Three Essays on Health and Pension Economics

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By

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Abstract

This thesis comprises two essays in health economics, and one on pension economics. The first two essays use the institutional changes (mainly physician payment changes) of primary care reform in Ontario to study the impact of financial incentives on physician behavior and continuity of care. Specifically, we focus on two major primary care physician/General Practitioner (GP) payment model transitions in the reform: from traditional fee-for-service (FFS) to the enhanced FFS (referred as the first transition), and from enhanced FFS to blended capitation (referred to as the second transition). The first essay uses the second transition as a quasi-natural experiment and explores how the payment structure in the blended capitation model influences the provision of healthcare services by GPs and their practice groups. The second essay uses the first and second transitions to examine the association between continuity of care and patient rostering that is incentivized by premiums and bonuses in the enhanced FFS and the blended capitation model. The last chapter diverges from this topic and addresses one aspect of social insurance, namely pensions in China; it assesses how internal migrants and locals differ in terms of the pension contributions they make and the benefits they receive under the national policies that were recently introduced to reduce the fragmentation of the pension operations.

The first chapter examines the switch in physician payment system from FFS to the blended capitation-FFS model on GPs' billing behavior within a group practice. There are multiple dimensions of payment blending in the blended capitation model: first, a blend of

capitation for services inside the capitated basket, which are quite commonly employed and represent a large proportion of the services offered by GPs, and FFS for services outside the basket; second, a blend of capitation and less than full-cost FFS payment for services inside the capitated basket; third, a blend of different payment mechanisms for rostering and non-rostering patients funded under blended capitation or traditional FFS ; fourth, a blend of pay for performance, capitation and FFS (Sweetman and Buckley, 2014). We provide both a theoretical model examining the provision of care inside and outside the capitated basket and an associated econometric analysis using comprehensive administrative data, and the second transition in primary care reform as a quasi-natural experiment. We construct a panel of continuously rostered patient-GP pairs and employ a propensity score weighted difference-in-differences approach to identify the impact of a change in the GPs' remuneration model on the shifting of services across payment categories which are created by multiple blending dimensions. Consistent with the theory presented, rostering GPs provide fewer capitated services and simultaneously more FFS services. Other GPs within the rostering group reduce service provision within the capitated basket, with no change in FFS services. All other GPs in Ontario have relative reductions, both inside and outside the basket, which is consistent with GPs concentrating their primary care with rostered patients as a result of the introduction of the capitation payment model.

The second chapter examines the impact of rostering on continuity of care, as measured indirectly by various indices, from both patients' and GPs' perspectives. The empirical analysis consists of two transitions, and three payment models with different 'levels' of rostering: traditional FFS has no rostering; enhanced FFS is termed as 'weak' rostering; blended capitation is termed ‘strong’ rostering. Estimation using propensity score weighted difference-in-differences with fixed effects is used in both transitions to identify the impacts of different ‘levels’ of rostering. Our results show that the strong patient rostering indeed strengthens the bond between patients and GPs in the second transition. Furthermore, GPs in the blended capitation model can also be combined with interdisciplinary teams to form Family Health Teams (FHTs). The FHT model performs better than the blended capitation model alone in keeping rostered patients within the rostering practice. However, we don’t find a significant increase of the continuity of care indices in the first transition, which is probably due to the rostering incentives behind enhanced FFS.

The third chapter examines how the recent reforms to improve pension portability affect the relative pension treatment of migrants compared to locals in China. Using simulation methods, we compare how residents who differ in terms of their *hukou*, a record of household residence registration, and in their productive characteristics and geographic locations are treated by the pension system in one municipality. Shenzhen in the province of Guangdong is chosen as a representative developed urban city in China. Our results show that, even after recent reforms, migrants fare poorly compared to locals with *hukou*; migrants who transfer to another urban pension plan are likely to experience larger reductions in benefits than migrants who retired and remained in Shenzhen; the least benefits go to migrants who have contributed to urban plans for less than 15 years and hence have coverage only under the County and Rural Residents’ Plan. We also find that the pension replacement rate is inversely associated with income level and positively associated with the age of retirement.

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Preface

Chapter 1 is co-authored with Professor Arthur Sweetman. Chapter 2 is co-authored with Professor Arthur Sweetman. Chapter 3 is co-authored with Professor M.W. Luke Chan and Professor Byron G. Spencer. All three are under review at journals. I was responsible for the empirical analysis, participated in all stages of the research, and wrote the manuscripts for all three chapters.

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Introduction

The thesis addresses policy-relevant questions through the application of economic theory and econometric techniques with a focus on, in chapters 1 and 2, physicians' responses to payment incentives and, in Chapter 3, the pension system in China and its treatment of migrant workers. It comprises three topics: the impact of changes in the payment models on the provision of care inside and outside the capitated basket and within primary health care practices, the impact of rostering incentivized by the payment models on continuity of care within practices, and the differential pension treatment between migrant and locals in the pension system of China. Micro-econometric techniques adopted in the thesis include propensity score estimation, difference-in-differences fixed effect regression, and simulation of the performance of the very recent pension plan.

Blended capitation models incorporating fee-for-service (FFS), pay-for-performance and/or other payment elements are increasingly common models of GP payment. They seek to avoid the extremes of traditional FFS and pure capitation. However, the evidence is limited regarding GPs' response to blended models, particularly the incentive to shift services across payment categories within the practice. The first chapter examines the switch from FFS plus pay-for-performance to a blended capitation model for GPs by firstly building a theoretical model and then testing the predictions empirically using Ontario administrative data. Following chapter 1, the next chapter proceeds to investigate the influence of rostering on continuity of care provided by GPs. Rostering incentivized by premiums and bonuses in the new primary care GP payment models in

Ontario is intended to improve continuity of care, stimulating the active provision of preventive care and reducing redundancy in health resource utilization by facilitating information flows and care coordination. However, whether GPs are motivated in the desired way by the incentives has rarely been studied. Chapter 2 explores the performance by contrasting three payment models with different degrees of rostering. Chapter 3 evaluates the differential pension treatments between migrants and locals in the currently fragmented pension system in China with limited portability across pension funds.

Chapter 1 relates to the seminal model of physician behavior from Ellis and McGuire (1986). Their model shows that prospective payment can lead to too few medical services and cost-based payment can result in too many services. Under-provision and over-provision inherent in capitation (prospective) and FFS (cost-based) payment systems, respectively, are significantly reduced by introducing mixed payment systems, aspects of which have been demonstrated empirically by some studies (Kantarevic et al., 2011; Kralj and Kantarevic, 2013; Krasnik et al., 1990; Wagstaff and Moreno-Serra, 2009). However, a consensus hasn't been reached in an optimal way to blend FFS and capitation. For example, McGuire (2011) argues 30% of total remuneration should be capitation and 70% FFS; in Norway, capitation consists of 30% of the income of an average GP (Iversen and Lurås, 2011); in the UK, approximately 75% of income comes from capitation, the rest from pay-for-performance (Roland et al., 2012); in Ontario, the capitation proportion of total income of an average GP blended capitation is 70%. With many different ways of blending capitation and FFS, Chapter 1 focuses on Ontario's multi-dimension blended model which is more complex version of the one-dimension: first, it blends in the form of fee codes separated into a "capitated basket" and FFS codes outside that basket; second, it blends within the capitated basket where GPs are paid a capitation amount plus a 15% FFS rate; third, it also blends different payment rates of services for rostered patients and those for non-rostered patients. With the multilayers of blending, it is meaningful to investigate how the multi-blend capitation payment models affect the provision of care across payment categories which are created by multiple blending dimensions.

Few theoretical models exist to explain GPs' response to multi-dimension blended capitation. Therefore, building on both Ellis and McGuire (1986) and McGuire and Pauly (1991), we develop a GP utility maximization model to approximate both enhanced FFS and blended capitation to predict the change of provision of care from FFS to blended capitation. Unlike McGuire and Pauly (1991), we focus on the comparison of the equilibria of the two payment models instead of the marginal change. This recognizes that switching from one payment model to the other is not a marginal change. Our model predicts that the total supply of services, and services in the capitated basket, drop while the change of services outside the capitated basket is undetermined.

Our empirical strategy relies on contrasting changes in outcomes for the treated and comparison GPs before and after the blended capitation model was introduced. As GPs voluntarily chose which model to join, we suspect that selection bias exists. Two methods are commonly used in the literature to solve the bias - one is difference-in-differences fixed effect regression, which identifies the treatment effect by controlling the time invariant unobservables; the other one is propensity score matching, which identifies the effect by estimating propensity scores, matching pairs with similar propensity score, and estimating the difference in the outcomes of the matched pairs. Imbens and Wooldridge (2009) recommend adopting a strategy that combines regression and propensity score methods in order to achieve some robustness to misspecification of the parametric models. Fixed effect regression removes the bias from the direct effect of the omitted unobserved fixed characteristics, and weighting removes the correlation between the treatment variable and the unobserved characteristics if a conditional independence assumption is credible (sometimes called unconfoundedness). Weighting also balances the sample so that the relevant coefficient in the regression is unbiased in the presence of functional form misspecification (Imbens, 2015). Therefore, we use a propensity score weighted difference-in-differences model, which is sometimes called double robust estimation (Wooldridge, 2010). Consistent with the theoretical predictions, our results show a reduction in services provided within the capitated portion of the practice and a simultaneous increase in those on the FFS side.

The second chapter investigates another aspect of primary care payment models in Ontario–the impact on continuity of care. A study by the Canadian Institute for Health Information (2015) indicates that relational continuity of care helps to establish a continuous patient–provider relationship, improving health outcomes, and reducing emergency department use and hospitalizations. Continuity of care is facilitated by patient rostering, which enables a patient to officially register with a GP and see the same GP over time. Patient rostering is rewarded by financial incentives in payment models. Enhanced FFS rewards GP for providing rostered patients with after-hours care and comprehensive care, and meeting pay-for-performance targets.[1] Blended capitation, in addition to those rewards, has an 'access bonus', which is reduced if rostered patients receive (with some exceptions) care from GPs other than those in the group to which their rostering GP belongs.

While some evidence shows that payment incentives influence physician behavior in particular situations, other studies find a small effects (Andreassen et al., 2013; J. Li et al., 2014). To investigate whether payment models with rostering incentives affect continuity of care, we compare traditional FFS with enhanced FFS, and enhanced FFS with blended capitation. The three most popular models are introduced in chorological order: traditional FFS existed long before the enhanced FFS model was introduced on July 1, 2003, and blended capitation was introduced on November 1, 2006. This created two quasi-natural experiments for us to identify the impact using the similar econometric technique as in Chapter 1-propensity score weighted difference-in-differences fixed effect model.[2] While the introduction of these payment models is plausibly exogenous with respect to the GPs, the GPs voluntarily decide whether to join the new payment model or remain in the old one hence you need the propensity scores etc. We also study the impact of a special model of blended capitation, the Family Health Team (FHT), which is a team of interdisciplinary health professionals and is designed to better improve continuity of care than other models.

To evaluate continuity of care, we construct a series of indices to measure the patient-GP relationship. As relational continuity of care, which refers to an ongoing

[1] Services include preventive-care management, out-of-office visits, after-hour care, etc.
[2] It is also used in studies such as Biroli et al.(2017), Kantarevic et al. (2011), Kralj and Kantarevic (2013) and etc.

relationship between a patient and one GP/group, is highly valued in primary care, our measures mainly focus on the frequency a patient sees the same rostering GP and that GP's group, and the exclusiveness of seeing the rostering GP. Since GPs in traditional FFS practice do not formally roster patients, we define the practice population for FFS GPs by using virtual rostering that assigns a patient to one GP in a year if that GP bills the highest number of dollars to him/her based on the previous two years of claims.[3] Our results show that continuity of care increases in blended capitation and even more in FHT relative to enhanced fee-for-service, but not in enhanced FFS relative to traditional fee-for-service.

In the third chapter, we are concerned about one aspect of the wellbeing of internal migrants – the pension treatment in a developing country – China. In developing countries people from rural and less developed cities are often driven by financial incentives and social welfare to move large urban cities, but empirical evidence regarding whether internal migration improves their wellbeing is mixed (Antman, 2011; Beegle et al., 2011). Besides, compared to locals, migrants have been documented to be at disadvantages in accessing social welfare (Chen and Feng, 2013; Gao et al., 2012; Liu, 2005; Lu and Piggott, 2015; Ning et al., 2016; Qin et al., 2014). This chapter contributes to the literature by examining differences between migrants and locals in terms of their pension contributions and benefits in the current pension system in China. Before the recent pension transfer policies, cross-jurisdiction transfers of pension contributions and records was limited. Most migrant workers who moved to another region would forego their contributions and not be entitled

[3]The methodology is also used in Balogh et al.(2013). We also compare several different virtual rostering algorithms in a separate paper: Xue Zhang and Arthur Sweetman (2015). Validation for Virtual Rostering Algorithm

to pension benefits. Starting in 2010, two new policies regarding pension transfer were implemented-one is “Interim approaches to transfer the pension plan for workers of enterprises in urban areas”, and the other is “Interim approaches to transfer between the County and Rural Residents Pension Plan and the Urban Workers Pension Plan”, which are proposed to improve the pension portability of both rural and urban migrants. We provide a comparison of existing pension plans in China, and explain the transfer policies in detail in Chapter 3.

As the policies came in recently and not enough data are available to reflect the contributions and the benefits to an individual across the lifecycle, we simulate the benefits and contributions by varying the contribution years in different plans and regions, *hukou*, gender, education and income level. We study this from the perspective of a single developed city in China-Shenzhen, which attracts many migrants from rural and less developed urban cities. In the simulation, we draw on features of the Shenzhen Urban Workers Pension Plan[4] to develop a model to assess the differential treatment of local and migrant workers. We assume for simplicity that the stylized plans for workers in urban and rural areas remain unchanged; while the results would be sensitive to any modification of the contribution or benefit rates and the associated regulations, the assumption of no change enhances our understanding of the system now in place. Our results show that the benefits for migrants in urban areas are less than for locals; migrants who transfer to another urban

[4] Source: Shenzhen Social Security Fund Board ---Shenzhen Urban Workers Pension Plan (深圳经济特区社会养老保险条例/实施细则)
http://www.szsi.gov.cn/sbjxxgk/zcfggfxwj/ylbx/201312/t20131220_2283692.htm
http://www.szsi.gov.cn/sbjxxgk/zcfggfxwj/ylbx/201212/t20121226_2094910.htm

plan may experience further reductions in benefits; migrants who contribute fewer than 15 years in urban areas and fall in the county and rural residents' plan have the least benefit eligibility.

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Chapter 1 Blended capitation and incentives: Fee codes inside and outside the capitated basket

1.1 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 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 GP services are paid as a bundle, create incentives to underprovide services. Also, many physicians dislike pure capitation since it is perceived to shift too much financial risk to them (Eggleston, 2005; Ellis and McGuire, 1986; Ma, 1994; Newhouse, 1996; Robinson, 2001; Russell, 2015; Scott et al., 2011). As a result, there is an increased emphasis on blended payment models (OECD, 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 GPs 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 GPs are paid a capitation amount plus a small FFS rate akin to the approach suggested by McGuire (2011). Third, although patient enrolment (i.e., rostering) is required of GPs, patients may opt out, and GPs 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 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, Li, Hurley, Decicca, & Buckley (2014) find that the incentives are sufficiently numerous and small that most have no measurable impacts.

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 GP 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, Di Tommaso, & Strøm, 2013; Brosig-Koch, Hennig-Schmidt, Kairies-Schwarz, & Wiesen, 2015; Gosden et al., 2001).

We contribute to the literature both by providing a theoretical model examining the provision of care inside and outside the capitated basket and 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 GPs 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 GP billings. We can examine how GPs with different relationships to the patient (rostering GP, same group practice as the rostering GP, and all GPs outside the rostering group) strategically respond to 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 is useful for the entire system in assessing this goal. This follows from the expectation, incorporated into the design of the payment system, that there will be a strengthening of the relationship between primary care providers (and 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 GPs. 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 GPs 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 GPs. 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 GPs 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 GP consistent with the idea of a medical home. Overall, across all GPs 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., 2015a), 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 GP continuously during the data period. The results are presented in section 6, and section 7 concludes.

1.2 Institutional Background

Prior to 1999 over 95% of GPs 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 the full-scope primary care medicine (e.g., practicing only 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 & Buckley (2014), Marchildon & 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. It blends FFS with pay-for-performance, has premiums associated with voluntary rostering, and requires both group practice (minimum of three not necessarily co-located GPs 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 GPs 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 1.1 shows the key elements of the enhanced FFS and blended capitation models. All services outside the blended capitation capitated basket are paid 100% of the same FFS rates as enhanced and traditional FFS GPs. However, services inside the capitated basket are paid differently in the two models. For enrolled patients, enhanced FFS GPs are paid 100% of the FFS fee, plus a 10% premium for a subset of 20 services. In contrast, blended capitation GPs 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 a function of only each patient's sex and age), plus 10% of the FFS payment (15% after October 2010). If rostered patients receive (with some exceptions) care from GPs other than those in the group to which their rostering GP belongs, then an "access bonus" is reduced accordingly. 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. 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, GPs joining the FFS model enhanced with pay-for-performance tend to increase the number of services provided, patient visits and distinct patients seen. GPs in blended capitation tend to reduce the total services, and are more responsive to diabetes management incentives than GPs in enhanced FFS.

1.3 Economic Model

Building on McGuire & 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 GPs experience disutility from demand inducement in their framework, whereas GPs express altruism for patients' health in our model. Our model focuses only on service provision and not on continuity of care.

The GP problem in the enhanced FFS environment can be stated as:

$$\max_{x_1>0, x_2>0} U\,(x_1 + x_2) + V\,(T - t\,(x_1 + x_2)) + \alpha[h(x_1) + h(x_2)] \qquad (1).$$

We assume that the GP receives income from the number of services that would be inside (x_1),[5] and outside (x_2), the basket were the GP working in a blended capitation model. The

[5] The formalization employs one type of service inside and outside the basket, but this can be interpreted as a composite service.

price of both services is normalized to one. A GP has T units of time that she can allocate to either leisure or to the provision of medical services inside (tx_1), or outside (tx_2), the basket where t represents the units of time required to provide one unit of either service. One interpretation of this approach is that services are appropriately priced and there is no price incentive to provide one or the other type of service under FFS. The utilities of income and leisure are denoted as U and V, respectively, and both are assumed strictly concave. Lastly, the patient benefits from each type of service and the health benefit of each service, denoted by h, is 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. Services inside and outside the basket are equally beneficial for health, but some relative benefit could be imposed without changing the nature of the problem as long as it is the same for enhanced FFS and blended capitation.

Using the superscript F to represent the optimum under enhanced FFS, the first-order conditions for this problem are:[6]

$$U'(x_1^F + x_2^F) - tV'(T - t(x_1^F + x_2^F)) + \alpha h'(x_1^F) = 0 \qquad (2)$$

$$U'(x_1^F + x_2^F) - tV'(T - t(x_1^F + x_2^F)) + \alpha h'(x_2^F) = 0 \qquad (3)$$

Combining (2) and (3) and given h is strictly concave, the number of services inside the basket is equal to services outside the basket $x_1^F = x_2^F$ at the optimum.[7]

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

$$\max_{x_1>0, x_2>0} U(\varphi x_1 + x_2 + C) + V(T - t(x_1 + x_2)) + \alpha[h(x_1) + h(x_2)] \qquad (4).$$

[6] The second order condition for the maximum is satisfied.
[7] The relationship between x_1^F and x_2^F could be a ratio ($x_1^F = cx_2^F$) if a relative benefit is assumed. This does not alter the nature of the solution.

We assume that the GP receives income from services inside the basket (x_1), services outside the basket (x_2), and the capitation per patient (C). The partially compensated ratio for services inside the capitated basket is φ, and $\varphi < 1$ given the capitation payment. Using the superscript BC to represent the optimum under blended capitation, the first-order conditions for this problem are:

$$\varphi U'(\varphi x_1^{BC} + x_2^{BC} + C) - tV'(T - t(x_1^{BC} + x_2^{BC})) + \alpha h'(x_1^{BC}) = 0 \qquad (5)$$

$$U'(\varphi x_1^{BC} + x_2^{BC} + C) - tV'(T - t(x_1^{BC} + x_2^{BC})) + \alpha h'(x_2^{BC}) = 0 \qquad (6)$$

Combining (5) and (6), yields $(\varphi - 1)U'(\varphi x_1^{BC} + x_2^{BC} + C) = \alpha(h'(x_2^{BC}) - h'(x_1^{BC}))$. Since $\varphi < 1$ and $h'' < 0$, the number of services outside the basket is greater than those inside the basket, $x_2^{BC} > x_1^{BC}$, at the optimum.

Given that switching payment models is voluntary, we assume that after joining the blended capitation model GPs maintain their incomes at no less than their incomes in the enhanced FFS model (i.e.,: $\varphi x_1^F + x_2^F + C \geq x_1^F + x_2^F$). Then it is the case that $x_1^{BC} + x_2^{BC} < x_1^F + x_2^F$.[8] Second, given that $x_1^{BC} + x_2^{BC} < x_1^F + x_2^F$, there are two possibilities. If $U'(x_1^F + x_2^F) - U'(\varphi x_1^{BC} + x_2^{BC} + C) \geq \mathrm{t}V'(\mathrm{T} - \mathrm{t}(x_1^F + x_2^F)) - tV'\big(T - t(x_1^{BC} + x_2^{BC})\big)$, then combining (2), (3), (5) and (6) implies that $x_1^{BC} < x_1^F$ and $x_2^{BC} \leq x_2^F$. Alternatively, if $U'(x_1^F + x_2^F) - U'(\varphi x_1^{BC} + x_2^{BC} + C) < tV'(T - t(x_1^F + x_2^F)) - tV'\big(T - t(x_1^{BC} + x_2^{BC})\big)$, then $x_1^{BC} \leq x_1^F$ and $x_2^{BC} > x_2^F$.

Overall, the total provision of services declines after GPs join the blended capitation model from the enhanced FFS one since $x_1^{BC} + x_2^{BC} < x_1^F + x_2^F$, and in the basket services are predicted to decline (i.e., $x_1^{BC} \leq x_1^F$). However, outside the basket, whether x_2^{BC} is greater than

[8] A proof is in the appendix.

x_2^F depends on the relative magnitudes of the marginal utility of income ($U'(x_1^F + x_2^F) - U'(\varphi x_1^{BC} + x_2^{BC} + C)$) and the marginal utility of leisure ($(tV'\left(T - t(x_1^F + x_2^F)\right) - tV'\left(T - t(x_1^{BC} + x_2^{BC})\right)$).

To recap, as long as those GPs who voluntarily switch from the enhanced FFS to the blended capitation model aim to at least maintain their income under the new blended capitation model compared to the old enhanced FFS one, then in this economic framework there are incentives to decrease total service provision and services inside the basket after switching. Service provision outside the basket may increase or decrease depending upon the strength of two competing effects, although any increase will be smaller than or equal to the decrease inside the basket ($x_2^{BC} - x_2^F < x_1^F - x_1^{BC}$).

1.4 Data

1.4.1 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.[9] Given Canada's universal public health care system, the claims database captures medical services provided by almost every GP 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 GPs and patients. The registered person database contains the age and

[9] 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).

sex of each resident, and the provider database lists the payment model of each GP 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.

1.4.2 Study Dataset

We select all GPs affiliated with the enhanced FFS model as of 1 April 2006. We retain those who stayed in that model or switched directly to the blended capitation model, and exclude GPs 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 are 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. Table 1.2 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 GPs switched. A slightly higher percentage of patients than GPs transferred to capitation as presented in Table 1.3, which suggests that GPs with slightly larger practices might be more attracted to the blended capitation model.

1.4.3 Variable Specifications

The dependent variable is the FFS equivalent value of the services provided. These are not the actual billings GPs 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.

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” that encouraged, for rostered patients, the provision of selected health assessments, preventive-care services, diagnoses and treatments. To make the two models comparable these premium fee codes are excluded in the main analysis for both models.[10] However, the appendix presents regressions including them and the results are substantively similar.

