F.P./G.P.
A004	GEN.RE-ASSESS-F.P./G.P.
A007	INTERMED.ASSESS/WELL BABY CARE-F.P./G.P./PAED.
A008	MINI ASSESSMENT-F.P./G.P.
A888	PARTIAL ASSESSMENT EM.DEPT EQUIVALENT
K005	INDIVIDUAL CARE PER 1/2 HR
K013	COUNSELLING-ONE OR MORE PEOPLE-PER 1/2HR.
K017	ANNUAL HEALTH EXAM-CHILD AFT. 2ND BIRTHDAY.
Q012A	AFTER HOURS PREMIUM

Table A2.3: Propensity score estimates

	Logit model		CBPS model	
	Coefficient	Std. error	Coefficient	Std. error
Expected gain in income	0.010***	0.0013	0.010***	0.0012
Expected gain in income squared	-1.20E-05	2.96E-06	-1.3E-05***	2.73E-06
Total services in 2003	0.006***	0.0019	0.005***	0.0017
Total services in 2003 squared	-1.40E-05	2.71E-06	-1.3E-05***	2.52E-06
Age	0.024	0.0303	0.034	0.028
Age squared	-0.001**	0.0003	-0.001***	0.0003
Female	0.615***	0.0995	0.598***	0.0882
FTE	0.861***	0.2706	1.000***	0.2253
Average ADG score	-0.151**	0.0757	-0.102*	0.062
Av. Age of patients	0.012*	0.0066	0.016***	0.0055
Prop. of patients in rural areas	-0.36*	0.2092	-0.231	0.1879
LHIN01 = Erie St. Clair	-0.732***	0.265	-0.740***	0.2461
LHIN02 = South West	-0.445*	0.2574	-0.521**	0.231
LHIN03 = Waterloo Wellington	-2.487***	0.3336	-2.546***	0.2966
LHIN04 = Hamilton Niagara Haldimand Brant	-0.662***	0.2321	-0.634***	0.2177
LHIN06 = Mississauga Halton	-0.663***	0.2305	-0.637***	0.2123
LHIN07 = Toronto Central	-0.690***	0.2132	-0.686***	0.196
LHIN08 = Central	-0.232	0.2192	-0.242	0.2036
LHIN09 = Central East	-0.434*	0.2235	-0.414**	0.206
LHIN10 = South East	-0.495	0.3061	-0.470*	0.2797
LHIN11 = Champlain	-0.321	0.2239	-0.339	0.2071
LHIN12 = North Simcoe Muskoka	-1.078***	0.3838	-1.336***	0.2988
LHIN13 = North East	-0.224	0.3041	-0.245	0.2739
LHIN14 = North West	-0.457	0.3925	-0.555	0.3587
Intercept	-0.935	0.7952	-1.476**	0.7234
Observations		4,171		

* p<0.10; **p<0.05; *** p<0.01

Table A2.4: Regression test before and after matching regression

Covariates	Before	After
Expected gain in income	0.2322	0.3873
Expected gain in income squared	0.2089	0.1927
Total services in 2003	0.3733	0.4540
Total services in 2003 squared	0.3167	0.4066
Age	0.0344	0.0321
Age squared	0.0361	0.0369
Female	0.0972	0.1918
FTE	0.4892	0.3854
Average ADG score	0.1413	0.2580
Av. Age of patients	0.0412	0.1670
Prop. of patients in rural areas	0.5063	0.4025
LHIN01 = Erie St. Clair	0.1126	0.2787
LHIN02 = South West	0.1397	0.3349
LHIN03 = Waterloo Wellington	0.1885	0.0583
LHIN04 = Hamilton Niagara Haldimand Brant	0.6505	0.3833
LHIN06 = Mississauga Halton	0.1529	0.0882
LHIN07 = Toronto Central	0.4173	0.9167
LHIN08 = Central	0.3133	0.6257
LHIN09 = Central East	0.9690	0.8911
LHIN10 = South East	0.9089	0.7156
LHIN11 = Champlain	0.6191	0.5753
LHIN12 = North Simcoe Muskoka	0.4355	0.1140
LHIN13 = North East	0.1161	0.2413
LHIN14 = North West	0.5727	0.4779
Number of Physians	4,157	4,157

Note: We consider a polynomial of degree 4 and 7 in the estimated propensity score to compute the F-tests for the covariates

Table A2.5: Inverse probability weighted (PSM) FE regressions results with year dummies for θ_t or with time trend and time trend squared for θ_t.

