RESEARCH ARTICLE

Physician characteristics, industry transfers, and pharmaceutical prescribing: Empirical evidence from medicare and the physician payment sunshine act

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Objective: To evaluate physician characteristics associated with pharmaceutical industry transfers and prescribing behavior after public reporting under the *Sunshine Act*.

Data Sources: 2014-2016 secondary data on industry transfers to physicians from the Open Payments Dataset supplemented with Medicare Part D prescription data, Medicare service data, and practice attributes from the Physician Compare Database.

Study Design: Using regression analysis with county/physician fixed effects, this study examines characteristics associated with the probability/magnitude of transfers and the association between transfers and prescriptions.

Data Collection: Using an iterative matching approach, this study identifies physicians who delivered outpatient Medicare services in 2014 ($n = 409\,041$) and tracks their annual transfers between 2014 and 2016 ($N = 1\,227\,123$) across six transfer categories. In addition, it examines their Medicare Part D prescription behavior between 2014 and 2015 ($N = 741\,659$).

Principal Findings: Industry transfers dramatically declined in 2015 and 2016. Transfers are significantly associated with increased prescription costs, branded prescribing, and prescribing for High-Risk Medications (HRMs).

Conclusions: Industry transfers have declined after public reporting. Transfers are associated with higher prescription costs and incidence of HRMs. Future research is needed to determine the causal impact on quality and cost-effectiveness of prescribed medications.

KEYWORDS

conflict of interest, *Physician Payment Sunshine Act*, physician-industry transfers

1 | INTRODUCTION

Historically, researchers and policy makers have expressed concerns over the potential for conflicts of interest (COI) in conjunction with physician-industry transfers (hereafter referred to as “transfers”) and relationships. Pharmaceutical companies and device manufacturers often attempt to influence physician behavior through compensation, industry-sponsored educational programs, gifts, and personal visits by sales representatives (also known as “detailing”).

Industry efforts at interaction have largely been successful with researchers estimating that as many as 94% of physicians accept some form of transfers predominately gaining an audience with physicians through food and beverage.^{1,2} Physicians, for whom time is a scarce resource, often use detailing as a means of easily acquiring information about new drugs, potentially improving the quality of treatment to the direct benefit of the patient.³⁻⁵

However, detailing is often a mixture of scientific evidence and promotional marketing that physicians have difficulty separating.⁶

In addition, several studies examining the therapeutic value of the most aggressively promoted drugs have indicated that these drugs are less innovative, possess little/no value over existing medications, and have generic substitutes.^{7,8} Furthermore, a number of studies have found evidence that transfers are associated with higher prescription costs and lower quality prescriptions implying that transfers may create an undue COI.⁹⁻¹²

Given the potential dangers associated with transfers and COI, multiple medical organizations [including the American Board of Internal Medicine Foundation jointly with the Institute on Medicine as a Profession (in 2006), the Association of American Medical Colleges (in 2008), and the Institute of Medicine (in 2009)] have developed guidelines for managing COIs. As of 2011, however, 44% of MD-Granting Schools had either not adopted policies or had permissive policies for COIs.¹³ In addition, both the Medicare Payment Advisory Commission and the Institute of Medicine have documented the need for greater transparency around the COI associated with transfers.¹⁴

The passage of Section 6002 of the *Affordable Care Act of 2010* also known as the *Physician Payments Sunshine Act (PPSA)* answered these calls for transparency by requiring the full disclosure of any payment or transfer of value from drug and device manufacturers to licensed physicians. Beginning in 2013, manufacturers that produce at least one product covered by Medicare, Medicaid, or Children's Health Insurance Program are required to report any transfer valued at \$10 or more to the Centers for Medicare and Medicaid Services (CMS).¹⁵

In light of public reporting under the PPSA, it is important for researchers and policy makers to understand how physicians and industry will respond. While one can anticipate that many physician-industry interactions such as collaborative research, academic grants, and royalties from physician-generated patents will not necessarily change, many other areas of interaction may experience moderate or dramatic refinement. Given the pressure from medical organizations and stigma from peers and the general public, physicians may be more reluctant to engage in conventional detailing or accept transfers such as food and beverage, gifts, or entertainment. Industry representatives may, in turn, respond by increasing the value of the interaction by providing larger transfers or by changing the composition of interactions altogether (eg, more informative detailing sessions).

Using a rich panel of physicians who treated Medicare patients in 2014, this study is the first to explore the evolution of transfers across time (from 2014-2016) and is the first to comprehensively explore which physician, practice, and area characteristics are associated with the probability and magnitude of transfers after public reporting under the Sunshine Act. It is the only study to control for local characteristics and unobservable factors using a fixed effect (FE) approach that accounts for unmeasured characteristics at a county, and even individual physician-level. It further contributes to the literature by comprehensively identifying the association between transfers and prescribing behavior under Medicare Part D. More specifically, it examines whether transfers are associated with

higher prescription costs, branded prescribing, cost-effectiveness of prescribed medications, and finally, the incidence of prescriptions for high-risk medications (which are recommended to be avoided by those older than 65 due to a high risk of serious side effects). It now describes the current literature evaluating factors associated with transfers and prescribing.

2 | EXISTING LITERATURE

Early studies examined transfers using small surveys of physicians or state-specific databases. Campbell et al¹ examined the probability of accepting transfers using a 2004 sample of 1662 physicians across six specialties. They found significant differences according to specialty and that physicians in solo/group practices (as opposed to hospitals) and male physicians were more likely to accept transfers. Using 1891 physicians surveyed in 2004, Campbell et al² estimated the probability of any relationships with industry and found that those practicing in solo/two-person practices/group practices accepted more transfers than those practicing in hospitals and medical schools and that transfers are greater in high Medicare cost regions. Kesselheim and Siri¹⁶ use 2009-2011 data on Massachusetts physicians to examine the total value/probability of payments across physician specialties using summary statistics and find significant variation in the prevalence and value of transfers across specialties.