Some services not included inside the capitated basket tend to be infrequent, large and costly ones over which GPs arguably have little control, including services required by complex patients. Also outside the basket are many preventative care services, such as

[10] Enhanced FFS physicians are eligible for 10% comprehensive care premium with fee-codes such as A001A, A003A, A007A, A008A, A901A, C882A, G365A, G538A, G539A, K005A, K013A, and K017A.

diabetes management, where the service-reducing incentives associated with capitation are undesirable. Most 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 GPs.[11] To ensure the results are not affected by these differences, we have done the analysis both excluding and including them with the former in the main text and the latter in the appendices.

For the propensity score analysis, the unit of analysis is the rostering GP and the dependent variable is binary and set to one if the GP switched to blended capitation by the end of the period, zero otherwise. Two classes of regressors are employed: those reflecting the individual GP’s characteristics, and variables – usually aggregate variables – reflecting the GP's practice. The variables and the functional forms employed are listed in Table 1.4, with descriptive statistics provided along with balancing tests in Table 1.5. Most variables are self-explanatory, but three are important and require an explanation. First, *expected income gain*, reflects the financial cost or benefit of the payment model switch holding practice style constant. This is similar to that employed by Kralj and Kantarevic (2013). The variable measures the difference in actual billings in 2006 when all GPs 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 GPs 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

[11] Blended capitation physicians are eligible three incentives not available to EFFS GPs. If in a rural area, they receive bonuses of $5,000 or $7,500 for billing for hospital services in excess of $2,000. They also receive $2,000 for providing prenatal care to five or more enrolled patients, and $2,000 for billing at least $1,200 for in-office clinical procedures.

defines 0 to be a dense urban area and 100 to be extremely remote. Finally, there are a set of six variables measuring billings in 2006 for each GP's continuously rostered patients. The billings 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 what GP bills for them.

For the second stage difference-in-differences fixed effect model the dependent variables are defined in section 5.2. The treatment variable is the proportion of the year during which the GP was affiliated with the blended capitation model, and is zero or one except in the transition year. One noteworthy variable is an indicator variable that equals one in the transition year and allows us to isolate any transition year effects. Other regressors are listed below each regression.

1.5 Empirical Framework

Our empirical strategy relies on contrasting, before and after the introduction of the blended capitation model, the FFS equivalent billings for continuously rostered patients of GPs who switched to the blended capitation model with those who remained in enhanced FFS. Billing codes inside and outside the capitated basket of the blended model are aggregated separately to allow contrasts on that key dimension. For each GP's patients, we explore billings by all GPs in the province, and three sub-groups: the rostering GP, those 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.

The specification employed is sometimes called doubly robust estimation since it produces consistent estimates as long as at least one of first stage propensity score, or the second stage ordinary least squares (in this case a panel difference-in-differences fixed-effects model) models is correctly specified (Wooldridge, 2010; Kralj & Kantarevic, 2013, provide an application). 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 & Sweetman, 2016) it does improve our confidence in the estimates be they interpreted as causal or conditional relationships. An unmeasured variable that would undermine a causal interpretation would, however, need to be time varying and correlated with the shift across payment models by different GPs in different years and we argue below that such variables are unlikely to be important.

1.5.1 Propensity Score Reweighting

As part of the effort to overcome the fundamental evaluation problem of selection bias, we estimate propensity scores to generate a comparison group by reweighting those GPs who remained in the enhanced FFS model so that they have similar pre-policy change characteristics as those who switched to the blended capitation one. 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. To operationalize this, we use a logit regression to estimate propensity scores, which are the probability of participating in the blended model. A non-parametric alternative was experimented with 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.[12]

We use observed characteristics in the pre-policy period, that is, 2006, in estimating the propensity scores. In part, our specification is guided by Imbens & Rubin's (2015) recommendation for flexible functional forms and against excluding variables from propensity score estimation models in the name of parsimony. Our specification is also guided by translating to our context evidence from the broader economics literature regarding variables that make causal inference/interpretation plausible (e.g., Heckman et al., 1999). We include in our propensity score estimation various measures of GP demographics and practice characteristics, a variety of measures of billings – both inside and outside of (what would become) the capitated basket – from before the blended capitation model was introduced by GPs in various rostering categories. In particular, we also employ the previously described measure of the opportunity cost of the payment model switch in the form of the expected income gain (or loss) from switching holding practice style constant.

In a subsequent 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.

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

1.5.2 Reweighted Difference-in-Differences with Alternative Dependent Variables

In the second step of the double robust procedure, and given that we have five years of data, we estimate panel fixed-effects models employing the generated weights for the comparison group.[13] Beyond matching/reweighting, the fixed effects control for any omitted time-invariant unobservables thereby adding to the credibility of the estimates. While causality can never be proven, we argue that the variables in our propensity score model in the context of this double robust empirical strategy with fixed effects and a consistent set of GP-patient pairs provides evidence that readers may credibly choose to interpret as causal.

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

$$ln(B_{ijt} + 1) = \alpha_i + \gamma_t + \beta X_{it} + \rho \pi_{jt} + \delta BCap_{jt} + u_{ijt} \quad (7)$$

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 GP is affiliated with

[13] As will be seen, in our first two specifications the fixed effects represent patient-physician pairs, whereas in the third they are at the physician level.

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., RIO 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 GP level.

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.

$$\Pr\left(B_{ijt} > 0 | X_{it}, \gamma_t, \pi_{jt}, BCap_{jt}, \alpha_i\right) = F\left(\alpha_i + \gamma_t + \beta X_{it} + \rho\pi_{jt} + \delta BCap_{jt}\right) \quad (8)$$

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 and using a fixed effect model:

$$lnB_{ijt} = \alpha_i + \gamma_t + \beta X_{it} + \rho\pi_{jt} + \delta BCap_{jt} + u_{ijt} \ (9).$$

The third approach is to aggregate the patient-level billings to the GP 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 GP (model C). At the GP level, the model is:

$$l\,n\left(\frac{B_{jt}}{p_j}\right) = \tau_j + \gamma_t + \rho\pi_{jt} + \delta BCap_{jt} + u_{jt} \ (10)$$

where p_j is the number of patients continuously rostered with GP j, and τ_j is GP 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. This leads to models of the general form:

$$lnB_{ijt} = \alpha_i + \gamma_t + \beta X_{it} + \rho\pi_{jt} + \delta BCap_{jt} + \theta\left(t * BCap_j\right) + u_{ijt} \text{ (11).}$$

Where t=1 if in the post-policy change period and zero otherwise. Rejecting the null hypothesis that θ equals zero provides evidence of a change in trend associated with the switch.

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 GP 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.[14] Given that the specifications are time-consuming to estimate, 299 bootstrap replications are undertaken for models A and B, while 999 replications for model C.

[14] In detail, we perform B bootstrap replications producing t-statistics $t_1^*, \ldots, t_B^*$, where $t_b^* = \frac{(\hat{\delta}_b^* - \hat{\delta})}{s_{\hat{\delta}_b^*}}$ (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 $t = \frac{(\hat{\delta} - \delta_o)}{s_{\hat{\delta}}}$. For a two-sided test of $H_0\colon \delta_o = 0$, the p-value is: $\frac{1}{B}\sum_{b=1}^{B} 1(|t| < |t_b^*|)$.

1.6 Results

1.6.1 Propensity Scores

Table 1.4 shows the logit model estimates used to generate the propensity scores, where the dependent variable is an indicator of switching to the blended capitation model in the data period. GPs who switched are more likely to be female, practice in rural areas, and have a slightly smaller group size and a somewhat older practice population. Importantly, pre-reform billing patterns are also important predictors as is the income gain variable.

The distribution of propensity scores of GPs who switched to the blended capitation model, above the x-axis in Figure 1, skews to the right while that of those who stay in enhanced FFS, below the x-axis, skews to the left, indicating that GPs who switched to the blended capitation model are more likely to have high propensity scores. 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 appendix; the results remain quite stable.

1.6.2 Summary Statistics

The unadjusted characteristics of GPs who stay in enhanced FFS are statistically and economically significantly different from that of those who switch to blended capitation. In Table 1.5, 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 the more rural areas. They also have fewer daily patient visits and work in smaller groups than the comparison GPs. Once matching and weighting are undertaken, however, the comparison GPs are quite similar to the treatment ones on the pre-treatment covariates and outcomes, with no statistically significant differences except for the rostering size.[15] Overall, propensity score matching effectively reduces 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 1.5 presents the weighted and unweighted billings in 2006. Tables 6 and 7 present, in two parts, the weighted shares of patients with strictly positive billings, and average billings for those patients with positive billings. In Tables 6 and 7, panel (1) summarizes patient visits with (effectively) each and every GP in the province. In panels (2) through (4), this total is decomposed into billings in three exhaustive and mutually exclusive groups: (2) the patient's rostering GP (if a reduction in access to their capitated GP frustrates patients and they visit another GP instead, then the aggregate will be reflected in this trend), (3) GPs other than the rostering GPs but in the same group practice, and (4) GPs outside the rostering GP's group. At the beginning of the data period, the averages for treatment and comparison GPs are similar. Over time, the percentage of patients in blended capitation who visit any GP in Ontario for services inside the basket (panel A in Table 1.6) declines compared to that of the patients enrolled with enhanced FFS GPs. The aggregate decrease comes from services provided by rostering

[15] 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.

GPs and other GPs in the rostering group. In contrast to services inside the capitated basket, the percentages of patients in blended capitation who visit their rostering GP and the associated billings for outside the basket services (panel B in Table 1.6) increase compared to patients enrolled with enhanced FFS GPs.

1.6.3 Main Results

Panel A in Table 1.7 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 GP 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. However, many economists like to look at standard errors, so nonparametric bootstrapped standard errors are presented in parentheses in this and comparable tables. The asterisks represent a more reliable form of inference in general however in this case the two rarely differ appreciably in terms of rejecting the null hypothesis at conventional levels.

The first row of Table 1.7 suggests that switching to capitation has an appreciable negative impact on average total FFS-equivalent billings by all GPs -- on the order of 12 to 19 percent.[16] Breaking this down in subsequent rows, we find that a GP switching to the blended capitation model leads to a drop in the value of inside the basket services provided

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

by the rostering GP. This is consistent with the predictions of the theoretical model. Across the various specifications, a statistically significant drop in billings by other GPs in the rostering group is also observed in Models B and C, although the change is not significant in model A. Notably, the value of services inside the basket from GPs outside the rostering group for all models decreases as well. The magnitude of this drop is greater than the reduction in the services provided by the rostering GP for model C, and smaller than the reduction by the rostering GP for Models A and B.

Panel B in Table 1.7 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 GP. However, for non-rostering GPs 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 offsetting effects: an insignificant reduction 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 GPs outside of the group containing the rostering GP, there are 3 to 5 percent decreases for models A and C. Model B shows a small and marginally significant decline in the likelihood of seeing patients rostered with other GPs outside the group.

One prediction of the model is that total billings, the sum of those inside and outside the basket, will decline for the rostering GP. As presented in the appendix, in all three empirical specifications we observe this to be the case, and it is also true for other GPs in the same group as the rostering GP and GPs 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.

1.6.4 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 1.8 shows the effect of blended capitation on FFS equivalent billings inside the basket by transition year using the aggregate model. Overall, it shows that the pattern in Table 1.7 is broadly consistent across cohorts – although precision is reduced. Billings for services outside the basket are shown in panel B. The main substantive difference from Table 1.7 is that for later cohorts of switchers, patients have no significant change in the services with GPs in the same group as the rostering GPs except for the first cohort and the reduction in the services outside the group become insignificant in the last cohort. We also explored the results using models A and B and they have patterns consistent with Table 1.8.

1.6.5 Differential Trend Extension

Results from regression models allowing differential trends after switching, equation (11), are presented in the right hand side two columns of Table 1.9. To facilitate comparisons, the leftmost column replicates the results in Table 1.7. 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 1.8, we present results for the aggregate model (model C), but we 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 GPs 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 GPs in the same group as the rostering GP neither the intercept nor the slope coefficients are statistically 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 GPs under blended capitation evolving their practice/billing patterns over time in response to the new payment model. Perhaps learning is occurring.

1.6.6 Heterogeneous Responses by Practice Style and Demographics

Subgroup analyses are presented in Table 1.10. 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 reported in Table 1.7. The first comparison is of GPs 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 GPs 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 GPs 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.

1.7 Discussion and Conclusions

Consistent with our theoretical predictions, the estimates presented indicate that GPs joining the blended capitation model tend to reduce FFS equivalent billings inside the capitated basket for their capitated patients. While the theory is ambiguous regarding FFS billings outside the basket, we observe an increase; that suggesting that the marginal utility of income dominates the marginal utility of leisure (i.e., on average those GPs who switch to capitation are not on the backward bending portion of the labour supply curve). On net, total billings decline, which is again consistent with the theory. The magnitude of the observed effects is economically significant, far from trivial, but not implausibly large.

Although there is a small FFS element inside the basket, the reduction in billings inside the capitated basket being larger in absolute value than the increase in billings outside of it is consistent with the shift from the overprovision associated with FFS to the reduced provision under capitation. 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 GP to obtain test results (and the GP bills for the visit), whereas under capitation a nurse or administrator may phone the patient with the results and a follow-up visit is 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 (increased productivity) and a reduction in the opportunity costs to patients.

For non-rostering GPs in the same group as the rostering GPs, we find that patients obtain fewer services inside the capitated basket, and fewer visits with billings outside the basket but higher billings conditional on a visit. That result is harder to interpret in the confines of our model, which focusses on the rostering GP. Plausibly, the administrative costs and complexity of sharing the capitation payment and/or bonuses among GPs in the rostering group induce the change in the 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 GPs outside the group also decline other interpretations are possible.

There are reductions in billings both inside and outside of the capitated basket for GPs outside the rostering group. Since patients are able to book appointments with other GPs without cost or penalty, this implies that they either feel an obligation to visit the capitated GP with whom they are rostered or that the rostering GP is by some means slightly reducing 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.

An important and obvious question is why we observe an increase in the services outside the basket for the rostering GP 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. Carter, Newhouse, & Relles (1990) find that one-third of the change in Medicare's case-mix index between 1986 and 1987 was due to up-coding, and Silverman & Skinner (2004) find up-coding in hospitals treating Medicare patients between 1989 and 1996. Additionally, and more positively, 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. This can be interpreted as an improvement in the quality of care.

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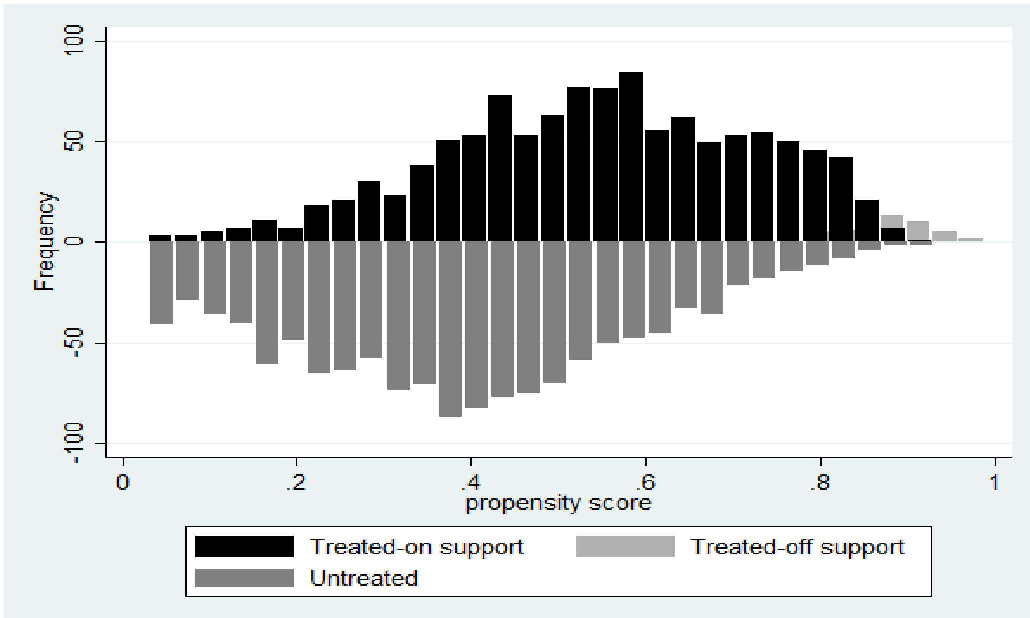

Figure 1.1 Distribution of physicians' estimated propensity scores

	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	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. A001A, A003A, A007A, A008A, A888A, A901A, A902A, C010A, C882A, G365A, G538A, G539A, G590A, G591A, K005A, K013A, K017A, K022A, K023A, K030A. (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.

Table 1.1 Remuneration methods of enhanced FFS and blended capitation payment models

	Patients consistently enrolled		All patients ever enrolled	
No. of patients	2,526,053		4,243,608	
	Mean	S.D.	Mean	S.D.
No. of patients per GP	1210	568	1795	824
%male	0.46	0.50	0.45	0.50
Age	40.4	22.1	40.5	22.3

Table 1.2 Characteristics of enrolled patients associated with GPs in the data in 2006

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

Table 1.3 Distribution of patients and GPs by blended capitation across years

Dependent Variable: Switch to Blended Capitation = 1; Remain enhanced FFS = 0				
Independent Variable	Coef.	S.E.	Odds ratio	S.E.
Characteristics of GPs				
Expected income gain/100000	0.39**	(0.19)	1.48**	(0.28)
(Expected income gain/10,0000) ^2	-0.10**	(0.05)	0.91**	(0.04)
(Expected income gain*place of graduation)/100000	0.33**	(0.16)	1.39**	(0.22)
(Expected income gain* %male)/100000	0.24	(0.15)	1.28	(0.19)
Age/100	-1.66	(5.11)	0.19	(0.97)
(Age/100)^2	-3.30	(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,2006/07				
Billings inside the basket, the rostering GP	-0.01*	(0.01)	0.99*	(0.01)
Billings inside the basket, GPs in the same group of the rostering GP	-0.04	(0.05)	0.96	(0.05)
Billings inside the basket, GPs outside the group	-0.04***	(0.01)	0.96***	(0.01)
Billings outside the basket, the rostering GP	-0.02***	(0.01)	0.98***	(0.01)
Billings outside the basket, GPs in the same group of the rostering GP	0.01	(0.01)	1.01	(0.01)
Billings outside the basket, GPs outside the 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 GPs in a practice group. RIO: Rurality Index of Ontario – an index of community population density and travel time to the nearest referral centers.

Table 1.4 Propensity scores logit estimates using fiscal year 2006/07 data

	Treatment (blended capitation)	Comparison (enhanced FFS)	
		unweighted	weighted
Number of GPs	1,114	1,368	1,114
Characteristics of GPs			
Expected income gain	29,000	-8100***	27,300
%Male GPs	65.4	66.7	65.0
Age	49.5	51.2***	49.6
RIO (rural index of Ontario)	6.9	3.7***	7.8
%working days annually	69.3	70.1	69.8
Daily visits	34.3	36.1***	33.9
Group size	51.6	62.8***	53.6
Years of practice	20.2	21	20.2
%place of graduation-Canada	83.4	72.7***	83.7
%place of graduation-USA	0.2	0.3	0.2
%place of graduation-UK	3.4	4.1	3.2
%place of graduation-other	13.4	23	13.3
Characteristics of practice population			
Roster size	1,508	1,505	1,466*
%Male patients	0.4	0.4	0.4
Age	40.7	40.1***	40.9
Past outcomes,2006/07			
Billings inside the basket, the rostering GP	126,000	135000***	127,000
Billings inside the basket, GPs in the same group of the rostering GP	7,000	7000	8,000
Billings inside the basket, GPs outside the group	24,000	28000***	24,000
Billings outside the basket, the rostering GP	13,000	13000***	13,000
Billings outside the basket, GPs in the same group of the rostering GP	4,000	3000***	4,000
Billings outside the basket, GPs outside the group	39,000	38000***	39,000

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 the mean of the original dataset; the weighted column shows weighted means based on propensity scores combined using local linear regression with a bandwidth of 0.1.

Table 1.5 Mean characteristics before switch for the treatment and comparison groups

Year	2006/07		2007/08		2008/09		2009/10		2010/11	
	%	$	%	$	%	$	%	$	%	$
Panel A: *inside* the capitated basket										
(1) *with any GPs*										
Comparison (enhanced FFS)	95	159,000	95	158,000	95	161,000	95	165,000	95	167,000
Treatment (blended capitation)	95	157,000	95	154,000	95	145,000	94	133,000	94	125,000
(2) *with rostering GP*										
Comparison (enhanced FFS)	80	127,000	79	124,000	79	126,000	78	128,000	77	129,000
Treatment (blended capitation)	80	126,000	79	123,000	79	115,000	77	103,000	76	94,000
(3) *with GPs in the same group as the rostering GP*										
Comparison (enhanced FFS)	52	8,000	51	7,000	50	7,000	49	6,000	48	6,000
Treatment (blended capitation)	52	7,000	51	7,000	50	6,000	47	4,000	45	4,000
(4) *with GPs outside the group of rostering GP*										
Comparison (enhanced FFS)	59	24,000	59	27,000	59	28,000	60	31,000	60	32,000
Treatment (blended capitation)	58	24,000	58	24,000	58	24,000	58	26,000	58	27,000
Panel B: *outside* the capitated basket										
(1) *with any GPs*										
Comparison (enhanced FFS)	83	56,000	83	58,000	83	61,000	83	62,000	82	71,000
Treatment (blended capitation)	83	56,000	82	57,000	83	60,000	83	63,000	82	70,000
(2) *with rostering GP*										
Comparison (enhanced FFS)	47	13,000	46	13,000	47	15,000	48	16,000	47	18,000
Treatment (blended capitation)	47	13,000	46	14,000	48	16,000	49	19,000	49	22,000
(3) *with GPs in the same group as the rostering GP*										
Comparison (enhanced FFS)	39	4,000	38	4,000	37	4,000	36	3,000	35	3,000
Treatment (blended capitation)	38	4,000	37	4,000	36	3,000	36	3,000	34	3,000
(4) *with GPs outside the group of rostering GP*										
Comparison (enhanced FFS)	50	39,000	49	41,000	49	42,000	49	43,000	49	50,000
Treatment (blended capitation)	50	39,000	49	39,000	49	41,000	49	41,000	49	45,000

Note: this table presents the percentages of patients with at least one billing code (i.e., visit) each year, and the associated mean values of FFS equivalent billings for services inside /outside the capitated basket among patients with strictly positive visits for each category of GP. Weights generated from the propensity scores are employed for the comparison group.

Table 1.6 Trends of weighted percentages and FFS equivalent billings inside and outside the blended capitation basket

	(1) Model A: costs including zeros	(2) Model B: costs 0/1, then costs | costs>=1		(3) Model C: aggregate 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***
	(0.00n8)	(0.015)	(0.010)	(0.012)
Ln(B), rostering GP	-0.090***	0.808***	-0.114***	-0.144***
	(0.008)	(0.019)	(0.013)	(0.012)
Ln(B), same group as rostering GP	-0.014	0.794***	-0.073**	-0.108***
	(0.003)	(0.049)	(0.028)	(0.010)
Ln(B), GPs outside the group	-0.039***	0.862***	-0.029***	-0.201***
	(0.005)	(0.019)	(0.009)	(0.019)
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***
	(0.009)	(0.012)	(0.009)	(0.008)
Ln(B), rostering GP	0.100***	1.103***	0.153***	0.223***
	(0.010)	(0.021)	(0.013)	(0.016)
Ln(B), same group as rostering GP	0.001	0.990	0.131***	-0.010
	(0.007)	(0.037)	(0.018)	(0.019)
Ln(B), GPs outside the group	-0.032**	0.952***	-0.006	-0.053***
	(0.007)	(0.011)	(0.008)	(0.009)
Patients fixed effects	Yes	Yes	Yes	No
GP fixed effects	No	No	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes

Note: bootstrapped standard errors 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. 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 the GP level and the standard errors are clustered at that level. Coef. is short for coefficient; 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, GPs annual working days, group size, year dummies and quadratic terms of all continuous variables.

Table 1.7 Effect of switching to the blended capitation model on FFS equivalent billings

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

Note: bootstrapped standard errors 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. Each fiscal year cohort represents GPs 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, GPs annual working days, group size, year dummies and quadratic terms of all continuous variables.