	(1) Log Total services	(2) Log CC services	(3) Log non-incentivized services	(4) Log Total services	(5) Log CC services	(6) Log non-incentivized services
FHG	0.0742***	0.0494***	0.0542***	0.0748***	0.0492***	0.0552***
	(0.00958)	(0.0125)	(0.0171)	(0.00959)	(0.0125)	(0.0171)
year_1	-	-	-	-0.414***	0.122	-0.449***
	-	-	-	(0.0621)	(0.0999)	(0.0998)
year_2	-	-	-	-0.298***	0.161*	-0.296***
	-	-	-	(0.0512)	(0.0827)	(0.0821)
year_3	-	-	-	-0.207***	0.123**	-0.198***
	-	-	-	(0.0385)	(0.0613)	(0.0615)
year_4	-	-	-	-0.133***	0.0901**	-0.170***
	-	-	-	(0.0266)	(0.0427)	(0.0427)
year_5	-	-	-	-0.0897***	0.0256	-0.101***
	-	-	-	(0.0142)	(0.0221)	(0.0225)
AH services price index	0.769***	0.723***	0.188	0.753***	0.728***	0.163
	(0.116)	(0.172)	(0.145)	(0.117)	(0.176)	(0.147)
Number of working holidays and weekends	0.0138***	0.0115***	0.0190***	0.0138***	0.0115***	0.0190***
	(0.000796)	(0.000957)	(0.00114)	(0.000795)	(0.000956)	(0.00114)
Age squared	-0.000585***	-0.000103	-0.000927***	-0.000585***	-0.000103	-0.000927***
	(0.000114)	(0.000161)	(0.000174)	(0.000114)	(0.000161)	(0.000174)
Av. ADG score	0.190***	0.260***	0.185***	0.189***	0.260***	0.184***
	(0.0269)	(0.0308)	(0.0391)	(0.0268)	(0.0308)	(0.0391)
Av. Age of patients	-0.0237***	-0.0332***	-0.0237***	-0.0237***	-0.0332***	-0.0237***
	(0.00374)	(0.00513)	(0.00551)	(0.00374)	(0.00513)	(0.00551)
Prop. of male patients	0.0375	-0.0410	-0.727	0.0406	-0.0419	-0.722
	(0.253)	(0.320)	(0.678)	(0.254)	(0.320)	(0.679)
Prop. of patients in rural areas	-0.0485	0.245	-0.133	-0.0499	0.246	-0.136
	(0.0994)	(0.389)	(0.194)	(0.0994)	(0.389)	(0.194)
LHIN02 = South West	0.0704	0.389	0.0341	0.0689	0.389	0.0318
	(0.121)	(0.297)	(0.284)	(0.120)	(0.297)	(0.284)
LHIN03 = Waterloo Wellington	-0.248	-0.364	0.441	-0.249	-0.363	0.439
	(0.167)	(0.346)	(0.286)	(0.166)	(0.346)	(0.286)
LHIN04 = Hamilton Niagara Haldimand Brant	-0.170	0.107	-0.283	-0.172	0.108	-0.287
	(0.110)	(0.263)	(0.290)	(0.110)	(0.263)	(0.290)
LHIN05 = Central west	-0.0681	0.128	-0.135	-0.0701	0.129	-0.138
	(0.117)	(0.234)	(0.277)	(0.116)	(0.234)	(0.277)
LHIN06 = Mississauga Halton	-0.110	0.0820	-0.193	-0.111	0.0824	-0.195
	(0.108)	(0.222)	(0.261)	(0.108)	(0.222)	(0.260)
LHIN07 = Toronto Central	-0.137	-0.0705	-0.245	-0.139	-0.0697	-0.249

