

The Effects of Physicians' Financial Transfers from Drug Firms on Prescribing of Physician-Administered Cancer Drugs*

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November 30, 2021

Abstract

Physicians commonly receive financial transfers from drug firms. We examine the impact of these relationships in the prescribing of physician-administered cancer drugs in Medicare. We identify the impact using a within-physician study design to account for drug firms' targeting of payments. We find that prescribing of the associated drug increases 10% in the six months after a payment is received, with the increase beginning sharply in the month of payment and fading out within a year.

JEL codes: I11 (Analysis of Health Care Markets); L15 (Information and Product Quality); D83 (Search; Learning)

*The authors thank Aaron Mitchell for helpful comments.

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1 Introduction

Spending on cancer drugs in the United States more than doubled between 2013 and 2018, driven by the introduction of new high-priced therapies and increases in price and quantity for existing drugs (IQVIA Institute for Human Data Science, 2019). While some innovative therapies have produced significant improvements in cancer survival (Kojien and Van Nieuwerburgh, 2019), the growing price tag has also spurred policy proposals to limit the exposure of the Federal government to further increases in expenditure (El-Kilani et al., 2020).

Cancer-treating physicians are unusually influential in choice of treatment for a given patient. Cancer regimens are complex, potentially involving multiple tools (drugs, radiation, or surgery), and patients are unlikely to be sufficiently informed to determine an alternative path. Payers who might otherwise control choice of treatment with prior authorization or step therapy rules may find it difficult to sufficiently specify guidelines for appropriate use, necessitating investment of clinical staff for each case. Because of this unusual influence over treatments, physicians are the primary target of marketing efforts for cancer drugs.

Physician-direct marketing has long been viewed as a potential policy concern (PBS Frontline, 2002). Drug firms' marketing activities include face-to-face visits from pharmaceutical sales representatives that will commonly involve purchase of a meal or beverage, and may include lucrative speaking fees or travel reimbursement. Drug firms track physicians' prescribing of the marketed drug, and target activities on high-prescribing physicians (Fugh-Berman and Ahari, 2007).

The potential principal-agent problem of financial relationships between drug firms and physicians is magnified for cancer drugs. Cancer therapies in the United States are procured through a "buy-and-bill" system in which providers generally retain a percent of the drug price for each administration. Drug-related revenue generates as much as three-quarters of revenue for oncology practices (Akscin, Barr and Towle, 2007). Because of these reimbursement rules, cancer-drug prescribing induced by physician-directed marketing activities will

on average generate increases in physician compensation.

In this paper, we provide novel evidence on the impact of financial interactions between drug firms and physicians on the prescribing of cancer drugs. We combine large-scale prescribing records from Medicare with mandatorily-reported financial interactions from the Federal Open Payments dataset. We overcome potential bias from drug firms' selective targeting of high-prescribing physicians (Fugh-Berman and Ahari, 2007) by using a within-physician design that compares a physician's prescribing after a payment to his or her prescribing just before. Moreover, we examine prescribing outcomes at the monthly level, ruling out the potential for time-varying confounders.

Our linkage of Open Payments and Medicare records of physician-administered drugs provides a number of novel descriptive facts. Physicians prescribing cancer drugs have frequent contact with pharmaceutical firms. Among the 10 cancer drugs in terms of total expenditure, between 20% and 63% of physicians prescribing the drug have had at least one financial interaction with the manufacturer of that drug. Moreover, a substantial share of this spending could potentially be influenced by these encounters. Among these drugs between 26% and 60% of spending on the drug occurs after the initial encounter. We report more detailed statistics in table 1.

We find that physicians increase prescribing of cancer drugs for which they have received payments precisely in the month in which the payment occurs. Expenditure on the relevant drug stays elevated for about ten months, and then falls back to pre-period levels. The magnitude of the effect is large, approximately a 10% increase. For two quantity outcomes, the number of claims and the number of patients, we find estimates that are of a similar pattern but smaller in magnitude and noisier.

Our study makes two major contributions. First, our study focuses on the effect of financial relationships for cancer drugs. Cancer drugs are a large and growing element of prescription drug spending where competition is muted. The tools that press drugmakers for discounts in Medicare Part D – formulary exclusion or tiered copays – are not used

for physician-administered drugs in Medicare. Instead, Medicare has historically covered all FDA-approved physician-administered drugs under the same terms, and features of the pricing rules incentivize high and rising prices (Howard et al., 2015). Health care providers face no incentive to unilaterally limit the options for patients (Bach, Saltz and Wittes, 2012).

