The Influence of New Medications on Prescribing Behavior by Practice Type: A Regression Analysis

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Abstract – The Influence of New Medications on Prescribing Behavior by Practice Type: A Regression Analysis by Rita M. Pattarini

Objective: To determine whether the type of practice to which physicians belong influences the types of medications they prescribe

Methods: The study used data from the National Ambulatory Medical Care Survey (NAMCS) to conduct a series of regressions for two pairs of medications. The first pair was for the treatment of high cholesterol. Advicor was the new medication and Lovastatin was the competitor. The second pair was for the treatment of arthritis. Humira was the new medication and Remicade was the competitor. For each pair, there were two sets of regressions that consisted of an unrestricted regression with all patients in the sample and a restricted regression limited to recipients of the two medications.

Results: The results of the study showed solo physicians were more likely to prescribe Advicor over Lovastatin, but less likely to prescribe Humira over Remicade.

Conclusions: The study suggests there is a difference present in the prescriptions written in solo versus group physicians and additional factors dealing with the specific drug must determine the direction of this difference.
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Introduction

This study explores whether the type of practice to which physicians belong influences the types of medications they prescribe. The type of practice is defined here as a solo practice or a group practice. A group practice consists of two or more physicians, with HMOs eliminated for consistency. In particular, I hypothesize that solo practice doctors might be less likely than group practice doctors to adopt new medications because, as owners, they face greater workloads and administrative burdens and are less exposed to peer consultation. The estimates presented in this paper can help to provide patients and health care professionals with information about how the choice of one doctor or another can affect treatment.

There is consistent agreement in the literature regarding the general benefits and consequences of solo and group practices. Solo practitioners lack peer consultation and ease of information sharing. Solo physicians report severe job constraints such as a heavy workload, out of hours calls, and administrative burden. Administrative issues have become too extensive to handle without staff assistance and multiple physicians. Group practice can help alleviate these disadvantages, but solo practice physicians most frequently cite difficulty with cooperation and autonomy as a barrier to joining a large medical group. Group practice also entails constant scrutiny, stricter adherence to quality and procedure, a sacrifice of professional status and a decreased possibility of earning a high income. Interestingly, a 2000 study did report that the time pressure ratio was the lowest with solo practitioners when compared with groups. Solo practitioners also seemed to spend the least amount of time stressed.

To analyze the effect of the type of practice on the types of medications prescribed, the data for this study was taken from the National Ambulatory Medical Care Survey (NAMCS). I selected two pairs of prescription for my analysis: Lovastatin and Advicor (the “new”
The results of the study showed there was a non-significant effect of the two conditions on solo and group practice behavior. There was a positive effect for Advicor after the approval date, indicating solo physicians were more likely to prescribe Advicor over Lovastatin. Interestingly, there was a negative effect for Humira after the approval date, indicating solo physicians were less likely to prescribe Humira over Remicade. The study suggests there is a measurable difference present in the prescribing behavior of solo versus group physicians when a new medication enters the market. However, additional factors special to the specific drug must determine the direction of this effect. One possible explanation for the discrepancy is Advicor incorporates Lovastatin plus a second drug together and purchasing one medication is cheaper than purchasing two separate ones.

The paper will progress in the following manner. The key institutional factors will discuss necessary basic facts concerning solo practice, group practice, and the medications involved in the study. Then there is a description of the dataset and some descriptive results. The next section is a presentation of the model followed by the results of the study. Lastly, the paper finishes with some concluding thoughts. The preliminary graphs are in the Figures section in the ‘Appendices’ at the end of the paper, followed by a descriptive table and regressions.

**Key Institutional Factors**

**Solo vs. Group Practice**

A discussion of group and solo practices is highly relevant. The latest data made available by the Bureau of Labor Statistics reports approximately 12% of physicians and surgeons were self-employed. An important voice for medical group practices since its conception in 1926, the Medical Group Management Association (MGMA) defines a group
drug to combine Lovastatin with Niacin into a single oral drug for lowering cholesterol. It is the same medication, but it is new in that it allows patients to only buy one prescription instead of two.\textsuperscript{15} Advicor was approved by the FDA in 2001 and appears in the sample in 2002.

