Operating on commission: Analyzing how physician financial incentives affect surgery rates using nationally representative household data

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April 9, 2007

Abstract

Measuring how physician financial incentives impact on medical service provision has been a preoccupation of healthcare economists for many years. While the literature has explored the financial incentives of primary care physicians in great detail, the fields in which specialist physicians work has been largely overlooked. In this paper, a theoretical model is developed in which the quantity of specialist medical services is a function of both specialist and primary care physician financial incentives. The empirical section of the paper employs the Restricted Use 1996/1997 Community Tracking Study (CTS) dataset to test the model's predictions using surgery rates as a proxy for the quantity of specialist services. The CTS is a household based survey which includes observational data on both primary care and specialist compensation. Using a variety of econometric specifications and controlling for adverse selection, I find the financial compensation has a large effect on surgery rates. When specialists are paid through a fee-for-system (FFS) methodology rather than a capitation or salaried basis, surgery rates increase 155%. There is suggestive evidence that surgery rates fall when primary care physicians are paid on a fee-for-service basis compared to capitation or salaried payments.

1 Introduction

The question of how financial incentives affect physician decision-making has been a frequent subject for investigation in both the medical and economics fields. Are doctors completely altruistic, basing their medical care decisions only on what is the in the patient's best interest, or do physician behave as *homo economicus*, maximizing their profits without regard to patient health? While many of the prior studies focus on the relationship between financial incentives and primary care services or hospitalizations, the treatment of specialist services has been inadequate. This paper develops a theoretical model to explain how financial incentives of the specialist and primary care physicians affect specialist service provision and tests the predictions of the model empirically using data on surgery rates.

This paper diverges from the prior literature in a number of ways. While this study can hardly claim to be the first to investigate the relationship between financial incentives and specialist care, it is one of the few to do so using household data. Most other studies—such as recent work by Shrank et al. (2005) and Brinker et al. (2006)—use patient visit data, which is subject to severe selection problems. Also, unlike most studies on specialist medical service provision, the data used for the following analysis are nationally representative and include both survey-response and observational variables and estimates from this paper employ direct measures of physician compensation—rather than using proxies such as HMO insurance dummy variables—in order to more accurately capture physician financial incentives.

Another dimension in which the paper diverges from the established literature is that the formal model integrates disparate medical fields in a systematic fashion. It is proposed that the amount of primary care services provided will directly affect the amount of special services rendered and vice versa. For example, in treating a disease, it is possible that a drug prescription given to the patient within the primary care setting may substitute for surgery by a specialist. Having the primary care physician (PCP) prescribe the drug may preclude the specialist from performing surgery. A theoretical model is derived in which each physician gains utility from profits and patient health, where patient health is a function of both primary care and specialist services. The comparative statics of the model demonstrate that increasing primary care services should decrease specialist services if the two are substitutes.

In the empirical section of the paper, financial incentives are found to significantly influence patient surgery frequencies. When a specialist changes from a capitation to a fee-for-service (FFS) compensation method, surgery rates increase by approximately 155%. In the outpatient setting, surgery rates rose by 157%. Some suggestive evidence is also found that primary care financial incentives affect surgery rates as predicted by the model.

This paper proceeds as follows. Section 2 relates a more in-depth review of the findings to date on the manner in which financial incentives affect medical service provision. Also discussed are methods used in the literature to control for adverse selection. Section 3 develops a theoretical model. The model will provide five general hypotheses which will later be tested empirically. Section 4 describes the Community Tracking Study (CTS) 1996/1997 Restricted Use data file. Section 5 describes the how the hypotheses derived from the model will be tested econometrically and section 6 shows the results of these tests. A concluding discussion can be found in section 7.

2 Literature Review

The manner in which financial incentives affect the provision of medical services has been studied extensively in both the economics and medical fields. The most famous of these studies is the RAND Health Insurance Experiment (HIE). This randomized control trial (RCT) took place between 1974 and 1977 in six sites across the United States. In one portion of the study, households were randomly assigned between one of fourteen different fee for service plans or one prepaid group practice (Manning et al. 1987). Manning and co-authors conclude that patients in prepaid group practice plans had 72% of the expenditures of those in fee-for-service plans.

Other randomized trials of physician compensation's effect on service provision have found similar results. Hickson, Altemeier, and Perrin (1987) randomized medical residents into two groups on their weekly trips to a community clinic. One group received $2 per patient visit and the other group received a salary of $20 per month. The authors found that the fee-for-service group saw more patients and saw each patient more frequently than the salaried group. Using randomized survey techniques, Shen et al. (2004) examined how doctors respond to different financial incentives by presenting them with a series of clinical vignettes. The vignettes received by the physicians were randomly varied to include patients whose insurance compensated the doctor through either fee-for-service or capitation payments. The authors concluded that in three out of four cases, physicians made less resource- and time-intensive decisions under capitation than fee-for-service compensation[1]. Physicians also claimed to be more "bothered"

[1] The four vignettes presented to the physicians were outpatient drug prescription, diagnostic test

when providing medical care in all four vignettes if the patient was a capitation patient.

While these randomized trials certainly provide strong evidence that financial incentives matter to physicians, they are not without problems. The RAND HIE was conducted over 25 years ago, and the Hickson et al. experiment is over 20 years old; neither is nationally representative. Also the Shen et al. study uses hypothetical survey responses rather than information on actual behavior. Finally, none of these papers focuses directly on the quantity of specialist care provided.

A myriad of studies have been conducted outside the RCT framework. Seminal work by Akerlof (1970) and Rothschild and Stiglitz (1976) suggests that when operating outside the RCT setting, a thorough researcher must be concerned with the phenomenon of adverse selection. Adverse selection occurs when individuals select physicians with varying compensation methods in ways that are correlated with their underlying risk. Healthy people may choose doctors paid via capitation since they expect to need less care and enjoy the insurance premium savings from selecting plans that offer more sparing coverage. Individuals with severe illnesses may prefer a fee-for-service physician if they anticipate significant medical care needs. It may appear that patients of 'capitation' physicians utilize fewer medical services because of the compensation structure, when in reality, the reason for the lower patient utilization may be a healthier patient base. In the presence of adverse selection, estimates of the effect of capitation compensation on service provision will be negatively biased, and hence, overstated.

This phenomenon of adverse selection has been documented in a variety of empirical studies. A randomized trial of Medicaid enrollees by Leibowitz, Buchanan, and Mann (1992) found significant selection by healthy individuals into HMOs. Another strand of research examines employer-provided health insurance in order to observe how fixed-dollar employer health insurance contributions affect insurance sorting. Studies of this type were conducted at Harvard (Cutler and Reber 1998) and with University of California retirees (Buchmueller 2000) and both papers found sorting by healthy individuals into more restrictive insurance plans. In Dhanani et al. (2004), the authors compare Medicare enrollees who switch from an HMO to FFS insurance (and vice versa) to individuals continually enrolled in HMOs or FFS insurance. The data shows that seventy

ordering, a specialist referral, and the management of end-stage heart failure. In the first three scenarios doctors prescribed fewer medical services for the capitation patients. For the management of end-stage heart failure there was no statistical difference across the two patient types.

percent of the difference in the number of inpatient hospital days between patients in the two health plans were due to favorable selection into the HMO by healthier individuals.

Given the widespread evidence supporting the appearance of adverse selection in the choice of health insurance, it is important to control for this phenomenon when using data from a non-randomized trial. Since the data I employ in the empirical portion of this paper uses observed insurance type—and does not have an experimental design—this poses a significant concern. There are three prominent methods used to deal with adverse selection. The first method is to control for the selection problems using observables. The use of primary diagnosis (Brinker et al. 2006), Diagnostic Cost Group (Yu, Ellis and Ash, 2001) or self reported health measures (Ettner 1997) is common, especially in the medical literature. The findings of studies which use this method and analyze specialist services are far from conclusive. Shrank et al. (2005) find that individuals were half as likely to have cataract extraction surgery when the ophthalmologist was paid through capitation compared to FFS basis. Although an imperfect proxy for physician compensation, Brinker et al. (2006) finds that payer type (e.g.: Medicare, Medicaid, capitation HMO, PPO, indemnity, self-pay, etc.) had no impact on surgery rates in the orthopaedic setting. Despite the medical literature's best efforts to control for health level variables, there still exists a significant worry that unobserved health factors could bias the findings of some studies towards concluding that physician financial compensation is important.

A second group of papers uses variation in plan compensation occurring due to a 'natural experiment.' Madden et al. (2005) look at how general practitioner (GP) service provision for Ireland's 'medical card' population changed when the government switched from paying GPs via FFS to a capitation method.[2] Dusheiko et al. (2006) examine the English government's decision to abolish its fundholding scheme for GPs in 1998/1999. The fundholding scheme created financial penalties for GPs who referred "too many" of their patients to specialist physicians. The 'quasi experimental' approach is very appealing to health economics researchers, but generally restricts the scope of the study to individuals affected by a government or employer policy change. No study I am aware of using the quasi-experimental method has investigated how financial incentives affect specialist care.

[2]General practitioners in the United Kingdom perform similar functions as do family practice doctors in the United States. Both are grouped under the umbrella of primary care medical services.

A final effective means to control for adverse selection is to examine a subpopulation of the data that has little or no choice of insurance. Using the Community Tracking Study—the same dataset utilized in this study—Polsky and Nicholson (2004) and Nicholson et al. (2004) analyze medical expenditure data for privately insured individuals who only receive one choice of health insurance from their employer. According to Pauly and Percy (2000), nongroup insurance plans tend have significantly higher load factors compared to group policies,[3] provide less generous benefits than group health insurance, and are at a significant tax disadvantage. Consequently, for most individuals who have the option of only one type of health insurance at their place of work, this is their only *de facto* health insurance option and thus, adverse selection should not be a problem. This study attempts to eliminate adverse selection bias both by controlling for observable health level (using the Physical Component Summary variable) and examines a subpopulation of individuals offered one insurance plan from their employer. Unfortunately since the dataset comes from a single year, longitudinal analysis employing a 'natural experiment' policy shock is infeasible using the CTS data.

Among the few papers using household data which examine specialist service provision and adequately control for adverse selection are papers by Polsky and Nicholson (2004) and the Saver et al. (2004). The Polsky and Nicholson paper looks at how HMO-membership affects total expenditures. Limiting their sample to employed individuals with only one choice of insurance, they find lower medical costs for individuals in HMOs even after controlling for adverse selection. HMOs, however, are only a proxy for physician compensation since most HMOs pay some physicians on a capitation basis and others on a FFS basis. Saver et al. (2004) compare the procedure frequencies *within* three different HMOs who paid some doctors on a FFS basis and others on a salaried or capitation basis. The authors find that fee-for-service compensation increases the rate of medical care provision for a variety of specialist procedures compared to specialists paid via either capitation or salary.[4] In the paper, the authors state that claim variation

[3] In their study, Pauly and Percy find that group health insurance typically have load factors between 5% and 30%. Nongroup health insurance premiums has load factors between 33% and 50% of the expected benefits.

