The Effect of Specialist Cost Information on Primary Care Physician Referral Patterns

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PRELIMINARY & INCOMPLETE DRAFT

July, 2016

Abstract

I examine the importance of cost information in the physician referral process. I partner with a group of physician medical practices – an Independent Practice Association ("the IPA") – to perform a field experiment testing whether providing information on the costliness of specialist physicians to primary care physicians (PCPs) alters the PCPs' referral behavior. The IPA's primary care practices were assigned randomly to treatment or control groups, and the treatment group practices were provided a list of average costs for several ophthalmologists that are affiliated with the IPA. Using data collected by the IPA, I compare differences in referral rates to the ophthalmologists of interest between the treatment and control groups. My results suggest that, during the first two months following the distribution of the cost list, the treatment group PCPs reallocated referrals towards the least expensive ophthalmology practice by 112% when the patients were the type where the costs incurred by the IPA for the referral depend on the treatment choices of the specialist. This large effect dissipated significantly, though not completely, over the following four months. For patients where specialist treatment choices have little impact on the costs the IPA incurs for referrals, I find no response to the treatment. This contrast in results suggests that PCP responses were influenced by cost reduction motives.

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†I thank the IPA and a number of its employees for working with me on this project and making it possible. Helpful comments on this draft were provided by: Marianne Bitler, W. David Bradford, Linda Cohen, Jeffrey McCullough, David Neumark, and Neeraj Sood; workshop participants at Clemson, Georgia State, and Kentucky; and conference participants at 2015 South Carolina Applied Micro Day, 2015 Southern Economic Association, 2015 Georgia Health Economics Research Day, 2016 American Society of Health Economists, and 2016 Midwest Health Economics Conference. Nevertheless, I remain responsible for any errors within.

1 Introduction

Economists have long argued that cost information plays an important role in the efficient allocation of resources (e.g. Hayek, 1945), but this argument relies on the assumption that cost or price information is available to decision makers at the time of their decision. In the American health care system, this assumption is quite often not true. In the course of everyday practice, physicians often make decisions regarding drugs to prescribe, tests to order, and referrals to make in the near total absence of the comparative costs of the options available. This phenomenon has to some extent been documented in the medical literature (e.g. Shulkin, 1988; Tierney et al., 1990; Reichert et al., 2000; Feldman et al., 2013), and also anecdotally to me personally by physicians of my acquaintance.

In this paper, I examine the importance of cost information in the physician referral process. In modern health care provision, physicians are highly specialized workers who are often loosely organized in teams when a patient's medical care requires input from physicians in more than one area of specialized knowledge. Such a team is typically led by a primary care physician (PCP), who refers the patient to specialists with relevant expertise. Since specialists may not all sell their services at the same rate, the patient's health care will only be cost efficient if the referral is made to the specialist who provides the required service (at the required level of quality) at the lowest price. In practice, however, the PCP usually does not have access to (and so cannot consider) information on the relative cost of available specialists, and so referrals are likely made inefficiently with respect to cost.

To investigate these issues, I partner with a group of physician practices – an Independent Practice Association ("the IPA") – to perform a field experiment testing whether the distribution of a report on the relative costliness of specialist physicians to PCPs alters the PCPs' referral behavior. The IPA's primary care practices are assigned randomly to treatment or control groups, and the PCPs of the treatment group practices are provided a list of average costs for several ophthalmologists that are associated with the IPA. Using data collected by the IPA, I compare differences between the treatment and control group referral rates to the ophthalmologists of interest for two different types of patients. For the first type of patients, when they are referred to ophthalmology, the costs the IPA incurs depend directly on the types of treatments the specialists chose. That is, if the ophthalmologist chooses more expensive treatments, the cost to the IPA will increase dollar-for-dollar. For this type of patients, I find that the treatment group PCPs reallocated referrals towards the least expensive ophthalmology practice by 112% during the first two months after the cost list distribution, an effect that dissipated significantly, though not completely, over the following four months. In contrast, I find no response to the treatment for the other type of patients, where ophthalmologist treatment costs are largely capitated – meaning the IPA pays a flat rate for most services. For these patients, the IPA's costs are much less likely to be affected by whether the specialist chooses more or less expensive treatments. This asymmetric result suggests that the PCPs' responses were influenced by cost reduction motives.

This project was reviewed by the staffs of UCI's Office of Research and Clemson's Office of Research Compliance and both confirmed that this study does not qualify as human subjects research since no identifying information was available to UCI or Clemson researchers as part of the project.

2 Background

The association of medical practices as an IPA happens for several reasons, but for the purposes of this project, the most important one is that it provides a network of medical resources that allow primary care practices to market HMO services to customers of insurance companies who offer HMO health insurance plans, but do not have vertically integrated medical facilities.[1] The IPA contracts with such insurance companies, after which their customers that have HMO plans can choose the IPA to be their provider.[2] The IPA's key selling point to these customers is its network of services, which patients know will be covered by their health plans with relatively little out-of-pocket cost. The IPA has been successful in pursuing this strategy, and as of the time this experiment was taking place, it had attracted roughly eighty thousand patient members.

To manage these patients, the IPA had relationships with approximately 150 PCPs and 350 specialists. Physician associates are not employees of the IPA (they are employees of their respective medical practices), but they are contracted with the IPA to provide services to the patients of the IPA. Informally speaking, the IPA serves as a middleman, receiving payment from patient insurance companies for providing health care services to the patients, then turning around and paying the physicians, who are the ones actually providing the medical services.

As a provider of HMO services, the IPA assigns each patient to a PCP who is responsible for the patient's overall health and who manages the care the patient receives through the IPA. The PCPs' roles as care managers are key to the financial success of the IPA, since they potentially keep costs down by limiting the use of unnecessary services. Most importantly for

[1]Other important reasons for the existence of the IPA include the facilitation of contracting with health insurance companies, which can be time and resource consuming for individual practices, and the improvement of those practices' bargaining positions within the contracting process, helping to increase negotiated rates they receive.

[2]The IPA does have a small population of patients that do not have HMO insurance (and who are mainly covered under Point-of-Service plans), but since more than 91% of the IPA's claims are generated by patients with HMO coverage, I focus on those patients, and all analyses herein are limited to those with HMO plans.

the purposes of this project, this role includes managing the services of specialist physicians (including those of ophthalmologists) which are almost always only covered under patient insurance when patients are referred by their PCP.[3] The PCPs have a direct financial incentive to perform their role as gatekeepers to costly services, as bonuses paid to the PCPs are based in part on the financial results of the IPA. So if PCPs reduce the cost of their patients' care by (for example) referring to less expensive specialists, then they could see larger bonuses.

While it is clear that the PCPs indeed had a financial interest in helping to keep costs down, it is less clear how strong that interest is, and what their awareness of it was. Since the IPA was associated with many PCPs, the relative impact of any single PCP's actions on costs are certain to be small relative to the overall costs of the IPA, and so an individual who works to save money for the IPA may go unrewarded if the rest of the group's actions end up negating those savings. Moreover, IPA management believed that PCP awareness of the potential for cost savings to affect bonuses was not high, since they were also affected by several types of care quality measures that were the primary focus of the PCPs' attention. On the other hand, in recent years, the IPA had been making efforts to communicate to the PCPs the importance of being mindful of costs. For example, in 2011, the IPA had provided the PCPs a list of the per patient average costs for gastroenterologists, and a report of each PCP's own patient costs. This report of PCP costs included a breakdown by specialty, making clear what share each contributed. Moreover, in July 2013, the IPA provided all PCPs a report on PCP costs that listed each physician's name and per-patient cost, rather than ID numbers that kept true identities private, hence making each PCP's cost known to all other PCPs. Thus, while the financial incentive's salience is not clear, it is certain that the PCPs were being encouraged by the IPA to be mindful of costs.

Physicians associated with the IPA receive compensation through two different payment systems: capitation and fee-for-service (FFS). Under the capitation system, physicians receive a fixed payment per-patient, per-month that covers a set of agreed-upon services. For example, for a PCP, standard office visits are capitated, meaning they are not reimbursed by the IPA as they occur, but are included under the regular capitation payment the PCP practice receives. This is true for a number of common services provided by PCPs. More generally, the extent of services which are paid via capitation vary by specialty and patient insurance (though there is a set of services that is common across insurance plans). For services that are not capitated, physicians are paid FFS, meaning a per-service basis. The payments, therefore, represent true marginal costs for these services for the IPA.

Both PCPs and specialists can have services that are paid on a capitated basis, but within

[3] Referrals from one specialist to another were possible, but the IPA is designed so that access to the specialist network in the first place goes through the PCP.

this paper, except for the paragraph above, any time capitation is discussed, it is in reference to services provided by ophthalmologists. That is, any time I reference services being capitated, or physicians being paid on a capitated basis, I am referring to payments by the IPA to ophthalmology practices – not PCPs.

The IPA categorizes its patients into two broad categories for operational reasons. About three-quarters are standard, non-Medicare patients (which I call "HMO patients", or "HMOs"), while the remaining quarter is comprised of Medicare Advantage patients (which I refer to as "SrHMO patients", or "SrHMOs").[4] Despite that HMO patients outnumber SrHMO ones by approximately three-to-one, SrHMO patients are responsible for more than 45% of all IPA claims. In ophthalmology, the distinction between these two types is particularly important: HMO patients are all paid on a FFS basis, but for SrHMOs, about three-quarters of services are capitated.[5] For example, when an HMO patient is referred to ophthalmology, the IPA pays for every service performed. In contrast, for SrHMO patients, the IPA makes a monthly flat payment to the ophthalmologist to cover the cost of a number of common services. If the ophthalmologist increases the intensity of treatment by increasing the use of capitated services, then the IPA does not incur additional costs. Thus for ophthalmology, increases in treatment intensity have more impact on IPA costs when it happens for HMO patients. For SrHMOs, the IPA's exposure is limited due to the capitation arrangement.

3 Experiment Description

The subjects of the experiment were all PCPs associated with the IPA who practiced in either the family practice or internal medicine specialties. Subjects assigned to the treatment group all received an informational treatment – a letter containing historical average costs of six ophthalmology practices affiliated with the IPA (the "treatment" or "cost report", which is described below) – while the control group subjects did not receive anything. In order to maximize the experiment sample size, all of the IPA's PCPs who were active at the time of the treatment distribution were included if they satisfied minimal criteria: they must have had at least ten claims during each calendar month from August 2013 through January 2014, and made at least one patient referral to ophthalmology during that period (total, not each month).[6]

[4]Medicare Advantage is a special program within Medicare that allows members to join HMOs that provide coverage for a broader array of services, but with less freedom of choice, than standard Medicare.

[5]The claims that are capitated also tend to be relatively expensive services. In 2013, the average cost of each claim for capitated services was more than twice that of FFS claims, and capitated claims represented about 88% of the total value of claims (where the Medicare "allowed amount" is taken as the cost of capitated services).

[6]The six month period ending January 2014 was used because it was the most current data available to me when the distribution list was finalized.

