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Family physician remuneration schemes and specialist referrals: Quasi-experimental evidence from Ontario, Canada.

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Family Physician Remuneration Schemes and Specialist Referrals: Quasi-experimental Evidence from Ontario, Canada

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Abstract

Understanding how family physicians respond to incentives from remuneration schemes is a central theme in the literature. One understudied aspect is referrals to specialists. While the theoretical literature has suggested that capitation increases referrals to specialists, the empirical evidence is mixed. We push forward the empirical research on this question by studying family physicians who switched from blended fee-for-service to blended capitation in Ontario, Canada. Using several health administrative databases from 2005-2013, we rely on inverse probability weighting with fixed-effects regression models to account for observed and unobserved differences between the switchers and non-switchers. Switching from blended fee-for-service to blended capitation increases referrals to specialists by about five to seven percent per annum. The cost of specialist referrals is about seven to nine percent higher in the blended capitation model relative to the blended fee-for-service. These results are generally robust to a variety of alternative model specifications and matching techniques, suggesting that they are driven partly by the incentive effect of remuneration. Policy makers need to consider the benefits of capitation payment scheme against the unintended consequences of higher referrals to specialists.

Key Words: Physician Behaviour; Primary Care; Specialists Referrals; Referral Costs; Remuneration, Propensity Score Matching, Fixed-effects; Canada

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

1. Introduction

Family physicians (FPs) control access to specialty care in many health care systems by playing a gatekeeping role. This non-price rationing mechanism is viewed as an effective way to reduce health care costs by keeping and treating patients with minor or less severe conditions within the primary care system. The effectiveness of the gatekeeping mechanism in reducing referrals to specialists depends on a number of factors, including how the FP is remunerated. Here, we investigate the referral behaviour of family physicians in Ontario's blended fee-for-service model (Family Health Group (FHG)) who switched to a blended capitation one (Family Health Organization (FHO)). What is particularly useful to note is that physicians practicing in these two models are eligible for otherwise similar comprehensive financial incentives for patient enrollment, health promotion, illness prevention and chronic disease management (Glazier et al., 2009).

The theoretical literature on gatekeeping has studied the role of FP remuneration schemes (Allard et al., 2011; Allard et al., 2014; Iversen and Lurås, 2000; Barros and Martinez-Giralt, 2003), optimal incentive contracts (Mariñoso and Jelovac, 2003; Malcomson, 2004), the role of patients' beliefs about the appropriateness of care (González, 2010), FPs' diagnostic abilities (Allard et al., 2011; Allard et al., 2014), physician altruism (Allard et al., 2011; Allard et al., 2014; Biglaiser and Ma, 2007) and competition among primary care physicians (Allard et al., 2014; Godager et al., 2015; Iversen and Ma, 2011) or among specialists (Brekke et al., 2007). This literature consistently predicts that capitation should increase referrals to specialists, relative to other models of physician payment. Iversen and Lurås (2000) examine referrals under two mixed payment systems: a practice allowance combined with a fee-for-service (FFS) component and capitation combined with a FFS system. Their model predicts that the substitution of the practice allowance by a capitation component increases referrals to specialists. Barros and Martinez-Giralt (2003) consider referral behaviour under capitation combined with a partial reimbursement for treatment costs and a pure FFS system and show that referrals to hospitals is lower under the extended capitation system. Allard *et al*. (2011, 2014) examine the treatment and referral decisions under a pure capitation and a pure FFS system and show that differences in referral rates under different remuneration schemes depend on the level of physician altruism, diagnostic ability and specific medical conditions. They conclude that the overall effect of capitation is likely to be more referrals to specialists when compared to FFS counterparts.

Although the theoretical literature generally predicts that capitation payments to primary care physicians will increase referrals to specialists, the empirical evidence on this question is limited and mixed. Krasnik *et al*. (1990) find that a change from a pure capitation payment system to one including a mixed fee-per-item decreases referral rates in Copenhagen, Denmark. In Iversen and Lurras (2000), moving from a system with a practice allowance combined with a FFS component to one with a capitation amount combined with a reduced FFS component increased referrals from primary care physicians to hospitals and specialists by 42% in one municipality in Norway. Capitation payments are also associated with an increased risk of making discretionary referrals in two cross-sectional studies in the US (Forrest et al., 2003; Forrest et al., 2006). However, some studies find no relationship between physician payment schemes and the referral patterns. Primary care physicians in England who are paid by capitation and FFS have similar referral rates compared to their salaried counterparts (Gosden et al., 2003); nor were differences found between FFS physicians and salaried ones in Norway (Sørensen and Grytten, 2003).

Two studies comparing the referral rates between the blended FFS model and blended capitation model in Ontario reach opposite conclusions (Kralj and Kantarevic, 2013; Liddy et al., 2014). Using data from 2006 to 2009, Kralj and Kantarevic (2013) find that physicians who switched to blended capitation have about 4% fewer referrals per enrolled patient than those who remained in the blended FFS model. However, Liddy *et al*. (2014), in a cross-sectional study using Ontario data from 2008 to 2010, find that physicians practicing in FFS have lower referral rates compared to those in blended capitation based models. It is unclear whether the opposite conclusions are due to different statistical methods employed or different time periods considered. Given the influence of Kralj and Kantarevic (2013) on the policy community,[1] the important question is: Can capitation payments of the type introduced in Ontario actually reduce referrals to specialists? To investigate this question, we are able to exploit a longer panel data set than was used in Kralj and Kantarevic (2013), which ensures that the physicians who switched into the blended capitation model earlier have had time to adjust to the new incentive structure.

Our study is also the first to provide empirical evidence on the relationship between physician payment schemes and the costs of referrals. In addition, we control for patient co-morbidity, a potentially important source of confounding neglected in the previous literature, using the well-known John Hopkin's adjusted clinical group methodology. Finally, we take into account that some patients may generate multiple referrals due to the complex nature of their health conditions, potentially skewing the findings.

In the remainder of the paper, section 2 presents a brief description of the institutional context that examines referrals to specialists and costs of such referrals. The data and variables are described in section 3. Section 4 presents the empirical methods, the results of which are reported

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[1] See the report by C.D. Howe Institute at: https://www.cdhowe.org/sites/default/files/attachments/research_papers/mixed/e-brief_168_0.pdf (accessed June 2017).

in section 5. Section 6 discusses the results in the context of existing empirical evidence. Finally, conclusions and policy implications are presented in section 7.

2. The Institutional Context

The Canadian health care system is publicly financed through taxation but privately delivered by physicians and not-for-profit agencies in each province. Patients do not pay for insured medical services provided by physicians and hospitals. Family physicians, or general practitioners are typically the initial contact person for patients and family physicians are the gatekeepers to specialist referrals, diagnostic testing and drug prescriptions. A FFS payment system for family physicians has dominated the Canadian landscape since the inception of Medicare in 1966. The Medicare system came under strain during late 1990s due to increased health care costs and the lack of access to primary health care services. The FFS system was partly blamed for the over-provision of heath care services and under-provision of quality and continuity of care. Two high-profile commissions on this issue (Romanow, 2002; Kirby, 2002) led to the introduction of far-reaching reforms in the early 2000s within various jurisdictions in Canada (Health Canada, 2007). In Ontario, primary care moved from solo to group practices and physicians were incentivized to switch from FFS to alternative incentive-based payment schemes, in an effort to improve access to and quality of care (Hutchison et al., 2011; Ricketts, 2011; Sarma et al., 2011). Several new types of primary care delivery models featuring these incentives were introduced over the past decade or so (Hutchison et al., 2011), with reform models such as Family Health Groups (FHGs), Family Health Networks (FHNs) and Family Health Organizations (FHOs) representing the engine of change in Ontario and paving the way for other jurisdictions in Canada.

By 2010, more than two-thirds of Ontario family physicians had voluntarily joined one of the new models, with FHO and FHG being the two most popular choices (Henry et al., 2012). The

FHG is a blended FFS model where the vast majority of payments is based on FFS but includes financial incentives for patient enrollment, health promotion and chronic disease management activities (Sweetman and Buckley, 2014). FHN and FHO models have an incentive structure similar to FHGs except that physicians are predominantly paid on a capitation basis for enrolled patients, adjusted for age and gender (Office of the Auditor General of Ontario, 2011; Glazier et al., 2012). Figure 1 presents the evolution of the practice types of family physicians in Ontario over the 2002-2013 period.

The organization of these blended FFS (FHG) and blended capitation (FHO) models is similar except for their payment schemes (Sweetman and Buckley, 2014). In addition to differences in base remuneration across the two models, FHO physicians receive 10% of the FFS value of core services provided to their registered patients upon submission of shadow billing to the Ministry and 100% of the FFS value of the core services provided to non-registered patients up to a limit (known as the hard cap). For non-core services provided to enrolled patients, FHO physicians receive the full FFS value with no upper limit.[2]

3. Data and Variables

Data come from several administrative databases held at the Institute for Clinical Evaluative Sciences (ICES) in Ontario, Canada. Primary care physicians and their demographic characteristics, age, sex, years since practice, and whether or not they graduated from an international medical school, were obtained from the ICES Physician Database (IPDB). The Corporate Provider Database (CPDB) contains the physician's model type, effective date of

[2] See Sweetman and Buckley (2014) for additional description of the similarities and differences between FHGs and FHOs.

eligibility for billing under the Ontario Health Insurance Plan (OHIP) and physician group size (based on the unique group affiliation number available in the CPDB).

OHIP provides information on referrals, including identifiers for the patient, the referring physician, the referred-to specialist, the date on which services were rendered, the corresponding fee codes and the claim amount associated with each specialist visit. To ensure that the physician who performed the service was indeed a specialist, we used the IPDB database to extract the physician's main specialty. If the main specialty was not "family practice/general practice" or "family practice/emergency medicine", then the physician was deemed a specialist. For each specialist referral, we calculate the total referral costs in 2002 Canadian dollars from the OHIP claims at the physician level.

The Client Agency Program Enrolment Database (CAPE) provides the physician's model type as in the CPDB and their enrolled patient's information. If a physician was affiliated with more than one practice type in a particular year, then the most recent one joined was selected in that year. The CAPE database is used to assign patients to physicians in all FHG and FHO models. Patient demographic information (age and sex) was obtained from the Registered Persons Database (RPDB), Ontario's health registry database. Patient postal codes from the RPDB were used to obtain the dissemination area level deprivation index and rurality index from Statistics Canada. The deprivation index is organized into quintiles, where the value of 1 represents the least marginalized and 5 the most marginalized; individuals with a rurality index of 40 or higher are considered to reside in rural areas (Kralj, 2000; Matheson et al., 2012). We derived patients' Aggregated Diagnosis Groups (ADGs) from patients' diagnosis codes using the Johns Hopkins Adjusted Clinical Group case-mix adjustment algorithm (The Johns Hopkins University, 2011), which is a well-known measure of patient comorbidity measure in primary care (Glazier et al., 2008). We derived ADGs for each patient based on patient's diagnosis codes from the health administrative databases available at the ICES. As the ADGs comprise 32 diagnosis groups, each patient has 32 indicator variables. We summed up ADGs for each patient, yielding an ADG score of up to 32. The ADG score used in our analyses is the average of patient ADG scores for each physician.

Group size sums up the number of primary care physicians with the same group number for delivering patient care. For each physician, years spent in a FHG or FHO model were calculated from the start date of patient enrollments associated with his/her practice. For example, if a physician switched from FFS to FHG and started rostering patients on July 3, 2007, then years spent in the FHG model in 2010 was calculated as the years between July 3, 2007 and March 31, 2010.

