EVALUATING THE EFFECT OF MEDICARE SHARED SAVINGS PROGRAM ACCOUNTABLE CARE ORGANIZATIONS ON PART D PHARMACEUTICAL SPENDING AND USE

by

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ABSTRACT

Medicare Shared Savings Program (MSSP) is one major model of the Accountable Care Organizations (ACOs) offered by Medicare to better manage health cost and improve the quality of health services. The payment MSSP ACOs receive from Medicare is directly related to its Medicare Part A and B spending and related health service quality. Currently Medicare Part D spending covering medication cost is not included in the calculation of MSSP ACOs shared savings and risks. Since improvement of medication coverage and drug adherence have been shown to decrease other medical cost such as hospital and outpatient care, ACO providers may be incentivized to increase the shared savings by lowering Part A and B spending through increasing Part D drug prescription. This study evaluated the effect of MSSP ACOs on the Part D spending and utilization with a quasi-natural difference-in-differences model. We investigated the change in outcome variables between pre- and post-ACO enrollment during 2010-2013 by comparing MSSP ACOs and non-ACO Medicare providers.

We found that when individually compared with non-ACO providers, Part D spending and use mildly increased after providers enrolled in MSSP. However, the statistical significance of this effect disappeared after controlling for other ACO providers started their MSSP contracts at different times. To evaluate the c. Characteristics of those providers not considered in this

study might also have an influence on Part D spending and thus a valid control group would need to be carefully chosen for future studies.

Public health significance: Understanding the ACO effects on Medicare Part D spending and utilization helps evaluate the success of ACOs to increase shared savings and to improve health quality compared with original management models in Medicare.

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PREFACE

I would like to express my gratitude to Dr. Robert Krafty for his guidance throughout this project and his support to my academic development as my thesis and academic advisor. I would like to thank Dr. Julia Driessen for offering the data, for her support about how to preprocess the original CMS data and understand the public health significance of this study. I would also like to thank Dr. Ada Youk for being my thesis committee member and her continuous support to my academic and professional development throughout my Master program. I am also thankful to the following graduate students in the Department of Biostatistics Silvia Liu, Caleb Huo, and Shu Wang for all their help.

Finally, I would like to thank my family for their love and support.

1.0 INTRODUCTION

1.1 MEDICARE

Medicare is a health insurance program managed by the Center for Medicare & Medicaid Services (CMS) to provide health-related cost management to most individuals with an age of 65 and older. The program is also available for people who are under 65 but fulfill certain criteria including receiving disability benefits or having End Stage Renal Disease (ESRD) [1].

Original Medicare consists of two Parts: first, Part A or Hospital Insurance that covers most of the inpatient services such as hospital and nursing care and home health services; second, Part B or the Medical Insurance that covers doctor's and outpatient services plus preventive services. The Original Medicare with Part A and B was enacted in 1965. In 2006, Medicare Part D, which offers prescription drug coverage was enacted. It offers beneficiaries who are enrolled in the Original Medicare program to join a drug plan to help pay for their Medicare drug spending. Medicare Part C, or the Medicare Advantage plans, are different from Original Medicare in the way that allows Medicare beneficiaries to manage their Medicare through a third party, mostly private companies contracted with Medicare to cover all Part A and B benefits. Some of the Medicare Advantage plans also provide Part D coverage and other coverage for their beneficiaries. Health Maintenance Organizations (HMO), Preferred Provider Organization (PPO) and Private Fee-For-Service Plans are all institutions that offer Medicare Advantage plans [1, 2, 3].

Previous literature suggests that for chronic diseases such as diabetes and hypercholesterolemia, increasing drug adherence is associated with reduced disease-related medical cost. Medication was found to be especially effective to manage those disease conditions, leading to less hospital or outpatient care. This offset effect was conjectured to produce an overall saving for health care cost [4]. However, the price sensitivity among Medicare beneficiaries based on this offset effect was also discussed by several studies. Specifically, when drug price increased, beneficiaries reduced their drug use and spending with an increasing utilization of outpatient care [5]; when prescription drug benefits enlarged such as starting enrollment in Medicare Part D plans, beneficiaries seemed to increase their spending for prescription drugs, which lowered other medical spending [6]. Another study looking at health insurance design for the elderly further confirms the offset effects of drug coverage improvement brought by Medicare Part D plans and found it to be especially substantial among chronically ill patients [7].

1.2 ACCOUNTABLE CARE ORGANIZATIONS

An Accountable Act Organization (ACO) is a group of Medicare providers who voluntarily join to share medical information and provide coordinated care for their patients. Different from non-ACO providers who receive their regular payment from Medicare, providers within the same ACO group could receive an extra amount of payment from Medicare or repay the portion of losses the group generates depending on its performance. This performance, including both the group's eligibility to stay in the ACO program and the amount of payment it gains or losses, is evaluated by The Centers for Medicare & Medicaid Services (CMS) based on an individual benchmark developed for each ACO group. This benchmark is an estimate of total Part A and B expenditure if the group did not participate in the ACO program. ACO providers are eligible to stay in the program if they meet their individual minimum saving rate (MSR) and gain a portion of the savings they generate, which is the "shared savings". Based on the risk sharing track each ACO group chooses, it might also be accountable for the loss it generates which exceeds its minimum loss rate (MLR) [8]. Opportunity to enroll in ACOs was available for any beneficiary who was already enrolled in Medicare Part A or/and B programs if he or she was not enrolled in Medicare Advantage Plans [3].

There are three types of ACO models that Medicare offers: first, the Pioneer ACO model that was launched in January 2012 for large groups and institutions with experience serving more than 15,000 beneficiaries annually; second, the Medicare Shared Savings Program (MSSP) that started in April 2012 for smaller and inexperienced providers; and third, the New Generation model started in January 2016 that integrates experience of prior ACOs to achieve higher care quality by using a prospectively set benchmark rather than the retrospective default [9]. The New Generation model allows beneficiaries to choose whether to be assigned to ACOs. By December 2016, there are 8 Pioneer ACOs, 433 Shared Savings Program ACOs and 18 New Generation ACOs serving about 9 million beneficiaries in total [10]. For this study, we will only focus on MSSP ACOs.

