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Analysis of Medicare Prescription Drug Coverage Enrollment

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Abstract

Objectives. To identify factors associated with Medicare beneficiaries' choices of prescription drug plans as part of Medicare Advantage (MAPDs) or stand-alone prescription drug plans (PDPs) in order to help policy-makers understand what drives constituents' choice between the two and potentially refine prediction models of future prescription drug plan enrollment.

Study Design. We propose a methodology based on beta regression to identify factors associated with Medicare enrollees' choice of MAPDs or PDPs. We consider demographic factors, medical condition factors and plan characteristics.

Data Sources. We use county level MAPD/PDP penetration rates and Medicare population data for all counties in the United States, except in Alaska.

Principal Findings. Our approach documents key differences in factors driving MAPD and PDP penetration rates.

Conclusions. Our methodology provides insights into the different segments of the U.S. Medicare population that MAPDs and PDPs appeal to.

Keywords. Medicare Advantage, Medicare Part D, penetration rates, beta regression, Prescription Drug Plans.

Background: PDPs vs. MA-PDs

Medicare is the federal health insurance program covering people aged 65 and over and people with permanent disabilities. Medicare beneficiaries have two ways of receiving prescription drug coverage. One way is to enroll in a Medicare Advantage plan that offers prescription drug coverage (MAPD). Medicare Advantage plans are provided by private insurance companies under contract with Medicare. Beneficiaries need to enroll in both Medicare Part A and Part B and pay an additional premium for MA enrollment; in addition, they are not eligible to enroll if they have End-Stage Renal Disease. Out-of-pocket spending is capped. The other way to obtain prescription drug coverage is to enroll in a Prescription Drug Plan (PDP) provided by Medicare directly. Beneficiaries must be enrolled in original Medicare. Original Medicare does not have a cap on out-of-pocket spending.[1]

In 2014, 37 million out of 54 million Medicare beneficiaries enrolled in Part D prescription drug plans. Among these Part D plan enrollees, 37% of all Medicare beneficiaries enrolled in a prescription drug plan were in an MAPD, with the remaining 63 percent in a freestanding PDP. The availability of MAPD plans and PDP plans differs widely. The national average number of PDP and MADP plans are about 30 and 60 respectively; however, the number of PDP plans in each state exhibits little volatility, while the number of MAPD plans in each state varies from 1 to 250.[2]

Multivariate probit models have been used in past research efforts to describe factors associated with Medicare beneficiaries' choices in enrolling in prescription drug plans, and their choices of an MAPD plan given enrollment in the prescription drug program.[3] Data collected and analyzed from surveys of 5,000 community-dwelling adults in CMS Region 25 (Iowa, Minnesota, North Dakota, South Dakota, Nebraska, Montana and Wyoming) suggest that factors including rurality, plan price, perceived future need for medications, and preferences drive the choice to enroll in a prescription drug plan, while rurality, state of residence and number of diagnosed medical conditions are contributing to people's decision to enroll in a MAPD plan given enrollment in a prescription drug plan. Since survey data was detailed at the member level, the response variables were binary, allowing the implementation of the probit regression model.

[1] Medicare. "How to get drug coverage". Retrieved May 5, 2015. http://www.medicare.gov/sign-up-change-plans/get-drug-coverage/get-drug-coverage.html

[2] Kaiser Family Foundation. Research brief. The Medicare Part D Prescription Drug Benefit. September 2014. http://files.kff.org/attachment/medicare-prescription-drug-benefit-fact-sheet

[3] Richard R. Cline, Marcia M. Worley, Stephen W. Schondelmeyer, Jon C. Schommer, Tom A. Larson, Donald L. Uden, and Ronald S. Hadsall. PDP or MA-PD? Medicare Part D enrollment decisions in CMS Region 25. Research in Social and Administrative Pharmacy, 6:130-142, 2010.

The objective of this paper is to identify factors associated with penetration rates of MAPD plans and PDP plans *at the county level* rather than the member level to provide local policy-makers with further insights into the MAPD versus PDP segmentation. We utilize a relatively new regression method called beta regression when investigating factors associated with enrollees' choice.[4] This method is particularly suitable for our penetration data since it is tailored for variables whose value lies in the interval (0, 1) such as proportions or penetration rates instead of being binary such as members' yes/no enrollment decisions.