[4] The authors examine specialist procedures in the cardiology, gastroenterology, ophthalmology, orthopedic, and ear, nose and throat (ENT) fields. In 7 of sixteen cases, FFS specialists provided more services than capitation specialists at a statistically significant level. In the nine remaining cases specialty service provision rates were unaffected by whether the physician was compensated via FFS or

in payment methodology is largely due to local market considerations, but no city or region fixed effects were used. Further, since the paper only looked at three HMOs in the western United States, the paper is not nationally representative.

3 Theoretical Model

To motivate the subsequent empirical analysis of physician behavior, this paper creates a two-stage sequential game. In the first stage, patients visit a primary care physician (PCP)[5]. During the visits, the PCP elects to treat an individual patient with a quantity of primary care medical services, q_i, where $q_i \in [0, \bar{q}]$. After each patient visits the PCP and receives a treatment quantity q_i, the patients then visit a specialist. For each patient the specialist physician chooses a quantity of surgical procedures, s_i, where for theoretical purposes s_i is continuous and $s_i \in [0, \bar{s}]$. In the empirical section of the paper, the number of surgeries each individual has during a year will be used as a proxy to measure the quantity of specialist services. In this model, patients do not have a choice over the quantity of their medical treatment. While this assumption is unrealistic, it will not alter the empirical predictions if patients are divided between physician compensation schemes as good as randomly.

3.1 The Specialist Stage

We can solve this model through backward induction. In the second stage, the specialist physician maximizes the following utility function which takes into account his total profit and a weighted sum of his the patients' health level.

$$max_{\{s_i\ \forall i\}} \quad U\Bigg(\pi, B\Bigg) = U\Bigg(\alpha(N-J) + p\sum_{i=1}^{J} s_i - c\Bigg(\sum_{i=1}^{N} s_i\Bigg), \sum_{i=1}^{N} \gamma_i B_i(s_i, q_i, \theta_i)\Bigg) \quad (1)$$

This function is similar to an earlier model derived by Ellis and McGuire (1986). I assume that the representative specialist has a fixed base of N patients, and of these

capitation. FFS physicians, also, provided more services than salaried specialists in 11 of 17 cases—the other six cases were not statistically different from zero.

[5]Doctors who specialize in family practice, general practice, internal medicine, pediatrics, and sometimes gynecology are generally considered to be primary care physicians.

patients 1 through J pay the specialist with FFS insurance and patients $J+1$ through N pay with a capitation health plan. The specialist receives utility from profits but also accumulates utility from a weighted sum of his patient's health level. Preferences are assumed to be strictly monotonic in both profits and the cumulative patient health level and the specialist has weakly diminishing marginal utility in both profits and patient health. Mathematically, this means $U_\pi, U_B > 0$ and $U_{\pi\pi}, U_{BB} \leq 0$, where $U_\pi = \frac{\partial U}{\partial \pi}$, $U_{\pi\pi} = \frac{\partial^2 U}{\partial \pi^2}$, and so on. To simplify the model I assume that the specialist utility function is separable between profits and patient health so that $U_{\pi B} = 0$.

A physician's profit function, π, is equal to the sum of the capitation and fee-for-service payments, less the cost of providing the surgeries. Each capitation patient pays the physician an annual amount, α, regardless of the quantity of specialist services he receives. The J FFS patients pay the specialist a price of p for each unit of medical service rendered, but do not owe an annual charge to the physician. The cost function, $c(\cdot)$, takes into account services provided to both capitation and FFS patients and is assumed to be convex.

One may be skeptical that neatly dividing physicians into capitation or FFS groupings is appropriate. Robinson et al. (2004) note that a mixed payment method where each patient pays physicians a fixed annual amount as well as a positive FFS price is becoming increasingly common, even for specialist services. Although one could incorporate a mixed payment system into the theoretical model, data limitations in the empirical section will not allow us to measure physician compensation under a Robinsonian framework. Another criticism can be found in Glied and Zivin (2002) where the authors argue that most physicians treat both FFS and capitation patients and are not able to offer patients with different insurance coverage completely disparate medical service quantities due to fixed costs, such as the duration of a physician visit. While the Glied and Zivin paper is interesting when analyzing office visit data, because the empirical section the paper uses surgery rates as the measure of specialist service provision, one would likely believe that a physician with a mixed capitation-FFS patient base would be able to perfectly discriminate their quantity of care for each patient.

The other argument in the specialist's utility function is the patient health function B. The function B is simply defined to be the weighted sum of each individual patient's health level, $B_i(\cdot)$. The variable γ_i symbolizes the weight the specialist gives to each patient's health level, but for simplicity, I will assume that the specialist values each patient's health level equally so that $\gamma_i = \gamma = 1$. Each individual's health function, $B_i(\cdot)$, depends on both the quantity of surgeries s_i and the amount of primary care services q_i. The function B also depends on θ_i which is the health level of the patient in absence of treatment (i.e.: $B_i(0, 0, \theta_i) = \theta_i$). The variable $\theta_i \in [\underline{\theta}, \bar{\theta}]$.

There are a few unique items to note about this model. First is the placement of a cumulative patient health measure within the physician's utility function. Inserting the patients' health directly into the physician's utility function is common in the health economics literature, but some readers may be skeptical that physicians care about the patient's utility. One can think of health care as dissimilar from a typical buyer-seller relationship because the physician advises the patient as to the best treatment. Thus doctor-patient relationship is more akin a principal-agent interaction rather than the standard buyer-seller relationship. Further, even if the physician lacks any altruistic tendencies, the doctor may care about his patients' health either to maintain their reputation or because he fears a malpractice suit in the case of poor health outcomes.

The second significant item of note in the model is that of the implicit treatment externality. In most competitive markets, the actions of one supplier do not affect the actions of other suppliers except through price. In this model, however, the amount of primary care services each patient receives will affect the amount of surgeries he receives since the quantity of primary care services indirectly enters into the specialist's utility function via patient health. To further illustrate this point, let us look at a hypothetical example. If a patient is cured by primary care services so that $B_i(s_i, q_i^*, \theta_i) = \bar{\theta}$ and $B_{s_i} = \frac{\partial B}{\partial s_i} = 0$, the physician will have no altruistic reason to treat the patient—since no treatment would be able to improve the individual's health—and would only treat him if it was to increase their profits. On the other hand, if the primary care physician does not treat the patient (i.e.: $B_i = B_i(s_i, 0, \theta_i) < \bar{\theta}$, $B_{s_i} > 0$), then the specialist has a non-monetary incentive to supply medical care to the patient since doing so will improve the patient's health and, thus, increase the specialist physician's utility.

Also, I do assume diminishing returns to medical treatment ($B_{s_i s_i}, B_{q_i q_i} < 0$), but do not restrict that the marginal benefit of any treatment to be non-negative. Unlike most markets, excess consumption of medical services can actually harm an individual, so the free disposal assumption does not hold for medical services.[6] Finally, it is also

[6]While free disposal does not occur in the production of health because $\frac{\partial B}{\partial s}$ or $\frac{\partial B}{\partial q}$ can be less than zero, the non-satiation of physician utility with regards to patient health—as well as profits—does hold

assumed that surgeries and primary care services are substitutes, $B_{s_i q_i} < 0$.

Now let us proceed to analyze how the specialist maximizes utility. The specialist's N first order condition (FOC) can be arranged as a vector $\mathbf{G} = (g_1, ..., g_N)' = \mathbf{0}$ where each equation g_i is a first order equation.

$$\begin{aligned} g_i &= U_\pi(p - c') + U_B B_{s_i} \quad & i = 1, ..., J \\ g_i &= (p - c') + \delta B_{s_i} \quad & i = 1, ..., J \end{aligned} \tag{2}$$

$$\begin{aligned} g_i &= -U_\pi c' + U_B B_{s_i} \quad & i = J+1, ..., N \\ g_i &= -c' + \delta B_{s_i} \quad & i = J+1, ..., N \end{aligned} \tag{3}$$

As shown above, one can simplify the equations by dividing through by U_π so that $\delta = \frac{U_B}{U_\pi}$. The term δ is equal to the marginal rate of substitution between a one dollar increase in net revenues and one dollar's worth increase of total patient health level. As McGuire and Ellis (1986) mention in their paper, even though this term may depend on π, B or the vector of specialist services $\mathbf{s}$, "as long as the net revenue and benefits for each patient are small relative to the total amounts for the [physician] then [δ] will be nearly constant." Thus, going forward I will assume that δ is constant.

Examining equation (2), one can see that $\delta > 0$ since $U_\pi, U_B > 0$, and thus $(p - c') > 0$ if and only if $B_{s_i} < 0$. This means that a specialist will refuse to provide profitable services if and only if these services would harm the patient. Conversely, $B_{s_i} > 0$ if and only if $(p - c') < 0$; a physician will only withhold beneficial medical treatment from the patient if the the treatment is sufficiently unprofitable. We can also look at two extreme cases to develop more intuition. If a physician is entirely altruistic and only cares about the patient's health (i.e.: $U_\pi \approx 0$, δ is large) then the doctor will provide medical treatment until the benefit from an additional unit of treatment is 0 at the optimum (i.e.: $B_{s_i} = 0$). On the other hand, if a physician is driven only by a profit motive (i.e.: $U_B = 0$, $\delta = 0$), then he will continue to treat patients until the profit from providing one extra unit of specialist medical services at the optimum was 0 (i.e.: $p - c' = 0$). One can easily see that equation (3) is equivalent to equation (2) save for the fact that in equation (3) the price, p, is implicitly equal to zero, and thus the marginal profit from performing any service for a capitation patient is always negative. Thus, the physician will never preform harmful medical care services on patients whose insurers

since U_B and U_π are strictly positive.

pay the doctors on a capitation basis since marginal profit for these patients is always negative.

3.2 Comparing how Compensations Methods affect the provision of surgeries in the Specialist Stage

Using the theory developed above, we will now compare how the quantity of specialist services changes as a patient's insurance plan varies between FFS and capitation insurance. First we will prove that specialists preform more surgeries for individuals with FFS payment mechanisms than for individuals with capitation payment schemes.

Let s_1^* be the optimal amount of surgeries provided to a FFS patient and s_{J+1}^* be the optimal amount of surgeries provided to a capitation patient. To compare two similar patients, one must assume that $q_1 = q_{J+1}$ and $\theta_1 = \theta_{J+1}$. Now, I will assume that $s_{J+1}^* > s_1^*$ and conduct a proof by contradiction.