1.2.1 Early Results of ACOs

Previous investigations demonstrate early promising results of MSSP ACOs implementation. In 2012, 58 MSSP ACOs reported a total of $705 million below the pre-set benchmark and earned shared savings of $315 millions. The total net saving for the year was $383 million including some losses generated by one MSSP ACO group. Out of the 33 quality measures, MSSP ACOs were reported to have improved on 30 measures. Although not every ACO earned shared savings, 60 additional ACOs held spending below their benchmarks [11]. For 2014, 92 MSSP ACOs reported a total of $806 million below the original benchmark and earned shared savings of $341 millions. The total net saving from MSSP ACOs was $465 millions with no losses. Survey results from 2013 and 2014 show that MSSP ACOs improved on 27 of the 33 quality measures. 89 ACOs held spending below their benchmarks despite not meeting the minimum saving rate and not earning any savings [12].

Previous literature also confirmed this early result of ACO effects. Before MSSP ACOs was enacted, one study investigating the Medical Physician Group Practice Demonstration (PGPD), an earlier pilot of ACOs, and the local control group from 2001 to 2009 showed that substantial medical savings were generated by some participating institutions but offset by lack of savings at other. These savings were also found to concentrated among Medicare-Medicaid dually eligible beneficiaries [13]. Another study looking at the quarterly medical spending of beneficiaries of Blue Cross Blue Shield (BCBS) of Massachusetts' Alternative Quality Contracts (AQC), an early commercial ACO initiative found that ACO was associated with lower spending but not consistently improved health care quality [14]. In 2015, one group studying the effect of Pioneer ACOs on total Medicare Part A and B expenditure and utilization found small increase in total Medicare expenditure in beneficiaries during 2012-2013 compared to 2010-2011, the period when beneficiaries were not yet enrolled in ACOs [15].

1.2.2 Difference-In-Differences Approach to Analyze ACO Effects

Studies mentioned above all used Difference-In-Differences (DID) approach to analyze the medical spending data. DID technique is a quasi-experimental design that can be applied to longitudinal or panel data to evaluate a causal effect between intervention and control groups. When randomization is not possible, especially in most observational studies, DID is useful to isolate and evaluate the intervention effect by treating the total change in response variable as a combination of both intervention effect and a natural change in time. This change in time is assumed to be the same for all groups. DID is often used to study the causal effects of policy or legislation change and large-scale program implementation [16]. DID models assume the following four conditions: intervention unrelated to outcome at baseline, parallel trends between intervention and control groups during baseline period, stable composition of intervention and control groups for repeated measures, and no spillover effects. Spillover effect refers to the policy change on one observational unit affecting the outcomes of other units [16]. Although studies evaluating the early ACO effects on medical spending used DID approach, they applied different techniques in adjusting for case mix between the intervention and control group, especially beneficiaries' differences in sociodemographic and clinical characteristics. These techniques included multiway clustering of standard errors [13], propensity score methods [14], and Oaxaca-Blinder reweighting technique [15].

Although the above results seem to suggest that early MSSP ACO succeeded in lowering Medicare Part A and B spending and generating net savings compared with pre-estimated benchmark amount, whether MSSP ACO truly lowered overall Medicare cost remains unclear. As mentioned above, only Medicare Part A and B spending are used to calculate the shared savings in ACO models without including Part D spending, which was around $67 billion accounting for 11.7% of the total Medicare spending in 2012 [17], and $69.7 billion accounting for 12% in 2013 [18]. Health care providers might have the incentives to generate more shared savings or to reduce beneficiaries' spending covered by Part A and B by increasing drug prescription that is covered by Part D. In this case, the ACO net savings could just be an offset effect of increased Medicare Part D prescription. In addition, previous literature [14,15] investigating ACO or similar effects on medical spending across time primarily focused on the comparisons between one intervention group and a control group without considering differences among intervention subgroups that entered the program at different times. These differences might also contribute to the changes in Part D spending in addition to the intervention effects of interest.

1.3 OBJECTIVE

In this observational study, we evaluated the relationship between MSSP ACO enrollment and Medicare Part D spending. We were especially interested in knowing whether enrollment in MSSP ACO program would increase the Part D drug prescription for ACO beneficiaries compared with those not assigned to MSSP ACOs in the same period. We identified two main groups of fee-for-service Medicare beneficiaries as our study subjects: one intervention group who started their enrollment in MSSP ACO plans in either 2012 or 2013, and a control group who met the eligibility to be enrolled in the same program but was not assigned to either during 2012 and 2013. We further divided our intervention groups into three subgroups based on their time of enrollment into the MSSP. We defined the pre-policy period as years 2010 to 03/31/2012 and post-policy period as from 04/01/2012 when the earliest cohort of Medicare providers started MSSP ACO contracts with CMS, to the end of 2013. We used a quasi-experimental difference-in-differences model to investigate the effect of MSSP ACOs on possible changes in Medicare Part D spending before and after the implementation of the program.

2.0 METHODS

2.1 STUDY POPULATIONS

Subjects for this study included beneficiaries consistently enrolled in Medicare Part A, B and D programs throughout the period from January 1, 2010 to December 31, 2013. Our intervention group consisted of beneficiaries who were assigned to MSSP ACOs in either 2012 or 2013, and our control group consisted of those who aligned with CMS standards of eligibility to be assigned to MSSP ACOs but did not enroll in any type of ACOs during 2012 or 2013. This alignment includes being enrolled in Medicare Part A or/and Part B but not Part C (Medicare Advantage Plans). Beneficiaries in our control group also resided in the same counties as those in the intervention group. Due to data acquisition limitations, we only requested a random sample of 76% of the total beneficiaries stayed in the MSSP ACOs in 2013 from the CMS as our intervention group. For control group, we randomly selected 5% of all Medicare beneficiaries as our base sample and then excluded those that did not meet the above inclusion criteria. Our final study population consisted of 859,808 beneficiaries for the intervention group and 440,801 beneficiaries for the control group.