These data sources are linked using encrypted physician and patient identifiers in order to construct a comprehensive database at the physician level. From this database, we select the cohort of physicians practicing in a FHG as of April 2006. We choose the year 2006 as the beginning of our study period since the number of family physicians practicing in FHGs reached its highest in 2006 (see Figure 1). After excluding physicians who had fewer than 500 patients, missing data on control variables, multiple switching, and the lack of follow-up until March 2013, we have a cohort of 2,617 physicians for our empirical analysis.

4. The Empirical Framework

4.1 Selection Bias

The main challenge with studying the impact of remuneration on referrals is that physicians who switched to the blended capitation model may be systematically different from those who remained in the blended FFS. Indeed, the descriptive data reported in table 1 confirm that physicians who eventually switched from blended FFS to blended capitation were different from those who remained in the blended FFS model, leading to a potential non-random selection bias. To account for such a bias, we rely on matching methods to ensure that the two groups are comparable at the baseline as of April 2006 in terms of several observable characteristics. Specifically, we estimate propensity scores to generate a comparison group by reweighting those physicians who remained in the blended FFS so that they have similar baseline characteristics compared to those who eventually switched to blended capitation.

We begin with a propensity score model (PSM) to estimate the probability of joining the blended capitation model using a logit regression (Rosenbaum and Rubin, 1983). For the PSM to reduce confounding, it must control for variables related to both outcome and treatment (Imbens and Rubin, 2015). The selection of potential confounders in the PSM is generally guided by the trade-offs between the variables' effects on bias and efficiency. If a variable is hypothesized to influence the outcome but not the treatment, including it in the PSM is expected to reduce bias (Austin, 2011); on the other hand, the inclusion of variables hypothesized to be associated with a treatment but not the outcome can decrease precision (Brooks and Ohsfeldt, 2013). Our PSM specification is guided by the desirability of flexible functional forms and parsimony, as well as the inclusion of variables that make causal interpretation plausible (Imbens and Rubin, 2015). We include the variables: age and its square, sex, years of practice in a non-FFS model and its square, international medical graduate status, group size, average age of patients in physician's practice, proportion of female patients in the practice and average ADG score of patients; we also include the proportion of patients living in deprived neighbourhoods and the proportion of patients living in rural areas that are expected to influence both outcome and treatment. Previous period referrals and the expected gain in income from joining the blended capitation model in 2006 (and its square)

are included as these variables relate to the probability of switching to FHO and hence serve as important confounders.[3]

The expected gain in income due to switching from blended FFS to blended capitation, as well as past referral behaviour, are potentially important as these variables may capture unmeasured variation in preferences and/or productivity. The expected gain in income from joining the FHO for blended FFS physicians in 2006 is calculated based on the actual services delivered during the 12 months preceding April 2006 for enrolled and non-enrolled patients. The following assumptions, based on the algorithm used by the Ministry of Health and Long-term Care (MOHLTC), are employed to calculate expected gain in income: (a) a capitation rate of $144.08 multiplied by the age-sex modifier for each enrolled patient, (b) 10% of FFS value for in-basket services to enrolled patients, (c) 100% of FFS value for out-of-basket services to any patient, (d) 100% FFS value for in-basket services to non-enrolled patients subject to the hard cap, and (e) several special payment eligibility rules. We use a kernel matching procedure as our interest lies in the estimation of the average treatment effect on the treated. Once a propensity score has been estimated for each observation, one must ensure that there is sufficient overlap in the distribution of propensity scores across two groups (the common support requirement). We have 16 observations in the switcher group that did not meet the common support requirement and were excluded. Our final analysis uses 1,281 blended FFS physicians (non-switchers or FHG group) and 1,320 blended capitation physicians (switchers or FHO group).

[3] Note that the inclusion of interaction terms and other non-linear terms did not improve the balancing conditions and hence were not used. Moreover, after-hour premiums, comprehensive care capitation payments, preventive care bonuses, chronic disease management and unattached patient fees were the same in both blended FFS and blended capitation models, and hence were excluded from the expected gain in income calculation.

To test if covariate balancing between switcher and non-switcher groups is achieved after matching we use *t* tests for the equality of means in the two groups before and after matching (Rosenbaum and Rubin, 1985). We also report the standardized bias (or standardized difference in means), 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, and the percentage reduction in bias after matching. There is no formal rule regarding how much imbalance is acceptable in a PSM, but the proposed maximum standardized bias for variables ranges from 10 to 25 percent in the literature (Austin, 2009; Stuart et al., 2013).

Although the standardized bias for all covariates is less than 10 percent (see table 1), the PSM method may still lead to biased estimated effect on outcomes if the propensity score model is misspecified (Kang and Schafer, 2007; Imbens and Rubin, 2015; Huber et al., 2013). In order to overcome the limitation of the PSM method and ensure balancing of covariates, we use two recently developed doubly robust matching methods: the covariate balancing propensity score (CBPS) method (Imai and Ratkovic, 2014) and the entropy balancing (EB) method (Hainmueller, 2012). CBPS uses a generalized method of moment framework to combine the score condition and covariate balancing moment conditions to ensure the balancing of covariates across the two groups (Imai and Ratkovic, 2014). The EB method is based on a maximum entropy reweighting scheme that ensures exact balance on the first, second, and possibly higher moments of the covariate distributions in the switcher and the re-weighted non-switcher group (Hainmueller, 2012). Covariate balancing constraints on first and second moments are used in our EB matching analysis. CBPS and EB matching methods are demonstrated to be robust to propensity score model specification (Fan et al., 2016; Zhao and Percival, 2017), hence confirming the robustness of our conclusions.

After generating a valid propensity score, the next step is to decide how to utilize these scores to compare the outcomes of two groups (Imbens and Rubin, 2015). Depending on the study objective, the literature suggests different approaches to estimate the effect on outcome using semi-parametric matching or reweighting techniques (Imbens and Rubin, 2015). Given our large set of covariates and the objective to estimate the average treatment effect on the treated, we apply the inverse probability weighting (IPW) estimator. The idea behind the IPW is to adjust the outcomes of the non-switcher group by weighting them with the inverse of the estimated propensity scores. Here, the weight for each switcher group observation is one and the weight for each observation in the non-switcher group is based on the relevant propensity score estimates (i.e., PSM, CBPS or EB scores).[4] The IPW estimator has desirable finite sample properties compared to alternative matching procedures (Huber et al., 2013; Imbens and Rubin, 2015). We, thus, employ weighted regression models based on estimated propensity scores from PSM, CBPS and EB methods to tease out the effect of switching from FHG to FHO on referrals.

4.2 Regression Models

To analyze the impact of switching from blended FFS to blended capitation on referrals and costs of referrals, we estimate the following two equations at the physician-level:

$$\ln R_{\mathrm{it}} = \alpha_i + \lambda\tau + \delta \mathrm{FHO}_{\mathrm{it}} + \beta' X_{\mathrm{it}} + \varepsilon_{\mathrm{it}} \qquad (1)$$

$$\ln C_{\mathrm{it}} = \alpha_i + \lambda\tau + \eta \mathrm{FHO}_{\mathrm{it}} + \beta' X_{\mathrm{it}} + \mu_{\mathrm{it}} \qquad (2)$$

where subscripts i and t represent physicians and time; $\ln R$ is the natural logarithm of the number of referrals or unique patient referrals; $\ln C$ is the natural logarithm of the costs of referrals at the

[4] Propensity score matching is performed using "psmatch2" program written in Stata (Leuven and Sianesi, 2003), CBPS is performed using Filip Premik's code available at http://grape.org.pl/fpremik/research/codes/, and EB is performed using "ebalance" program written in Stata (Hainmueller and Xu, 2013).

physician level; τ is a time trend; FHO is a dummy variable equal to 1 if the physician practices in the FHO and 0 if s/he practices in the FHG; X includes age, age squared, years of practice in the chosen model and its square, international medical graduate status, group size, average age of patients in physician's practice, proportion of female patients in the practice, average ADG score of patients, proportion patients living in deprived neighbourhoods, proportion of patients living in rural areas; α_i is a physician-specific idiosyncratic term; and ε and μ are error terms.

For each outcome, we first estimate these equations using both a cross-sectional and a pooled ordinary least squares (OLS) technique. Because of the potential correlation of individual effects over time and unobserved time-invariant heterogeneity at the physician level, we re-estimate each specification using a population-average estimator and a fixed-effects estimator. We begin with estimating the above models with and without correcting for selection bias and then use IPW estimators (labeled as weighted regressions in all tables). In each regression model, the standard errors are clustered at the physician level. We argue that the results of the weighted fixed-effects estimator are preferable, as this estimator not only accounts for selection bias but also controls for the time-invariant physician-specific factors arising from the likes of preferences, altruism and diagnostic ability. We investigated heterogeneous responses of physicians by different cohorts of switchers to examine the relevant cohort-specific effects. Since physicians practicing in rural areas may be expected to have different practice patterns compared to those in urban areas, we explored the sensitivity of our estimated effects by excluding a small number of physician working in rural setting. We also examined the heterogeneous response of physicians with respect to sex and age group. Finally, the extent of physician-patient relationships in terms of continuous formal enrollment may affect referrals; thus, we investigated the effect of capitation on referrals for patients enrolled with the same physician for at least six years. IPW estimators based on PSM, CBPS and EB matching methods provide robustness checks of our conclusions.

5. Results

5.1 Matching Results

Table 1 reports the difference-in-means for all variables before and after PSM. The t-tests for equality of means in the switcher and non-switcher groups are based on a regression of the variable on the treatment indicator. Before matching, this is based on an unweighted regression on 2,617 observations, after matching, the regression is based on the PSM weight applied to the common support sample (2,601 observations). Table 1 also reports the standardized bias and the percentage reduction in bias after matching. We see that before matching all estimated coefficients were statistically significant at the one percent level with a standardized bias ranging from three percent to seventy-four percent. This finding reveals substantial differences between the switchers and non-switchers with respect to several observable characteristics, suggesting the potential presence of selection bias.

In terms of physician characteristics, physicians in the switcher group are relatively younger, have fewer years of experience in the relevant non-FFS model, are less likely to be foreign graduates, and have a smaller group practice and a larger roster size compared to the non-switcher group. The proportion of females in the switcher group is slightly higher than the non-switcher group. Turning to practice characteristics, the average age of patients in the switcher group is slightly higher and they are slightly healthier in terms of their co-morbidities. The switcher group has fewer patients from deprived areas but more patients from rural areas relative to the non-switcher group. Most importantly, physicians in the switcher group expect to gain an additional $75,600 per year on average compared to those in the non-switcher group. The results show that after matching and re-weighting the non-switcher observations, the two groups are comparable in terms of baseline observable characteristics. In order to assess the quality of our matching, we plot the distribution of the propensity score for switcher and non-switcher groups before and after matching in Figure 2. We also plot the standardized mean differences and variance ratios for all variables in Figure 3. After matching, the standardized mean differences for all covariates are closer to zero, while the corresponding variance ratios closer to one. Figures 2-3 illustrate the improvement of post-matching propensity scores, suggesting that our matching process is reasonably successful. Appendix Table A1 reports the difference-in-means for all variables, standardized biases and the percentage reduction in bias after CBPS and EB matching methods. As seen in Table A1, some covariates are still in imbalance when CBPS matching is employed, but the EB matching method eliminates covariate imbalance between the switchers and non-switchers. The estimates for propensity score models based on PSM and CBPS are reported in Appendix A (table A2). The descriptive statistics are reported and discussed in Appendix B.