Table 1.8 Impact of switching by cohort using Model C

	DID with fixed-effects Coef.	DID with differential trend Coef.	Linear trend Coef.
Panel A: Effect on services *inside* the basket by differential trend			
Ln(B), all GPs in Ontario	-0.192***	-0.143***	-0.058***
	(0.012)	(0.021)	(0.022)
Ln(B), rostering GP	-0.144***	-0.102***	-0.050*
	(0.012)	(0.024)	(0.027)
Ln(B), same group as rostering GP	-0.108***	-0.077***	-0.037**
	(0.010)	(0.016)	(0.016)
Ln(B), GPs outside the group	-0.201***	-0.130***	-0.084**
	(0.019)	(0.031)	(0.034)
Panel B: Effect on services *outside* the basket by differential trend			
Ln(B), all GPs in Ontario	0.032***	0.097***	-0.078***
	(0.008)	(0.015)	(0.016)
Ln(B), rostering GP	0.223***	0.268***	-0.053
	(0.016)	(0.034)	(0.038)
Ln(B), same group as rostering GP	-0.010	-0.011	0.002
	(0.019)	(0.033)	(0.036)
Ln(B), GPs outside the group	-0.053***	0.038**	-0.108***
	(0.009)	(0.017)	(0.018)

Note: nonparametric bootstrapped standard errors 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, GPs annual working days, group size, year dummies and quadratic terms of all continuous variables.

Table 1.9 Effect of switching by differential trend

	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.	coef.	s.e.	coef.	s.e.	coef.	s.e.
Panel A：Effect on services *inside* the basket								
Baseline	-0.192***	(0.012)	-0.144***	(0.012)	-0.108***	(0.010)	-0.201***	(0.019)
Expected income gain in 2006								
Above median	-0.176***	(0.015)	-0.115***	(0.015)	-0.107***	(0.015)	-0.195***	(0.026)
Below median	-0.227***	(0.020)	-0.206***	(0.022)	-0.117***	(0.017)	-0.206***	(0.030)
GP gender								
Male	-0.192***	(0.015)	-0.150***	(0.014)	-0.094***	(0.012)	-0.215***	(0.024)
Female	-0.192***	(0.024)	-0.132***	(0.024)	-0.130***	(0.018)	-0.183***	(0.034)
GP age group								
0-44	-0.200***	(0.018)	-0.146***	(0.018)	-0.120***	(0.015)	-0.202***	(0.028)
45-59	-0.187***	(0.019)	-0.150***	(0.020)	-0.110***	(0.017)	-0.200***	(0.031)
60+	-0.178***	(0.033)	-0.134***	(0.027)	-0.074**	(0.031)	-0.173***	(0.051)
Panel B: Effect on services *outside* the basket								
Baseline	0.032***	(0.008)	0.223***	(0.016)	-0.010	(0.019)	-0.053***	(0.009)
Expected income gain in 2006								
Above median	0.023**	(0.010)	0.172***	(0.018)	-0.038	(0.025)	-0.039***	(0.013)
Below median	0.053***	(0.015)	0.297***	(0.028)	0.003	(0.032)	-0.065***	(0.014)
GP gender								
Male	0.033***	(0.011)	0.253***	(0.022)	0.008	(0.024)	-0.072***	(0.012)
Female	0.026**	(0.013)	0.159***	(0.023)	-0.041	(0.032)	-0.019	(0.015)
GP age group								
0-44	0.026**	(0.012)	0.192***	(0.020)	-0.033	(0.028)	-0.050***	(0.013)
45-59	0.043***	(0.014)	0.241***	(0.028)	-0.001	(0.032)	-0.054***	(0.014)
60+	0.020	(0.025)	0.235***	(0.049)	0.027	(0.049)	-0.072***	(0.028)

Note: bootstrapped standard errors are in parentheses. The significance levels shown in the table are percentile-t bootstrapped. All specifications control variables are the same as above.

Table 1.10 Effect of switching by subgroup

Appendix for

"Blended primary payment models and fee codes inside and outside the capitated basket"

Part I: Empirical Extensions and Sensitively Tests

Among the in-the-basket fee codes there is a pay-for-performance incentive called the comprehensive-care premium available exclusively for the enhanced FFS model, and only for rostered patients. Aside from incentivizing rostering by adding a premium to a few common diagnosis and treatment codes, it encourages the provision of health assessments, preventive-care services (e.g., Pap smears, immunizations). Enhanced FFS GPs are eligible for 10% comprehensive care premium for fee-codes including A001A, A003A, A007A, A008A, and A901A. As shown in panel A in Appendix Table 1, the comprehensive care premium positively incentivizes provision of in-the-basket services.

There are additional pay-for-performance payments for the blended capitation GPs relative to enhanced FFS GPs for services outside the basket. For example, GPs receive $5,000 or $7,500 if in a rural area with RIO higher than 40 for providing $2,000 in hospital services, $2,000 for providing care to five or more enrolled patients, $2,000 for providing at least $1,200 in office procedures(Sweetman and Buckley, 2014). Based on economic theory, one would expect that the gap between enhanced fee-for-service and blended capitation would be made greater by including these fee codes. But in panel B in Appendix Table 1, there is no obvious change relative to Table 8 in the texts in the magnitudes of the coefficients probably because the size of these incentives was small.

Appendix Table 2 shows the effect of joining a blended capitation model on total FFS equivalent billings (i.e., aggregating fee codes inside and outside the capitated basket). It indicates a negative impact of switching on the total value of services provided, as expected from the theoretical model.

Appendix Table 3 compares the effect of joining a blended capitation model and a Family Heath Team, and that of only joining a blended capitation and finds that GPs of these two types do not response differently to the capitated incentives of the blended capitation model.

Appendix Tables 4-8 provide sensitivity tests on cohort effect and trend effect using model A and B. The results do not differ substantively from the model C in the main body of the paper. Appendix Table 8 provides sensitivity tests for the regressions in Table 8. They contain estimates of the impacts of switching to blended capitation on the provision of services using a variety alternative matching estimators. In the baseline model in Table 8, we match the comparison and treatment GPs using local linear regression with a bi-weight kernel, 0.1 bandwidths and trimming at the level of 0.05. In the sensitivity analyses, we use: i) kernel matching as an alternative to local linear regression; ii) 0.05 and 0.2 bandwidths in place of 0.1 for the local linear regression; iii) alternative kernel functions the normal and Epanechnikov, and iv) different trimming levels (10% and 0%) using local linear regression.

(1)	(2) Model A: costs including zeros	(3) Model B: costs 0/1, then costs | costs>=1		(4) Model C: aggregate to GP level
	Coef.	Exp (coef.)	Coef.	Coef.
Effect of switching to the blended capitation model on FFS equivalent billings *inside* the basket				
Ln(B), all GPs in Ontario	-0.308***	0.833***	-0.270***	-0.283***
	(0.008)	(0.009)	(0.006)	(0.006)
Ln(B), rostering GP	-0.281***	0.897***	-0.286***	-0.296***
	(0.010)	(0.012)	(0.006)	(0.008)
Ln(B), same group as rostering GP	-0.087	0.818***	-0.194**	-0.240***
	(0.012)	(0.030)	(0.011)	(0.023)
Ln(B), GPs outside the group	-0.150***	0.810***	-0.064***	-0.209***
	(0.013)	(0.016)	(0.008)	(0.014)
Effect of switching to the blended capitation model on FFS equivalent billings *outside* the basket				
Ln(B), all GPs in Ontario	0.050***	1.023**	0.071***	0.030***
	(0.009)	(0.012)	(0.009)	(0.008)
Ln(B), rostering GP	0.098***	1.100***	0.146***	0.195***
	(0.010)	(0.020)	(0.013)	(0.014)
Ln(B), same group as rostering GP	-0.002	0.983	0.127***	-0.021
	(0.007)	(0.036)	(0.018)	(0.020)
Ln(B), GPs outside the group	-0.031**	0.952***	-0.003	-0.044***
	(0.007)	(0.011)	(0.008)	(0.009)
Patients fixed effects	Yes	Yes	Yes	No
GP fixed effects	No	No	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes

Note: B represents FFS equivalent billings. Model A adds $1 to the dependent variables and the standard errors are clustered at the patient level; Model B is a two-part model, and the standard errors are clustered at the patient level; Model C aggregates the billings to the general practitioner (GP) level and the standard errors are clustered at that level. Coef. is short for coefficient; 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, GPs annual working days, group size, year dummies and quadratic terms of all continuous variables.

Appendix Table 1.1 Effect of switching to the blended capitation model including comprehensive care premium fee-codes and pay-for-performance fee-code

(1)	(2) Model A: costs including zeros	(3) Model B: costs 0/1, then costs | costs>=1		(4) Model C: aggregate to GP level
	Coef.	Exp (coef.)	Coef.	Coef.
Ln(B), all GPs in Ontario	-0.203***	0.933***	-0.197***	-0.183***
	(0.006)	(0.009)	(0.004)	(0.004)
Ln(B), rostering GP	-0.183***	1.003	-0.228***	-0.217***
	(0.009)	(0.013)	(0.005)	(0.007)
Ln(B), same group as rostering GP	-0.073***	0.873***	-0.122***	-0.180***
	(0.012)	(0.028)	(0.010)	(0.023)
Ln(B), GPs outside the group	-0.125***	0.872***	-0.038***	-0.104***
	(0.012)	(0.012)	(0.005)	(0.0086)
Patients fixed effects	Yes	Yes	Yes	No
GP fixed effects	No	No	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes

Note: B represents FFS equivalent billings. Model A adds $1 to the dependent variables and the standard errors are clustered at the patient level; Model B is a two-part model, and the standard errors are clustered at the patient level; Model C aggregates the billings to the general practitioner (GP) level and the standard errors are clustered at that level. Coef. is short for coefficient; 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, GPs annual working days, group size, year dummies and quadratic terms of all continuous variables.

Appendix Table 1.2 Effect of joining blended capitated basket model on inside and outside basket services aggregated together

(1)	(2) Model A: costs including zeros		(3) Model B: costs 0/1, then costs | costs>=1				(4) Model C: aggregate to GP level	
	Coef.	S.E.	Exp(coef.)	S.E.	Coef.	S.E.	Coef.	S.E.
Effect of switching to the blended capitation model on FFS equivalent billings *inside* the basket								
Ln(B), all GPs in Ontario								
FHO only	-0.113***	(0.008)	0.820***	(0.016)	-0.109***	(0.010)	-0.170***	(0.012)
FHT	-0.120***	(0.013)	0.804***	(0.026)	-0.090***	(0.021)	-0.217***	(0.025)
Ln(B), rostering GP								
FHO only	-0.083***	(0.008)	0.817***	(0.021)	-0.115***	(0.013)	-0.127***	(0.013)
FHT	-0.094***	(0.014)	0.798***	(0.035)	-0.073***	(0.028)	-0.168***	(0.025)
Ln(B), same group as rostering GP								
FHO only	-0.011	(0.003)	0.829***	(0.058)	-0.077**	(0.033)	-0.086***	(0.010)
FHT	-0.017	(0.005)	0.762***	(0.070)	-0.043	(0.039)	-0.145***	(0.022)
Ln(B), GPs outside the group								
FHO only	-0.038***	(0.005)	0.868***	(0.020)	-0.032***	(0.009)	-0.183***	(0.020)
FHT	-0.040***	(0.008)	0.844***	(0.030)	-0.004	(0.017)	-0.211***	(0.037)
Effect of switching to the blended capitation model on FFS equivalent billings *outside* the basket								
Ln(B), all GPs in Ontario								
FHO only	0.058***	(0.009)	1.032**	(0.013)	0.081***	(0.009)	0.040***	(0.009)
FHT	0.016	(0.016)	0.997	(0.022)	0.034**	(0.015)	-0.010	(0.015)
Ln(B), rostering GP								
FHO only	0.108***	(0.011)	1.114***	(0.023)	0.164***	(0.014)	0.246***	(0.017)
FHT	0.057***	(0.018)	1.046	(0.037)	0.102***	(0.022)	0.123***	(0.027)
Ln(B), same group as rostering GP								
FHO only	0.008	(0.008)	1.034	(0.044)	0.124***	(0.020)	0.025	(0.021)
FHT	0.009	(0.011)	0.993	(0.067)	0.142***	(0.031)	-0.078**	(0.032)
Ln(B), GPs outside the group								
FHO only	-0.034***	(0.008)	0.946***	(0.012)	-0.002	(0.009)	-0.056***	(0.010)
FHT	-0.043***	(0.015)	0.949**	(0.021)	-0.029*	(0.016)	-0.074***	(0.017)

Note: FHT represents GPs who are both FHO and FHT; FHO only represents GPs who are FHO but not FHT.

Appendix Table 1.3 Effect of joining blended capitated basket model by FHT and FHO GPs

	2007/08 cohort	2008/09 cohort	2009/10 cohort	2010/11 cohort
	Coef.	Coef.	Coef.	Coef.
Impact on services *inside* the basket				
Ln(B), all GPs in Ontario	0.014	-0.035***	-0.067***	-0.044***
	(0.014)	(0.011)	(0.008)	(0.005)
Ln(B), rostering GP	0.032**	-0.023*	-0.049***	-0.038***
	(0.014)	(0.012)	(0.009)	(0.006)
Ln(B), same group as rostering GP	-0.014	-0.002	-0.005*	-0.008*
	(0.006)	(0.004)	(0.002)	(0.002)
Ln(B), GPs outside the group	-0.004	-0.016**	-0.028***	-0.006
	(0.009)	(0.007)	(0.006)	(0.005)
Impact on services *outside* the basket				
Ln(B), all GPs in Ontario	0.005	-0.006	0.029***	0.027***
	(0.020)	(0.013)	(0.010)	(0.007)
Ln(B), rostering GP	-0.014	0.038**	0.052***	0.035***
	(0.023)	(0.015)	(0.012)	(0.008)
Ln(B), same group as rostering GP	-0.012	-0.010	0.002	0.005
	(0.017)	(0.012)	(0.007)	(0.004)
Ln(B), GPs outside the group	0.036*	-0.024**	-0.025***	-0.002
	(0.019)	(0.010)	(0.008)	(0.006)

Note: B represents FFS equivalent billings. 2007/08 cohort represents GPs who switched to the blended capitation model during fiscal year 2007/2008. 2008/09 cohort represents GPs who switched to the blended capitation model during fiscal year 2008/2009. 2009/10 cohort represents GPs who switched to the blended capitation model during fiscal year 2009/2010. 2010/11 cohort represents GPs who switched to the blended capitation model during fiscal year 2010/2011. All specifications control for: the percent of male patients, roster size, average age of patients, the practice’s rurality index, average daily patients visits, GPs annual working days, group size, year dummies and quadratic terms of all continuous variables.

Appendix Table 1.4 Impact of switching by cohort using Model A

	2007/08 cohort		2008/09 cohort		2009/10 cohort		2010/11 cohort	
	Exp (coef.)	Coef.	Exp (coef.)	Coef.	Exp (coef.)	Coef.	Exp (coef.)	Coef.
Impact on services *inside* the basket by cohort using the two-part model								
Ln(B), all GPs in Ontario	1.077**	-0.031	0.934***	-0.035**	0.882***	-0.052***	0.926***	-0.043***
	(0.035)	(0.027)	(0.024)	(0.015)	(0.015)	(0.011)	(0.010)	(0.008)
Ln(B), rostering GP	1.157***	-0.042	0.911***	-0.030	0.892***	-0.045***	0.924***	-0.050***
	(0.053)	(0.038)	(0.033)	(0.019)	(0.022)	(0.013)	(0.014)	(0.010)
Ln(B), same group as rostering GP	0.927	-0.103**	0.925	0.006	0.980	-0.036	0.853***	-0.043**
	(0.092)	(0.045)	(0.080)	(0.039)	(0.046)	(0.027)	(0.035)	(0.020)
Ln(B), GPs outside the group	0.985	-0.030	0.965	-0.017	0.896***	-0.001	0.964**	-0.019*
	(0.040)	(0.019)	(0.030)	(0.011)	(0.023)	(0.010)	(0.017)	(0.010)
Impact on services *outside* the basket by cohort using the two-part model								
Ln(B), all GPs in Ontario	0.986	0.015	1.013	-0.009	1.017	0.035***	1.003	0.043***
	(0.027)	(0.017)	(0.018)	(0.012)	(0.013)	(0.010)	(0.009)	(0.008)
Ln(B), rostering GP	0.965	-0.012	1.109***	0.020	1.041*	0.079***	1.008	0.075***
	(0.043)	(0.026)	(0.031)	(0.018)	(0.022)	(0.015)	(0.012)	(0.012)
Ln(B), same group as rostering GP	0.916	0.138***	0.986	-0.098***	1.033	0.1451***	0.986	0.045***
	(0.069)	(0.032)	(0.061)	(0.026)	(0.036)	(0.019)	(0.021)	(0.013)
Ln(B), GPs outside the group	1.082***	-0.042**	0.963**	0.004	0.957***	0.006	0.999	-0.011
	(0.032)	(0.018)	(0.016)	(0.012)	(0.013)	(0.011)	(0.010)	(0.007)

Note: B represents FFS equivalent billings. 2007/08 cohort represents GPs who switched to the blended capitation model during fiscal year 2007/2008. 2008/09 cohort represents GPs who switched to the blended capitation model during fiscal year 2008/2009. 2009/10 cohort represents GPs who switched to the blended capitation model during fiscal year 2009/2010. 2010/11 cohort represents GPs who switched to the blended capitation model during fiscal year 2010/2011. All specifications control for: the percent of male patients, roster size, average age of patients, the practice's rurality index, average daily patients visits, GPs annual working days, group size, year dummies and quadratic terms of all continuous variables.

Appendix Table 1.5 Impact of switching by cohort using Model B

	DID with fixed-effects	DID with differential trend	Linear trend
	Coef.	Coef.	Coef.
Panel A: Effect on services *inside* the basket by differential trend			
Ln(B), all GPs in Ontario	-0.120***	-0.094***	-0.030**
	(0.008)	(0.013)	(0.013)
Ln(B), rostering GP	-0.090***	-0.073***	-0.020
	(0.008)	(0.016)	(0.017)
Ln(B), same group as rostering GP	-0.014	-0.015	0.001
	(0.003)	(0.004)	(0.004)
Ln(B), GPs outside the group	-0.039***	-0.021*	-0.022
	(0.005)	(0.012)	(0.014)
Panel B: Effect on services *outside* the basket by differential trend			
Ln(B), all GPs in Ontario	0.050***	0.076***	-0.030*
	(0.009)	(0.018)	(0.018)
Ln(B), rostering GP	0.100***	0.122***	-0.026
	(0.010)	(0.022)	(0.023)
Ln(B), same group as rostering GP	0.001	-0.010	0.013
	(0.007)	(0.008)	(0.010)
Ln(B), GPs outside the group	-0.032***	-0.012	-0.023
	(0.007)	(0.015)	(0.017)

Note: B represents FFS equivalent billings. All specifications control for: the percent of male patients, roster size, average age of patients, the practice's rurality index, average daily patients visits, GPs annual working days, group size, year dummies and quadratic terms of all continuous variables.

Appendix Table 1.6 Effect of switching by differential trend using Model A

	DID with fixed-effects costs 0/1, then costs | costs>=1		DID with differential trend costs 0/1, then costs | costs>=1		Linear trend	
	Exp(coef.)	Coef.	Exp(coef.)	Coef.	Exp(coef.)	Coef.
Panel A: Effect on services *inside* the basket by differential trend						
Ln(B), all GPs in Ontario	0.810***	-0.112***	0.845***	-0.090***	0.951*	-0.026
	(0.015)	(0.010)	(0.023)	(0.017)	(0.027)	(0.019)
Ln(B), rostering GP	0.808***	-0.114***	0.856***	-0.117***	0.934	0.003
	(0.019)	(0.013)	(0.033)	(0.023)	(0.040)	(0.025)
Ln(B), same group as rostering GP	0.794***	-0.073**	0.806***	0.001	0.982	-0.087*
	(0.049)	(0.028)	(0.065)	(0.049)	(0.093)	(0.049)
Ln(B), GPs outside the group	0.862***	-0.029***	0.909*	-0.028*	0.939	-0.002
	(0.019)	(0.009)	(0.045)	(0.016)	(0.051)	(0.017)
Panel B: Effect on services *outside* the basket by differential trend						
Ln(B), all GPs in Ontario	1.024**	0.073***	1.010	0.119***	1.016	-0.055***
	(0.012)	(0.009)	(0.022)	(0.018)	(0.023)	(0.019)
Ln(B), rostering GP	1.103***	0.153***	1.117***	0.185***	0.985	-0.038
	(0.021)	(0.013)	(0.041)	(0.028)	(0.039)	(0.028)
Ln(B), same group as rostering GP	0.990	0.131***	0.937	0.093***	1.066	0.044
	(0.037)	(0.018)	(0.046)	(0.026)	(0.060)	(0.028)
Ln(B), GPs outside the group	0.952***	-0.006	0.957*	0.042**	0.994	-0.057***
	(0.011)	(0.008)	(0.025)	(0.017)	(0.029)	(0.018)

Note: B represents FFS equivalent billings. All specifications control for: the percent of male patients, roster size, average age of patients, the practice's rurality index, average daily patients visits, GPs annual working days, group size, year dummies and quadratic terms of all continuous variables.

Appendix Table 1.7 Effect of switching by differential trend using Model B

	Ln(B), all GPs in Ontario	Ln(B), rostering GP	Ln(B), same group as rostering GP	Ln(B), GPs outside the group
	coef.	coef.	coef.	coef.
Panel A：Effect on services *inside* the basket				
Baseline	-0.192***	-0.144***	-0.108***	-0.201***
	(0.012)	(0.012)	(0.010)	(0.019)
Alternative estimators				
Kernel	-0.192***	-0.143***	-0.108***	-0.200***
	(0.012)	(0.012)	(0.010)	(0.019)
Alternative bandwidths				
0.05	-0.191***	-0.143***	-0.107***	-0.200***
	(0.012)	(0.012)	(0.010)	(0.019)
0.2	-0.193***	-0.143***	-0.109***	-0.202***
	(0.012)	(0.012)	(0.010)	(0.019)
Alternative kernel functions				
Normal	-0.193***	-0.143***	-0.109***	-0.203***
	(0.012)	(0.012)	(0.010)	(0.019)
Epanechnikov	-0.204***	-0.147***	-0.113***	-0.220***
	(0.015)	(0.013)	(0.012)	(0.026)
Alternative trimming values				
10%	-0.191***	-0.147***	-0.107***	-0.192***
	(0.012)	(0.012)	(0.010)	(0.018)
No trimming	-0.192***	-0.139***	-0.115***	-0.206**
	(0.012)	(0.012)	(0.010)	(0.019)
Panel B: Effect on services *outside* the basket				
Baseline	0.032***	0.223***	-0.010	-0.053***
	(0.008)	(0.016)	(0.019)	(0.009)
Alternative estimators				
Kernel	0.032***	0.225***	-0.011	-0.053***
	(0.008)	(0.016)	(0.019)	(0.009)
Alternative bandwidths				
0.05	0.033***	0.224***	-0.009	-0.052***
	(0.008)	(0.016)	(0.020)	(0.010)
0.2	0.031***	0.220***	-0.009	-0.055***
	(0.008)	(0.016)	(0.019)	(0.009)
Alternative kernel functions				
Normal	0.031***	0.220***	-0.009	-0.055***
	(0.008)	(0.016)	(0.019)	(0.009)
Epanechnikov	0.034***	0.230***	-0.005	-0.057***
	(0.010)	(0.018)	(0.023)	(0.012)
Alternative trimming values				
10%	0.037***	0.232***	-0.002	-0.051***
	(0.008)	(0.016)	(0.019)	(0.009)
No trimming	0.027***	0.208***	-0.021	-0.052***
	(0.008)	(0.016)	(0.020)	(0.009)

All estimations control for the percent of male patients and its squared term, roster size and its squared term, average age of patients and its squared term, GPs practice rural index and its squared term, daily visits paid to GPs and its squared term, number of working days annually and its squared term, group size and its squared term and year dummies.

Appendix Table 1.8 Effect by alternative matching estimators

Appendix Part II:

Proof that $x_1^{BC} + x_2^{BC} < x_1^F + x_2^F$ in support of the argument in section 3.