Looking at equation (2) and (3), we can easily see that $U_\pi(p - c') > -U_\pi c'$ since $p > 0$. Also, since it is assumed that $B_{s_i s_i} < 0$ and $s_{J+1}^* > s_1^*$, it must be the case that $B_{s_1} > B_{s_{J+1}}$. Since δ is constant, one can show that the left hand side (LHS) of equation (2) is greater than the LHS of equation (3) if $s_{J+1}* > s_1*$. Our FOC, however, claim that both equations must be equal to zero, and thus it is impossible that LHS (2)>LHS (3). Thus, by contradiction I have shown that $s_1* \geq s_{J+1}*$. In other words, patients with FFS health plans will receive (weakly) more services than patients with capitation health plans *ceteris paribus*.

Using comparative statics, we can preform a more precise analysis of the affect of price on a specialist level of service provision. In order to simplify the analysis, I will assume going forward that each specialist has $N = 2$ patients and with $J = 1$ FFS patients. If we find that $\frac{\partial s_i}{\partial p}|_{p=0} > 0$, we will show that FFS patients receive more specialist services than capitation patients.[7] Differentiating the two first order conditions with respect to p, we find:

$$\frac{\partial \mathbf{s}}{\partial p} = \begin{pmatrix} \frac{\partial s_1}{\partial p} \\ \frac{\partial s_2}{\partial p} \end{pmatrix} = \begin{pmatrix} > 0 \\ \leq 0 \end{pmatrix} \tag{4}$$

[7]Although switching from a FFS to capitation payment plan changes an individuals p and α, since it can easily be shown that $\frac{\partial \mathbf{s}}{\partial \alpha} = \mathbf{0}$, one only needs to analyze the $\frac{\partial \mathbf{s}}{\partial p}$ derivative to find the sign of a patient's change from capitation to FFS

The full derivation is shown in Appendix A.1. The intuition for this result is simple; when capitation patients (i.e.: $i = 1$ when $p = 0$) switch to FFS health plans, surgery rates increase since the physician's net marginal revenue will increase. For capitation patients who do not switch to FFS health plans (i.e.: $i = 2$) the surgery rates may decrease slightly since the specialist's net marginal revenue will decrease slightly when the cost function is convex. If the cost function is linear, then $\frac{\partial s_2}{\partial p} = 0$. The result of the comparative statics and the proof elaborated above provide the basis for my first hypothesis:

Hypothesis 1 *Holding all else constant, specialists paid via a fee-for-service (FFS) compensation method will perform more surgeries than those paid via a capitation.*

3.3 How changes in primary care physician service provision affect surgery rates

One goal of this paper is to take a more systematic approach to health care analysis. By explicitly modelling the fact that both specialist and primary care quantities of medical services affect health, theory predicts that the quantity of primary care services should impact surgery rates. To mathematically determine how these movements in primary care service provision affect surgery rates, we simply apply the implicit function theorem and differentiate the vector of specialist first order equations ($\mathbf{G}$) with respect to the quantity of primary care services, q_i:

$$\frac{\partial s_1}{\partial q_1} = \frac{1}{|\mathbf{G_s}|}\delta B_{s_1 q_1}(c'' - \delta B_{s_2 s_2}) < 0 \tag{5}$$

$$\frac{\partial s_2}{\partial q_2} = \frac{1}{|\mathbf{G_s}|}\delta B_{s_2 q_2}(c'' - \delta B_{s_1 s_1}) < 0 \tag{6}$$

The full derivation of $\frac{\partial \mathbf{s}}{\partial \mathbf{q}}$ is given in Appendix A.2. The assumption driving this result is that primary care services and specialist services are substitutes (i.e.: $B_{s_i q_i} < 0$). Thus, an increase in primary care services q_i will decrease the marginal effectiveness of treating patient i with surgery and thus a rational specialist would decrease surgery provision to the patient.

An illustrative scenario may be helpful here to gain some intuition. Let us assume that a PCP prescribes a drug for a patient to treat their heart condition (i.e.: q_i increases). A specialist might decide to forego the surgery (i.e.: a decrease in s_i) if the

PCP's drug is salubrious for the patient and if the PCP's treatment decreases the patient's marginal health benefit from surgery. On the other hand, if the PCP had decided against prescribing the drug, the patient's marginal helath benefit from surgery will increase and the specialist likely would decide to perform the surgery.

One complication which arise in the model is the possibility that primary care could create a synergy with specialist care (i.e.: $B_{s_i q_i} > 0$). For instance, visiting a PCP more frequently may lead to discovering serious illnesses earlier. When a specialist conducts a surgery earlier in a disease's incubabtion period, this treatment may be more effective towards increasing the patient's health level. In this case, we would find that $\frac{\partial s_i}{\partial q_i} > 0$. Going forward in this paper, however, I focus on the case where specialist and PCP medical care are substitutes.

Following the arguments made in the prior two paragraphs, we are lead to my second hypothesis.

Hypothesis 2 *If one were to assume that primary care services are substitutes for surgeries, then an increase in the quantity of primary care services will decrease the amount of surgeries performed (i.e.: $\frac{\partial s_i}{\partial q_i} < 0$).*

3.4 First stage: The primary care physician treatment decision

Now let us move on to the first stage of the game. In this stage, the representative primary care provider (PCP) has a similar utility function to that of the specialist.

$$max_{q_i\ \forall i} \quad \hat{U}\Big(\hat{\pi}, B\Big) = \hat{U}\Bigg(\hat{\alpha}(N-K) + \hat{p}\sum_{i=1}^{K} q_i - \hat{c}\Big(\sum_{i=1}^{N} q_i\Big), \sum_{i=1}^{N} B\Big(s_i^*(q_i), q_i, \theta_i\Big)\Bigg) \quad (7)$$

The same functional form assumptions as in equation (1) hold for this utility function. The PCP has N number of patients, of which K patients have FFS health plans and $(N-K)$ patients have capitation health plans. In this model, it is possible for the patient's health plan to compensate a PCP via capitation but a specialist via FFS (and vice versa). Similarly to the specialist case, we can construct an $(Nx1)$ vector of first order equations: $\mathbf{F} = (f_1, ..., f_N)' = \mathbf{0}$.

$$\begin{aligned} f_i &= \hat{U}_\pi * (\hat{p} - \hat{c}') + \hat{U}_B[B_{s_i}\tfrac{\partial s_i}{\partial q_i} + B_{q_i}] \quad & i = 1, ..., K \\ f_i &= (\hat{p} - \hat{c}') + \hat{\delta}[B_{s_i}\tfrac{\partial s_i}{\partial q_i} + B_{q_i}] \quad & i = 1, ..., K \end{aligned} \quad (8)$$

$$\begin{array}{ll} f_i = -\hat{U}_\pi * \hat{c}' + \hat{U}_B[B_{s_i}\frac{\partial s_i}{\partial q_i} + B_{q_i}] & i = K+1, ..., N \\ f_i = -\hat{c}' + \hat{\delta}[B_{s_i}\frac{\partial s_i}{\partial q_i} + B_{q_i}] & i = K+1, ..., N \end{array} \tag{9}$$

Just as in equations (2) and (3), the FOC (8) is equal to the FOC (9) when $\hat{p} = 0$. The first terms in the PCP's FOC are similar to the two first terms in equations (2) and (3), and $\hat{\delta} = \frac{\hat{U}_B}{\hat{U}_\pi}$ is again well-approximated by a constant in a setting with a large number of patients. The second term, however, has a subtle difference from that specialist's first order conditions. By increasing the amount of primary care services, the PCP will increase the health of the individual (if $B_{q_i} > 0$). According to hypothesis 2, however, increasing q_i will induce the specialist to decrease s_i. If $B_{s_i} > 0$ then increasing primary care services could actually decrease patient health even though the direct effect of increased primary care services on health is positive. One can think back to the example given earlier where patients either receive prescription drugs from a PCP and forego surgery or refuse the pharmaceutical and have the specialist preform the surgical procedure. While the model uses the generally defined fields of primary and specialist care, this framework could easily be applied to more narrowly defined medical fields such as cardiologists and cardiothorasic surgeons.

3.5 How physician financial incentives in the primary care setting affect the provision of specialist care

The next logical step in this systemic analysis of financial incentives and surgery rates is to analyze how variation in PCP compensation methodology affects surgery rates. Mathematically, our task is to sign the derivative $\frac{\partial \mathbf{s}}{\partial \hat{p}}$. Algebra tells us that $\frac{\partial \mathbf{s}}{\partial \hat{p}} = \frac{\partial \mathbf{s}}{\partial \mathbf{q}}\frac{\partial \mathbf{q}}{\partial \hat{p}}$. From section 3.3, we know the value of $\frac{\partial \mathbf{s}}{\partial \mathbf{q}}$ so now all that needs to be done is to apply the implicit function theorem to calculate $\mathbf{F}_{\hat{p}}$ and $\mathbf{F}_{\mathbf{q}}$.

$$\frac{\partial \mathbf{q}}{\partial \hat{p}} = -[\mathbf{F}_{\mathbf{q}}]^{-1}\mathbf{F}_{\hat{p}} = \frac{1}{|\mathbf{F}_{\mathbf{q}}|}\begin{pmatrix} c'' - \hat{\delta}\left(\frac{\partial^2 B(s_2(\mathbf{q}), q_2, \theta_2))}{\partial {q_2}^2}\right) \\ -c'' \end{pmatrix} \tag{10}$$

Similar to equation (4), $\frac{\partial q_1}{\partial \hat{p}}$ is positive, but $\frac{\partial q_2}{\partial \hat{p}}$ is either negative or zero depending on whether the cost function is convex or linear. Appendix A.3 gives the necessary conditions in order to sign $\frac{\partial q_1}{\partial \hat{p}}$. Intuitively, when PCP are paid more for marginal care, they will want to preform more services for FFS patients. Also, we can condition on

$\hat{p} = 0$ and interpret these results to mean that when an individual moves from capitation to FFS insurance, the quantity of primary care services supplied will increase.

If $\frac{\partial q_1}{\partial \hat{p}} > 0$ for FFS patients, then $\frac{\partial s_1}{\partial \hat{p}} < 0$. Appendix A.4 proves this result formally. The conclusion leads us to my third hypothesis.

Hypothesis 3 *If the amount of compensation for primary care services ($\hat{p}$)* increases, *then the amount of surgeries performed will* decrease *due to a substitution effect. In the data, holding constant the specialist's compensation method, one would predict that changing primary care physician compensation from capitation to fee-for-service will* decrease *surgical rates.*

3.6 The efficacy of primary care services and surgery rates

The above analysis assumes that surgery and primary care services are substitutes (i.e.: $B_{s_i q_i} < 0$). However, many physicians believe that financial incentives do not affect their decision making in the case where surgical procedures which are considered to be non-elective. The Shen et al. (2004) study found survey responses of treatment intensity varied greatly between fee-for-service and capitation patients in three cases where treatment was 'more elective.' In the relatively non-elective case of the management of end-stage heart failure, the authors found no difference in the physician's intended treatment intensity for FFS and capitation patients. Shrank et al. (2005) finds that cataract surgery rates are responsive to financial incentives, but non-cataract ophthalmological surgery rates—which the authors deem to be non-elective—do not respond when physician financial incentives change.