2.2 DATA COLLECTION

We obtained all beneficiary data from the Center for Medicare and Medicaid Services (CMS). Information about our covariates examined in the study came from several segments of the Master Beneficiary Summary File (MBSF) from the CMS: the base segments of Part A, B and D for beneficiaries' enrollment and entitlement information and demographics, and the Chronic Conditions segment for beneficiaries' 27 chronic conditions. We collected our Medicare prescription drug costs and payment data from another file, the Part D Drug Event File (PDE) which CMS used to make payments to Medicare Part D plans. We also utilized the Geographic Crosswalks and Research Files from the Dartmouth Atlas of Health Care organization to attain the hospital referral regions (HRR) of our beneficiaries based on their zip codes found in the MBSF segment A and B file. All data was processed and analyzed using SAS 9.

2.3 OUTCOME MEASURES

2.3.1 Response Variables

Because MSSP ACOs started their contracts with the CMS during 2012 and 2013 at three different time points: 25 started on April 1, 2012; 85 started on July 1, 2012; and 105 started on January 1, 2013, we calculated our outcomes per beneficiary per quarter from January 1, 2010 to December 31, 2013 instead of annually. This resulted in 16 quarters per beneficiary in total for our final data setup. The two outcome variables of interest were the total quarterly Medicare Part D spending per beneficiary and the total quarterly Part D counts of monthly prescriptions filled per beneficiary. We standardized the prescription counts by a month of 30 days using drug information about days of supply. For each specific prescription record, if the days of supply was smaller than or equal to 30, the prescription count is 1; if not, the prescription count was calculated by dividing the days of supply by 30.

2.3.2 Covariates

To better control for potential confounding effects, we adjusted for demographics, income/subsidy status, and health-related conditions throughout the four years 2010-2013. Demographic characteristics included sex (male as the reference group), age (<65 as the reference group, 65-74, 75-84, and 85+), and race or ethnicity (non-Hispanic White as the reference group, Black, Hispanic, Asian/Pacific Islander, Native, and Other). We categorized our beneficiaries into three levels of income and subsidy status: beneficiaries with both Medicare and Medicaid coverage eligible, beneficiaries not eligible for Medicaid but were below 150% federal poverty line to receive a subsidy for Part D program, and those with no income subsidy as the reference group. Health-related conditions consisted of whether one had the end-stage renal disease (ESRD) or any of the 27 chronic conditions pre-defined by the CMS Chronic Condition Warehouse (CCW). The 27 conditions included some common chronic diseases such as dementia, cardiovascular diseases, diabetes and major types of cancers. We also created a categorical variable of the total number of CCW chronic diseases (<3 as the reference group, 3-5, 6+) as one of our covariates. In addition, we controlled for the hospital referral region as a categorical covariate (more than 300 regions and each as one level).

2.4 STATISTICAL ANALYSIS

Based on the characteristics of this study: observational nature with no randomization, assignment of MSSP ACOs not related to Part D spending at baseline, parallel trends between intervention and control group (Figure 1), stable composition of study population and study measures across time and independent outcomes among beneficiaries, we chose to use a DID model to best evaluate the change of Part D drug counts and spending before and after beneficiaries' assignment to MSSP ACOs. Specifically, we defined our baseline period as from 2010 and 2011 and our intervention period as from 2012 to 2013. Our intervention period was also the first and second performance years of MSSP ACOs.

2.4.1 Model Development

As mentioned before, MSSP ACOs started their contracts with CMS at three different time points, naturally forming three cohorts of beneficiaries. To better study the cohort effect of MSSP ACOs, we looked at the change of Part D spending for each cohort first and then combined the three cohorts together as one MSSP ACO group. The following are the DID models for each cohort and the whole MSSP ACO group. For each model, we were interested in evaluating the estimates of the time-dependent policy variable, which denotes the change of enrollment in MSSP ACOs over time.

Model for Each Cohort

$$log[E(Y_{i,t})] = \alpha + \boldsymbol{\beta_1} * quarters + \beta_2 * I.aco + \beta_3 * policy_t\ (0 = pre, 1 = post) + \boldsymbol{\beta_5} * hrrnum + \boldsymbol{\beta_6} * covariates_{i,t}$$

Notes:

$Bolded\ \boldsymbol{\beta} = vectored\ coefficients\ associated\ with\ categorical\ variables\ with\ multiple\ levels$

$Y_{i,t\_counts} \sim Negative\ Binomial;\ Y_{i,t\_spending} \sim Normal$

$Y_{i,t} = Part\ D\ spending\ or\ counts\ for\ beneficiary\ i\ at\ quarter\ t$

quarters = 16 quarters from Spring 2010 to Winter 2013

$hrrnum = hospital\ referral\ region\ number\ (> 300\ categories)$

$covariates = sex, age, race, income, ESRD, 27\ CCW\ chronic\ conditions\ and\ the\ sum\ of\ CCW$

<u>*Model for Whole MSSP*</u>

$$log[E(Y_{i,t})] = \alpha + \boldsymbol{\beta_1} * quarters + \beta_2 * I.aco_{cohort1} + \beta_3 * I.aco_{cohort2} + \beta_4 * I.aco_{cohort3} + \beta_5 * policy_{cohort1,t}(0 = pre, 1 = post) + \beta_6 * policy_{cohort2,t}(0 = pre, 1 = post) + \beta_7 * policy_{cohort3,t}(0 = pre, 1 = post) + \boldsymbol{\beta_8} * hrrnum + \boldsymbol{\beta_9} * covariates_{i,t}$$