Second, our paper brings the state-of-the-art econometric study design of Carey, Lieber and Miller (2021) to the study of cancer drug prescribing. The recent review of Mitchell et al. (2021) found 36 studies examining the association of financial incentives and physician prescribing, but that more than half (21) had serious risk of bias. Many studies do not account for drug firms’ targeting of payments to high-prescribing physicians, or do not account for the physician’s patient pool, which influences the potential prescriptions he or she might write. Our design compares within physicians in the months surrounding a payment to identify a plausibly causal effect.

These contributions highlight how we augment the prior literature. The closest paper to ours applies a within-physician design to cancer-drug prescribing and finds that physicians with payments in recent years increased their relative prescribing of that drug (Mitchell, Winn and Dusetzina, 2018). That study uses a dataset derived from Medicare Part D; the dataset is subject to censoring and only covers a subset of oral cancer drugs. We examine physician-administered cancer drugs and increase the credibility of our findings by showing a sharp short-run response to a payment, in the month it is received.

2 Background

2.1 Direct-to-Physician Marketing

Pharmaceutical firms focus most of their marketing expenditures on physicians, in recognition of physicians’ key role in deciding whether to prescribe a drug and choosing among competitors. In 2012, pharmaceutical firms directed \$23 billion in marketing expenditures towards physicians, in the form of detailing, samples, or sponsorship of educational meetings

(Pew Charitable Trusts, 2013). These financial encounters are widespread; a 2009 survey found that almost 84 percent of physicians had some form of financial interaction with pharmaceutical manufacturers (Campbell et al., 2010). These marketing expenditures have long been viewed with suspicion, with influential physician leader Marcia Angell describing financial relationships as “amounting to bribery from the drug companies” (PBS Frontline, 2002). However, the pharmaceutical industry, and some physician defenders, note that these financial relationships can facilitate education on pharmaceutical advances or correct under-prescribing (Campbell, 2007).

Both health care organizations and governments have taken action to regulate direct-to-physician marketing activities. In recent years, many academic medical centers or large health systems prohibited receipt of gifts or meals or placed restrictions on the access of pharmaceutical sales representatives (Larkin et al., 2017). Starting in the early 1990s, several states have introduced various levels of mandatory industry payment reporting, including Minnesota, California, Maine, Vermont, West Virginia, Massachusetts and the District of Columbia. Some of these states simply required reporting to the state government, but MA, VT, and MN created public searchable databases of industry payments.

At the Federal level, the 2010 Physician Payments Sunshine Act required pharmaceutical firms to track financial interactions with physicians and mandated their public disclosure. The resulting database, *Open Payments*, was intended to supplement or replace the patchwork of reporting systems in existence and allow for greater transparency around physician-industry relationships in the context of a broader strategy for addressing conflicts of interest (Richardson et al., 2014).

2.2 Provision and Reimbursement of Cancer Drugs in Medicare

Medicare shoulders about one third of the costs of all cancer care delivered in the U.S. (Shooshtari, Kalidindi and Jung, 2019), of which about 70% are for drugs (Newcomer, 2020). Medicare provides cancer drugs to its enrollees in a number of ways depending on the drug’s

route of administration, the site of care, and the individual’s insurance arrangement.

Medicare coverage for cancer drugs depends on whether it is administered by a physician or self-administered by the patient at home. Cancer drugs that are infused or injected, or where the patient needs monitoring for adverse reaction, will typically be administered by a physician (or physician extender) and will be covered by Medicare Part B. A common example is chemotherapy. If a cancer drug can be self-administered by the patient, and is not explicitly defined as a Part B drug,¹ it is covered along with other outpatient therapies under the Medicare Part D program.