Data description

Our data combines three sources: penetration data, census data, and Part D plan data. The dependent variables are penetration rates of MAPD and PDP, which are retrieved from the Kaiser Family Foundation website.[5] We exclude Alaska because Alaska is the only state that has zero MAPD penetration rate (its PDP penetration rate is 39%); according to the Kaiser Family Foundation, no private insurance companies in Alaska offered Medicare Advantage plans. We initially consider 36 independent variables including demographic variables, condition variables, cost variables and plan variables. These data come from three sources: the "State/County Table - All Beneficiaries" from CMS's public use files,[6] the "State & County QuickFacts" from the US Census Bureau,[7] and "Plan & Premium Information for Medicare Plans Offering Part D" from CMS.[8] We have data for 3,029 counties in the United States.

The correlations between independent variables and penetration rates are provided in Table 1, where all correlations higher than 0.20 in absolute value are boldfaced. The *number of available MAPD plans* is highly correlated with MAPD and PDP penetration rates; in other words, the more MAPD plans in a county, the higher their MAPD penetration rate and the lower their PDP penetration rate. Other variables that have relatively high correlations with MAPD/PDP penetration rates are: *average age of Medicare beneficiaries*, *percentage of population with Bachelor's degree or higher*, *per capita income*, *percentage of Medicare beneficiaries who are also eligible for Medicaid*, *average HCC score*, and a few other medical conditions.

[4] Silvia L.P. Ferrari and Francisco Cribari-Neto. Beta regression for modelling rates and proportions. Journal of Applied Statistics, 31(7):799-815, 2004.

[5] Kaiser Family Foundation. Medicare advantage: MA-PD plan enrollment as a percent of total Medicare population. Table "MA-PD Plan Enrollment as a Percent of Total Medicare Population" 2014 data. http://kff.org/medicare/state-indicator/enrollees-as-a-of-total-medicare-population/

[6] Centers for Medicare & Medicaid Services. Public use file: New data on geographic variation. http://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/Medicare-Geographic-Variation/GV_PUF.html

[7] United States Census Bureau. State & county quickfacts. http://quickfacts.census.gov/qfd/index.html

[8] Centers for Medicare & Medicaid Services. Prescription drug coverage - general information. https://www.cms.gov/Medicare/Prescription-Drug-Coverage/PrescriptionDrugCovGenIn/

Table 1 Correlations of variables

Variable name	PDP_rate	MAPD_rate	total_rate
cnt_mapd	**-0.44**	**0.57**	0.06
cnt_pdp	0.08	-0.06	0.05
Average_Age	0.19	**-0.28**	-0.07
Percent_Female	0.19	-0.06	0.19
Percent_Male	-0.19	0.06	-0.19
Percent_Non_Hispanic_White	0.08	-0.04	0.07
Percent_African_American	0.1	-0.04	0.09
Percent_Hispanic	-0.05	0.08	0.04
Percent_Other_Unknown	-0.13	0.06	-0.1
Bachelor_degree_or_higher_perc	**-0.32**	0.15	**-0.26**
Homeownership_rate	0.07	-0.05	0.03
Per_capita_money_income	**-0.27**	0.09	**-0.26**
Persons_below_poverty_level_per	0.2	-0.06	0.2
Percent_Eligible_for_Medicaid	0.17	0.07	**0.31**
Average_HCC_Score	-0.06	**0.21**	0.16
Percent_of_heart_attack	0.09	-0.06	0.06
Percent_of_atrial_fibrillation	0.05	-0.02	0.04
Percent_of_kidney_disease	-0.11	**0.22**	0.11
Percent_of_obstructive_pulmonary	0.18	-0.12	0.1
Percent_of_depression	-0.05	0.2	0.16
Percent_of_diabetes	0.12	0	0.16
Percent_of_heart_failure	**0.26**	-0.19	0.14
Percent_of_ischemic_heart	0.17	-0.14	0.07
Percent_of_breast_cancer	-0.14	0.07	-0.13
Percent_of_colorectal_cancer	**0.24**	-0.17	0.14
Percent_of_lung_cancer	0.05	-0.06	0
Percent_of_prostate_cancer	-0.05	-0.01	-0.09
Percent_of_asthma	-0.2	0.15	-0.11
Percent_of_hypertension	0.15	-0.06	0.13
Percent_of_high_cholesterol	-0.1	0.1	-0.01
Percent_of_arthritis	0.15	-0.12	0.07
Percent_of_osteoporosis	-0.07	0.07	0
Percent_of_alzheimer	0.01	0.05	0.09
Percent_of_stroke	-0.09	0.07	-0.04
Part_B_Drugs_Standardized_Costs_perc	-0.1	0.09	-0.04
Percent_of_Beneficiaries_Using_PB	-0.15	0.14	-0.04