	(0.123)	(0.239)	(0.266)	(0.123)	(0.239)	(0.265)
LHIN08 = Central	-0.0719	0.130	-0.145	-0.0736	0.131	-0.148
	(0.109)	(0.231)	(0.258)	(0.108)	(0.231)	(0.258)
LHIN09 = Central East	-0.104	0.0992	-0.145	-0.106	0.0997	-0.148
	(0.112)	(0.244)	(0.276)	(0.111)	(0.244)	(0.276)
LHIN10 = South East	0.119	0.123	-0.253	0.116	0.124	-0.258
	(0.277)	(0.471)	(0.304)	(0.277)	(0.471)	(0.303)
LHIN11 = Champlain	0.208	0.554	0.0287	0.206	0.555	0.0248
	(0.235)	(0.401)	(0.355)	(0.234)	(0.401)	(0.354)
LHIN12 = North Simcoe Muskoka	-0.135	0.179	-0.430	-0.136	0.179	-0.431
	(0.127)	(0.262)	(0.285)	(0.127)	(0.262)	(0.284)
LHIN13 = North East	0.0618	0.906	-0.203	0.0590	0.907	-0.207
	(0.211)	(0.950)	(0.380)	(0.211)	(0.950)	(0.379)
LHIN14 = North West	0.00447	-1.346	0.172	-0.00152	-1.344	0.163
	(0.277)	(1.146)	(0.391)	(0.277)	(1.147)	(0.391)
Time trend	0.160***	0.0855***	0.207***	-	-	-
	(0.0141)	(0.0204)	(0.0224)	-	-	-
Time trend squared	-0.00608***	-0.00798***	-0.00719***	-	-	-
	(0.000927)	(0.00117)	(0.00139)	-	-	-
Non-incentivized services price index	0.00305	-0.0670*	-0.314***	-	-	-
	(0.0361)	(0.0369)	(0.0550)	-	-	-
CC services price index	-0.898***	-1.175***	-0.898***	-	-	-
	(0.177)	(0.207)	(0.230)	-	-	-
Constant	6.250***	5.313***	5.876***	5.941***	4.021***	5.343***
	(0.346)	(0.540)	(0.609)	(0.410)	(0.666)	(0.693)
Observations	24,964	24,964	24,964	24,964	24,964	24,964
R-squared	0.295	0.215	0.216	0.295	0.215	0.216
Number of physicians	4,164	4,164	4,164	4,164	4,164	4,164

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A2.6: Inverse probability weighted (PSM) HDFE regressions results

	Log Total services	Log CC services	Log non-incentivized services
FHG	0.0872***	0.0285***	0.0438***
	(0.00544)	(0.00678)	(0.00852)
AH services price index	0.607***	0.0573	-0.0398
	(0.0797)	(0.0988)	(0.108)
Non-incentivized services price index	0.0341	-0.0292	-0.279***
	(0.0390)	(0.0449)	(0.0640)
CC services price index	-0.713***	-0.925***	-0.661***
	(0.177)	(0.208)	(0.253)
Number of working holidays and weekends	0.0132***	0.0113***	0.0175***
	(0.000691)	(0.000862)	(0.000878)
Av. ADG score	0.0535**	0.136***	0.0425
	(0.0256)	(0.0325)	(0.0320)
Av. Age of patients	-0.00117	-0.000773	-0.00712
	(0.00459)	(0.00517)	(0.00620)
Prop. of male patients	0.0902	0.306	-0.286
	(0.186)	(0.294)	(0.292)
Prop. of patients in rural areas	-0.194	-0.207	-0.487
	(0.169)	(0.330)	(0.355)
LHIN02 = South West	-0.0878	0.296	-0.179
	(0.113)	(0.420)	(0.167)
LHIN03 = Waterloo Wellington	-0.0241	0.235	0.177
	(0.163)	(0.353)	(0.228)
LHIN04 = Hamilton Niagara Haldimand Brant	-0.0462	0.232	-0.0757
	(0.132)	(0.324)	(0.186)
LHIN05 = Central west	0.0215	0.222	0.0710
	(0.135)	(0.320)	(0.190)
LHIN06 = Mississauga Halton	-0.0600	0.137	-0.0210
	(0.130)	(0.313)	(0.194)
LHIN07 = Toronto Central	-0.150	-0.0287	-0.183
	(0.138)	(0.325)	(0.193)
LHIN08 = Central	-0.148	0.0680	-0.0958
	(0.127)	(0.319)	(0.176)
LHIN09 = Central East	-0.137	0.0405	-0.00577
	(0.128)	(0.321)	(0.192)
LHIN10 = South East	0.198	0.0996	0.531*
	(0.224)	(0.444)	(0.285)
LHIN11 = Champlain	0.213	0.525	0.551
	(0.310)	(0.478)	(0.389)
LHIN12 = North Simcoe Muskoka	-0.0529	0.0928	0.0269
	(0.111)	(0.318)	(0.175)
LHIN13 = North East	-0.100	-0.0273	0.314
	(0.258)	(0.531)	(0.345)
LHIN14 = North West	-0.339	-2.388**	0.559
	(0.257)	(1.037)	(0.381)