The second pair of drugs includes Humira (adalimumab) and its predecessor Remicade (infliximab), both prescriptions for rheumatoid arthritis. A 2007 study in the American Journal of Medicine cited that an estimated 25 men and 54 women per 100,000 in the population are afflicted with rheumatoid arthritis, making it the most common inflammatory arthritis. The article also included a statistic stating it was responsible for 250,000 hospitalizations and 9 million physician visits in the U.S. each year.\textsuperscript{16} The National Institute of Arthritis and Musculoskeletal and Skin Diseases publishes a handout that claims 1.3 million adults, or 0.6\% of the U.S. population, suffer from rheumatoid arthritis. This number is low when compared to previous estimates due to a recent re-defining of the condition, but still encompasses over 1 million people.\textsuperscript{17}

Both Humira and Remicade are medications known as TNF-alpha blockers. TNF-alpha is a protein that can cause pain and inflammation as well as severe joint damage.\textsuperscript{18} The FDA approved Remicade, the second TNF inhibitor, in 1999. The drug uses a combination of human and mouse proteins to create a monoclonal antibody. Humira is different because it is the first fully human monoclonal antibody.\textsuperscript{16} The other important difference between Humira and Remicade deals with administration of the drug. Humira is self-administered as a biweekly subcutaneous injection whereas Remicade is an intravenous infusion only provided in the physician's office.\textsuperscript{19} The first instance of Humira in the sample is in 2005 indicating a possible sample error as the FDA approved it a few years earlier. This discrepancy in time period is most
Descriptive Results

The preliminary charts and graphs reveal a few interesting points about the sample. Figure 1 shows a graph for each pair of drugs; panel A shows the numbers of prescriptions of the cholesterol drugs, Advicor and Lovastatin, by year, and panel B shows the numbers of prescriptions of Humira and Remicade, the arthritis drugs, by year. The dashed line represents the new medication in both panels and the solid line represents the older competitor. Both y-axes are weighted to represent the national estimate. The x-axis for the Humira and Remicade graph begins with the year 2000 due to the availability of data in the sample.

Panel A shows the introduction of Advicor to the sample in 2002 and illustrates how vastly popular Lovastatin was, even after the introduction of Advicor. There is a sharp and mostly continuous increase in Lovastatin starting in 2002 that peaks at over 5,000,000 annual prescriptions. There is also a steady upward trend in Advicor, but at a slower rate than Lovastatin. In Panel B of Figure 1, there is an observable drop in prescriptions for Humira in 2006 that is most likely the result of a problem with the sample. Unlike Humira's jagged increase, Remicade steadily increases to around 900,000 annual prescriptions with the exception of one drop from 550,000 to 200,000 annual prescriptions in 2002 to 2003.

Figure 2 shows the number of prescriptions that were written in solo or group practices, clinics or urgicenters, health or mental health centers, family planning clinics, HMOs, and other practice types. Figure 2 is divided into two panels: panel A shows the prescriptions written for Lovastatin vs. Advicor and panel B shows the prescriptions written for Remicade vs. Humira. Both panels are organized in a horizontal bar graph with the darker bar representing the newer medication. The x-axis was weighted to represent the national estimate.
written in a solo practice. While Lovastatin is the largest in the sample, the prescriptions written for Advicor, Remicade, and Humira were similar in number and estimated at between around 500,000 and 2,000,000. Even Humira with the fewest prescriptions had a sample size of hundreds of thousands of prescriptions over the years based on the y-axis scale of 2,000,000.

Figure 5 is a series of four panels that shows the number of solo and non-solo practices in the sample that prescribed the medications each year. Panel A is a graph illustrating the breakdown of solo and non-solo practices prescribing Lovastatin; panel B is a similar graph for Advicor; likewise, panel C depicts Remicade and panel D, the final graph, depicts the practices prescribing Humira. In each panel, the dashed line represents the solo practice. Unlike the previous figures, Figure 5 is a pure description of the sample itself without weights.