Let us assume that surgeries classified as 'non-elective' are ones which greatly improve patient health, but primary care services are ineffectual in altering the patient's health level. Mathematically this means that $B_{s_i} \gg 0$, $B_{q_i} = 0$, and thus $B_{s_i q_i} = 0$. In this case, we see that equations (5) and (6) will equal zero. In other words, a change in the provision of primary care services will not affect surgery rates. By extension, we can conclude $\frac{\partial \mathbf{s}}{\partial \hat{p}} = \mathbf{0}$, which leads to our fourth hypothesis.

Hypothesis 4 *In the case of* non-elective *surgery, changing primary care financial incentives will have little or no effect on surgery rates. When analyzing empirical data, one would predict that surgeries classified as* 'inpatient' *will be less responsive to financial incentives than those classified as* 'outpatient.'

4 Data

To test the four hypotheses proposed in the theoretical model outlined above, this paper will utilize of the Community Tracking Study 1996/1997 Restricted Use data set. This cross-sectional study was funded by the Robert Wood Johnson Foundation and is a nationally representative household survey of over sixty thousand individuals. The survey methodology uses stratified sampling and all subsequent estimates and standard errors derived in this paper will account for the idiosyncracies of this survey design. For more detailed information on the survey design of the Community Tracking Study see Kemper et al. (1996)[8].

Household surveys such as the CTS have the advantage of providing a representative look at the health of a society. In general, however, these surveys often have inaccurate data regarding patient insurance information and diagnostic variables. Health status is often self-reported on a relatively uninformative one to five scale.[9] Variables describing physician compensation are typically either omitted or unknown by the survey respondents. On the other hand surveys of physicians or studies using the patient-physician encounter as the unit of observation give more detailed diagnostic information and more accurate information regarding physician compensation measures. Yet the physician or patient-visit surveys also have their flaws. These studies often lack important demographic information such as patient income and education and suffer from large selection biases.[10]

The true analytical power of the CTS is that it is a nationally representative household survey, but using the Restricted Use Followback Survey the researcher knows detailed information regarding patient insurance information. In the Followback section, survey workers collected information regarding an individual's insurance coverage directly by contacting the patient's insurance company. The data collected include variables such as patient deductibles, copayment and coinsurance rates, referral require-

[8]The CTS documentation of the survey design are available online as well at the Inter-University Consortium for Political and Social Reserach (ICPSR) website: http://www.icpsr.umich.edu/

[9]For instance, in the Currently Population Survey (CPS), the health status question is: "Would you say ...'s health in general is: 1-Excellent, 2-Very Good, 3-Good, 4-Fair, or 5-Poor."

[10]This survey method will produce estimates which give excess weight to people who are more sick or who treat their illnesses with aggressive physician intervention since both these types of individuals will make more physician visits and thus appear more frequently in the data.

ments, and—most importantly for this paper—the manner in which the insurance company compensates primary care *and* specialist physicians. Permission for the author to use the data collected within the restricted use Followback survey was granted by representatives from the Inter-University Consortium for Political and Social Research (ICPSR).

The benefits from having observational data from the individual's insurance company include not only more information, but more accurate information. Using the CTS, Cunningham, Denk and Sinclair (2001) showed that only 30.3% of individuals were able to correctly answer four questions regarding their own insurance coverage.[11] A study by Reschovsky et al. (2002) demonstrated that patient satisfaction with their health plan depended on whether they believed they were in HMO, not whether they were actually in an HMO.[12] These two studies demonstrate that having observational data is extremely important when using insurance or physician compensation variables since self-reported survey responses of these measures tends to be highly inaccurate.

In the empirical analysis section of this paper, the data set is limited to only those with private insurance in which the Followback survey were able to match the respondent's information with the insurance companies' information. Among those with private insurance, the match rate was 75%. This limits our survey to 28,578 people. The sample is then further condensed to include only individuals between ages 18 and 64 in order to exclude children and those eligible for Medicare. The new sample size is 22,958 observations.

[11] The questions included: 1) Is there a book or directory of doctors associated with the insurance plan? 2) If the patient does not have a referral, will their insurance company pay for any of the costs of visits outside the network? 3) Is the individual required to sign up with a primary care doctor? and 4) Is a referral required to see a specialist?

[12] Among individuals who were *actually* enrolled in an HMO, 9.6% of individuals who claimed to be in an HMO were dissatisfied with their health plan while only 6.3% of individuals who claimed to not have an HMO were dissatisfied with their insurance. Among individuals who were *actually* enrolled in a non-HMO plan, 10.1% of individuals who claimed to be in an HMO were dissatisfied compared to only 7.3% of individuals who claimed to have a non-HMO health plan.

5 Estimation Strategy

5.1 Creating the variables

The goal of this paper is to find how different physician compensation schemes affect surgery rates. In order to do this, we first create four dummy variables: CC, FF, CF, and FC.

The first letter of the two letter abbreviation determines whether the primary care phsyician is paid via fee-for-service (F) or capitation (C). The second letter represents the manner in which the specialist is compensated. Thus, the variable CF is equal to unity when the individual's insurance plan pays the PCP with a capiation payment and the specialist on a FFS basis. In the data, capitation and salaried physicians are lumped into the same "capitation" category. This is done because both salaried and capitated physicians receive a non-positive pecuniary benefit from providing marginal services and thus both have have an incentive to provide less treatment than in the fee-for-service setting.[13] All subsequent regressions were run after separating out salaried and capitation physicians. The results—which are not reported in this paper—give similar coefficient results as when the capitation and salaried physicians are grouped together, but the standard errors are less precise.

In the data we find that 27.5% of patient's insurance plans pay their primary care physician via capitation compensation. These same insurance companies pay specialists via capitation compensation only 16.2% of the time. Remler et al. (1997) completed a national physician survey physicians in 1995 and found that the mean primary care physician practice received capitation payment for 18% of its patients and the mean specialist received capitation payment for 10% of its patients. Remler's capitation reimbursement figures are lower than the ones found here for two reasons: 1) the Remler data is survey based, not observational and thus there could be some response bias; and 2) if physicians base their responses on either their patient base or their typical patient experience, in the presence of adverse selection the physician will interact with capitation patients less frequently if this sub-population is comprised of healthier individuals.

[13]Both salaried- and capitation-compensated physicians receive zero marginal revenue for each unit of treatment given. The salaried individual, however, only incurs the cost of their own labor or effort level, while the capitation-paid physician bears the additional burden of paying for all fixed and variable costs of the treatment out of their own pocket.

For these reasons, the data from the CTS seem reasonable.

One complication arising in the data is that some physicians are compensated through a global capitation payment. Under this arrangement, the costs for primary, specialist and hospital care are completely born by the the primary care provider. Of course, very few physicians would agree to global capitation due to the risk that a few patients may need exorbitant medical care. Physicians, however, can pool their risk by joining group practices. Osgood (1997) notes that the physician structure under global capitation "...is usually a large, multi-specialty structure spread over a large geographic area." Examples of group practices paid via global capitation include single-plan group practices such as Kaiser Permanente or individual practice associations (IPAs). Although the researcher knows how the group practice is paid, the data do not describe how each individual physician is compensated by the practice.

Physicians working for global capitation group practices are likely to be individually compensated in one of two ways: using financial withholds or implementing a system such as the Resource-Based Relative Value Scale (RBRVS). The financial withhold compensation method applies mainly to primary care providers. Working in a financial withhold system, each physician still receives a base capitation or salaried payment but is financially penalized (or rewarded) when the PCP's patient base incurs above average (or below average) specialist service utilization rates. One would predict that physicians working under a global capitation system with financial withholds would have incentives most closely aligned with physicians in regular capitation practices. In fact, studies by Martin et al. (1989) and Dusheiko (2005) find that the financial withholds compensation structure reduces the average patient's specialist service utilization.

On the other hand, individual physicians may be paid on a RBRVS basis. Physician working under this payment mechanism receive a fee-for-service payment for each service, but the price of the service is dependent on the total number of services provided by all the doctors in the practice.[14] Marginal revenue for each physician under the RBRVS system is positive and, thus, physicians have the incentive to act more like fee-for-service

[14]To greatly simplify the RBRVS system, assume a group practice receives a fixed V dollars per year to care for their patient base and each physician provides a quantity of medical services q_i. A single physician's revenue is determined by the equation:

$$\pi_i = p(q_i, q_{-i})q_i = \frac{V}{\sum_{j=1}^{N} q_j} q_i.$$

providers.

In order to isolate the researcher's ambiguities regarding physician compensation under global capitation, a fifth physician compensation variable is created, G, which is equal to unity if the individual is part of a health plan with global capitation and zero otherwise.[15] A description of all five physician compensation dummy variables is given in Table 1. Table 2 breaks down each financial compensation dummy variable by type of insurance structure.

As we can see from the table 2, the series of physician compensation variables do not fall neatly into insurance product categories. Thus, prior studies analyzing an HMO's effect on medical service provision are not isolating the affect of physician financial compensation on service provision. For instance, assuming that primary care physicians in HMOs are paid via capitation would be incorrect since approximately 32% of PCPs who work for HMOs are paid via FFS. On the other hand, one fifth of PCPs paid via capitation do not work for HMOs.

In order to analyze the affect of physician compensation on specialist medical services in the data, I assume that specialist medical services S are a function of the the five physician compensation dummy variables as well as the vector of covariates $\mathbf{z}_i$. The matrix of all dependent variables is defined to be $\mathbf{x}_i$.

$$S_i = f(FF_i, CC_i, CF_i, FC_i, G_i, \mathbf{z}_i) = f(\mathbf{x}_i) \tag{11}$$

For brevity, the i subscripts will be dropped in the remainder of the paper.

The dependent variable which will be used in the subsequent analysis is the number of surgeries each individual has had performed in the last year. The 'number of surgeries' is chosen as the dependent variable for a number of reasons. First, it is highly unlikely that a surgical procedure is performed by a primary care physician. Using a measure such as doctors visits or the number of diagnostic tests an individual has during a year

If we take the derivative of the marginal revenue function, π, it is easy to show that:

$$\frac{\partial \pi}{\partial q_i} = p\Big(1 - \frac{q_i}{\sum_{j=1}^{N} q_j}\Big) > 0$$

. For more information on RBRVS, see Berlin, Faber and Berlin (1997).