Additionally, three additional PCPs who were social contacts of me personally were excluded. In the end, a total of 93 PCPs – 35 internists and 58 family practitioners – were included in the experiment. These physicians were typically organized into group practices, which I measure using the office addresses of the PCPs (since affiliation via legal entities was not observable). Thus, a PCP practice in the context of this project is either one PCP or multiple ones that have the same office address listed with the IPA. In total, there were 55 included practices, with 24.33 of them being internal medicine and 30.67 family practice (fractional practices resulted from a mixed specialty group).

To account for the organization of PCPs into practices, assignment into treatment and control groups took place at the practice level, so that either all PCPs in a practice were assigned to the treatment group, or none were. This feature of the experimental procedure was intended to minimize control group contamination via discussion between PCPs, since if the subjects were going to discuss the information received in the treatment, it seemed likely that it would take place within the practice. To the extent, however, that discussion outside the practice indeed took place and resulted in control group contamination (a possibility that I cannot directly observe), the results of the experiment may understate the effects of the treatment (since contamination in this case would imply bias towards a null finding).

Ophthalmology was chosen to be the specialty for which cost information was distributed to PCPs for three main reasons. First, ophthalmology as a specialty receives a large number of referrals from the IPA's PCPs. During the twelve month period from March 2012 through February 2013, the ophthalmology specialty received 3,467 referrals from Family Practitioners and 2,461 from Internists. For both types of PCPs, these were enough to make ophthalmology the fourth most often referred to specialty in the IPA. Second, before this experiment, the IPA PCPs had never previously received any information about ophthalmologist costs, allowing for the measurement of the effect of completely new information. Third, as the medical specialty of physicians who treat and study diseases and functions of the eye, ophthalmology is a particularly highly specialized area of medicine, and PCPs typically cannot substitute their own services, or the services of other specialists, for those of ophthalmologists. Ideally, the introduction of cost information to the PCPs would not affect the likelihood of a referral to the specialty of interest. That is, for a given patient, the probability he will be referred to the specialty of interest will be the same both before and after the introduction of cost information. Since ophthalmology is so specialized, it seems likely that the only margin of response available to PCPs would be to which ophthalmologist the referral is made, *not* whether or not to refer to ophthalmology at all.

During the experiment, the IPA collected data on PCP referrals as part of its normal operations. This data was generated by the PCPs' activities of seeing and treating patients as part of their usual medical practices in their regular offices. The IPA regularly collects all of this data, and all of the physicians are aware of this data collection. However, none of the physicians were made aware of the fact that the distribution of the cost information was related to an experiment or that an outside researcher was involved. Thus, interpretation of the PCPs behavior observed in the experiment is plausibly not obscured by the so-called "Hawthorne Effect", since no unusual observation was apparent to the subjects.

3.1 Experimental Treatment: the Cost Report

The experimental treatment for this study was a report listing six busy ophthalmology practices, along with two numbers for each practice: separate, risk-adjusted, 180-day cost averages for newly referred patients to ophthalmology for both standard HMO patients and SrHMO patients. Together with the cost report, the treatment group PCPs also received a cover letter from the CEO of the IPA, briefly explaining the reason for receiving the report and a description of how the costs were calculated. Anonymous facsimiles of the report and cover letter are attached as Figures 1 and 2.

The cover letter was included with the report in order to explain to the PCPs what the report contained and why, but its contents were crafted with three goals in mind. The first was to help it seem to the PCPs that their receipt of the cost report was not out-of-the-ordinary. Hence, its first sentence stated that the report was "requested by" the PCPs of the IPA and that it was part of a "continuing" effort to "share information on specialty costs." This was emphasized to help minimize the chance that the mere act of receiving unusual correspondence from the IPA would alter the behavior of the PCPs.

The second goal of the cover letter was to help make the cost figures seem credible to the PCPs. Credibility was important in this situation because, even if physicians truly would respond to cost information when they had it, if the PCPs did not believe the the numbers they were provided, they would have no reason to adjust their behavior in response to them. In such a situation, the experiment could end up failing to find evidence of an effect even if one truly existed. Therefore, to add an air of authority to the letter, it bore the signature of the organization CEO and was printed on IPA letterhead.[7] Additionally, to emphasize accuracy, the letter specifically mentioned that the figures were based on actual, recent patient encounters and that IPA claims were used for the calculations. Most importantly, to underscore that the figures were comparable across ophthalmologists, the letter briefly described, in simple terms, how the figures were risk-adjusted. This was an important point since the PCPs were well

[7]The letterhead included a large IPA logo at the top left, and the IPA's mailing address and contact numbers running along the bottom of the page. These features of the letter, along with the CEO's signature and name, are omitted from the included copy to keep the IPA's identity private.

aware of the potential for characteristics of underlying patient populations to affect costs. In the letter, the risk-adjustment process was explained as having used only patient conditions that were "common across practices" and that the figures reflected "IPA-wide prevalence instead of individual practice level prevalence."

The last goal of the cover letter was to support the notion that the cost report numbers were relevant to the PCPs. Much like credibility, relevance was important in this case since if the PCPs did not feel the figures were relevant to them, they were unlikely to act on them. The emphasis in the letter on comparability serves towards this goal in addition to the credibility, since it means the costs can help the PCPs compare the ophthalmologists against each other. Moreover, its mention that the numbers were based on patients with common conditions implied that the figures were likely to be relevant to the PCP's own patients. Additionally, in the final paragraph, it mentions that the ophthalmology practices included on the report were those who served many IPA patients and did so with good patient satisfaction scores, implying they had a track record of providing quality care for the IPA. Lastly, the first sentence mentioning the continuing efforts on costs serves as a subtle reminder to the PCPs that the IPA had been emphasizing cost control and had asked the PCPs to be mindful of the cost implications of their actions.

The cost report itself, unlike the cover letter, did not appear on IPA letterhead, but it did have a large IPA logo on the top. Below that, the rest of the document was comprised of two parts: the cost table and a set of footnotes with additional information. On the left side of the table were the names of six ophthalmology practices. Below each practice name were the names of the IPA network ophthalmologists associated with each of those practices in smaller, italicized print. For the facsimile included here, these names (which are confidential) are replaced by identification numbers that reflect the ranking of the practices in terms of the cost figures contained on the report. The first digit of the ID indicates the practice's ranking in cost (from less to more) for HMO patients. So the first digit of the least costly practice is number one, and for the most costly, it is six. The second digit is a placeholder – a zero – for all practices. The third and last digit indicates the ranking in terms of SrHMO patients. So practice 101 is the least expensive practice for both types of patients. Practice 603, however, is the most costly in terms of HMO patients, but for SrHMOs, it is the third least costly.

In presenting cost figures, the table was designed to be as simple as possible. It was clear that, given the many demands competing for the attention of the PCPs, a cost report that could be interpreted easily had the best chance of being read, understood, and remembered. Only one number, therefore, was presented for each type of patient, per practice. To make this figure as informative and relevant as possible, it was designed to estimate the average charges to the IPA over a 180-day period for a given patient generated by the ophthalmologist receiving a referral for a new ophthalmologic condition.[8] In other words, it was intended to represent the marginal cost to the IPA of a new referral. Figures were presented for both HMOs and SrHMOs, with the calculations of the two types having been performed completely independently.[9] Given the goal of simplicity, I originally planned to present only one cost figure per ophthalmology practice, but the IPA management preferred providing both, and given the difference in financial treatment between both types of patients, presenting both provided an opportunity to examine if the PCPs would respond differently to the two types. Once the costs were produced, the list was sorted by the HMO patient cost, from lowest (at the top) to highest (at the bottom). The SrHMO patient cost did not play a role in this sorting, so the ordering of the practices on the report does not reflect any information contained in the SrHMO figures.

As can be seen on in the table, the variation in costs between the ophthalmologists is quite high. For HMO patients, practice 101's $147 figure is less than half of practice 603's $333 number. There is less variation for SrHMO patients, but the cost of the most expensive practice, 406, is more than 25% higher than the least expensive, practice 101. Variation in ophthalmologist cost does not come from the per-procedure price varying across physicians – it comes from differences in intensity-of-treatment. For example, a more costly ophthalmologist might take patients more quickly to surgery than less expensive ones. Thus, one way to think about the cost estimates is to think of them as weighted measures of treatment intensity (where the procedure price is the weight). In fact, for the SrHMO costs, this interpretation is particularly appropriate since the procedure price is never actually paid on capitated services – it merely represents a measure of what the procedure *would cost* if it were paid on a per-procedure basis.

The footnotes under the table provide brief descriptions of the calculation, including reiterating that the numbers were risk-adjusted and that they were based on new ophthalmologic conditions, and also mentioning the criteria for a practice to be included. These notes served to buttress the credibility of the figures provided by providing additional details suggesting the costs were calculated carefully and reasonably. Additionally, the first footnote served as an explicit reminder for the PCPs of the difference between HMO and SrHMO patients by noting that SrHMO services are highly capitated in ophthalmology.

Distribution of the experimental treatment took place on May 5th, 2014, when the IPA mailed the ophthalmologist cost report and cover letter to the treatment group subjects via the U.S. Postal Service. I use referrals data from the six-month period beginning May 16th and ending November 15th, 2014 (the "post-period") to measure the impact of the treatment.

[8]The 180-day period began the date of the first claim made by the ophthalmologist. A "new" condition meant that the set of visits used in the calculation had to be preceeded by a period of at least 180 days in which no ophthalmology claims were observed for the patient.

[9]That is, the costs for an ophthalmology practice's HMOs did not play a role in the calculation of the SrHMO costs, and vice versa.

For analyses that adjust for preexisting differences between the groups, I use the six complete months from November 2013 through April 2014 (the "pre-period"). Referrals from the fifteen days between these periods (May 1st through 15th, 2014) are excluded so that the pre-period could be based on six complete calendar months and to allow time for the reports to be delivered and then opened and read by the PCPs.

Regular mail was used to distribute the treatment for three main reasons. First, in its normal operations, IPA management often used mail for communication with its physicians – especially for important information. Sending the treatment in this manner, therefore, made it likely to be read by the PCPs and also unlikely to seem unusual to them or to suggest outside involvement. Secondly, the IPA management and I wanted to implement a real-world type method that would be feasible for the IPA or other groups to replicate outside of an experimental setting. Lastly, this method put little burden on IPA staff. This approach, though, has the important weakness that it is not possible to observe which PCPs actually received and opened the cost report letter.

4 Econometric Evaluation

The basis of evaluation for all the following analyses is the intention-to-treat approach, which is necessary since the cost reports were delivered by mail and I did not observe their receipt, nor did I take any steps to survey the PCPs to confirm their knowledge of the cost information.[10] The major disadvantage to this is that my analyses, which assume everyone assigned to the treatment group were indeed treated, will understate the true treatment effects to the extent that some treatment groups PCPs did not receive, or did not understand or retain, the cost information.