Panel A (Lovastatin) shows an upward trend similar to the number of total annual prescriptions in Figure 1. Panel B (Advicor) and panel D (Humira) show non-solo practices as significantly more prevalent in the sample. Panel B shows a two-tiered increase in non-solo practices with a slight dip between 2003 and 2005. The number of solo practices increases dramatically in 2003, but then sees a steady decline from 2004 onward. Panel D shows a sharp increase in solo practices starting in 2006 and a more jagged increase in non-solo practices beginning in 2004. Although panel C (Remicade) has higher values for non-solo practices, they track annually in a similar pattern to the solo practice values indicating tandem growth with the exception of a sharp jump in 2002 for solo practices.

The descriptive characteristics table [Table 1] contains sample means for solo versus non-solo practices with corresponding t-values in the far right column. The standard errors are located in parentheses beneath the sample means. Each variable represents a descriptor of the physician or the patient that is relevant to the regressions. The variables are divided into six
the employment status of the physician into account and indicates owner, employee, or contractor.

To accomplish the goals of the study, I will be utilizing the following linear structural model:

\[
\text{Prescription}_{it} = \beta_0 + \beta_1 \text{SOLO}_{it} + \beta_2 \text{SOLO}_{it} \cdot I\{\text{YEAR}_{it} \geq 2002\} + \beta_3 I\{\text{YEAR}_{it} \geq 2002\} + \mu \cdot \text{xit} + \epsilon
\]

For each set, this model is used twice. The binary dependent variable for the first regression set is a prescription for either drug in the set, given whether the patient visited a solo or group practice in a certain year (SOLO\(_{it}\)), whether a patient visited a solo practice after the new medication was available (SOLO\(_{it}\) \cdot I\{\text{YEAR}_{it} \geq 2002\})), whether the year was post-introduction of the new medication (I\{\text{YEAR}_{it} \geq 2002\}), and a set of controls that accounted for various patient and physician characteristics (\(\mu \cdot \text{xit}\)). For Prescription\(_{it}\), a one represented receiving either of the two medications and a zero represented all other outcomes. Likewise, SOLO\(_{it}\) and SOLO\(_{it}\) \cdot I\{\text{YEAR}_{it} \geq 2002\} are binaries with a one assigned for solo practice and a zero assigned for group practice. Using this model, I will be able to take prescription outcomes and isolate its correlation with physician practice type, while controlling for other factors. The second regression set follows the same model except the binary dependent variable is whether a prescription was written for the new or old medication. In this case, the new medication was assigned a one and the old medication was assigned a zero. A patient weight was used to expand the data to a national estimate.
medications. It further indicates additional controls did not heavily impact the regression and so the possibility that an unknown control may drastically sway these results is minimized.

Table 3 restricts the same to cases in which Lovastatin or Advicor was prescribed, and the binary dependent variable is an indicator for whether the newer drug (Advicor) was the one prescribed. A one indicated Advicor and a zero was assigned to Lovastatin. Similar to Table 2, each column shows results from a different ordinary least squares (linear probability model) regression. The columns add controls progressively in the same manner as Table 2.

Table 3 showed some significant indicators. The solo variable for the years after 2002 gradually increased from 0.088 in column (1) to .197 in column (7), illustrating an increasing effect with additional controls. Likewise, the solo variable for all the years steadily decreased from near zero in column (1) to -0.161 in column (7). Therefore, there is a possibility that the values in the seventh regression are still conservative due to some unaccounted for control. The adequacy of the model is demonstrated by the $R^2$ values. The final $R^2$ of .154 in column (7) suggests that a log regression may more be a more adequate model. The high standard errors also suggest the possibility of an error in the construction of the model. The most realistic regression, column (7) shows the positive effect of the solo practice variable for the years after 2002 was .197. The negative solo variable for all years (-0.161) may be explained by the fact that Lovastatin was vastly popular and continued to be so after Advicor entered the market, even though some solo physicians were changing their prescribing behavior. It is also likely that some of the change is due to the fact that one prescription is generally less expensive than two prescriptions that are equivalent to Advicor.