Since $U'(\varphi x_1^F + x_2^F + C) < U'(x_1^F + x_2^F)$, $\varphi < 1$ then from Equation (2):

$\varphi U'(\varphi x_1^F + x_2^F + C) - tV'(T - t(x_1^F + x_2^F)) + \alpha h'(x_1^F) < \varphi U'(x_1^F + x_2^F) - tV'(T - t(x_1^F + x_2^F)) + \alpha h'(x_1^F) < U'(x_1^F + x_2^F) - tV'(T - t(x_1^F + x_2^F)) + \alpha h'(x_1^F) = 0$

$\rightarrow \varphi U'(\varphi x_1^F + x_2^F + C) - tV'(T - t(x_1^F + x_2^F)) + \alpha h'(x_1^F) < 0$

Combining with equation (5)

$$\varphi U'(\varphi x_1^F + x_2^F + C) - tV'(T - t(x_1^F + x_2^F)) + \alpha h'(x_1^F) < \varphi U'(\varphi x_1^{BC} + x_2^{BC} + C) - tV'(T - t(x_1^{BC} + x_2^{BC})) + \alpha h'(x_1^{BC})$$

as $x_2^{BC} > x_1^{BC}$ then

$$\varphi U'(\varphi x_1^{BC} + x_2^{BC} + C) - tV'(T - t(x_1^{BC} + x_2^{BC})) + \alpha h'(x_1^{BC}) < \varphi U'(\varphi x_1^{BC} + x_1^{BC} + C) - tV'(T - t(x_1^{BC} + x_1^{BC})) + \alpha h'(x_1^{BC})$$

Therefore,

$$\varphi U'(\varphi x_1^F + x_2^F + C) - tV'(T - t(x_1^F + x_2^F)) + \alpha h'(x_1^F) < \varphi U'(\varphi x_1^{BC} + x_1^{BC} + C) - tV'(T - t(x_1^{BC} + x_1^{BC})) + \alpha h'(x_1^{BC})$$

As $x_1^F = x_2^F$, and U, V, h are strictly concave, then

$$x_1^{BC} < x_1^F$$

Since $\varphi x_1^F + x_2^F + C > x_1^F + x_2^F$, and $\varphi < 1$,then

$$C > x_1^F(1 - \varphi) > x_1^{BC}(1 - \varphi)$$

$\rightarrow$

$$C > x_1^{BC}(1 - \varphi)$$

Then adding x_2^{BC} on both sides and rearranging yields

$$\varphi x_1^{BC} + x_2^{BC} + C > x_1^{BC} + x_2^{BC}$$

On the other hand, equation (2) +(3) yields

$$2U'(x_1^F + x_2^F) - 2\,tV'(T - t(x_1^F + x_2^F)) + \alpha h'(x_1^F) + \alpha h'(x_2^F) = 0 \quad (12)$$

equation (4) +(5) yields

$$(1 + \varphi)U'(\varphi x_1^{BC} + x_2^{BC} + C) - 2\,tV'(T - t(x_1^{BC} + x_2^{BC})) + \alpha h'(x_1^{BC}) + \alpha h'(x_2^{BC}) = 0$$

As $\varphi < 1$, then

$$2U'(\varphi x_1^{BC} + x_2^{BC} + C) - 2\,tV'\big(T - t(x_1^{BC} + x_2^{BC})\big) + \alpha h'(x_1^{BC}) + \alpha h'(x_2^{BC}) > 0$$

As $\varphi x_1^{BC} + x_2^{BC} + C > x_1^{BC} + x_2^{BC}$, then

$$2U'\big(x_1^{BC} + x_2^{BC}\big) - 2\,tV'\big(T - t(x_1^{BC} + x_2^{BC})\big) + \alpha h'(x_1^{BC}) + \alpha h'(x_2^{BC}) > 0 \quad (13)$$

Combining (12) and (13)

$$2U'(x_1^F + x_2^F) - 2\,tV'\big(T - t(x_1^F + x_2^F)\big) + \alpha h'(x_1^F) + \alpha h'(x_2^F) < 2U'\big(\varphi x_1^{BC} + x_2^{BC}\big) - 2\,tV'\big(T - t(x_1^{BC} + x_2^{BC})\big) + \alpha h'(x_1^{BC}) + \alpha h'(x_2^{BC})$$

Assume $M'(x_1 + x_2) = h'(x_1) + h'(x_2)$,

$$2U'(x_1^F + x_2^F) - 2\,tV'\big(T - t(x_1^F + x_2^F)\big) + \alpha M'(x_1^F + x_2^F) < 2U'\big(\varphi x_1^{BC} + x_2^{BC}\big) - 2\,tV'\big(T - t(x_1^{BC} + x_2^{BC})\big) + \alpha M'(x_1^{BC} + x_2^{BC})$$

As M, U, V and h are strictly concave, then

$$x_1^{BC} + x_2^{BC} < x_1^F + x_2^F$$

Chapter 2 Do primary care payment models with rostering measurably improve continuity of care?

2.1 Introduction

High levels of continuity of care, especially in primary care, are found to be associated with improved health outcomes, increased preventive care provision, and reductions in emergency department use and hospitalizations (Menec et al., 2005; Iversen and Lurås, 2011). However, in practice, there is limited and mixed evidence on the performance of primary care reform in improving continuity of care (David et al., 2016). Our study examines the impact on continuity of care of a set of primary care reforms in Ontario, Canada.

Continuity of care is facilitated by patient rostering, whereby a patient officially enrolls with a general practitioner (GP). Internationally, patient rostering is often rewarded by financial incentives for physicians, while on the patients' side it usually means increased access to general preventive, diagnostic and curative services (Kalucy and Jackson-Bowers, 2009; Nolte et al., 2008). We measure continuity of care using various indices which focus on the exclusiveness of the relationship between patients and their rostering GP and/or GPs in the same group practice.

From a base of traditional fee-for-service (FFS), the sequential introduction of two physician payment models —enhanced FFS and blended capitation— is used to study the impact of rostering on continuity of care. We evaluate the effects of no rostering compared to two “levels” of rostering, which we interpret as weak and strong. Both new models similarly reward physicians for providing patients with after-hours and comprehensive care, and meeting pay-for-performance (P4P) targets. However, the enhanced FFS model financialy incentivizes voluntary (weak) rostering, whereas the blended capitation model has (strong) mandatory rostering with penalties for patients who see other GPs (i.e., negation – see Sweetman and Buckley, 2014).

Since GPs voluntarily join payment models, care is required in drawing causal inferences (Rudoler et al., 2015). Selection biases are addressed using propensity score reweighting in a difference-in-differences panel fixed-effect model where the sample comprises continuously rostered patient-GP pairs. This estimation strategy controls for important observable GP and practice characteristics, for potential selection on fixed unobservables through the inclusion of GP individual fixed-effects, and for patient selection into the practice by virtue of focusing exclusively on the (sometimes virtually) continuously rostered population. Overall, we observe no measurable effect of the move to an enhanced FFS payment model on continuity of care, but for blended capitation statistically and economically significant improvements are observed.

In section 2 we briefly overview the history of physician payment models in Ontario, Canada, while section 3 reviews studies of continuity of care and its measurement, and defines the continuity of care indexes employed. Section 4 describes the administrative data source used in the empirical analysis, and section 5 presents an empirical strategy to identify the impact of rostering on continuity of care. We discuss our results in section 6, while section 7 summarizes the conclusions and discusses the identification and interpretation of the findings arguing that stronger rostering in the context of this payment model improves continuity of care.

2.2 History and Context

Canada has a set of universal physician and hospital care systems each of which is publicly funded and operated by a provincial/territorial government. Beginning in the late 1990s, these governments adopted a voluntary approach to physicians' engagement in incremental primary care reform (Marchildon and Hutchison, 2016; Hutchison et al., 2011). In the province of Ontario, key policy innovations were often embedded in agreements between the Ontario Medical Association and the Ontario Ministry of Health and Long-Term Care. Most primary health care policy innovations encompassed physicians' payment and practice models.

Family Health Groups (FHGs) and Family Health Organizations (FHOs) are the two major new primary care payment models. Prior to FHGs, traditional FFS was the dominant payment mode. The FHG is an enhanced FFS model incorporating traditional FFS plus enrolment premiums, and P4P bonuses and incentives. The FHO is a blended model with a “capitated basket” of services paid predominantly by capitation mixed with some FFS, services outside that basket are FFS, plus it has P4P almost identical to the FHG (Sweetman and Buckley, 2014). Both reformed models require GPs to practice in groups of at least three and reward physicians for providing after hours and comprehensive care. Rostering patients is optional for enhanced FFS GPs but required for blended capitation. There is no rostering for traditional FFS, however virtually rostered patients can be identified. Also, GPs in the blended model receive a “bonus” of around 20 percent of the capitation rate if their enrolled patients receive core services exclusively from GPs in their group. The bonus is reduced by the FFS value of core services delivered by GPs outside that group.

The enhanced FFS model was introduced on July 1, 2003 and became very popular quite quickly. However, a substantial number of these GPs then switched to the blended capitation model once it was introduced on November 1, 2006 (Kralj and Kantarevic, 2013). These two shifts create an opportunity to study changes in the continuity of care as some GPs switched from no rostering to weak rostering, and then to strong rostering.

An interdisciplinary primary health care group known as the Family Health Team (FHT) was established in Ontario in April 2005. It is a practice model rather than a physician-payment model, but is only available to GPs paid by capitation or salary. It consists of a team of GPs, nurses, and interdisciplinary health professionals that may include dieticians, psychologists, pharmacists, social workers and/or others. FHTs promote comprehensive and interdisciplinary services such as chronic disease management, counseling, health education and palliative care (Sweetman and Buckley, 2014). GPs who wish to join an FHT are required to submit an application to the Ministry of Health and Long-term Care, and not all applications are accepted as submitted. This two-sided selection implies that blended capitation GPs who join an FHT may be significantly different than those who do not.

2.3 Continuity of care

Various measures have long been employed to assess the effect of continuity of care on costs and health (Shen and Zuckerman, 2005; Menec et al., 2005). Some are quite simple, such as measuring the duration and frequency of contact with a regular provider, and counting the number of providers seen within a fixed time period. A usual provider of care (UPC) variable, first proposed by Breslau and Reeb (1975), measures the proportion of visits with the (nominally) main provider over a given period, and the continuity of care index (COC), by Bice and Boxerman (1977), weights both the frequency of visits to each provider and the dispersion of visits between providers. Subjective (patient opinion) continuity of care measures also exist (e.g., Bentler et al., 2014), but cannot be calculated using claims data so are not pursued here.

Recent empirical studies use density indices like UPC to examine the influence of continuity of care on outcomes. For example, David et al. (2016) focus on utilization on both the extensive and intensive margins to study the impact of patient-centered medical homes and continuity of care. The Canadian Institute for Health Information (2015) looks at the relationship between continuity of care as measured by UPC and avoidable hospital services. Aside from density indexes, Iversen and Lurås (2011) use the number of patients switching physicians as an indicator of continuity of care.

The continuity of care indexes employed in this study are as follows, with time subscripts suppressed for simplicity although each is calculated on a fiscal year basis. For each GP, *m*, and each continuously rostered patient (i.e., rostered the entire period of the study), *r*, the share who only see their rostering GP each fiscal year is:

$$\%RosterOnly_m = \frac{n_{rm}}{n_m} * 100\% \qquad (1)$$

where n_{rm} is the number of those rostered patients who only visited their rostering GP within a year; n_m is the total number of patients who were continuously rostered with that GP during the sample period. This measures, from the GP's perspective, the proportion of rostered patients who only visited the rostering GP.

The share of rostered patients who only see GPs in their rostering GP's group, g, is:

$$\%RosterGrpOnly_m = \frac{n_{rg}}{n_m} * 100\% \qquad (2)$$

where n_{rg} is the number of those rostered patients who only visited GPs in their rostering group (including the rostering GP) within a year. This index reflects the primary care reform process under study, which emphasized group practice, and cannot be calculated for traditional FFS.

The average number of GPs seen by each GP's continuously rostered patients is calculated as:

$$(GPs/Patient)_m = \frac{\sum_{r=1}^{r=n_m}(t_{rm})}{n_m} \qquad (3)$$

where t_{rm} is, for patient *r* rostered with GP *m*, the total number of GPs seen within the year. This index measures the number of primary care providers, including the rostering GP and those in the same group, with whom the patient had contact within a year, and assumes that a greater concentration of care with fewer providers signifies stronger relationships, more consistent care plans, and smoother transfers of information.

The average number of GPs beyond the rostering GP seen by the rostering GP's continuously rostered patients is:

$$NonRoster_m = \frac{\sum_{r=1}^{r=n_m}(nonr_{rm})}{n_m} \qquad (4)$$

where $nonr_{rm}$ is the number of GPs seen within the year other than the rostering GP. This index measures the number of non-rostering GPs, including those in the same group as the rostering GP, with whom the patient had contact. It assumes that a higher number of non-rostering providers signifies a weaker bond between each patient and her/his rostering GP.

The average number of GPs outside the rostering GP's group seen by her/his continuously rostered patients is:

$$NonRosterGrp_m = \frac{\sum_{r=1}^{r=n_m} nonrg_{rm}}{n_m} \qquad (5)$$

where $nonrg_{rm}$ is the number of non-rostering GPs outside the rostering GP's group seen within the year. As with $\%RosterGrpOnly$, this index cannot be calculated for traditional FFS.

Breslau's usual provider continuity index (UPC, Breslau et al., 1975) is:

$$UPC_m = \frac{\sum_{r=1}^{r=n_m} \frac{v_{rm}}{V_{rm}}}{n_m} \qquad (6)$$

where v_{rm} is the total number of visits to the rostering GP, and V_{rm} is the total number of visits to all GPs by patients rostered to *m*. This index sums the number of visits to the rostering provider in a year over the total number of visits to all GPs, and then averages across all rostered patients for each GP in the sample.

Bice et al.'s continuity of care index (COC, Bice et al., 1977) is:

$$COC_m = \frac{\sum_{r=1}^{r=n_m} \frac{\sum_{j=1}^{j=t_{rm}} (v_{rm}^{j} - V_{rm})}{V_{rm}\,(V_{rm} - 1)}}{n_m} \qquad (7)$$

where v_{rm}^{j} is the total number of visits within the year to GP *j* (*j* is any GP seen by patient *r*). This index measures the concentration of care and accounts for the number of different GPs seen. The COC falls with an increasing number of providers.

2.4 Data

2.4.1 Administrative sources

Our data come from administrative records maintained by the Ontario Ministry of Health and Long-Term Care. The Ontario Health Insurance Plan claims database includes the billings of essentially all GPs and specialists in the province, and the Client Agency Program Enrollment (CAPE) Database provides information on patients rostered with each GP in a primary care reform model. The Corporate Provider Database has information on the demographics and payment models of GPs. These databases are linked by encrypted unique identifiers of GPs and patients and enable us to examine characteristics and construct continuity of care measures.[17]

2.4.2 Study datasets

The sample used for the first transition, from (traditional) FFS to enhanced FFS with weak rostering, contains all GPs in the province who were FFS in fiscal year 2002/03 and met the criteria below. They then either stayed as FFS, or switched to enhanced FFS directly and stayed in enhanced FFS to 2006/07. The sample used for the second transition, from enhanced FFS to blended capitation, similarly contains all GPs who were in enhanced FFS in 2006/07. They then either stayed in enhanced FFS or switched to blended capitation directly and stayed as FHOs to 2010/11.

Our samples exclude GP specialists and comprise GPs who both actively submit at least one of the common primary care fee codes every year and (as relevant) virtually or officially roster patients. The sample is further restricted to continuously enrolled physician-patient pairs. As shown in Table 1, 3,376 GPs were in traditional FFS at the beginning of the sample period. By the end of it, 2,339, approximately two-thirds, switched to enhanced FFS. Similarly, for the second transition 3,087 GPs were in enhanced FFS at the beginning of the period, but by the end 1,342 GPs, or about 44%, switched to blended capitation with 33% exclusively blended capitation and 11% also affiliated with an interdisciplinary FHT. Since many GPs started their practice under the enhanced FFS

[17] Research ethics was through the Hamilton Integrated Research Ethics Board (#11-086-C).

payment model, enhanced FFS GPs in Table 1 need not have switched from FFS.

2.5 Empirical Strategy

2.5.1 "Official" and virtual rostering

For the new payment models, there is an "official" rostering/enrollment process whereby patients sign a form which is submitted to the provincial Ministry of Health. However, since FFS GPs do not formally roster patients we employ virtual rostering for them and their comparators. A patient is virtually rostered with a GP in a year if that GP bills the highest dollar value for that patient the previous two years of all GPs seen by the patient (Balogh et al. 2013). Patients are virtually assigned to GPs on an annual basis and we retain in the sample for analysis patients who were continuously rostered with the same GP during the entire sample period.

For the transition from enhanced FFS to blended capitation, both official and virtual rostering are compared. Our unit of analysis is the GP, so patient-level information is aggregated, but the underlying sample for this transition contains 3,591,709 patients who are continuously rostered by at least one approach. Contrasting the two, 67.6% of virtually rostered patients are assigned to their officially rostering GP, 0.4% are assigned a different GP, and 32% are virtually assigned to a GP but not officially rostered to any GP. On the other hand, 33% of officially rostered patients cannot be virtually rostered with a particular GP since they had zero visits in the first panel year and the one preceding it, or due to a tie in the assigning criteria.

2.5.2 Empirical Methodology and Identification

Imbens and Wooldridge (2009), and Imbens and Rubin (2015) recommend adopting a strategy that combines regression and propensity score methods in order to achieve robustness to misspecification of the parametric models. Therefore, a difference-in-differences fixed-effects model is used after reweighting the comparison group using propensity scores combined via local linear regression. This technique is sometimes called double robust estimation (Wooldridge, 2010). Propensity scores predict the likelihood of changing payment models. Matching identifies the set of comparison group observations which are most similar to each treatment group member, and weighting balances the distribution of characteristics of the treated and comparison groups so that functional form misspecification in the regression does not bias the treatment variable's coefficient. Fixed-effects in the regression remove the bias from omitted unobserved fixed characteristics, and employing the set of continuously rostered patients (rostered with the GP prior to the introduction of each new payment model) addresses bias from patient selection into the GP's practice. If the set of control variables are sufficient so that the conditional independence assumption (sometimes called unconfoundedness, or selection on observables) is credible —that is, treatment is not correlated with time varying unobservables— then the coefficients of interest can be interpreted as causal impacts (Imbens, 2015). In this case, as will be seen, we believe that the conditioning variables employed will convince many readers that, in this context, the treatment is plausibly unconfounded (Smith and Sweetman, 2016).

The first step uses a logit model to estimate propensity scores that are used in a matching estimator —local linear regression— to generate weights.[18] The unit of analysis is the rostering GP. The dependent variable in propensity score estimation is set to one if, by the end of the relevant period, the GP switched to enhanced FFS from traditional FFS in the first transition, or blended capitation from enhanced FFS in the second transition, and zero otherwise. The control variables employed include the GPs' characteristics pre-switch such as age, gender, place of graduation, the rurality index of Ontario (RIO, which ranges from 0, dense urban to 100, extremely remote; Kralj, 2009), the average number of patient visits per calendar day, the number of GPs in a practice group, and the annual number of working days. Average characteristics of patients – such as roster size, average patient age, and the percent of patients who are male – are also included, as are past continuity of care indices that might be associated with unobserved GP/practice characteristics and the switching decision. One noteworthy variable is *expected income gain* which reflects the cost or benefit of the payment model switch holding practice style constant.[19] The provincial Ministry of Health provided the same income gain calculation to GPs in this period to aid them in decision-making, so this is a crucial conditioning variable for identification. Quadratic terms are also included for all continuous variables.

In the fixed-effect regression step, the models are:

First transition: $$\log(M_{1mt}) = \alpha_{1m} + \lambda_{1t} + \beta_1 X_{1mt} + \delta_1 FHG_{mt} + u_{1mt} \qquad (8)$$

[18] Frölich et al. (2015) find that a non-parametric first stage can have superior properties; we did experiments with a non-parametric first stage but found that in this reasonably well-behaved context it makes little difference. Since the non-parametric estimator is substantially more time consuming we employ the logit.
[19] This is similar to that employed by Kralj and Kantarevic (2013) and Kantarevic and Kralj (2013).

Second transition: $\log(M_{2mt}) = \alpha_{2m} + \lambda_{2t} + \beta_2 X_{2mt} + \delta_2 FHO_{mt} + u_{2mt}$ (9)

where M_{1mt} and M_{2mt} are measures of continuity of care in fiscal year t for GP m, α_{1m} and α_{2i} are GP fixed-effects, λ_{1t} and λ_{2t} are year fixed-effects, and X_{1mt} and X_{2mt} are vectors of time varying characteristics. FHG_{mt} (or FHO_{mt}) is the proportion of the year in which a GP was affiliated with the enhanced FFS (or blended capitation) model — 1 or 0 in a year without a shift in payment model. Another noteworthy variable is an indicator variable that equals one in the transition year and allows us to isolate any transition year effects. Other regressors are listed below each table. The u_{1mt} and u_{2mt} terms are potentially clustered and heteroskedastic errors.

To distinguish the effect of joining blended capitation from joining both blended capitation and FHT, the following is estimated:

$$\log(M_{2mt}) = \alpha_{2m} + \lambda_{2t} + \beta_2 X_{2mt} + \rho FHO\_only_{mt} + \gamma FHT_{mt} + u_{2mt} \qquad (10).$$

FHO_only_{mt} is the treatment indicator which measures the percentage of the year in which a GP was affiliated with blended capitation but not an FHT; FHT_{mt} similarly measures affiliation with both blended capitation and an interdisciplinary team.

To improve inference we undertake pairs percentile-t bootstrapping that is clustered on the GP with 999 replications of the entire multi-step estimation process for each bootstrap sample. Instead of using the standard t-distribution, given H_0: b=0 we simulate the distribution of $t=(\hat{b}-0)/se(\hat{b})$ using $t^*=(b_n^*-\hat{b})/se(b_n^*)$, where $\hat{b}$ is the estimate of b, b_n^* the bootstrap coefficient for the n^{th} cluster resample, and $se(b_n^*)$ the standard error of the resampled coefficient estimated using the cluster robust formula. This technique does not produce standard errors but only p-values. The standard errors presented are based on the cluster robust formula for the regression model and given the multi-step estimation process employed are not as reliable as the asterisks displayed based on the bootstrapping.

2.6 Results

2.6.1 Matching for the traditional FFS to enhanced FFS transition

Summary statistics for enhanced FFS GPs, and the comparison group of traditional FFS GPs, in fiscal year 2002/2003, before the introduction of enhanced FFS, are presented on the left-hand side of Table 2. Both unweighted and weighted results are provided for the comparison group. The comparison group refers to GPs who remained in a traditional FFS model from 2002/2003 to 2006/2007, and the treated group refers to GPs who switched to the enhanced FFS model at any point in the sample period. On average, GPs who would subsequently choose to join the enhanced FFS model are younger, more likely to have graduated in Canada and have statistically significant more daily visits, a larger roster size, and fewer years of experience than those who chose to remain in traditional FFS. Switchers' practices are also located in more rural areas and, quite importantly, they have significantly higher expected income gains if they were to switch to enhanced FFS.

The indices $GPs/Patient$ and $\%NonRoster$ are lower in the treated group, suggesting that, on average, these patients visited fewer GPs in total, and fewer GPs with whom they were not rostered. In accord with this, the indices $\%RosterOnly$ and UPC are higher in the treated group suggesting that more patients of GPs who would switch to these models visited only their rostering GP, and are more likely to visit their rostering GP consecutively in the year. Overall, these findings indicate a higher pre-existing average level of continuity of care among GPs who chose to join enhanced FFS before the introduction of the model. The differences in these observable characteristics between the treated and comparison groups make regression sensitive to the misspecification of the functional form of the control variables in estimating the coefficient for the treatment variable. This issue is mitigated by employing propensity score weighting to balance the sample (Imbens, 2015; Imbens and Rubin, 2015).