The primary outcome of interest for this study is the share of a PCP practice's ophthalmology referrals that an ophthalmology practice receives. Let $p \in \{1, 2, ..., P\}$ and $s \in \{1, 2, ..., S\}$ index the PCP and specialist practices, respectively, and $\tau \in \{0, 1\}$ index the time periods (where zero indicates the pre-period and one the post-period). I notate the referral share using $\theta_{ps\tau} \equiv REFS_{ps\tau}/TOTREFS_{p\tau}$, where $REFS_{ps\tau}$ is the number of ophthalmology referrals between p and s during period τ, and $TOTREFS_{p\tau}$ is the total ophthalmology referrals made by p during τ. The use of referral share helps make the dependent variable more comparable between practices that may have different numbers of physicians and patients.

I use two methods to evaluate the effects of the treatment on $\theta_{ps\tau}$. The first is comparison of

[10]One reason I did not administer a survey was that it did not seem feasible in the context of my relationship with the IPA. Another was that I wanted to keep the intervention as close to normal business activity as possible, and pursuing a survey or other intervention would have sacrificed (at least to some extent) that feature of this project.

post-period mean referral share across groups by ophthalmology practice (focusing only on the practices that were listed on the cost report).[11] This method is valid for evaluation given the randomization of assignment and the fact that pre-period measures do not show any statistically significant differences between the groups before treatment (shown below).

There is an important weakness to this approach, however. Despite the fact that pre-period differences are not statistically significant, this study does not have a high level of precision due to the fact that there are only 55 PCP practices. The implication of this is that non-significant pre-period differences could still have important implications on estimates if one controls for them. Moreover, as is discussed more below, these 55 practices were not enough to randomize on a stratified basis within ophthalmology practice, so the issue could be even more pronounced when controlling for differences within ophthalmology groups.

Therefore, as a robustness check of the results using only post-period means, the second method of evaluation uses regression techniques to add controls for pre-period differences across groups. The regression models used for these purposes both allow for separate post-period differences for each of the ophthalmology practices (as in the first approach), but differ in the type of control used for the pre-period. The first, more restricted model only controls for the mean difference between the treatment and control groups as a whole. This model has the following form:

$$\theta_{ps\tau} = \sum_{j=1}^{6} \left(\beta_{1j} I_p A_\tau O_{\{s=j\}} + \beta_{2j} A_\tau O_{\{s=j\}} \right) + \beta_3 I_p + u_{ps\tau}. \tag{4.1}$$

Here indicator dummies A_τ and I_p identify the post-period and treatment group members, respectively, and the set of indicator dummies, $\{O_{\{s=j\}} | 1 \leq j \leq 6\}$, identify each of the six ophthalmology practices listed on the cost report treatment. The unobserved error term is given by $u_{ps\tau}$.

The β_{1j} coefficients in Equation 4.1 are difference-in-differences (DD) measures of the change in average referral shares for each of the separate Ophthalmologist practices. That is,

$$\begin{aligned} \beta_{1j} = & E[\theta_{ps\tau} | A_\tau = 1, I_p = 1, s = j] - E[\theta_{pst} | A_\tau = 1, I_p = 0, s = j] \\ & - \left(E[\theta_{ps\tau} | A_\tau = 0, I_p = 1, s = j] - E[\theta_{ps\tau} | A_\tau = 0, I_p = 0, s = j] \right). \end{aligned} \tag{4.2}$$

This model allows for a separate post-period difference for each ophthalmology practice, but it uses the same pre-period difference for all of them (it restricts the second line of equation

[11] For a given PCP, referral shares must sum to one across all possible ophthalmologists, so the *change* in the distribution of share across all possible ophthalmology practices in response to the treatment must sum to zero. By focusing only on the practices listed on the cost report, there is no restriction on the sum of estimators.

4.2 to be equal to β_3 for all j).[12] If the data has large, non-significant differences between the treatment and control groups (across ophthalmology practices, not within) then this form of control will change the results versus just using the post-period data.

The second model relaxes the restriction on the pre-period difference, allowing a separate one for each ophthalmology practice. It is given by:

$$\theta_{ps\tau} = \sum_{j=1}^{6} \left(\beta_{1j} I_p A_\tau O_{\{s=j\}} + \beta_{2j} A_\tau O_{\{s=j\}} + \beta_{3j} I_p O_{\{s=j\}} + \beta_{4j} O_{\{s=j\}}\right) + u_{ps\tau}. \tag{4.3}$$

This is a DD model, like the previous one, though here it produces the same estimates as one would obtain by performing separate DD regressions for each of the ophthalmology practices.[13] Hence, this approach strengthens the manner in which pre-period differences are addressed: it formally controls for pre-existing differences in knowledge of specialist practice characteristics like location and quality. To the extent that these are large enough, this type of control could change the estimates obtained.

To investigate how the treatment affected referrals over time, I also evaluate the intervention using data where the periodicity is bimonthly. This allows for the calculation of the referral change for three different periods after the distribution of the cost report. Let $t \in \{1, 2, .., 6\}$ be a bimonthly time index, where if $t = 1, 2$, or 3 then $\tau = 0$, and if $t = 4, 5$, or 6 then $\tau = 1$.[14] Given this index, I recalculate a bimonthly version of the referral share variable, θ_{pst}, and estimate mean referral share differences between groups for each period. As before, I also use two different regression models to control for pre-period differences within ophthalmology practices. The first is given by:

$$\theta_{pst} = \sum_{j=1}^{6} \sum_{k=4}^{6} \left(\beta_{1jt} I_p A_\tau O_{\{s=j\}} T_{\{t=k\}} + \beta_{2jt} A_\tau O_{\{s=j\}} T_{\{t=k\}}\right) + \beta_3 I_p + \sum_{h=1}^{6} \gamma_t T_{\{t=h\}} + u_{pst}. \tag{4.4}$$

Here, $\{T_{\{t=h\}} | 1 \leq h \leq 6\}$ is a set of indicator dummies identifying each two-month period,

[12] Let $\overline{\theta}_{T,A,j}$ and $\overline{\theta}_{C,A,j}$ be the sample average of the referral share of the treatment and control groups, respectively, for ophthalmology practice j in the post-period (where A indicates "after"). Also let $\overline{\theta}_{T,B}$ and $\overline{\theta}_{C,B}$ be the averages for the treatment and control groups, respectively, in the pre-period (B for "before"). Note these pre-period averages are the same for each specialist practice. Then for this regressions model, the the resulting estimates for the β_{1j}s are exactly the same as one would obtain via the formula $\overline{\theta}_{T,A,j} - \overline{\theta}_{C,A,j} - \left(\overline{\theta}_{T,B} - \overline{\theta}_{C,B}\right)$.

[13] It is also the same as performing the calculation using sample averages. Given the definitions in footnote 12, and adding $\overline{\theta}_{T,B,j}$ and $\overline{\theta}_{C,B,j}$ to indicate pre-period treatment and control group averages, respectively, for specialist practice j, this approach produces estimates that are the same as if one performed the DD calculation $\overline{\theta}_{T,A,j} - \overline{\theta}_{C,A,j} - \left(\overline{\theta}_{T,B,j} - \overline{\theta}_{C,B,j}\right)$ for each ophthalmology practice.

[14] Precisely, the pre-period is divided into three periods, $t = 1$ for November and December 2013, $t = 2$ for January and February 2014, and $t = 3$ for March to April 2014. During the post-period, $t = 4$ for May 16th to July 15th, $t = 5$ for July 16th to September 15th, and $t = 6$ for September 16th to November 15th (all in 2014).

and the γ_t coefficients represent bimonthly-period fixed effects that control for referral share time trends. This model produces three coefficient estimates of interest for each ophthalmology practice (the β_{1jt}s), one for each two-month span following the treatment distribution. These represent differences between the groups for each period and ophthalmology practice – after differencing out the aggregate differences between the treatment and control groups during the pre-period (via the β_3 coefficient) and controlling for cross-group time trends (via the time fixed effects).

The more flexible second model allows for separate, pre-period group differences for each ophthalmology practice:

$$\theta_{pst} = \sum_{j=1}^{6}\left(\sum_{k=4}^{6}\left(\beta_{1jt}I_pA_\tau O_{\{s=j\}}T_{\{t=k\}} + \beta_{2jt}A_\tau O_{\{s=j\}}T_{\{t=k\}}\right) + \beta_{3jt}I_pO_{\{s=j\}} + \beta_{4jt}O_{\{s=j\}}\right) + \sum_{h=1}^{6}\gamma_t T_{\{t=h\}} + u_{pst}. \tag{4.5}$$

All model parameters are estimated using Stata/MP 13.1 software for Windows StataCorp (2013), and all standard errors account for clustering at the PCP practice level. This is necessary because the treatment may induce PCPs to re-allocate referrals between ophthalmologists on the cost report, suggesting error term correlation for PCP-specialist observations within a PCP practice cluster.

4.1 Referrals Data

The IPA operates on a system in which the PCP serves as a gatekeeper for access to specialists. Each patient is, at all times, assigned to a PCP who decides when specialists are needed. When such a decision is made, the PCP submits the referral to the IPA for approval. This allows the IPA to confirm that the service will be covered by the patient's insurance, thereby keeping costs down. This structure provides several advantages for the study of referrals. First, the approval process provides a direct manner of tracking physician referrals, implying less error in referral measurement than if they had to be inferred from claims data or other methods. Second, the approval process also implies a strong financial incentive for referrals to be reported to the IPA, since services would not be covered without approval. This improves the representativeness of the referrals observed in the data. Third, the gatekeeper aspect of the IPA increases the frequency that PCPs make referral decisions, since patients have a financial incentive to obtain referrals through their PCPs instead of self-referring. These advantages aside, though, some PCP referral decisions are not observable using the IPA data. These include referrals that are not approved because they are not covered by patient insurance, and those that are never sent for approval through the IPA system. One possible reason a referral might not be sent for approval is that the PCP or patient feels certain that the service would not be covered, and so the referral is made informally.

To implement the econometric strategy discussed above, I calculate referral shares using all of the IPA's submitted and approved referrals for patients 18 years and older. Since the cost report listed costs for HMO and SrHMO patients separately, I calculate referral shares for both groups. Specifically, HMO patient referral shares are calculated as the number of HMO patient referrals to a given specialist divided by the total number of HMO patient referrals, and SrHMO patient shares are calculated analogously. Mean differences and regression models are all estimated separately for the different types of patients.

Table 1 presents pre-period summary statistics for the referral share variables by ophthalmology practice. During the six-month pre-period, the 93 subject PCPs made 3,171 referrals to the ophthalmology specialty, 68.2% of those being directed to the practices listed on the cost report. Among the ophthalmology practices listed on the report, there was fairly wide variation in the number of referrals received, with practice 505 receiving the fewest at 5.7%, and 406 the most at 17.2%. On average, the cost report practices received a little more than 10% of each PCP group's referrals, with individual ophthalmology practices receiving as little as 4% (practice 505's HMO share) to as much as 18% (603's HMO share). Each cost report practice had similar referral shares for HMO and SrHMO patients, with 101 having the largest difference – 7.9% for HMO patients, 10.7% for SrHMO patients.