Observations	24,961	24,961	24,961
R-squared	0.938	0.945	0.946

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A2.7: Impact of switching from FFS to FHG on service production (unweighted regressions)

	Number of services				Weighted quantity of services (in 2003 CAN dollars)			
Outcomes	Pooled OLS	FE	HDFE	RE Tobit with UE	Pooled OLS	FE	HDFE	RE Tobit with UE
Log Total number of services	0.184***	0.069***	0.077***	-	0.146***	0.073***	0.0874***	-
	(0.014)	(0.007)	(0.005)	-	(0.013)	(0.006)	(0.005)	-
Log Number of CC services	0.176***	0.041***	0.027***	-	0.176***	0.040***	0.027***	-
	(0.019)	(0.009)	(0.006)	-	(0.019)	(0.008)	(0.006)	-
Log Number of AH services	¶0.199***	-	†0.252***	0.244***	¶0.199***	-	†0.249***	0.242***
	(0.008)	-	(0.007)	(0.007)	(0.008)	-	(0.007)	(0.007)
Log number non-incentivized services	0.318***	0.061***	0.067***	-	0.304***	0.053***	0.043***	-
	(0.023)	(0.011)	(0.008)	-	(0.025)	(0.012)	(0.008)	-
Observations	24,964	24,964	24,961	24,964	24,964	24,964	24,961	24,964
Physicians	4,164	4,164	4,161	4,164	4,164	4,164	4,161	4,164

Legend: Significance level: * p<0.10; **p<0.05; *** p<0.01. Robust standard errors in parentheses.¶Pooled Tobit estimates. †RE Tobit without unobserved effect.

Note: HDFE: High-dimensional fixed-effects, FE: Fixed effects, RE: Random-effects, FFS=Fee For service, FHG= Family Health Group. OLS regressions include prices of the different services, time trend and its squared, age, age squared, number of working holidays and weekends, gender (female), IMG, average ADG score, average age of patients, % of patients in rural areas, % of male patients, 14 geographic indicators for regional health areas (LHINs) (LHIN number one: Erie St. Clair is used as reference), and an intercept. Fixed Effects regressions include the same explanatory variables as in OLS except IMG, female, and age. High-dimensional Fixed effects regressions include the same explanatory variables as in Fixed Effects regressions except time trend, time trend squared and age squared. Tobit is applied to AH services which contains 31.5% of zero-observations. The RE Tobit models include time trend, time trend squared, IMG, gender (female), 14 geographic indicators for regional health areas (LHINs), (FTE>=0.5), number of working holidays and weekends, age, prices of different services, average age of patients, % of patients in rural areas, and, % of male patients with or without time average variables (unobserved heterogeneity). The Pooled Tobit model includes the same explanatory variables as in RE Tobit model plus age squared

Table A2.8: Quantity and percentage of the non-incentivized services provided by switchers by type of patients over time