Table 4 is organized in the same way as Table 2. The dependent variable is a binary indicator for whether Humira or Remicade was prescribed, with a one representing a prescription
Conclusion

This study attempted to ascertain whether the type of practice to which physicians belong influences the types of medications they prescribe. The study used two different pairs of medications: Advicor vs. Lovastatin, and Humira vs. Remicade. The study also included a number of controls under the categories of health status, demographics, physician descriptors, region, insurance variables, and employment status.

The results revealed the following conclusions. Solo physicians were more likely to prescribe Advicor over Lovastatin, but less likely to prescribe Humira over Remicade. Although both sets of prescriptions failed to show the same consistent trend, there was a significant difference in prescribing behavior for both Advicor and Humira. This suggests that not only is there a difference present in the prescriptions written in solo versus group physicians, but that there are additional factors regarding the type of drug that determine the direction of this difference. One possible explanation for the discrepancy is Advicor incorporates Lovastatin plus a second drug together and purchasing one medication is cheaper than purchasing two separate ones. Although this study determined an effect on prescribing behavior, it was not designed to identify the actual source of the observed effect. This represents a significant gap in our knowledge and understanding of the physician-patient relationship.

Endnotes

3 Feron, 171
5 Casalino, 1961.
Appendices

Figures

Figure 1 – Number of Annual Prescriptions

Panel A:

![Graph showing number of annual prescriptions for each drug by year, with two y-axes weighted to represent the national estimate. The x-axis for the Humira and Remicade graph begins with the year 2000 due to the availability of data in the sample.]

Panel B:

![Graph showing number of annual prescriptions for each drug by year, with two y-axes weighted to represent the national estimate. The x-axis for the Humira and Remicade graph begins with the year 2000 due to the availability of data in the sample.]

Figure 1 has a graph for each prescription pair and shows the number of prescriptions written for each drug by year. Both y-axes are weighted to represent the national estimate. The x-axis for the Humira and Remicade graph begins with the year 2000 due to the availability of data in the sample.
Figure 4 - Number of Solo and Non-Solo Practices in Sample That Prescribed Medications

Panel A
Lovastatin:

Panel B
Advicor:

Panel C
Remicade:

Panel D
Humira:

Figure 4 is a series of four panels, one per medication. Each medication is broken down into whether it was prescribed in a solo or non-solo practice by year. There is no weight alteration.
Table 2

<table>
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<tr>
<th>Effect of Solo Practice Visitations on Total Prescriptions (Unrestricted Sample)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
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<tr>
<td>Solo x Year &gt;= 2002</td>
<td>-0.002 ***</td>
<td>-0.002 ***</td>
<td>-0.002 ***</td>
<td>-0.002 ***</td>
<td>-0.002 ***</td>
<td>-0.002 ***</td>
<td>-0.002 ***</td>
</tr>
<tr>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
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<td>Practice is Solo/100</td>
<td>-0.016 *</td>
<td>-0.005</td>
<td>-0.016 *</td>
<td>-0.016</td>
<td>0.008</td>
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<td>0.040 *</td>
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<tr>
<td>Year &gt;= 2002</td>
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<td>0.003 ***</td>
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<tr>
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<td>Yes</td>
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<tr>
<td>Employment Controls?</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

R^2 | 0.002 | 0.009 | 0.010 | 0.010 | 0.010 | 0.011 | 0.011 |

The dependent variable for this unrestricted regression is an indicator for receiving either Advicor or Lovastatin. The regressions add additional controls as the columns progress from left to right as indicated by the 'Yes' term. The Practice is Solo variable was multiplied by one hundred for reading comprehension. A patient weight was used to represent the national estimate. * = p-value < .05; ** = p-value < .01; *** = p-value < .001.
Table 4

<table>
<thead>
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<th></th>
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<tbody>
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<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>0.001***</td>
</tr>
</tbody>
</table>

The dependent variable for this unrestricted regression is an indicator for receiving either Humira or Advicor. The regressions add additional controls as the columns progress from left to right as indicated by the ‘Yes’ term. The following variables were multiplied by one hundred for reading comprehension: Solo*Year, and Practice is Solo. A patient weight was used to represent the national estimate. ‘*’ = p-value < .05; ‘**’ = p-value < .01; ‘***’ = p-value < .001.