For each administration of a Part B drug that takes place in a physician’s office, Medicare reimburses the administering physician a flat fee for the administration service itself as well as 104.3% of the drug’s average sales price (ASP).² The reimbursement rate of 104.3% ASP is paid regardless of the actual raw drug costs the physician incurred in obtaining the drug.³

Administrations of Part B drugs that take place in the outpatient department of a hospital campus are subject to different rules. Typically Medicare pays an additional “facility fee” for these claims (Neprash et al., 2015). The Part B reimbursement rule of 104.3% ASP applies to these claims as well, unless the drug is sufficiently inexpensive to be deemed not “separately payable” (Medicare Payment Advisory Commission, 2020).⁴ Finally, hospitals that qualify for the Federal 340B program acquire physician-administered drugs at substantial discounts, meaning that Medicare reimbursements to these hospitals may exceed acquisition costs by

¹Part B will pay for oral cancer drugs if the same drug is available in injectable form or if the oral drug is a prodrug of the injectable drug. Anti-emetics in oral form which would normally be covered by Part D may be covered in part or fully by Part B if included as a Part B drug regimen. The drugs included in this study are almost always paid under Part B and as a result we are able to observe the vast majority of the Medicare population demand for them.

²The Medicare portion of this payment has been subject to budget sequestration rules since 2013, reducing it from its historical percentage of 106% (Nguyen and Sheingold, 2020).

³Physicians in office settings commonly obtain the drug via group purchasing organizations. The drug maker reports the data on sales that generates the ASP on which prices are based. The 4.3% add-on has been variously justified by the need to compensate small-scale providers who pay above-average prices, the cost of maintaining sufficient inventory, or to compensate for the inflation in drug prices since the data used to generate the ASP (Medicare Payment Advisory Commission, 2016).

⁴We observe administrations of non-separately payable drugs administered in the outpatient setting. These administrations have zero associated allowed amount and as a result receive a zero weight in our primary regression.

31% (Wright, 2010).

Finally, the above reimbursement rules pertain to individuals enrolled in Medicare fee-for-service. Medicare pays a capitated rate to private insurers for individuals who opt into a managed care Medicare Advantage plan. Medicare Advantage plans set their own reimbursement rules for oncology services, although in practice the rules are quite similar between the two programs (Trish et al., 2017; Clemens and Gottlieb, 2017).

3 Data and Empirical Strategy

3.1 Data Sources

3.1.1 Medicare Claims

Our prescribing data come from the 2013-2018 Medicare fee-for-service (FFS) Carrier and Outpatient claims of a random 20% sample of Medicare FFS beneficiaries enrolled during these years. Carrier claims include services by non-institutional providers (primarily physicians), and Outpatient claims contain services furnished in hospital outpatient departments. As described above, Part B drugs can appear in either Carrier or Outpatient claims, depending on the provider and place of service. Both Carrier and Outpatient claims contain information on the Healthcare Common Procedural Coding System (HCPCS) code used to identify specific cancer drugs, service date, payments, and the service provider's National Provider Identifier (NPI).

When a drug is newly launched on the market, it does not immediately receive its own HCPCS code, and instead will be billed under catch-all HCPCS codes.⁵ As a result, we are not able to identify these drugs in Medicare claims until a HCPCS code is issued, usually in the following January. There are 17 drugs (about 16.7% of our list of included drugs) that were newly launched between 2013 and 2018. We adjust for this limitation of our data in our analysis.

⁵For example, chemotherapy drugs "not otherwise classified" can be reported under J9999.

3.1.2 Open Payments Database

We use the Centers for Medicare and Medicaid Services' (CMS) Open Payments Database (OPD) to identify financial transfers from the pharmaceutical companies to physicians. The OPD is a transaction-level dataset that contains nearly the universe of all payments and in-kind "transfers of value" to physicians and teaching hospitals from pharmaceutical companies, beginning August 2013 and updated annually. A payment (or transfer of value) may be exempt from reporting if 1) the amount is below the small payment reporting threshold (around \$10), and 2) the total annual amount of payments to a single recipient does not exceed the total annual amount reporting threshold (around \$100). However, many Open Payments reflects many payments that are not required, suggesting pharmaceutical firms simply report all encounters.

For each payment, we observe the physician's name, address, the name of the drug or drugs associated with the payment (if applicable), and the category of payment. Examples of categories of payments include research, meals, travel, gifts, and speaking fees. Among all drug-related payments, speaking fees represent the largest category in terms of dollar amount, accounting for over 40% of all amounts reported, followed by meals (food and beverage), consulting fee, travel and honoraria (Hwong et al., 2014). Between 2013 and 2018, the median payment in the OPD was approximately \$15 while the top 5% of payments exceed \$245 per transaction. Between 2014 and 2018, drug companies spend between \$140 and \$150 million per year on payments related to Part B drugs. These payments went to between 142 and 186 thousand physicians each year. The median physician receiving any payment related to Part B drugs earns approximately \$55 from these payments, while the top 5% earn in excess of \$1000 annually. Approximately 17% of Part B drug related transactions involve a cancer drug, while over 25% of Part B drug associated payments are in relation to cancer drugs.