Further, we observe that most independent variables are oppositely correlated with the MAPD and PDP penetration rates. For example, the correlation between average age and MAPD rate is -0.28, while the correlation between average age and PDP rate is 0.19. This suggests that counties having a Medicare population with higher average age tend to have Medicare members enrolled in stand-alone PDP plans rather than MAPD plans, in spite of the lack of cap on out-of-pocket spending. Also, counties with a higher percentage of people with Bachelor's degree or higher are more likely to enroll in MAPD plans than PDP plans. Hence, these attributes have different impacts on MAPD versus PDP enrollment.

Statistical models on enrollment rate of PDP and MAPD plans

Because our response variables – penetration rates – are proportions, the best-suited statistical model here is *beta regression*. Linear regression and logistic regression are not appropriate for our purposes: linear regression might give us predictions out of the restricted range and logistic regression requires the distribution of the response variable to be binomial, which is not the case here. Beta regression assumes that the response variable follows a continuous beta distribution and is related to other variables through a specific regression structure. The beta distribution is a family of continuous probability distributions defined on the interval [0, 1] parametrized by two positive shape parameters: mean and precision. The beta regression model is obtained by assuming that the mean of the independent random response variables (each obeying a beta distribution), is such that an "appropriately defined transformation" of the mean will be linear in the observations on the regressors. The "appropriate transformation" is defined through a function called the link function.

In our numerical experiments, we test four link functions: (i) logit, (ii) probit, (iii) complementary log-log and (iv) log-log. The log-log link always outperforms the others; hence we will only present the results with that link function, defined by $g(\mu) = \log\{-\log(\mu)\}$. The estimation of coefficients is conducted using Maximum Likelihood Estimation (MLE). Closed-form expressions of those estimated parameters are not available. Therefore, the parameter estimates are obtained numerically by using a nonlinear optimization algorithm.

Beta regression can be implemented using the statistical software SAS (using procedures NLMIXED, NLIN or GLIMMIX and a macro called Beta Regression[9]) or using R with the package 'betareg'.[10] The implementation results using the 'betareg' package in R are shown in the next section. We implemented the beta regression after removing the 171 penetration rates reported as zero because the number of enrollees in those counties is ten or less.

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[9] Christopher J. Swearingen, Maria S. Melguizo Castro, and Zoran Bursac. Modeling percentage outcomes: The %beta regression macro. In SAS Global Forum 2011, number Paper 335-2011, 2011.
[10] Francisco Cribari-Neto and Achim Zeileis. Beta regression in R. Journal of Statistical Software, 34:1-24, 2010.

Beta regression implementation results in R

The beta regression is run with two data sets: (i) all the data points and (ii) a training set only of two-third of the data selected randomly, with one-third of the data put aside to test the model on a testing data set. The results in both cases are similar, with a mean-square error value for case (ii) of 0.01 suggesting the absence of over-fitting. Since our purpose here is to identify explanatory variables for the whole landscape of existing counties, we present the results using the first data set (case (i)) only. Results in case (ii) are similar.

We first include all independent variables in the beta regression model; however, some of the variables such as the percentage of people with heart attack are not statistically significant. We thus delete non-significant variables and fit the model again until all variables left are significant at the 0.05 significance level. Again, while we ran the regression for all four link functions, only the results for the best-performing one (log-log) are presented here. Table 2 summarizes the coefficients estimates of significant variables for the three models (MAPD, PDP, Combined). Diagnostic measures suggest this model is a good fit. For instance for MAPD plans, the log-likelihood is 3,999, Akaike Information Criterion (AIC) is -7,956.1 and the pseudo R^2 of the model is 0.527; all explanatory variables are significant at the 0.05 significance level.

Two variables have coefficient estimates with the same signs in the MADP and PDP models: *percentage of non-Hispanic white population*, and *percentage of Bachelor degree or higher population*. This suggests that these two factors affect MAPD enrollment and PDP enrollment in the same direction. Fourteen variables have opposite signs in the coefficients for MAPD and PDP plan penetration.

- Nine factors have positive effects on PDP penetration rates but negative effects on MAPD penetration rates: *number of MAPD plans available*, *average age*, *percentage of females*, *percentage of people eligible for Medicaid*, and *percentage of people with obstructive pulmonary/ diabetes/ ischemic heart/ colorectal cancer/ hypertension*.
- Five factors negatively related to PDP enrollments but positively related to MAPD enrollments are *homeownership rate*, *average HCC score*, *percentage of people with kidney disease/high cholesterol/ Alzheimer*.