Results from the propensity score estimation are presented in the appendix, however the resulting weighted characteristics of the FFS GPs shown in Table 2 are not statistically significantly different from those of enhanced FFS GPs except for average age, and the indexes *NonRoster*, *NonRosterGrp*. However, given the number of tests being conducted and the p-values observed, this number of marginally statistically significant outcomes is not unexpected and in all cases the weighting brings the comparison sample means close to the treated ones.

2.6.2 Matching for the enhanced FFS to blended capitation transition

The middle (using virtual rostering) and right-hand side (using official rostering) of Table 2 present summary statistics for the treated and comparison samples in 2006/07. In this case, the comparison group remained in enhanced FFS and the treated group switched to blended capitation at some point. Clearly, the practice population and style of physicians have dramatic impacts on the relative remuneration (i.e., the income gains) of the two payment models.

Contrasting the official and virtual rostering in the middle and right hand side of Table 2, the characteristics of GPs are extremely similar. However, the patient populations differ markedly. This is unexpected for blended capitation where rostering is mandatory for “regular” patients. Compared with official rostering, the virtual continuity of care indices are larger. Officially, blended capitation has a larger roster size, but virtual rostering shows the reverse. The continuity of care indices of both enhanced FFS and blended capitation using virtual rostering are greater because, by design, the virtual rostering algorithm assigns patients to those providers who bill the most. The characteristics of enhanced FFS and blended capitation are comparable after weighting for both virtual/official rostering.

Turning to Table 3, which contrasts physicians in the blended capitation model with and without the interdisciplinary FHT, prior to the blended capitation model being introduced GPs who would subsequently join an FHT, on average, practice in more rural areas, and have a larger physician group but smaller rostering size than GPs in blended capitation alone.

2.6.3 Panel fixed-effect models

Treating both blended capitation models homogenously, Table 4 reports the impacts of weak and strong rostering on the abovementioned continuity of care indices using double robust estimation. Each coefficient represents a regression, and each row has a common index as the dependent variable. Column (1) suggests that switching to enhanced FFS, a weak rostering model, does not measurably impact continuity of care. However, switching to blended capitation with continuous enrollment measured by virtual rostering, in column (2), statistically significantly improves the continuity of care indices. Both the percentage of patients who see only their rostering GP and the *UPC* increase, while the number of GPs seen per patient and the number of GPs seen beyond the rostering GP both decrease. Column (3) studies officially rostered patient-physician pairs and has a similar pattern of results as virtual rostering, but oddly the coefficient on *%RosterGrpOnly* becomes negative and statistically significant. Overall, the results suggest improvements in continuity of care, with magnitudes that are important, not so large as to be incredible and (although not a perfect analogy) of comparable magnitudes as the changes in the over/under-provision of services associated with the shift between enhanced FFS and blended capitation (Kralj and Kantarevic, 2013).

Table 5 breaks the patient sample into four subcategories in columns (1), (2), (3) and (6); columns (4) and (5), respectively, reflect the same samples as columns (1) and (2), but the regressions employ differently measured covariates. Column (1) comprises patients attached to the same GP by both official and virtual rostering, while column (2) reflects patients where there is a mismatch between virtual and official rostering. Column (3) focuses on those virtually rostered to a particular GP but not officially rostered with any GP, and column (6) addresses the converse; that is, those who are officially, but not virtually, rostered because they did not have a medical visit in the relevant two years. As seen from the sample sizes, when both approaches assign a physician-patient pair they are very likely to agree. However, there are substantial numbers of patients who cannot be assigned by one, or the other, of the two approaches.

The left (virtual) and right (official) hand sides of Table 5 reflect different samples used to calculate the aggregate practice-level regressors. As can be seen, different coefficient estimates follow, but they are within the norms of statistical precision. On this front, Table 5 is a sensitivity test.

Turning to the results, most of the continuity of care indices across the various subgroups are qualitatively similar to those in Table 4, although the smaller samples of patients in columns (2) and (5) produce larger standard errors. The coefficient shift for *%RosterGrpOnly* between columns (2) and (3) of Table 4 is seen to emanate from those who are officially rostered, but either mismatched or not matched by virtual rostering. *COC* is the only index that seems to have a sign reversal across the subsamples: positive where the methods match, but negative where they mismatch and only have the official roster. This makes sense with *COC* improving for patients with more visits at the start of the period, but worsening for those with very infrequent/no visits initially.

Table 6 splits the blended capitation model into its two constituent parts: with and without an interdisciplinary team. Both the blended capitation only and FHT models have statistically significant impacts on improving continuity of care. But, the addition of the interdisciplinary team appreciably increases the size of those impacts. Inter-professional teams appear to strengthen the bond between patients and their primary care practices.

2.7 Discussion and Conclusion

Multiple continuity of care indices are employed to evaluate the effect of rostering on the physician-patient relationship in primary care. Using comprehensive administrative data, we create a panel of GPs and continuously rostered patients, and employ a propensity weighted difference-in-differences approach to identify the impact of “weak” and “strong” rostering compared to traditional FFS. In the context of the payment models under study, weak implies that rostering is voluntary with financial incentives for enrolling patients. Strong rostering is mandatory with financial penalties for patients seeing GPs outside the rostering GP’s group in a blended capitation model with pay-for-performance. Weak rostering is found to have no measurable impact on the continuity of care indexes employed. In contrast, strong rostering appears to statistically significantly strengthen the bond between patients and GPs according to the continuity of care indexes employed; the magnitudes of the impacts are clinically important. Additionally, some GPs in the blended capitation payment model also elect to join a new interdisciplinary practice model, and the continuity of care indices are seen to improve substantially more with interdisciplinary care.

Given that physicians voluntarily change payment models, whether these results are best interpreted as causal impacts or well-controlled conditional covariances is a judgment for the reader. We believe that the set of conditioning variables including the fixed-effects, and the focus on continuously rostered patient-GP pairs, addresses the selection issues well and makes a causal interpretation of the payment model switching plausible. The control variables include demographics of the physician and patient population, measures of continuity of care prior to the introduction of the new payment models which characterize practice styles and, quite importantly, an estimate of the income gain (or loss) that would accrue to each physician if the fiscal year prior to the introduction of the new model were remunerated according to the old versus new payment model. This latter information was provided to physicians by the Ministry of Health and was part of their decision-making process.

Even if readers elect to interpret the results as non-causal, they remain interesting and further research might be undertaken to consider potential confounders. While we focus on rostering (in the context of particular payment models) as the key element of the payment model switch driving continuity of care, some readers may prefer to view the “package” of elements of each model as driving the causal change in continuity of care. For example, those who switch models may have simultaneously started making greater use of electronic medical records.

We limit patients to those continuously rostered in order to address selection issues. While patients with non-continuous enrollment patterns may experience different changes in continuity of care as a result of the introduction of these models (Iversen and Lurås, 2011), Kantarevic and Kralj (2014) find no patient ‘dumping’ using a comparison between blended capitation payment and FFS in Ontario.

Finally, although our results indicate increased continuity of care, we are cautious in drawing conclusions about quality of care. Our continuity of care measures are limited to relational continuity. Information and management measures of continuity are not feasible using current administrative data and these have important implications for quality (Hutchison et al., 2011), as might other factors not considered here.

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Panel A: Sample for FFS to Enhanced FFS transition 2002/2003 to 2006/2007					
	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007
FFS	3,376	2,449	1,808	1,168	1,037
Enhanced FFS	0	9,27	1,568	2,208	2,339
Panel B: Sample for Enhanced FFS to blended capitation transition 2006/2007 to 2010/2011					
	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011
Enhanced FFS	3,087	2,914	2,373	2,044	1,745
Blended Capitation only	0	135	602	854	1,018
Blended Capitation + FHT	0	38	111	188	324

Notes: FFS: Fee-for-service. FHT: (Interdisciplinary) Family Health Team. Fiscal years end March 31.

Table 2.1 Distribution of physicians by payment model by fiscal year

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	FFS to Enhanced FFS (virtual), 2002/2003			Enhanced FFS to Blended Capitation (virtual), 2006/2007			Enhanced FFS to Blended Capitation (virtual), 2006/2007		
	Treated (Enhanced FFS)	Comparison (Traditional FFS)		Treated (Blended capitation)	Comparison (Enhanced FFS)		Treated (Blended capitation)	Comparison (Enhanced FFS)	
		weighted	unweighted		weighted	unweighted		weighted	unweighted
Number of physicians	2,242	2,242	1,016	1,275	1,275	1,732	1,274	1,274	1,740
Characteristics of physicians									
Expected income gain	30,047	31,966	12,894***	21,703	22,002	-26,340***	21,670	22,366	-25,940***
Age	50.6	50.9	53.9***	50.1	50.1	52	50	50.2	52.1***
%Male	68	67	71.0**	62.5	61.5	65.2	62.6	62.2	65.2
Years of practice	21	21.1	23.0***	20.7	20.7	21.6***	20.6	21.6	21.6***
RIO (Rurality Index of Ontario)	7.7	7.9	6.7*	7.28	7.3	4.1***	7.4	7.6	4.1***
Daily no. of visits	32.4	32.8	29.2***	33.1	32.8	35***	33.2	32.6	35.0***
Annual working days	251	252.1	221.8***	244.55	247.3	248.2	247.4	247.8	249.2
Group size							51	52.3	65.4***
% graduation-Canada	81.2	79.2	74.6***	84.1	84.3	73.2***	84.1	84.6	73.2***
% graduation-USA	0.2	0.1	0.6*	0.1	0.2	0.4	0.2	0.2	0.4
% graduation-UK	4.7	4.7	5.8	3.3	3.2	3.8	3.3	3.3	3.9
Characteristics of practice population									
Roster size	1,354	1,400**	927***	1,519	1,522	1,588***	1,379	1,364	1,287***
Mean patient age	38.9	39.5*	34.3***	41.2	41.1	40.4***	41	41	44.2
Mean patient %male	45.6	45.9	47.8***	44.1	44.2	45.6***	43.4	43.4	40.7
Past outcomes, the year before switch									
%RosterOnly$_m$	0.4	0.42	0.36***	0.52	0.52	0.53	0.45	0.45	0.45
%RosterGrpOnly$_m$				0.69	0.69	0.67***	0.62	0.61	0.61
GPs/Patient$_m$	2.13	2.06*	2.39***	1.69	1.68	1.68	1.54	1.53	1.57**
NonRoster$_m$	1.18	1.11*	1.42***	0.75	0.75	0.75	0.73	0.72	0.75
NonRosterGrp$_m$				0.40	0.40	0.43***	0.39	0.39	0.43***
UPC$_m$	0.78	0.79	0.76*	0.83	0.83	0.84*	0.78	0.77	0.77
COC$_m$	0.64	0.66	0.61	0.73	0.72	0.74***	0.69	0.69	0.70***

Notes: The asterisks reflect p-values from t-tests for equality of means in the treatment and comparison groups. ***, ** 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 of physicians in a practice group. Members of the treatment groups switch to the new payment at some point in the period under study, whereas those in the comparison group remain in the initial payment model. “Official” refers to officially rostered patients-GP pairs; “Virtual” refers to virtually rostered pairs.

Table 2.2 Means of pre-switch characteristics by transition

	(1)	(2)	(3)	(4)
	Official Rostering		Virtual Rostering	
	Interdisciplinary FHT	Blended Capitation only	Interdisciplinary FHT	Blended Capitation only
Number of physicians	326	1,015	326	1,015
Characteristics of physicians				
Expected income gain	20,995	26,520	20,995	26,520
Age	49.0*	50	49.0*	50
%Male physicians	60.1	64	60.1	64
Years of practice	19.9	21	19.9	21
RIO/Rurality index of Ontario	13.0***	7.0	13.0***	7.0
%place of graduation-Canada	84.4	85.0	84.4	85.0
%place of graduation-USA	0.3	0.1	0.3	0.1
%place of graduation-UK	3.7	3.0	3.7	3.0
Daily visits	32.2*	33.6	32.2*	33.6
No. of working days	240.0***	249.5	240.0***	249.5
Group size	57.6*	48.3	57.6*	
Characteristics of practice population				
Roster size	1245.4***	1424.6	1373.3***	1568
%Male patients	43.4	43.5	43.6	44.4
Age	41.3	41	41.4	41.3
Outcomes prior to the introduction of blended capitation (2006/07)				
%RosterOnly$_m$	0.41***	0.46	0.48***	0.53
%RosterGrpOnly$_m$	0.62	0.61	0.70*	0.68
GPs/Patient$_m$	1.61***	1.52	1.79***	1.66
NonRoster$_m$	0.81***	0.70	0.85***	0.72
NonRosterGrp$_m$	0.37	0.39	0.38	0.40
UPC$_m$	0.75***	0.78	0.82***	0.84
COC$_m$	0.66***	0.70	0.70***	0.73

Notes: The asterisks reflect p-values from t-tests for equality of means in the treatment and comparison groups. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels respectively. “Blended capitation only” refers to physicians who switch to blended capitation but not FHT at any point in the sample period, while “FHT” refers to physicians who also affiliate with a FHT at some point. “Official” refers to official rostered patients; “Virtual” refers to virtual rostered patients.

Table 2.3 Characteristics by group and rostering type, 2006/07

Dependent Variable: Log of	(1) Enhanced FFS (virtual rostering) N_{GP}	δ_1	(2) Blended capitation (virtual rostering) N_{GP}	δ_2	(3) Blended capitation (official rostering) N_{GP}	δ_2
$\%RosterOnly_m$	3,022	0.022	3,005	0.063***	3,002	0.054***
		(0.027)		(0.007)		(0.008)
$\%RosterGrpOnly_m$			3,006	0.0003	3,012	-0.016**
				(0.0065)		(0.007)
$GPs/Patient_m$	3,208	0.012	3,006	-0.042***	3,014	-0.035***
		(0.010)		(0.003)		(0.004)
$NonRoster_m$	3,163	0.015	3,006	-0.083***	3,012	-0.075***
		(0.015)		(0.008)		(0.008)
$NonRosterGrp_m$			3,006	-0.024*	3,011	-0.011
				(0.012)		(0.012)
UPC_m	3,191	-0.008	3,006	0.016***	3,013	0.030***
		(0.023)		(0.003)		(0.005)
COC_m	3,172	0.015	3,006	0.009**	3,014	0.0007
		(0.015)		(0.004)		(0.0042)

Notes: Each coefficient is from a difference-in-differences regression with fixed-effects using propensity score weights. The sample sizes (number of GPs) vary slight across regressions because of missing data for the dependent variable and/or non-varying dependent variables. The dependent variables are the log of continuity of care indices. “Enhanced FFS” refers to physicians who remain in enhanced FFS throughout the entire sample period. “Blended capitation” refers to physicians who switch to blended capitation at any point in the sample period. “Official” refers to official rostered patients; “Virtual” refers to virtual rostered patients. All specifications control for: the percent of male patients, roster size, average age of patients, the practice’s rurality index, average daily patient visits, GPs annual working days, group size, GP fixed-effect, year dummies and quadratic terms of all continuous variables. Standard errors, in parentheses, are clustered on the GP, but the asterisks are from 999 percentile-t cluster bootstraps; * p<0.10, ** p<0.05, *** p<0.01.

Table 2.4 Impact of rostering on the continuity of care; Transitions from FFS to enhanced FFS, and enhanced FFS to blended capitation

	(1)		(2)		(3)		(4)		(5)		(6)	
	Aggregate Regressors Based on Virtual Rostering						Aggregate Regressors Based on Official Rostering					
Log of	Officially and virtually rostered, matched		Officially and virtually rostered, mismatched		Virtually rostered, officially non-rostered		Officially and virtually rostered, matched		Officially and virtually rostered, mismatched		Officially rostered, virtually non-rostered	
	N_{GP}	δ_2	N_{GP}	δ_2	N_{GP}	δ_2	N_{GP}	δ_2	N_{GP}	δ_2	N_{GP}	δ_2
$\%RosterOnly_m$	2,973	0.060***	1,726	-0.009	3,005	0.051***	2,974	0.052***	167	-0.058	2,983	0.066***
		(0.007)		(0.024)		(0.008)		(0.007)		(0.236)		(0.012)
$\%RosterGrpOnly_m$	2,976	0.002	1,800	-0.001	3,006	-0.011	2,977	-0.007	1,370	-0.045*	2,994	-0.044***
		(0.006)		(0.020)		(0.007)		(0.006)		(0.025)		(0.010)
$GPs/Patient_m$	2,976	-0.043***	1,856	-0.051**	3,006	-0.033***	2,977	-0.036***	1,955	-0.035	3,001	-0.036***
		(0.004)		(0.022)		(0.004)		(0.004)		(0.022)		(0.005)
$NonRoster_m$	2,972	-0.089***	1,786	-0.079**	3,006	-0.052***	2,974	-0.074***	1,955	-0.054**	2,999	-0.074***
		(0.009)		(0.035)		(0.009)		(0.009)		(0.021)		(0.008)
$NonRosterGrp_m$	2,971	-0.032**	1,693	-0.020	3,005	0.011	2,973	-0.013	1,866	0.027	2,996	-0.006
		(0.013)		(0.044)		(0.013)		(0.014)		(0.030)		(0.012)
UPC_m	2,976	0.014***	1,856	-0.0005	3,006	0.009***	2,977	0.011***	1,412	0.081	3,000	0.071***
		(0.003)		(0.0158)		(0.003)		(0.003)		(0.069)		(0.008)
COC_m	2,976	0.010**	1,835	-0.036	3,006	0.003	2,977	0.007*	1,939	-0.053**	2,998	-0.027***
		(0.004)		(0.028)		(0.005)		(0.004)		(0.026)		(0.006)
$N_{Patients}$	1,808,979		11,677		856,184		1,808,979		11,677		914,869	

Notes: Each coefficient is from a difference-in-differences regression with fixed-effects using propensity score weights. The dependent variables are the log of continuity of care indices. "Officially and virtually rostered, matched" refers to patients who are officially rostered, and virtually assigned to the same GP; "Officially and virtually rostered, mismatched" refers to patients who are officially rostered with one GP, but virtually assigned to a different one; "Virtually rostered, officially non-rostered" refers to patients who are virtual rostered but not officially rostered; "Officially rostered, virtually non-rostered" refers to patients who are officially rostered, but not virtually assigned. N_{GP} refers to the number of GPs/observations in each regression; $N_{Patients}$ refers to the total number of patients rostered to all GPs in each column used to calculated the practice-level variables. All specifications control for: the percent of male patients, roster size, average age of patients, the practice's rurality index, average daily patient visits, GPs annual working days, group size, GP fixed-effect, year dummies and quadratic terms of all continuous variables. Standard errors, in parentheses, are clustered on the GP, but the asterisks are from 999 percentile-t cluster bootstraps; * p<0.10, ** p<0.05, *** p<0.01.

Table 2.5 Impact of rostering on the continuity of care; Comparing official and virtual rostering for blended capitation

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable		Virtual			Official	
Log of	N_{GP}	Blended capitation only	FHT	N_{GP}	Blended capitation only	FHT
$\%RosterOnly_m$	3,005	0.043***	0.083***	3,002	0.032***	0.092***
		(0.008)	(0.014)		(0.008)	(0.016)
$\%RosterGrpOnly_m$	3,006	-0.004	0.008	3,012	-0.027***	0.009
		(0.007)	(0.015)		(0.007)	(0.014)
$GPs/Patient_m$	3,006	-0.028***	-0.047***	3,014	-0.026***	-0.050***
		(0.004)	(0.008)		(0.004)	(0.008)
$NonRoster_m$	3,006	-0.064***	-0.124***	3,012	-0.053***	-0.123***
		(0.008)	(0.017)		(0.008)	(0.017)
$NonRosterGrp_m$	3,006	-0.007	-0.072***	3,011	0.013	-0.072***
		(0.014)	(0.023)		(0.014)	(0.021)
UPC_m	3,006	0.012***	0.024***	3,013	0.021***	0.050***
		(0.003)	(0.006)		(0.005)	(0.010)
COC_m	3,006	0.004	0.012	3,014	-0.005	0.005
		(0.004)	(0.008)		(0.004)	(0.009)

Notes: Each coefficient is from a difference-in-differences regression with fixed-effects using propensity score weights. The sample sizes (number of GPs) vary slight across regressions because of missing data for the dependent variable and/or non-varying dependent variables. The dependent variables are the log of continuity of care indices. "Blended capitation only" refers to physicians who, at any point in the sample period, switch to blended capitation but not FHT (i.e., ρ_{FHO_only} in equation 10), while "FHT" refers to physicians who switch to blended capitation and are also affiliated with a FHT (i.e., γ_{FHT} in equation 10). "Official" refers to officially rostered patients; "Virtual" refers to virtual rostered patients. All specifications control for: the percent of male patients, roster size, average age of patients, the practice's rurality index, average daily patient visits, GPs annual working days, group size, GP fixed-effect, year dummies and quadratic terms of all continuous variables. Standard errors, in parentheses, are clustered on the GP, but the asterisks are from 999 percentile-t cluster bootstraps; * p<0.10, ** p<0.05, *** p<0.01.

Table 2.6 Impact of rostering on the continuity of care indices; Transition to Blended Capitation with and without an interdisciplinary care team

Appendix for

"Do primary care payment models with rostering measurably improve continuity of care?"

Propensity scores analysis

For all the matching procedures below, we impose a common support condition and also trim the sample. That is, we drop any treatment observations that meet either of these conditions: 1) its propensity score is higher than the maximum or less than the minimum propensity score of the comparison group; or 2) its propensity score is in the highest 5% of the scores of the treated group.

Transition from FFS to enhanced FFS (virtual)

The central columns of Appendix Table 1 show the logit model estimates used to generate the propensity scores, where the dependent variable is an indicator of the general practitioner (GP) switching to the enhanced model at any time between 2002/03 and 2006/07. GPs who are female, have more daily visits, locate in rural areas and who have a somewhat older and more male concentrated practice population are more likely to join the enhanced FFS model. In addition, the probability of joining enhanced FFS has a greater positive association with the expected income gain for GPs graduating from Canada than from abroad.

The distribution of propensity scores of GPs who switched to the enhanced FFS model, above the x-axis in Appendix Figure 1, skews greatly to the right while that of those who stayed in traditional FFS, below the x-axis, skews slightly to the left, indicating that GPs who switched to the enhanced FFS model are more likely to have high propensity scores.

Transition from enhanced FFS to blended capitation (official)

The right-hand side columns in Appendix Table 1 present the propensity score logit estimates for participation in the blended capitation model. Like GPs who transit from FFS to enhanced FFS, GPs who transit from enhanced FFS to blended capitation are more likely to practice in rural areas and have a somewhat older practice population. The probability of GPs who switching to blended capitation also has even greater association with the expected income gain for male GPs graduating from Canada than from abroad. Unlike those who transited from FFS to enhanced FFS, GPs who transited from enhanced FFS to blended capitation are associated with fewer daily visits and annual working days. The distributions of propensity scores of GPs of enhanced FFS and blended capitation are shown in Appendix Figure 2.

Transition from enhanced FFS to blended capitation (virtual)

The right-hand side columns in Appendix Table 2 show the propensity score logit estimates of the transition from enhanced FFS to blended capitation using the virtual rostered patient population while the central columns show the official rostering version as a comparison. Overall, the magnitudes and significance levels of the coefficients using virtual rostering are similar to those using official rostering. As the virtual and the official rostering patients are not the same, some of the coefficients for the continuity of care indices which measures both the behaviors of GPs and patients in the virtual rostering version have different magnitudes and directions from the official rostering. The distributions of propensity scores of both treated and comparison groups using virtual rostering are shown in Appendix Figure 3 and are similar to those using official rostering.