Notes:

Bolded $\boldsymbol{\beta}$ *= vectored coefficients associated with categorical variables with multiple levels*

$Y_{i,t\_counts} \sim Negative\ Binomial$; $Y_{i,t\_spending} \sim Normal$

$Y_{i,t} = Part\ D\ spending\ or\ counts\ for\ beneficiary\ i\ at\ quarter\ t$

quarters = 16 quarters from Spring 2010 to Winter 2013

$hrrnum = hospital\ referral\ region\ number\ (> 300\ categories)$

$covariates = sex, age, race, income, ESRD, 27\ CCW\ chronic\ conditions\ and\ the\ sum\ of\ CCW$

For this study, we used Generalized Estimating Equations (GEE) to obtain the model estimates because we only focused on investigating the group effect of MSSP ACOs on Medicare Part D spending. We also pre-specified our estimated working correlation matrix as auto-regressive (AR1) as we expected the association between two measures is related to their distance in time. Specifically, we assumed for each beneficiary, the association of Part D spending between each two neighboring quarters is stronger than the association between quarters that are two or three times farther apart. We also treated each individual beneficiary effect as a random effect in the GEE models.

3.0 RESULTS

3.1 DESCRIPTIVE STATISTICS

Table 1 shows that there were 81,360 beneficiaries enrolled in the MSSP ACOs that started their contracts on April 1, 2012, and 372,846 beneficiaries, almost 4.5 times more than the first cohort enrolled in MSSP ACOs started on July 1, 2012. Our last cohort consists of 405,602 beneficiaries assigned to MSSP ACOs with contracts started on January 1, 2013. The average age across all four groups was quite similar and was around 71. About 62% MSSP beneficiaries were females compared with 65% females for the control group. Across all groups, more than 72% of the beneficiaries were non-Hispanic white. Most beneficiaries in our study received no low-income subsidy, and around 34% having Medicare and Medicaid dual coverage. The average percentage of ESRD for our sample was around 1%, and the average total number of CCW chronic conditions was about 4 across all four groups.

Table 1. Summary of Characteristics Comparison Between the Intervention Group and Control Group in 2010, by Start Date of Medicare Shared Savings Program Accountable Care Organizations

	Medicare Shared Saving Program ACO Group			**Control Group**	**P-value**
	Starting on Apr 1, 2012	Starting on Jul 1, 2012	Starting on Jan 1, 2013		
Number of Total Beneficiaries	81,360	372,846	405,602	440,801	
Age (yr), %	71.03±12.84	70.15±13.22	69.86±13.24	70.72±12.12	<0.0001
<65	18.6	20.4	21.4	20.4	
65-74	39.6	40.4	40.8	38.0	
75-84	30.5	28.9	28.0	30.1	
≥85	11.3	10.2	9.9	11.5	
Female, %	62.8	62.6	62.2	65.3	<0.0001
Race/ethnicity, %					<0.0001
Non-Hispanic White	72.4	82.2	80.3	80.1	
Black	8.1	8.2	8.1	9.2	
Hispanic	10.0	5.1	6.8	5.9	
Asian/Pacific Islander	8.5	3.4	3.8	2.5	
Native	0.2	0.2	0.2	0.5	
Other	0.7	0.8	0.8	0.7	
Low income subsidy status, %					<0.0001
Medicaid dual eligible	37.2	33.7	34.6	34.1	
Non-dual low income subsidy	4.5	4.2	4.8	5.0	
No low income subsidy	58.3	62.1	60.6	60.9	
End-stage renal disease, %	1.1	1.0	0.9	1.0	<0.0001
CCW priority chronic conditions					<0.0001
Total number of conditions, Mean	4.2	3.8	3.8	4.0	<0.0001†
<3 conditions, %	27.9	32.6	32.8	30.0	
3-5 conditions, %	44.2	43.9	43.9	45.2	
≥6 conditions, %	27.9	23.5	23.3	24.8	
Having a specific CCW priority chronic condition, %					
Acute Myocardial Infarction	0.6	0.6	0.6	0.6	0.0324
Alzheimer's Disease	3.6	3.0	3.2	3.8	<0.0001
Alzheimer's Disease and Related Disorders or Senile Dementia	8.8	7.3	7.5	8.7	<0.0001
Atrial Fibrillation	7.4	7.1	6.8	7.4	<0.0001
Cataract	24.1	22.7	23.0	23.8	<0.0001
Chronic Kidney Disease	13.2	12.6	12.4	13.0	<0.0001
Chronic Obstructive Pulmonary Disease	10.5	10.4	10.2	11.5	<0.0001
Heart Failure	14.3	13.0	12.4	14.5	<0.0001
Diabetes	32.4	29.7	29.5	30.6	<0.0001
Glaucoma	12.7	12.0	12.0	12.2	<0.0001
Hip/Pelvic Fracture	0.6	0.6	0.5	0.6	<0.0001

Table 1 Continued

Ischemic Heart Disease	34.3	29.9	29.8	32.3	<0.0001
Depression	14.6	16.6	16.9	16.8	<0.0001
Osteoporosis	11.4	8.3	8.4	8.9	<0.0001
Rheumatoid Arthritis / Osteoarthritis	33.1	32.2	32.1	35.1	<0.0001
Stroke / Transient Ischemic Attack	4.0	3.5	3.4	3.9	<0.0001
Breast Cancer	3.4	3.3	3.2	3.6	<0.0001
Colorectal Cancer	1.1	1.1	1.1	1.2	0.0888
Prostate Cancer	2.9	2.7	2.8	2.6	0.0001
Lung Cancer	0.6	0.5	0.5	0.5	0.0047
Endometrial Cancer	0.3	0.3	0.3	0.3	0.6819
Anemia	29.3	23.8	23.2	25.2	<0.0001
Asthma	6.0	5.7	5.9	5.9	0.0001
Hyperlipidemia	58.4	53.8	53.4	54.3	<0.0001
Benign Prostatic Hyperplasia	7.0	5.5	5.7	5.3	<0.0001
Hypertension	66.0	62.8	62.4	65.6	<0.0001
Acquired Hypothyroidism	15.4	14.7	14.8	10.4	<0.0001

