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Blended capitation and incentives: Fee codes inside and outside the capitated basket

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ABSTRACT

Blended capitation physician payment models incorporating fee-for-service (FFS), pay-for-performance and/or other payment elements seek to avoid the extremes of both FFS and capitation. However, evidence is limited regarding physicians' responses to blended models, and potential shifts in service provision across payment categories within the practice. We examine the switch from FFS to a blended capitation-FFS model for primary care physicians in group practice. The empirical analysis shows patients experiencing 9–14% reductions in capitated services and simultaneous increases of 10–22% in FFS services from their rostering physicians. Unusually, our data permit changes among non-rostering physicians to be observed. Other physicians within the rostering group reduce the provision of capitated fee codes, with no net change in FFS services. All other physicians in the jurisdiction reduce both capitated and FFS services, which is consistent with patients concentrating their primary care with one provider as a result of capitation.

1. Introduction

To encourage equitable, efficient and patient-oriented primary care, many countries are experimenting with innovative physician remuneration methods (Devlin and Sarma, 2008; Geruso and McGuire, 2016; Ho and Pakes, 2014; Iezzi et al., 2014; Kontopantelis et al., 2015; Scott and Jan, 2011). Preferred payment structures for primary care physicians/general practitioners (GPs), who act as the first contact with patients and coordinate specialist care, are the subject of long and ongoing debate. Traditional Fee-For-Service (FFS) is associated with 'over-treatment' or 'inappropriate treatment' since a physician's remuneration depends on the quantity of services provided and not the quality or appropriateness of care. At another extreme, pure capitation, where primary care physician services are paid a fixed amount per time period (e.g., per year), creates incentives to underprovide services. Also, many physicians dislike pure capitation since it is perceived to shift too much financial risk to them (Eggleston, 2005; Robinson, 2001; Russell, 2015; Scott et al., 2011; Ellis and McGuire, 1986; Ma, 1994; Newhouse, 1996). As a result, there is an increased emphasis on blended payment models (Srivastava et al., 2016).

We study a payment model introduced in Ontario, Canada as part of that province's public and universal Medicare system (Hutchison et al., 2011) that blends on multiple dimensions. First, only selected core services are capitated. For enrolled (i.e., rostered) patients some fee codes (services) are bundled in a "capitated basket" while the remaining "outside the basket" ones are paid FFS. This first device serves at least two roles. It reduces the risk borne by physicians through capitation since they are remunerated by FFS for uncommon and sometimes costly services against which their practices are too small to diversify effectively. Also, it alleviates concerns that preventive services might be subject to the under-allocation incentives of capitation since many such services are placed outside the basket. A second dimension of blending occurs inside the capitated basket where physicians are paid a capitation amount plus a small FFS rate akin to the approach suggested by McGuire (2011). Third, although patient enrolment is required of physicians, patients may opt out, and physicians also see new and transient patients who are not rostered. All services for these non-enrolled individuals are paid FFS; however the total amount of such FFS fees for codes that are in-the-basket are capped to prevent what could become parallel FFS and capitated patient groups within practices – that is, to avoid a type of within-practice cream skimming. A final form of blending is that a pay-for-performance system with patient-specific bonuses and practice-wide incentives overlays the capitated/FFS structure. However, although the pay-for-performance component is addressed empirically, it is not the

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focus of our study and is not included in the theoretical analysis since it is almost identical for the blended capitation model and the enhanced FFS one employed as a comparison. Also, the evidence on the effect of these incentives is mixed (Li et al., 2014; Kralj and Kantarevic, 2013).

Concerns regarding our limited understanding of the operation of incentives following from physician payment models arise from discrepancies between studies showing that such incentives influence physician behavior in some situations but not in others. Overall, there is no consensus regarding how complex payment structures and contextual factors affect the degree to which incentives are acted upon (e.g., Andreassen et al., 2013; Brosig-Koch et al., 2015; Gosden et al., 2001).

Our analysis contributes to the literature by providing a better understanding of the behavioral change of physicians in response to the blended capitation model across different payment categories in different relationships with patients. We develop a simple theoretical model examining the provision of care inside and outside the capitated basket, followed by an associated econometric analysis. The empirical work addresses GP self-selection in switching payment models and estimates shifts in the distribution of billing codes not only for rostering physicians but also for different categories of GPs. The latter is rare in empirical work, but is feasible given Ontario's public and universal approach to health care delivery which provides (effectively) the universe of physician billings. We can examine how primary care physicians with different relationships to the patient (rostering physician, physicians in the same group practice as the rostering GP, and all GPs outside the rostering group) are affected by remuneration incentives.

Capitation is, in part, intended to improve the quality of care on a number of dimensions and, in particular, to facilitate "medical homes" as discussed by, for example, McGuire (2011) and David et al. (2016). Understanding the impact of switching to blended capitation on the entire system is useful for accessing this goal. Medical homes follow from the expectation, incorporated into the design of the payment system, that there will be a strengthening of the relationship between primary care providers (including providers in the same group practice who share medical records) and their rostered patients. One corollary is that under capitation a higher share of patients' primary care needs should be provided by their rostering GPs group than under FFS.

Our results indicate a marked drop in services inside the basket provided by rostering physicians. Other GPs in the same practice have similar, but attenuated, responses. GPs outside the rostering group have a simultaneous decrease in inside the basket services. Across all physicians in the province, there is a 12–19% decrease in the value of services provided inside the capitated basket. In contrast, outside the basket, there is a 10–22% increase by rostering physicians while – surprisingly, given the goals of group practice – other GPs in the same group are less likely to see one of their colleague's patients but, conditional on a visit, are more likely to bill outside of the basket. For physicians outside the rostering group, there are reductions in billing outside of the basket suggesting that there is indeed some concentration of patients with their rostering physician consistent with the idea of a medical home. Overall, across all physicians in the province, the net effect is an increase in billings outside the basket.

In Section 2 we provide institutional background. Section 3 derives a theoretical model that addresses the incentives associated with the non-marginal change from one payment model to another and assesses how the blended model affects the supply of care inside and outside the basket. Section 4 describes the data, and Section 5 presents an empirical strategy that some readers may (plausibly) interpret as providing causal impacts, while others may prefer to regard the estimates as well controlled conditional relationships. Since GPs voluntarily choose to join a specific payment model (Rudoler et al., 2015), addressing self-selection bias is central. To this end, we employ propensity score estimation in the context of a difference-in-differences panel fixed effect model. Moreover, to assist with identification, we focus on patients who remain enrolled with the same physician continuously during the sample period.[1] The results are presented in Section 6, and Section 7 concludes.

2. Institutional background

Prior to 1999 over 95% of primary care physicians in Ontario were paid by traditional FFS. This dropped to approximately 30% by 2013, with many of those remaining in FFS not practicing full-time and/or full-scope primary care medicine (e.g., sports medicine). A series of primary care reforms introduced a menu of physician payment models in order to improve the quality and continuity of care as detailed by Sweetman and Buckley (2014), Marchildon and Hutchison (2016), and McLeod et al. (2016). Selection into each model was voluntary on the part of GPs and early models had modest takeup. The first reformed model that gained wide acceptance was the highly remunerated Family Health Group (FHG) introduced in 2003. FHGs are considered to be highly remunerated because, compared to the traditional FFS, they receive premiums and bonuses not available to that group. The payment model blends FFS with pay-for-performance, has premiums associated with voluntary rostering, and requires both group practice (minimum of three not necessarily co-located physicians who share medical records) and after hours care. We refer to this as enhanced FFS.

Building on the enhanced FFS model, in 2006 Family Health Organizations (FHOs) were introduced. We refer to this model as blended capitation since it combines capitation with FFS and pay-for-performance. Many elements of this model, including pay-for-performance, group practice and after hours care are the same or very similar to enhanced FFS, but patient enrollment is mandatory. This model is well remunerated and quickly became very popular with many physicians switching voluntarily to it from other models including enhanced FFS. This study focuses on the latter transition since it isolates the effect of blended capitation.

Table 1 shows the key elements of the enhanced FFS and blended capitation models. All services outside the capitated basket are paid the same FFS rates as enhanced FFS physicians. However, services inside the capitated basket are paid differently. For enrolled patients, enhanced FFS physicians are paid 100% of the FFS fee, plus a 10% premium for a subset of 20 services. In contrast, blended capitation physicians are paid a capitation amount (a fixed amount per year for each patient regardless of the number of services provided; in the period under study it was only a function of each patient's sex and age), plus 10% of the FFS payment (also called shadow billing premium; it was increased to 15% after October 2010).[2] Beyond this, blended capitated physicians receive an "access bonus" for enrolled patients. If rostered patients receive (with some exceptions) services from primary care physicians other than those in the group to which their rostering physician belongs, then this "access bonus"

[1] Our intention in studying patients continuously enrolled with a GP the entire sample period is to control for patient selection bias. At the suggestion of a referee, we relax our selection of patients to include those who were enrolled with each physician in any year during the sample period. The results are in the online appendix.