Recently, investigators have begun to explore industry transfers using Open Payment Data (OPD) released under the PPSA. For example, Karas et al¹⁷ examined payment characteristics across the full first year of public reporting (2014) among pediatricians. Marshall et al¹⁸ used regression analysis to examine the probability/magnitude of transfers among allopathic and osteopathic specialties in 2014. They found that male physicians, oncologists (relative to nononcologists), solo practitioners, and those in high Medicare spending regions were more likely to accept transfers. Using 2015 OPD, Tringale et al¹⁹ examined conditional transfers using regression analysis. They found that males and those in high Medicare spending regions accepted more transfers and that solo practitioners accepted less.

Several studies have examined the relationship between transfers and prescribing behavior among physicians using data prior to the PPSA. Spurling et al²⁰ performed a comprehensive review of 58 studies examining the exposure of information provided by pharmaceutical companies and prescribing behavior. They concluded that, "with rare exceptions, studies of exposure to information provided directly by pharmaceutical companies have found associations with higher prescribing frequency, higher costs, and lower prescribing quality or have not found significant associations" (Spurling et al²⁰, pg. 1) though they remain cautious about the ability to reach definitive conclusions about the relationship due to study limitations. Pham-Kanter et al²¹ use employer-sponsored insurance claims data on prescribing from 2003-2009 to examine the impact of sunshine laws in Maine and West Virginia. They find

that sunshine laws produced a small reduction in branded statin prescribing. Brax et al²² conducted a meta-analysis of studies examining the relationship between interactions with pharmaceutical companies and prescribing patterns, predominately focused on studies using data prior to the PPSA. Within the 19 evaluated studies, they found 15 with associations between industry interaction promoting a medication, inappropriate prescribing rates, increased prescription costs, and lower prescribing quality. Yeh et al¹¹ used a 2011 cross section of Massachusetts physicians to examine transfers and Medicare part D statin prescriptions and found that transfers were positively associated with branded prescriptions. Datta and Dave²³ use a longitudinal monthly dataset on 150 000 physicians spanning 1997-1999 to examine the effects of industry detailing on prescriptions for the detailed drug and found a positive relationship. Carey et al²⁴ examined the impact of pharmaceutical transfers on prescribing behavior under Medicare Part D from 2011 to 2013 and found that patients are more likely to be prescribed a drug when their prescriber received a transfer from its company; however, examining efficacy data from clinical trials, they find that those receiving transfers are more likely to be prescribed higher quality drugs on average.

In addition, a few studies have examined transfers after the PPSA. DeJong et al¹⁰ use a cross-section of physicians observed in 2013 and examine the association between industry meals and prescribing patterns for Medicare Part D beneficiaries. They find increased rates of prescribing among those who received a meal promoting the drug interest. Fleischman et al²⁵ perform a cross sectional analysis of hospital referral regions with 2013-2014 OPD and Medicare Part D prescriptions for two drug classes. They find that transfers are associated with increased rates of prescribing. Perlis and Perlis²⁶ use 2013 OPD and find that transfers are associated with greater levels of branded prescribing and prescription costs per Part D beneficiary.

While some common overall results can be observed across each of these studies, existing work has predominately explored these issues using either simple summary statistics or using regression analysis with extremely limited explanatory variables. Furthermore, existing studies examining transfers after the PPSA did so using simple cross sections which limit their ability to estimate changes in physician and industry behavior over time. This study expands on these studies by (a) examining changes in transfers and prescribing behavior using a panel of physicians, (b) including a more comprehensive set of physician and practice characteristics, and (c) controlling for unobserved physician and area characteristics that may influence transfers through the inclusion physician/county FEs.

3 | DATA AND SAMPLING

This institutional review board exempt study uses publicly available data from the 2014-2016 OPD on general payments containing manufacturer reported transfers reported under the PPSA. The OPD data are supplemented with physician attributes from

the Physician Compare National Downloadable File (PCNDF) containing general information on all eligible health care providers (ie, those with at least one practice location address/specialty code in the Medicare Provider Enrollment, Chain, and Ownership System who have submitted at least one annual Medicare claim), Medicare Part B service provision data from the 2013-2015 Medicare Fee-For-Service Provider Utilization and Payment Data-Physicians and Other Supplier Public Use Files (hereafter referred to as the SPUs), and data on physician-specific prescription rates and costs from the Medicare Part D Prescriber (MPDP) Public Use Files for 2014 and 2015.

Using the 2014 SPU file containing all physicians submitting Medicare Part B claims in the calendar year 2014, the analysis identifies physicians practicing in the contingent United States, with unique first/last name/zip code combinations (N = 517 441). Using this sample, it identifies physicians who also have characteristics present in the PCNDF using unique National Provider Identifiers (NPIs) [N = 453 628], who simultaneously have unique first/last name/zip code combinations from the 2014-2016 OPD sample (N = 451 235). The analysis identifies 333 160 physicians who are present in both the OPD data and the SPU sample with unique first/middle/last name zip code matches. Using a first name/last name/state match, it identifies 105 271 physicians who did not accept a transfer between 2014 and 2016 (ie, those who appear in the SPU sample but do not appear in 2014-2016 OPD data). Using first name/last name/state matches in conjunction with geocoded SPU and OPD address locations, it further identifies 10 020 physicians with unique first/middle/last names who have SPU/OPD transfer address locations that are within 70 linear miles of each other. The analysis excluded the remaining 2784 providers without definitive matches in the OPD. Finally, it eliminated providers with invalid primary specializations (eg, those with unknown physician specialty codes, dentists, chiropractors, etc.), specialties with insufficient sample sizes, and those with missing practice/graduation data, resulting in an overall sample of 409 041 observations per year.

Collectively, this [Medicare physician] sample spans a total of three years for an overall sample of 1 227 123 observations that are used to examine attributes associated with transfers. To explore the relationship between transfers and physician prescribing behavior, the analysis identifies members of the Medicare physician sample who are present in either the 2014 and 2015 MPDP files, which indicates, that they prescribed medications under Medicare Part D (N = 741 659).