We convert names and addresses in the Open Payments database to NPIs using the CMS National Plan and Provider Enumeration System (NPPES) database.

3.2 Sample Construction

3.2.1 Physician-Administered Cancer Drugs

To identify the physician-administered cancer drugs to be included in the analysis sample, we start with a list of HCPCS codes that is the subset of two sources. The first source is the Medicare Part B Drug Spending Dashboard released by CMS. These are HCPCS-level data files containing details regarding the quantity and spending for all drugs reimbursed under Medicare Part B, available annually from 2014 to 2018 (Centers for Medicare and Medicaid Services, 2020). We identified 703 unique HCPCS drug codes reimbursed under Part B at some point in our study period.⁶ The second source is the list of cancer drug HCPCS codes published by the National Cancer Institute’s Surveillance, Epidemiology and End Results (SEER) Program (National Cancer Institute, 2021). The SEER list was continuously updated. There are 196 HCPCS codes contained in both lists.

There are a number of drugs that can be used for cancer, but are most commonly used for non-cancer indications (e.g. hormonal therapies). To limit our attention to cancer therapies, we use a subset of Part B drugs where there is a significant amount of prescribing by oncologists. We first define oncology specialties using two definitions. The "narrow" definition includes specialties in hematology/oncology and medical oncology. The "broad" definition additionally includes internal medicine, urology, obstetrics/gynecology, radiation oncology, surgical oncology, and hematology. Each drug identified in the previous step will need to satisfy either one of the following criteria to be included: (1) at least 25% of the drug’s Medicare claims must be administered by oncologists in the narrow definition, or (2) at least 10% of the drug’s claims must be administered by oncologists in the narrow definition, and 50% of the claims must be administered by oncologists in the broad definition. This process rules out drugs that are labeled as cancer drugs in the SEER list but are frequently used outside of cancer care, the most common category of which is hormone therapy. We additionally

⁶We manually add Q9978 and J9200 which are recently established cancer drug HCPCS codes. We also add 17 temporary C codes that are used in the outpatient setting prior to establishment of a permanent J code.

exclude any drug in the hormone therapy category from those that satisfy all above criteria. Our final list of physician-administered cancer drugs consist of 147 unique HCPCS codes of 99 drugs. Following (Carey, Lieber and Miller, 2021), a drug is defined as an ingredient (or ingredient combination) in either branded or generic status. We do not differentiate between administrations of the same ingredient in different dosage forms.

3.2.2 Sampled Physicians

Using the list of cancer drugs identified above, we obtain the list of physicians who administered these drugs in either Carrier or Outpatient Medicare claims from August 2013 to December 2018. For Carrier claims, we use the performing NPI variable on the same line item as the drug’s HCPCS code; for Outpatient claims, we use the claim attending physician NPI. We note that a physician could administer a treatment regimen that was chosen by another physician – i.e., a partner in the practice. However, over the period we examine, 65% of individuals who ever get a physician-administered cancer drug received all their drugs from a single physician, and the mean number of administering physicians was 1.7. This suggests that the “administering” physician is indeed the physician choosing among cancer therapies.

We reassign claims for cancer drugs where the administering provider is a physician extenders (nurse practitioners or physician assistants) because we expect they are implementing a physician’s treatment plan and because Open Payments does not report payments to physician assistants over our sample period. We preferentially reassign these claims to (1) the physician who last prescribed a cancer drug to this patient (within a six-month window), (2) the physician who next prescribes a cancer drug to this patient (within a six-month window), or (3) the physician who last provided an Evaluation and Management service to this patient (within a six-month window), if that physician ever prescribes any cancer drugs.

Finally, we exclude any physician who administered fewer than 10 claims of our included cancer drugs between August 2013 and December 2018. These excluded physicians account

for (2.22%) of the number of total administrations. Our final physician sample consists of 51,353 physicians, of whom 18.1% are oncologists in the narrow definition, 61.7% are oncologists in the broad definition.⁷

3.2.3 Physician-Drug-Month Level Analysis File

Our analysis file is at the physician-drug-month level. We aggregate drug claims to the month level in order to conduct the event-study that analyzes any changes in behavior overtime after receiving a payment from the drug company associated with a given cancer drug.