5.2 Regression Results

The cross-sectional regression results in each year with and without PSM weighting are discussed in Appendix B. The cross-sectional results clearly demonstrate that the magnitude of the estimated coefficient on FHO is much larger after 2010. However, these results are potentially unreliable estimates of the impact of blended capitation on referrals, as unobservable physician-specific factors such as preferences, altruism and diagnostic ability may be correlated with switching behaviour. Moreover, cross-sectional data cannot account for the timing of the switch. Table 2 presents the estimated impact of switching to blended capitation using panel data on our three outcomes for the OLS, population-average (PA) and fixed-effects estimators. The corresponding unweighted regression results and those based on CBPS and EB weights are presented in Appendix

C (table C1a-C1c). Across the board, FHO is positively associated with referrals, but the magnitude of this association dramatically diminishes as we control for the potential correlation of individual effects,[5] suggesting that time-invariant physician characteristics, e.g., altruism and diagnostic ability, may play an important role.

The left panel of table 2 reports PSW-weighted regression results on enrolled and non-enrolled patients. Switching to the blended capitation model is associated with a 21.7%, 7.4%, and 6.7% increase in the number of referrals in the OLS, PA, and fixed-effects models, respectively.[6] The results from the specifications that use unique patient referrals reveal that the blended capitation model is associated with a 12.0%, 7.7%, and 7.4% increase in the number of referrals in the OLS, PA, and fixed-effects models. Likewise, our results show a positive relationship between the blended capitation model and the costs of referrals in each of our model: switching to the blended capitation model is associated with a 25.9%, 9.7%, and 8.8% increase in the costs of referrals in the OLS, PA, and fixed-effects models.

Since non-enrolled patients are treated on the basis of FFS payment in both blended FFS and blended capitation models, the results from the left panel of table 2 may not reflect the true impact of incentives stemming from remuneration. The right panel of table 2 presents results based on referrals when our analysis is restricted to enrolled patients only. We see that, while the effect on referrals continues to be positive, it is slightly smaller with this restricted data (in the neighbourhood of five to six percent rather than the seven to eight percent for all patients, which is a contrary to cross-sectional results. We find that switching to FHO model leads to an increase

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[5] The detailed regression results are available from the corresponding author upon request.
[6] These numbers differ slightly from those reported in table 5 because we use the percent change interpretation of a dummy variable in the context of a semi-logarithmic model using Halvorsen–Palmquist adjustment approach (Halvorsen and Plamquist, 1980).

in the number of referrals, unique patient referrals and costs of referrals by 4.8%, 5.5% and 6.5%, respectively for the enrolled patients. The results based on CBPS and EB matching methods produce very similar results. Consistent with theory, our fixed-effects results confirm that blended capitation is unambiguously associated with higher referrals and higher costs of referrals.

5.3 Cohort Effects

We conducted analyses by different cohorts of switchers to see if our results were driven by specific cohorts. The cohort-specific results for all patients and enrolled patients are reported in tables 3a and 3b. Table 3a reveals significant increases in the magnitude of the estimated coefficients of FHO across successive cohorts of switchers. The results from tables 3a and 3b show that earlier cohorts of switchers were undertaking relatively fewer referrals compared to those of later cohorts of switchers. Based on fixed-effect estimates, we find that switching to FHO leads to an increase in the referrals, unique patient referrals and the costs of referrals by 9.3%, 10.3% and 12.2% for the 2008 cohort of switchers as compared to 14.6%, 13.8% and 13.5% for the 2012 cohort. A similar pattern appears for the enrolled patients: for the 2008 cohort, switching to FHO leads to an increase in referrals, unique patient referrals and the costs of referrals by 6.8%, 7.8% and 8.8%, as compared to 11.5%, 12.1% and 11.4% for 2012. The results based on CBPS and EB weights corroborate these results (Appendix C, tables C2a-C2d). The positive relationship between blended capitation payment and specialist referrals predicted by economic theory is present for all cohorts of switchers. We also find a small increase in the magnitude of the coefficient of FHO across the successive cohorts of switchers.

5.4 Heterogeneous Effects

Thus far, blended capitation payments are associated with higher referrals and higher costs of referrals. We conducted several sub-group analyses to find out if the response of physicians differ with respect to several distinct features. Because of the small number of rural physicians in our sample, we conducted analyses using only those practicing in urban areas. The results reported in table 4 show that the estimated coefficients of FHO are almost identical to our main results reported in table 2, supporting our key conclusions.

The responses of male and female physicians were analyzed separately. The effect of capitation on referrals for male physicians are reported in table 5a and that of females in table 5b. Although the OLS results show a large coefficient of FHO on referrals for both males and females for all patients as well as the enrolled patients, the estimated effects are much smaller once account is taken of physician-specific heterogeneity. The fixed-effect results for all patients show that switching to FHO is associated with slightly more referrals among male physicians (seven to nine percent) compared to female physicians (four to eight percent). However, the fixed-effects results for enrolled patients are either significant at the 10% level or statistically insignificant with the exception of the costs of referrals among females.

Our third sub-group analysis uses data parsed by younger and older physicians. We conducted separate analysis for younger than 55 and those 55 and older in 2006. The estimates for younger group (below 55 years) are presented in table 6a and that of older group (55 years and over) are in table 6b. Looking at the fixed-effects results for all patients, we see that the older group make more referrals than the younger group when switching to FHO. Regarding the estimates for enrolled patients, the results are statistically insignificant for the younger group, but for the older group the effects are in the range of ten to eleven percent higher. That more experienced physicians make more referrals may be due to the fact that they respond more to the pure incentive effects of capitation and/or to the possibility that are less likely to work with allied health professionals.

Finally, it is conceivable that the extent of continuity in physician-patient relationship may affect referral patterns. If the capitation payment induces the provision of high quality care designed to encourage disease prevention and health promotion through continuity, we may expect fewer referrals. If there is cream skimming on the part of FHO physicians, we may also see fewer referrals. The ADG scores over time, however, suggest that there is virtually no change in the patient selection in the FHOs, suggesting very limited influence of cream skimming. On the other hand, if FHO physicians take advantage of the incentives and make excessive referrals, we may see larger referrals for enrolled patients. A priori, the effect of continuity on the referrals of switchers is ambiguous.

Using patients enrolled with the same physician for at least six years during 2006-2013 as our measure of continuity, we find that switching to FHO leads to about 5% higher referrals for all patients in our fixed-effects models (table 7), but statistically significant at 10% level. The fixed-effects results for the enrolled patients show that switching to FHO does not increase the number of referrals, but the costs of referrals increase by about 6%. This result suggest that continuity of physician-patient relationship may buffer against the unintended consequence of higher referrals associated with the blended capitation payment. The results based on CBPS and EB weighted regressions are very similar to the PSM weighted results.

6. Discussion

Our results are consistent with theoretical predictions of the effect of capitation on family physician referrals to specialists (Allard et al., 2011; Allard et al., 2014; Iversen and Lurås, 2000; Barros and Martinez-Giralt, 2003) and with some previous empirical studies (Iversen and Lurås, 2000; Krasnik et al., 1990; Liddy et al., 2014), but they are contrary to the results of Kralj and

Kantarevic (2013) who found that physicians who switched from the FHG to FHO actually reduced their referrals to specialists by 4%.

At least two potential differences between Kralj and Kantarevic (2013) and our study may explain the contradictory findings. First, their study does not control for co-morbidities, whereas we do. Second, their study is based on switchers from 2007-2009, while we were able to extend the time period to 2013. Indeed, if we restrict the analysis to the 2006 to 2009 period then our results replicate those of Kralj and Kantarevic (2013). As can be seen in table 8 (excluding ADGs), switching to the blended capitation model is associated with an 4.3%, 3.3%, and 4.5% decrease in the number of referrals, unique patients and costs of referrals in the fixed-effects models, respectively. Of note is the fact that the exclusion of ADGs (our co-morbidity indicator) has a large impact on pooled estimates, but does not have a large influence on referrals in the fixed-effects models because the fixed-effects estimator eliminates unmeasured differences at the physician-level, including those arising from patient comorbidity. These results are robust to the use of CBPS and EB matching methods (Appendix C, tables C3a-C3b). The time period under study, however, is of crucial importance. Table 9 very clearly shows the impact of extending the time frame on the estimated results: referrals to specialist and costs of referrals are much larger over the 2010-2013 period, so much so that they outweigh the initial reduction in referrals found in the earlier (2006-2009) one. Altogether, our results suggest that, as physicians switched from blended FFS to blended capitation, there was some initial reduction in referrals to specialists among early switchers (the Kralj and Kantarevic finding) but this reduction was not sustained over time. On the contrary, referrals increased significantly once this adjustment period ended. It is difficult to know exactly why we observe this apparent change in behaviour of switchers. One conjecture is that, perhaps the early switchers were more enthusiastic about practicing in a capitation payment system compared to the late switchers, resulting, initially, in fewer patient referrals to specialists. As they learned more about the payment system, they learned too about potential gains from referrals. Along similar lines, it may well be that after years of experience within the FFS environment, a period of adjustment was required to fully understand the incentives embodied in the capitation model. Either way, we conclude that capitation is eventually associated with more specialist referrals in comparison to FFS.

It is plausible, however, that some FHO physicians, especially those in family health teams, use allied health professionals more than would be the case in FFS. Since some FHO physicians may substitute these other health professionals for their own time, it may negatively influence referrals to specialists to some extent. If this is indeed the case, our estimates would understate the referral-incentive effect from capitation and should then be considered as a lower estimate of the impact of switching from blended FFS to blended capitation payments.

7. Conclusions, Limitations and Policy Implications

Physicians in a blended capitation scheme are more likely to refer patients to specialists compared to those in a blended FFS. Our analysis shows that the cost of referrals is about seven to nine percent higher in the blended capitation model relative to the blended FFS. The number of referrals to specialists is about five to seven percent higher in the blended capitation model compared to the blended FFS. This result is robust to the use of unique patient referrals – about five to seven percent higher in the blended capitation model relative to the blended FFS.

We offer insights into why our results contrasted so starkly to those of Kralj and Kantarevic (2013). During the earlier years of switching from blended FFS to blended capitation, referrals fell, but thereafter they increased quite substantially. We think that the institutional environment in which switching took place during the early phase of reform may help reconcile our results with theirs. Our longitudinal analysis covering seven years after the introduction of FHO model allows sufficient time for physicians to react to the new environment and adjust referral practices, and highlights the importance of long panel data when conducting studies on physician behaviour.

Our study has limitations. First, the estimation strategy employed does not imply a causal impact of remuneration on referrals as selection on unobservable factors could still play a role. Although we controlled for pre-treatment referrals, the expected gain in income by switching from blended FFS to blended capitation and a host of other physician and patient characteristics in our propensity score models, the conditional independence assumption necessary for a causal interpretation may not be satisfied. Second, our approach relies on the assumption that the propensity score specification is correctly estimated. The IPW estimators may not be appropriate if the specification of the explanatory variables is incorrect or the parametric approach does not capture the true switching behaviour. Although our results are robust to several plausible specifications and recently developed doubly robust matching methods such as covariate balancing and entropy balancing, it could still be subject to some bias if there are unobservables beyond those for which we have already controlled. Third, our measure of referral costs include only payments made to specialists by the Ontario Ministry of Health rather than any measure of social costs.

Nevertheless, we find evidence that the physician payment scheme matters in referral decisions and that capitation payments are associated with increased referrals to specialists. Our estimated conditional relationships bring collective understanding a step closer to the likelihood of a causal conclusion. Policy makers designing capitation payment schemes in an effort to reduce health care costs and improve access to physician services, like Ontario's blended capitation model, need to consider the benefits of such payment schemes against the unintended consequences of higher referral costs to specialists.