4 | DEPENDENT VARIABLES AND ESTIMATION METHOD

Using the Medicare physician sample, the analysis examines the probability and conditional dollar value of annual transfers from 2014 to 2016 across six categories reported in Table 1 Panel A. These six categories including food and beverage, education, travel/lodging, compensation for consulting, compensation for other services (not

TABLE 1 Summary statistics for annual physician-pharmaceutical industry transfers and physician prescribing behavior

Variable	Description	Year			Year					
		2014		2015	2016		2014	2015	2016	
		Mean/Prop (SD)	[Median]	Mean/Prop (SD)	[Median]	Mean/Prop. (SD)	[Median]	Mean/Prop (SD)	Mean/Prop (SD)	Mean/Prop (SD)
Panel A: Descriptions and summary statistics for pharmaceutical-based industry transfers										
		Proportion accepting transfers			Inflation adjusted conditional mean \$ value					
Food/Beverage	Food and beverage (such as when a drug manufacturer brings coffee/snacks to the physician's office, or pays for a physician's meal)	0.571 (0.495)	0.562 (0.496)	0.515 (0.500)	484.69 (771.02)	515.08 (812.81)	440.94 (682.62)			
N		409 041	409 041	409 041	233 421	230 058	210 646			
Education	Payments or transfers of value for classes, activities, programs, or events that involve the imparting or acquiring of particular knowledge or skills	0.200 (0.400)	0.165 (0.371)	0.112 (0.316)	88.42 (546.71)	84.60 (647.52)	40.90 (412.60)			
N		409 041	409 041	409 041	81 985	67 491	45 945			
Travel/Lodging	Travel and Lodging	0.039 (0.192)	0.038 (0.194)	0.031 (0.173)	3459.02 (7110.78)	3711.85 (7618.82)	3353.63 (6538.14)			
N		409 041	409 041	409 041	15 764	16 058	12 671			
Consulting	Payments made for advice or expertise	0.046 (0.209)	0.038 (0.192)	0.024 (0.153)	4374.54 (12305.64)	5065.60 (12977.70)	5478.03 (14518.21)			
N		409 041	409 041	409 041	18 818	15 713	9869			
Other Services	Payments for speaking, training, and educational engagements that are not for continuing education	0.030 (0.172)	0.036 (0.185)	0.031 (0.174)	19073.01 (31801.61)	20414.46 (36702.45)	18725.61 (32225.99)			
N		409 041	409 041	409 041	12 453	14 568	12 742			
Any transfers	Payments or transfers of value for food and beverage, education, travel/lodging, consulting, other services (not consulting), gifts, entertainment, honoraria	0.593 (0.491)	0.579 (0.494)	0.526 (0.499)	2219.30 (13315.09)	2450.70 (14681.91)	2039.33 (12366.56)			
N		409 041	409 041	409 041	242 439	236 769	214 961			

(Continues)

TABLE 1 (Continued)

Variable	Description	Year		Year	
		2014	2015	2016	2016
		Mean/Prop (SD) [Median]	Mean/Prop (SD) [Median]	Mean/Prop (SD) [Median]	Mean/Prop (SD) [Median]
<i>Panel B: Descriptions and summary statistics for medicare part D prescribing behavior</i>					
Real Annual Prescription Cost/ Beneficiary	The physician's inflation adjusted annual prescription cost per among Part D Beneficiaries with at least one prescription	1039.58 (2227.87) [547.49]	1167.97 (2641.10) [588.15]		
N		367 211	367 005		
Prescription Costs/ Day	Inflation adjusted annual prescription drug cost per day supplied	4.06 (11.13) [1.94]	4.73 (14.53) [1.92]		
N		370 912	370 747		
Percentage of Costs from Branded Drugs	Percentage of Annual Real Total Prescription Costs attributable to Brand name prescription drugs	0.689 (0.182) [0.700]	0.689 (0.195) [0.707]		
N		251 603	256 315		
Prescription Costs/ Day for Substitutable Medications	Inflation adjusted annual prescription drug cost per day supplied for Patented Medicine Prices Review Board classified drugs that were deemed to provide "moderate, little or no therapeutic advantage over comparable medicines" and competing products	7.06 (31.83) [1.60]	7.58 (41.76) [1.46]		
N		265 148	268 257		
Prescribed High-Risk Medications	1 if physician prescribed a high-risk medication to an individual 65 or older that is recommended by the American Geriatric Society to be avoided in persons aged 65 or older due to a high risk of serious side effects	0.746 (0.435) 258 477	0.725 (0.447) 258 379		
N					
Percentage of 65+ Part D Beneficiaries with Prescription for HRM	Percentage of physician's 65+ Medicare Part D Patients with at least one high-risk medication prescription during the year	0.105 (0.084) [0.102]	0.088 (0.076) [0.084]		
N		164 790	163 557		

consulting), and any transfers (collectively including the previously noted five categories and additional, rare event categories [ie, those with annual probabilities of two percent or less] such as gifts, entertainment, and honoraria).

To explore the relationship between transfers and prescribing behavior, the analysis examines several dependent variables. Descriptions and summary statistics for these variables are provided in Table 1 Panel B. Given that previous studies found evidence of elevated prescription costs and increased use of brand-name medications with higher levels of transfers, the analysis further explores this issue by examining the relationship between transfers and the physician's inflation adjusted: (a) annual prescription cost per Part D beneficiary, (b) average Part D prescription cost per prescribed day, and (c) percentage of total Part D prescription costs associated with branded prescriptions. As noted by others, however, industry detailing and education can help inform physicians and direct them toward more clinically effective (and potentially more expensive) nongeneric medications, implying that higher prescription costs may also be associated with higher quality. To examine the impact on costs independent of quality, the analysis also examines costs per prescribed day for medications that were deemed by the Canadian Human Drug Advisory Panel (HDAP), an independent medical board (composed of doctors, pharmacists, and other health care professionals), as having moderate, little, or no therapeutic advantage over comparable medications. Using the HDAP drug classifications in conjunction with substitute medications identified by the Patented Medicine Price Review Board, this study constructs prescription costs per prescribed day for 266 branded medications and generic equivalents across 27 different drug categories (eg, the erectile dysfunction drug Viagra, Cialis, Revatio, Adcirca, Levitra, Staxyn, and generic Sildenafil). A full list of medications and their substitutes is provided in Appendix S1. Given that these medications have comparable substitutes and therapeutic quality to existing medications, higher costs per day for these medications in conjunction with transfers could imply lower overall cost-effectiveness.