We construct three outcome variables at the physician-drug-month level: (1) quantity of drugs, defined as number of line items in the Carrier file and revenue center claims in the Outpatient file; (2) number of patients receiving the drug; (3) drug expenditures, measured as the total allowed amount representing the sum of payments from Medicare, the patient and any third-party payer (e.g. Medicaid or other insurer).⁸

Our independent variable of interest is a dichotomous indicator for whether a physician received a payment or transfer of value for a given cancer drug during our study period. We dichotomize our payment variable because of evidence in Carey, Lieber and Miller (2021) that even small payments are influential in prescribing.

In our final analysis file, we include only physician-drugs pairs that either involve an associated financial transaction from the drug company, or that the physician has prescribed the drug at some point in our study period, or both. In other words, we exclude all physician-drug pairs with neither payment records in the OPD nor prescribing history in Medicare claims as they do not contribute to our event study estimates (described further in Section 3.2). During our study period, there are 548,367 unique physician-drug pairs that satisfy the

⁷Reported physician specialties can change over time. We count an oncologist as a physician that ever reports an oncology specialty.

⁸Note that we do not include expenditures for the service of drug administration, only those on the drugs themselves. This outcome is a closer proxy to drug firm revenues, which is what marketing encounters and related payments are designed to influence. In addition, this ensures consistency between the Carrier and Outpatient files, as administration service fees differ depending on the place of service of administration and affiliation of service providers, but are the same across drugs administered in the same setting by the same provider (Company, 2013).

above criteria, of which 16.59% involve both a financial transaction with the drug payment and prescribing of the same drug in Medicare, 16.05% involve an industry payment with no prescribing history for that drug, and 67.36% had no industry payment but had prescribing history.

In our primary event study analysis (further described below), we ensure that each physician-drug pair in our sample has at least 12 months of prescribing history prior to and after the first observed payment from the pharmaceutical company. We thus restrict the sample to physician-drug pairs where the first payment occurred in or after August 2014. This means we exclude observations for any drugs where the administration occurred before August 2013, and exclude observations for physician-drug pairs where there was an associated industry payment before August 2014. Additionally we exclude observations for physician-drug pairs where there was an associated payment within the first 12 months a newly launched drug was detectable in our analysis sample. Among our analytic sample of physician-drug observations, 105,834 (19%) are associated with an initial payment occurring within the first 12 months.

3.3 Summary Statistics

We present summary statistics for the full analytic sample that satisfy our inclusion criteria at the drug, physician and physician-drug level, as well as those for the estimation sample with additional inclusion criteria at the physician-drug-month level.

In the full analytic sample 29,127 or 56.72% of physicians out of a total of 51,353 received at least one industry payment associated with a Part B cancer drug in the OPD between August 2013 and December 2018, with a total number of 1,142,335 payments and a total value of \$128,278,734. The median payment is \$14.54. Food and beverages is the most frequent payment category in terms of number of payments, and compensation for speaking, education and training engagements consists of the largest category in terms of expenditure. At the drug level, 70 (70.7%) out of the 99 included Part B cancer drugs were associated with

at least one payment, with a maximum amount of total drug-specific payment of \$13891395 (Opdivo - Nivolumab). The top 3 most paid drugs in our full sample (Opdivo, Prolia/Xgeva, and Kyprolis) account for just under 28% of total payments.

Table 2 provides additional summary statistics for the full sample and for our preferred analysis sample where we restrict to physicians with at least 12 months of non-payment prior to first observed industry payment. This results in a loss of (6.2%) of physicians from 51,353 to 48,163 but larger reductions in the total number of drug claims (18.47%) and total drug expenditures (30.45%). Restricting to physicians with 12 months of non-payment also results in a large decrease in the total number of industry payments suggesting that payments are part of ongoing industry-physician relationships. The remaining physicians in our sample are less likely to receive industry payments at the physician-drug level (19% versus 33%), and less likely to both receive payment for and administer the related drug compared to physicians in our full sample (9% versus 17%).

Across all physician-drug-month observations (N=34,429,869) in Medicare during our study period, physicians who received at least one industry payment account for 30.21% of total claims and 49.17% of total drug expenditures. Further, 24.27% of all drug claims and 40.52% of all drug expenditures occurred after a physician's first industry payment. Our preferred specification restricts our sample only to those physicians with a 12 month pre-period with no associated payments (N=28,929,608). After this restriction, physicians who received at least one industry payment account for 14.41% of total claims and 26.91% of total drug expenditures. Further, 8.32% of all drug claims and 16.57% of all drug expenditures occurred after a physician's first industry payment.