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Figure 1

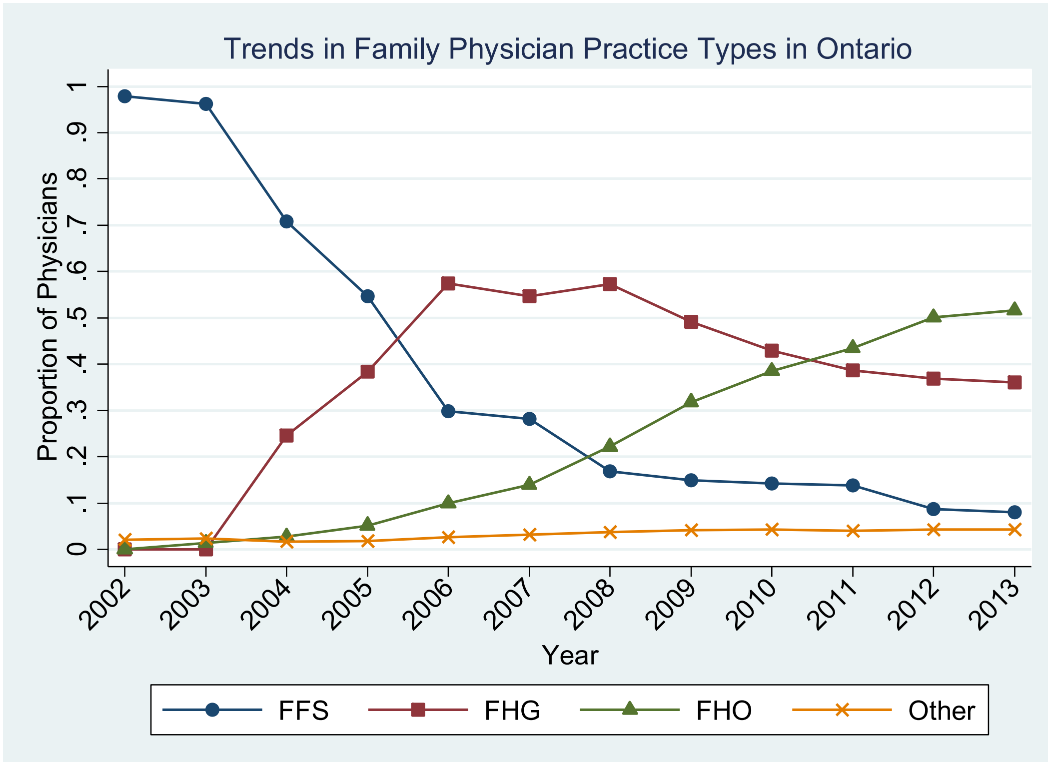

Figure 2
Propensity Score Before and After Matching

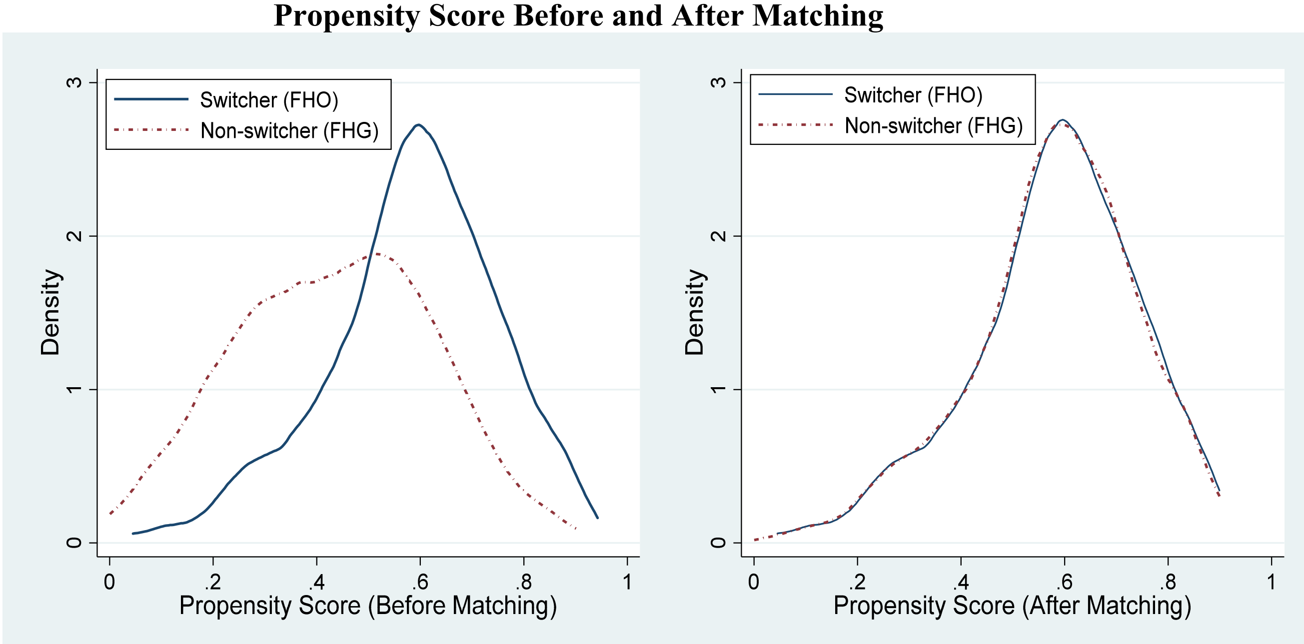

Figure 3
Standardized Mean Difference and Variance Ratio

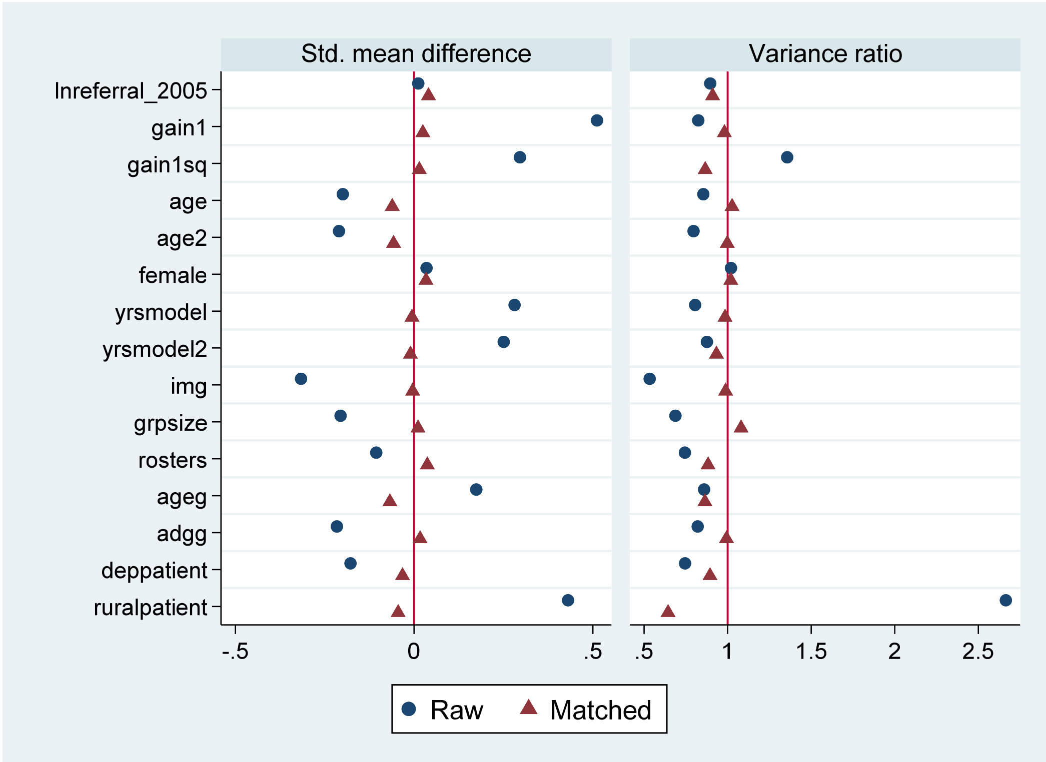

Table 1
***t* Test and Standardized Bias before and after PSM**

Variables	**Means and Standardized Bias before Matching**				**Means and Standardized Bias after PSM**				
	Switcher (FHO)	Non-Switcher (FHG)	*P* value of *t* test before Matching	%Bias	Switcher (FHO)	Non-Switcher (FHG)	*P* value of *t* test after PSM	%Bias	%reduction in |bias| after PSM
Physician Characteristics									
Age (in years)	50.423	52.344	0.000	-19.6	49.125	49.494	0.276	-3.8	80.8
Age^2	2632.2	2842.7	0.000	-20.5	2489.5	2524.7	0.299	-3.4	83.3
Years in the model	4.3535	6.603	0.000	-46.2	1.8587	1.8707	0.673	-0.2	99.5
$(\text{Years in the model})^2$	40.152	69.731	0.000	-31.3	3.9895	4.0378	0.622	-0.1	99.8
Female (%)	0.37905	0.36304	0.002	3.3	0.36742	0.36559	0.922	0.4	88.6
IMG (%)	0.09872	0.21027	0.000	-31.2	0.10758	0.11246	0.689	-1.4	95.6
Group size	25.883	40.823	0.000	-27.4	39.512	40.498	0.645	-1.8	93.4
Roster size	1626.4	1708.1	0.000	-10.2	1826	1789.3	0.217	4.6	55.1
Patient Characteristics									
Average Age	40.169	39.188	0.000	15.1	39.147	39.349	0.386	-3.1	79.4
ADG	3.2036	3.3668	0.000	-33.8	3.2939	3.298	0.800	-0.9	97.5
Deprived areas (%)	24.875	27.914	0.000	-19.4	27.722	27.693	0.962	0.2	99.1
Rural areas (%)	13.427	5.0523	0.000	42.6	10.5	9.9424	0.505	2.8	93.3
Past Outcome									
Log of referrals in 2005	7.5033	7.5038	0.946	-0.1	7.6073	7.5943	0.527	1.9	-2532
Financial gain									
Expected gain in income (thousand $)	164.57	88.956	0.000	74.4	129.56	127.57	0.511	2.0	97.4
$(\text{Expected gain})^2$	38674	16979	0.000	53.8	22775	22430	0.755	0.9	98.4

Table 2
Coefficient of FHO on the number and costs of referrals

	Enrolled and Non-enrolled Patients (PSM Weighted Regression results)			**Enrolled Patients (PSM Weighted Regression results)**		
Outcome Variables	**OLS**	**PA**	**FE***	**OLS**	**PA***	**FE***
Log of total referrals	0.196*** (0.034)	0.071*** (0.024)	0.065*** (0.025)	0.209*** (0.034)	0.054** (0.024)	0.047* (0.026)
R^2	0.547		0.202	0.548		0.214
Log unique patient referrals	0.114*** (0.030)	0.074*** (0.021)	0.071*** (0.023)	0.129*** (0.030)	0.058*** (0.022)	0.054** (0.023)
R^2	0.598		0.240	0.603		0.268
Log of referral costs	0.230*** (0.032)	0.093*** (0.021)	0.084*** (0.023)	0.240*** (0.033)	0.074*** (0.022)	0.063*** (0.023)
R^2	0.578		0.226	0.578		0.246
Observations	20,808	20,808	20,808	20,808	20,808	20,808
Physicians	2,601	2,601	2,601	2,601	2,601	2,601

OLS: Ordinary Least Squares; PA: Population-average; FE: Fixed-Effects
Robust standard errors adjusted for 2601 clusters in parentheses
*** $p<0.01$; ** $p<0.05$; * $p<0.1$
⁎ Within R^2 for FE models
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table 3a
Coefficient of FHO on the number and costs of referrals by cohorts of switchers (all patients)