Finally, the analysis examines the incidence and relative rates of prescribing for a less desirable drug category, High-Risk Medications (HRMs). HRM are prescription drugs recommended by the American Geriatrics Society to be avoided in persons aged 65+ years because of a high risk of serious side effects, when safer drug choices may be available. For HRMs, the analysis explores the association between transfers and the probability of prescribing to Part D beneficiaries 65 or older and the frequency of relative prescribing by examining the percentage of the physician's 65+ Medicare Part D beneficiaries who were prescribed HRMs during the year.

To examine physician and practice attributes associated with transfers, this study uses multiple linear regression analysis to estimate linear probability models for the annual probability of receiving a transfer in each of the six previously described categories. In addition, it explores the magnitude of transfers across each category by log transforming the conditional magnitude of real transfers. This transformation permits for ease in interpretation as coefficient

estimates can be interpreted as approximate percentage changes in each transfer category.²⁷ For each prescription behavior dependent variable, the study uses multiple linear regression analysis with the acceptance of any transfers and the natural log of the conditional dollar magnitude of any transfers as the key independent variables in separate regressions. Given the likely correlation across error terms, all standard errors are clustered by physician.

5 | EXPLANATORY VARIABLES

The analysis expands on a number of explanatory variables present in other studies. Descriptions and summary statistics for these explanatory variables are reported in Table 2. Following existing studies, the analysis includes controls for the physician's gender and expands on existing studies by including FEs for 45 distinct specialties.

To control for practice size, the study expands on the literature by using a more comprehensive seven group categorical classification (ie, solo, 2-3, 4-10, 11-20, 21-50, 51-100, and 100+). Practice size is identified as the physician's smallest practice based on practice identification numbers (as reported in the PCNDF). Given that most transfers are in conjunction with detailing that involves costly time in conjunction with car travel, one can anticipate that detailers will more likely target larger practices, where physicians are more concentrated.

Existing studies largely control for area characteristics using the regional classification of Medicare spending (ie, whether low, average, or high); however, those covered under Medicare consume roughly double the number of prescriptions per capita as those in 19-64 age demographic.²⁸ This implies that physicians and specialties with greater Medicare treatment volume are more likely targets for transfers, independent of regional spending. In addition, the percentage of a practice's revenue from Medicare varies systematically across specialties,²⁹ implying that Medicare spending by region is likely an inadequate control for individual physician treatment patterns. Given that existing studies only control for Medicare spending region or use regional census controls, they likely experience confounding through omitted variable bias. To improve on the methodology of previous studies, this study controls for the physician's Medicare treatment volume through the inclusion of the natural log of the physician's total annual Relative Value Units (RVUs) billed to Medicare in the previous year (from the SPU files). It uses lagged values for RVUs to account for any contemporaneous endogeneity in Medicare treatment and transfers.

Since previous studies have found evidence of fewer transfers among hospital-based physicians, the analysis also controls for whether the physician's Medicare revenue predominately originates from office-based visits by using the relative share of office and facility Medicare RVU billing in the previous year to classify the physician as either facility- or office-based.

Furthermore, existing studies have used only simple cross sections of data, limiting their ability to examine changes in transfers and prescribing over time. Given that this analysis tracks the same

TABLE 2 Descriptions and summary statistics for explanatory variables

Variable	Description	Medicare physician sample			Part D physician sample	
		2014	2015	2016	2014	2015
		Mean/Prop (SD)	Mean/Prop (SD)	Mean/Prop (SD)	Mean/Prop (SD)	Mean/Prop (SD)
Male	1 if physician is male, 0 if female	0.709 (0.454)	0.709 (0.454)	0.709 (0.454)	0.715 (0.452)	0.715 (0.452)
Medicare RVUs	Sum of annual billed Medicare Relative Value Units (across physician, practice expense, and malpractice) in the year prior to observation	3452.155 (5458.179)	3520.399 (5287.956)	3540.635 (5274.769)	3622.900 (5589.933)	3683.558 (5420.232)
Office-Based	1 if the percentage of Medicare RVUs billed from a facility is less than 50%	0.607 (0.488)	0.556 (0.497)	0.556 (0.496)	0.638 (0.481)	0.594 (0.491)
<i>Practice size: Categorized based on the physician's smallest PACID. For physicians without a PACID, defined as solo practice</i>						
2 to 3 members	1 if practice size is 2 to 3 members	0.080 (0.272)	0.080 (0.272)	0.080 (0.272)	0.084 (0.278)	0.084 (0.278)
4 to 10 members	1 if practice size is 4 to 10 members	0.129 (0.336)	0.129 (0.336)	0.129 (0.336)	0.131 (0.338)	0.131 (0.338)
11 to 20 members	1 if practice size is 11 to 20 members	0.075 (0.263)	0.075 (0.263)	0.075 (0.263)	0.075 (0.263)	0.075 (0.263)
21 to 50 members	1 if practice size is 21 to 50 members	0.104 (0.305)	0.104 (0.305)	0.104 (0.305)	0.104 (0.305)	0.104 (0.305)
51 to 100 members	1 if practice size is 51 to 100 members	0.079 (0.269)	0.079 (0.269)	0.079 (0.269)	0.079 (0.270)	0.079 (0.270)
100+ members	1 if practice size is more than 100 members	0.368 (0.482)	0.368 (0.482)	0.368 (0.482)	0.352 (0.478)	0.352 (0.477)
<i>Years in practice: Categorized based on observation year minus the physician's year of graduation</i>						
11-19 yr	1 if 11-19 years in practice	0.262 (0.440)	0.262 (0.440)	0.262 (0.439)	0.261 (0.439)	0.260 (0.439)
20-29 yr	1 if 20-29 years in practice	0.268 (0.443)	0.269 (0.443)	0.269 (0.444)	0.271 (0.444)	0.272 (0.445)
30+ yr	1 if 30+ years in Practice	0.304 (0.460)	0.331 (0.470)	0.331 (0.479)	0.308 (0.462)	0.335 (0.472)
N		409 041	409 041	409 041	370 912	370 747

physicians over a three-year period, it is able to expand on this previous work and isolate changes across time through the inclusion of year FEs (ie, whether the physician is observed in 2014 [the reference year], 2015, or 2016).