Most variables appear in all three models, but sometimes at different significance levels. Occasionally, some variables are significant in one model but might not be significant in others. For example, the percentage of people with asthma has a negative impact on PDP penetration but no significant impact on MAPD penetration. In contrast, the variable about the percentage of beneficiaries using Medicare Part B has a positive relationship with MAPD plan penetration, but not PDP plan penetration. This is intuitive since enrollment in both Medicare Part A and Part B is required in order to enroll in MAPD plans. Similar factors (significant for one model but not the other) include number of PDP plans available, per capita money income, percentage of people below poverty level, percentage of people with atrial fibrillation/breast cancer/prostate cancer/stroke, and Part B drug standardized Medicare costs as a percentage of total standardized Medicare costs.

Table 2 Summary of coefficients estimates for MAPD, PDP, and Total

	PDP		MAPD		Total	
Parameter	Estimate	Signi.[11]	Estimate	Signi.	Estimate	Signi.
(Intercept)	-5.9280	***	2.4790	***	-2.9850	***
cnt_mapd	-0.0118	***	0.0208	***	0.0037	***
cnt_pdp	0.0143	***	N/A	N/A[12]	0.0113	***
Average_Age	0.0575	***	-0.0508	***	0.0206	***
Percent_Female	3.1290	***	-0.8483	**	2.3480	***
Percent_Non_Hispanic_White	0.1679	***	0.1874	***	0.3108	***
Bachelor_degree_or_higher_perc	-0.4015	***	-0.4411	***	-0.8792	***
Homeownership_rate	-0.3007	***	0.4534	***	N/A	N/A
Per_capita_money_income	0.0000[13]	***	N/A	N/A	0.0000	.
Persons_below_poverty_level_per	0.8762	***	N/A	N/A	0.5370	***
Percent_Eligible_for_Medicaid	1.5300	***	-0.2359	*	1.5880	***
Average_HCC_Score	-1.1170	***	1.5523	***	0.2831	**
Percent_of_atrial_fibrillation	0.8717	.	N/A	N/A	1.5850	***
Percent_of_depression	N/A	N/A	N/A	N/A	0.3751	*
Percent_of_heart_failure	N/A	N/A	N/A	N/A	-0.3908	*
Percent_of_kidney_disease	-0.6750	**	0.9764	***	N/A	N/A
Percent_of_obstructive_pulmonary	1.1110	***	-2.2263	***	-1.1500	***
Percent_of_diabetes	1.3410	***	-1.3787	***	N/A	N/A
Percent_of_ischemic_heart	0.8841	***	-1.4635	***	N/A	N/A
Percent_of_breast_cancer	N/A	N/A	-1.7833	.	N/A	N/A
Percent_of_colorectal_cancer	4.6670	***	-3.6122	**	3.8520	***
Percent_of_prostate_cancer	1.7760	*	N/A	N/A	N/A	N/A
Percent_of_asthma	-1.7180	***	N/A	N/A	-2.2520	***
Percent_of_hypertension	1.0210	***	-1.1590	***	N/A	N/A
Percent_of_high_cholesterol	-0.8609	***	0.5189	***	-0.4981	***
Percent_of_alzheimer	-1.3240	***	0.9932	**	N/A	N/A
Percent_of_stroke	-2.6300	***	N/A	N/A	-3.2040	***
Part_B_Drugs_Standardized_Costs_perc	N/A	N/A	0.8453	*	0.5984	.
Percent_of_Beneficiaries_Using_PB	N/A	N/A	0.2277	***	0.1324	**

[11] Significance codes: 0.000001 '***', 0.001 '**', 0.01 '*', 0.05 '.', 0.1 ' '.
[12] N/A means the variable is not significant in the model.
[13] The actual coefficient estimate of this variable is a very small number close to zero, but not zero exactly.

Conclusions

This research brief has described factors associated with the choice of Medicare enrollees of MAPD plans and PDP plans when they obtain prescription drug coverage, using high-level census data, plan data and plan penetration data. We used beta regression and implemented the methodology in the statistical software R. Our results uncover significant differences in the models explaining MAPD and PDP enrollment. Most importantly, this research brief documents that MAPDs and PDPs are selected by different segments of the Medicare population rather than being pure substitutes of each other.

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