[2] Shadow billings are records submitted by physicians for patient services that are funded through sources other than FFS. These records are identical to FFS billings including having a FFS fee code, but the payment is zero. In April 2002, shadow billing premiums were created to encourage the submission of claims paperwork for capitated services for the Family Health Network, an earlier and much less popular voluntary capitation model. The approach was extended to the model we study from its inception. Although not initiated with blending inside the basket in mind, it nevertheless started a new type of blending.

Table 1
Remuneration methods of enhanced FFS and blended capitation payment models.

	Enhanced FFS	Blended capitation
	Services *inside* the blended capitation basket	
Patient rostered with the GP	100% FFS + CCP premium[a]	15% FFS, access bonus[b] capitation
Patient rostered with a GP in the same group	100% FFS	15% FFS, access bonus, capitation
Patient rostered with a GP outside the group, or not rostered	100% FFS	100% FFS, hard cap[c]
	Services *outside* the blended capitation basket	
	100% FFS	100% FFS

Note: (a). CCP: Comprehensive Care Premium—10% FFS bonus for 20 fee codes for enrolled patients in enhanced FFS model; see Appendix A for details. (b). Access bonus: 18.5% if enrolled patients receive inside-the-basket services only from GPs in the rostering group; negated for visits to GPs outside of the rostering GP's group. (c). Hard cap: total annual inside the basket billings for non-rostered patients can be no more than a maximum, which was $ 55,950 for each physician in 2011.

is reduced accordingly, although it cannot be negative. Although structured as a bonus, this is a form of negation with a cap. However, there are no remuneration implications for rostered patients visiting emergency departments or specialists. The access bonus is calculated by multiplying the sum of all eligible enrolled patients' base capitation amount by 0.1859 and then subtracting external primary care claims without allowing the bonus to be less than zero. For patients who are not enrolled or who are enrolled with GPs outside the relevant group, both enhanced FFS and blended capitation GPs receive 100% FFS but, as mentioned, GPs in blended capitation face a cap on the annual total.

Empirical studies that investigate these models focus on access, the quantity and quality of care, effects on referrals to specialists and emergency department use, and pay-for-performance (e.g., Devlin and Sarma, 2008; Kantarevic et al., 2010; Kantarevic and Kralj, 2013; Li et al., 2014). As expected, physicians joining the FFS model enhanced with pay-for-performance tend to increase the number of services provided, patient visits and distinct patients seen. Physicians in blended capitation tend to reduce the total services, and are more responsive to diabetes management incentives than GPs in enhanced FFS.

3. Economic model

Building on McGuire and Pauly (1991), we characterize a GP's optimal service provision choices in a utility maximizing framework that incorporates approximations to enhanced FFS and blended capitation. Importantly, unlike McGuire and Pauly's model, which is used to study marginal changes in payment structures on service provision, we are interested in analyzing the non-marginal shift from enhanced FFS to blended capitation which involves contrasting the two payment models' equilibria. Another difference is that physicians experience disutility from demand inducement in their framework, whereas physicians express altruism for patients' health in our model. Our model focuses only on service provision and not on continuity of care.

Firstly, the rostering GP's problem in the enhanced FFS environment can be stated as:

$$\max_{x_1>0,x_2>0} U(p_1x_1+p_2x_2)+V(T-(t_1x_1+t_2x_2))+\alpha [h(x_1)+g(x_2)] \quad (1)$$

We assume that the rostering GP receives income from the number of services that would be inside (x_1),[3] and outside (x_2), the basket were the enhanced GP working in a blended capitation model, and the p's are the prices of each service. Subsequently, we normalize p_1 to one so that p is the relative price ratio p_2/p_1. A GP has T units of time that she can allocate to either leisure or to the provision of medical services inside (t_1x_1), or outside (t_2x_2), the basket where t_1 and t_2 represent the units of time required to provide one unit of either service. Time is the only cost in our model so prices may be interpreted as net of non-time costs. The utilities of income and leisure are denoted as U and V, respectively, and both are assumed to be strictly concave. Lastly, the patient benefits from each type of service and the health benefits of each service, denoted by h and g, are strictly concave. The parameter α is a weight the GP puts on the health benefits received by the patient and is assumed to be positive.

Using the superscript F to represent the optimum under enhanced FFS, the first-order conditions for this problem are[4]:

$$U'\left(x_1^F+px_2^F\right)-t_1V'\left(T-\left(t_1x_1^F+t_2x_2^F\right)\right)+\alpha h'\left(x_1^F\right)=0 \quad (2)$$

$$pU'\left(x_1^F+px_2^F\right)-t_2V'\left(T-\left(t_1x_1^F+t_2x_2^F\right)\right)+\alpha g'\left(x_2^F\right)=0 \quad (3)$$

The rostering GP's problem in the blended capitation environment can be stated as:

$$\max_{x_1>0,x_2>0} U(\varphi x_1+px_2+C)+V(T-(t_1x_1+t_2x_2))+\alpha [h(x_1)+g(x_2)] \quad (4)$$

and we assume that the GP now also receives capitation per patient (C). The partially compensated ratio for services inside the capitated basket is φ, and $0<\varphi<1$. Using the superscript BC to represent the optimum under blended capitation, the first-order conditions for this problem are:

$$\varphi U'\left(\varphi x_1^{BC}+px_2^{BC}+C\right)-t_1V'\left(T-\left(t_1x_1^{BC}+t_2x_2^{BC}\right)\right)+h'\left(x_1^{BC}\right)=0 \quad (5)$$

$$pU'\left(\varphi x_1^{BC}+px_2^{BC}+C\right)-t_2V'\left(T-\left(t_1x_1^{BC}+t_2x_2^{BC}\right)\right)+\alpha g'\left(x_2^{BC}\right)=0 \quad (6)$$

Combining (2) and (5) yields

$$\varphi U'\left(\varphi x_1^{BC}+px_2^{BC}+C\right)-U'\left(x_1^F+px_2^F\right)-\left[t_1V'T-\left(t_1x_1^{BC}+t_2x_2^{BC}\right)-t_1V'\left(T-\left(t_1x_1^F+t_2x_2^F\right)\right)\right]+\alpha h'\left(x_1^{BC}\right)-\alpha h'\left(x_1^F\right)=0 \quad (7)$$

Combining (3) and (6) yields

$$pU'\left(\varphi x_1^{BC}+px_2^{BC}+C\right)-pU'\left(x_1^F+px_2^F\right)-\left[t_2V'\left(T-\left(t_1x_1^{BC}+t_2x_2^{BC}\right)\right)-t_2V'\left(T-\left(t_1x_1^F+t_2x_2^F\right)\right)\right]+\alpha g'\left(x_2^{BC}\right)-g'\left(x_2^F\right)=0 \quad (8)$$

[3] The formalization employs one representative service for each of inside and outside the basket; these can be interpreted as composite services.

[4] The second order condition for the maximum is satisfied.

As we can see from (7) and (8), the directions of the changes in x_1 and x_2 depend on the relative magnitude of the change of marginal utility of income and leisure with respect to x_1 and x_2 given h and g are concave. Four cases follow based on the directions of each of two inequalities (we ignore equality as a case). The two questions can be written as:

$$\varphi U'\left(\varphi x_1^{BC} + p x_2^{BC} + C\right) - U'\left(x_1^F + p x_2^F\right) \gtrless t_1 V' \left(T - \left(t_1 x_1^{BC} + t_2 x_2^{BC}\right)\right) - t_1 V'\left(\mathrm{T} - \left(t_1 x_1^F + t_2 x_2^F\right)\right), \text{ and}$$

$$p U'\left(\varphi x_1^{BC} + p x_2^{BC} + C\right) - p U'\left(x_1^F + p x_2^F\right) \gtrless t_2 V' \left(T - \left(t_1 x_1^{BC} + t_2 x_2^{BC}\right)\right) - t_2 V'\left(\mathrm{T} - \left(t_1 x_1^F + t_2 x_2^F\right)\right).$$

If the left hand side of the first inequality is larger, then $x_1^{BC} > x_1^F$; otherwise the reverse is the case. Similarly, if the left hand side of the second is larger, then $x_2^{BC} > x_2^F$; otherwise the converse holds.

Not all cases are equally plausible. In this context, given that C is large and φ is small (10%, then increased to 15%) the left-hand side of the first inequality is unlikely to be larger in practice. The empirical research discussed above on "pure" capitation, when φ=0 and C is large, also suggests that the left side of the first inequality is smaller, and our blended model is similar inside the basket. In this context, we expect $x_1^F > x_1^{BC}$; that is, there will be a reduction in service provision inside the capitated basket. McGuire (2011) argues for a much larger φ to be employed, in which case the first inequality might be ambiguous.

