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Pharma Payments and Physician Concentration: An Empirical Analysis

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Abstract

This paper uses a rent-seeking framework to empirically examine the effect of physician concentration at the state level on the dollar amount of payments made to physicians from the pharmaceutical industry. Using OLS and 2-stage least squares, this paper finds increased physician concentration at the state level is associated with lesser payment amounts made to physicians from pharmaceutical companies for overall physician concentration and office-based physician concentration. The results for hospital-based concentration were mixed. These findings provide important insights for health policy literature regarding which factors reduce the propensity to rent-seeking to affect health care outcomes and costs.

Introduction

As part of the Physician Payment Sunshine Act, payments between physicians and the pharmaceutical industry exceeding $10 are legally required to be reported to the federal government. The act passed as a component of the Affordable Care Act to increase visibility into the interactions between physicians and the pharmaceutical industry. Foremost, the legislation intends to raise consumer awareness of their physician's financial interactions to prevent potential conflicts of interest (Richardson 2014). These payments take place for a variety of reasons including research grants, speaking fees, travel funds, payment for serving in educational capacities, gifts, meals, and consulting services (Leonard 2014). This information is compiled and released by the Center for Medicare & Medicaid. The first report released in late 2013.

With the recent systematic collection and release of these financial transactions, many published pieces have expressed surprise and concern regarding the magnitude and frequency of payments made to physicians (Thomas, Armendariz, and Cohen 2014; Fiorillo 2015; Carlson 2016). Among these pieces' primary concerns are the potential perverse incentives physicians face to change their prescribing habits when receiving payments from pharmaceutical companies which can serve to increase health care costs. Although many pieces implicitly assume the outcomes of these exchanges are undesirable, it is important to note changes in prescribing habits could benefit patients. Some pieces note these financial transactions are frequently for research purposes and can provide a significant information-distribution role in the medical field (LaMattina 2015; McArdle 2016).

The recent interest in physician's financial relationships with the pharmaceutical industry is likely a result of the first release of nationally representative data. Conflict of interests' effects on the physician-patient relationship and the overall functioning of the health care market has been examined extensively (Mushkin 1958; Arrow 1963; Emmanuel and Emmanuel 1992; Mooney and Ryan 1993; Ryan 1994; Wazana 2000; Rodwin 2013). Furthermore, similar legislation was previously enacted to require disclosure of payments made to physicians from pharmaceutical companies at the state level in Minnesota, California, Maine, Vermont, West Virginia, and Washington DC before the Physician Payment Sunshine Act (Ross et al. 2007).[1]

Recently written pieces and previous literature examining potential conflict of interest issues largely speculate whether relationships between pharmaceutical companies and physicians improve or harm how the health care sector functions. Unfortunately, determining which is difficult. A more fruitful approach to understanding these financial interactions, given their frequency and magnitude, may be to ask why such transactions are mutually beneficial? It is evident why frequent interaction and large financial transactions from the pharmaceutical industry benefits physicians. Why, however, are pharmaceutical companies willing to make these exchanges?

[1] In 2009, Vermont banned pharmaceutical companies from distributing funds and gifts to physicians.

A pharmaceutical company issuing payments might be a form of rent-seeking exchange. Pharmaceutical companies may provide funding for entertainment, dining, traveling, or honorariums for speaking to influence and obtain favorable treatment from physicians. Resources expended on influencing physicians could be allocated to more productive uses, making these exchanges harmful to overall welfare (Tullock 2005).

Examining these from a rent-seeking lens places pharmaceutical companies as rent-seeking (favor seeking) parties and physicians the rent-providing (favor granting) parties. This reframing allows us to examine the financial transactions as welfare wasting efforts which drive up health care costs in an effort for pharmaceutical companies to influence physicians. Additionally, using a rent-seeking framework allows us to examine which factors reduce wasted resources.

This paper works to expand the rent-seeking framework into a previously overlooked aspect of health care which is regaining interest due to recent legislation. Previous literature examines physicians or pharmaceutical parties as rent-seeking parties (Chu 2008; Epstein and Johnson 2012; Reilly and Santerre 2013; March, Martin, and Redford 2016). The previous literature has not used the rent-seeking framework to examine the relationship between physicians and the pharmaceutical industry.

In this paper, I examine if increased physician concentration at the state level reduces the dollar amount of payments made by pharmaceutical companies to physicians. If the number of rent-providing physicians increases, the ability to extract rents from physicians by pharmaceutical companies becomes comparatively more commonplace. As a consequence, an increase in physician concentration should decrease the dollar amounts spent per physician. The reductions in the payment amount, therefore, reduce wasteful uses of resources to influence physicians.

I specifically examine physician concentration of total physicians, physicians in office-based practices, and physicians in hospital-based practices to examine if physicians within varying levels of competition between each other affect their ability to obtain comparatively higher payment amounts from the pharmaceutical industry. To empirically examine this relationship, I use ProPublica's Dollars for Doctors database. This analysis provides insight into which factors influence the amount pharmaceutical companies are willing to pay for the opportunity to influence physicians prescribing habits. A stronger understanding of these influencing factors could help reduce wasteful spending in the health care field and cut health care costs.