Dependent Variable:	Switch to Enhanced FFS=1, 2002/2003		Switch to Blended Capitation=1, 2006/2007 (Official)	
Independent Variable	Coefficient	S.E.	Coefficient	S.E.
Expected income gain/100000	0.46	(0.35)	0.19	(0.17)
(Expected income gain/100000)^2	-0.06	(0.05)	-0.05	(0.04)
Expected income gain*Canadian Grad./100000	0.21*	(0.11)	0.31**	(0.14)
(Expected income gain* %male)/100000	-0.01	(0.08)	0.28**	(0.13)
Age/10	-0.58	(0.42)	-0.52	(0.43)
(Age/100)^2	-0.28	(4.03)	-0.42	(4.35)
%Male	-1.55**	(0.61)	-0.8	(0.56)
%Male*age/100	1.89	(1.21)	2.12**	(1.08)
%place of graduation-Canada	0.14	(0.15)	0.19	(0.12)
%place of graduation-USA	0.29	(0.78)	-0.54	(0.93)
%place of graduation-UK	0.31	(0.29)	0.20	(0.24)
RIO/100; (Rurality Index of Ontario)	2.31***	(0.77)	4.82***	(0.82)
(RIO/10)^2	-0.07***	(0.01)	-5.61***	(1.36)
Daily no. of visits	0.03**	(0.01)	-0.04*	(0.02)
(Daily no. of visits/10)^2	-0.02*	(0.01)	0.05**	(0.02)
%Working days annually	0.24	(1.53)	-3.12	(2.15)
(%Working days annually)^2	0.98	(1.30)	2.29	(1.60)
Group size/1000			-0.60	(1.56)
(Group size/100) ^2			0.03	(0.04)
Roster size/1000	0.17	(0.30)	1.26***	(0.30)
(Roster size/1000)^2	-0.20**	(0.09)	-0.4***	(0.07)
Mean patient age/10	3.02***	(0.27)	1.43***	(0.53)
(Mean patient age/10)^2	-0.35***	(0.04)	-0.12**	(0.06)
Mean patient %male	5.07***	(1.39)	-1.31	(1.95)
Mean patient %male^2	-5.23***	(1.50)	-0.01	(2.17)
$\%RosterOnly_m$	-0.87	(0.55)	0.99	(1.32)
$\%RosterGrpOnly_m$			-4.78***	(1.81)
$MDs|Patient_m$	0.03	(0.10)	-3.73**	(1.65)
$NonRoster_m$			3.81**	(1.76)
$NonRosterGrp_m$			-2.92***	(1.03)
UPC_m	-0.04	(0.11)	9.33***	(2.15)
COC_m	0.26	(0.19)	-7.45***	(1.58)
Constant	-3.99***	(1.52)	4.25**	(1.96)
N		3,376		3,081
pseudo R2		0.33		0.15

Notes The asterisks reflect p-values from t-tests for equality of means in the treatment and comparison groups. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels respectively. “Blended capitation” refers to physicians who eventually switch to blended capitation at any point in the sample period. “Enhanced FFS” refers to physicians who remain in enhanced FFS throughout the entire sample period. RIO: Rurality Index of Ontario – an index of community population density and travel time to the nearest referral centers.

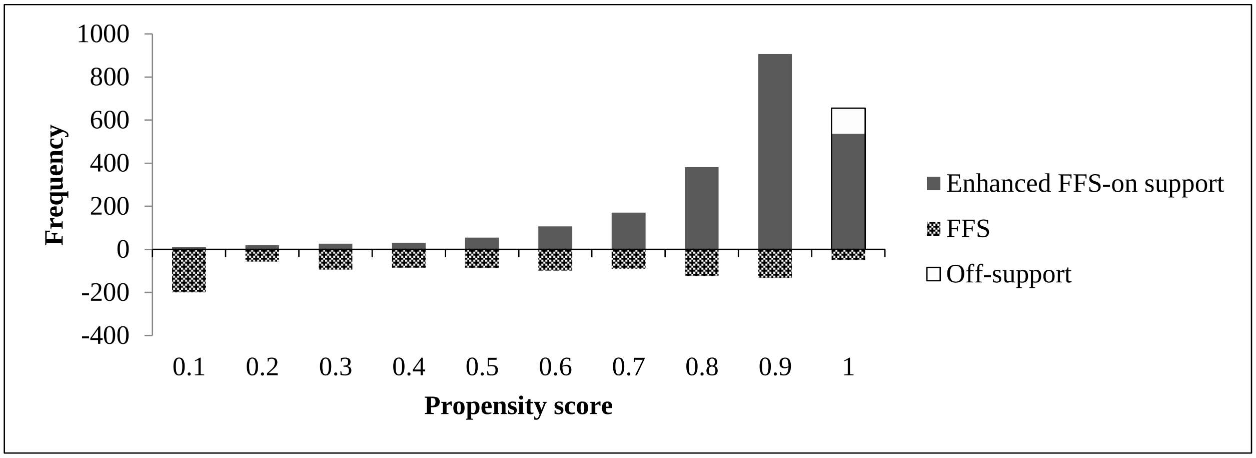
Appendix Table 2.1 Propensity scores logit estimates, by transition

Dependent Variable:	Switch to Blended capitation=1 (official)		Switch to Blended capitation =0 (virtual)	
Independent Variable	Coefficient	S.E.	Coefficient	S.E.
Expected income gain/100000	0.19	(0.17)	0.13	(0.16)
(Expected income gain/10000)^2	-0.05	(0.04)	-0.10**	(0.05)
(Expected income gain*place of graduation)/100000	0.31**	(0.14)	0.46***	(0.14)
(Expected income gain* %male)/100000	0.28**	(0.13)	0.27**	(0.14)
Age/10	-0.52	(0.43)	-6.79	(4.26)
(Age/100)^2	-0.42	(4.35)	1.09	(4.27)
%Male	-0.8	(0.56)	-0.63	(0.56)
%Male*age/100	2.12**	(1.08)	1.98*	(1.07)
%place of graduation-Canada	0.19	(0.12)	0.13	(0.12)
%place of graduation-USA	-0.54	(0.93)	-0.44	(0.93)
%place of graduation-UK	0.20	(0.24)	0.18	(0.24)
RIO/100; (Rurality Index of Ontario)	4.82***	(0.82)	5.49***	(0.80)
(RIO/10)^2	-5.61***	(1.36)	-6.51***	(1.35)
Daily no. of visits	-0.04*	(0.02)	-0.03	(0.03)
(Daily no. of visits/10)^2	0.05**	(0.02)	0.05	(0.03)
%Working days annually	-3.12	(2.15)	-2.17	(2.02)
(%Working days annually)^2	2.29	(1.60)	1.65	(1.51)
Group size/1000	-0.60	(1.56)	-1.07	(1.50)
(Group size/100)^2	0.03	(0.04)	3.90	(4.66)
Roster size/1000	1.26***	(0.30)	1.01***	(0.37)
(Roster size/1000)^2	-0.4***	(0.07)	-0.35***	(0.09)
Mean patient age/10	1.43***	(0.53)	1.84**	(0.87)
(Mean patient age/10)^2	-0.12**	(0.06)	-0.18*	(0.10)
Mean patient %male	-1.31	(1.95)	0.83	(2.06)
Mean patient %male^2	-0.01	(2.17)	-2.58	(2.46)
$\%RosterOnly_m$	0.99	(1.32)	1.16	(1.18)
$\%RosterGrpOnly_m$	-4.78***	(1.81)	-2.68	(1.72)
$MDs|Patient_m$	-3.73**	(1.65)	-5.08*	(2.82)
$NonRoster_m$	3.81**	(1.76)	4.96*	(3.00)
$NonRosterGrp_m$	-2.92***	(1.03)	-1.89*	(0.98)
UPC_m	9.33***	(2.15)	14.71***	(3.53)
COC_m	-7.45***	(1.58)	-11.26***	(1.96)
Constant	4.25**	(1.96)	-11.26***	(1.96)
N		3,081		3,073
pseudo R2		0.15		0.14

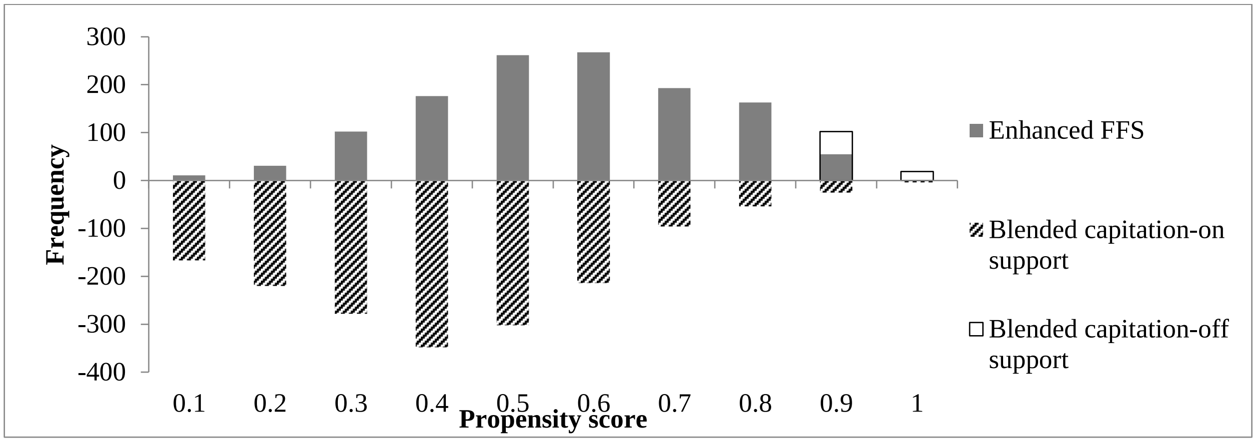
Notes: The asterisks reflect p-values from t-tests for equality of means in the treatment and comparison groups. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels respectively. “Blended capitation” refers to physicians who eventually switch to blended capitation at any point in the sample period. “Official” refers to official rostered patients;

“Virtual” refers to virtual rostered patients. RIO: Rurality Index of Ontario – an index of community population density and travel time to the nearest referral centers.

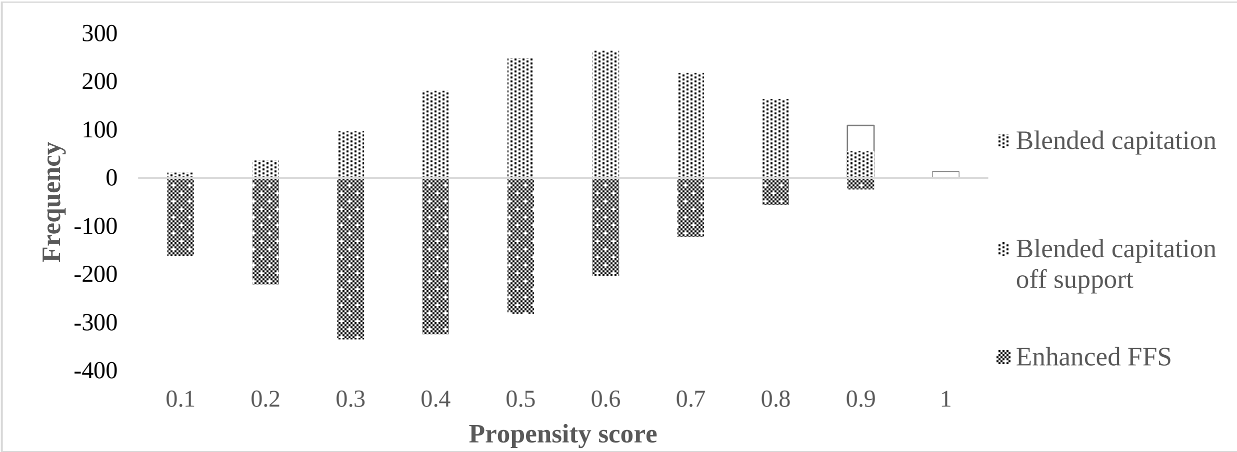
Appendix Table 2.2 Propensity scores logit estimates, by rostering type, 2006/07



Appendix Figure 2.1 Propensity score distribution for FFS (comparison) and enhanced FFS (treatment) using virtual rostering, 2002/03



Appendix Figure 2.2 Propensity score distribution by enhanced FFS and blended capitation (official), 2006/07



Appendix Figure 2.3 Propensity score distribution by enhanced FFS and blended capitation (virtual), 2006/07

Chapter 3 The Pensions of Migrant and Local Workers in China: A Case Study of Shenzhen

3.1 Introduction

As economies develop the role of the family in the provision of income security for the elderly generally diminishes and the role of the state increases. That transition continues in China. Social needs that were previously met largely by families first became societal responsibilities with the emergence of the "iron rice bowl" in which urban workers in state-run firms had assured employment and, with it, housing, healthcare, and pensions. That changed after 1978, when Deng Xiaoping introduced reforms to allow for more free market activity, and the responsibility for social welfare gradually shifted more to government agencies. However, China has a multiregional governance structure in which each region enjoys a degree of autonomy and has full control within its jurisdiction in certain areas such as personnel, finance, industry, and agriculture (Xu, 2011). Thus, while the central government's Ministry of Human Resources and Social Security has overall responsibility for the social welfare system,[20] what is provided and who contributes vary sometimes from one locale to another. Here we focus on one important component of social insurance in China, namely the pension system, the broad outline of which was designed at the national level but whose financial and administrative management remains decentralized (Holzmann et al., 2012; Peng, 2011). Our concern is to assess the implications for beneficiaries.

Social insurance, through risk pooling and cross-subsidy, is expected to result in some redistribution from those who are better off to those who are poorer, but significant concerns have been identified in relation to China (Liu et al., 2016) and much remains to be done to improve pensions in the developing world more generally (Mares and Carnes, 2009). It is evident that the provisions of pension plans can compromise efficient redistribution and financial sustainability; they can also restrict portability and thereby impede the mobility of the labor force (Holzmann et al., 2012) and the costs could well be greater when responsibilities are fragmented. However, the costs need to be compared to the possible benefits of having plans that differ from one location to another. Xu (2011), for example, attributes the success of China's economic reform in the past three decades to regional decentralization: since subnational governments know local preferences and institutional arrangements better than the central government, when empowered and incentivized they are more likely to develop policy reforms that are successful locally. Boffa et al. (2016) develop a model that helps to explain when decentralization is beneficial

[20] Resources: the state council of the People's Republic of China, 2014. Available at http://english.gov.cn/state_council/2014/09/09/content_281474986284102.htm (accessed 19 Dec 2016)

and also why it can undermine accountability. Their model implies that a single government with multiple policy objectives faces better incentives in spending its budget and discharging its responsibilities than would a number of special purpose governments. That means that a federal system is desirable only if the information on which policy measures should be based varies sufficiently across regions. However, in this paper we put aside the matter of whether distributed responsibilities might be productive and focus instead on the impact that the fragmentation of pension plans has on migrants and local residents.

China aims to have a universal pension system, one that pools all workers and retirees in both rural and urban areas into a system with common rules, but with regulations, contribution rates, and benefit levels that can continue to differ across regions and between urban and rural areas (Cai and Cheng, 2014; Holzmann et al., 2012). Until recently there were few portability agreements between local schemes, such that it was difficult for migrant peasant workers to transfer acquired rights from one plan to the other (Holzmann et al., 2012). This constituted a barrier to the mobility of labor, one that has restrained the formation of a nationwide labor market.

While recent policy changes have reduced such concerns, considerable fragmentation remains. In what follows, based on pension policies now in place, we assess how the movement of migrants across jurisdictions affects the welfare of migrants as compared to locals.[21] We find it informative to consider the system from the perspective of

[21] Beyond the inequities and possibly low participation rate that such differences introduce, there is also concern about the sustainability of the system itself, given the looming increase in the ratio of pensioners to workers in combination with the transition to partial funding of the system itself ; that is a topic left for future analysis.

one municipality and to focus on the differences that exist in terms of pension contributions made and benefits received by those who are entitled to live in that municipality (because it is their registered *hukou*) and those who are not. The current *hukou* system was designed to facilitate resource allocation, restrict the provision of subsidies to selected groups, and to control internal migration, especially rural-to-urban migration (Whyte, 2010). Each town and city issued its own *hukou* (the *hukou* system was introduced in 1958), which gave residents access to social welfare services in that jurisdiction. Individuals were broadly categorized as "rural" or "urban" based on their place of residence (Martin, 1992).[22] Moreover, the *hukou* is hereditary, passed on by one's parent(s) no matter where one was actually born (Song, 2014).

Starting in the late 1970s, the numbers migrating in search of jobs surged in response to market reform. However, migrants are not entitled to urban benefits unless their *hukou* is converted to a full urban one (Afridi et al., 2015; Song, 2014). While rural-urban *hukou* conversion is possible, for example for those recruited by state-owned enterprises or those who enroll in higher education institutions (Chan and Zhang, 1999; Song, 2014), in the larger cities where most migrants are employed, the award of local urban *hukou* status is based on criteria such as schooling, working skills, and contributions to social insurance (Song, 2014) that make *hukou* conversion extremely hard for those with little education.

In what follows we examine how residents who differ in terms of their *hukou*, their productive characteristics, and their geographic mobility are treated by the pension system

[22] The urban population is the total population which includes those administered at city or town level; the rural population is the total population which is administered at the county level (excluding towns).

in Shenzhen, a large municipality in the province of Guangdong. Shenzhen is representative of developed urban cities in China, with its large number of migrants from less developed urban and rural areas. In Shenzhen, as elsewhere, access to education, healthcare, work, and social welfare benefits is determined in signficant measure by one's *hukou.* Migrants (defined here as those with a *hukou* other than Shenzhen) typically have less access than locals (those with a Shenzhen *hukou*). Some of the disadvantages for migrants have been documented (Chen and Feng, 2013; Gao et al., 2012; Liu, 2005; Lu and Piggott, 2015; Ning et al., 2016; Qin et al., 2014), but differences between migrants and locals in terms of their pension contributions and benefits have not been examined. This paper contributes to the literature by simulating the pension contributions and benefits of both locals and migrant workers, and assesses the magnitude of the disadvantage faced by the latter group, based on the pension program newly in place in Shenzhen.

The rest of the paper is organized as follows. The next section briefly reviews the literature on pension systems in China and the treatment of migrant workers. The major pension plans are compared and the policies that relate to the transfer of contributions across jurisdictions are discussed in Section 3. Cross-jurisdiction transfer of pension contributions and records was limited before the recent reforms; most migrant workers who moved to another region would forego their contributions and not be entitled to pension benefits. Starting in 2010, however, that changed but those whose place of residence is not the same as their *hukou* are still at a disadvantage; the difference depends importantly on whether the transfer is from an urban to a rural plan. The simulation analysis in Section 4 assesses how the plans now in place affect the relative welfare of migrants compared to locals in the pension system. Section 5 concludes.

3.2 Literature review

Of present concern is the literature that discusses the development of China's pension system, the differential treatment of individuals insofar as it depends on their *hukou*, and regional differences in pension provisions in China.

Wang et al. (2004) describe the pension reform that took place before 2000. They focus on the financial costs associated with the transition from what was, for those covered, basically a pay-as-you-go system to a partially funded system. Their concern is with both the increased burden on those contributing (since benefit payments would continue to those currently eligible even while those currently working would be required to contribute also to their individual accounts) and the implicit pension debt that results from underfunding the benefits promised to present and future pensioners. They build a computable general equilibrium model to simulate the impact that levying a social security tax and injecting fiscal resources would have on the sustainability of the pension system. Li and Mérette (2005) develop a computable overlapping-generations general equilibrium model to analyze the impact on sustainability of such key policy options as cutting the pay-go benefit rate and increasing the retirement age; they also note the important role played by total factor productivity.

He (2008) examines the distributional effects of the employees/workers pension system in urban China, from both intra-generational and intergenerational perspectives; more specifically, he compares the 1997 and 2005 pension systems to assess how the 2005 pension reform affected net pension benefits as measured by the difference between lifetime contributions and benefits. He finds that the 2005 system raised the net pension benefits of every generation and reduced intergenerational inequality. He finds also that the net benefits were larger for those who were older at the time of the reform as well as for those with lower wages.

Wang et al. (2014) take a broader perspective in that they consider an exhaustive set of five pension systems: employees/workers pension system, public institutions employee old-age insurance system, urban residents old-age insurance system, rural social endowment insurance system, and civil servants insurance system.[23] For each they calculate "fairness coefficients" based on pension income, contributions, demand (reflecting the local cost of necessities), and generation income gap; they conclude that the differences across the pension plans are "absolutely unfair" (p 25).[24] A more recent study (Song et al., 2015) takes into account China's high growth rate and builds a dynamic overlapping-generations general equilibrium model to analyze the welfare effects of several proposed pension reforms. It concludes that delaying necessary reforms would yield large

[23] The plan names are translated differently in Wang et al. (2014).

[24] The authors calculate the ratios of pension contribution to pension income for various pension schemes. They set a series of cut-off points based on the ratio of the standard deviation to the mean, the most extreme of which is categorized as 'absolute unfairness'.

welfare gains for the (poorer) current generations while imposing only small costs on (richer) future generations.

Other studies have investigated the differential impact of the *hukou* system on those who have local household registration as compared to migrants who do not. Liu (2005) examines the impact on social and economic outcomes at the individual level; he concludes that, by denying migrants access to benefits routinely available to locals, the *hukou* system contributes to worse outcomes in terms of educational attainment, employment status, and health care for migrants. Chen and Feng (2013) elaborate on the differences in access to education and find that migrant students who are unable to enroll in public schools perform significantly worse than the *hukou* students in terms of their educational outcome. Qin et al. (2014) evaluate the efficacy of the current health insurance system as it relates to China's migrant worker population; they find that it is not effective in alleviating the financial burden of healthcare and promoting formal medical care utilization among migrant workers, possibly due to the lack of a systematic financing plan for outpatient treatment and the segmentation between insurance platforms.

Some other studies examine the relative wellbeing of rural residents compared to their urban counterparts. Li et al. (2014) find that hypertension has significant negative effects on the labor supply of the urban elderly but not on those living in rural areas. The differences in response are probably due to the inferior financial status of rural residents as compared to their urban counterparts. Ning et al. (2016) examine the effect of the New Rural Pension Scheme (NRPS) on the labor supply of the elderly in rural China; in contrast to the impact in urban areas, they find no evidence that the receipt of pension income from the NRPS program induces withdrawal from the labor market. This implies that extensive coverage of the NRPS program in China may not be generous enough to improve the wellbeing of the elderly especially those in bad health condition.

3.2.1 Overview of current public pension policies

3.2.1.1 Comparison of major pension plans

Pension policies in China have evolved over the last two decades and coverage has increased. Before 1997 coverage was limited to those working in state-owned enterprises; the benefits they received at retirement were not linked to any prior contributions. But, starting in 1997, a contributory pension system for urban workers was established in which the cost of providing pensions was partly borne by employers and their employees and partly by the state. Individuals employed in either private enterprises or state-owned corporations were expected to participate in the Urban Workers Pension Plan while those employed by the government and public institutions were expected to participate in the Government and Public Service Employees Pension Plan. The plans were partially funded; those already retired were not affected by the reforms and transitional rules were applied to some of those already employed. A new phase started after 2005, when an integrated social security system covering both urban and rural areas was developed, with comprehensive and unified management methods. The Rural Pension Plan was introduced in parallel with the Urban Workers Pension Plan for those living in rural areas and not employed by enterprises. Most recently, in 2014, the Rural Pension Plan was merged with the Urban Residents Pension plan to form the County and Rural Residents Plan for those not covered by other social pension plans. In total, China now has three major pension plans:

Urban Workers Pension Plan (城镇职工基本养老保险),[25] County and Rural Residents Pension Plan (城乡居民养老保险),[26] and the Government and Public Service Employees Pension Plan (机关事业单位工作人员养老保险).[27] Before 2015 the Government and Public Service Employees Pension Plan did not require contributions from employees but, starting in 2015, they are required to contribute at a rate similar to that of private employees. Self-employed individuals may choose to join the Urban Workers Pension Plan; if they do their contribution rates are similar to those employed by enterprises.

Table 1 compares the national guidelines for Urban Workers Pension Plans[28] with the Shenzhen Urban Workers Plan, a stylized version of the County and Rural Residents Pension Plan,[29] and the Government and Public Service Employees Pension Plan, all as of 2014. According to the National guidelines, both employers and employees make contributions based on wages paid: employer contributions go to the social pooling fund while employee contributions go to their individual accounts. Employers contribute 20% of the wage and employees 8%. (The participation of self-employed individuals is voluntary, and the contribution rates are 20% of the reported monthly income, of which 8% goes to their individual pension account.) In Shenzhen Urban Workers Pension Plan employers contribute only 13% of the wage and employees contribute 8%, but those rates

[25] Source: Ministry of Finance of the People's Republic of China--National Urban Workers Pension Guidelines(国务院关于完善企业职工基本养老保险制度的决定) http://www.mof.gov.cn/zhuantihuigu/knqzshap/zcwj/200805/t20080519_23117.html

[26] Source: Ministry of Human Resource and Social Security of the People's Republic of China---Stylized County and Rural Residents Pension Plan (国务院关于建立统一的城乡居民基本养老保险制度的意见) http://www.mohrss.gov.cn/gkml/xxgk/201405/t20140527_131029.html

[27] Source: The State Council of the People's Republic of China--- Civil Servants and Public Institution pension plan (国务院关于机关事业单位工作人员养老保险制度改革的决定) http://www.gov.cn/zhengce/content/2015-01/14/content_9394.htm

[28] The guidelines date from 2005 but, with some revisions, they continue to apply.