In mid-September of 2014 – four months into the post-period, one of the ophthalmologists working at practice 302 left the practice and the IPA specialist network. This physician, who I call 302L,[15] was not the only ophthalmologist in that practice, but 302L handled the bulk of practice 302's IPA patients and received the vast majority of IPA referrals (302L received more than 78% of practice 302's referrals during the pre-period). The departure of 302L, therefore, represented a significant change in the ability of practice 302 to service the IPA's patients during the last two months of the post-period. To the extent that information about 302L's departure disseminated differently between the treatment and control groups, my estimates of the impact of treatment may be affected.

[15] L since this physician left.

5 Experiment Results

5.1 Randomization

Stratified randomization was used to assign PCP practices to treatment or control groups. Practices were stratified on the basis of five pre-treatment dummy variables: whether the practice was an Internal Medicine practice; whether the per-physician count of SrHMO referrals exceeded the pre-period median of all the PCP practices, and the same for HMO referrals; and whether the per-physician count of SrHMO claims exceeded the pre-period median of all the PCP practices, and the same for HMO claims. These practice-level measures were created using all IPA claims and referrals data for the six-month period from August 2013 through January 2014[16]. Re-randomization was not performed; the seed for the random number generator used to produce the assignment was set to the date that the randomization was implemented, 20140430.[17]

The underlying assumption of the analyses herein is that the randomization process was successful in producing a control group that can credibility serve to estimate the counterfactual outcome of what would have happened had the treatment group not received the cost report. This assumption cannot be verified with data, but some suggestive evidence can be offered by examining the similarities (or lack thereof) of the groups during the pre-period. To this end, Table 2 presents practice-level, pre-period sample averages by treatment status, which are measured for the whole six-month period. The most notable difference was that the control group was assigned more internal medicine practices than the treatment group, though it was not statistically significant at conventional levels. Similarly, none of the other measures had significant differences, either. Appendix Tables A.7 and A.8 present similar, practice-level and PCP-level averages (respectively) using the data that was available at the time the randomization was performed. Like the pre-period data, there were no significant differences. Table 3 presents the pre-period distribution of PCP practices size (i.e. the number of physicians), which is similar across groups. A chi-squared test for distribution differences failed to reject at conventional significance levels.

Figure 6 presents a plot of the differences in average referral share between the treatment and control groups by ophthalmology practice, with 95% confidence intervals indicated by red lines. Results are presented in the same order as they appeared on the cost report: sorted by cost for HMO patients from least expensive practices (on the left) to most costly (on the right).

[16]This time frame does not coincide with the six-month pre-period of November 2013 to April 2014 because January was the latest month of data available before the distribution of the treatment)

[17]The function runiform() in Stata/SE 12.1 for Windows was used for random number generation (StataCorp, 2011).

As can be seen, none of the pre-period differences are statistically significant at conventional significance levels. Similarly, 6 plots referral share differences using bi-monthly data, and shows that none of the two-month period differences are significantly different from zero during the pre-period.[18]

Despite that there were not statistically significant pre-period differences, it is worth noting that some of the non-significant differences within ophthalmology practices are fairly large. The most important example of this is the case of ophthalmology practice 101, whose 0.09864 share of the treatment group's HMO referrals was 66% more than its 0.05931 share from the control group (both figures measured using six-month periodicity data). This issue might have been addressed in the randomization process by stratifying by pre-period referral shares to each ophthalmology practice, but since this would have meant six stratification variables, each with (at least) two values, this approach did not seem feasible with only 55 subjects.[19] I therefore present analyses below that include pre-period controls as robustness checks for my primary analyses which are based on only post-period differences.

5.2 Comparison of Simple Means

Given the lack of statistically significant differences in the pre-period, then the simplest evaluation of the treatment is the post-period difference between groups. These are plotted for six-month data in Figure 6 (and presented numerically in Appendix Table B.9). For HMO patients, ophthalmology practices 101 and 204 received a higher share of referrals from the treatment group than from the control group, while all other practices received less. Practice 101's difference is by far the largest at 0.0704, which is nearly statistically significant at the 5% significance level ($t = 1.951$). Compared to the average referral share of the control group during the post-period (across all practices) of 0.114, this represents an effect of almost 62%. Compared to the control group's referral share *to practice 101 only* of 0.0600, though, it represents an increase of more than 117%. For the other practices, the differences were not statistically significant, though it is worth noticing that the overall pattern in the graph is consistent with referrals being redirected towards practice 101 and away from the others.

Considering next the results for the SrHMO patients, practices 101 and 204 have positive differences, 406 and 505 are negative, and 302 and 603 are effectively zero. Notably, the difference for 101 is much smaller at 0.0207, and is not significant, nor are any of the other values at conventional levels. Whereas the results for HMO patients are consistent with the

[18]Tables containing numeric values for the plots in Figures 6 and 6 can be found in Appendix B.

[19]If each ophthalmology practice share variable contained the minimum of two values (i.e. low and high referrals), then there would have been 36 mutually exclusive groups to split the 55 practices between, implying fewer than two subjects for many groups.

possibility that referrals are redirected from the more expensive practices towards the least expensive practice, here we do not see a similar pattern. The least expensive practice in terms of SrHMO patients was number 101, and while it does have a positive difference, it is much smaller than the difference for HMO patients. Moreover, the second and third least expensive practices, 302 and 603, both had differences of zero, while the fourth practice in cost had the largest difference at 0.03466. The fifth and sixth ranked practices had negative differences. Overall, then, the pattern does not seem to be consistent with a reallocation on the basis of cost. Nor does the pattern seem consistent with the order of presentation on the cost report. Thus, the pattern of results for SrHMO patients does not appear to be related to the cost report.

To examine how the effect of the treatment evolved over time, I turn next to data measured over bi-monthly periods. Figure 6 presents plots of the differences in average referral share for each two-month period (which are also presented numerically in Appendix Tables B.10 and B.11). Here we see that for HMO patients, the six-month data hide a large spike in referrals coming from the treatment group immediately after the distribution of the cost report, which then dissipates somewhat over the next two periods. The period four difference between groups of 0.1485 is very large: it suggests an effect of more than 130% when compared to the 0.114 post-period average share for the control group across all practices (and more than 310% when compared to the 0.04775 average share of referrals sent to practice 101 by the control group for period four). Moreover, the estimate is statistically significant at the 5%-level (p-value = 0.0108). Periods five and six are not statistically significant at conventional levels, but their point estimates are still relatively large at 0.07987 (70% of the 0.114 benchmark) and 0.05589 (49% of 0.114). Practice 204 also shows a large positive difference during period four at 0.06287, which is statistically significant at the 10%-level (p-value = 0.0841) and is 55% of the 0.114 benchmark. This case is different from that of practice 101, though, because the large difference for 204 comes primarily from a large drop in the control group referral share during period four, and then the difference disappears in the following two periods. In contrast, the difference seen for practice 101 comes from the treatment group increasing after the distribution of the costs report while the control group shares stay relatively stable.[20] Compared to practice 101 and 204, the other practices do not exhibit such large trend changes. Practices 302 and 603 do see generally negative effects, though only period six for 302 has a statistically significant difference (-0.08610) at a conventional level (10%, p-value = 0.0853).

The bottom panel of Figure 6 presents the same, bi-monthly mean differences for SrHMO patients. Here we do not see any drastic spikes during the post-period for practice 101, as we do for the HMO patients. In fact, for the most part across all practices the differences are all close

[20]These features of the data are reported in Appendix Table B.10.

to zero, with three exceptions. The first two are statistically significant at conventional levels: practice 204, period five has a share difference of 0.08825 (5%-level, p-value = 0.0147), while practice 505 has a difference of -0.04703 (10%-level, p-value = 0.0784) during period six. The third is practice 603 during period six, with a non-significant difference of -0.07685.[21] These are all large differences, but they do not seem to be consistent with the practice ranking in terms of costs or order on the cost report. Additionaly, these differences are not persistent over time, and in the case of 505 and 603, the decreases can be traced to large increases in control group referrals while the treatment group referrals stay relatively stable. Thus, as was the case when using six-month data, the pattern does not seem related to the information on the cost report.

So overall we see that for HMO patients, practice 101, the least expensive in terms of HMO patients on the cost report, received a disproportionately large shares of referrals from the treatment group during the post-period, and except for the small positive difference for the second least expensive practice, number 204, the rest saw fewer referrals from the treatment group. The pattern for SrHMO patients, on the other hand, seemingly had no correlation with the information on the cost report. The use of bi-monthly data reveals that in the case of HMO patients, the increase in referrals was concentrated in the treatment group during the first two months after the distribution of the treatment. For SrHMO patients, the differences were small in most cases and, again, seemingly unrelated to the cost report.

At this point, it is worth recalling the primary differences between the SrHMO and HMO patients: SrHMO patients all have Medicare Advantage insurance, and so ophthalmology services for them are largely capitated.[22] This implies that intensity of treatment does not affect the IPA costs nearly as much as it does for HMO patients. Knowing this, one way to interpret the combined results for both patient types is that the PCPs understand the difference in financial impact between HMO and SrHMO referrals, and incorporate that knowledge into their decisions. For patients where the intensity of medical treatment affects costs, they respond by shifting patients towards the practice they believe is most cost effective, but for patients where intensity does not have an impact, they seemingly make their decisions without concern for the relative cost of the specialist.

Another feature of the data it is briefly worth re-visiting is the dissipation over time of the response to the treatment. There are (at least) two possible explanations. One is that since the treatment is informational, over time the information spreads from the treatment group PCPs to those in the control group, and the difference is reduced because both groups' referral shares reflect the treatment effect. Another possibility, though, is that the actual effect of the cost report on the treatment group PCPs fades over time. Based on the mean differences

[21]See Appendix Table B.11.

[22]As Medicare members, they are also older, on average.

reported in Appendix Table B.10, the second possibility appears more likely, since the control group referral shares stay relatively stable over the entire six periods, while the treatment group shares fall both periods following the fourth period spike. The follow up question then becomes, why does the effect fade? Here the data cannot be informative, but there are (again) at least two possibilities: perhaps over time the PCPs simply forget about the cost report, or, alternatively, maybe after sending patients to ophthalmology practice 101, they receive feedback that convinces them not to refer there any more. For example, this could be because they do not perceive 101 providing the value or quality they were expecting. Unfortunately, the investigation of these possibilities will have to be left to future research.

5.3 Regression Model Estimates

I turn now to regression methods that allow for the incorporation of controls for pre-period differences. Table 5 presents estimates of the β_{1jt} coefficients of Equations 4.1 and 4.3 using data with six-month periodicity, where each column reports results from a separate regression. Ophthalmology practice coefficient estimates are presented in the same order as they were listed on the cost report: sorted from least expensive practices for HMOs at the top to most expensive at the bottom.