For categorical variables: p-value was calculated using Chi-square test
† For continuous variables: p-value was calculated using one-way ANOVA

Notes:
Plus–minus values are means ±SD.
CCW = Chronic Condition Warehouse

Figure 1 shows that throughout the baseline period of 2010-2011, the average quarterly Part D spending increased with the same trends across all four groups. Specifically, spending for each group increased about $115 from quarter 1 to quarter 8. Compared with the control group over time, MSSP cohort 1 had a roughly $35 higher quarterly Part D spending, and cohort 2 and 3 had Part D spending that was about $40 constantly lower. This result fulfills the “parallel baseline trend” requirement of using DID technique to model the Part D spending for our study.

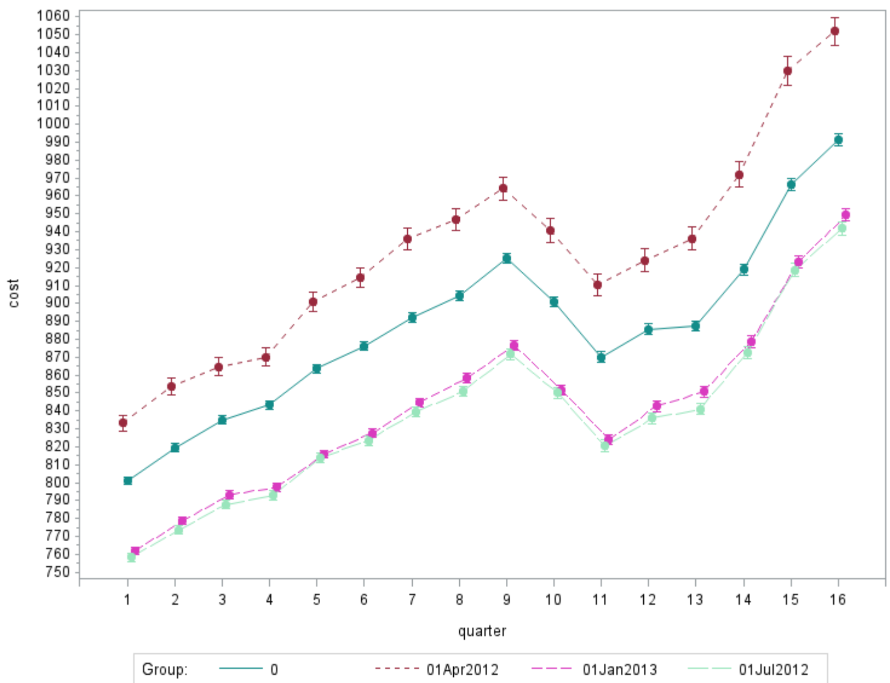


Figure 1. Comparing Baseline Trends in Quarterly Unadjusted Part D Spending Among the Intervention and Control Group

Similarly, Figure 2 also shows the parallel baseline trends of increased Part D drug counts from quarter 1 to quarter 8 for across all four groups. However, different from spending, all three MSSP cohorts had lower baseline drug counts compared with the control group. Specifically, MSSP cohort 1 and 2 was about 0.7 counts lower than that of the control group, and cohort 3 was about 0.6 lower.

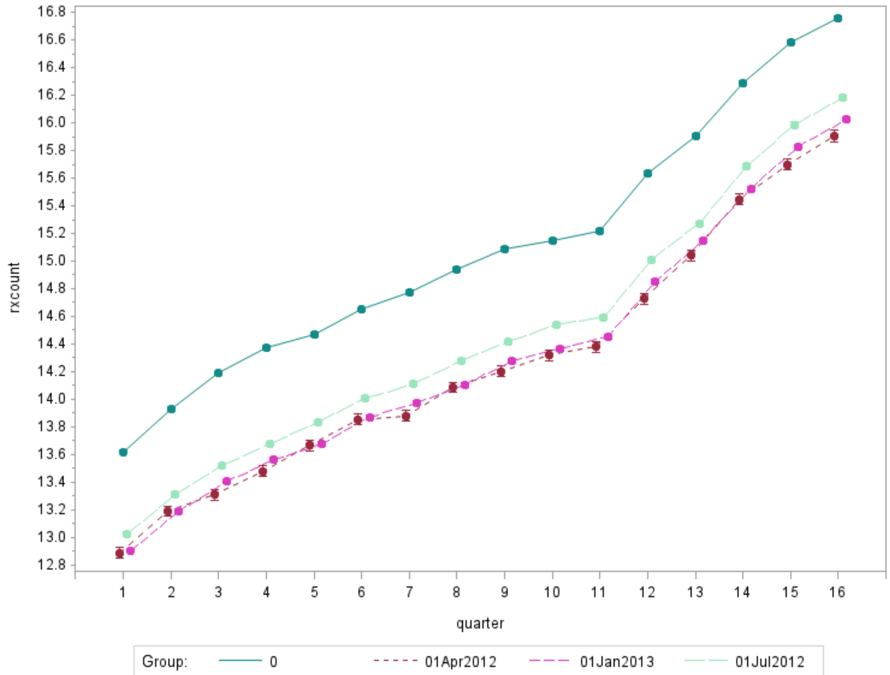


Figure 2. Comparing Baseline Trends in Quarterly Unadjusted Part D Counts Among the Intervention and Control Group

3.2 MODEL STATISTICS

For Part D prescription counts, data show that for each cohort model, the variances are about 8 times larger than the means. Specifically, the means and variances (in parentheses) of the prescription counts for each cohort model are listed accordingly: 14.97 (124.42), 14.81(124.01) and 14.73(123.56). Due to overdispersion and positive skewness of count data, we used a Negative Binomial model with a log link to model Part D prescription counts instead of a Poisson model. Although the original raw data for Part D spending used in each cohort model were positively skewed, we used a Normal model with log link to model it based on the extremely large sample size of the data.