In addition, no studies examining transfers or prescribing behavior after the PPSA have included area controls, even at a state level. The inclusion of state controls (or a lower geographic unit) is important for several reasons. First, several states (ie, Massachusetts, Minnesota, Vermont, and West Virginia, as well as the District of Columbia) have public reporting requirements and restrictions on relationships that predate the PPSA. Second, some states have placed limitations on the interactions and permissible

transfers between industry and health care professionals (eg, California, Connecticut, Louisiana, Nevada). Given these state level differences in restrictions and reporting, it is very important to include area controls in any analysis of transfers. Furthermore, state level differences in tort reform and unobserved local area characteristics (such as wealth and health status of the population) may also influence physician behavior, implying a high potential for omitted variable bias without the inclusion of some form of area FEs. This study uses a FE approach to isolate and remove omitted variable bias by including either county or physician-level FEs that fully account for unobservables at the county or physician-level and higher, respectively.

6 | RESULTS FOR PHYSICIAN AND PRACTICE ATTRIBUTES AND INDUSTRY TRANSFERS

Estimated regression results for the acceptance of any transfers that include county FEs are reported in Table 3 for all specialties and for broadly defined specialty subsamples of primary care, medical specialists, and surgical specialties (defined in the Table 3 footnote). Alternative models estimated with physician FEs in place of county FEs are reported in Table S1. Table 4 reports results for the sample of all specialties for the five categories of food and beverage, education, travel/lodging, consultations, and other services. For each outcome, the first column provides estimates for the probability of accepting at least one annual transfer. The second column provides estimates for the natural log of the real dollar value of transfers conditional on receiving at least one annual transfer in the category.

Across all estimated models, males consistently display a higher probability and magnitude of accepting transfers. All specialty results (columns 1 and 2) reveal that male physicians are 3.4 percentage points more likely to accept a transfer than female physicians (whose average predicted acceptance is 54%) and conditional on receipt of a transfer, accept 27.1% more annual transfers than female physicians (who are predicted to accept approximately \$185).

Medicare treatment volume, as measured through the natural log of lagged annual billed Medicare RVUs, is positively associated with the probability of receiving transfers across all estimated models and for the conditional volume of transfers for all categories except travel/lodging and consulting. Any transfers results (Table 3), indicate that a 10% increase in annual Medicare RVUs is associated with a 0.3 percentage point increase in the probability of accepting any transfers and a 0.8%-1.4% increase in the dollar value of transfers. Physicians who practice primarily in an office-based setting are 11.9% more likely to accept transfers than those in a facility/hospital setting (whose average predicted acceptance is 54%) and conditional on acceptance, received 43.1% more transfers than facility-based physicians (who on average are predicted to accept \$171).

Estimates for year FEs indicate overall declines in transfers in 2015 and 2016 relative to 2014. Any transfers results indicate that physicians were 2.1%-4.5% less likely to accept some form of transfers in 2015 (than the all specialty prediction for 2014 of 60% acceptance) and were 7.2%-10.3% less likely in 2016. For the total magnitude of transfers conditional on acceptance, those observed in 2015 accepted 2.9%-12% less transfers than in 2014 (whose predicted average was \$244.86) and 16.7%-36% less transfers in 2016. These results carry through for most individual categories (food/beverage, education, and other services) and models that included physician fixed effects (Table S1). Exceptions include the conditional dollar magnitudes for travel/lodging and consulting, which displayed increases for the magnitude of transfers.

Results for practice size reveal that, relative to solo practitioners (with an average predicted acceptance of 59% and conditional annual acceptance of \$216), practices of 2-3 and 4-10 members consistently accepted more transfers across all estimated categories.

For any transfers, practices of 2-3 and 4-10 members were approximately 6% more likely to accept some kind of transfer and accepted 19%-21% more transfers annually. This overall result is consistent with the previous prediction that detailers target larger practices. Practice sizes greater than 10 however, exhibit much more heterogeneity. For example, primary care physicians in larger practices (11+ members) are less likely to accept any transfers (3%-15%) and accept far fewer transfers (4%-22%). For specialists and surgical specialists, however, the probability of accepting transfers increase for all but those with 100+ members, and the conditional magnitude of transfers increases by between 5% and 21%. These results for practice size are likely due to the fact that, within our sample, members of larger practices are typically facility-based (ie, 51.17% of physicians are facility-based among practices of 11+ vs 27.7% among practices of less than 11 physicians) for whom previous work and this study have found to accept fewer transfers. For these physicians, variability in physician presence/availability and differences in practice culture may make the practice less appealing targets for detailing despite their larger size.

Estimated results for years in practice reveal strong evidence that physicians later in their careers accept more transfers across almost all categories. These results are consistent with case studies reporting that middle and late-career physicians use detailing to help inform them about new medications. For any transfers, those with 11-19, 20-29, and 30+ years of experience are found to be 2.7, 3.8, and 1.4 percentage points more likely to accept some form of transfer than those with 10 or fewer years of experience who had an average predicted acceptance rate of 54%. Those with 11-19, 20-29, and 30+ years of experience were also found to accept 14.2, 24, and 10.3% more transfers than physicians with 10 or fewer years of experience (whose predicted conditional annual acceptance was valued at \$196).