Columns [1] and [2] report estimates for Equation 4.1, which incorporates a control for the difference in means between the treatment and control groups, where means are calculated across all ophthalmology practices. Overall, both regressions generally exhibit the same pattern as is seen when looking only at the post-period differences. For HMO patients, the two least expensive practices (101 and 204) both had more referral share coming from the treatment group than the control, while the four more expensive practices had less. For SrHMO patients, 101 and 204 again have positive estimates, 302's and 603's are nearly zero, and 406 and 505 have negative ones. Between the two regressions, the only coefficient estimate that is significant at conventional levels is that of practice 101 for HMO patients, which is significant at the 5%-level (p-value = 0.036). The estimate is quite large at 0.0711, which represents an effect of 62% when compared to the benchmark of 0.114 (the average share of the post-period control group), and is much larger – by a factor of at least two – than the magnitudes of all the other practice coefficients. Thus, the control for the overall difference between the two groups does not result in any interpretive differences versus the results using post-period means.

Results for Equation 4.3 are found in columns [3] and [4], which relaxes the specification of the pre-period control by allowing a separate one for each ophthalmology practice. As discussed in Section 4, this is the same as performing a separate DD for each ophthalmology practice. This more flexible approach results in some important differences. Most notably, for

HMO patients, the estimate for practice 101 falls by more than half to 0.0311, which is not statistically significant. For SrHMO patients, the estimate for practice 204 becomes 0.0375, which is large in magnitude at almost 33% of the 0.114 benchmark. It is also statistically significant at the 5%-level (p-value = 0.029), the only coefficient estimate to be significant at conventional levels between the two regressions. Despite these differences, there are still some interpretive similarities with the results in columns [1] and [2] when the overall pattern is considered. For HMOs, the practice 101 estimate is relatively large and positive while the others are either much smaller in magnitude or negative. For SrHMOs, the estimates do not have any pattern that appears related to the ordering of the practices. Moreover, the estimates are mostly similar to those in column [2]; only the first two practices have notable differences. The estimate for practice 204 is somewhat larger, but the difference in statistical significance is driven by the much smaller standard error in column [4] (had it been unchanged, the larger estimate would still not be statistically significant). The change in estimate for practice 101 from 0.0146 to -0.0281 is relatively large, but this change does not make a difference in the interpretation of the pattern.

Overall, when measuring the effect of the treatment using six-month period data, controlling for the per-period difference between the treatment and control groups does not change the results in any meaningful way as compared to using post-period differences only. However, when controls for pre-period differences for each ophthalmology group are included, the results weaken, particularly with respect to practice 101's result for HMO patients, which is no longer statistically significant. Estimates are very imprecise, though, and the overall pattern remains to some degree, including the fact that practice 101's coefficient estimate implies a large effect.

Moving next to results produced using data with bi-monthly periodicity, Table 6 presents estimates for the β_{1jt} coefficients of Equations 4.4 (columns [1] through [6]) and 4.5 (columns [7] to [12]). In this table, each regression is presented across three different columns, with all the coefficients for a given period appearing in the same column. Thus, results for a given ophthalmology practice over time can be read in the same row, moving from period four on the left to period six on the right.

As was the case for the six-month periodicity data, the addition of a control for the single difference in means between the groups does not result in any interpretive changes versus the use of post-period differences only. Like before, the results show that practice 101 experienced a large spike in HMO patient average referral share during period four, the first after the treatment distribution. The point estimate of 0.1537 (column [1]) is statistically significant at the 1%-level (p-value = 0.006), and represents an effect of 135% when compared to the control group's benchmark average referral share of 0.114. As before, the effect partially dissipates over the following two periods – the point estimates are large in magnitude but not statistically significant. Practice 204 also shows a much smaller, but still relatively large in magnitude, increase in referral share during period four with a point estimate of 0.0681, which is significant at the 10%-level. This increase disappears the next period, though, as both subsequent periods have point estimates of effectively zero. For the other practices, there are no coefficients are statistically significant. Most are either small in magnitude or negative, with practices 302 and 603 showing large (non-significant) negative share estimates. For practice 603, this large negative effect is persistent in all three periods, which is consistent with a reallocation by PCPs from 603 to 101, but given the low precision, the evidence of this is merely suggestive. For 302, the negative estimates are possibly influenced by the exit of that practice's primary ophthalmologist, 302L (discussed in Section 4.1). On the other hand, the negative effect started before 302L left, which still might have been a reflection of PCPs becoming aware of 302L's impending exit, but combined with the fact that the negative effect is not present in the SrHMO referrals, the results do not seem entirely consistent with the pattern one might expect when a physician leaves the network.

Columns [4] through [6] show results for SrHMO patients. It is noticeable here that during the fourth period, all the differences are relatively small, suggesting little overall change in market share allocation across practices during that period. Additionally, as observed before, there are three estimates that are notably large; two are statistically significant and one is not. In all three cases, the point estimates are very similar to when only post-period differences were used: 0.0812 (significant at 10%-level, p-value = 0.065) for practice 204 during period five; -0.0541 (significant at 10%-level, p-value = 0.089) for 505 during period six; and -0.0839, the largest in magnitude (but not significant), for practice 603 in the final period. While these estimates suggest large differences between the groups for the periods they appear, overall the estimates for SrHMO patients continue to lack a pattern that seems consistent with a behavioral response from the PCPs for these patients that is related to the treatment.

Columns [7] to [9] present estimates for HMO patients once controls for pre-period differences for each practice are included. Once again, there is a similar overall pattern, with a few, mostly subtle changes. The period four spike in referral share is still present for practice 101, being estimated at 0.1272 (significant at the 5%-level, p-value = 0.025), an effect size of 112% relative to the 0.114 control group benchmark. Except for one, all the other point estimates are not statistically significant, and most are a little bit smaller in magnitude. So, for practice 101, the estimates for periods five and six are smaller than in columns [2] and [3], though still above the pre-period level, and still reflecting the dissipation from the period four level. Practice 603 still has large, negative point estimates that are consistent with losing market share to practice 101. One of the cases where point estimates did not get smaller in magnitude, though, is practice 505, which shows negative estimates that are larger in magnitude than in columns [1] to [3], consistent with both 603 and 505 seeing some loss in referrals. The other noticeable difference for these results is practice 406, which has estimates that are positive and larger than before, especially the coefficient for period five, which at 0.1040 (significant at the 5%-level, p-value = 0.076) represents an effect of 91% (relative to the 0.114 benchmark). While it is possible that these estimates could be reflective of a true effect of the cost report treatment, the driver of their magnitude is not an increase in treatment group referrals during the post-period as much as a deficit during the pre-period, particularly during period one (as shown in Figure 6).

The last three columns of Table 6, columns [10] through [12], contain the results for SrHMO patients. The bulk of the point estimates are very similar to the estimates contained in columns [4] through [6], with only two differences of note. The first is that all three point estimates for practice 101 are negative, and the second is that the estimate for practice 505 in the last period is smaller in magnitude and not statistically significant as it was previously. These differences, though, do not change the overall apparent lack of a relationship with the cost report for SrHMO patient referrals.

6 Conclusion

This study reports the results of a field experiment that took place during 2014 in the medical offices of PCPs associated with the IPA. Subject PCPs, who were all internists or family practitioners, received a report listing the per-patient average cost for six busy ophthalmology practices that were part of the IPA network of specialist physicians. These costs varied not because of differences in per-procedure prices, but because of different treatment approaches used by the ophthalmologists. The costs were listed for two separate types of patients: HMO patients, who had HMO insurance coverage through private insurers, and SrHMO patients, who were part of the Medicare Advantage program. Since ophthalmologists were paid by the IPA for each procedure performed for HMO patients, but were paid flat rates that covered most services for SrHMOs, there were asymmetric financial incentives for the two patient types with respect to referrals. An HMO patient sent to a less expensive ophthalmologist translates to lower costs for the IPA, but the same for a SrHMO is likely to have little impact at all on IPA costs. This project, therefore, inspects the effect on both types of patients separately, allowing for differential responses by the PCPs.

Analyses of the data produced by the experimental intervention suggest that the PCP subjects responded to the cost report by changing their referral patterns in a dramatic way. In particular, for the case of HMO patients, the treatment group PCPs increased the share of their ophthalmology referrals they sent to the least expensive ophthalmology practice by more than double during the first two months after the distribution of the cost report. This increase faded over the following four months, but it did not entirely disappear, as referrals were still above the pre-period rate for that practice by a large amount (though estimates were not statistically significant at conventional levels). While there is some indication that the second least expensive practice received more referrals initially, the other, more expensive practices all generally received fewer or a similar amount of referrals after treatment. For SrHMO patients, on the other hand, there was generally little change in referral patterns. For those differences that are seen, there is seemingly no relationship with the ranking of ophthalmology practices on the cost report. Given the differential financial incentives facing the PCPs by patient type, this differential response is consistent with a behavioral model for the PCPs in which they were cognizant of, and concerned with, the cost impacts of their treatment decisions.

In one sense, this result is surprising given that it suggests that a large change in behavioral patterns was induced by a relatively low cost intervention. On the other hand, it is not so surprising given that the subjects had a financial incentive to reduce costs. Even though this incentive is a very indirect one and potentially small, it is definitely not zero. Moreover, the cost to the PCPs of reallocating referrals between network ophthalmologists is likely zero, so reallocating referrals in response to the cost report was likely close to an optimal choice for the PCPs. That is, given that the PCPs really only stood to gain by reallocating referrals, maybe the large response is not so surprising.

Another reason one might find the size of the results surprising is the nature of the delivery of the treatment via mail. In order for a treatment to be observed, the PCPs had to receive, open, read, understand, and remember the contents of the cost report – and any one of those steps could have failed, resulting in no treatment and, hence, no response. On the other hand, for several years before the intervention, the IPA had been emphasizing the importance of costs and the PCPs influence over them. So the subjects interest in the information contained in the cost report may have been higher than it ordinarily would have been in the absence of such preparation. Moreover, while it is true that the PCP had to obtain and digest the cost report before any response could be observed, at least the treatment was sent directly to the PCPs so that they did not need to seek it out on their own accord.

Lastly, the large observed responses belie an important weakness of this study: a relatively small sample size that resulted in estimates that were imprecise. Given the size of the IPA, the sample size for this project was as large as it could be, but a goal for future research could be to work with larger organizations, allowing for larger samples that could improve the precision of estimates. Stronger statements could then be made about the extent and persistence of responses. Other goals might be to explore what types of interventions result in more persistent changes, and to what extent repeated exposure affects responses.

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May 1, 2014

Dear Doctor,

As requested by our primary care physicians, we are continuing our efforts to share information on specialty costs by rendering physician. To that end, please find the included report on average costs per patient for IPA Ophthalmology practices. These costs are based on actual claims from encounters with patients who were newly referred to Ophthalmology, and who had their first encounters with Ophthalmologists during the twelve-month period from July 2012 through June 2013. All claims over the 180-day period following the first encounter were used in the calculations.