Table 2 shows the estimates for the time-dependent policy variable in models for both Part D prescription counts and spending. Row 1 lists the results for each individual cohort model. Except for cohort 1 spending, ACO effects were shown to be statistically significant on both prescription counts and spending for all three cohorts when individually compared with the control group. Although the effect was statistically significant, estimates are very small ranging from 0.0023 to 0.0083. The sign of the estimates indicates that both Part D prescription counts and spending increased after the enrollment of MSSP ACOs throughout 2012 and 2013. The magnitude of the estimates shows that the rate of increase for Part D prescription counts was largest for cohort 3 (β=0.0070) followed by cohort 1 (β=0.0046) and then cohort 2 (β=0.0023). Differently, the rate of increase for spending seems to decrease over time with cohort 1, beneficiaries who stayed in the MSSP ACOs the longest having the lowest increase rate and cohort 3, those enrolled in the program the latest having the highest increase rate.

Row 2 in Table 2 shows that when controlling for MSSP cohort 2 and 3 besides the original control group, the ACO effects were no longer statistically significant for both counts and spending for MSSP cohort 1. Similarly, when controlling for MSSP cohort 3 besides the original control group, the ACO effects were also no longer statistically significant for both counts and spending for cohort 2. However, for cohort 3, the ACO effects remain statistically significant for both counts and spending. Similar to the pattern of the change in estimates for counts in individual cohort models, the estimates for both counts and spending in full models were largest for cohort 3 followed by cohort 1 and 2.

Table 2. Effects of Medicare Shared Saving Program Accountable Care Organizations on Medicare Part D Spending and Use

		MSSP ACOs Starting on Apr 1, 2012		**MSSP ACOs Starting on Jul 1, 2012**		**MSSP ACOs Starting on Jan 1, 2013**	
MODEL	**VARIABLES**	Count of Prescription Fills	Quarterly Part D Spending	Count of Prescription Fills	Quarterly Part D Spending	Count of Prescription Fills	Quarterly Part D Spending
Cohort Model	ACO Effects	0.0046***	0.0049	0.0023***	0.0066**	0.0070***	0.0083**
	No. of observations	8,354,576	8,354,576	13,018,352	13,018,352	13,542,448	13,542,448
Full Model	ACO Effects	0.0016	0.0045	0.0009	0.0039	0.0048***	0.0046*
	No. of observations	20,809,744	20,809,744	20,809,744	20,809,744	20,809,744	20,809,744

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

4.0 DISCUSSION

According to our results, when individually comparing each cohort MSSP ACOs with the selected control group, Medicare Part D prescription spending and counts did mildly increase after beneficiaries' enrollment in ACOs as expected. However, the validity of this effect might be questionable because when controlling for other ACO cohorts, the effects were no longer statistically significant. These results indicate that our models did not capture the pure ACO effects very well. By applying the DID technique, we assume that the change in outcome variables is only due to the change of MSSP enrollment by adjusting for the covariates included in the models. In other words, we assume there were no differences among the four groups before they started MSSP ACO enrollment. This means that for cohort 1, any one of the rest three groups could serve as a comparison group if it did not enroll in the MSSP, and the ACO effects for cohort 1 was expected to be the same no matter which group it compared to. However, our results show that once we change our comparison group from the original control group to all beneficiaries who have not yet started their enrollment in MSSP ACOs, the ACO effects changed from statistically significant to not statistically significant. This suggests that there might be some differences among the four groups even before they started the MSSP ACO enrollment that our models did not take into account.

One possible reason this might have happened is that instead of all four groups being totally different from each other, those health providers who chose to form ACOs and enrolled in MSSP might be different from those who stayed outside of the MSSP. The former might be more naturally intending to enroll in MSSP and might have already been practicing health management similar to that of the MSSP. If this is true, it would be difficult to tell whether the savings or the better quality of health services generated by MSSP ACOs are purely due to the program or could be a mixed effect of both the program and the original characteristics of those health providers.

To test our conjecture, we ran the full models using cohort 3 as the new control without including the original control group. We also excluded data from quarters 13 to 16 where the policy variable has a value of 1 for all three ACO groups. Results indicate that the ACO effects were not at all statistically significant for either cohort in models for either counts or spending: $\beta_{cohort1,count} = -0.0012, p = 0.3670$; $\beta_{cohort2,count} = -0.0013, p = 0.1067$; $\beta_{cohort1,spending} = 0.0012, p = 0.7817$; $\beta_{cohort2,spending} = 0.0003, p = 0.9334$. This confirms our speculation that characteristics affecting Part D spending were likely to exist among ACO providers before their enrollment in MSSP. These characteristics might have masked the real ACO effects on Part D spending, making it not statistically significant in our full models.

Although we were only interested in evaluating the importance of the ACO effects on Medicare Part D spending in this study, a possible secondary objective is to look at the change of the effects over time. When using the DID model, we averaged out the change in outcome variables across time before and after the policy implementation, which does not reflect the change over time after the implementation. Health providers' response to the policy is likely to change as time goes by, and the pattern of the change could influence the general effect of the policy, leading it not only due to the start time of the program (cohort effect in our study) but also the length of stay in the program. However, to fully assess this more time points would be needed.