[15]The variable G also includes 'full professional capitation' in which the practice is liable for paying for primary and specialist care, but do not have to pay for hospital care. Under global capitation, the practice is also responsible for hospital expenses as well as primary and specialist care.

can create data accuracy problems. The individual may incorrectly attribute primary care services to specialists—and vice versa—which would bias the data. Also surgeries and primary care services are less likely to be substitutes than primary care services and other specialist services. Thus, the estimates shown in the data will tend to underestimate the responsiveness of specialist services to changes in primary care services provision. Although one would ideally like to use other measures of specialist services to further test the model's predictions, the number of surgeries is the only variable in the dataset which exclusively pertains to specialist care.

Looking at the vector of explanatory variables, $\mathbf{z}$ includes individual information such as age, age-squared, gender, income, marriage status and a constant term. Other covariates in $\mathbf{z}$ are education and race dummies. There are five education dummies (less than high school, graduated from high school, some college, graduated from college, some graduate school) and four race dummies (Caucasian, African-American, Latino, and Asian/Native American/Other). Finally we have a health variable which is the proportional to the Physical Component Summary (PCS). The PCS is continuous variable constructed from twelve detailed questions regarding the respondent's health status.[16] Summary information for each of these measures is shown in Table 3.

5.2 Regression set up

As stated earlier, we will be using the number of surgeries an individual has had during the prior year as the dependent variable. Since the number of surgeries is restricted to be a non-negative integer, a count data model must be employed. A logical starting point is to use the Poisson model. The Poisson regression is frequently used in the medical literature, but contains the severe restriction that the dependent variable's conditional mean and variance must be equal (i.e.: $E(S|\mathbf{X}) = Var(S|\mathbf{X})$).

To test whether or not the Poisson model is appropriate, one can estimate a type I negative binomial regression (Negbin I) where $Var(S|\mathbf{X}) = (1+\alpha)E(S|\mathbf{X})$.[17] Cameron

[16]For example, two of the twelve questions included in the PCS calculation ask whether a person's health limits them from "Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf" and "Climbing several flights of stairs?" Other questions inquire as to the emotional state of the person and whether or not they suffer significant pain.

[17]The negative binomial is similar to the Poisson model. The Poisson density is given by:

$$f(S|\mathbf{X}) = \frac{e^{-\lambda(\mathbf{X};\beta)}\lambda(\mathbf{X};\beta)^S}{S!}.$$

and Trivedi (1986) demonstrate that a Wald test can be conducted to test the null hypothesis that $\alpha = 0$ (i.e.: the Poisson model is acceptable). The null hypothesis that the Poisson regression is acceptable is strongly rejected ($P < 0.01$) in all the specifications which will be used in this paper.[18] Thus, the negative binomial (i.e. Negbin I) model will be the econometric model employed throughout the majority of the paper.[19]

5.3 Controlling for Adverse Selection

One worry noted earlier is that of adverse selection. If physicians who are compensated via capitation provide less generous medical services, but also contract with health plans with lower premiums, it is likely that healthy individuals will choose these health plans. If this was the case, individuals with capitated PCPs would have fewer surgeries not due to financial incentives, but because they are healthier patients. To investigate whether adverse selection is a problem, one must first look at a table of means divided between the group of individuals with a choice of insurance and the group of individuals offered only one type of insurance. Table 4 has these results.

The "no choice" group seems to have fewer surgeries in both the outpatient and inpatient categories. This group is also more likely to have FFS insurance, more likely to be male, less likely to be married and have a slightly lower income than individuals in the "adverse selection" category. On the other hand, it seems that there is no difference between the groups on the dimensions of age, education and race.

To further test for adverse selection, I regress the Physical Component Summary on the four compensation dummies (FF is omitted) as well as age and gender variables to see if individuals with capitation-reimbursed PCPs are healthier than patients whose

The Poisson generally uses a λ parameter where $\lambda(\mathbf{X};\beta) = e^{\mathbf{X}\beta}$. The negative binomial regression assumes that the lambda parameter is measured with some error, ϵ, so that now $\lambda(\mathbf{X};\beta) = e^{\mathbf{X}\beta+\epsilon}$. If we assume ϵ is distributed according to the Gamma distribution, we arrive at the negative binomial model. For a more in-depth treatment of the derivation of the negative binomial function, see Cameron and Tirvedi (1986).

[18]See Table 7 for the parameter estimates of α.

[19]Although the results from the Negbin I model are presented in this paper, the analysis was also conducted using the Negbin II framework in which it is assumed that $Var(S|\mathbf{X}) = E(S|\mathbf{X})[1+\alpha E(S|\mathbf{X})]$. Neither the qualititave or quantitative results change significantly when the Negbin II specification is used.

PCPs receive FFS compensation. Age and gender information are included since insurance companies selling group insurance generally know the age and gender of the employees which their policy covers. The results of the above regression are shown in Table 5. The data show that individuals in the CC, CF and FC groups seem to be healthier than those in the FF groups, while individuals in the G category are even less healthy. Nevertheless, only the results from the FC group are statistically significant, but since the FC compensation method is used by less than 0.5% of the patients in the sample (i.e.: 86 observations total) one can conclude that overall the null hypothesis of no observable health differences between the fee-for-service and all other groups can be accepted.

In an effort to further control for any unobservable selection effects, I divide the sample into two groups. One group is offered a choice of multiple insurance plans at work and the other group is offered only one insurance option. This method for controlling for adverse selection was also used by Polsky and Nicholson (2004). Healthy individuals with a choice of insurance at work could sort themselves into 'capitation-compensation' insurance and those who are less healthy could sort into insurance plans who pay physicians via FFS. Those offered only one type of health plan at work do not have this sorting option available to them. As discussed earlier, for most individuals non-group insurance is a poor substitute to group insurance purchased through one's employer. This leads to the final hypothesis.

Hypothesis 5 *In hypothesis 3, we claimed that when primary care physicians were compensated via capitation, this would increase surgery rates. Empirically, this would imply that $\beta_{CF} > 0$. If adverse selection is a problem, however, then healthier individuals will sort towards insurance plans with capitated primary care. If the regression coefficient for the specification where the individual is offered one health plan is given by β_{CF} and the regression coefficient where the individual is offered multiple plans at work is given by $\tilde{\beta}_{CF}$, then theory predicts that $\beta_{CF} > \tilde{\beta}_{CF}$ if adverse selection is a problem.*

There are three major confounding factors which could bias the coefficients estimated from the 'no choice' estiamtes: physician selection, spousal insurance and job choice. Hellinger (1996) notes that is is possible that physicians who treat patients in a less aggressive manner may migrate to employers with capitation payment plans while those with more aggressive treatment styles may choose FFS employment. Under the data currently available, it is impossible to separate whether the physicians migrate to financial plans whose incentives favor their practice style or whether the financial incentives actually change the physician's practice style from an unobserved counterfactual.

The second issue is that individuals who only have one choice of insurance at work may not, in fact, be limited to this single option. If their spouse is employed, the individual may be added to their spouse's group insurance plan. One method to solve this problem is to only examine single individuals. Restricting the sample in this manner reduces the sample size by over two-thirds to only 1900 observations. Further, mean age and number of surgeries per person decreases, making the sample less nationally representative.

The paper also assumes that an individual's place of employment is chosen without regards to the manner in which physicians are compensated. Since Cunningham, Denk and Sinclair (2001) demonstrates that individuals have poor knowledge of their own insurance, it is highly unlikely that health plans are chosen based on physician compensation method. It is possible, however, that individuals select their employer based on whether they offer an HMO, preferred provider organization (PPO), point-of-service plan (POS) or FFS health plan. The health plan type is correlated with the manner in which physicians are compensated so there could be some bias. The bias stemming from additional choices of group health plans through spousal insurance or job selection, however, would likely reinforce adverse selection effects and thus decrease the parameter estimates on physician compensation variables where the primary care provider was paid via capitation (i.e.: the dummy variables CF and CC). This would make it less likely to conclude that that hypothesis 3 is true, but the bias's effect on the results from hypothesis 1 is ambiguous.

5.4 Non-financial Physician Incentives

One confounding factor ignored throughout this paper is the possibility that non-financial incentives play a role in surgical rates. Referral requirements, provider network restrictions, and mandatory PCP sign-ups may affect provider decision-making in ways not modelled in this paper. The subsequent analysis will examine how financial incentives affect surgery rates with and without referral requirements.

Referral requirements compel patients to receive 'permission' from a primary care doctor before they visit a specialist. Seminal work by Shortell (1979) claims that a social exchange model reflects best how the referral system functions. If this were the case, financial incentives to over- or under-provide care may be muted by these social interactions created by referral requirements. Franks et al. (1999) claims that referrals are decided through physician supply actions while Shea et al. (1999) claims that patient demand is the ultimate driver of these referrals.

A new specification to isolate the effects of referrals would be:

$$S = g(nFF, nCC, nCF, nFC, nG, rFF, rCC, rCF, rFC, rG, \mathbf{X})$$

where $rFF = ref * FF$ and $n * FF = (1 - ref) * FF$, where ref is a dummy variable equal to one when a referral is required by the health plan and zero otherwise.[20] If referral requirements restrict specialist service, we would expect $\beta_{nFF} > \beta_{rFF}$, $\beta_{nCC} > \beta_{rCC}$, $\beta_{nCF} > \beta_{rCF}$, $\beta_{nFC} > \beta_{rFC}$, and $\beta_{nG} > \beta_{rG}$. We would also expect all previous hypotheses to hold. This would imply that $\beta_{nCF} > \beta_{nCC}$ and $\beta_{nCF} > \beta_{nFF}$ as well as $\beta_{rCF} > \beta_{rCC}$ and $\beta_{rCF} > \beta_{rFF}$. The first two groups of predictions reflect hypotheses (1) and (3) respectively for health plans without referral requirements and the latter two predictions test these hypotheses for health plans with referral restrictions.

6 Results

Now we will proceed to test the hypotheses established in earlier sections with the CTS data. A summary of the five hypotheses established so far are shown in Table 6. Coefficient estimates are weighted to take into account the stratified sampling nature of the data in order that all conclusions drawn in the paper can be applied to the national population. All statistical tests in this section use heteroskedastic-corrected, clustered standard errors.[21] Unless otherwise noted, results are reported as the percentage change in the surgery rate from a one unit change of the independent variable. For dummy variables, coefficients are calculated as the percentage change in the number of surgeries when the binary variable changes from zero to one. All conclusions inferred from these

[20] Two referral requirement variables are available in the data are 1) whether or not the plan will cover any costs to in-network specialist seen without referrals and 2) whether or not the plan will cover out of network specialists seen without a referral. Both yield similar results so the former specification is used.

[21] The clustering is done geographically by survey site. Small rural areas, and mid-sized cities in similar regions are grouped together.

results should be interpreted as the affect of variable x_j on surgery rates for individuals aged 18 to 64 with employer-provided insurance.