	PSM Weighted fixed-effects regressions				
Outcome Variables	**2008 Switchers**	**2009 Switchers**	**2010 Switchers**	**2011 Switchers**	**2012 Switchers**
Log of total referrals	0.089*** (0.034)	0.089*** (0.033)	0.105** (0.042)	0.137*** (0.045)	0.136** (0.056)
R^2 (Within)	0.244	0.215	0.241	0.238	0.233
Log unique patient referrals	0.098*** (0.031)	0.088*** (0.030)	0.109*** (0.039)	0.116*** (0.042)	0.129** (0.052)
R^2 (Within)	0.272	0.249	0.275	0.271	0.259
Log of referral costs	0.115*** (0.031)	0.094*** (0.029)	0.114*** (0.038)	0.128*** (0.041)	0.127** (0.050)
R^2 (Within)	0.261	0.233	0.257	0.259	0.255
Observations	11,480	13,736	12,424	12,216	11,464
Physicians	1,435	1,717	1,553	1,527	1,433

Robust standard errors in parentheses
*** p<0.01; ** p<0.05; * p<0.1
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table 3b
Coefficient of FHO on the number and costs of referrals by cohorts of switchers (enrolled patients)

	PSM Weighted fixed-effects regressions				
Outcome Variables	**2008 Switchers**	**2009 Switchers**	**2010 Switchers**	**2011 Switchers**	**2012 Switchers**
Log of total referrals	0.062* (0.034)	0.077** (0.033)	0.083* (0.043)	0.119*** (0.046)	0.119** (0.058)
R^2 (Within)	0.234	0.215	0.237	0.232	0.225
Log unique patient referrals	0.075** (0.031)	0.077** (0.031)	0.089** (0.040)	0.101** (0.043)	0.114** (0.053)
R^2 (Within)	0.254	0.239	0.262	0.256	0.243
Log of referral costs	0.084*** (0.032)	0.080*** (0.030)	0.091** (0.038)	0.109*** (0.041)	0.108** (0.052)
R^2 (Within)	0.267	0.245	0.268	0.269	0.264
Observations	11,480	13,736	12,424	12,216	11,464
Physicians	1,435	1,717	1,553	1,527	1,433

Robust standard errors in parentheses
*** p<0.01; ** p<0.05; * p<0.1
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table 4
Coefficient of FHO on referrals and costs of referrals: Practicing in Urban areas

	Enrolled and Non-enrolled Patients (PSM Weighted Regression results)			Enrolled Patients (PSM Weighted Regression results)		
Outcome Variables	**OLS**	**PA**	**FE***	**OLS**	**PA***	**FE***
Log of total referrals	0.210*** (0.031)	0.074*** (0.025)	0.067** (0.026)	0.214*** (0.032)	0.052** (0.025)	0.045* (0.027)
R^2	0.537		0.210	0.542		0.246
Log unique patient referrals	0.136*** (0.025)	0.077*** (0.022)	0.073*** (0.024)	0.144*** (0.025)	0.057** (0.023)	0.053** (0.024)
R^2	0.611		0.254	0.620		0.288
Log of referral costs	0.245*** (0.030)	0.098*** (0.022)	0.088*** (0.023)	0.248*** (0.031)	0.075*** (0.023)	0.064*** (0.024)
R^2	0.561		0.237	0.566		0.275
Observations	19,792	19,792	19,792	19,792	19,792	19,792
Physicians	2,474	2,474	2,474	2,474	2,474	2,474

OLS: Ordinary Least Squares; PA: Population-average; FE: Fixed-Effects
Robust standard errors adjusted for 2474 clusters in parentheses
*** p<0.01; ** p<0.05; * p<0.1
⁎ Within R^2 for FE models
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table 5a
Coefficient of FHO on referrals and costs of referrals: Males

	Enrolled and Non-enrolled Patients (PSM Weighted Regression results)			Enrolled Patients (PSM Weighted Regression results)		
Outcome Variables	**OLS**	**PA**	**FE**[*]	**OLS**	**PA**[*]	**FE**[*]
Log of total referrals	0.235*** (0.047)	0.080** (0.037)	0.072* (0.070)	0.256*** (0.048)	0.065* (0.038)	0.052 (0.041)
R^2	0.498		0.182	0.500		0.185
Log unique patient referrals	0.138*** (0.043)	0.091*** (0.034)	0.087** (0.036)	0.160*** (0.043)	0.076** (0.035)	0.070* (0.037)
R^2	0.539		0.230	0.546		0.219
Log of referral costs	0.278*** (0.045)	0.099*** (0.033)	0.087** (0.035)	0.296*** (0.046)	0.081** (0.034)	0.066* (0.037)
R^2	0.543		0.198	0.543		0.212
Observations	13,328	13,328	13,328	13,328	13,328	13,328
Physicians	1,666	1,666	1,666	1,666	1,666	1,666

OLS: Ordinary Least Squares; PA: Population-average; FE: Fixed-Effects
Robust standard errors adjusted for 1666 clusters in parentheses
*** p<0.01; ** p<0.05; * p<0.1
⁎ Within R^2 for FE models
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table 5b
Coefficient of FHO on referrals and costs of referrals: Females

	Enrolled and Non-enrolled Patients (PSM Weighted Regression results)			Enrolled Patients (PSM Weighted Regression results)		
Outcome Variables	**OLS**	**PA**	**FE***	**OLS**	**PA***	**FE***
Log of total referrals	0.133*** (0.042)	0.053** (0.023)	0.049** (0.024)	0.132*** (0.044)	0.036 (0.022)	0.032 (0.024)
R^2	0.608		0.255	0.618		0.296
Log unique patient referrals	0.075** (0.032)	0.045*** (0.017)	0.043** (0.019)	0.078** (0.034)	0.029* (0.017)	0.028 (0.019)
R^2	0.669		0.274	0.684		0.327
Log of referral costs	0.158*** (0.040)	0.081*** (0.021)	0.075*** (0.023)	0.154*** (0.041)	0.061*** (0.021)	0.055** (0.023)
R^2	0.615		0.291	0.625		0.332
Observations	7,480	7,480	7,480	7,480	7,480	7,480
Physicians	935	935	935	935	935	935

OLS: Ordinary Least Squares; PA: Population-average; FE: Fixed-Effects
Robust standard errors adjusted for 935 clusters in parentheses
*** p<0.01; ** p<0.05; * p<0.1
* Within R^2 for FE models
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table 6a
Coefficient of FHO on referrals and costs of referrals: <55 years in 2006

	Enrolled and Non-enrolled Patients (PSM Weighted Regression results)			**Enrolled Patients (PSM Weighted Regression results)**		
Outcome Variables	**OLS**	**PA**	**FE***	**OLS**	**PA***	**FE***
Log of total referrals	0.207*** (0.039)	0.063** (0.030)	0.056* (0.032)	0.216*** (0.039)	0.039 (0.030)	0.033 (0.032)
R^2	0.562		0.157	0.571		0.202
Log unique patient referrals	0.123*** (0.036)	0.067** (0.028)	0.064** (0.030)	0.136*** (0.036)	0.046* (0.028)	0.042 (0.030)
R^2	0.605		0.171	0.619		0.220
Log of referral costs	0.247*** (0.037)	0.085*** (0.026)	0.076*** (0.027)	0.254*** (0.037)	0.059** (0.026)	0.050* (0.028)
R^2	0.593		0.200	0.597		0.253
Observations	14,376	14,376	14,376	14,376	14,376	14,376
Physicians	1,797	1,797	1,797	1,797	1,797	1,797

OLS: Ordinary Least Squares; PA: Population-average; FE: Fixed-Effects
Robust standard errors adjusted for 1797 clusters in parentheses
*** p<0.01; ** p<0.05; * p<0.1
⁎ Within R^2 for FE models
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table 6b
Coefficient of FHO on referrals and costs of referrals: ≥ 55 years in 2006

	Enrolled and Non-enrolled Patients (PSM Weighted Regression results)			**Enrolled Patients (PSM Weighted Regression results)**		
Outcome Variables	**OLS**	**PA**	**FE***	**OLS**	**PA***	**FE***
Log of total referrals	0.155*** (0.060)	0.094*** (0.035)	0.095** (0.037)	0.175*** (0.067)	0.088** (0.041)	0.092** (0.043)
R^2	0.540		0.309	0.529		0.269
Log unique patient referrals	0.083* (0.046)	0.094*** (0.025)	0.099*** (0.026)	0.101** (0.050)	0.084** (0.030)	0.094*** (0.031)
R^2	0.606		0.372	0.595		0.307
Log of referral costs	0.186*** (0.059)	0.114*** (0.035)	0.114*** (0.040)	0.120*** (0.065)	0.106*** (0.040)	0.106** (0.045)
R^2	0.566		0.298	0.559		0.281
Observations	6,432	6,432	6,432	6,432	6,432	6,432
Physicians	804	804	804	804	804	804

OLS: Ordinary Least Squares; PA: Population-average; FE: Fixed-Effects
Robust standard errors adjusted for 804 clusters in parentheses
*** p<0.01; ** p<0.05; * p<0.1
* Within R^2 for FE models
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table 7
Coefficient of FHO on referrals and costs of referrals: Continuity ≥ 6 years

	Enrolled and Non-enrolled Patients (PSM Weighted Regression results)			**Enrolled Patients (PSM Weighted Regression results)**		
Outcome Variables	**OLS**	**PA**	**FE***	**OLS**	**PA***	**FE***
Log of total referrals	0.164*** (0.033)	0.060** (0.027)	0.053* (0.030)	0.170*** (0.033)	0.046* (0.027)	0.037 (0.030)
R^2	0.582		0.142	0.582		0.151
Log unique patient referrals	0.087*** (0.030)	0.063*** (0.024)	0.061** (0.026)	0.096*** (0.030)	0.049** (0.025)	0.046* (0.027)
R^2	0.638		0.210	0.643		0.204
Log of referral costs	0.200*** (0.031)	0.085*** (0.024)	0.076*** (0.026)	0.203*** (0.031)	0.068*** (0.024)	0.057** (0.026)
R^2	0.614		0.170	0.614		0.184
Observations	18,576	18,576	18,576	18,576	18,576	18,576
Physicians	2,322	2,322	2,322	2,322	2,322	2,322

OLS: Ordinary Least Squares; PA: Population-average; FE: Fixed-Effects
Robust standard errors adjusted for 2601 clusters in parentheses
*** p<0.01; ** p<0.05; * p<0.1
* Within R^2 for FE models
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table 8
Coefficient of FHO on the number and costs of referrals for Enrolled Patients (2006-2009)

	PSM Weighted Regressions (Include ADG)			**PSM Weighted Regressions (Exclude ADG)**		
Variable	**OLS**	**PA**	**FE***	**OLS**	**PA**	**FE***
Log of total referrals	0.112*** (0.036)	-0.033* (0.018)	-0.043** (0.020)	0.070* (0.039)	-0.037** (0.019)	-0.044** (0.020)
R^2	0.555		0.160	0.498		0.149
Log unique patient referrals	0.078** (0.032)	-0.019 (0.014)	-0.033** (0.015)	0.053 (0.034)	-0.021 (0.014)	-0.034** (0.015)
R^2	0.613		0.193	0.584		0.184
Log of referral costs	0.141*** (0.034)	-0.025 (0.017)	-0.045** (0.018)	0.095** (0.038)	-0.030* (0.018)	-0.046*** (0.019)
R^2	0.578		0.220	0.513		0.204
Observations	10,404	10,404	10,404	10,404	10,404	10,404
Physicians	2,601	2,601	2,601	2,601	2,601	2,601

OLS: Ordinary Least Squares; RE: Population-average; FE: Fixed-Effects
Robust standard errors adjusted for 2601 clusters in parentheses
*** p<0.01; ** p<0.05; * p<0.1
∗ Within R^2 for FE models
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table 9
Coefficient of FHO on the number and costs of referrals for Enrolled Patients (2010-2013)