4.1 STRENGTHS

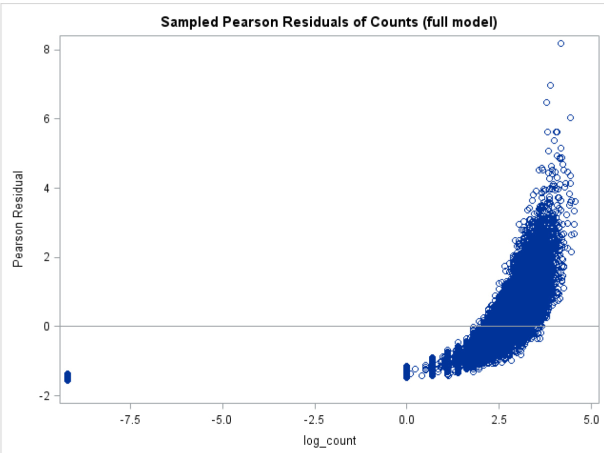
This study was the first study to look at ACO effects on Medicare Part D spending and utilizations. It was also the first study to evaluate the cohort effects of MSSP ACO groups controlling for other cohort groups. It raised the question about how to define an appropriate control group to evaluate the ACO effects on Medicare spending by demonstrating that results from analysis only adjusting for beneficiaries' characteristics might be inaccurate, and potential differences between ACO and non-ACO providers need to be considered for future analysis.

4.2 LIMITATIONS AND FUTURE DIRECTION

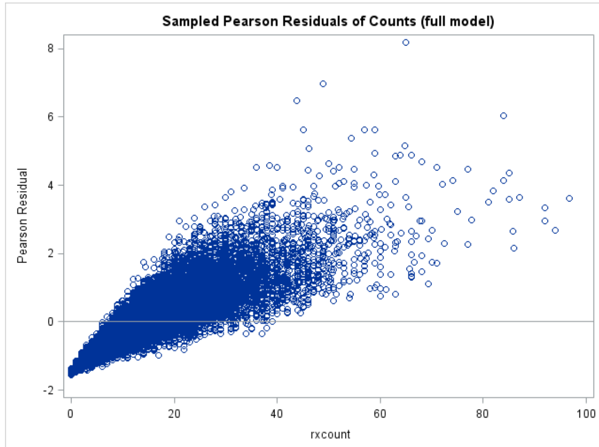
One limitation of this study was that the control group did not serve well as a reference group to reflect the ACO effects on Part D spending and utilization. Future research can study the characteristics of health providers in MSSP ACOs to better isolate the effects from factors other than ACO enrollment on the change of Medicare Part D spending. This would allow a better and valid control group for comparisons to study the real ACO effects on Part D spending. Another limitation of the study was that model diagnostics were not presented for this study. Since overall good-of-fit test or standardized Pearson residuals are not available for GEE models, sampled Pearson residuals (in the Appendix) obtained from the full models were difficult to explain. Although other diagnostic statistics such as predicted values or cook's distance are available, SAS crashed due to technicality issues when trying to obtain these statistics. Therefore, further analysis needed to assess model fit.

APPENDIX A: PEARSON RESIDUAL PLOTS

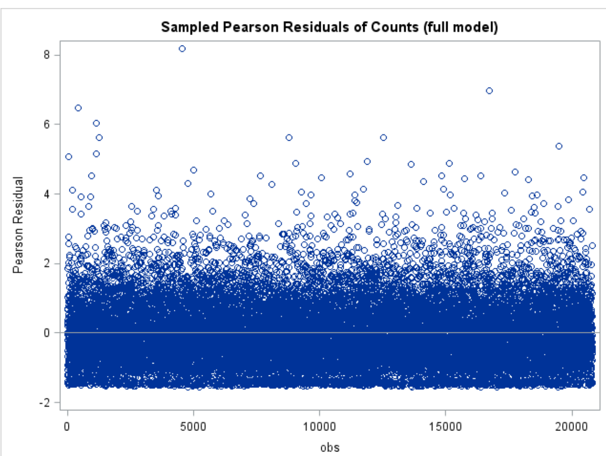
Part I. Unstandardized Pearson Residual Plots of Full Model of Part D Prescription Counts