6.1 Unbiased Specifications

In the first set of specifications we restrict the sample to individuals who are offered only one health plan through their employer. As discussed previously, this methodology—along with the use of the PCS variable to control for health level—should eliminate biases resulting from adverse selection. The first three columns of Table 7 give the results from the negative binomial regression. The column headings 'Total,' 'Out,' and 'In' correspond to whether the dependent variable is total surgeries, outpatient surgeries, or inpatient surgeries.

Looking across all three specifications, the parameter estimates from variables in the $\mathbf{z}$ vector are mostly as expected. Healthier individuals are less likely to have surgery. Age does not have any impact on surgery rates, but this is due to the fact that age is correlated with health. Because of pregnancy considerations, women are more likely to have surgery. Surprisingly, caucasians, individuals with more education, and individuals with more income are more likely to have surgery. If insurance quality is correlated with educational attainment, income, or non-minority status, this may, this may explain the difference, however due to data restrictions I can not empirically test this possibility. Finally, married individuals have more surgeries on average.

Let us examine physician compensation dummy variables using total surgeries as the dependent variable. The omitted dummy variable in the regression is FF so the coefficents should be interpreted as the effect on surgery rates relative to a FF baseline. The CF compensation scheme leads to 8% more surgery rates and CC lowers surgery rates by 58%. The estimates for FC show an statistically insignificant increase in surgery rates compared to FF, but the FC coefficient estimates should be viewed skeptically since there are only 28 individuals in the 'no choice' subsample with fee-for-service PCPs and capitation compensated specialists. Global capitation payment, G, has no significant affect on surgery rates which is surprising, but likely due to the ambiguous nature in which the physicians are compensated.

Let us now proceed to test the hypotheses derived from the theoretical model. Hypothesis 1 predicts that $\beta_{CF} > \beta_{CC}$. If this hypothesis is true, this would mean that holding the primary care physician's compensation constant, a change in the specialist compensation from capitation to fee-for-service will increase surgery rates. Column 1 reveals that switching specialist compensation from capitation to fee for service increases surgery rates by 155%.[22] The prediction that surgeons paid via fee-for-service perform more operations than surgeons paid via capitation holds true in the data at the 1% significance level ($P \leq 0.001$).

Hypothesis 3 predicts that holding specialist compensation constant, changing PCP from capitation to FFS compensation will decrease surgery rates. Mathematically, we predict $\beta_{CF} > \beta_{FF}$, but because FF is the omitted variable, the prediction becomes $\beta_{CF} > 0$. If this were to hold, it would imply that holding specialist compensation constant, changing PCP payment methods from FFS to capitation would increase surgery rates. The coefficient estimates show that switching the primary care physician from FFS to capitation increase surgery rates 8% but this finding is not statistically different from zero.

The results of the negative binomial regression for outpatient and inpatient surgeries are shown in columns 2 and 3 respectively. Hypothesis 4 claims that elective surgery rates will be more responsive to changes in physician compensation than the "less elective" inpatient surgeries, and we find this to be the case. Outpatient surgery rates under CF are 22% higher than the rates under a FF regime, while outpatient rates using a CC compensation pairing are 53% below the surgery rates under FF. When we test hypothesis 1 (ie: $\beta_{CF} > \beta_{CC}$), we find that outpatient surgery rates are 157% higher when the specialist switches from capitation to fee-for-service compensation. This result is significant at the 1% level ($P < 0.001$). Evidence in support of hypothesis 3—testing whether or not a change in primary care compensation affects surgery rates—is less robust. Changing the primary care provider from a fee-for-service to a capitation compensation basis increases surgery rates by 22%, but this results is not statistically significant at even the 10% level.

For inpatient surgeries, one would expect similar results as in the outpatient case, but—according to hypothesis 4—the findings are likely to be of a smaller magnitude. The third column of Table 7 shows the results from the negative binomial regression using inpatient surgeries as the dependent variable. Results from testing hypothesis 1, $\beta_{CF} > \beta_{CC}$, is signed as predicted but it is highly insignificant. The indirect effect of the PCP compensation on surgery rates is of the opposite sign as anticipated, but is not

[22] This is calculated as: $\frac{\beta_{CF}-\beta_{CC}}{(1+\beta_{CC})} = \frac{0.0843-(-0.5754)}{1+(-.05754)}$.

statistically different from zero.

The results from the total surgeries and outpatient only regressions strongly support hypotheses 1 and 3. Surgical frequency increased 155% and 157% in the total and outpatient only cases when specialist compensation changed from a capitation to a FFS method. Altering PCP compensation from a FFS to a capitation reimbursement scheme, increased surgery rates as predicted, but the results were not statistically significant. The results using inpatient surgeries as the dependent variable were less conclusive as the tests for hypothesis (1) and (3) were statistically insignificant. Because of hypothesis (4), however, the finding that outpatient surgery is most responsive to financial incentives than inpatient surgeries is unsurprising.

6.2 Results with Selection

Another hypothesis to test is whether or not adverse selection is occurring. Our earlier analysis using the Physical Component Summary seemed to indicate there was no selection based on observables. Hypothesis 5 claims that if there is adverse selection and that selection occurs based on knowledge of the primary care doctor's compensation, we would expect $\tilde{\beta}_{CF}$ to be of a smaller magnitude than in the setting without adverse selection.

In table 7, columns 4, 5, and 6 give the results of a negative binomial regression when individuals have a choice of insurance plans at their work. The analysis is conducted using total surgeries, outpatient surgeries and inpatient surgeries as the dependent variable. In all three specifications, the parameter estimate for CF changes signs and become negative. Throughout these specifications where the individual has a choice of insurance, surgery rates are highest when both the primary care physician and the specialist are compensated via FFS. This analysis demonstrates that there is likely some omitted factors which affect surgery rates and are correlated with a person's choice of health plan. Thus, one can conclude that it was wise to restrict the sample to individuals without a choice of health plan in our analysis above even after controlling for the PCS health variable, and the evidence supports the validity of hypothesis 5.

6.3 Alternate Regression Specifications

Even though the negative binomial appears to be a valid econometric specification for this analysis, a discerning reader may have some reservations. For instance, let us assume that person A has one surgery and person B has two. While it would be reasonable to assume that person B utilizes more medical services person than person A, they may not use twice as many services. To take this into account, Columns 1 and 2 of Table 8 use an ordered probit regression, so that the total number of surgeries becomes a categorical variable rather than a count variable. As we can see, using the ordered probit regression does not materially change the results in either the 'choice of insurance' or 'no choice of insurance' subpopulations.

Also, one may worry that because less than 5% of individuals in the Community Tracking Study have more than one surgery during the year, the negative binomial regression may be imprecise accurate due to a lack of variation. To assuage these concerns, the surgery variable is redefined to be a dummy variable equal to unity when an individual had one or more surgeries during the year and zero otherwise. A logit regression is run using this binary variable as the dependent variable. The results from this regression are reported in Columns 3 and 4 of Table 8. As we can see from the the parameter estimates in both the logit and conditional probit cases, the conclusions inferred from the negative binomial estimates are robust to a number of econometric specifications.

6.4 Non-Financial Incentives

Now let us look at the results in Table 9 which incorporate referral restrictions into the model. For brevity, the results of the negative binomial regression using total surgeries as the dependent variable are not shown here, but I report the sign and relevant t-statistics instead. The theoretical prediction that the direct effect of moving specialist compensation from capitation to FFS will increase surgery rates still strongly holds. We can see that from column (1) of Table 8 that the hypothesis test that $\beta_{nCF} = \beta_{nCC}$ is rejected at the 5 percent level ($P < 0.049$). Examining physicians who work for health plans with referral restrictions, we still find that the direct effect of changing specialist compensation to fee-for-service increases surgery rates. The null that $\beta_{rCF} = \beta_{rCC}$ is strongly rejected at the 1% level ($P < 0.008$). This evidence strongly suggests that hypothesis 1 holds.

Moving on to hypothesis 3, the indirect effect of changing primary care compensation rates from FFS to capitation is positive as predicted without referral requirements, but negative for plans with referral requirements. Neither of these results, however, is statistically different from zero. The conclusions which should be culled from these tests are that the direct affect of changing specialist compensation appears to have a strong affect on surgery rates, but the indirect affect of primary care physician compensation on surgery rates is not apparent in the data. These are the same results which materialized when the analysis was conducted ignoring referral restrictions.

Do referral requirements actually decrease surgical rates? To test this, one should examine each of the five compensation combinations (i.e.: FF,CC,CF,FC, and G) and compare surgery rates when referrals are required and when they are not. The four hypothesis tests are shown at the bottom of table 9.[23] We find that referral restrictions decrease surgical rates in 2 cases (CF and CC) but increase them in the other two cases (FF and G), but these results are not statistically significant in any of the four cases. Although referral requirements may restrict access to some specialist services, is seems from this data set that they have a very limited effect on surgery rates.

7 Conclusion

7.1 Major Findings

Using an empirical methodology similar to Polsky and Nicholson (2004) and Saver et al. (2004), this study found that switching specialist compensation from capitation to FFS increased total and outpatient surgery rates by 155% and 157% respectively. As predicted, similar results were found for inpatient surgeries, but these results were not statistically significant. Even when taking into account referral requirements or altering the econometric specification, it was consistently found that FFS specialists preformed more surgeries per person on average than specialist paid on a capitated basis.

The conclusions reported here are consequential because this is one of the few studies to use nationally representative, household data to estimate how physician financial incentives affect the provision of specialist—rather than primary care—services. Further,

[23]We cannot test the affect of referral requirements on the FC compensation group because rFC dummy variable equals unity for only one observation.

the Community Tracking Study Restricted Use data set used in this study eliminates serious measurement error biases which have been shown to occur in survey data. Any selection effects which may remain after restricting the sample to only individuals offered one health insurance plan through their employer would only bias the estimates against concluding in favor of hypothesis 1.

The theoretical model constructed also predicts that primary care compensation methods should affect specialist service provision. While conclusive evidence supporting this point is not found in this paper, this may be due to the choice of the dependent variable. Medicine functions along a spectrum of care intensity; dividing the entirety of medicine into either primary care or surgery likely omits significant substitution effects which lie in between these two categories. More comprehensive specialist data should be able to detect this phenomenon if it occurs. Further, the existence of financial withholds for PCP seems to suggest that primary care decision-making affects the amount of specialist care provided. If this was not the case, why would insurance plans go through the trouble of implementing this compensation method?

7.2 Concerns

While the preferred specification lends support to the major hypotheses from the theoretical section, a careful reader may not be entirely convinced of the results. First, while surgeries are certainly provided exclusively by specialists, using surgery rates as the dependent variable is a coarse measure of the amount of specialist services a patient receives. The measure leaves out specialist doctors visits, diagnostic tests, pharmaceutical prescriptions and other forms of specialist treatments. This problem, however, is likely to bias estimates of financial incentives' effect on specialist service provision closer to zero. Secondly, this analysis only looks at individuals who have insurance through their employers. These findings are nationally representative, but only for this subpopulation aged 18-64 with employer provided insurance. One should be cautious to extend any conclusions made in this paper to uninsured individuals or individuals with government-provided insurance. Finally, although the problems of physician selection, spousal insurance, and job selection are not addressed, these effects are likely to bias the estimates towards finding a zero effect.