	PSM Weighted Regressions (Include ADG)			PSM Weighted Regressions (Exclude ADG)		
Variable	**OLS**	**PA**	**FE***	**OLS**	**PA**	**FE***
Log of total referrals	0.286*** (0.040)	0.163*** (0.031)	0.116*** (0.036)	0.162*** (0.041)	0.124*** (0.032)	0.114*** (0.037)
R^2	0.549		0.173	0.490		0.167
Log unique patient referrals	0.161*** (0.034)	0.116*** (0.028)	0.105*** (0.033)	0.090*** (0.035)	0.087*** (0.029)	0.103*** (0.035)
R^2	0.599		0.199	0.571		0.192
Log of referral costs	0.305*** (0.038)	0.171*** (0.030)	0.115*** (0.035)	0.174*** (0.039)	0.132*** (0.031)	0.113*** (0.037)
R^2	0.585		0.202	0.520		0.194
Observations	10,404	10,404	10,404	10,404	10,404	10,404
Physicians	2,601	2,601	2,601	2,601	2,601	2,601

OLS: Ordinary Least Squares; PA: Population-average; FE: Fixed-Effects
Robust standard errors adjusted for 2,601 clusters in parentheses
*** p<0.01; ** p<0.05; * p<0.1
⁎ Within R^2 for FE models
All regressions include the full set of control variables, X_{it}, defined in Section 4

Appendix A
Table A1
t Test and Standardized Bias after CBPS and EB Matching

Variables	Means and Standardized Bias after CBPS					Means and Standardized Bias after EB				
	Switcher (FHO)	Non-Switcher (FHG)	*P* value of *t* test before CBPS	%Bias	%reduction in |bias| after CBPS	Switcher (FHO)	Non-Switcher (FHG)	*P* value of *t* test after EB	%Bias	%reduction in |bias| after EB
Physician Characteristics										
Age (in years)	49.125	49.569	0.191	-4.5	76.9	49.125	49.125	0.999	0.0	100.0
Age^2	2489.5	2531.5	0.216	-4.1	80.1	2489.5	2489.5	0.999	0.0	100.0
Years in the model	1.8587	1.8539	0.867	0.1	99.8	1.8587	1.8587	1.00	0.0	100.0
$(\text{Years in the model})^2$	3.9895	3.9865	0.976	0.0	100.0	3.9895	3.9894	1.00	0.0	100.0
Female (%)	0.36742	0.35345	0.457	2.9	12.7	0.36742	0.36741	1.00	0.0	99.9
IMG (%)	0.10758	0.11695	0.447	-2.6	91.6	0.10758	0.10758	1.00	0.0	100.0
Group size	39.512	40.037	0.808	-1.0	96.5	39.512	39.513	1.00	0.0	100.0
Roster size	1826	1781.2	0.132	5.6	45.2	1826	1826	1.00	0.0	100.0
Patient Characteristics										
Average Age	39.147	39.422	0.241	-4.2	72.0	39.147	39.147	1.00	0.0	100.0
ADG	3.2939	3.2949	0.951	-0.2	99.4	3.2939	3.2939	1.00	0.0	100.0
Deprived areas (%)	27.722	28.3	0.346	-3.7	81.0	27.722	27.722	1.00	0.0	100.0
Rural areas (%)	10.5	11.668	0.193	-5.9	86.1	10.5	10.5	1.00	0.0	100.0
Past Outcome										
ln(referrals) in 2005	7.6073	7.5872	0.335	2.9	-3963	7.6073	7.6073	0.999	0.0	97.0
Financial gain										
Expected gain in income (thousand $)	129.56	127.73	0.543	1.8	97.6	129.56	129.56	0.999	0.0	100.0
$(\text{Expected gain})^2$	22775	22200	0.598	1.4	97.4	22775	22774	1.00	0.0	100.0

Table A2
Propensity Score Estimates

Variable	Logit Model	CBPS Model
Physician Characteristics		
Age (in years)	0.070 (0.044)	0.030 (0.051)
Age^2	-0.001** (0.0004)	-0.007 (0.0005)
Years in the model	1.322*** (0.293)	1.567*** (0.340)
$(\text{Years in the model})^2$	-0.288*** (0.087)	-0.361*** (0.100)
Female (%)	-0.106 (0.115)	-0.037 (0.130)
IMG (%)	-0.178 (0.129)	-0.276** (0.129)
Group size	-0.002*** (0.001)	-0.002*** (0.001)
Roster size	-0.0005*** (0.0001)	-0.0004*** (0.0001)
Constant	-3.966*** (1.273)	-3.246*** (1.432)
Patient Characteristics		
Average Age	0.030*** (0.011)	0.028** (0.011)
ADG	0.018 (0.138)	0.010 (0.142)
Deprived areas (%)	-0.002 (0.003)	-0.003 (0.003)
Rural areas (%)	0.012*** (0.003)	0.009*** (0.003)
Past Outcome		
ln(referrals) in 2005	0.108 (0.120)	0.128 (0.119)
Financial gain		
Expected gain in income (thousand $)	0.012*** (0.001)	0.012*** (0.001)
$(\text{Expected gain})^{2/}/1000$	-0.013*** (0.0000)	-0.015*** (0.0000)

*** p<0.01; ** p<0.05; * p<0.1

Appendix B
Descriptive and Cross-sectional Regression Results

Descriptive Results

The weighted descriptive statistics for each year are reported in table B1. Between 2006 and 2013, the average number of all referrals in the non-switcher group decreased from 2,370 to 2,349 while in the switcher group it increased from 2,445 to 2,484. The vast majority of referrals are for enrolled patients: the average number of these referrals increased from 2,136 to 2,192 in the non-switcher group and 2,266 to 2,317 in the switcher group. The number of unique patient referrals decreased in both groups – from 899 to 854 in the non-switcher group and 915 to 874 in the switcher group. The corresponding decreases for the enrolled patients are from 795 to 783 in the non-switcher group and 832 to 810 in the switcher group. Over the same period, the average costs of all referrals in 2002 Canadian dollars increased from $147,832 to $154,371 in the non-switcher group and $155,988 to $165,018 in the switcher group. As with the number of referrals, the vast of majority of the costs of referrals are due to enrolled patients: the costs per physician increased from $133,793 to $144,004 in the non-switcher group and from $145,020 to $153,742 in the switcher group. However, the distribution of referrals and of costs of referrals exhibit large variations across physicians and over time in both groups. The increase in the number of referrals and the costs of referrals could be partly attributed to incentives arising from the remuneration schemes.

Cross-sectional Regression Results

The cross-sectional regression results in each year are reported in table B2a, with the corresponding PSM weighted regression results in table B2b. The unweighted regression results show that the log of referrals and the log costs of referrals are statistically significant (at the 1% level) in each year. As shown in table B2a, for unique patient referrals, the estimated coefficient on being part of a FHO is statistically significant from 2011 onwards. After applying PSM weights, the estimated coefficient on FHO displays the same pattern. The results for referrals and the costs of referrals are slightly different, with the exception of 2009 the coefficient of FHO is statistically significant in all years (most times, at the 1% level). The cross-sectional results clearly demonstrate that the magnitude of the estimated coefficient on FHO is much larger after 2010. These results are corroborated when CBPS and EB matching methods are used (tables B12c-B2d). This differential impact over time could be explained by two factors: the majority of switching did not occur until 2010 and the switchers may have needed time to change their practice patterns in response to incentives embodied in capitation system of payment.

One potential issue with the preceding discussion is that it includes both enrolled and non-enrolled patients – but we would expect the remuneration effect to be driven by the enrolled patients. We, thus, conducted analyses using only enrolled patients; these PSM weighted regression results are reported table B3b. The corresponding unweighted results are presented in table B3a, and those based on CBPS and EB weights are presented in tables B3c-B3d). As can be seen from table B3b, the magnitude of the estimated coefficient on FHO increases after 2010 and is slightly larger when compared to the results reported in table B2b, suggesting that the association between capitation payments and referrals is maintained for the enrolled patients.

Table B1
Weighted Sample Means*

	Non-switcher Group (N=1,281)								Switcher Group (N=1,320)							
Variables	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Outcomes (All patients)																
Referrals	2370	2363	2400	2395	2369	2402	2308	2349	2445	2468	2492	2453	2450	2475	2424	2484
Unique referrals	899	893	902	898	887	882	854	849	915	913	923	914	903	899	879	874
Referral costs**	148	149	156	158	159	163	153	154	156	158	163	163	166	171	162	165
Outcomes (Enrolled Patients)																
Referrals	2136	2187	2236	2241	2206	2242	2160	2192	2266	2336	2364	2320	2303	2323	2268	2317
Unique referrals	795	815	829	831	817	814	791	783	832	853	866	856	841	837	817	810
Referral costs**	134	139	146	148	148	153	143	144	145	150	155	154	156	160	151	154
Physician Characteristics																
Age (in years)	49	50	51	52	53	54	55	56	49	50	51	52	53	54	55	56
Years in the model	1.9	2.7	3.7	4.6	5.6	6.5	7.4	8.4	1.9	2.6	3.2	2.7	2.7	2.7	2.9	3.7
Female (%)	36.6	36.6	36.6	36.6	36.6	36.6	36.6	36.6	36.7	36.7	36.7	36.7	36.7.	36.7	36.7	36.7
IMG (%)	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8
Group size	40	39	47	48	47	42	40	38	40	38	46	43	36	22	17	17
Roster size	1789	1780	1765	1749	1726	1706	1678	1630	1825	1841	1831	1796	1767	1734	1698	1654
Patient Characteristics***																
Age	39	40	40	41	41	42	42	43	39	40	40	41	41	42	42	43
ADG	3.3	3.3	3.2	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.1
Deprived areas (%)	27.7	27.1	26.7	26.4	26.1	25.9	25.9	25.8	25.8	27.3	26.9	26.6	26.4	26.2	26.2	26.1
Rural areas (%)	9.9	9.8	9.8	9.8	9.6	9.7	9.7	9.8	9.7	10.5	10.5	10.5	10.5	10.5	10.4	10.5

Notes: * the weights are from the propensity score matching; ** thousand dollars; *** Patient characteristics at the physician level; IMG=International Medical Graduates; ADG= Aggregate Diagnosis Groups.