[29] We use the national guidelines of the plan as the stylized plan in simulation, but in practice it differs across regions.

apply only for those earning between a lower limit (defined as 60% of the local average wage) and an upper limit (set at three times the local average wage). (Self-employed individuals are not required to participate but they can join by contributing 13% of their reported monthly incomes to the social pooling fund, and 8% to their individual pension accounts.) In addition, employers contribute 1% to Shenzhen's supplementary pension fund, but only for locals; no contributions are made on behalf of migrants and they receive no benefit from this source.

In all three plans the basic amount of benefit is calculated, in accordance with the guidelines, as 1% of the average of an individual's indexed wage (w_{aij}[30]) and the local average wage of last year ($w_{a,t-1}$[31]) multiplied by the individual's number of contribution years. The monthly benefit from the individual account in Shenzhen is calculated by dividing the accumulated account balance by 139 for those retiring at age 60, 195 at age 50 and 170 at age 55.[32] Note that the basic benefit adjusts after retirement to reflect half of any changes[33] in the local wage while the individual benefit is fixed in nominal terms.

In addition to the basic amount, benefits not reported in Table 1 are available to those who started work before July 31, 1992. They are entitled to a transition pension equal to 1.2% of the individual indexed wage multiplied by the number of years worked before July 31, 1992 for contribution made fewer than 25 years before July 31, 1992, and if the

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[30] w_{aij} is the individuals' monthly indexed average wage and N is the contribution year.
[31] $w_{a,t-1}$ is monthly average wage of workers in Shenzhen in year t-1.
[32] Numbers come from Shenzhen Social Security Fund Board, 2013. Shenzhen Urban Workers Pension Plan (深圳经济特区社会养老保险条例实施细则). Available at http://www.szsi.gov.cn/sbjxxgk/zcfggfxwj/ylbx/201312/t20131220_2283692.htm (accessed on Dec. 12,2016)
[33] It is the average of the local average wage and the wage in the year before the individual's retirement, and therefore, it is partially indexed to the local average wage.

contribution made over 25 years before that time, they are entitled to a transition pension equal to contribution years less 25, then multiplied by 1%, and plus 30%. Among them, individuals who have registered *hukou* status in Shenzhen before retirement and have contributed for at least ten years in Shenzhen are eligible for an additional adjustment pension benefit (in addition to supplementary benefits - yrs * $\frac{w_{aij}}{w_{a,j-1}}$*18.25+20).[34] The national Government and Public Service Employees Pension Plan is similar to the Urban Workers Pension Plan but with a generous annuity. The older version of the national Government and Public Service Employees Pension Plan was a form of state welfare that was fully paid for by the government. Members were not required to pay any premiums. By contrast, the Urban Worker Pension Plan is a form of mandatory social insurance that requires employers and employees to contribute a significant share of their income, as noted above. In late 2014 the central government decided to adapt the social insurance design in the national Government and Public Service Employees Pension Plan but with the guarantee that public employees' benefits will not decrease (Liu et al., 2016).

Benefits from the County and Rural Residents Pension Plan are limited to the basic amount and the amount from each person's individual account. The basic amount is paid by the government to those who are eligible when they reach age 60; no previous contributions are required. The individual account consists of four parts: the individual contribution, town/village collective subsidy, government subsidy and interest from investments. All parts are paid monthly. Participants can choose any one of 12 levels of

[34] $w_{a(j-1)}$ is the average monthly wage of workers in Shenzhen in year j-1, one year before retirement.

annual individual contribution: RMB 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1500, and 2000. Local governments have the authority to set up different contribution levels but, by and large, they are similar to the national rates. All individual contributions flow into their individual accounts. Their basic pension amount comes from the town/village collective subsidy and the government subsidy; it is much less generous than is the basic benefit amount received by urban workers and is not indexed to the local average wages.[35]

While the central government issues general guidelines relating the structure of pension plans, each municipality has some autonomy in determining how the plans are implemented. We focus on Shenzhen; its Urban Workers Pension Plan is taken as a typical pension plan of urban China. In the simulation experiments that follow, identical plans are assumed to be implemented in all urban areas and the stylized County and Rural Residents Pension Plan portrayed in Table 1 is assumed to be implemented in all rural areas.

Tables 2 and 3 show both the number of participants and the value of the funds in 2013 and 2014 in two major pension plans. It is evident that, for the country as a whole, the County and Rural Residents Pension Plan has about 50% more participants than the Urban Workers Pension Plan but that its total deposits are only about 12% as large. For Shenzhen, reflecting its urban nature, almost all participants as well as funds are in the Urban Workers Pension Plan. Our concern is with how individuals fare in terms of the contributions they make to pension plans during their working years, the benefits they receive in their retirement years, and how the contributions and benefits differ depending

[35] However, the government can raise the minimum benefit amount if necessary.

on the possible changing alignment between their *hukou* and their place of work during the contributory period.

3.2.1.2Transfer of pension records and funds among different pension plans

3.2.1.2.1 Transfers among urban pension plans

At the end of 2009, China promulgated the "Interim approaches to transfer the pension plan for workers of enterprises in urban areas (城镇企业职工基本养老保险关系转移接续暂行办法)", [36] which has become the foundation for a smooth transfer of pension records and funds and, moreover, an expansion of China's pension plan. This document specifies the transfer arrangements for workers in an urban area who move to work in an urban area in another province: it states that the contributions of all workers, including migrant workers who participated in the Urban Workers Pension Plan, can be transferred; that includes both contributions in individual accounts and a portion of the payments made by enterprises. Before the policy came into effect in 2009 only the amount in the individual account could be transferred; the amount contributed by enterprises would stay in the local social pooling fund while the responsibility for payment of benefits would fall on the place that received the migrants. As a result, the migrant-losing place would benefit while the migrant-receiving place would bear the financial burden. After the 2009 transfer policy was introduced, however, all employees were required to participate fully in the Urban Workers Pension Plan and the

[36]Source: The Central Peoples' government of China-- Interim approaches to transfer the pension plan for workers of enterprises in urban areas (城镇企业职工基本养老保险关系转移接续暂行办法) http://www.gov.cn/zwgk/2009-12/29/content_1499072.htm

amount transferred from the social pooling fund was set at 12% of contributory wage times the contribution term. In other words, $12/13^{th}$ of the total amount (rather than all) would be transferred.

Migrant workers who quit employment and hence stop contributing to the plan have their individual account records saved and interest continues to accumulate; if they return to employment in the same urban area their contributions will resume. Those who move to work in other places can transfer their accounts. Table 4 describes the transferability of funds across urban areas, and how the contribution years are counted in the pension formula. The fund that has accumulated in the individual account is fully transferable as is $12/13^{th}$ of the pensionable wage multiplied by the contribution years in the social pooling account, while $1/13^{th}$ is retained in the pooling account of the sending region. Individual benefits are not affected by the transfer, and the contribution years in each place are counted in the total contribution years in calculating the benefit.

The transfer policy stipulates that if, at the time of retirement, an individual's place of residence is his or her own *hukou*, that place will manage the social pooling and individual pension accounts and be the *hukou* responsible for paying the pension benefit. The responsibility varies for those whose place of residence at the time of retirement is not same as their *hukou*. If contributions have been made in the place of residence for more than ten years, that place is responsible for managing the funds and paying the pension benefit; if contributions have been made for less than 10 years the pension funds will be sent to the last place where the contribution period exceeded 10 years and it will pay the pension benefits. Finally, if contributions have been made for less than 10 years in each location where the individual has worked the pension funds will be sent to the place where the *hukou* is registered and it will be responsible.

Table 5 provides a simplified description of the transfer policy and how the place responsible for pension benefit payments is determined. Suppose that an individual with *hukou* in A moves from A to B and to C, all of which are urban areas. He/she then either stays in C or returns to A to work until retirement. In all cases, the individual is assumed to have made at least 15 years of contributions in total and so is eligible for pension benefits. If he/she goes back to A where the *hukou* is registered and works until retirement, then A will pay the pension benefits. If he/she stays in C until retirement, the place responsible for benefits depends on the individual's contribution years in C: if more than 10, C will pay the pension benefits; otherwise, the last place where the individual has made more than 10 years of contribution will be responsible. If the contribution years in each of the places (A, B, and C) is less than 10, then the *hukou* (A) is responsible for paying the pension benefits. Whatever the outcome, the amount of benefit paid depends on the characteristics of the plan that is in effect in the area responsible for payment. But the urban areas to which migrant workers return get only a portion of the accumulated contributions even though they assume full liability for such payments.

3.2.1.2.2 Transfers between the rural and urban pension plans

In 2014, China promulgated the "Interim approaches to transfer between the County and Rural Residents Pension Plan and the Urban Workers Pension Plan

(城乡养老保险制度衔接暂行办法)”.[37] The transfer from a rural to an urban plan is permitted only if contributions to the urban plans have been made for more than 15 years and only the deposit in the individual account is transferrable. The years of contribution to the rural plan are not counted in calculating benefits from the social pooling account.

Individuals who have contributed to the urban plan can transfer all assets in their individual accounts to the rural plan and the years of contribution to the social pooling are included in the total years of contribution in calculating the pension benefits from the rural plan.

In the simulations, we assume that when individuals move to urban regions they work and join the Urban Workers Pension Plan while those in rural regions will join the Rural and County Residents Pension Plan. When transferring between urban regions, the contribution years of the individuals are fully transferrable as well as the history/records of individual indexed wages (both of which are used in the calculation of pension benefits; see below). The amount of the pension benefit and the regions that are responsible to pay are determined by the length of contribution and the place of retirement. Individuals who stay for longer than ten years and retire in the region are entitled to the urban workers pension benefits of the region; otherwise, they are entitled to those of the last working place. When transferring between urban and rural plans, the contribution years are not transferrable from rural to urban, but are fully transferable from urban to rural. Funds in the individual accounts are fully transferrable. Those individuals who contribute for at least

[37] Transfer between the County and Rural Residents Pension Plan and the Urban Workers Pension Plan (城乡养老保险制度衔接暂行办法) http://www.mohrss.gov.cn/gkml/xxgk/201402/t20140228_125006.htm

fifteen years in the Urban Workers Pension Plan are entitled to the pension benefits in that plan; otherwise, they are entitled to benefits under the terms of the Rural and County Residents Pension Plan.

3.3 The simulation of stylized cases

3.3.1 The model

We draw on features of the Shenzhen Urban Workers Pension Plan,[38] hereafter the SZ Plan, to develop a model which we use to examine the differential treatment of local and migrant workers. The model is as follows.

Basic pension benefit (monthly) $$P_{b,i,t-j} = \frac{(w_{a,t-1}+w_{a,i,j})}{2} \times N \times 1\% \qquad (t>j) \qquad (1)$$

where $w_{a,t-1}$ is the average monthly Shenzhen wage in year t-1, $w_{a,i,j}$ is the monthly indexed average wage of individual *i* who retires in year *j*, and *N* is the number of contribution years. This portion of the benefits is partially indexed in that it adjusts to reflect half of any yearly increase in the average wage.

Individual indexed wage (monthly) $$w_{a,i,j} = \frac{\sum_{t=1}^{t=N} \frac{w_{i,t}}{w_{a,t-1}}}{N} \times w_{a,j-1} \qquad (t<j) \qquad (2)$$

[38] Source: Shenzhen Social Security Fund Board ---Shenzhen Urban Workers Pension Plan (深圳经济特区社会养老保险条例/实施细则)
http://www.szsi.gov.cn/sbjxxgk/zcfggfxwj/ylbx/201312/t20131220_2283692.htm
http://www.szsi.gov.cn/sbjxxgk/zcfggfxwj/ylbx/201212/t20121226_2094910.htm

where w_{it} is the individual's average monthly wage in year t, $w_{a(j-1)}$ is the average monthly wage in Shenzhen in year *j-1*, one year before retirement.

Individual account pension benefit (monthly) $P_{it} = \frac{D_{ij}}{r}$ (3)

where D_{ij} is the accumulated deposit in individual account in the year of retirement and r depends on age at retirement; r is 139 at age 60, 170 at age 55 and 195 at age 50.

Accumulated deposit $D_{it} = D_{it-1} \times (1 + i_t) + d_{it} + I_{it}$ (4)

where i is the annual interest rate;[39] d is the annual deposit, the sum of month *n* contributions, and *I* is interest accumulation.

Deposit (annual) $d_{it} = 8\% \times \sum_{n=1}^{12} w_{int}$. (5)

Interest accumulation (annual) $I_{it} = \frac{1}{12} \times i_t \times \sum_{n=1}^{12} d_{int} \times (12 - n + 1)$ (6)

and d_{int} is the deposit in month *n* in year *t* (1≤n≤12).

In addition, individuals who have *hukou* in Shenzhen are entitled to receive:

Supplementary insurance (monthly) $P_{s,i,t-j} = N \times \frac{w_{a,i,j}}{w_{a,j-1}} \times \alpha + \beta$ (t>j) (7)

Where, as of 2015, α = 18.5 and β = 20, both in RMB.

[39] It is announced by the local government each year.

3.3.2 Simulation results

Based on the above model we simulate and compare the contributions that hypothetical local and migrant workers would make during their working years and the pension benefits they would receive after retirement. (Hereafter "locals" refers to those with a Shenzhen *hukou* and "migrants" refers to those whose *hukou* is not in Shenzhen.) Tables 7-12 provide a variety of measures that show the pension benefits of locals and of migrants. The measures take account of the age of retirement, the length of the contribution period in Shenzhen, and the length of the contribution period elsewhere, including whether in another urban area or in a rural area. In all cases it is assumed that prices and wages are constant, and that, unless otherwise stated, all wages are at an average level. To facilitate comparisons, all values are expressed as indexes.

Pension benefits for migrants relative to locals

Table 7 shows the pension benefits that migrants with differing periods of work in Shenzhen could expect to receive; their prospective benefits are expressed relative to the benefits of locals. All workers are assumed to start working and hence contributing to one or other plan at age 16 and to continue to age 60, 55, or 50 (and hence to contribute for 45, 40 or 35 years). No distinction in the modeling is made between males and females, but we note that the standard age of retirement is 60 for males and either 55 or 50 for females, depending on their level of education. All urban workers are assumed to have the same (average) wage. Migrants differ from locals only in terms of the number of years in Shenzhen and whether they are always covered by an urban pension plan when not in

Shenzhen (Panel A), a rural plan before migrating to Shenzhen and an urban plan thereafter (Panel B), or an urban plan only while in Shenzhen (Panel C).

The disadvantage for migrants is evident in all cases. Panel A shows that migrants who are covered by urban plans throughout their working lives have pension benefits that are about 20% less than locals – slightly more for those who retire at age 60 and slightly less for those who retire at 50. The benefit gap, as compared to the locals, is explained entirely by the supplementary benefit for which only locals are eligible. Panel B focuses on the impact that the age of migration to Shenzhen (hence leaving rural pension coverage and gaining urban coverage) has on the benefit ratio for migrants who remain under an urban plan until retirement (although possibly leaving Shenzhen for another urban area). The advantage of longer coverage under an urban plan is evident. Those who migrate by age 16, and hence whose entire working lives are covered by urban plans, would have the same pensions as those in Panel A. Migrating 10 years later, at age 26, would increase the gap by 15 to 21 percentage points; migrating at age 36, would increase it by a further 15 to 21 points.

Panel C differs from Panel B in that it relates to the situation of those who move to a rural area when they leave Shenzhen. The results show that the benefits are almost independent of the age at which contributions to the urban plan are first made, provided that contributions are made for at least 15 years. There is no reduction in benefits if the move takes place at the end of the working period, after 45, 40, or 35 years. However, the fewer years of urban plan coverage the greater the loss. Migrants who retire at 60 with 15 years of urban plan coverage (and 35 of rural plan) would receive benefits only 31 percent as large as locals. Those with fewer than 15 years of urban coverage are especially disadvantaged since they would be eligible for benefits from only the rural plan. For example, those with 9 years would have benefits that are only 13% as large.

The analysis in Tables 7 assumes that the average wage is the same in all cities. However, migrants to Shenzhen from other urban areas come mostly from areas in which the average wage is lower. Table 8 shows the average wage in each of the top six migrant registered urban sources within Guangdong and also outside Guangdong, expressed relative to the average wage in Shenzhen.[40] It appears that the average wage in the sending areas is about 30% less than in Shenzhen. That difference is important for those who return to their cities of origin before retirement (or move to other cities with wage levels lower than those in Shenzhen). That is because pension benefits are determined by the rules that apply in the area responsible for making the payments and will reflect the lower wage rate in those areas.

Table 9 shows the impact on pension benefits of such migration, assuming that the wage in the urban area making payment is 30% below that in Shenzhen. Again, all values are relative to the benefit payment that would be received by Shenzhen locals who start working at age 16 and continue to retirement. The main diagonals represent the benefits of migrants who stay in Shenzhen until retirement, off-diagonal elements relate to migrants who move to another urban area before retirement and whose pension benefits reflect the lower wage rate in that area. The retirement pension benefits for those who stay in Shenzhen

[40] The top migrant origin cities is based on tabulations from the 2005 China 1% National Population Sample Survey, the latest information available to us; the average wage information relates to 2013.

until retirement are about 8% higher than individuals who move elsewhere and are not eligible to be paid by Shenzhen. The pension benefits are positively associated with the length of the contribution period in Shenzhen where the local average wage is higher.

Pension benefits to contribution ratios for migrants

Table 10 compares the total pension benefits received by migrants to their total contributions. The working history assumptions are the same as in Table 7. The benefits are those derived from both the social pooling and individual accounts and reflect, as appropriate, the contributions made by both individuals and firms to both rural and urban pension plans. The individual contribution to rural plans is assumed to be RMB750, the average of the 12 levels of contribution (as described in the previous section). Expected values are obtained by discounting future contributions and benefits by the probabilities of survival and hence of continuing to make contributions and eventually to receive benefits, as seen from the perspective of age 16. The magnitudes of both the numerator (the expected benefit) and the denominator (the expected contribution) depend on age at the time of migration, the number of years of contribution to each type of plan, and when in the working life they occurred. The contributions to the Shenzhen plan are assumed to occur in the years immediately following migration. The discount factors are based on the 2012 life tables for China.[41]

[41] Global Health Observatory data repository/Mortality and global health estimates/Life tables http://apps.who.int/gho/data/view.main.60340?lang=en

Table 10 shows that the ratio of expected benefits to expected contributions for migrants exceeds 1.00 in all cases that involve at least 15 years of contributions to the urban plan. Thus individuals will get back more than they contribute, at least in expected value terms as defined here. Migrants who retire at 60 with urban plan coverage throughout their working lives (Panel A) have an expected benefit-contribution ratio of 1.18; for those who retire at 55 the ratio is 1.42 while for those who retire at 50 it is 1.69. The ratios in the latter two cases are higher than in the first both because the contribution period is shorter (35 or 40, as compared to 45) and the benefit period longer. The ratios are slightly lower for locals who retire after the same working period (see the note to Table 8). That is because locals not only get supplementary benefits, but also contribute to the supplementary fund.

For individuals who transfer from a rural plan to an urban plan (Panel B) the ratios of expected benefits to expected contributions are slightly higher for those who migrate later in the working period. That is because the length of the contribution period, but not the benefit period, is reduced. However, the differences are very small. Panel C shows the outcome for those who migrate to Shenzhen at the ages indicated, work for a specified number of years, and then return to an area with a rural pension plan. The interesting feature is that the benefit-contribution ratios are almost independent of both the age at which contributions to the urban plan are first made and the length of the contribution period in that plan, provided that contributions are made for at least 15 years. That is, while the expected benefits are lower for those with fewer years of contribution, so are the amounts contributed; they adjust in the same proportion. Those with fewer years of contributions are not eligible for benefits from the social pooling account;[42] instead, funds to which they would otherwise be entitled remain in the local account.

Table 11 shows the ratios of expected benefits to expected contributions. The main diagonal represents individuals who stay until retirement and are therefore eligible for Shenzhen pension benefits. Their ratios are higher than those off the main diagonal, which relate to individuals who move to another Urban Workers Pension Plan before retirement and are not eligible to be paid by Shenzhen. For them the ratios are negatively associated with the length of contribution period in Shenzhen; that is because the Shenzhen wage and hence the contribution is higher the longer individuals stay in Shenzhen while the benefit outside Shenzhen is lower.

Pension benefits for migrants by education level relative to local

As specified in Table 1, the contribution to the pension plan depends on wage income: in the Shenzhen plan contributions are collected only on wages that are at least 60% and no more than 300% of the average wage. To assess the implications of the plan for individuals at various earnings levels, in Table 12 we distinguish five wage rates, each associated with a level of education, to show how pension benefits vary, taking account of the age of first employment (which increases with level of education and hence affects years of contribution), age of retirement (60, 55, 50), and *hukou* status (locals, migrants).

[42] We have no estimate of the number who become ineligible for such benefits, but Gao (2015) reported that 16.8 percent of participating migrants self-selectively withdrew from the urban workers pension plan in 2007. Before the 2009 pension plan transfer policy came into effect we would expect that migrants leaving Shenzhen would often choose a partial refund from the plan, namely, the balance in their individual accounts.

The income levels in Table 12, w_e, are the average wage for each education level, males and females combined, expressed relative to the lowest level (≤ junior).[43] Based on the available evidence, wage rates increase sharply with level of education, such that those who have completed high school earn 75% more than those with junior education or less while those with postgraduate degrees earn six times more. The results reported in the table show various measures of pension benefits and how they differ for otherwise identical individuals with different levels of education, *hukou* status, and age of retirement.

Ben is the pension benefit expressed as a proportion of the amount that would be received by someone with local *hukou* status who has no more than junior education and who has contributed from the age of beginning work until retirement. The benefit payment increases with the wage level, but less rapidly. That is because the benefit is based on the average of the retiree's own (indexed) wage and the average local wage. Consider, for example, someone with a college degree who retires at age 60. As compared to someone with junior education or less, such a person has relative earnings that are more than three times greater but a pension that is less than twice as large.

The ratio Ben/w_e is a measure of the replacement rate, of how pension income in retirement compares to earnings before retirement. It is calculated as the ratio of the average pension income for each education group to that group's average earnings before retirement. For locals in the lowest earnings category the replacement rate is 1.27, meaning that

[43] The education levels are defined as follows: <=Junior, Junior school completed or less; High school, high school completed; College, college, completed; Undergrad, undergraduate degree, completed; >=Grad, post-graduate degree, completed.

pension income exceeds earnings by 27%. That occurs because employment income in the lowest income group is below the average in Shenzhen. However, there is a fairly rapid reduction in replacement rate as income increases; for example, pension income is 27% lower than employment income for those with an undergraduate degree and 36% lower for someone with a postgraduate degree. The replacement rates for migrants also vary inversely with the wage level, but they are some 14 to 18 points lower than for locals.

The expected benefit/contribution ratio also decreases with income; by this measure as well, the plan is targeted in such a way as to be of relatively greater benefit for those with lower incomes before retirement. However, these further calculations highlight two points. The first is that the ratios are somewhat higher for migrants than for locals. That is because of the supplementary benefits: only locals receive them, but the contributions on which they are based (see Table 1) apply only for locals. It turns out that once the cost of this benefit is taken into account it is much less valuable for locals than it might have seemed. However, the differences are relatively small, of the order of 3%, on average. The second is that the ratio exceeds 1.00, indicating a net benefit, in all income/education categories for those who retire at 55 or 50, whether locals or migrants, but for those who retire at 60 there is a net benefit for locals in only the two lowest income/education categories and for migrants in only the three lowest. We note, however, that as before, the discounting accounts for the survival probabilities from age 16 and the survival probabilities are assumed to be the same for all education groups; to the extent that those with higher levels of education live longer, the benefits and hence the ratios of expected values would be somewhat understated.