Since our goal was to produce a broad measure of cost, we calculated the averages using claims for patients across a range of diagnoses. However, in order to increase the comparability of the averages, we only used diagnoses that were common across practices, and adjusted diagnosis proportions to reflect IPA-wide prevalence instead of individual practice level prevalence. As a result, for the patients included in this analysis, cataract diagnoses were the most common, occurring roughly 50% of the time. Since cataract conditions are relatively costly to treat, these patients accounted for almost 71% of the average costs reported.

Lastly, to further improve comparability, only practices that saw more than 300 newly referred patients and had patient satisfaction scores above 80% were included.

Sincerely,

Chief Executive Officer

Figure 1: Cover Letter for Ophthalmologist Cost Report

Average 180-Day Cost for Newly Referred Patients to Ophthalmology

For patients with first encounters with Ophthalmology during the twelve-month period from July 2012 through June 2013

Practice / Physician Name	HMO Patients	SrHMO Patients
101	$147	$450
204	$215	$502
302	$230	$456
406	$270	$575
505	$292	$561
603	$333	$470

Notes:

(1) Ophthalmology is paid fee-for-service for HMO patients. For SrHMO patients, approximately 75% of procedure codes are capitated, with the rest being fee-for-service. Costs for capitated codes are based on the Medicare fee schedule for claims submitted.

(2) Averages have been adjusted for observable differences in the underlying health of specialist patient populations, and rounded to the nearest dollar.

(3) Newly referred patients are those that had not had a claim in Ophthalmology for the previous 180-days and were referred to Ophthalmology by an internist or FP during the previous 180-days.

(4) Ophthalmology practices included on this report all had at least 300 newly referred patients, had patient satisfaction scores for all practice ophthalmologists exceeding 80%.

Figure 2: Ophthalmologist Cost Report

Table 1: Characteristics of ophthalmology practices

	Pre-Period Summary Statistics					
	Total Referrals Received		Average Share of PCP Referrals		Average Cost (as Reported to PCPs)	
Practice ID	Count	Share of All Referrals	HMO Patients	SrHMO Patients	HMO Patients	SrHMO Patients
101	346	10.9%	0.0793	0.1073	147	450
204	228	7.2%	0.0553	0.0544	215	502
302	463	14.6%	0.1187	0.1055	230	456
406	546	17.2%	0.1686	0.1560	270	575
505	181	5.7%	0.0404	0.0473	292	561
603	400	12.6%	0.1809	0.1654	333	470
Cost report practices	2,164	68.2%	0.1072	0.1060	–	–
All others	1,007	31.8%	0.3568	0.3640	–	–
All ophthamologists	3,171	100%	–	–	–	–

Table 2: Comparison of pre-period observables

	Group Mean			
Variable	Control	Treated	t-stat	p-value
Internal Medicine Practice	0.519	0.357	1.2	0.235
Total HMO referrals per-PCP all-practice median	0.556	0.571	-0.12	0.908
Total SrHMO referrals per-PCP all-practice median	0.556	0.5	0.406	0.687
Total referrals per-PCP (all types)	342.5	315.9	0.629	0.532
Total ophthalmology referrals per-PCP	34.3	31.59	0.645	0.522
Total ophthalmology HMO referrals per-PCP	11.32	11.7	-0.23	0.816
Total ophthalmology SrHMO referrals per-PCP	22.98	19.89	0.928	0.358
Total practice referrals (all types)	570.9	608.8	-0.27	0.792
Total practice ophthalmology referrals	55.78	59.46	-0.28	0.779
Total practice HMO ophthalmology referrals	18.56	21.68	-0.61	0.545
Total practice SrHMO ophthalmology referrals	37.22	37.79	-0.06	0.949
PCPs share of referrals that are male patients	0.417	0.42	-0.11	0.914
PCPs share of referrals that are patients 60 or older	0.609	0.574	0.932	0.355
PCPs share of referrals that are patients ages 40 to 59	0.281	0.301	-0.79	0.435
PCPs share of referrals that are patients ages 18 to 39	0.11	0.125	-0.95	0.345

Table 3: Practice size distribution by treatment status

Number of PCPs in practice	Control Group	Treatment Group	Any Treatment Status
1	16 59.26%	17 60.71%	33 60.00%
2	7 25.93%	4 14.29%	11 20.00%
3	3 11.11%	5 17.86%	8 14.55%
4	1 3.70%	1 3.57%	2 3.64%
6	0 0.00%	1 3.57%	1 1.82%
All Practice Sizes	27 100.00%	28 100.00%	55 100.00%

Percentages are relative to column totals. Pearson's chi-square statistic equals 2.3311 and P-value equals 0.675.

Table 4: Experimental results: dependent variable sample averages

	Group		
	Control	Treatment	Both
Only HMO referrals			
Pre-period	0.108	0.107	0.107
Post-period	0.114	0.108	0.111
Both	0.111	0.108	0.109
Only SrHMO referrals			
Pre-period	0.103	0.109	0.106
Post-period	0.106	0.108	0.107
Both	0.104	0.108	0.107

Observation counts are 168 for the treatment group (28 PCP practices times 6 ophthalmology practices) and 162 for the control group (27 times 6) and are both the same in pre- and post-periods.

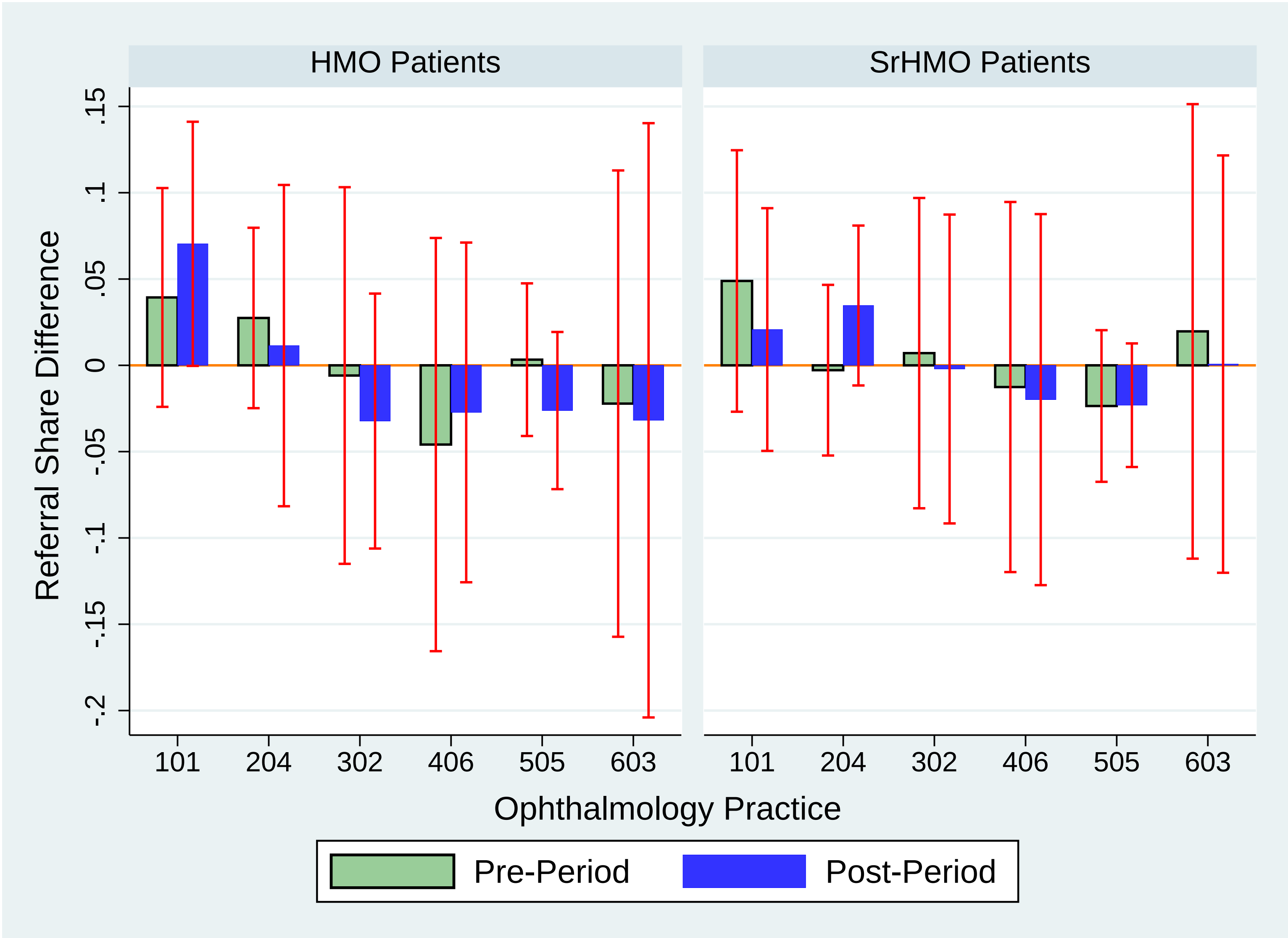

Figure 3: Difference in mean referral share between groups (treatment minus control) using data measured over six-month periods. 95% confidence intervals represented by red lines. The pre- and post-periods took place from Nov. 2013 to Apr. 2014 and May 16th to November 15th, 2014, respectively. See Appendix Table B.9 for detailed calculations underlying these plots.