Table B2a
Coefficient of FHO on the number and costs of referrals (all patients)
(Unweighted OLS regression results)

Outcome Variables	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Log of total referrals	0.044*** (0.015)	0.055*** (0.015)	0.058*** (0.015)	0.051*** (0.016)	0.075*** (0.018)	0.115*** (0.023)	0.236*** (0.031)	0.320*** (0.040)
R^2	0.544	0.542	0.560	0.552	0.552	0.560	0.584	0.572
Log of unique patient referrals	0.004 (0.012)	0.008 (0.012)	0.017 (0.012)	0.018 (0.013)	0.025* (0.014)	0.064*** (0.018)	0.142*** (0.025)	0.200*** (0.033)
R^2	0.574	0.581	0.608	0.602	0.608	0.621	0.640	0.620
Log of referral costs	0.065*** (0.015)	0.069*** (0.015)	0.065*** (0.015)	0.056*** (0.016)	0.078*** (0.018)	0.130*** (0.022)	0.255*** (0.032)	0.353*** (0.040)
R^2	0.559	0.562	0.582	0.580	0.579	0.588	0.603	0.594
Physicians	2,601	2,601	2,601	2,601	2,601	2,601	2,601	2,601

Robust standard errors in parentheses
*** p<0.01; ** p<0.05; * p<0.1
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table B2b
Coefficient of FHO on the number and costs of referrals (all patients)
(PSM Weighted OLS regression results)

Outcome Variables	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Log of total referrals	0.031* (0.017)	0.037** (0.017)	0.034*** (0.017)	0.015 (0.018)	0.037* (0.024)	0.078*** (0.028)	0.194*** (0.038)	0.290*** (0.052)
R^2	0.543	0.536	0.555	0.544	0.536	0.548	0.577	0.568
Log of unique patient referrals	0.005 (0.013)	0.004 (0.013)	0.006 (0.014)	0.0001 (0.015)	0.002 (0.016)	0.041* (0.024)	0.113*** (0.033)	0.177*** (0.045)
R^2	0.587	0.582	0.606	0.594	0.591	0.606	0.626	0. 611
Log of referral costs	0.054*** (0.017)	0.052*** (0.017)	0.038** (0.017)	0.019 (0.018)	0.039** (0.019)	0.091*** (0.027)	0.209*** (0.038)	0.310*** (0.050)
R^2	0.565	0.562	0.582	0.577	0.571	0.586	0.606	0.597
Physicians	2,601	2,601	2,601	2,601	2,601	2,601	2,601	2,601

Robust standard errors in parentheses
*** p<0.01; ** p<0.05; * p<0.1
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table B2c

**Coefficient of FHO on the number and costs of referrals (all patients)
(CBPS Weighted OLS regression results)**

Outcome Variables	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Log of total referrals	0.031* (0.018)	0.035** (0.017)	0.033* (0.017)	0.011 (0.018)	0.032* (0.020)	0.073*** (0.027)	0.185*** (0.037)	0.289*** (0.051)
R^2	0.542	0.540	0.560	0.551	0.543	0.551	0.579	0.568
Log of unique patient referrals	0.003 (0.014)	0.002 (0.013)	0.004 (0.013)	-0.004 (0.014)	-0.003 (0.016)	0.035 (0.023)	0.103*** (0.032)	0.171*** (0.044)
R^2	0.583	0.583	0.607	0.596	0.593	0.606	0.625	0.609
Log of referral costs	0.055*** (0.018)	0.053*** (0.017)	0.039** (0.017)	0.018 (0.018)	0.037** (0.019)	0.087*** (0.026)	0.200*** (0.037)	0.307*** (0.049)
R^2	0.568	0.569	0.588	0.589	0.582	0.594	0.611	0.600
Physicians	2,601	2,601	2,601	2,601	2,601	2,601	2,601	2,601

Robust standard errors in parentheses
*** p<0.01; ** p<0.05; * p<0.1
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table B2d
Coefficient of FHO on the number and costs of referrals (all patients)
(Entropy Weighted OLS regression results)

Outcome Variables	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Log of total referrals	0.029 (0.020)	0.033* (0.020)	0.020 (0.020)	0.010 (0.021)	0.040* (0.023)	0.083*** (0.029)	0.196*** (0.039)	0.304*** (0.055)
R^2	0.525	0.523	0.543	0.538	0.525	0.541	0.563	0.559
Log of unique patient referrals	0.010 (0.015)	0.010 (0.015)	0.009 (0.014)	0.002 (0.015)	0.011 (0.017)	0.049** (0.021)	0.121*** (0.030)	0.194*** (0.044)
R^2	0.591	0.588	0.614	0.606	0.598	0.618	0.634	0.620
Log of referral costs	0.050** (0.020)	0.046** (0.020)	0.034* (0.019)	0.014 (0.020)	0.041* (0.022)	0. 090*** (0.027)	0.205*** (0.039)	0.319*** (0.051)
R^2	0.547	0.545	0.567	0.567	0.554	0.573	0.589	0.582
Physicians	2,601	2,601	2,601	2,601	2,601	2,601	2,601	2,601

Robust standard errors in parentheses
*** $p<0.01$; ** $p<0.05$; * $p<0.1$
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table B3a
Coefficient of FHO on the number and costs of referrals (Enrolled Patients)
(Unweighted OLS regression results)

Outcome Variables	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Log of total referrals	0.078*** (0.015)	0.086*** (0.015)	0.084*** (0.015)	0.076*** (0.016)	0.093*** (0.018)	0.128*** (0.024)	0.231*** (0.032)	0.327*** (0.046)
R^2	0.563	0.561	0.571	0.563	0.560	0.565	0.586	0.554
Log of unique patient referrals	0.040*** (0.012)	0.040*** (0.012)	0.044*** (0.012)	0.043*** (0.013)	0.044*** (0.014)	0.078*** (0.018)	0.139*** (0.026)	0.209*** (0.038)
R^2	0.602	0.611	0.631	0.620	0.621	0.631	0.646	0.603
Log of referral costs	0.102*** (0.016)	0.100*** (0.015)	0.091*** (0.015)	0.080*** (0.016)	0.096*** (0.018)	0.143*** (0.023)	0.249*** (0.033)	0.355*** (0.044)
R^2	0.579	0.580	0.592	0.590	0.587	0.593	0.603	0.582
Physicians	2,601	2,601	2,601	2,601	2,601	2,601	2,601	2,601

Robust standard errors in parentheses
*** $p<0.01$; ** $p<0.05$; * $p<0.1$
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table B3b
Coefficient of FHO on the number and costs of referrals (Enrolled Patients)
(PSM Weighted OLS regression results)

Outcome Variables	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Log of total referrals	0.060*** (0.017)	0.061*** (0.017)	0.055*** (0.017)	0.036* (0.018)	0.051** (0.021)	0.090*** (0.028)	0.194*** (0.039)	0.333*** (0.073)
R^2	0.555	0.554	0.568	0.557	0.545	0.557	0.580	0.527
Log of unique patient referrals	0.034*** (0.013)	0.030** (0.013)	0.029** (0.013)	0.021 (0.014)	0.017 (0.016)	0.053** (0.024)	0.113*** (0.033)	0.219*** (0.063)
R^2	0.610	0.610	0.629	0.613	0.605	0.621	0.634	0.562
Log of referral costs	0.081*** (0.018)	0.076*** (0.017)	0.059*** (0.017)	0.039** (0.018)	0.053*** (0.020)	0.103*** (0.027)	0.206*** (0.040)	0.310*** (0.050)
R^2	0.573	0.576	0.591	0.585	0.577	0.592	0.607	0.597
Physicians	2,601	2,601	2,601	2,601	2,601	2,601	2,601	2,601

Robust standard errors in parentheses
*** $p<0.01$; ** $p<0.05$; * $p<0.1$
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table B3c
Coefficient of FHO on the number and costs of referrals (Enrolled Patients)
(CBPS Weighted OLS regression results)

Outcome Variables	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Log of total referrals	0.060*** (0.018)	0.061*** (0.017)	0.055*** (0.017)	0.033* (0.019)	0.047** (0.020)	0.085*** (0.028)	0.184*** (0.038)	0.322*** (0.068)
R^2	0.556	0.558	0.573	0.565	0.552	0.562	0.582	0.533
Log of unique patient referrals	0.034*** (0.014)	0.029** (0.013)	0.028** (0.013)	0.014 (0.017)	0.012 (0.016)	0.047** (0.029)	0.101*** (0.033)	0.206*** (0.059)
R^2	0.607	0.612	0.630	0.616	0.609	0.622	0.633	0.568
Log of referral costs	0.083*** (0.019)	0.078*** (0.018)	0.061*** (0.018)	0.039** (0.018)	0.051*** (0.019)	0.099*** (0.026)	0.196*** (0.039)	0.307*** (0.049)
R^2	0.575	0.582	0.596	0.597	0.589	0.600	0.613	0.600
Physicians	2,601	2,601	2,601	2,601	2,601	2,601	2,601	2,601

Robust standard errors in parentheses
*** p<0.01; ** p<0.05; * p<0.1
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table B3d
Coefficient of FHO on the number and costs of referrals (Enrolled Patients)
(Entropy Weighted OLS regression results)

Outcome Variables	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Log of total referrals	0.055*** (0.021)	0.053*** (0.020)	0.046** (0.020)	0.027 (0.021)	0.051** (0.023)	0.092*** (0.030)	0.194*** (0.040)	0.325*** (0.063)
R^2	0.540	0.541	0.556	0.548	0.532	0.547	0.564	0.538
Log of unique patient referrals	0.037*** (0.015)	0.031** (0.014)	0.026* (0.014)	0.019 (0.015)	0.023 (0.017)	0.059*** (0.022)	0.122*** (0.031)	0.216*** (0.050)
R^2	0.614	0.616	0.637	0.622	0.611	0.630	0.630	0.597
Log of referral costs	0.075*** (0.021)	0.066*** (0.020)	0.050*** (0.019)	0.029 (0.020)	0.052** (0.022)	0.101*** (0.028)	0.202*** (0.040)	0.319*** (0.051)
R^2	0.559	0.561	0.577	0.575	0.560	0.578	0.590	0.582
Physicians	2,601	2,601	2,601	2,601	2,601	2,601	2,601	2,601

Robust standard errors in parentheses
*** p<0.01; ** p<0.05; * p<0.1
All regressions include the full set of control variables, X_{it}, defined in Section 4

Appendix C

Table C1a
Coefficient of FHO on the number and costs of referrals

	Enrolled and Non-enrolled Patients (Unweighted Regression results)			Enrolled Patients (Unweighted Regression results)		
Outcome Variables	**OLS**	**PA**	**FE***	**OLS**	**PA**	**FE***
Log of total referrals	0.220*** (0.027)	0.062*** (0.016)	0.050*** (0.017)	0.225*** (0.028)	0.035** (0.016)	0.021 (0.017)
R^2	0.554		0.207	0.559		0.245
Log unique patient referrals	0.141*** (0.023)	0.067*** (0.014)	0.058*** (0.014)	0.150*** (0.023)	0.041*** (0.014)	0.031** (0.015)
R^2	0.605		0.236	0.615		0.268
Log of referral costs	0.263*** (0.027)	0.088*** (0.015)	0.073*** (0.016)	0.266*** (0.027)	0.059*** (0.015)	0.043*** (0.016)
R^2	0.578		0.233	0.582		0.276
Observations	20,808	20,808	20,808	20,808	20,808	20,808
Physicians	2,601	2,601	2,601	2,601	2,601	2,601

OLS: Ordinary Least Squares; PA: Population-average; FE: Fixed-Effects
Robust standard errors adjusted for 2601 clusters in parentheses
*** p<0.01; ** p<0.05; * p<0.1
* Within R^2 for FE models
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table C1b
Coefficient of FHO on the number and costs of referrals

	Enrolled and Non-enrolled Patients (CBPS Weighted Regression results)			**Enrolled Patients (CBPS Weighted Regression results)**		
Outcome Variables	**OLS**	**PA**	**FE***	**OLS**	**PA**	**FE***
Log of total referrals	0.191*** (0.033)	0.068*** (0.023)	0.063*** (0.025)	0.201*** (0.034)	0.050** (0.024)	0.045* (0.025)
R^2	0.551		0.200	0.553		0.216
Log unique patient referrals	0.109*** (0.028)	0.072*** (0.021)	0.070** (0.022)	0.122*** (0.029)	0.055*** (0.021)	0.053** (0.023)
R^2	0.598		0.237	0.606		0.248
Log of referral costs	0.225*** (0.031)	0.089*** (0.021)	0.082*** (0.022)	0.233*** (0.032)	0.068*** (0.021)	0.061*** (0.023)
R^2	0.585		0.224	0.586		0.247
Observations	20,808	20,808	20,808	20,808	20,808	20,808
Physicians	2,601	2,601	2,601	2,601	2,601	2,601

OLS: Ordinary Least Squares; PA: Population-average; FE: Fixed-Effects
Robust standard errors adjusted for 2601 clusters in parentheses
*** p<0.01; ** p<0.05; * p<0.1
* Within R^2 for FE models
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table C1c
Coefficient of FHO on the number and costs of referrals