3.4 Conclusion

In the last two decades Chinese government agencies have come to play a major role in the development of pension systems and hence in the provision of income security for older persons. While the central government lays out the broad parameters within which local plans operate, the regulations that govern pension plans are determined at the provincial and/or city levels and, as it happens, they differ considerably from one location to another. In consequence the contributions that individuals make while working and also the benefits that they receive while retired depend importantly on the location where that work took place. However, they depend also on *hukou* registration and hence on one's entitlement to live in the location of work. Those working outside their own *hukou* generally fare worse than those with local registration, and we find that the differences can be substantial.

We have used simulation techniques to assess how otherwise identical individuals, differing only in their registered *hukou*, would fare in a pension system characterized by the cumulative changes in national guidelines that took place over the two decades ending in 2015. We assume for simplicity that the stylized plans for workers in urban and rural areas remain unchanged; while the results would be sensitive to any modification of the contribution or benefit rates and the associated regulations, the assumption of no change enhances our understanding of the system now in place. The contributions and benefits of migrants who spend some or all of their working years in Shenzhen are compared to those of Shenzhen locals who are assumed not to move. Shenzhen is chosen as a representative large urban centre that has attracted a very large number of migrant workers. We compare the contributions and benefits of hypothetical migrants who differ in terms of when they start to work in Shenzhen, how long they stay, their age of retirement, and their skill level (as represented by educational attainment) with the benefits and contributions of otherwise identical locals.

We find that migrants who spend their entire working lives (starting at age 16) in Shenzhen would retire with pensions that are about 20% lower than those that would be received by Shenzhen locals. Those who move to Shenzhen from other urban centres with pension plans and wage levels that are the same as the ones in Shenzhen would have their contributions transferred and, on retirement, would receive the same benefit as other migrants. However, those who move from rural areas 10 years later, at age 26, and who had 10 years of coverage under the rural plan, would have retirement benefits that are lower by a further 16 to 21 percentage points, depending on their age of retirement; there would be a further reduction of similar magnitude for those who moved to Shenzhen at 36 rather than 26. Those who transfer with fewer than 15 years of contribution to the Shenzhen plan would lose all entitlement to benefits from it; their benefits from the rural plan would be only about 15% as large as those who spent all their working years in the Shenzhen plan.

The wage rates in Shenzhen are high relative to those in other urban areas from which migrants originate, and that too will affect benefit levels for those who return before retirement. For example, those who return to an urban area where the wage rate is 30%

lower would have retirement benefits that are as much as 20 percentage points lower (depending on the number of years of work in Shenzhen) than if they had not returned.

We considered also the situation of typical individuals at various points on the income distribution, and conclude that the system is quite progressive: the replacement rate (pension income in retirement relative to wage income while working) is inversely related to the level of income. For example, those with the lowest wages who retire at 60 have replacement rates that exceed 1.00 (1.27 for locals, 1.09 for migrants) while those with the highest wages have replacement rates that are much lower (0.64 for locals, 0.50 for migrants). Furthermore, the replacement rate is positively related to the age of retirement; earlier retirement is associated with a lower replacement rate. Again, however, migrants fare somewhat worse. For lower income individuals, the replacement rates are about 15% lower for migrants than for locals; for those with higher incomes they are about 23% lower.

While migrants are at a clear disadvantage, as compared to locals, in terms of their pension income and replacement rate, they do better by another measure. That measure compares their expected benefits (future benefits, discounted by the life table probability of receipt) to their expected contributions (future contributions, discounted by the life table probability of contributing), both as seen from age 16. While migrants receive lower levels of retirement benefits, they also make lower contributions. It turns out that the ratio of expected benefits to expected contributions is a little higher for migrants than for locals. In addition, we find that the plan is relatively generous, in that the ratio exceeds 1.00 for migrants who have at least 15 years of contribution to the plan in Shenzhen. However, more important for most migrants might be the loss or at least reduction in benefits that results from the restrictions on the transferability of contributions between urban and rural plans. While migrants who contribute to urban plans for at least 15 years are entitled to basic benefits that adjust with the urban area's average wage, those who contribute for fewer years would receive much less generous benefits from the county and rural residents' plan.

While the characteristics of the plans have major impacts on individuals, they affect also the aggregate value of the flows of contributions into pension funds, the flows of benefit payments out of them, and the evolution of the overall value of the funds themselves. In further research we propose to model the relevant flows and stocks and assess the longer-term sustainability of the municipal plans such as the one in Shenzhen. Of particular interest are the impacts of population aging, the proposed increase in the retirement age, the possible success of policies designed to attract more highly educated migrants, and the limited transferability of contributions for migrant workers who leave the plan. The last matter is of importance since the social pooling portion of contributions is not fully transferable across jurisdictions. As a result a significant portion of the contributions of transitory migrant workers would remain in the fund without a corresponding claim on future benefits.

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	National Urban Workers Pension Guidelines	Shenzhen Urban Workers Pension Plan	Stylized County and Rural Residents Pension Plan	Government and Public Service Employees Pension Plan
Effective year	2005	2014	2014	2014
Targeted population	All employees (Includes self-employed)	Non-public employees (Includes self-employed)	Voluntary for those not in other plans	Public employees
Minimum contribution years	15	15	15	15
Contributory wage		(*as % of local average/minimum wage*[44])		
-lower limit	60% of average	100% of minimum	n/a	60% of average
-upper limit	300% of average	300% of average	n/a	300% of average
Contribution rates		(*as % of monthly wage*)		
-social pooling (employer)	20%	13%	n/a	20%
-individual account (employee)	8%	8%	Choice of 12 levels	8%
-local supplementary pension fund (employer)	Varies across provinces/cities	1% if SZ *hukou*;0% otherwise	n/a	Varies across provinces/cities
-enterprise annuity	Optional	Optional	n/a	8% employer, 4% employee
Normal retirement age	Men: 60 Women: 50 or 55	Men: 60 Women: 50 or 55	60 for everyone	Men: 60 Women: 50 or 55
Retirement benefits		(*monthly*)		
-basic amount (from social pooling)	yrs *1%*$\frac{(w_{a,t-1}+w_{aij})}{2}$	yrs * 1%*$\frac{(w_{a,t-1}+w_{aij})}{2}$	Minimum: RMB 78 (in 2015)	yrs *1%*$\frac{(w_{a,t-1}+w_{aij})}{2}$
-individual account	Deposits/x (x depends on age at retirement)	Deposits/x (x depends on age at retirement)	Deposit/139	Deposits/x (x depends on age at retirement)
-local supplementary pension fund	Varies across provinces/cities	for employee who has SZ *hukou* = yrs * $\frac{w_{aij}}{w_{a,j-1}}$*18.25+20	n/a	Varies across provinces/cities
-enterprise annuity	Not clear	Not clear	n/a	Not clear

Table 3.1 Major pension plans in China

[44] According to Shenzhen Statistical Yearbook 2016 and Shenzhen Ministry of Human Resource and Social Security, the minimum wage of 2015 is around 30% of the average wage of Shenzhen. Average wage of Shenzhen 2015: http://www.sztj.gov.cn/xxgk/tjsj/tjnj/201701/W020170120506125327799.pdf (accessed 19 Dec 2016). Minimum wage of Shenzhen 2015: http://www.szhrss.gov.cn/tzgg/201502/t20150206_2815254.htm (accessed 19 Dec 2016)

	Urban Workers Pension Plan				County and Rural Residents Pension Plan		
	Population	Total Participants	No. of Contributors	No. of Beneficiaries	Total Participants	No. of Contributors	No. of Beneficiaries
				National Level			
2014	1,393,784	341,240	255,310	85,930	501,070	357,940	143,130
2013	1,357,000	322,180	241,770	80,410	497,500	483,690	13,810
				Shenzhen			
2014	10,780.00	7,911.20	7,679.40	231.8	6.8	4	2.8
2013	10,630.00	8,349.10	7,550.50	798.6	6.3	3.7	2.6

Sources: for the national level -- Ministry of Human Resource and Social Security of the People's Republic of China—National social security information disclosure, 2013, 2014 (全国社会保险情况, 2013,2014年), obtained from http://www.mohrss.gov.cn/SYrlzyhshbzb/dongtaixinwen/buneiyaowen/201406/t20140624_132597.htm; http://www.mohrss.gov.cn/SYrlzyhshbzb/dongtaixinwen/buneiyaowen/201505/t20150528_162040.html; for Shenzhen--Shenzhen social security fund board--Shenzhen pension information disclosure 2013 and 2014 (深圳市社会保险信息披露通告, 2013, 2014), obtained from http://www.szsi.gov.cn/sbjxxgk/tjsj/sicbltj/201411/t20141112_2660753.htm http://www.szsi.gov.cn/sbjxxgk/tjsj/sicbltj/201506/t20150624_2930715.htm (accessed on Dec.16, 2016)

Table 3.2 Number of participants, contributors and beneficiaries of two major pension plans in China and Shenzhen (in thousands)

	Urban Workers Pension Plan					County and Rural Residents Pension Plan		
	Yearly In-flow	Yearly Out-flow	Total Deposits	Individual Accounts	Social Pooling Account	Yearly In-flow	Yearly Out-flow	Total Deposits
					National Level			
2014	2,531,000	2,175,500	3,180,000	500,100	2,679,900	231,000	157,100	384,500
2013	2,268,000	1,847,000	2,826,900	415,400	2,411,500	205,200	134,800	300,600
					Shenzhen			
2014	57,754	14,932	225,732	134,356	91,376	24	24	43
2013	48,312	12,057	182,910	113,408	69,502	26	22	44

Sources: for the national level -- Ministry of Human Resource and Social Security of the People's Republic of China—National social security information disclosure, 2013, 2014 (全国社会保险情况, 2013,2014年), obtained from http://www.mohrss.gov.cn/SYrlzyhshbzb/dongtaixinwen/buneiyaowen/201406/t20140624_132597.htm http://www.mohrss.gov.cn/SYrlzyhshbzb/dongtaixinwen/buneiyaowen/201505/t20150528_162040.html; for Shenzhen--Shenzhen social security fund board--Shenzhen pension information disclosure 2013 and 2014 (深圳市社会保险信息披露通告, 2013, 2014), obtained from http://www.szsi.gov.cn/sbjxxgk/tjsj/sicbltj/201411/t20141112_2660753.htm http://www.szsi.gov.cn/sbjxxgk/tjsj/sicbltj/201506/t20150624_2930715.htm (accessed on Dec.16, 2016)

Table 3.3 Inflow, outflow and deposit levels of two major pension plans in China and Shenzhen (in millions of RMB)

Funds	
Individual account	Social pooling account
Fully transferable	12% of the pensionable wage times the contribution years
Benefits	
Individual benefit	Basic pension benefit
Fully transferable	Contribution years fully transferable

Source: The Central Peoples' Government of China-- Interim approaches to transfer the pension plan for workers of enterprises in urban areas (城镇企业职工基本养老保险关系转移接续暂行办法) http://www.gov.cn/zwgk/2009-12/29/content_1499072.htm

Table 3.4 Transferability of the Urban Workers Pension Plans across urban area

Stays in C (Pension record not in the place where registered (A))				
Place responsible for paying	Contribution years in B<10		Contribution years in B>=10	
	Contribution years in C<10	Contribution years in C⩾10	Contribution years in C<10	Contribution years in C⩾10
Contribution yrs in A<10	A	C	B	C
Contribution yrs in A⩾10	A	C	B	C
Returns to A (Pension record not in the place where registered (A))				
Place responsible for paying	Contribution years in B<10		Contribution years in B>=10	
	Contribution years in C<10	Contribution years in C⩾10	Contribution years in C<10	Contribution years in C⩾10
Contribution yrs in A<10	A	A	A	A
Contribution yrs in A⩾10	A	A	A	A

Source: The Central Peoples' Government of China-- Interim approaches to transfer the pension plan for workers of enterprises in urban areas (城镇企业职工基本养老保险关系转移接续暂行办法) http://www.gov.cn/zwgk/2009-12/29/content_1499072.htm

Table 3.5 Jurisdictions responsible for paying the urban workers pension benefits for individuals with *hukou* in A

	County and Rural Residents Pension Plan to Urban Workers Pension Plan		Urban Workers Pension Plan to County and Rural Residents Pension Plan	
	Individual account	Social pooling account	Individual account	Social pooling account
Contributions	Fully transferable	n/a	Fully transferable	Non-transferrable
Benefits	Fully transferable	n/a	Fully transferable	Contribution years in the plan transferable

Source: Transfer between the County and Rural Residents Pension Plan and the Urban Workers Pension Plan (城乡养老保险制度衔接暂行办法)
http://www.mohrss.gov.cn/gkml/xxgk/201402/t20140228_125006.htm

Table 3.6 Transferability between the County and Rural Residents Pension Plan (R) and the Urban Workers Pension Plan (U)

	Retires at age		
	60	55	50
Panel A. Transfer from other Urban Workers Pension Plan to Urban Workers Pension Plan of SZ			
	81	80	79
Panel B. Transfer from County and Rural Residents Pension Plan to Urban Workers Pension Plan of SZ (or other Urban Workers Pension Plan)			
Transfer at age 16	81	80	79
Transfer at age 26	65	61	58
Transfer at age 36	48	43	37

Panel C. Transfer from County and Rural Residents Pension Plan to Urban Workers Pension Plan of SZ and back to County and Rural Residents Pension Plan

Retires at \ Years in SZ	45	40	35	25	15	9
60	81		65	48	31	13
55		80	71	52	33	12
50			79	58	37	12

Source: Authors' calculations.
Note: The pension benefits of migrant workers are expressed relative to local workers with Shenzhen *hukou*; all workers are assumed to contribute from age 16 until the age of retirement.

Table 3.7 Pension benefits of migrants who transfer among pension plans, relative to Shenzhen locals, by age of retirement, percent

Within Guangdong			Outside Guangdong		
City	% of total	Average wage relative to SZ	Province	% of total	Average wage relative to SZ
Meizhou	4	0.69	Hunan	11	0.74
Jieyang	3	0.53	Hubei	8	0.76
Shanwei	2	0.58	Sichuan	7	0.83
Maoming	2	0.64	Henan	5	0.66
Heyuan	2	0.61	Jiangxi	5	0.74
Zhanjiang	2	0.61	Guangxi	5	0.72

Source: Authors' calculations. The migration proportions are drawn from the *2005 China 1% National Population Sample Survey* and the average wage figures from the *China Statistics Yearbook, 2013* Note: "% of total" represents the percentage of Shenzhen population in 2005 whose *hukou* is in the location specified; it is based on the *2005 China 1% National Population Sample Survey*. The "average wage relative to SZ" is based on urban residents only and drawn from the *Guangdong Statistics Yearbook, 2013* and the *China Statistics Yearbook, 2013*.

Table 3.8 Migrants to Shenzhen from the top six urban migrant sources, both within and outside Guangdong, and the average wages in those places relative to Shenzhen, 2013

Age of transfer \ Years in SZ	Moves to Shenzhen at 16, leaves after years indicated, and retires at 60				
	45	35	25	15	9
Age 16	81	70	67	63	60
Age 26		78	67	63	60
Age 36			74	63	60

Age of transfer \ Years in SZ	Moves to Shenzhen at 16, leaves after years indicated, and retires at 55				
	40	35	25	15	9
Age 16	80	70	66	62	60
Age 26		76	66	62	60
Age 36			72	62	60

Age of transfer \ Years in SZ	Moves to Shenzhen at 16, leaves after years indicated, and retires at 50			
	35	25	15	9
Age 16	79	67	62	60
Age 26		75	62	60
Age 36			70	60

Source: Authors' calculations.
Note: The pension benefits of migrant workers are expressed relative to local workers with Shenzhen *hukou*; all workers are assumed to contribute from age 16 until the age of retirement.

Table 3.9 Pension benefits of migrants, relative to Shenzhen locals who retire at 60, 55, and 50, for those who transfer from the Shenzhen plan to another urban plan where the average wage is 30% lower, by years of work in Shenzhen starting at age of transfer

	Retires at age		
	60	55	50
Panel A. Transfer from other Urban Workers Pension Plan to Urban Workers Pension Plan of SZ			
	1.18	1.42	1.69
Panel B. Transfer from County and Rural Residents Pension Plan to Urban Workers Pension Plan of SZ to other Urban Workers Pension Plan			
Age 16	1.18	1.42	1.69
Age 26	1.19	1.43	1.69
Age 36	1.20	1.43	1.69

Panel C. Transfer from County and Rural Residents Pension Plan to Urban Workers Pension Plan of SZ to County and Rural Residents Pension Plan

Retires at 60	45	35	25	15	9
Age 16	1.18	1.16	1.16	1.16	0.72
Age 26		1.19	1.17	1.17	0.73
Age 36			1.2	1.18	0.73
Retires at 55	**40**	**35**	**25**	**15**	**9**
Age 16	1.42	1.41	1.4	1.4	0.78
Age 26		1.43	1.42	1.4	0.79
Age 36			1.43	1.42	0.79
Retires at 50		**35**	**25**	**15**	**9**
Age 16		1.69	1.67	1.65	0.81
Age 26			1.69	1.66	0.86
Age 36				1.68	0.87

Source: Authors' calculations.
Note: The expected benefit-contribution ratios for those with Shenzhen *hukou* are as follows (retirement at 60, 1.14; at 55, 1.32; at 50, 1.64.

Table 3.10 The ratio of expected benefits to expected contributions for those migrating to Shenzhen Plan at specified ages

Age of transfer \ Years in SZ	Retires at 60				
	45	35	25	15	9
Age 16	1.18	1.09	1.11	1.13	1.15
Age 26		1.20	1.11	1.13	1.15
Age 36			1.24	1.13	1.15

Age of transfer \ Years in SZ	Retires at 55				
	40	35	25	15	9
Age 16	1.42	1.29	1.32	1.35	1.38
Age 26		1.46	1.32	1.36	1.38
Age 36			1.50	1.36	1.38

Age of transfer \ Years in SZ	Retires at 50			
	35	25	15	9
Age 16	1.69	1.55	1.60	1.63
Age 26		1.74	1.60	1.63
Age 36			1.80	1.63

Source: Authors' calculations.
Note: Expected benefits and contributions are discounted by the probability of survival of China in 2012 at each successive age, looking from age 16, obtained from http://apps.who.int/gho/data/?theme=main&vid=60340 (accessed on Dec. 16, 2016)

Table 3.11 The ratio of expected benefits to expected contribution, assuming cities other than Shenzhen have an average wage 70% of Shenzhen

Education	Worked from age	w_e	Retires at 60 ben	Retires at 60 ben / w_e	Retires at 60 E(ben)/E(con)	Retires at 55 ben	Retires at 55 ben / w_e	Retires at 55 E(ben)/E(con)	Retires at 50 ben	Retires at 50 ben / w_e	Retires at 50 E(ben)/E(con)
A: With SZ *hukou*											
<=Junior	16	1.00	1.00	1.27	1.60	0.83	1.05	1.96	0.72	0.92	2.43
High	18	1.75	1.35	0.98	1.28	1.09	0.79	1.50	0.95	0.69	1.86
College	21	3.10	1.93	0.79	1.07	1.51	0.62	1.23	1.30	0.53	1.53
Undergrad	22	4.25	2.43	0.73	1.00	1.88	0.56	1.13	1.62	0.48	1.42
Grad	25	6.00	3.03	0.64	0.95	2.29	0.48	1.05	1.94	0.41	1.33
B: Without SZ *hukou*											
<=Junior	16	1.00	0.86	1.09	1.65	0.70	0.89	2.02	0.61	0.78	2.51
High	18	1.75	1.12	0.81	1.32	0.89	0.64	1.54	0.77	0.56	1.92
College	21	3.10	1.55	0.63	1.11	1.18	0.48	1.26	1.02	0.42	1.57
Undergrad	22	4.25	1.93	0.58	1.03	1.45	0.43	1.16	1.25	0.37	1.45
Grad	25	6.00	2.38	0.50	0.98	1.73	0.37	1.08	1.47	0.31	1.36

Source: Authors' calculations.

Note: Measures relating to benefits are defined as follows– w_e is the average wage in each education category relative to the average wage for those with junior education or less – ben is pension benefit that would be received in each education category relative to the benefit receipt for those with junior education or less– E(ben)/E(con) is the ratio of expected benefits to expected contributions; discounted from the age of starting work. The education levels are the highest level attained; they are: Junior school completed or less; High school, completed; College, completed; Undergraduate degree, completed, Post-graduate degree, completed

Table 3.12 Measures of relative pension benefit by level of education, age of first employment, age of retirement, and *hukou*

Conclusion

This thesis consists of three chapters that address policy-relevant questions with focuses on physicians' response to payment models, and differential pension treatments of internal migrants and locals in a developing country-China. As understanding how physicians respond to changes in the payment method is important for policy makers and researchers alike. The first chapter examines the switch from FFS plus pay-for-performance to a blended capitation model for GPs by firstly building a theoretical model and then testing the predictions empirically using Ontario administrative data. The second chapter proceeds to explore how different types of rostering incentivized by each payment model affect continuity of care within practices using similar econometric techniques in both chapters. Since we are concerned about the wellbeing of migrants after the recent pension reform in China that improved pension portability across regions, we assess the differential pension treatment between migrant and locals in the third chapter.

In the first chapter, our results indicate that physicians joining the blended capitation model tend to reduce the provision of care inside the basket and increase the provision of care outside the basket. Some of the reduction in the provision of inside the basket services may follow from changes in practice style that many patients would view as beneficial. It is possible that previous FFS payment encouraged the over provision of unnecessary services in response to financial self-interest (supplier-induced demand) and partially reimbursement for the cost of inside the basket services incentivized physicians to reduce the supply, which would likely represent an improved use of clincal resources and a reduction in the opportunity costs to patients. The increase in provision of outside the basket services could be interpreted from two sides: one is physician cost shifting, taking advantage of the blended capitation model; on the other hand, since a lot of preventive care and chronic disease management incentives and bonuses are also outside the capitated basket, it could be interpreted as an improvement in both quality of care and patients' access to care. Patients also obtain fewer services from both physicians in the same group as the rostering physicians and from those outside the group for both inside and outside the basket services. These findings are consistent across a series of propensity score weighted difference-in-differences models designed to control for selection on observables and fixed unobservables, and across a set of sensitivity tests.

In the second chapter, our results show that patient rostering indeed strengthens the bond between patients and physicians when physicians transition from FHGs to FHOs. In contrast, no improvement is observed in the shift from traditional fee-for-service to enhanced fee-for-service (i.e., the FHG model). The reason that the increase in continuity of care measurements is not significant from FFS to FHG might be that the rostering incentives behind the FHG model encourage the provision of selected services to rostered patients but do not restrict their patients from seeing other physicians. This could lead to an oversupply of targeted services to rostered patients without improving continuity of care. However, the rostering incentives behind the FHO model discourage physicians from letting their rostered patients see other physicians, which significantly increases some of the continuity of care measures. The multidisciplinary health professional team model, FHT, could foster accountability for efficient, integrated care through care management tools and quality improvement, which further facilitates patients to receive care from providers within their teams. The FHT model appears to perform even better than the FHO without without interdisciplinary team in keeping rostered patients within the rostering practice.

In the third chapter, we have shown that differences of pension treatment exists among residents, migrants from urban areas, migrants from rural areas, migrants who return to urban areas outside Shenzhen, and migrants who return to rural areas. Migrants are projected to have total pension benefits that are almost 20% lower than the benefits of locals due just to the supplementary benefit for locals in all cases. Since the minimum contribution years to get pension benefits from Urban Workers Pension Plan is 15, individuals who contribute less than 15 years would fall into the County and Rural Residents Pension Plan and therefore receive much lower benefits than individuals who contribute at least 15 years. From analyzing pension treatments by income distribution, the system is quite progressive: the replacement rate (pension income in retirement relative to wage income while working) is inversely related to the level of income. Furthermore, it turns out that the ratio of expected benefits to expected contributions is a little higher for migrants than for locals, which is possibly because although migrants receive lower levels of retirement benefits, they also make lower contributions.