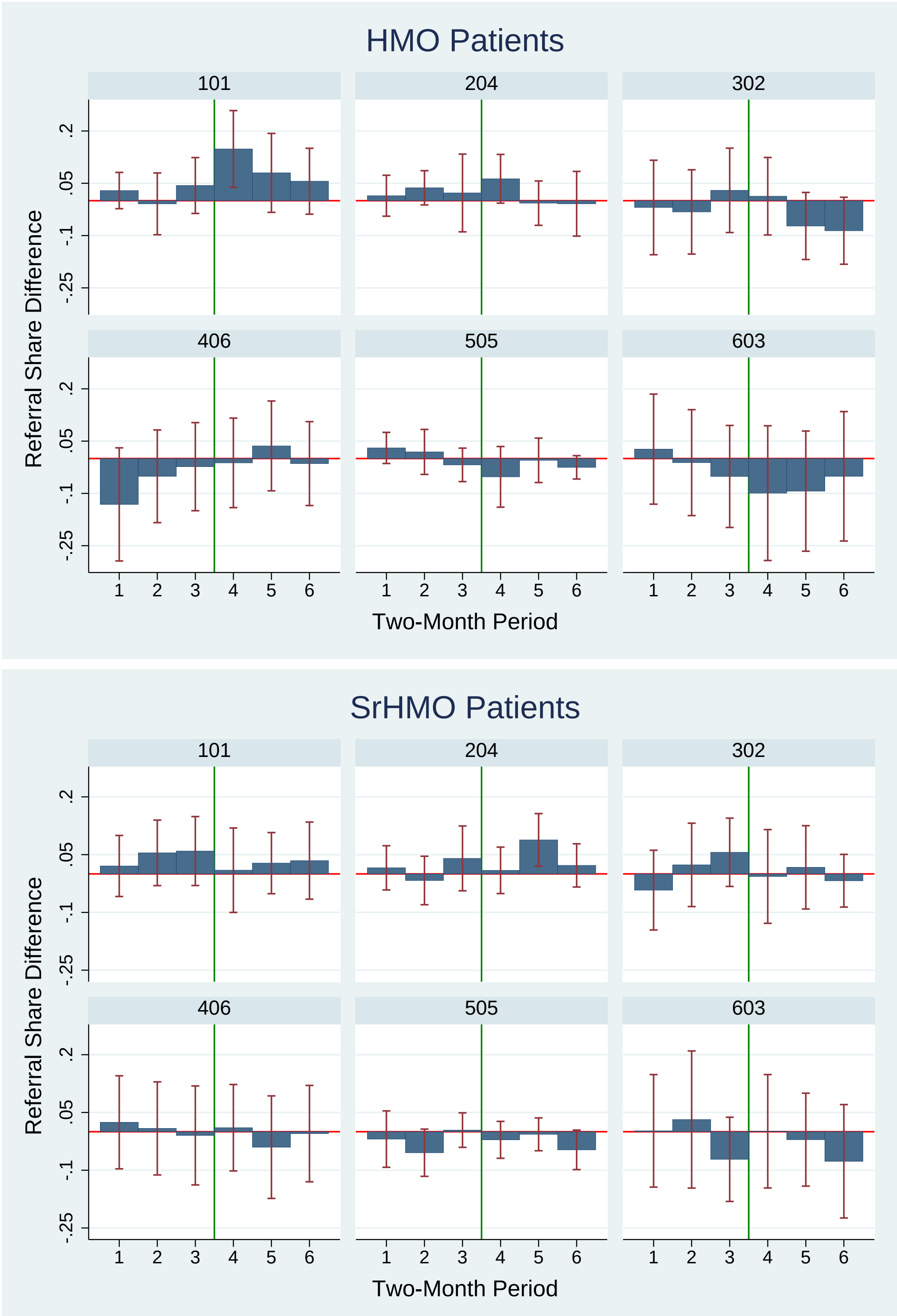

Figure 4: Difference in mean referral share between groups (treatment minus control) using data measured over two-month periods. 95% confidence intervals are represented by red lines. The green vertical lines divide the pre- and post-periods (Nov. 2013 to Apr. 2014 and May 16th to Nov. 15th, 2014, respectively). See Appendix Tables B.10 and B.11 for detailed calculations underlying these plots.

Table 5: Effect of treatment on referral share after controling for pre-period group differences
Referral shares measured over six-month periods

	Referral Patient Type			
Ophthalmology Practice	HMO	SrHMO	HMO	SrHMO
	[1]	[2]	[3]	[4]
101	0.0711**	0.0146	0.0311	-0.0281
	(0.033)	(0.033)	(0.038)	(0.029)
	[0.036]	[0.662]	[0.415]	[0.329]
204	0.0121	0.0285	-0.0160	0.0375**
	(0.055)	(0.031)	(0.047)	(0.017)
	[0.826]	[0.356]	[0.732]	[0.029]
302	-0.0316	-0.0082	-0.0264	-0.0092
	(0.038)	(0.046)	(0.033)	(0.027)
	[0.413]	[0.859]	[0.422]	[0.732]
406	-0.0266	-0.0260	0.0186	-0.0073
	(0.047)	(0.048)	(0.035)	(0.027)
	[0.570]	[0.592]	[0.595]	[0.789]
505	-0.0255	-0.0292	-0.0295	0.0005
	(0.030)	(0.026)	(0.019)	(0.015)
	[0.395]	[0.266]	[0.136]	[0.975]
603	-0.0312	-0.0054	-0.0097	-0.0189
	(0.081)	(0.056)	(0.068)	(0.033)
	[0.702]	[0.923]	[0.887]	[0.570]
F-test of joint significance	[0.1493]	[0.1978]	[0.7163]	[0.0921]*
Pre-period control type				
Diff btw treat & control grp means	X	X		
Treat/control diff within oph practs			X	X

Statistical significance for two-sided t-tests indicated by *=p<0.1, **=p<0.05, and ***=p<0.01. Each column presents results from a separate regression, each on the same 660 observations. Standard errors are adjusted for within-PCP-practice clustering and presented in parentheses, while p-values for two-sided tests are given in brackets.

Table 6: Effect of treatment on referral share after controling for pre-period group differences
Referral shares measured over two-month periods. Each set of three columns presents one regression model.

Oph.	HMO Patients (N=1,872)			SrHMO Patients (N=1,914)			HMO Patients (N=1,872)			SrHMO Patients (N=1,914)		
Pract.	t=4	t=5	t=6	t=4	t=5	t=6	t=4	t=5	t=6	t=4	t=5	t=6
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
101	0.1537***	0.0851	0.0612	0.0026	0.0209	0.0274	0.1272**	0.0586	0.0346	-0.0351	-0.0168	-0.0103
	(0.054)	(0.055)	(0.046)	(0.054)	(0.036)	(0.050)	(0.055)	(0.053)	(0.044)	(0.050)	(0.028)	(0.043)
	[0.006]	[0.127]	[0.191]	[0.962]	[0.569]	[0.584]	[0.025]	[0.273]	[0.432]	[0.484]	[0.545]	[0.814]
204	0.0681*	-0.0017	-0.0034	0.0022	0.0812*	0.0150	0.0388	-0.0310	-0.0327	-0.0034	0.0756**	0.0094
	(0.040)	(0.039)	(0.053)	(0.035)	(0.043)	(0.036)	(0.029)	(0.039)	(0.051)	(0.017)	(0.035)	(0.030)
	[0.095]	[0.966]	[0.949]	[0.950]	[0.065]	[0.679]	[0.192]	[0.429]	[0.520]	[0.843]	[0.035]	[0.752]
302	0.0182	-0.0673	-0.0808	-0.0137	0.0100	-0.0248	0.0199	-0.0655	-0.0791	-0.0191	0.0045	-0.0302
	(0.057)	(0.050)	(0.051)	(0.062)	(0.055)	(0.037)	(0.044)	(0.051)	(0.051)	(0.039)	(0.032)	(0.035)
	[0.749]	[0.181]	[0.120]	[0.827]	[0.856]	[0.505]	[0.656]	[0.200]	[0.128]	[0.628]	[0.887]	[0.386]
406	-0.0072	0.0414	-0.0092	0.0033	-0.0472	-0.0120	0.0554	0.1040*	0.0534	0.0027	-0.0478	-0.0126
	(0.062)	(0.063)	(0.060)	(0.052)	(0.062)	(0.058)	(0.059)	(0.058)	(0.048)	(0.037)	(0.038)	(0.039)
	[0.908]	[0.511]	[0.878]	[0.951]	[0.448]	[0.839]	[0.349]	[0.076]	[0.275]	[0.943]	[0.215]	[0.746]
505	-0.0473	0.0001	-0.0200	-0.0281	-0.0138	-0.0541*	-0.0627	-0.0152	-0.0354	0.0023	0.0166	-0.0236
	(0.050)	(0.037)	(0.025)	(0.031)	(0.029)	(0.031)	(0.038)	(0.019)	(0.023)	(0.015)	(0.021)	(0.030)
	[0.347]	[0.997]	[0.418]	[0.367]	[0.636]	[0.089]	[0.105]	[0.430]	[0.127]	[0.878]	[0.442]	[0.435]
603	-0.0940	-0.0882	-0.0457	-0.0058	-0.0277	-0.0839	-0.0872	-0.0814	-0.0389	0.0130	-0.0088	-0.0650
	(0.092)	(0.081)	(0.088)	(0.071)	(0.056)	(0.069)	(0.081)	(0.068)	(0.071)	(0.050)	(0.033)	(0.044)
	[0.312]	[0.280]	[0.606]	[0.934]	[0.624]	[0.229]	[0.284]	[0.238]	[0.584]	[0.794]	[0.792]	[0.144]
	Pre-period control: diff btw treat & control grp means						*Pre-period controls: treat/control diff within oph practs*					

Each model also includes a dummy variable for each time period. Statistical significance for two-sided t-tests indicated by *=p<0.1, **=p<0.05, and ***=p<0.01. Standard errors are adjusted for within-PCP-practice clustering and presented in parentheses, while p-values for two-sided tests are given in brackets.

Appendix A Statistical comparison at time of randomization

When randomization of PCP practices between treatment and control groups occured in April 2014, it was performed with stratification based on data from the latest six-month-period available, August 2013 through January 2014. Appendix Table A.7 presents comparison statistics at the PCP-practice level for that period, while Appendix Table A.8 contains summary statistics at the individual-PCP level.

Appendix Table A.7: PCP-practice-level summary statistics using data available at time of randomization
Based on referrals and claims for August 2013 through January 2014

	Sample Averages			
	Control Group	Treatment Group	T-statistic	P-value
Internal Medicine Practice	0.5185	0.3571	1.2003	0.2354
Total SrHMO claims per-PCP ≥ all-practice median	0.5556	0.4643	0.6672	0.5075
Total HMO claims per-PCP ≥ all-practice median	0.5185	0.5000	0.1348	0.8932
Number of claims per-PCP	707.9877	629.1250	1.0352	0.3053
Number of HMO claims per-PCP	380.1574	365.5565	0.2581	0.7974
Number of SrHMO claims per-PCP	327.8302	263.5685	1.5898	0.1178
Total SrHMO referrals per-PCP ≥ all-practice median	0.5185	0.5714	-0.3873	0.7001
Total HMO referrals per-PCP ≥ all-practice median	0.5185	0.6071	-0.6530	0.5166
Total referrals per-PCP (all types)	335.1759	301.4583	0.8553	0.3962
Total practice SrHMO ophthalmology referrals	34.5185	34.0357	0.0615	0.9512
Total practice HMO ophthalmology referrals	17.4444	20.4286	-0.6053	0.5476
Total practice ophthalmology referrals	51.9630	54.4643	-0.2099	0.8345
PCP's share of referrals that are male patients	0.4194	0.4109	0.2813	0.7795
PCP's share of referrals that are patients 60 or older	0.5886	0.5593	0.7675	0.4462
PCP's share of referrals that are patients ages 40 to 59	0.2927	0.3056	-0.5273	0.6002
PCP's share of referrals that are patients ages 18 to 39	0.1187	0.1352	-0.9423	0.3503

The sample includes 55 primary care physician practices total: 27 in the control group and 28 in the treatment group. T-statistic calculation assumes equal variances. P-value is for the two-sided test that there is no difference in means. Calculated using all IPA claims and referrals data for the six-month period from August 2013 through January 2014.