In contrast, the second inequality is difficult to sign; indeed, it may plausibly go in alternative directions for different GPs depending upon the relative magnitudes of their marginal utilities of income and leisure, although our empirical analysis focusses on mean changes in service provision so cannot see this potential heterogeneity. Nothing can be said about aggregate service provision (i.e., the sum of x_1 and x_2) since if x_2 is positive it may exceed the decrease in x_1 if the relative change in the marginal utility of leisure is sufficiently small. The online Appendix makes stronger assumptions and provides sharper predictions.

Although this model focuses on rostering GPs, GPs in the same group face the same external incentives; therefore, the same model applies. GPs outside the rostering group may be members of one of a small number of payment models, with the two in this study being the largest. (See McLeod et al., 2016 for a quantification of sizes of the various models.) Ignoring models in remote/specific areas and clinics targeting disadvantaged groups, which in total represent an extremely small share of GPs, almost all GPs are in one of two situations. Either they are in one of two capitated models (the one under study or an earlier small/experimental model comprising less than 3% of GPs) and therefore see a limited number of patients on a FFS basis, or they are in enhanced or traditional FFS models facing FFS incentives. Since medically necessary physician services are paid out of general tax revenue in Canada with no direct cost to (and no negation for) the patient, there is nothing preventing patients from seeking out GPs beyond their rostering GP except for transactions costs and (potential) wait times. For the GP's outside the rostering group, they are guaranteed that all visits will be reimbursed and there is no penalty for providing services to patients enrolled with other GPs. Indeed, becoming aware that a patient is enrolled elsewhere would rely on the patient voluntarily providing that information.

Overall, we expect that patients will visit other GPs if they wish, with few access limitations. Indeed, there are a sufficient number of GPs working FFS in drop-in clinics that capacity constraints (in all but quite rural areas) are not serious for patients who put a modest effort into finding a GP other than their rostering GP. We, therefore, regard services by GPs outside the rostering group as facing traditional FFS incentives and we do not model their utility directly since it is well known.

To recap, for rostering GPs in the situation under study, we expect x_1 to decline while x_2 may increase or decrease depending upon the relative magnitudes of the marginal utilities of income and leisure. GPs in the same group as the rostering GP share the same incentives and so can be modelled similarly. GPs outside the rostering group are expected to act, in sufficient numbers, like traditional FFS GPs and treat all patients who approach them (perhaps with wait times).

4. Data

4.1. Data sources

Anonymized administrative databases from the Ontario Ministry of Health and Long-Term Care for the fiscal years 2006–2010 are employed in this study to generate a five-year GP-level panel.[5] Given Canada's universal public health care system, the claims database captures medical services provided by almost every physician in Ontario for almost all patients. (Key exceptions are members of the military and the national police force, and federal inmates.) Additionally, the enrollment database catalogues the official rostering relationship between primary care physicians and patients. The registered person database contains the age and sex of each resident, and the provider database lists the payment model of each physician and identifies group practices. By merging these databases, we can find the number and type of services provided by each GP in the province for each patient.

4.2. Study dataset

We select all primary care physicians affiliated with the enhanced FFS model as of 1 April 2006. Retaining those who stayed in that model or switched directly to the blended capitation model, we exclude physicians with "focused practices" (e.g. those working in sports medicine clinics) and those who did not provide primary care services every year. Patients in our dataset for analysis are those who were enrolled with the same doctor during the entire period, but were not resident in long-term care facilities since they have a smaller set of inside-the-basket fee codes than other patients. However, as a sensitivity test (not shown) we also perform the analysis including long-term care patients and the results do not change appreciably; results including those rostered part year are in an appendix. Table 2 shows that our subset of patients is not very different from the population based on their gender and age. Since the patients were continuously enrolled with the same GPs, they were transferred to the blended capitation model when their physicians switched. A slightly higher percentage of patients than physicians transferred to capitation as presented in Table 3.

5. Empirical framework

Given that we have five years of data, we estimate the effect of joining the blended capitation payment model using panel fixed-effects estimators, whereby we contrast, before and after the introduction of the blended capitation model, the FFS equivalent billings for continuously rostered patients of physicians who switched to the blended capitation model with those who remained in enhanced FFS. The dependent variable—FFS equivalent value of

[5] What we refer to as, for example, 2006 comprises data from April 1, 2006 to March 31, 2007. The analysis was approved by the Hamilton Integrated Research Ethics Board (#11-086-C).

Table 2
Characteristics of enrolled patients associated with physicians in the data in 2006.

	Patients consistently enrolled			All patients ever enrolled		
No. of patients	2,526,053			4,243,608		
	Mean	S.D.	I.Q.R	Mean	S.D.	I.Q.R
No. of patients per physician	1210	568	709	1795	824	1006
%male	0.46	–	–	0.45	–	–
Age	40.4	22.1	35.7	40.5	24.7	36.6

Note: I.Q.R refers to interquartile range, and S.D. to standard deviation.

Table 3
Distribution of patients and physicians by blended capitation across years.

	2006/07	2007/08	2008/09	2009/10	2010/11
% patients in blended capitation	0	5	25	37	47
% physicians in blended capitation	0	6	23	34	44

the services provided—is not the actual value of billings physicians received but the approved billings as if they were paid 100% FFS. This allows FFS and blended capitation to be compared using a common metric. Billing codes inside and outside the blended model's capitated basket are aggregated separately to allow contrasts on that key dimension. Further, for each GP's patients we explore billings by all GPs in the province using three mutually exclusive and exhaustive sub-groups: the rostering GP, other GPs in the same group practice, and those outside of that practice. This expansive analysis allows a much fuller picture of reactions across the entire "system" than is normally possible.

5.1. *Difference-in-differences fixed effect models with alternative dependent variables*

As is common in health economics, our dependent variables contain zeros and are skewed. We employ alternative tactics to address this issue. A first, relatively simple, approach (referred to as model A), adds \$1 to the dependent variables for all observations and then takes the natural logarithm. (Given the values in the left tail of the dependent variables, \$1 seems reasonable. However, we also experimented with adding five cents and the results did not change substantively). This leads to the model

$$ln(B_{ijt}+1) = \alpha_i + \gamma_t + \beta X_{it} + \rho\pi_{jt} + \delta BCap_{jt} + u_{ijt} \quad (9)$$

where B_{ijt} is the FFS equivalent billings of patient i who is rostered with general practitioner j in year t. The percentage of the year in which each physician is affiliated with blended capitation is denoted $BCap_{jt}$ (zero, when enhanced FFS; one, when blended capitation; and fractional, in the year of a switch); α_i is an individual patient fixed effect; γ_t is a year fixed effect; π_{jt} and X_{it} are vectors of time varying practice (e.g., a rurality index and roster size) and aggregate patient (e.g., average age and percent male) characteristics respectively; and u_{ijt} is an idiosyncratic error term clustered at the physician level. One noteworthy variable in X is an indicator that equals one in the transition year and allows us to isolate any transition year effects.

The second specification is a two-part model (model B). Part one is a panel logit model to estimate the probability that patients receive services.

$$Pr\left(B_{ijt} > 0|X_{it}, \gamma_t, \pi_{jt}, BCap_{jt}, \alpha_i\right) = F\left(\alpha_i + \gamma_t + \beta X_{it} + \rho\pi_{jt} + \delta BCap_{jt}\right) \quad (10)$$

where $F(.)$ is the logistic cumulative distribution function. The second part is a fixed effect model conditional on $B_{ijt} > 0$ where we estimate the effect of treatment on the value of services provided omitting the observations in which there is a zero value in the dependent variable:

$$lnB_{ijt} = \alpha_i + \gamma_t + \beta X_{it} + \rho\pi_{jt} + \delta BCap_{jt} + u_{ijt} \quad (11)$$

The third approach is to aggregate the patient-level billings to the physician level and then divide them by the number of patients continuously rostered with each GP over the five year period, which represents annual average billing per enrolled patient for each physician (model C). At the physician level, the model is:

$$ln\left(\frac{B_{jt}}{p_j}\right) = \tau_j + \gamma_t + \rho\pi_{jt} + \delta BCap_{jt} + u_{jt} \quad (12)$$

where p_j is the number of patients continuously rostered with physician j, and τ_j is physician j's fixed effect.

An extension to our base model provides greater flexibility by allowing a post-policy linear trend differential between the treated and comparison groups. The post-policy variable is to address the concern that physicians' behavior may evolve with time as they become more familiar with the new payment model.[6] This leads to models of the general form:

$$lnB_{ijt} = \alpha_i + \gamma_t + \beta X_{it} + \rho\pi_{jt} + \delta BCap_{jt} + \theta\left(t_{jt} * BCap_j\right) + u_{ijt} \quad (13)$$

where $t_{jt} = 0$ prior to each switch, and increments by one for each year after it. Rejecting the null hypothesis that θ equals zero provides evidence of a change in trend associated with the switch.