7 | RESULTS FOR INDUSTRY TRANSFERS AND PHYSICIAN PRESCRIBING BEHAVIOR

Table 5 presents key results examining the association between the probability and conditional magnitude of any transfers and six distinct prescription-based outcome measures that are estimated with either county- or physician-level FEs. Expanded results are reported in Tables S2 and S3. While both sets of models find statistically significant estimates of the same sign, physician FE models produce results of substantially lower magnitudes suggesting that unobserved physician and patient characteristics explain much of the variation in prescribing behavior. For example, models with county FEs find that those who didn't accept any transfers had average predicted annual prescription cost of \$361.12, daily prescription cost of \$2.21, and 66.2% of their total prescription cost due to branded drugs. These same models find that physicians who accepted transfers have 36% higher annual prescription costs per beneficiary, 11.3% higher prescription costs per day, and 4.1 percentage points more of their total prescription costs due to branded drugs. Using physician FEs,

TABLE 3 Determinants of physician-industry transfers by broad specialty 2014-2016

	All specialties		Primary care		Medical specialists		Surgical specialists	
	(1) Prob. Coeff. (SE)	(2) ln (\$) Coeff. (SE)	(3) Prob. Coeff. (SE)	(4) ln (\$) Coeff. (SE)	(5) Prob. Coeff. (SE)	(6) ln (\$) Coeff. (SE)	(7) Prob. Coeff. (SE)	(8) ln (\$) Coeff. (SE)
Male	0.034*** (0.001)	0.271*** (0.007)	0.031*** (0.002)	0.223*** (0.010)	0.032*** (0.002)	0.400*** (0.013)	0.033*** (0.003)	0.106*** (0.013)
ln(Medicare RVUs +1)	0.031*** (0.000)	0.112*** (0.001)	0.032*** (0.000)	0.139*** (0.002)	0.028*** (0.000)	0.095*** (0.003)	0.032*** (0.001)	0.082*** (0.003)
Office-based	0.119*** (0.001)	0.431*** (0.007)	0.159*** (0.002)	0.750*** (0.011)	0.088*** (0.002)	0.312*** (0.013)	0.078*** (0.003)	0.038*** (0.013)
Year 2015	-0.029*** (0.001)	-0.029*** (0.003)	-0.024*** (0.001)	-0.032*** (0.005)	-0.021*** (0.001)	0.040*** (0.005)	-0.045*** (0.002)	-0.120*** (0.006)
Year 2016	-0.082*** (0.001)	-0.227*** (0.003)	-0.072*** (0.001)	-0.167*** (0.005)	-0.076*** (0.001)	-0.202*** (0.006)	-0.103*** (0.002)	-0.360*** (0.007)
<i>Practice size</i>								
2 to 3 members	0.060*** (0.002)	0.213*** (0.011)	0.047*** (0.004)	0.221*** (0.018)	0.050*** (0.004)	0.298*** (0.022)	0.097*** (0.005)	0.137*** (0.018)
4 to 10 members	0.057*** (0.002)	0.194*** (0.010)	0.025*** (0.004)	0.179*** (0.017)	0.045*** (0.003)	0.255*** (0.019)	0.118*** (0.004)	0.214*** (0.016)
11 to 20 members	0.019*** (0.003)	0.043*** (0.013)	-0.028*** (0.005)	-0.111*** (0.021)	0.020*** (0.004)	0.128*** (0.023)	0.080*** (0.005)	0.178*** (0.020)
21 to 50 members	-0.006** (0.002)	0.009 (0.012)	-0.049*** (0.004)	-0.104*** (0.018)	0.010*** (0.004)	0.060*** (0.022)	0.041*** (0.005)	0.188*** (0.020)
51 to 100 members	-0.012*** (0.003)	0.035*** (0.013)	-0.051*** (0.004)	-0.035* (0.020)	-0.006 (0.004)	0.068*** (0.025)	0.042*** (0.005)	0.165*** (0.023)
100+ members	-0.104*** (0.002)	-0.052*** (0.010)	-0.144*** (0.003)	-0.220*** (0.015)	-0.098*** (0.003)	0.050*** (0.019)	-0.056*** (0.004)	0.080*** (0.017)
<i>Years in practice</i>								
11-19 yr	0.027*** (0.002)	0.142*** (0.009)	0.034*** (0.003)	0.064*** (0.013)	0.017*** (0.003)	0.225*** (0.017)	0.000 (0.004)	0.090*** (0.015)
20-29 yr	0.038*** (0.002)	0.240*** (0.009)	0.055*** (0.003)	0.191*** (0.014)	0.027*** (0.003)	0.318*** (0.018)	-0.013*** (0.004)	0.129*** (0.015)
30+ yr	0.014*** (0.002)	0.103*** (0.009)	0.054*** (0.003)	0.124*** (0.015)	0.005* (0.003)	0.114*** (0.018)	-0.064*** (0.004)	-0.011 (0.015)
Constant	0.282*** (0.004)	4.163*** (0.017)	0.256*** (0.005)	3.786*** (0.024)	0.473*** (0.006)	4.392*** (0.034)	0.503*** (0.006)	4.287*** (0.026)
R-Squared	0.214	0.181	0.194	0.14	0.282	0.143	0.198	0.162
N	1 227 123	694 169	474 738	260 532	442 617	262 468	309 768	171 169

Notes: Estimated using Ordinary Least Squares Multiple Regression with physician clustering using Stata 15. Each model was estimated with county fixed effects and a full set of specialty fixed effects (not reported). Primary Care includes: Family Practice, General Practice, Geriatric Medicine, Internal Medicine, Pediatric Medicine. Medical Specialists include: Allergy/Immunology, Cardiac Electrophysiology, Cardiology, Critical Care (Intensivists), Dermatology, Emergency Medicine, Endocrinology, Gastroenterology, Hematology/Oncology, Infectious Disease, Interventional Radiology, Medical Oncology, Nephrology, Neurology, Nuclear Medicine, Osteopathic Manipulative Medicine, Pain Management, Pathology, Preventive Medicine, Psychiatry, Pulmonary Disease, Radiation Oncology, Rheumatology, Sports Medicine. Surgical Specialists include: Cardiac Surgery, Colorectal Surgery (formerly proctology), General Surgery, Gynecological/Oncology, Hand Surgery, Maxillofacial Surgery, Neurosurgery, Obstetrics/Gynecology, Ophthalmology, Orthopedic Surgery, Otolaryngology, Plastic and Reconstructive Surgery, Surgical Oncology, Thoracic Surgery, Urology, Vascular Surgery.

*** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$.

TABLE 4 Determinants of physician-industry transfers 2014-2016

	Food/Beverage		Education		Travel/Lodging			Consulting		Other services	
	(1) Prob. Coeff. (SE)	(2) ln (\$) Coeff. (SE)	(3) Prob. Coeff. (SE)	(4) ln (\$) Coeff. (SE)	(5) Prob. Coeff. (SE)	(6) ln (\$) Coeff. (SE)	(7) Prob. Coeff. (SE)	(8) ln (\$) Coeff. (SE)	(9) Prob. Coeff. (SE)	(10) ln (\$) Coeff. (SE)	
Male	0.031*** (0.001)	0.162*** (0.006)	0.027*** (0.001)	0.067*** (0.007)	0.022*** (0.001)	0.272*** (0.030)	0.019*** (0.000)	0.343*** (0.029)	0.018*** (0.000)	0.491*** (0.041)	
ln(Medicare RVUs+1)	0.031*** (0.000)	0.111*** (0.001)	0.020*** (0.000)	0.009*** (0.002)	0.003*** (0.000)	-0.017*** (0.007)	0.003*** (0.000)	-0.031*** (0.007)	0.004*** (0.000)	0.026*** (0.008)	
Office-based	0.118*** (0.001)	0.475*** (0.006)	0.096*** (0.001)	0.026*** (0.008)	0.006*** (0.001)	0.018 (0.025)	0.009*** (0.001)	-0.218*** (0.027)	0.011*** (0.001)	0.089*** (0.032)	
Year 2015	-0.023*** (0.001)	-0.030*** (0.003)	-0.045*** (0.001)	-0.255*** (0.007)	-0.001*** (0.000)	0.032** (0.016)	-0.009*** (0.000)	0.433*** (0.018)	0.003*** (0.000)	-0.193*** (0.017)	
Year 2016	-0.070*** (0.001)	-0.186*** (0.003)	-0.098*** (0.001)	-0.627*** (0.007)	-0.009*** (0.000)	0.061*** (0.017)	-0.024*** (0.000)	0.683*** (0.021)	-0.001*** (0.000)	-0.288*** (0.019)	
Practice size											
2 to 3 members	0.064*** (0.003)	0.181*** (0.010)	0.023*** (0.002)	0.026** (0.011)	0.009*** (0.001)	0.208*** (0.049)	0.009*** (0.001)	0.277*** (0.049)	0.011*** (0.001)	0.028 (0.055)	
4 to 10 members	0.062*** (0.002)	0.168*** (0.008)	0.008*** (0.002)	-0.003 (0.010)	0.009*** (0.001)	0.195*** (0.044)	0.007*** (0.001)	0.332*** (0.044)	0.010*** (0.001)	0.02 (0.050)	
11 to 20 members	0.022*** (0.003)	0.008 (0.010)	-0.021*** (0.002)	-0.035*** (0.013)	0.008*** (0.001)	0.198*** (0.052)	0.006*** (0.001)	0.382*** (0.054)	0.008*** (0.001)	0.103* (0.060)	
21 to 50 members	-0.004 (0.002)	-0.020** (0.010)	-0.028*** (0.002)	-0.052*** (0.012)	0.005*** (0.001)	0.292*** (0.050)	0.004*** (0.001)	0.397*** (0.050)	0.004*** (0.001)	0.250*** (0.059)	
51 to 100 members	-0.013*** (0.003)	0.008 (0.011)	-0.024*** (0.002)	-0.036*** (0.013)	0.005*** (0.001)	0.199*** (0.055)	0.005*** (0.001)	0.427*** (0.055)	0.004*** (0.001)	0.123*** (0.063)	
100+ members	-0.108*** (0.002)	-0.157*** (0.008)	-0.056*** (0.001)	-0.055*** (0.010)	0.008*** (0.001)	0.350*** (0.040)	0.007*** (0.001)	0.649*** (0.039)	0.000 (0.001)	0.275*** (0.047)	
Years in practice											
11-19 yr	0.022*** (0.002)	0.050*** (0.007)	0.020*** (0.001)	0.014 (0.012)	0.012*** (0.001)	0.290*** (0.041)	0.013*** (0.001)	0.210*** (0.039)	0.009*** (0.001)	0.569*** (0.060)	
(Continues)											

(Continues)

TABLE 4 (Continued)

	Food/Beverage			Education			Travel/Lodging			Consulting			Other services		
	(1) Prob. Coeff. (SE)	(2) ln (\$) Coeff. (SE)		(3) Prob. Coeff. (SE)	(4) ln (\$) Coeff. (SE)		(5) Prob. Coeff. (SE)	(6) ln (\$) Coeff. (SE)		(7) Prob. Coeff. (SE)	(8) ln (\$) Coeff. (SE)		(9) Prob. Coeff. (SE)	(10) ln (\$) Coeff. (SE)	
20-29 yr	0.030*** (0.002)	0.128*** (0.008)		0.040*** (0.001)	0.01 (0.012)		0.018*** (0.001)	0.398*** (0.042)		0.018*** (0.001)	0.298*** (0.040)		0.012*** (0.001)	0.581*** (0.062)	
30+ yr	0.004* (0.002)	0.053*** (0.008)		0.029*** (0.001)	-0.041*** (0.012)		0.007*** (0.001)	0.366*** (0.043)		0.011*** (0.001)	0.280*** (0.041)		0.001* (0.001)	0.427*** (0.062)	
Constant	0.269*** (0.004)	4.258*** (0.014)		0.012*** (0.002)	3.248*** (0.021)		-0.038*** (0.001)	5.607*** (0.096)		-0.019*** (0.001)	4.319*** (0.078)		-0.049*** (0.001)	6.529*** (0.123)	
R-Squared	0.214	0.217		0.124	0.079		0.057	0.073		0.053	0.31		0.064	0.238	
N	1 227 123	674 125		1 227 123	195 421		1 227 123	44 493		1 227 123	44 400		1 227 123	39 763	

Notes: Estimated using Ordinary Least Squares Multiple Regression with physician clustering using Stata 15. Each model was estimated with county fixed effects and a full set of specialty fixed effects (not reported).