Appendix Table A.8: Individual-PCP-level summary statistics using data available at time of randomization
Based on referrals and claims for August 2013 through January 2014

	Sample Averages			
	Control Group	Treatment Group	T-statistic	P-value
Total referrals (all types)	347.3488	322.6600	0.7827	0.4358
Total SrHMO ophthalmology referrals	21.6744	19.0600	0.9639	0.3376
Total HMO ophthalmology referrals	10.9535	11.4400	-0.3736	0.7096
Total ophthalmology referrals	32.6279	30.5000	0.6483	0.5184
Total claims	724.7907	657.0400	1.0507	0.2962
Total HMO claims	396.8372	374.0000	0.4840	0.6295
Total SrHMO claims	327.9535	283.0400	1.2367	0.2194
Internal Medicine Specialty	0.4186	0.3400	0.7742	0.4408
Share of referrals that are male patients	0.4156	0.4034	0.4072	0.6848
Share of referrals that are patients 60 or older	0.5736	0.5665	0.2218	0.8249
Share of referrals that are patients ages 40 to 59	0.2950	0.3037	-0.4602	0.6465
Share of referrals that are patients ages 18 to 39	0.1315	0.1297	0.1105	0.9122

The sample includes 93 PCPs total: 43 in the control group and 50 in the treatment group. PCPs took their assignments from those of their practices. T-statistic calculation assumes equal variances. P-value is for the two-sided test that there is no difference in means. Calculated using all IPA claims and referrals data for the six-month period from August 2013 through January 2014.

Appendix B Detailed Means Tables

Appendix Table B.9: Mean referral shares, by group, ophthalmology practice, and period
Referral shares measured over six-month periods

		Treatment Group			Control Group			Group Difference	
Oph.Pract.	Period	Mean	Std.Err.	N	Mean	Std.Err.	N	=[3]-[6]	Std.Err.
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Panel A: HMO Patients									
101	Pre	.09864	.02594	28	.05931	.01898	27	.03933	.03234
101	Post	.1304	.03048	28	.06002	.01873	27	.0704	.03609
204	Pre	.0688	.02028	28	.04135	.01718	27	.02745	.02667
204	Post	.0758	.02899	28	.06436	.03789	27	.01144	.04749
302	Pre	.1159	.03543	28	.1217	.04317	27	-.005893	.05567
302	Post	.07835	.02263	28	.1106	.03037	27	-.03228	.03768
406	Pre	.146	.04117	28	.1919	.04523	27	-.0459	.06107
406	Post	.1202	.03086	28	.1474	.03988	27	-.02728	.05021
505	Pre	.04199	.01814	28	.03871	.01319	27	.003284	.02256
505	Post	.0236	.01291	28	.04979	.01951	27	-.0262	.02323
603	Pre	.17	.04788	28	.1922	.0496	27	-.02218	.06892
603	Post	.2218	.05826	28	.2536	.06596	27	-.03185	.08784
Panel B: SrHMO Patients									
101	Pre	.1313	.03053	28	.08246	.02337	27	.04888	.03865
101	Post	.1158	.02518	28	.09501	.02554	27	.02074	.03587
204	Pre	.05301	.01872	28	.05583	.01682	27	-.002813	.02522
204	Post	.07492	.0209	28	.04026	.01043	27	.03466	.02363
302	Pre	.109	.03642	28	.1019	.02747	27	.007077	.04587
302	Post	.1078	.03022	28	.1099	.03433	27	-.002118	.04565
406	Pre	.1499	.04042	28	.1624	.03667	27	-.01257	.0547
406	Post	.1548	.03763	28	.1746	.03995	27	-.01988	.05484
505	Pre	.03571	.0166	28	.05927	.01498	27	-.02356	.02241
505	Post	.03248	.0103	28	.05558	.01523	27	-.0231	.01826
603	Pre	.1751	.04943	28	.1554	.04529	27	.01967	.06718
603	Post	.1618	.03832	28	.1611	.04865	27	.0007271	.06168

Calculation of standard errors for difference of group means assumes equal variances between groups.

Appendix Table B.10: Mean referral shares , by group, ophthalmology practice, and period HMO patients only. Referral shares measured over two-month periods

		Treatment Group			Control Group			Group Difference	
Oph.Pract.	Period	Mean	Std.Err.	N	Mean	Std.Err.	N	=[3]-[6]	Std.Err.
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
101	1 - Pre	.07372	.02062	27	.04455	.01653	26	.02917	.02655
101	2 - Pre	.07675	.02938	27	.08572	.03453	26	-.008972	.04521
101	3 - Pre	.1003	.03432	27	.05675	.02218	27	.04358	.04086
101	4 - Post	.1962	.04993	26	.04775	.0256	26	.1485	.05611
101	5 - Post	.1369	.05094	24	.05706	.0272	24	.07987	.05774
101	6 - Post	.1244	.04362	26	.06855	.02063	26	.05589	.04825
204	1 - Pre	.0537	.02258	27	.03939	.01956	26	.01431	.02997
204	2 - Pre	.05293	.02228	27	.01589	.01076	26	.03704	.02505
204	3 - Pre	.1032	.04323	27	.08098	.03696	27	.02224	.05688
204	4 - Post	.07882	.03421	26	.01595	.01009	26	.06287	.03567
204	5 - Post	.03726	.02296	24	.04421	.02293	24	-.006958	.03245
204	6 - Post	.05487	.02588	26	.06357	.03966	26	-.008695	.04736
302	1 - Pre	.1051	.0432	27	.1245	.05436	26	-.01941	.06916
302	2 - Pre	.1129	.03713	27	.1451	.04967	26	-.03213	.0617
302	3 - Pre	.1288	.04725	27	.09911	.03977	27	.02969	.06176
302	4 - Post	.1126	.03876	26	.09968	.04142	26	.01291	.05672
302	5 - Post	.05705	.0257	24	.1296	.04182	24	-.07251	.04908
302	6 - Post	.03275	.02094	26	.1188	.04434	26	-.0861	.04904
406	1 - Pre	.1488	.05106	27	.2803	.0656	26	-.1316	.08276
406	2 - Pre	.1478	.04264	27	.1988	.05311	26	-.05092	.06784
406	3 - Pre	.1252	.04397	27	.1485	.04711	27	-.02333	.06445
406	4 - Post	.1219	.03782	26	.1344	.05344	26	-.01246	.06547
406	5 - Post	.1458	.0519	24	.1096	.04031	24	.03615	.06571
406	6 - Post	.1433	.04484	26	.1578	.04193	26	-.01444	.06139
505	1 - Pre	.03646	.02156	27	.006073	.006073	26	.03039	.02277
505	2 - Pre	.05882	.02786	27	.03986	.01701	26	.01895	.03294
505	3 - Pre	.03281	.01685	27	.05097	.01778	27	-.01816	.0245
505	4 - Post	.03237	.02036	26	.08493	.03946	26	-.05256	.04441
505	5 - Post	.03527	.02806	24	.04039	.01642	24	-.005116	.03251
505	6 - Post	.01169	.006882	26	.03697	.01565	26	-.02528	.0171
603	1 - Pre	.1901	.06096	27	.1631	.05221	26	.02695	.08053
603	2 - Pre	.1911	.05482	27	.2028	.05475	26	-.01171	.0775
603	3 - Pre	.128	.04958	27	.1794	.05581	27	-.05141	.07465
603	4 - Post	.1687	.06128	26	.2679	.0772	26	-.09928	.09857
603	5 - Post	.1697	.05201	24	.2632	.07094	24	-.09346	.08796
603	6 - Post	.2291	.06034	26	.2801	.07305	26	-.05099	.09475

Calculation of standard errors for difference of group means assumes equal variances between groups.

Appendix Table B.11: Mean referral shares , by group, ophthalmology practice, and period SrHMO patients only. Referral shares measured over two-month periods

		Treatment Group			Control Group			Group Difference	
Oph.Pract.	Period	Mean	Std.Err.	N	Mean	Std.Err.	N	=[3]-[6]	Std.Err.
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
101	1 - Pre	.09786	.03322	26	.0773	.02351	27	.02056	.04045
101	2 - Pre	.1255	.03486	27	.07092	.02585	27	.0546	.0434
101	3 - Pre	.157	.03524	26	.0976	.02928	27	.05936	.04567
101	4 - Post	.102	.029	28	.09232	.04899	26	.009627	.05596
101	5 - Post	.1155	.03089	25	.08758	.02635	26	.02795	.04049
101	6 - Post	.1257	.04251	27	.09127	.02831	27	.03447	.05107
204	1 - Pre	.06417	.02531	26	.04838	.01522	27	.0158	.02928
204	2 - Pre	.04387	.01966	27	.06095	.02538	27	-.01708	.03211
204	3 - Pre	.08836	.03981	26	.04806	.01752	27	.0403	.04294
204	4 - Post	.06432	.02635	28	.05508	.0146	26	.009238	.03076
204	5 - Post	.1166	.03332	25	.02833	.01201	26	.08825	.03488
204	6 - Post	.06285	.02378	27	.04078	.01599	27	.02208	.02865
302	1 - Pre	.09102	.0371	26	.1332	.03758	27	-.04219	.05284
302	2 - Pre	.1228	.04319	27	.0994	.03441	27	.02344	.05522
302	3 - Pre	.1249	.04044	26	.06882	.02138	27	.0561	.04527
302	4 - Post	.1271	.03727	28	.1337	.05044	26	-.006609	.06211
302	5 - Post	.1298	.04372	25	.1128	.03413	26	.01702	.05522
302	6 - Post	.06859	.02055	27	.08635	.02822	27	-.01776	.03491
406	1 - Pre	.158	.04726	26	.1336	.0399	27	.02442	.06167
406	2 - Pre	.1536	.04462	27	.1451	.04253	27	.008572	.06164
406	3 - Pre	.1515	.05263	26	.1612	.03961	27	-.009702	.06554
406	4 - Post	.1555	.04098	28	.1452	.03981	26	.01032	.05728
406	5 - Post	.139	.0457	25	.1792	.05007	26	-.04014	.06794
406	6 - Post	.1628	.04442	27	.1677	.04586	27	-.004923	.06384
505	1 - Pre	.05174	.02237	26	.07093	.02965	27	-.01919	.03735
505	2 - Pre	.03284	.01584	27	.08745	.02701	27	-.05461	.03131
505	3 - Pre	.03315	.02047	26	.02898	.01072	27	.004172	.02286
505	4 - Post	.03472	.01479	28	.05579	.01976	26	-.02107	.02445
505	5 - Post	.03304	.01662	25	.03978	.01416	26	-.006741	.02178
505	6 - Post	.02988	.01447	27	.07691	.02184	27	-.04703	.0262
603	1 - Pre	.1373	.05514	26	.1351	.05036	27	.002267	.07457
603	2 - Pre	.2197	.06469	27	.188	.06378	27	.03169	.09085
603	3 - Pre	.09598	.03163	26	.1677	.04548	27	-.07172	.05579
603	4 - Post	.1668	.04854	28	.1655	.05782	26	.001224	.07511
603	5 - Post	.1265	.03717	25	.1472	.04866	26	-.02065	.06157
603	6 - Post	.14	.03865	27	.2168	.06444	27	-.07685	.07515

Calculation of standard errors for difference of group means assumes equal variances between groups.