5.2. *Potential confounding issues and strategies to further mitigate bias*

5.2.1. *Misspecification and propensity score reweighting*

While the difference-in-differences fixed effect models control for unobserved time-invariant characteristics, we are concerned about potential misspecifications that could bias the estimates. Therefore, we employ a strategy sometimes called doubly robust estimation. That is, before contrasting the outcomes of the two groups we reweight GPs who remained in the enhanced FFS model by their probabilities (also called "propensity scores") of switching to the blended capitation model so that they have pre-policy change characteristics similar to those who switched to blended capitation. A comparison between those who switch and those who remain in enhanced FFS can be credibly interpreted as a causal impact of switching if the comparison group is a plausible counterfactual for the treated one. Thus the reweighted fixed effect models are more

[6] For example, as physicians become more familiar with the fee codes inside and outside the basket, they may submit more claims outside the capitated basket and adjust their behaviors to maximize their income in the blended capitation model.

robust to misspecification, thereby adding to the credibility of the estimates. This produces consistent estimates as long as at least one of the first stage propensity score or the second stage ordinary least squares (in this case a panel difference-in-differences fixed-effects specification) models is correctly specified (Wooldridge, 2002; Kralj and Kantarevic, 2013, provide an application).

To operationalize this we use a logit regression to estimate propensity scores, which are the conditional probability of participating in the blended model. That is:

$$p(x) = Pr(BC_{j,2010} = 1|X_{j,2006})$$

where $p(x)$ is the propensity score; $BC_{j,2010}$ is a binary variable and set to one if the rostering GP switched to blended capitation by the end of the period, zero otherwise; $X_{j,2006}$ includes variables that are regarded in the economics literature as important to make causal inference/interpretation plausible (see, e.g., Heckman et al., 1999). These include flexibly specified individual GP's characteristics and (usually aggregate) variables reflecting the physician's practice in the pre-policy period (i.e., 2006). We follow the guidelines by Imbens and Rubin (2015) recommending against excluding variables from propensity score estimation in the name of parsimony.

Additionally, we include in our propensity score estimation three important covariates. First, *expected income gain*, reflects the financial cost or benefit of the payment model switch holding practice style constant. This is similar to a variable employed by Kralj and Kantarevic (2013). It measures the difference in actual billings in 2006 when all physicians were in the enhanced FFS model to those that, counterfactually, would have been received under the blended capitation model. The provincial Ministry of Health provided the same calculation to physicians in this period to aid them in their decision-making, so this is a crucial conditioning variable. Second, geography is captured using the Rurality Index of Ontario (RIO), which defines 0 to be a dense urban area and 100 to be extremely remote. Finally, a set of six variables measure billings in 2006 for each GP's continuously rostered patients for services that under the blended capitation model will be inside or outside the capitated basket. These are paid to three categories of GPs: the rostering GP, those in the same group, and those outside the group. These measures are aggregated to the rostering GP regardless of which GP bills for them. As an alternative to the logit, we experiment with non-parametric estimation since it can sometimes provide improved performance (Frölich et al., 2015), but we found that it made little substantive difference in this context and was much more time consuming to estimate especially given the bootstrapping discussed below.[7]

In the reweighting (matching) step, we employ local linear regression to generate weights from the propensity scores for the comparison group. To ensure credible comparisons where covariates are better balanced, a common support condition is imposed as presented below. Although using both steps does not eliminate the need for the conditional independence assumption in order for the estimates to have a causal interpretation (i.e., there can be no unmeasured confounding variables – see Smith and Sweetman, 2016) they do improve our confidence in the estimates be they interpreted as causal or well controlled conditional relationships. An unmeasured variable that would undermine a causal interpretation would need to be time varying and correlated with the shift across payment models by different physicians in different years and we argue below that such variables are unlikely to be important.

Inference in all of these specifications is nonstandard since the weights are estimated. We, therefore, bootstrap the entire process of propensity score matching, weight generation, and model estimation. Also, the standard errors need to be clustered at the physician level since that is the level of decision-making. A bootstrap with asymptotic refinement is expected to provide better approximation leading to improved inference (Cameron and Trivedi, 2005). Therefore, we undertake a nonparametric percentile-t cluster bootstrap where each bootstrap replicate t-statistic is re-centered around the overall estimate.[8] Given that the specifications are time-consuming to estimate, 299 bootstrap replications are undertaken for models A and B, and 999 replications for model C. Although more replications do no harm, the minimum number of bootstrap replications was selected using the method of Davidson and MacKinnon (2004).

5.2.2. Other confounding issues

One common concern is potential data erosion in reporting of the services inside the basket following the shift to capitation. If physicians do not have to submit claims to be paid (such as in capitation or salary models), they may be less concerned with accuracy or cease submitting paperwork. However, since blended capitation physicians in Ontario must submit claims for services inside the basket to be paid the shadow billing premium, the accuracy and completeness of the billing submission is expected to be satisfactory.

Capitation payments were age and sex but not acuity adjusted, and the basket of codes included in the capitation payment represents a large proportion of services typically provided. For most of our study period, there were 119 fee codes in the capitated basket including, for example, general assessment, pre-dental/pre-operative general assessment, periodic oculo-visual assessment, allergy skin testing, intradermal/muscular injections, and family psychotherapy. Several new fee codes were added in September, 2011. It is, for the most part, a very predictable/stable set of tasks (Sweetman and Buckley, 2014). One complication for the quantitative analysis is that among the in-the-basket fee codes is a set of 20 for which the enhanced FFS model obtained a "comprehensive-care premium" for rostered patients that incentivized the provision of selected health assessments, preventive-care services, diagnoses and treatments. To make the two models comparable, and to focus on the switch to capitation rather than the loss of the premium, these fee codes are excluded in the main analysis for both models. However, the Appendix presents regressions including these codes and the results are qualitatively similar.

Some services not included inside the capitated basket tend to be infrequent, large and costly ones over which physicians arguably have little control, including services required by complex patients.

[7] The non-parametric propensity score estimator employed relies on local constant (Nadaraya-Watson) kernel regression. We use the kernel regression method of Racine and Li (2004), which allows for both continuous and discrete regressors and is implemented in the 'np' package of Hayfield and Racine (2008).

[8] In detail, we perform B bootstrap replications producing t-statistics $t_1^*, \ldots, t_B^*$, where $t_b^* = \frac{\left(\hat{\delta}_b^* - \hat{\delta}\right)}{s_{\hat{\delta}_b^*}}$ (i.e., the estimates t_b^* are centered around $\hat{\delta}$); $\hat{\delta}$ is the estimate of δ; $\hat{\delta}_b^*$ is the estimate in the bth bootstrap; $s_{\hat{\delta}_b^*}$ is the standard error of the estimate $\hat{\delta}_b^*$ and is calculated using the analytical cluster-robust standard error on the bootstrap re-sample. The empirical distribution of $t_1^*, \ldots, t_B^*$, ordered from the smallest to the largest, is then used to approximate the distribution of $t = \frac{\left(\hat{\delta} - \delta_o\right)}{s_{\hat{\delta}}}$. For a two-sided symmetric test of $H_0\!:\!\delta_o = 0$, the p-value is: $\frac{1}{B}\sum_{B}^{b=1} 1(|t| < |t_b^*|)$.

Table 4
Propensity scores logit estimates using fiscal year 2006/07 data.

Dependent Variable: Switch to Blended Capitation = 1; Remain enhanced FFS = 0				
Independent Variable	Coef.	S.E.	Odds ratio	S.E.
Characteristics of physicians				
Expected income gain x10^{-5}	0.39**	(0.19)	1.48**	(0.28)
(Expected income gain x10^{-6}) ^{2}	−0.10**	(0.05)	0.91**	(0.04)
(Expected income gain*Canadian Grad)x10^{-5}	0.33**	(0.16)	1.39**	(0.22)
(Expected income gain* %male)x10^{-5}	0.24	(0.15)	1.28	(0.19)
Age/100	−1.66	(5.11)	0.19	(0.97)
$(Age/100)^2$	−3.3	(5.20)	0.04	(0.19)
Male	−1.11*	(0.65)	0.33*	(0.21)
Male*age/100	2.53**	(1.26)	12.51**	(15.70)
Place of graduation-Canada	0.26**	(0.13)	1.3**	(0.16)
Place of graduation-USA	0.10	(0.97)	1.11	(1.08)
Place of graduation-UK	0.21	(0.25)	1.23	(0.31)
Characteristics of practice population				
RIO/100	0.62***	(0.10)	1.87***	(1.93)
$(RIO/100)^2$	−0.71***	(0.19)	0.49***	(0.96)
Daily no. of visits	−0.05***	(0.02)	0.95***	(0.02)
(Daily no. of visits/10)^2	0.07***	(0.02)	1.08***	(0.00)
%Working days annually	1.18	(2.74)	3.26	(8.93)
(%Working days annually)^2	−0.54	(1.97)	0.58	(1.14)
Group size/1000	0.69	(1.57)	1.98	(3.11)
(Group size/1000)^2	−0.57	(4.70)	0.57	(2.66)
Roster size/1000	1.24***	(0.39)	3.47***	(1.35)
(Roster size/1000)^2	−0.43***	(0.09)	0.65***	(0.06)
Patient age/10	0.02	(2.08)	1.02	(2.13)
Patient age/10)^2	−0.16	(0.10)	0.85	(0.09)
Patient%male	2.13	(2.86)	8.43	(24.14)
Patient%male^2	−2.72	(3.34)	0.07	(0.22)
Past outcomes (billings),2006/07				
Inside basket; rostering GP	−0.01*	(0.01)	0.99*	(0.01)
Inside basket; same group as rostering GP	−0.04	(0.05)	0.96	(0.05)
Inside basket; outside group	−0.04***	(0.01)	0.96***	(0.01)
Outside basket; rostering GP	−0.02***	(0.01)	0.98***	(0.01)
Outside basket; same group as rostering GP	0.01	(0.01)	1.01	(0.01)
Outside basket; outside group	−0.01***	(0.00)	0.99***	(0.00)
Constant	15.04	(17.58)		
Pseudo R-square	0.13			
Sample size	2540			