***p < 0.01, **p < 0.05, *p < 0.1.

physicians who accepted transfers were found to have 3% higher annual prescription costs per beneficiary, 1.2% higher prescription costs per day, and 0.3% more of their total prescription costs due to branded drugs than those without transfers (whose average predicted values for each respective category were \$443.09, \$2.35, and 68.7%)

Using the natural log of the conditional dollar magnitude of transfers provides a similar story, indicating that a 10% increase in transfers is associated with a 0.3-1.31% increase (from \$600.51) in annual prescription costs per beneficiary, a 0.13-0.59% increase (from \$2.60) in prescription costs per day, and a 0.03-0.12% increase (from 71.67%) in their total prescription costs due to branded drugs.

Estimates for prescription costs per day for substitutable medications (Columns 7 and 8) are both positive and statistically significant indicating that the rise in prescription costs and substitution toward branded medications is not necessarily cost-effective. Those who accept transfers have 1.8%-17.4% higher prescription costs per day (than those without transfers whose predicted costs were \$1.73 and \$1.56) and a conditional 10% increase in transfers is associated with a 0.14%-0.69% increase in costs per day among substitutable medications implying an \$.003 to \$0.14 increase in costs per day.

Finally, Columns 9-12 of Table 5 explores the relative rates of prescribing HRM among 65+ beneficiaries. Estimated models indicate that physicians without transfers have an average predicted probability of prescribing at least one HRM during the year at 70% and 73.3% under county and physician FE models and have approximately 9.2% of their 65 or older Medicare patients with an HRM prescription. Accepting transfers is associated with an increase in the probability of prescribing HRMs for each respective model by 5.3 and 0.3 percentage points and increases the share of 65+ patients with an HRM prescription by 0.7 percentage points. Conditional on acceptance, a 10% increase in transfers is associated with a 0.01-0.1 percentage point increase (over the estimated predicted average of 78%) in the probability of prescribing an HRM and increases the share of 65+ patients with an HRM prescription by 0.01-0.02 percentage points (over the average prediction of 10.3%).

8 | CONCLUSION

Using a sample of Medicare treating physicians observed across 2014-2016, this study examines physicians and area attributes associated with transfers and Medicare Part D prescription behavior. It finds that males, those with greater Medicare treatment volumes, office-based physicians, and those with larger practices tend to accept more transfers. Furthermore, it finds that the probability and volume of transfers substantially declined over the observation period. While not causal, this suggests that public reporting under the Sunshine Act has substantially reduced transfers from pharmaceuticals. Examining prescribing behavior under Medicare Part D, it finds that physicians who either accepted transfers or accepted more transfers had higher beneficiary prescription costs, a greater

TABLE 5 Association between physician-industry transfers and prescribing behavior/costs 2014–2015

In(Real annual prescription cost/Beneficiary)			In(Real prescription cost/Day)		Percentage of costs from branded drugs		In(Prescription costs/Day) for substitutable medications		P(High-risk medication)		Percentage of 65+ part D beneficiaries with prescription for a high-risk medication	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	
Panel A: Association between receiving at least one transfer and prescribing behavior/Costs												
Any transfers	0.358*** (0.003)	0.029*** (0.003)	0.113*** (0.002)	0.012*** (0.003)	0.041*** (0.001)	0.003*** (0.001)	0.174*** (0.004)	0.018*** (0.006)	0.053*** (0.001)	0.003*** (0.001)	0.007*** (0.000)	0.000 (0.000)
	0.608	0.94	0.55	0.892	0.446	0.852	0.454	0.86	0.557	0.978	0.521	0.935
	734 216		741 659		507 918		533 405		516 856		328 347	
Panel B: Association between the magnitude of transfers and prescribing behavior/Costs												
In(\$ Any transfers)	0.131*** (0.001)	0.030*** (0.002)	0.059*** (0.001)	0.013*** (0.001)	0.012*** (0.000)	0.003*** (0.000)	0.069*** (0.001)	0.014*** (0.003)	0.010*** (0.000)	0.001*** (0.000)	0.002*** (0.000)	0.001*** (0.000)
R-Squared	0.62	0.943	0.597	0.919	0.469	0.87	0.485	0.874	0.566	0.981	0.534	0.937
N		456 650		459 122		330 879		357 572		338 623		225 747
Fixed effects	County	Physician	County	Physician	County	Physician	County	Physician	County	Physician	County	Physician

Notes: Estimated using Ordinary Least Squares Multiple Regression with physician clustering using Stata 15. County fixed-effect models were estimated with a full set of control variables including those listed in Table 4 as well as county fixed effects. Physician fixed-effect models were estimated with time variant control variables listed in Table 4.

*** $p < 0.01$.

percentage of branded prescriptions, higher prescription costs among clinically equivalent substitutable medications, and greater rates of prescribing of HRM among the elderly.

Collectively, these results suggest that the continuation of public reporting will reduce physician-industry relationships and may result in more cost-effective/higher quality prescriptions from providers. Caution, however, must be taken with these conclusions given that these results are not necessary causal and given the lack of patient-specific conditions that could indicate the most appropriate prescription treatment.

Furthermore, given that detailing simultaneously informs and attempts to persuade physicians over medication use, if these preliminary estimates are indicative of long-term trends, physicians may need alternative avenues to acquire and update their knowledge of treatment. For example, state-sponsored academic detailing programs³⁰ and information-based electronic drug databases³¹. In addition, more research is needed to evaluate how consumers, physicians, and industry are adapting to the Sunshine Act and to monitor the potential ramifications of quality and cost-effectiveness after this intervention.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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