7.3 Areas for future research

Future research should investigate how specialist financial incentives affect a broader range of specialist medical services than simply surgeries. Also, future empirical studies should model physician compensation in an even more sophisticated manner, taking into account the possibility that physicians are paid simultaneous via capitation and fee-for-service by the same patient. For instance, it is possible that a physician may receive a capitation payment, but their contract with a health plan may allow carve-outs where the physician will be able to receive FFS compensation for performing certain procedures. On the topic of adverse selection, re-examining this problem with new data which could control for endogenous job choice would be a significant advance.

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A Appendix

A.1 Comparative Statics of $\frac{\partial \mathbf{s}}{\partial p}$

To calculate $\frac{\partial \mathbf{s}}{\partial p}$, we start by creating a (N *x 1*) vector $\mathbf{G}$ where each element of $\mathbf{G}$ is a first order condition. To simplify the calculations, I assume there are only two patients ($N = 2$) with one FFS and one capitation patient ($J = 1$), but the analysis could easily be extended to the more complicated case. The first $J = 1$ elements correspond to equation (2) and the subsequent $(N - J)$=1 elements correspond to equation (3). Using the implicit function theorem, we simply need to calculate $\frac{\partial \mathbf{s}}{\partial p} = -\mathbf{G}_{\mathbf{s}}^{-1}\mathbf{G}_p$.

$$\mathbf{G}_p = (1,0)' \qquad \mathbf{G}_{\mathbf{s}} = \begin{pmatrix} -c'' + \delta B_{s_1 s_1} & -c'' \\ -c'' & -c'' + \delta B_{s_2 s_2} \end{pmatrix}$$

$$\mathbf{G}_{\mathbf{s}}^{-1} = \frac{1}{|G_s|} \begin{pmatrix} -c'' + \delta B_{s_2 s_2} & c'' \\ c'' & -c'' + \delta B_{s_1 s_1} \end{pmatrix}$$

Here $|\mathbf{G}_{\mathbf{s}}|$ is the determinant of the $\mathbf{G}_{\mathbf{s}}$ matrix. We calculate $|\mathbf{G}_{\mathbf{s}}|$ as follows:

$$|\mathbf{G}_{\mathbf{s}}| = \delta^2 B_{s_1 s_1} B_{s_2 s_2} - c''\delta[B_{s_1 s_1} + B_{s_2 s_2}] > 0$$

Since $|\mathbf{G}_{\mathbf{s}}| \neq 0$, G_s is invertible. Multiplying out $-[\mathbf{G}_{\mathbf{s}}]^{-1}\mathbf{G}_p$ we have:

$$\frac{\partial \mathbf{s}}{\partial p} = -[\mathbf{G}_{\mathbf{s}}]^{-1}\mathbf{G}_p = \frac{1}{|\mathbf{G}_{\mathbf{s}}|} \begin{pmatrix} c'' - \delta B_{s_2 s_2} \\ -c'' \end{pmatrix}$$

Since I have shown earlier that $\delta > 0$ and $B_{s_i s_i} < 0$, one can see that raising the price will increase the amount of specialist services provided to the FFS patient, but decrease the amount of services provided to the capitation patient. The specialist services supplied to the capitation patient decrease because an increase in s_1 will increase the marginal cost if $c'' > 0$ and thus the specialist will want to decrease services provided to capitation patients. If $c'' = 0$, however, $\frac{\partial s_1}{\partial p}$ is still positive but now $\frac{\partial s_2}{\partial p} = 0$.

A.2 Comparative Statics of $\frac{\partial \mathbf{s}}{\partial \mathbf{q}}$

Using the implicit function theorem we know that $\frac{\partial \mathbf{s}}{\partial \mathbf{q}} = -\mathbf{G}_{\mathbf{s}}^{-1}\mathbf{G}_{\mathbf{q}}$. Having already calculated $\mathbf{G}_{\mathbf{s}}^{-1}$ in section A.1, we only need to solve for $\mathbf{G}_{\mathbf{q}}$.

$$\mathbf{G_q} = \begin{pmatrix} \delta B_{s_1 q_1} & 0 \\ 0 & \delta B_{s_2 q_2} \end{pmatrix}$$

The cross-derivatives (i.e.: $B_{s_i s_j}$, $B_{s_i q_j}$ where $i \neq j$) are zero because a change in primary care services for patient 1 will not affect the health level of patient 2 (and vice versa). If one were believe that there were significant externalities to medical service provision—as in the case of vaccinations against contagious diseases such as influenza or Hepatitis A—then the cross derivatives would be non-zero. Since the empirical section of the paper uses surgery rates as the dependent variable of interest, it seems reasonable to believe that one patient's marginal health benefit from a surgical procedure would change little if another patient experienced an increase in primary care services or surgery rates.

Now we simply solve the equation.

$$\frac{\partial \mathbf{s}}{\partial \mathbf{q}} = -\mathbf{G_s}^{-1}\mathbf{G_q} = \frac{1}{|\mathbf{G_s}|}\begin{pmatrix} \delta B_{s_1 q_1}[c'' - B_{s_2 s_2}] & -\delta B_{s_2 q_2} c'' \\ -\delta B_{s_1 q_1} c'' & \delta B_{s_2 q_2}[c'' - B_{s_1 s_1}] \end{pmatrix} = \begin{pmatrix} \leq 0 & \geq 0 \\ \geq 0 & \leq 0 \end{pmatrix}$$

We can see that the diagonal elements of $\frac{\partial \mathbf{s}}{\partial \mathbf{q}}$ are weakly (strictly) negative since $B_{s_i q_i}$ is weakly (strictly) negative, while the off diagonal elements of $\frac{\partial \mathbf{s}}{\partial \mathbf{q}}$ are weakly positive. This makes intuitive sense since according to the rationale behind hypothesis 2, an increase in the quantity of primary care services should decrease the amount of specialist services for a given patient if the two types of medical care are substitutes. The cross-derivatives are only non-zero because an increase in the primary care services to 'patient 1' will decrease the amount of specialist services 'patient 1' receives, and thus this will alter the marginal cost for the physician's other patients. If the cost function is linear (i.e.: $c'' = 0$) then the cross derivatives across patients would be zero.

A.3 Comparative Statics of $\frac{\partial \mathbf{q}}{\partial \hat{p}}$

Now we move on to analyze the PCP's first stage decision. I create a matrix $\mathbf{F}$ of the N PCP first order conditions. The first K of the equations correspond to individuals who have health plans which pay PCPs on a FFS basis and the next $(N - K)$ equations correspond to individuals with health plans that pay PCPs on a capitation basis.

To find the primary care physicians response when a patient changes from capitation to FFS insurance, one simply needs to calculate $\frac{\partial \mathbf{q}}{\partial \hat{p}}|_{p=0}$ since $\frac{\partial \mathbf{q}}{\partial \hat{\alpha}} = \mathbf{0}$. I again employ the implicit function, which states: $\frac{\partial \mathbf{q}}{\partial \hat{p}} = -[\mathbf{F_q}]^{-1}\mathbf{F}_{\hat{p}}$.

$$\mathbf{F}_{\hat{p}} = (1,0)'$$
$$\mathbf{F_q} = \frac{1}{|\mathbf{F_q}|}\begin{pmatrix} -\hat{c}'' + \hat{\delta}\Phi_1 & -\hat{c}'' \\ -\hat{c}'' & -\hat{c}'' + \hat{\delta}\Phi_2 \end{pmatrix}$$
$$\Phi_i = 2B_{s_i q_i}\frac{\partial s_i}{\partial q_i} + B_{s_i}\frac{\partial^2 s_i}{\partial {q_i}^2} + B_{q_i q_i}$$
$$|\mathbf{F_q}| = \hat{\delta}^2 B_{q_1 q_1} B_{q_2 q_2} - \hat{c}''\hat{\delta}\left[B_{q_1 q_1} + B_{q_2 q_2}\right] > 0$$

The derivative $\frac{\partial^2 s_i}{\partial {q_i}^2}$ is equal to zero as long as $B_{s_i q_i q_i} = 0$ which will be generally true as long as $B_i(\cdot)$ can be closely approximated with a quadratic function. The off-diagonal elements of $\mathbf{F_q}$ are positive. A sufficient condition to sign the diagonal elements of $\mathbf{F_q}$ is for $\Phi_i < 0$. If this were to hold it would imply that as q_i increased, the marginal health benefits from PCP care would decrease twice as fast as the marginal benefit from specialist care (due to a reduction in specialist care) would increase. Now we can solve $\frac{\partial \mathbf{q}}{\partial \hat{p}}$.

$$\frac{\partial \mathbf{q}}{\partial \hat{p}} = -[\mathbf{F_q}]^{-1}\mathbf{F}_{\hat{p}} = \frac{1}{|\mathbf{F_q}|}\begin{pmatrix} \hat{c}'' - \hat{\delta}\left[\Phi_2\right] \\ -\hat{c}'' \end{pmatrix}$$

Just as we found in the specialist case, increasing the price paid by FFS patients will increase services supplied by the PCP and will decrease (have no effect on) services provided to capitation patients as long as the cost function is convex (linear).

A.4 Comparative Statics of $\frac{\partial \mathbf{s}}{\partial \hat{p}}$

Since we have now calculated $\frac{\partial \mathbf{s}}{\partial \mathbf{q}}$ and $\frac{\partial \mathbf{q}}{\partial \hat{p}}$, we now simply need to multiply these two figures together. The empirical section of the paper tested the CF compensation group against the FF group and in the theory we would want to predict how a change in PCP compensation from capitation to FFS would affect surgery rates conditioning on the fact that the specialist is paid via FFS. Since $\frac{\partial \mathbf{s}}{\partial \mathbf{q}}$ does not depend on specialist compensation parameters (i.e.: p or α), the conclusions from this theoretical section can be directly applied to make our empirical prediction that $\beta_{CF} > \beta_{FF}$.

$$\frac{\partial \mathbf{s}}{\partial \hat{p}} = \frac{\partial \mathbf{s}}{\partial \mathbf{q}}\frac{\partial \mathbf{q}}{\partial \hat{p}} = \frac{1}{|\mathbf{G_s}||\mathbf{F_q}|}\begin{pmatrix} x \\ y \end{pmatrix} \quad \begin{pmatrix} < 0 \\ \geq 0 \end{pmatrix}$$

where

$$x = \delta B_{s_1 q_1}[c'' - B_{s_2 s_2}][c'' - \Phi_2] + \delta B_{s_2 q_2}(c'')^2$$
$$y = \delta^2 B_{s_1 q_1} c''[\Phi_2] - \delta B_{s_1 q_1}(c'')^2 - \delta c'' B_{s_2 q_2}[c'' - B_{s_1 s_1}]$$

We see from the value of x that if a patient's health plan was to switch from compensating PCPs on a capitation to a FFS basis—or equivalently there was an increase in $\hat{p}$—we see that the amount of specialist services decreases. Does this make sense? If primary care and specialist care are substitutes, then an increase in $\hat{p}$ will increase q_1 which will lead the specialist to decrease s_1 since the marginal benefit of his specialist treatment has decreased as the amount of primary care services has increased.