Table 1: Industry payments among top 10 most expenses drugs

	Drug expenditures (millions of dollars) (1)	Share of physicians with industry pay- ment (2)	Share of expendi- tures post industry payment (3)
Rituxan	2,259	0.49	0.46
Neulasta	1,738	0.36	0.46
Prolia	1,451	0.53	0.50
Opdivo	1,099	0.62	0.60
Herceptin	894	0.42	0.37
Keytruda	803	0.63	0.54
Alimta	688	0.47	0.41
Velcade	657	0.39	0.39
Epogen	427	0.20	0.26
Aranesp	415	0.32	0.37

Notes. This table provides details regarding the proportion of physicians receiving any industry payments for the 10 drugs with largest expenditures in our full sample. We report among all physicians who prescribe the drug at least once the share who have had at least one financial encounter with the drug manufacturer. Column 3 reports the share of total expenditures that that relate to physician administrations after a physician’s first financial encounter with that drug manufacturer.

Table 2: Sample summary statistics

	Full sample (1)	Analysis sample (2)
Unique physicians	51,353	48,163
Unique drugs	99	99
Claims	13,872,699	11,310,648
Drug expenditures (millions of dollars)	14,855	10,331
Total industry payments	128,278,734	23,219,234
Industry payments in cash	92,020,056	16,114,869
Industry payments in-kind	26,078,077	7,104,365
Physician-drug observations	548,367	455,223
Physician is paid and prescribes	0.17	0.09
Physician is paid, does not prescribe	0.16	0.10
Physician not paid but prescribes	0.67	0.81
Average industry payments if paid (3)	5	2.92

Notes. Column 1 reports summary statistics for the full sample. We report our preferred analysis sample in column 2 after restriction to those physician-drug combinations with a minimum of 12 months of no no industry payments prior to first observed payment. 3. We report the average number of payments a physician receives for a drug condition on the physician receiving at least one payment.

3.4 The Event Study Approach

Our core empirical strategy is a difference-in-differences (DD) design implemented via an event study. Since physicians who receive payments from a drug company in relation to a specific drug are likely more prone to prescribing that drug even in the absence of such payments (Fugh-Berman and Ahari, 2007), the cross-sectional relationship between receipt of industry payment and drug prescribing is likely upward biased relative to the true impact of such payment on prescribing. The DD and event study design exploits potential changes over time in the prescribing behavior of a physician who received an industry payment, relative to control physicians who did not receive a payment.

The primary specification is as follows:

$$y_{pdt} = \sum_{r \neq -1} PresPaid_{pd} \beta_r + \delta_{pd} + \delta_{dt} + \epsilon_{pdt}, \quad (1)$$

where p indexes physicians, d indexes drugs, and t indexes year-months. y_{pdt} is one of the three outcome variables (number of claims, number of patients or drug expenditures) at the physician-drug-month level. $PresPaid_{pd}$ is an indicator that equals 1 if the physician ever received an industry payment associated with drug d in our study period, and β_r ($r = -13, \dots, -2, 0, 1 \dots 13$) is a series of indicators for the year-month relative to the year-month when the physician *first* received the payment (if ever). The month immediately prior to the month of payment ($r = -1$) is omitted as the baseline period. We estimate β_r for up to 13 months both prior to and after the event of payment, and treat any available time periods for physician p and drug d outside of this time range as month -13 (if before the event) or month 13 (if after the event). In the results section, we report only the coefficients β_r for $-12 \leq r \leq 12$.

Note that because we define the event as the year-month for the *first* payment (or transfer of value) from the drug company to the physician in association with the focal drug, and because there could be multiple payments between the drug company and the physician

during our study period related to the same drug, the β_r coefficients should be interpreted as the effect of the initiation of such financial relationship, rather than the effect of the first payment alone.

δ_{pd} and δ_{dt} are physician \times drug and drug \times year-month fixed effects, respectively. δ_{pd} account for any time-invariant physician characteristics (observed and unobserved) that lead to both higher likelihood of the physician receiving a drug related industry payment and of prescribing the drug in the absence of the payment. δ_{dt} account for secular changes in prescribing a specific drug common to all physicians, such as patent expiration. Observations for both physician-drug pairs with and without an associated industry payment will contribute to drug \times year-month fixed effects. For any physician-drug pairs that involve an industry payment but no prescribing, all dependent variables will be zero for all time periods. Regression standard errors are clustered at the physician level.