Rent-Seeking in the Physician and Pharmaceutical Company Relationship

In any rent-seeking exchange, there are at least two parties: the rent-providers, who hold and exchange rents (or favors), and the rent-seekers who want to exchange with the providers. A rent is obtained when a rent-seeker can maintain above market clearing returns by receiving favorable treatment from a rent-provider (Tollison 1982, 2012). The amount of resources devoted to rent-seeking depends on the number rent-seeking parties and the perceived value of obtaining rents (Tullock 2005). Comparatively more valuable rents coupled with numerous rent-seekers makes the rent-provider able to extract a higher price for their rents.

Although most rent-seeking literature examines the government or governing bodies as the rent-providers and parties seeking government favors as the rent-seekers, this framework can be

extended to physicians and the pharmaceutical industry. Because the pharmaceutical industry can financially benefit if they successfully influence physicians to prescribe their pharmaceuticals, companies devote resources into activities including meals, travel stipends to sponsored events, or compensation for providing testimony on their products.

Previous economic and medical literature indicates physicians hold rents. Primarily, the prevalence and persistence of asymmetric information between the physician and the patient (Arrow 1963; Newhouse 1970; Farley 1986; Reilly and Santorre 2013) as well as restrictions on the supply of physicians (Svorny 2004) allow for physicians to maintain a critical role in distributing pharmaceuticals and medical products.[2] A consequence of information asymmetry in conjunction with barriers of entry to practice medicine is physicians' face comparatively less threat of financial and legal repercussions if they act against patients interests (March 2016). Financial exchanges with the pharmaceutical industry provide such a motivation. The third-party payment system provides further incentive to increase health care costs because it reduces cost-consciousness (Goodman 2012).

The regularity of interactions between the pharmaceutical industry and physicians provides evidence of physicians' rent-providing capability. In 2004 over 90% of physicians interacted with a pharmaceutical company (Blumenthal 2004). Wazana (2000) found physicians interact with pharmaceutical sales representatives four times a month on average. Further, surveys conducted on 446 physicians found approximately 54% were visited by a pharmaceutical sales representative at least once daily (Güldal and Semin 2000).

Physicians benefit from these interactions professionally and personally. Professionally, interactions provide up-to-date researching findings and other medical discoveries (Stossel 2015). In a survey conducted by Andaleeb and Tallman (1996), many physicians found, "the financial support the companies provided for continuing medical education programs was…vital" (p. 79). Personally, pharmaceutical companies frequently provide physicians generous financial support to attend sponsored luncheons and give costly gifts to physicians in exchange for their time and attention (Gaedeke et al. 1999).[3]According to previous medical literature, physicians commonly consider gifts and other forms of payment an entitlement of their work (Lexchin 1989; Jacobs 1999; Katz, Caplan and Merz 2010).

Pharmaceutical companies expend considerable resources in their interactions with physicians. In 1999, pharmaceutical companies spent approximately $8 billion on hiring, training and equipping sales representatives (Coyle 2002). Expenditures on interactions with physicians have increased over time. Pharmaceutical company's advertisement targeted toward physicians increased $8,000 to $10,000 per physician from 2001-2005, which was double the average amount from 1996 (Jastifer and Roberts 2009). Pharmaceutical companies also e-profile physicians to database information on which physicians to target (Alkhaled et al. 2014).[4]

[2]The rents obtained from the physicians are a result of the rent-seeking behavior physicians engage in themselves. However, examining the sources of rent obtained by physicians is beyond the scope of this paper.

[3]According to ProPublica's dollars for Doctors Database, the average gift payment amount was approximately $575.

[4] Physicians engaged in e-profiling were associated with more pharmaceutical sales representatives' visits.

The pharmaceutical industry invests large amounts of resources into these interactions because this influence can be financially beneficial. Wazana (2000) examined 29 studies on physician behavior and found rapid prescribing of new drugs (instead of generics) and other forms of "non-rational prescribing" (p. 375) associated with interacting with pharmaceutical sales representatives, attending company sponsored continued medical education, or funded conference travel.[5] In a controlled experiment, Chren and Landefeld (1994) found physicians were more request pharmaceuticals to be added to hospital formularies after interacting with a pharmaceutical sales representative. Similar findings on changes in prescribing practices were found when physicians attended a pharmaceutical company sponsored symposium (Orlowski and Wateska 1992) and obtained free product samples (Warrier et al. 2010). Similarly, Katz, Caplan, and Merz (2010) and Goodman (2001) also found gifts from pharmaceutical companies can influence physician behavior.