Note: ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels respectively. Daily number of visits represents the average number of patient visits per calendar day. Group size represents the number physicians in a practice group.

Also outside the basket are many preventative care services, such as diabetes management, where the service-reducing incentives associated with capitation are undesirable. Almost all fee-codes outside the basket are common to the enhanced FFS and blended capitation models, except for a small number of incentive payments for blended capitation physicians.[9] To ensure the results are not affected by these differences, we have done the analysis both excluding and including relevant fee codes with the former in the main text and the latter in appendices. They are qualitatively similar.

6. Results

6.1. Propensity scores

Table 4 shows the logit model estimates used to generate the propensity scores, where the dependent variable is an indicator for switching to the blended capitation model by the end of the sample period. Physicians who switched are more likely to be female, practice in rural areas, have a higher expected income gain and fewer daily visits. Importantly, pre-reform billing patterns and the income gain variable are crucial for causal identification.

The distribution of propensity scores for physicians who switched to the blended capitation model (above the x-axis in Fig. 1) skews to the right while that of those who stay in enhanced FFS (below the x-axis) skews to the left, indicating that physicians who switched to the blended capitation model are more likely to have high propensity scores. While there is appreciable overlap, to ensure common support, we trim the top 5% of observations in the treated group. Experiments with other trimming values, and various specifications, are presented in the online appendix; the results remain quite stable.

6.2. Summary statistics

The unadjusted characteristics of GPs who stay in enhanced FFS are statistically and economically significantly different from those who switch to blended capitation. In Table 5, the asterisks represent p-values from *t*-tests for equality of means in the treatment (after trimming) and comparison groups. Crucially, those GPs who switch models have dramatically higher expected income gains from switching and practice in more rural areas. They also have fewer daily patient visits and work in smaller groups than the comparison physicians. Once matching and weighting are undertaken, however, the comparison physicians are quite similar to the treatment ones on the pre-treatment covariates and outcomes, with no

9 Blended capitation physicians are eligible for three incentives not available to enhanced FFS GPs. If in a rural area, they receive bonuses of $5000 or $7500 for billing for hospital services in excess of $2000. They also receive $2000 for providing prenatal care to five or more enrolled patients, and $2000 for billing at least $1200 for in-office clinical procedures.

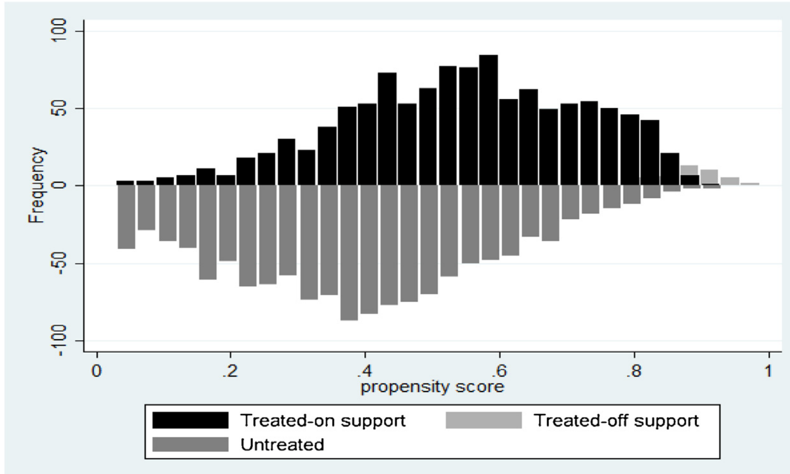

Fig. 1. Distribution of physicians' estimated propensity scores.

statistically significant differences except for the rostering size.[10] Overall, propensity score matching effectively eliminates pretreatment imbalances in our data by reweighting.

Comparing the treatment and weighted comparison groups, and services inside and outside of the capitated basket, the lower portion of Table 5 presents weighted and unweighted mean billings in 2006 along with their values at the 25th, 50th and 75th percentiles. Fig. 2 visualizes the trends in weighted average billings. The upper left of Fig. 2 shows FFS equivalent billings of patient visits with all GPs in the province. The remaining plots decomposed this into three exhaustive and mutually exclusive groups: the patient's rostering physician, GPs in the same group practice, and GPs outside the rostering physician's group. At the beginning of the sample period, the averages for treatment and comparison physicians are similar. Over time, the FFS equivalent billings of patients in blended capitation who visit any primary care physician in Ontario for services inside the basket (upper left) declines compared to that of patients enrolled with enhanced FFS physicians. The aggregate decrease comes from services provided by rostering physicians and other GPs in the rostering group. In contrast to services inside the capitated basket, the FFS equivalent billings of patients in blended capitation who visit their rostering physician for outside the basket services (upper right) increase compared to patients enrolled with enhanced FFS physicians.

6.3. *Main results*

Panel A in Table 6 presents the coefficients of interest for services inside the basket. The coefficients represent the percent change in billings; the exponentiated coefficients represent changes in the odds of patients having at least one visit. Models A and B are from the patients' perspective, and model C is aggregated to the physician level. Percentile-t bootstrapping with asymptotic refinement does not produce standard errors but only p-values and these are presented in the form of asterisks on the coefficients and in parentheses in the second row beneath each coefficient. However, many economists like to look at standard errors, so nonparametric bootstrapped standard errors are presented in the upper parentheses in this and comparable tables. While the percentile-t is more reliable, in this case the two rarely differ appreciably in terms of rejecting the null hypothesis at conventional levels.

The first row of Table 6 suggests that switching to capitation has an appreciable negative impact on average total FFS-equivalent billings by all primary care physicians – on the order of 12–19 percent.[11] Breaking this down in subsequent rows, we find that switching to the blended capitation model leads to a drop in the value of inside the basket services provided by the rostering physician. Across the various specifications, a statistically significant drop in billings by other physicians in the rostering group is also observed in models B and C, although the change is not statistically significant in model A. Notably, the value of services inside the basket supplied by physicians outside the rostering group decreases as well for all models.

Panel B in Table 6 tells a complementary story. In contrast to the inside the basket results, total billings for services outside the basket increase slightly as seen in the first row. All three models suggest that almost all of this increase is driven by the rostering physician. However, for non-rostering physicians in the rostering group practice the results are interesting. Both model A and model C show no significant change in billings. Model B, the two-part model, decomposes this into two effects: an insignificant change in the likelihood of seeing patients rostered with other GPs in the practice but, conditional on a patient visit, the billing code is more likely to be outside the basket. Turning to physicians outside of the rostering group, there are 3–5 percent decreases for models A and C. Model B shows that this is attributable to a decline in the likelihood of seeing patients rostered with physicians outside the group rather than a decline in service provision conditional on a visit.

As for the total billings, the sum of those inside and outside the basket, in all three empirical specifications we observe a decline for the rostering physician as presented in the online appendix, and the same is true for GPs in the same group as the rostering physician, and also physicians outside of the rostering group. One goal of rostering/capitation and the access bonus (i.e., negation) is to improve continuity of care by concentrating primary care services for each patient with a particular group practice that has shared record keeping. This seems to have occurred in the sense that billings by those outside the group decreased.

[10] The difference in roster sizes is only statistically different from zero at the 10% level. Given the number of variables in the regression, the probability of having at least one difference that is nonzero at the 10% level by random luck is high.

[11] This reduction reflects the value of services provided using FFS prices and not the remuneration received by blended capitation physicians.

Table 5
Characteristics before switch for the treatment and comparison groups on various parts of distribution.