The key identifying assumption for the post-event β_r ($0 \leq r \leq 12$) coefficients in Equation 1 to yield unbiased estimates of the effect of industry payment on prescribing of physician-administered cancer drugs is the parallel trends assumption, i.e. in the absence of any industry payment associated with a given drug, physician prescribing behavior with respect to that drug (relative to the physician-drug mean) would not have changed differentially among those who received the payments relative to those who did not receive any payment. While this assumption cannot be directly tested, the pre-period β_r ($r < 0$) coefficients allow us to observe any non-parallel trends in prescribing among the paid physicians before the industry payment occurred. An absence of such changes strengthen the plausibility of the identifying assumption.

Recent work by (Borusyak, Jaravel and Spiess, 2021) has proposed alternative methods of estimating event studies. Those methods correct important underidentification challenges when all units are eventually treated, and can otherwise improve efficiency. While we have a large number of untreated units (physicians not paid for a particular drug), we demonstrate that our findings are very similar when using their methods in the Appendix.

In estimating Equation 1, we weight each physician-drug-month observation by the average number of patients that received any included Part B cancer drug from that physician across all periods. This weighting choice is analogous to Carey, Lieber and Miller (2021), who weight by the average number of patients in the drug’s therapeutic class. There are two advantages to this weighting. First, weighting by the number of patients means our analysis is representative of patients’ experiences rather than physicians’. However, weighting by the average number of patients on any cancer drug means that observations in which a physician is paid for a drug but does not prescribe it still have positive weights.

4 Preliminary Results

We report the coefficients from Equation 1 in Figure 1. Panel (a) refers to the expenditure outcome. We find that physicians who will be paid (at time 0) are not altering prescribing relative to never-paid physicians in the twelve months prior to first payment. But beginning sharply at the month of payment, prescribing of the associated drug jumps. The flat pre-trends and the sharp jump in prescribing lends credence to a causal interpretation.

The magnitude of the response is large. A linear combination of the 13 post-period coefficients is 48.32 (se 16.04), or a 7.93% increase relative to the mean of \$609. This is approximately 50 percent more than the comparable percent response in Carey, Lieber and Miller (2021), who report a 5.2% increase in expenditures. A linear combination of the first 7 post-period coefficients is 62.84 (se 17.93), or a 10.32% increase relative to the mean.

The effect of a payment on the quantity outcomes is smaller and less precise. For number of claims, we find that a payment is associated with a 1.43% increase over the first six months, although the response is statistically different from zero (0.0033, se 0.0090). The linear combination of the post-period coefficients for number of patients is not statistically different from zero (0.0011, se 0.0045). In addition, there is a mild upward pre-trend for number of patients, which makes interpretation of the post-period difficult.

One way to reconcile the larger increase in expenditure relative to number of claims or number of patients is that physicians are choosing more expensive versions of the drug, either due to increased strength or differences in formulation. In addition, there is potential for measurement error in our measure of the number of claims, which would tend to bias coefficients downward.

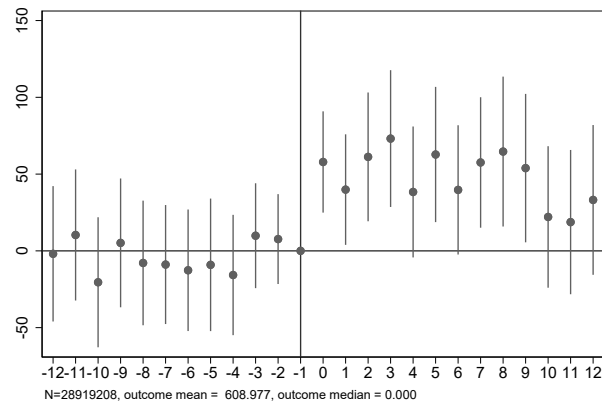
5 Conclusion and Next Steps

In the initial analysis, we find potentially large impact of industry payment on expenditures of physician-administered cancer drugs, with smaller impact on number of claims and no impact on number of patients. These findings suggest that physicians may have responded to the financial incentives by increasing prescribing of these cancer drugs, most likely on the intensive margin.