Sampled Pearson Residuals vs. Log-Transformed Part D Prescription Counts

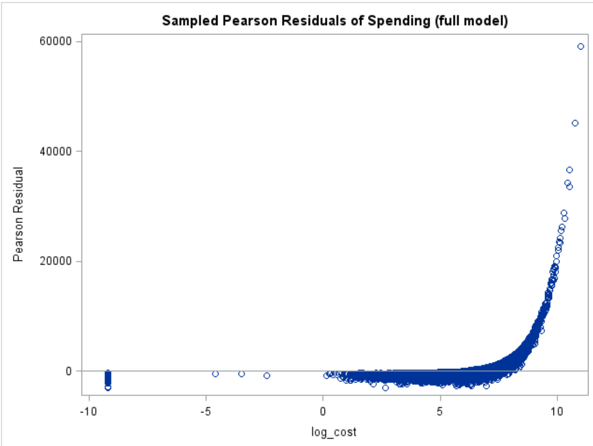


Sampled Pearson Residuals vs. raw Part D Prescription Counts

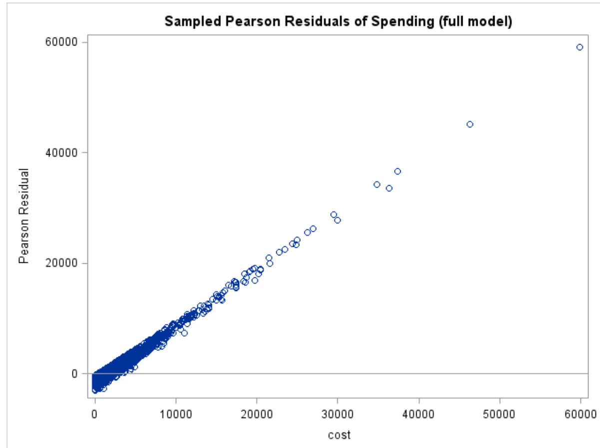


Sampled Pearson Residuals vs. Index

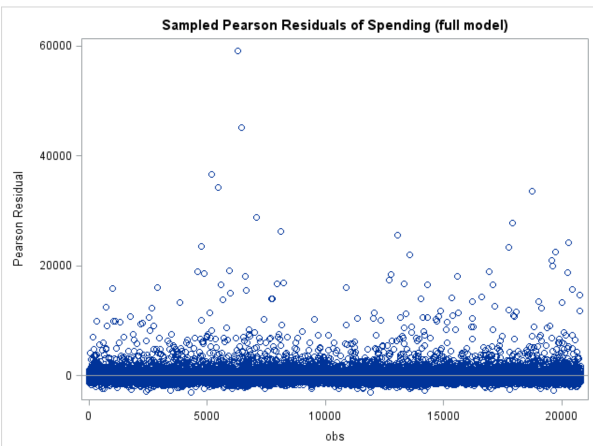
Part II. Unstandardized Pearson Residual Plots of Full Model of Part D Spending



Sampled Pearson Residuals vs. Log-Transformed Part D Spending in Full Model



Sampled Pearson Residuals vs. raw Part D Spending in Full Model



Sampled Pearson Residuals vs. Index in Full Model of Part D Spending

APPENDIX B: SAS CODE FOR ANALYSIS

I. Full Model for Part D Spending

```
proc genmod data=mssp.mssp_acoV4;
	class bene_id quarter hrrnum;
	model cost = quarter aco_group_numeric mssp_time sex_numeric age_cat1 age_cat2
			age_cat3 race_1 race_2 race_3 race_4 race_5 race_6 lis_1 lis_2
			esrd_numeric ami_flag alzh_flag alzh_demen_flag atrial_fib_flag
			cataract_flag chronickidney_flag copd_flag chf_flag diabetes_flag
			glaucoma_flag hip_fracture_flag ischemicheart_flag depression_flag
			osteoporosis_flag ra_oa_flag stroke_tia_flag cancer_breast_flag
			cancer_colorectal_flag cancer_prostate_flag cancer_lung_flag
			cancer_endometrial_flag anemia_flag asthma_flag hyperl_flag
			hyperp_flag hypert_flag hypoth_flag ccw_1 ccw_2 hrrnum/
		dist=normal link=log;
	repeated subject=bene_id / type=ar;
run;
```

II. Full Model for Part D Prescription Counts

```
proc genmod data=mssp.mssp_acoV4;
	class bene_id quarter hrrnum;
	model rxcount = quarter aco_group_numeric mssp_time sex_numeric age_cat1 age_cat2
			age_cat3 race_1 race_2 race_3 race_4 race_5 race_6 lis_1 lis_2
			esrd_numeric ami_flag alzh_flag alzh_demen_flag atrial_fib_flag
			cataract_flag chronickidney_flag copd_flag chf_flag diabetes_flag
			glaucoma_flag hip_fracture_flag ischemicheart_flag depression_flag
			osteoporosis_flag ra_oa_flag stroke_tia_flag cancer_breast_flag
			cancer_colorectal_flag cancer_prostate_flag cancer_lung_flag
			cancer_endometrial_flag anemia_flag asthma_flag hyperl_flag
			hyperp_flag hypert_flag hypoth_flag ccw_1 ccw_2 hrrnum/
		dist=nb link=log;
	repeated subject=bene_id / type=ar;
run;
```

III. Sample Cohort Model for Part D Spending

```
proc genmod data=mssp.mssp_acoV4;
	class bene_id quarter hrrnum;
	model cost = quarter aco_group_numeric mssp_time sex_numeric age_cat1 age_cat2
			age_cat3 race_1 race_2 race_3 race_4 race_5 race_6 lis_1 lis_2
			esrd_numeric ami_flag alzh_flag alzh_demen_flag atrial_fib_flag
			cataract_flag chronickidney_flag copd_flag chf_flag diabetes_flag
			glaucoma_flag hip_fracture_flag ischemicheart_flag depression_flag
			osteoporosis_flag ra_oa_flag stroke_tia_flag cancer_breast_flag
			cancer_colorectal_flag cancer_prostate_flag cancer_lung_flag
			cancer_endometrial_flag anemia_flag asthma_flag hyperl_flag
			hyperp_flag hypert_flag hypoth_flag ccw_1 ccw_2 hrrnum/
		dist=normal link=log;
	repeated subject=bene_id / type=ar;
	where mssp_group not in('2','3');
run;
```

IV. Sample Cohort Model for Part D Prescription Counts

```
proc genmod data=mssp.mssp_acoV4;
       class bene_id quarter hrrnum;
       model rxcount = quarter aco_group_numeric mssp_time sex_numeric age_cat1 age_cat2
                    age_cat3 race_1 race_2 race_3 race_4 race_5 race_6 lis_1 lis_2
                    esrd_numeric ami_flag alzh_flag alzh_demen_flag atrial_fib_flag
                    cataract_flag chronickidney_flag copd_flag chf_flag diabetes_flag
                    glaucoma_flag hip_fracture_flag ischemicheart_flag depression_flag
                    osteoporosis_flag  ra_oa_flag  stroke_tia_flag  cancer_breast_flag
                    cancer_colorectal_flag    cancer_prostate_flag    cancer_lung_flag
                    cancer_endometrial_flag   anemia_flag   asthma_flag   hyperl_flag
                    hyperp_flag hypert_flag hypoth_flag ccw_1 ccw_2 hrrnum/
             dist=nb link=log;
       repeated subject=bene_id / type=ar;
       where mssp_group not in('2','3');
run;
```

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