	Treated group (blended capitation)				Comparison (enhanced FFS)								Equal means	
		Weighted				Unweighted				P-values				
	Mean	Median	25%	75%	Mean	Median	25%	75%	Mean	Median	25%	75%	Before weighted	After weighted
Number of physicians	1114				1114				1368					
Characteristics of physicians														
Expected income gain	29,000	30,700	−6100	63,200	27,300	28,100	−5000	61,800	−8100***	1143	−47,700	40,800	0.000	0.570
%Male physicians	65.4				65.0				66.7				0.669	0.871
Age	49.5	50.6	44.0	56.9	49.6	50.7	44.0	57.2	51.2***	52.6	45.4	58.8	0.000	0.922
RIO (rural index of Ontario)	6.9	2.0	0.0	7.0	7.8	2.0	0.0	7.0	3.7***	0.0	0.0	3.0	0.000	0.116
%working days annually	69.3	69.3	63.0	76.2	69.8	69.0	62.7	77.3	70.1	69.9	63.3	77.8	0.272	0.396
Daily visits	34.3	32.7	25.6	41.2	33.9	32.7	25.4	40.4	36.1***	34.4	26.9	43.4	0.002	0.340
Group size	51.6	25	12.0	47.0	53.6	23.0	11.0	59.0	62.8***	26.0	12.0	61.0	0.000	0.528
Years of practice	20.2	21.3	15.3	28.3	20.2	21.3	15.3	28.2	21**	22.3	15.3	29.3	0.019	0.949
%place of graduation-Canada	83.4				83.7				72.7***				0.000	0.836
%place of graduation-USA	0.2				0.2				0.3				0.529	0.862
%place of graduation-UK	3.4				3.2				4.1				0.312	0.805
%place of graduation-other	13.4				13.3				23***				0.000	0.904
Characteristics of practice population														
Roster size	1508	1416	1061	1838	1466*	1369	1056	1797	1505	1368	1006	1842	0.667	0.087
%Male patients	44.2	47.9	35.0	51.6	44.3	48.0	34.7	52.3	44.5	48.6	35.0	52.3	0.634	0.830
Age	40.7	40.5	36.6	44.8	40.9	40.5	36.4	45.2	40.1***	39.6	35.5	44.2	0.004	0.585
%Patients age <19	22.8	22.4	17.1	28.7	22.7	22.1	16.8	27.8	23.1	23.0	16.9	28.9	0.485	0.662
%Patients age [19,39)	24.5	23.2	20.0	27.0	24.4	23.6	20.3	27.4	25.4***	24.8	21.2	28.8	0.000	0.657
%Patients age [39,59)	31.3	31.2	28.5	33.7	31.4	31.4	28.7	33.9	31.4	31.5	28.5	34.3	0.389	0.721
%Patients age [59,79)	17.1	16.5	11.8	21.9	17.2	16.4	11.6	22.3	16.3***	15.0	10.8	20.8	0.003	0.654
Past outcomes (FFS equivalent billings, 2006/07)														
Inside the basket, the rostering GP	126,000	118,900	80,909	163,400	127,000	116,900	80,500	163,000	135,000***	121,973	82,800	174,500	0.000	0.755
Inside the basket, in the same group of the rostering GP	7000	490	1800	10,100	8000	4700	1700	10,300	7000	4142	1500	9700	0.281	0.504
Inside the basket, outside the group	24,000	21,000	13,200	30,600	24,000	21,000	13,900	30,300	28,000***	23,076	15,300	34,300	0.000	0.231
Outside the basket, the rostering GP	13,000	10,400	6000	16,800	13,000	9900	6100	16,600	13,000	9967	5900	17,000	0.820	0.591
Outside the basket, in the same group of the rostering GP	4000	2100	700	4900	4000	2000	700	4900	3000***	1407	500	3500	0.000	0.637
Outside the basket, outside the group	39,000	34,200	23,500	49,200	39,000	33,700	22,900	48,400	38,000	33,136	22,400	47,700	0.444	0.651

Note: Billings are rounded up to hundreds for confidentiality. The asterisks represent *t*-tests for equality of means in the treatment and comparison groups. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels respectively. The unweighted column shows values across various parts of the distribution of the original dataset; the weighted column shows weighted values based on propensity scores combined using local linear regression with a bandwidth of 0.1.

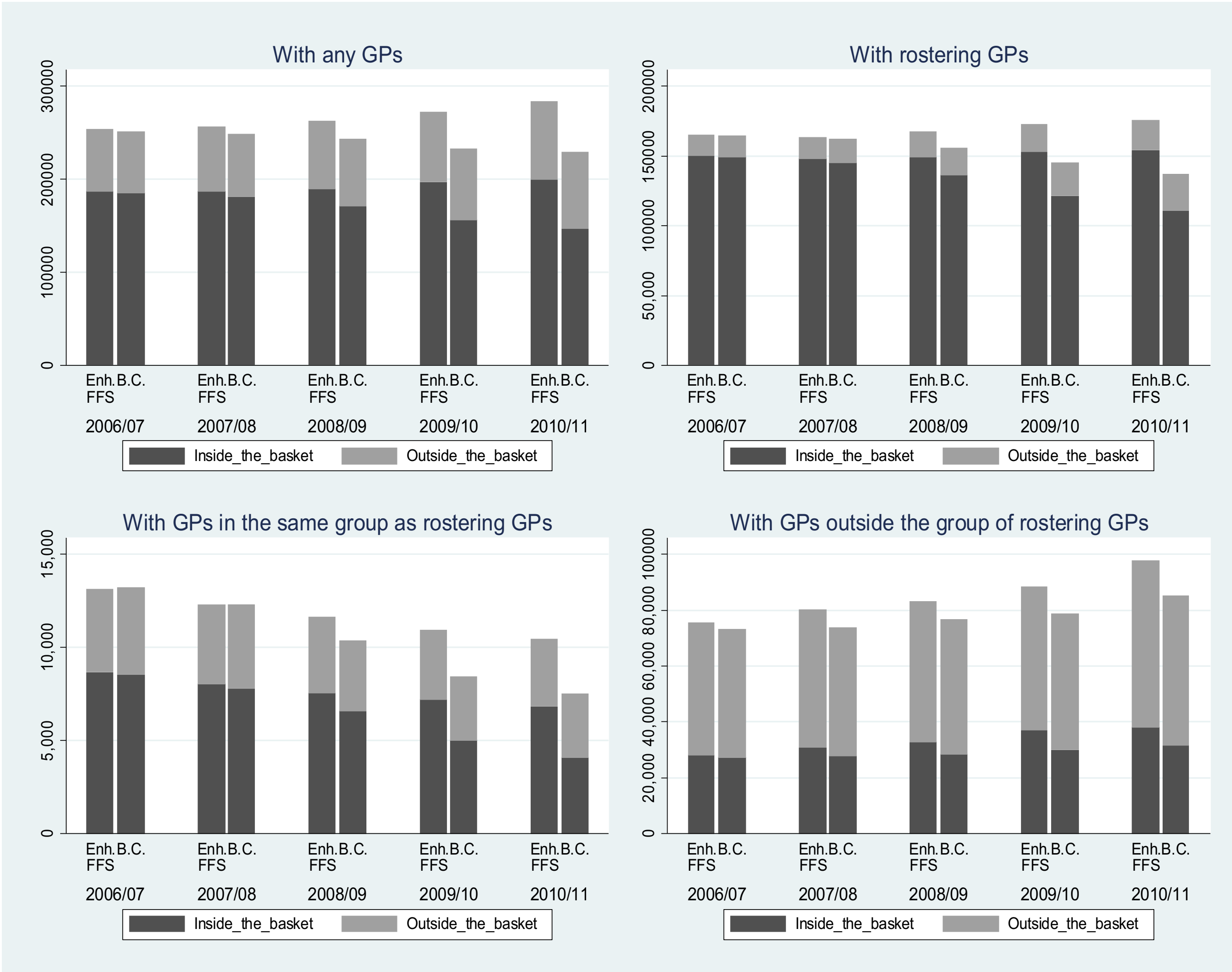

Fig. 2. Weighted FFS equivalent billings *inside* and *outside* the blended capitation basket.
Note: This figure presents the associated mean values of FFS equivalent billings for services inside and outside the capitated basket of GPs in the treated and comparison groups. Weights generated from the propensity scores are employed for the comparison group. "B.C." refers to the treated physicians who join the blended capitation model. "Enh. FFS." Refers to physicians who stay in the enhanced FFS model.