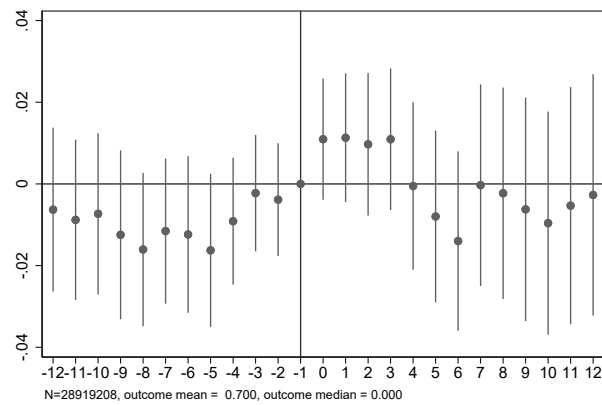
Going forward, we plan to further examine potential heterogeneity in responses along at least two dimensions. First, physicians face differential reimbursement incentives when administering cancer drugs based on their affiliation with hospital systems and site of administration. These incentives may compound the financial incentives from industry payment, resulting in potentially different responses based on physician affiliation with hospitals. For instance, it may be that the increase in expenditures is higher among physicians affiliated with hospitals, as provider reimbursement for drug administration in hospital outpatient settings is higher. This may be especially the case for physicians affiliated with 340B hospitals which are entitled to large discounts (between 20% and 50%) on outpatient drugs purchased from manufacturers, making it more profitable to increase administration of outpatient cancer drugs.

Second, the responses to industry payment may also differ depending on whether the patient is dually eligible for Medicare and Medicaid. The majority of state Medicaid programs have enacted policies that limit a provider's total reimbursement to the Medicaid rate

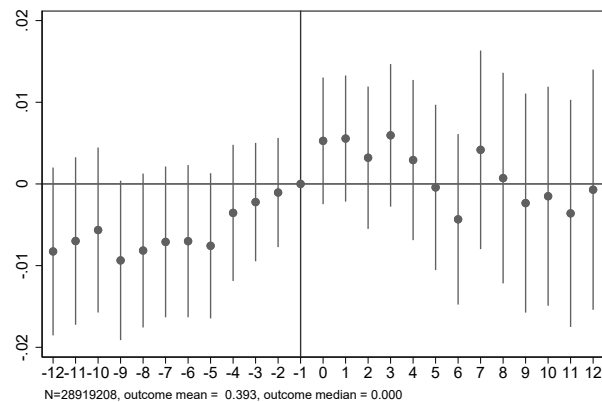
Figure 1: Impact of Drug Firm Payments on Prescribing of Physician-Administered Cancer Drugs



(a) Expenditure



(b) # Claims



(c) # Patients

Notes: This figure reports the coefficients from estimation of Equation 1 for three different outcome variables: expenditure, number of claims, and number of patients. The x-axis represents months before or after a first payment for a related drug (time 0). Event times before -12 or after 12 are binned and not reported.

for the service, including reimbursement for physician-administered drugs. Thus, providers will not on average obtain the full cost-sharing amounts from state Medicaid programs for dually eligible beneficiaries, which are typically paid for out-of-pocket in the case of non-dual Medicare beneficiaries or by their supplementary insurance. We will examine the impact of Open Payments encounters on physicians' dual and non-dual patients separately.

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A Alternative Treatment Effect Estimators

In this section we briefly describe the event study estimation methods of (Borusyak, Jaravel and Spiess, 2021) and report our main findings using their methods. Their treatment effect estimator proceeds in two steps:

1. Using only untreated observations (the union of never-treated and pre-treatment observations), fit the model $y_{pdt} = \delta_{pd} + \delta_{dt} + \varepsilon_{pdt}$. This step generates unit and time fixed effects uncontaminated by treatment. Using these fixed effects, generate a counterfactual y_{pdt}^O to represent the untreated potential outcome for each treated observation.
2. Generate each treatment effect $\tau_{pdt} = y_{pdt} - y_{pdt}^O$. These treatment effects can be aggregated with any given weighting; we aggregate them using our usual weights (physician’s number of Part B cancer patients, averaged over time) for each post-treatment event time.

In addition, they propose a “pre-trends” test that interacts the treatment dummy with the pre-treatment event times using only the untreated observations used in Step 1.

We report our results using their methods in Figures xxx. We find...