	Enrolled and Non-enrolled Patients (Entropy Weighted Regression results)			**Enrolled Patients (Entropy Weighted Regression results)**		
Outcome Variables	**OLS**	**PA***	**FE***	**OLS**	**PA***	**FE***
Log of total referrals	0.212*** (0.035)	0.071*** (0.022)	0.067*** (0.023)	0.222*** (0.037)	0.051** (0.022)	0.046* (0.024)
R^2	0.537		0.204	0.541		0.231
Log unique patient referrals	0.137*** (0.027)	0.074*** (0.018)	0.072*** (0.020)	0.150*** (0.028)	0.055*** (0.019)	0.052*** (0.021)
R^2	0.607		0.246	0.616		0.270
Log of referral costs	0.242*** (0.034)	0.094*** (0.019)	0.087*** (0.021)	0.250*** (0.035)	0.072*** (0.020)	0.063*** (0.022)
R^2	0.563		0.231	0.566		0.283
Observations	20,808	20,808	20,808	20,808	20,808	20,808
Physicians	2,601	2,601	2,601	2,601	2,601	2,601

OLS: Ordinary Least Squares; PA: Population-average; FE: Fixed-Effects
Robust standard errors adjusted for 2601 clusters in parentheses
*** p<0.01; ** p<0.05; * p<0.1
⁎ Within R^2 for FE models
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table C2a
Coefficient of FHO on the number and costs of referrals by cohorts of switchers (all patients)

	CBPS Weighted fixed-effects regressions				
Outcome Variables	**2008 Switchers**	**2009 Switchers**	**2010 Switchers**	**2011 Switchers**	**2012 Switchers**
Log of total referrals	0.088*** (0.034)	0.088*** (0.032)	0.104** (0.042)	0.134*** (0.044)	0.135** (0.056)
R^2 (Within)	0.241	0.213	0.239	0.235	0.231
Log unique patient referrals	0.097*** (0.030)	0.087*** (0.029)	0.107*** (0.038)	0.114*** (0.041)	0.129** (0.051)
R^2 (Within)	0.269	0.246	0.272	0.267	0.256
Log of referral costs	0.113*** (0.031)	0.093*** (0.028)	0.112*** (0.037)	0.125*** (0.040)	0.126** (0.049)
R^2 (Within)	0.259	0.231	0.256	0.257	0.234
Observations	11,480	13,736	12,424	12,216	11,464
Physicians	1,435	1,717	1,553	1,527	1,433

Robust standard errors in parentheses
*** p<0.01; ** p<0.05; * p<0.1
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table C2b

Coefficient of FHO on the number and costs of referrals by cohorts of switchers (all patients)

	Entropy Weighted fixed-effects regressions				
Outcome Variables	**2008 Switchers**	**2009 Switchers**	**2010 Switchers**	**2011 Switchers**	**2012 Switchers**
Log of total referrals	0.088*** (0.031)	0.091*** (0.029)	0.108*** (0.038)	0.145*** (0.042)	0.139*** (0.052)
R^2 (Within)	0.249	0.218	0.246	0.244	0.238
Log unique patient referrals	0.098*** (0.027)	0.087*** (0.025)	0.109*** (0.034)	0.123*** (0.037)	0.131*** (0.045)
R^2 (Within)	0.280	0.255	0.284	0.281	0.266
Log of referral costs	0.098*** (0.027)	0.087*** (0.025)	0.109*** (0.034)	0.123*** (0.037)	0.131*** (0.045)
R^2 (Within)	0.280	0.255	0.284	0.281	0.266
Observations	11,480	13,736	12,424	12,216	11,464
Physicians	1,435	1,717	1,553	1,527	1,433

Robust standard errors in parentheses

*** $p<0.01$; ** $p<0.05$; * $p<0.1$

All regressions include the full set of control variables, X_{it}, defined in Section 4

Table C2c
Coefficient of FHO on the number and costs of referrals by cohorts of switchers (enrolled patients)

	CBPS Weighted fixed-effects regressions				
Outcome Variables	**2008 Switchers**	**2009 Switchers**	**2010 Switchers**	**2011 Switchers**	**2012 Switchers**
Log of total referrals	0.060* (0.034)	0.076*** (0.032)	0.081* (0.042)	0.15*** (0.051)	0.118** (0.057)
R^2 (Within)	0.237	0.217	0.240	0.235	0.227
Log unique patient referrals	0.074** (0.031)	0.076*** (0.030)	0.087** (0.040)	0.097** (0.042)	0.113** (0.053)
R^2 (Within)	0.258	0.243	0.266	0.261	0.247
Log of referral costs	0.082*** (0.031)	0.079*** (0.029)	0.088** (0.038)	0.105*** (0.041)	0.106** (0.051)
R^2 (Within)	0.269	0.246	0.270	0.271	0.265
Observations	11,480	13,736	12,424	12,216	11,464
Physicians	1,435	1,717	1,553	1,527	1,433

Robust standard errors in parentheses
*** $p<0.01$; ** $p<0.05$; * $p<0.1$
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table C2d
Coefficient of FHO on the number and costs of referrals by cohorts of switchers (enrolled patients)

	Entropy Weighted fixed-effects regressions				
Outcome Variables	**2008 Switchers**	**2009 Switchers**	**2010 Switchers**	**2011 Switchers**	**2012 Switchers**
Log of total referrals	0.059*** (0.032)	0.076*** (0.034)	0.081** (0.040)	0.123*** (0.043)	0.118** (0.054)
R^2 (Within)	0.261	0.236	0.263	0.259	0.250
Log unique patient referrals	0.072*** (0.028)	0.074*** (0.026)	0.085** (0.035)	0.103*** (0.038)	0.110** (0.047)
R^2 (Within)	0.287	0.268	0.296	0.292	0.274
Log of referral costs	0.083*** (0.030)	0.079*** (0.027)	0.091** (0.037)	0.117*** (0.039)	0.110** (0.050)
R^2 (Within)	0.292	0.265	0.292	0.296	0.289
Observations	11,480	13,736	12,424	12,216	11,464
Physicians	1,435	1,717	1,553	1,527	1,433

Robust standard errors in parentheses
*** $p<0.01$; ** $p<0.05$; * $p<0.1$
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table C3a
Coefficient of FHO on the number and costs of referrals for Enrolled Patients (2006-2009)

	CBPS Weighted Regressions (Include ADG)			CBPS Weighted Regressions (Exclude ADG)		
Variable	**OLS**	**PA**	**FE***	**OLS**	**PA**	**FE***
Log of total referrals	0.108*** (0.035)	-0.036** (0.018)	-0.044** (0.020)	0.065* (0.038)	-0.039** (0.019)	-0.045** (0.020)
R^2	0.560		0.160	0.503		0.149
Log unique patient referrals	0.075** (0.031)	-0.021 (0.024)	-0.035** (0.015)	0.050 (0.032)	-0.023* (0.014)	-0.035** (0.015)
R^2	0.614		0.191	0.586		0.182
Log of referral costs	0.138*** (0.034)	-0.027 (0.017)	-0.044** (0.018)	0.090** (0.037)	-0.031* (0.017)	-0.045** (0.019)
R^2	0.584		0.220	0.520		0.204
Observations	10,404	10,404	10,404	10,404	10,404	10,404
Physicians	2,601	2,601	2,601	2,601	2,601	2,601

OLS: Ordinary Least Squares; RE: Population-average; FE: Fixed-Effects
Robust standard errors adjusted for 2601 clusters in parentheses
*** p<0.01; ** p<0.05; * p<0.1
⁎ Within R^2 for FE models
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table C3b
Coefficient of FHO on the number and costs of referrals for Enrolled Patients (2006-2009)

	Entropy Weighted Regressions (Include ADG)			**Entropy Weighted Regressions (Exclude ADG)**		
Variable	**OLS**	**PA**	**FE***	**OLS**	**PA**	**FE***
Log of total referrals	0.137*** (0.037)	-0.041** (0.019)	-0.051** (0.020)	0.091** (0.040)	-0.042** (0.019)	-0.051** (0.021)
R^2	0.543		0.208	0.487		0.150
Log unique patient referrals	0.113** (0.029)	-0.023* (0.014)	-0.040*** (0.015)	0.086*** (0.030)	-0.024* (0.014)	-0.039** (0.016)
R^2	0.019		0.204	0.591		0.196
Log of referral costs	0.161*** (0.036)	-0.032* (0.018)	-0.053 (0.019)	0.111*** (0.040)	-0.035* (0.018)	-0.053*** (0.020)
R^2	0.565		0.224	0.498		0.210
Observations	10,404	10,404	10,404	10,404	10,404	10,404
Physicians	2,601	2,601	2,601	2,601	2,601	2,601

OLS: Ordinary Least Squares; RE: Population-average; FE: Fixed-Effects
Robust standard errors adjusted for 2601 clusters in parentheses
*** p<0.01; ** p<0.05; * p<0.1
* Within R^2 for FE models
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table C4a
Coefficient of FHO on the number and costs of referrals for Enrolled Patients (2010-2013)

	CBPS Weighted Regressions (Include ADG)			CBPS Weighted Regressions (Exclude ADG)		
Variable	**OLS**	**PA**	**FE***	**OLS**	**PA**	**FE***
Log of total referrals	0.279*** (0.039)	0.158*** (0.030)	0.118*** (0.035)	0.154*** (0.040)	0.120*** (0.031)	0.117*** (0.037)
R^2	0.554		0.177	0.496		0.170
Log unique patient referrals	0.152*** (0.033)	0.111*** (0.027)	0.106*** (0.032)	0.081** (0.034)	0.084*** (0.028)	0.105*** (0.034)
R^2	0.603		0.206	0.574		0.198
Log of referral costs	0.300*** (0.037)	0.167*** (0.029)	0.115*** (0.035)	0.166*** (0.038)	0.129*** (0.030)	0.114*** (0.036)
R^2	0.593		0.205	0.529		0.197
Observations	10,404	10,404	10,404	10,404	10,404	10,404
Physicians	2,601	2,601	2,601	2,601	2,601	2,601

OLS: Ordinary Least Squares; PA: Population-average; FE: Fixed-Effects
Robust standard errors adjusted for 2,601 clusters in parentheses
*** p<0.01; ** p<0.05; * p<0.1
⁎ Within R^2 for models
All regressions include the full set of control variables, X_{it}, defined in Section 4

Table C4b
Coefficient of FHO on the number and costs of referrals for Enrolled Patients (2010-2013)

	Entropy Weighted Regressions (Include ADG)			Entropy Weighted Regressions (Exclude ADG)		
Variable	**OLS**	**PA**	**FE***	**OLS**	**PA**	**FE***
Log of total referrals	0.295*** (0.041)	0.152*** (0.031)	0.116*** (0.035)	0.168*** (0.042)	0.124*** (0.032)	0.116*** (0.037)
R^2	0.545		0.195	0.486		0.188
Log unique patient referrals	0.174*** (0.032)	0.114*** (0.026)	0.103*** (0.031)	0.100*** (0.032)	0.093*** (0.027)	0.103*** (0.032)
R^2	0.618		0.227	0.588		0.220
Log of referral costs	0.309*** (0.039)	0.160*** (0.029)	0.115*** (0.035)	0.175*** (0.040)	0.130*** (0.031)	0.115*** (0.036)
R^2	0.575		0.226	0.509		0.217
Observations	10,404	10,404	10,404	10,404	10,404	10,404
Physicians	2,601	2,601	2,601	2,601	2,601	2,601

OLS: Ordinary Least Squares; PA: Population-average; FE: Fixed-Effects
Robust standard errors adjusted for 2,601 clusters in parentheses
*** p<0.01; ** p<0.05; * p<0.1
⁎ Within R^2 for FE models
All regressions include the full set of control variables, X_{it}, defined in Section 4