6.4. Potential heterogeneous responses by physician transition cohort

Differences in the impacts of switching might result if early switchers are systematically different from those who move to capitation later – after seeing it to be more remunerative. Perhaps early switchers are more philosophically attuned to capitation and have different reactions than those who switch later. Panel A in Table 7 shows the effect of blended capitation on FFS equivalent billings inside the basket by transition year using the aggregate model, while panel B shows services outside the basket. We also explored the results using models A and B and they have patterns consistent with Table 7. Overall, Table 7's results show that the pattern in Table 6 is broadly consistent across cohorts – although precision is reduced. The main substantive difference from Table 6 is that for later cohorts of switchers patients experience no statistically significant change in services by physicians in the same group as the rostering physicians, and the reduction in the services outside the group becomes statistically insignificant for the last cohort. Of course, post-switching trends may influence the interpretation of these coefficiente.

6.5. Differential trend extension

Results for the two key coefficients from regression models allowing differential trends after switching, Eq. (13), are presented in the right hand side two columns of Table 8. To facilitate comparisons, the leftmost column replicates the results in Table 6. Rejecting the null hypothesis that the trend coefficient equals zero provides evidence that the response to the adoption of capitation evolves over time. As with Table 7, we present results for the aggregate model (model C), but examined all three specifications and the findings are consistent. Overall, there appear to be strongly statistically significant declining trends for services inside the basket as GPs learn and adjust their practice patterns to the new payment model. For services outside the capitated basket, the pattern is more complex. For total service provision and for physicians outside the rostering group we see declining trends after initial increases (with a small average increase for GPs outside the rostering group). On average rostering GPs increase their billings outside the basket appreciably, with a small negative and not statistically significant subsequent trend. For physicians in the same group as the rostering GP neither the intercept nor the slope coefficients are statistically

Table 6
Effect of switching to the blended capitation model on FFS equivalent billings.

	(1) Model A: Costs including zeros	(2) Model B: Costs 0/1, then costs | costs > =1		(3) Model C: Aggregated at GP level
	Coef.	Exp. (coef.)	Coef.	Coef.
Panel A:Effect of switching to the blended capitation model on FFS equivalent billings*inside*the basket				
Ln(B), all GPs in Ontario	−0.120***	0.810***	−0.112***	−0.192***
S.E.	(0.008)	(0.015)	(0.010)	(0.012)
P-value	(0.000)	(0.000)	(0.000)	(0.000)
Ln(B), rostering GP	−0.090***	0.808***	−0.114***	−0.144***
S.E.	(0.008)	(0.019)	(0.013)	(0.012)
P-value	(0.000)	(0.000)	(0.000)	(0.000)
Ln(B), same group as rostering GP	−0.014	0.794***	−0.073**	−0.108***
S.E.	(0.003)	(0.049)	(0.028)	(0.010)
P-value	(0.247)	(0.000)	(0.023)	(0.000)
Ln(B), GPs outside the group	−0.039***	0.862***	−0.029***	−0.201***
S.E.	(0.005)	(0.019)	(0.009)	(0.019)
P-value	(0.003)	(0.000)	(0.000)	(0.000)
Panel B:Effect of switching to the blended capitation model on FFS equivalent billings*outside*the basket				
Ln(B), all GPs in Ontario	0.050***	1.024**	0.073***	0.032***
S.E.	(0.009)	(0.012)	(0.009)	(0.008)
P-value	(0.000)	(0.030)	(0.000)	(0.000)
Ln(B), rostering GP	0.100***	1.103***	0.153***	0.223***
S.E.	(0.010)	(0.021)	(0.013)	(0.016)
P-value	(0.000)	(0.000)	(0.000)	(0.000)
Ln(B), same group as rostering GP	0.001	0.990	0.131***	−0.010
S.E.	(0.007)	(0.037)	(0.018)	(0.019)
P-value	(0.987)	(0.746)	(0.000)	(0.602)
Ln(B), GPs outside the group	−0.032**	0.952***	−0.006	−0.053***
S.E.	(0.007)	(0.011)	(0.008)	(0.009)
P-value	(0.037)	(0.000)	(0.428)	(0.000)
Patients fixed effects	Yes	Yes	Yes	No
GP fixed effects	No	No	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes

Note: Nonparametric bootstrapped standard errors (above) and percentile-t bootstrapped p-values (below) are in parentheses. The significance levels illustrated by asterisks are percentile-t bootstrapped: ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels respectively. B represents FFS equivalent billings. Model A adds $1 to the dependent variables and Model B is a two-part model; for both the standard errors are clustered at the patient level; Model C aggregates the billings to, and is clustered at, the GP level. Exp(coef.) is short for the exponentiated coefficient. All specifications control for: the percent of male patients, roster size, average age of patients, the practice's rurality index, average daily patients visits, GP's annual working days, group size, year dummies and quadratic terms of all continuous variables.

different from zero. There is evidence of gradually improving continuity of care – i.e., an increasing share of services is provided by the rostering GP – and of physicians under blended capitation evolving their practice/billing patterns over time in response to the new payment model. Perhaps learning is occurring.

6.6. Heterogeneous responses by practice style and demographics

Subgroup analyses are presented in Table 9. Again, results from the aggregate model (i.e., model C) are presented, but the other two models are similar. Services inside the basket are presented in the uppermost panel and those outside the basket are below. In each subsample, we observed changes consistent with the theoretical model presented above and as reported in Table 6. The first comparison is of physicians grouped by their pre-switching expected income gain. In both panels, the coefficients for GPs other than the rostering GP are remarkably similar for the two income gain groupings. However, those rostering GPs whose pre-existing practice style was consistent with higher expected income gains change their billing patterns statistically and economically significantly less than do physicians with lower expected income gains. This coincides with the idea that those with larger benefits from changing their billing pattern make larger changes. Compared to females, rostering male physicians appear to have larger average behavioural responses targeted at increasing their gross billings under the new system, as seen primarily for outside the basket billings. Across age groups we see very few if any differences.

7. Discussion and conclusions

For rostering GPs, we observe a decline in FFS equivalent billings inside the capitated basket (a decline in both the number of visits and billings per visit) and an increase outside the basket (again, on both the extensive and intensive margins). With respect to our model this suggests that, as expected, the change of marginal utility of leisure dominates that of income with respect to inside the basket services which have a very low remuneration rate. For services outside the basket, the change in the marginal utility of income dominates that of leisure; these GPs appear not to be on the backward bending portion of their labour supply curves. The magnitude of the observed effects is economically significant, far from trivial, but not implausibly large.

Total FFS equivalent billings decline (which is not to say that total income declines given the capitation and incentive payments). This is consistent with the shift from the overprovision associated with traditional FFS. Some of the reduction in services may follow from changes in practice style that many patients would view as beneficial. Further research is needed to explore these issues, but one example of such a change is that in a FFS environment patients may be more likely to be asked to return to see the physician to obtain test results (and the physician bills for the visit), whereas under capitation a nurse or administrator may phone the patient with the results and a follow-up visit scheduled only if it is required. If this were the case, assuming that test results are actually checked, it would likely represent an improved use of clinical resources

Table 7
Impact of switching by cohort using Model C.

	2007/08 cohort	2008/09 cohort	2009/10 cohort	2010/11 cohort
	Coef.	Coef.	Coef.	Coef.
Panel A:Impact on services *inside* the basket				
Ln(B), all GPs in Ontario	−0.219***	−0.199***	−0.179***	−0.138***
S.E.	(0.023)	(0.015)	(0.019)	(0.030)
P-value	(0.000)	(0.000)	(0.000)	(0.000)
Ln(B), rostering GP	−0.105***	−0.143***	−0.169***	−0.128***
S.E.	(0.030)	(0.015)	(0.021)	(0.033)
P-value	(0.002)	(0.000)	(0.000)	(0.000)
Ln(B), same group as rostering GP	−0.160***	−0.100***	−0.091***	−0.131***
S.E.	(0.027)	(0.013)	(0.015)	(0.027)
P-value	(0.000)	(0.000)	(0.000)	(0.000)
Ln(B), GPs outside the group	−0.279***	−0.209***	−0.170***	−0.098**
S.E.	(0.034)	(0.024)	(0.030)	(0.044)
P-value	(0.000)	(0.000)	(0.000)	(0.028)
Panel B:Impact on services *outside* the basket				
Ln(B), all GPs in Ontario	0.024	0.027**	0.030**	0.095***
S.E.	(0.017)	(0.011)	(0.013)	(0.024)
P-value	(0.122)	(0.013)	(0.026)	(0.000)
Ln(B), rostering GP	0.160***	0.234***	0.236***	0.220***
S.E.	(0.034)	(0.020)	(0.028)	(0.048)
P-value	(0.000)	(0.000)	(0.000)	(0.000)
Ln(B), same group as rostering GP	0.099**	−0.024	−0.041	−0.005
S.E.	(0.046)	(0.026)	(0.030)	(0.052)
P-value	(0.034)	(0.306)	(0.204)	(0.967)
Ln(B), GPs outside the group	−0.041**	−0.059***	−0.070***	0.038
S.E.	(0.021)	(0.012)	(0.014)	(0.024)
P-value	(0.036)	(0.000)	(0.000)	(0.155)

Note: Nonparametric bootstrapped standard errors (above) and asymptotic refined percentile-t bootstrapped p-values (below) are in parentheses. The significance levels shown in the table illustrated by asterisks are ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels respectively. B represents FFS equivalent billings. Each fiscal year cohort represents physicians who switched to the blended capitation model during that year. Coef. is short for coefficient. All specifications control for: the percent of male patients, roster size, average age of patients, the practice's rurality index, average daily patients visits, GP's annual working days, group size, year dummies and quadratic terms of all continuous variables.