B List of Figures

Table 1: Physician Compensation Variables Explained

Variable	**Explanation**
FF	PCP paid via fee-for-service; Specialist paid via fee-for-service
CC	PCP paid via capitation; Specialist paid via capitation
CF	PCP paid via capitation; Specialist paid via fee-for-service
FC	PCP paid via fee-for-service; Specialist paid via capitation
G	Practice paid via *global* capitation, physician compensation uncertain

Table 2: Physician Compensation by Insurance Type

Ins Type	**FF**	**CC**	**CF**	**FC**	**G**
HMO	17.3%	85.3%	68.2%	90.7%	92.4%
POS	13.5%	13.4%	31.3%	7.0%	6.9%
PPO	49.0%	1.2%	0.5%	2.3%	0.7%
FFS	20.1%	0.0%	0.0%	0.0%	0.0%
Total	100%	100%	100%	100%	100%

Table 3: Table of Means

Variable	Mean	Std. Dev.	Min	Max
$Total\ Surgeries$	0.187	0.524	0	5†
$Outpatient\ Surgeries$	0.137	0.448	0	5†
$Inpatient\ Surgeries$	0.050	0.257	0	5†
FF	0.721	0.448	0	1
CC	0.054	0.227	0	1
CF	0.106	0.308	0	1
FC	0.004	0.064	0	1
G	0.114	0.318	0	1
$Health$	5.126	0.844	1.1	6.8
$Male$	0.506	0.500	0	1
Age	40.0	11.98	18	64
Age^2	1,747	986.0	324	4096
$< HighSchool$	0.101	0.302	0	1
$HighSchool$	0.324	0.468	0	1
$SomeCollege$	0.300	0.458	0	1
$College$	0.191	0.393	0	1
$> College$	0.085	0.278	0	1
$Married$	0.713	0.453	0	1
$Caucasian$	0.778	0.415	0	1
$African - American$	0.101	0.302	0	1
$Asian - American$	0.039	0.193	0	1
$Latino$	0.082	0.274	0	1
$Income$ ($\$10,000s$)	5.38	3.37	0	15†
n		22958		

† Surgeries top-coded at 5; Income top-coded at 15 (i.e.:$150,000)

Table 4: Means: With and without Group Health Insurance Choice

	Choice		No Choice	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Total Surgeries	0.198	0.543	0.164	0.483
Outpatient Surgeries	0.143	0.459	0.126	0.424
Inpatient Surgeries	0.056	0.274	0.039	0.220
FF	0.682	0.466	0.799	0.400
CC	0.066	0.249	0.031	0.173
CF	0.120	0.325	0.078	0.269
FC	0.004	0.062	0.005	0.068
G	0.128	0.334	0.087	0.281
$Health$	5.093	0.889	5.194	0.740
$Male$	0.472	0.499	0.574	0.494
Age	40.6	12.37	38.9	11.09
Age^2	1,802	1,022.8	1,636	897.0
$< HighSchool$	0.101	0.301	0.103	0.304
$HighSchool$	0.310	0.463	0.350	0.477
$SomeCollege$	0.302	0.459	0.294	0.456
$College$	0.197	0.398	0.177	0.382
$> College$	0.089	0.285	0.076	0.264
$Married$	0.722	0.448	0.694	0.461
$Caucasian$	0.767	0.423	0.802	0.399
$African - American$	0.107	0.309	0.090	0.287
$Asian - American$	0.041	0.198	0.034	0.182
$Latino$	0.085	0.280	0.074	0.262
$Income$ ($\$10,000s$)	5.51	3.45	5.12	3.18
n	16210		6748	

Table 5: Physician Compensation Affect on PCS Health Variable

Variable	**Coefficient**
CC	0.1487
	(0.2397)
CF	0.0602
	(0.2298)
FC	1.0577
	(0.3669)
G	-0.2075
	(0.1930)
$Male$	1.2846
	(0.1353)
Age	0.1130
	(0.0261)
Age^2	-0.0031
	(0.0003)
$Constant$	51.4806
	(0.4823)

Table 6: List of Hypothesis

Hypothesis	**Empirical Test**
(1) Direct specialist compensation effect on surgery rates	$\beta_{CF} > \beta_{CC}$
(2) Primary care service affect on surgery rates	none
(3) Indirect effect of PCP compensation on surgery rates	$\beta_{CF} > \beta_{FF}$
(4) More robust findings if surgery is elective	$\beta_{CF} \geq \beta_{CC}$,$\beta_{CF} \geq \beta_{FF}$
(5) Adverse selection for group offered multiple health plans	$\beta_{CF} < \beta_{FF}$

Table 7: Results from the Negative Binomial Regression

	No Choice			Choice		
Variable	Total	Out	In	Total	Out	In
CC	-0.5754	-0.5256	-0.7582	-0.1330	-0.1497	-0.0409
	(0.2566)	(0.2966)	(0.5186)	(0.1330)	(0.2111)	(0.2212)
CF	0.0843	0.2178	-0.4712	-0.1099	-0.1561	0.0147
	(0.1436)	(0.1849)	(0.3615)	(0.0678)	(0.0994)	(0.1004)
FC	0.1375	0.1788	-0.0118	-0.5559	-0.6905	-0.2303
	(0.3688)	(0.3504)	(0.4109)	(0.1634)	(0.5035)	(0.7769)
G	0.0708	0.1649	-0.3010	-0.0942	-0.1156	-0.0494
	(0.1064)	(0.1550)	(0.2928)	(0.0767)	(0.0889)	(0.1167)
$Health$	-0.3271	-0.2496	-0.5335	-0.4491	-0.3711	-0.6394
	(0.0478)	(0.0578)	(0.0417)	(0.0262)	(0.0313)	(0.0485)
$Male$	-0.2699	-0.1543	-0.6499	-0.1605	-0.0518	-0.4648
	(0.0491)	(0.0677)	(0.1761)	(0.0319)	(0.0472)	(0.0810)
Age	-0.0142	0.0089	-0.0739	0.0042	0.0132	-0.0148
	(0.0237)	(0.0339)	(0.0410)	(0.0128)	(0.0166)	(0.0276)
Age^2	0.0003	0.0000	0.0010	0.0000	-0.0001	0.0002
	(0.0003)	(0.0004)	(0.0005)	(0.0002)	(0.0002)	(0.0003)
$High\ School$	0.3107	0.3449	0.1270	0.1399	0.1680	0.1358
	(0.2368)	(0.1840)	(0.5723)	(0.1516)	(0.2245)	(0.1398)
$Some\ College$	0.3951	0.3604	0.4884	0.2396	0.2989	0.1823
	(0.2274)	(0.2181)	(0.4063)	(0.1319)	(0.1794)	(0.1456)
$College$	0.5377	0.5196	0.5609	0.1164	0.1572	0.0834
	(0.2735)	(0.2502)	(0.4935)	(0.1632)	(0.2257)	(0.1668)
$> College$	0.3193	0.2862	0.2823	0.0942	0.2035	-0.2082
	(0.3655)	(0.2204)	(0.8800)	(0.1253)	(0.1803)	(0.1959)
$Married$	0.1439	0.2165	-0.0767	-0.1644	-0.3055	0.2621
	(0.1102)	(0.1250)	(0.2653)	(0.0492)	(0.0601)	(0.1258)
$African-Am.$	-0.3135	-0.2994	-0.3499	-0.2072	-0.3374	0.0798
	(0.1694)	(0.1963)	(0.2110)	(0.1012)	(0.0983)	(0.1562)
$Asian-Am.$	-0.0376	-0.0773	0.2992	-0.1713	-0.2581	0.0270
	(0.2241)	(0.2907)	(0.2780)	(0.1600)	(0.1701)	(0.2716)
$Latino$	-0.2951	-0.3180	-0.1919	-0.1526	-0.1824	-0.0806
	(0.2434)	(0.2141)	(0.5772)	(0.1376)	(0.1627)	(0.2118)
$Income$ (\$10k)	0.0079	0.0004	0.0371	0.0320	0.0423	0.0029
	(0.0167)	(0.0226)	(0.0337)	(0.0064)	(0.0092)	(0.0112)
$P(CF = CC)$	0.000	0.001	0.654	0.865	0.975	0.807
$P(CF = 0)$	0.557	0.239	0.192	0.105	0.116	0.884

Table 8: Ordered Probit and Logit Results: No Adverse Selection Group
Dependent Variable: Total Number of Surgeries

	Ordered Probit		Logit	
Variable	No Choice	Choice	No Choice	Choice
CC	-0.2681	-0.0688	-0.4528	-0.1185
	(0.1311)	(0.0828)	(0.2326)	(0.1415)
CF	0.0529	-0.0555	0.0802	-0.0818
	(0.0771)	(0.0387)	(0.1229)	(0.0570)
FC	-0.0615	-0.3305	-0.3475	-0.6115
	(0.2251)	(0.0798)	(0.3623)	(0.1742)
G	0.0658	-0.0439	0.1132	-0.0549
	(0.0626)	(0.0446)	(0.1119)	(0.0730)
$Health$	-0.1994	-0.2743	-0.3135	-0.4004
	(0.0260)	(0.0161)	(0.0398)	(0.0224)
$Male$	-0.1881	-0.0959	-0.3383	-0.1407
	(0.0293)	(0.0193)	(0.0545)	(0.0335)
$P(CF = CC)$	0.000	0.871	0.001	0.790
$P(CF = 0)$	0.492	0.151	0.514	0.151

Table 9: Referral Requirements

A	B	*Hyp. Rel.*	*Reason*	*Actual Rel.*	$P(A = B)$
nCF	nCC	$+$	$Hyp.$ 1 $(CF > CC)$	$+$	0.049
rCF	rCC	$+$	$Hyp.$ 1 $(CF > CC)$	$+$	0.008
nCF	nFF	$+$	$Hyp.$ 3 $(CF > FF)$	$+$	0.134
rCF	rFF	$+$	$Hyp.$ 3 $(CF > FF)$	$-$	0.446
nFF	rFF	$+$	$Referral\ Restriction$	$-$	0.391
nCC	rCC	$+$	$Referral\ Restriction$	$+$	0.622
nCF	rCF	$+$	$Referral\ Restriction$	$+$	0.209
nG	rG	$+$	$Referral\ Restriction$	$-$	0.125