	Enrolled patients.		Non-enrolled patients		Total patients	
Year	mean (sd)	Percentage	mean (sd)	Percentage	mean (sd)	Percentage
Switchers' non-incentivized services (in 2003 dollars)						
2003	3,745(5,849)	9%	38,542(37,534)	91%	42,286(41,862)	100%
2004	15,023(21,264)	34%	28,869(32,646)	66%	43,888(44,353)	100%
2005	25,351(28,319)	56%	19,957(25,248)	44%	45,308(44,941)	100%
2006	32,586(31,402)	81%	7,458(11,337)	19%	40,040(39,147)	100%
2007	33,328(35,601)	86%	5,242(9,450)	14%	38,560(42,827)	100%
2008	33544(41,294)	88%	4,431(9,231)	12%	37,939(48,991)	100%
Switchers' number of non-incentivized services						
2003	203(334.3)	7%	2,747(2,487)	93%	2,951(2,707)	100%
2004	1,032(1,577)	33%	2,069(2,299)	67%	3,102(2,943)	100%
2005	2,247(2,524)	55%	1,848(2,158)	45%	4,095(3,351)	100%
2006	3,164(2,773)	84%	590.6(976.9)	16%	3,754(3,222)	100%
2007	2,985(2,854)	89%	373(759.6)	11%	3,358(3,296)	100%
2008	3,213(3,071)	91%	302(724.0)	9%	3,513(3,572)	100%

Table A2.9: Impact of switching from FFS to FHG on service production (in 2003 dollars)

	Inverse probability weighted regressions (CBPS)				Inverse probability weighted regressions (EB)			
Outcomes	Pooled OLS	FE	HDFE	RE Tobit with UE	Pooled OLS	FE	HDFE	RE Tobit with UE
Log Total services	0.044***	0.075***	0.087***	-	0.048***	0.076***	0.087***	-
	(0.016)	(0.009)	(0.005)	-	(0.016)	(0.009)	(0.005)	-
Log CC services	0.036	0.050***	0.028***	-	0.041*	0.054***	0.028***	-
	(0.022)	(0.012)	(0.007)	-	(0.022)	(0.013)	(0.007)	-
Log AH services	¶0.045***	-	†0.168***	0.148***	¶0.049***	-	†0.170***	0.151***
	(0.010)	-	(0.005)	(0.006)	(0.010)	-	(0.005)	(0.006)
Log non-incentivized services	0.396***	0.051***	0.044***	-	0.398***	0.053***	0.044***	-
	(0.036)	(0.018)	(0.008)	-	(0.036)	(0.018)	(0.008)	-
Observations	24,964	24,964	24,961	24,964	24,964	24,964	24,961	24,964
Physicians	4,164	4,164	4,161	4,164	4,164	4,164	4,161	4,164

Legend: Significance level: * p<0.10; **p<0.05; *** p<0.01. Robust standard errors in parentheses.¶Pooled Tobit estimates. †RE Tobit without unobserved effect.

Note: HDFE: High-dimensional fixed-effects, FE: Fixed effects, RE: Random-effects, FFS=Fee For service, FHG= Family Health Group. OLS regressions include prices of the different services, time trend and its squared, age, age squared, number of working holidays and weekends, gender (female), IMG, average ADG score, average age of patients, % of patients in rural areas, % of male patients, 14 geographic indicators for regional health areas (LHINs) (LHIN number one: Erie St. Clair is used as reference), and an intercept. Fixed Effects regressions include the same explanatory variables as in OLS except IMG, female, and age. High-dimensional Fixed effects regressions include the same explanatory variables as in Fixed Effects regressions except time trend, time trend squared and age squared. Tobit is applied to AH services which contains 31.5% of zero-observations. The RE Tobit models include time trend, time trend squared, IMG, gender (female), 14 geographic indicators for regional health areas (LHINs), (FTE>=0.5), number of working holidays and weekends, age, prices of different services, average age of patients, % of patients in rural areas, and, % of male patients with or without time average variables (unobserved heterogeneity). The Pooled Tobit model includes the same explanatory variables as in RE Tobit model plus age squared.