Table 8
Effect of switching by differential trend.

	No time trend	With a linear time trend	
	DID	DID	Linear trend
	Coef.	Coef.	Coef.
Panel A: Effect on services *inside* the basket by differential trend			
Ln(B), all GPs in Ontario	−0.192***	−0.143***	−0.058***
S.E.	(0.012)	(0.021)	(0.022)
P-value	(0.000)	(0.000)	(0.005)
Ln(B), rostering GP	−0.144***	−0.102***	−0.050*
S.E.	(0.012)	(0.024)	(0.027)
P-value	(0.000)	(0.000)	(0.082)
Ln(B), same group as rostering GP	−0.108***	−0.077***	−0.037**
S.E.	(0.010)	(0.016)	(0.016)
P-value	(0.000)	(0.000)	(0.029)
Ln(B), GPs outside the group	−0.201***	−0.130***	−0.084**
S.E.	(0.019)	(0.031)	(0.034)
P-value	(0.000)	(0.000)	(0.018)
Panel B: Effect on services *outside* the basket by differential trend			
Ln(B), all GPs in Ontario	0.032***	0.097***	−0.078***
S.E.	(0.008)	(0.015)	(0.016)
P-value	(0.000)	(0.000)	(0.000)
Ln(B), rostering GP	0.223***	0.268***	−0.053
S.E.	(0.016)	(0.034)	(0.038)
P-value	(0.000)	(0.000)	(0.177)
Ln(B), same group as rostering GP	−0.010	−0.011	0.002
S.E.	(0.019)	(0.033)	(0.036)
P-value	(0.602)	(0.755)	(0.991)
Ln(B), GPs outside the group	−0.053***	0.038**	−0.108***
S.E.	(0.009)	(0.017)	(0.018)
P-value	(0.000)	(0.035)	(0.000)

Note: Nonparametric bootstrapped standard errors (above) and asymptotic refined bootstrapped p-values (below) are in parentheses. The significance levels shown in the table are percentile-t bootstrapped: ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels respectively. B represents FFS equivalent billings. Coef. is short for coefficient. All specifications control for: the percent of male patients, roster size, average age of patients, the practice's rurality index, average daily patients visits, GP's annual working days, group size, year dummies and quadratic terms of all continuous variables.

Table 9
Effect of switching by subgroups.

	Ln(B), all GPs in Ontario			Ln(B), rostering GP			Ln(B), same group as rostering GP			Ln(B), GPs outside the group		
	Coef.	S.E.	P-value	Coef.	S.E.	P-value	Coef.	S.E.	P-value	Coef.	S.E.	P-value
Panel A: Effect on services *inside* the basket												
Baseline	−0.192***	(0.012)	(0.000)	−0.144***	(0.012)	(0.000)	−0.108***	(0.010)	(0.000)	−0.201***	(0.019)	(0.000)
Expected income gain in 2006												
Above median	−0.176***	(0.015)	(0.000)	−0.115***	(0.015)	(0.000)	−0.107***	(0.015)	(0.000)	−0.195***	(0.026)	(0.000)
Below median	−0.227***	(0.020)	(0.000)	−0.206***	(0.022)	(0.000)	−0.117***	(0.017)	(0.000)	−0.206***	(0.030)	(0.000)
Physician gender												
Male	−0.192***	(0.015)	(0.000)	−0.150***	(0.014)	(0.000)	−0.094***	(0.012)	(0.000)	−0.215***	(0.024)	(0.000)
Female	−0.192***	(0.024)	(0.000)	−0.132***	(0.024)	(0.000)	−0.130***	(0.018)	(0.000)	−0.183***	(0.034)	(0.000)
Physician age group												
0–44	−0.200***	(0.018)	(0.000)	−0.146***	(0.018)	(0.000)	−0.120***	(0.015)	(0.000)	−0.202***	(0.028)	(0.000)
45–59	−0.187***	(0.019)	(0.000)	−0.150***	(0.020)	(0.000)	−0.110***	(0.017)	(0.000)	−0.200***	(0.031)	(0.000)
60+	−0.178***	(0.033)	(0.000)	−0.134***	(0.027)	(0.000)	−0.074***	(0.031)	(0.003)	−0.173***	(0.051)	(0.000)
Panel B: Effect on services *outside* the basket												
Baseline	0.032***	(0.008)	(0.000)	0.223***	(0.016)	(0.000)	−0.010	(0.019)	(0.602)	−0.053***	(0.009)	(0.000)
Expected income gain in 2006												
Above median	0.023**	(0.010)	(0.023)	0.172***	(0.018)	(0.000)	−0.038	(0.025)	(0.106)	−0.039***	(0.013)	(0.000)
Below median	0.053***	(0.015)	(0.002)	0.297***	(0.028)	(0.000)	0.003	(0.032)	(0.746)	−0.065***	(0.014)	(0.000)
Physician gender												
Male	0.033***	(0.011)	(0.004)	0.253***	(0.022)	(0.000)	0.008	(0.024)	(0.758)	−0.072***	(0.012)	(0.000)
Female	0.026**	(0.013)	(0.042)	0.159***	(0.023)	(0.000)	−0.041	(0.032)	(0.177)	−0.019	(0.015)	(0.206)
Physician age group												
0–44	0.026***	(0.012)	(0.000)	0.192***	(0.020)	(0.000)	−0.033	(0.028)	(0.224)	−0.050***	(0.013)	(0.001)
45–59	0.043**	(0.014)	(0.014)	0.241***	(0.028)	(0.000)	−0.001	(0.032)	(0.434)	−0.054***	(0.014)	(0.002)
60+	0.020	(0.025)	(0.918)	0.235***	(0.049)	(0.000)	0.027	(0.049)	(0.357)	−0.072**	(0.028)	(0.024)

Note: Nonparametric bootstrapped standard errors, and asymptotically refined bootstrapped p-values, are in parentheses. The significance levels shown are percentile-t bootstrapped. All specifications control variables are the same as above.

(increased productivity) and a reduction in transactions costs to patients.

For non-rostering physicians in the same group as the rostering physician, we find that patients obtain fewer services inside the capitated basket, as expected, and fewer visits with billings outside the basket but higher billings conditional on a visit. The contrasting outside the basket results relative to rostering GPs is hard to interpret in the confines of our model (though billings do go up conditional on a visit). Possibly, the transactions costs of sharing the capitation payment and/or bonuses among physicians in the rostering group induces the reduced number of visits. This seems to go against a key goal of group practice which is that patients be jointly cared for by group members, but since visits to physicians outside the group also decline other interpretations are possible. More postively, the reductions in the number of visits to non-rostering GPs in the rostering group may reflect the time made available to rostering GPs by the reduction in service provision inside the capitated basket combined with patients' preferences for their rostering GP.

There are reductions in billings both inside and outside of the capitated basket for physicians outside the rostering group. Since patients are able to book appointments with other physicians without cost or penalty, this implies that they either feel an obligation to visit the capitated physician with whom they are rostered, that rostering GPs are providing faster service, or that the rostering physician is by some means inducing a reduction in visits to other GPs compared to what would otherwise occur. Such reductions are the goal of the access bonus and are in line with the improved continuity of care associated with a medical home as long as patients are not being diverted to emergency room care.

An important and obvious question for future research is why we observe an increase in services outside the basket for the rostering physician and to a lesser extent those in the same practice conditional on a visit. There are several potential non-exclusive explanations. Firstly, since empirical studies suggest that the income effect of physicians' labor supply in Ontario is small (Kantarevic et al., 2008), physicians could manipulate service reporting to their advantage. This is a phenomenon closely related to what is sometimes called up-coding under activities based payment. Empirical studies find substantial evidence of up-coding. Silverman and Skinner (2004) find that one-third of the change in Medicare's case-mix index between 1986 and 1987 was due to up-coding, and Carter et al. (1990) find up-coding in hospitals treating Medicare patients between 1989 and 1996. Additionally, since preventive care and chronic disease management fee codes are largely outside the capitated basket, and many are associated with pay-for-performance incentives and bonuses, any reduction in low medical value codes in the capitated basket because of a switch away from FFS's incentives allows time for additional preventative care outside the basket. However, in the Appendix we identify fee-codes associated with several categories of preventive care and find no obvious shift to preferentially providing preventative care services.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.jhealeco.2018.03.002.

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