Because these frequent and costly exchanges transactions may serve a rent-seeking and net welfare decreasing role in the health care market, it is critical to address what factors work to reduce payment amounts devoted to wasteful activity. Perhaps the key motivating factor in why pharmaceutical companies expend large financial resources is the amount of rents a physician has to exchange. If the number of physicians (rent-providers) increases, the amount of potential rents available also increases. As a consequence, the attractiveness of competing for the rents of an individual physician reduces. The decrease in the motive to secure rents from any particular physician may result in comparatively fewer resources devoted to obtaining rents by rent-seekers (pharmaceutical companies).

Increases in physician concentration could reduce the dollar amounts spent by pharmaceutical companies. Some examples reductions in payment amounts could include giving less expensive gifts, cheaper meals, lower speaking honorariums, or fewer travel expenses covered for attending sponsored events medical conferences. Physician concentration increases could also work to reduce the number of patients any physician may see, who are the ultimate consumers of pharmaceutical companies' products and the source of value of the rents.

Although the relationship between physician concentration and payments from the pharmaceutical industry has not been examined empirically, other works examining physician concentrations found increases in physician concentration were associated with patient-oriented outcomes. Shamans (2015, 456) found higher concentrations of general practitioners per capita were associated with higher prescription rates "to satisfy patient's expectations". Austin and Baker (2015) found less physician practice competition was associated with higher costs for fifteen common procedures. Similar findings were obtained when examining concentration for specialized physician practices. Dunn and Shapiro (2015) showed cardiologists in higher concentrated markets were associated with higher service provision including more diagnostic procedures. While these findings do not indicate an absence or reduction in rent-seeking from pharmaceutical companies, they do indicate higher physician concentration is associated with comparatively more patient-oriented outcomes.

[5] This "non-rational prescribing" is measured as a change in the physicians prescribing habits before and after receiving compensation. Although changes in prescribing habits are an important insight, as noted above, it is not sufficient to determine if this change was beneficial. It does, however, indicate the potential to influence physician's prescribing practices.

Previous empirical analyses indicate higher amounts of payments from pharmaceutical companies were made to physicians specialized in internal medicine or psychiatry and comparatively older (Norris et al. 2012).[6] The effect of a physician's sex on their ability to obtain payments remains unclear (Norris et al. 2012; Rose et al. 2014). Previous literature also notes the importance of personal connection in establishing a financial relationship with the pharmaceutical company (Rose et al. 2014; Alkhaled et al. 2014). The role of personal connections on establishing financial relationships, although self-explanatory, has not been empirically examined. The effect of physician concentration on the payment amount received the pharmaceutical industry is ultimately an empirical question which this paper now examines.

Data

Data on the payment amount received by physicians, the type of payment, the physician's specialty, and the location of the physician's practice were obtained from ProPublica's Dollars for Doctors Database. The data was collected from manufacturers making payments to physicians, teaching hospitals, and Group Purchasing Organizations (GPOs) who are legally required to report payments to the Center for Medicare & Medicaid Services. Applicable manufacturers are divided into type 1 and type 2 manufacturers.

A type 1 manufacturer includes any organization operating in the US or a US territory who engages in the production, preparation, propagation, compounding, or conversion of a covered drug, medical device, or biological device.[7] Type 2 organizations include organizations under common ownership with a type 1 manufacturer and assist a type 1 organization regarding production, preparation, propagation, sales, or distribution of a covered drug or medical device. Applicable GPOs include organizations which operate within the US or a US territory that purchase, arrange for, or negotiate purchases for a covered drug, medical device, or biological device without being solely used by the GPO. Covered drugs and medical devices are defined as those devices or products which require a prescription (for drugs), pre-market approval by the FDA (for devices) or are reimbursed by Medicare, Medicaid, or Children's Health Insurance Program.[8]

Payments were collected from August to December 2013. Payment types are divided into 16 categories: consulting fees, compensation for service other than consulting, honoraria, gifts, entertainment, food and beverage, travel and lodging, education, research, charitable contribution, royalty or license, current or prospective ownership or investment interest, serving as faculty or as a speaker for an unaccredited and non-certified continuing educational program, serving as faculty or as a speaker for an accredited or certified continuing educational program, grants, and space rental or facility fees. Descriptions of each form of payment are provided in Table 1 below.
Table 1. Payment Types and Descriptions.

[6] In the author's sample, the median and mean age was 53 with a range of 36-75 years.
[7] I do not include payments made in US territories in this analysis because physician concentration data is unavailable.
[8] Exceptions include those manufacturers whose receive less than 10% of their revenues from covered drugs and medical devices, foreign entities who contribute to the manufacturing of a covered product but have no business presence in the US, Manufacturers who only produce the materials for a covered drug or device but do not produce the finished product, entities which produce or use covered products within the entity itself (hospitals, hospital-based pharmacies, laboratories, etc.), and wholesalers who do not hold the title of a covered drug or medical device.

Payment Type	Description
Consulting Fees	Payments made to physicians for advice and expertise on a particular medical product or treatment.
Compensation for Service other than Consulting	Payments made to physicians for speaking, training, and education engagements that are not for continuing education.
Honoraria	Similar to consulting fees, but generally reserved for a one-time, short duration activity.
Gifts	A general category, which will often include anything provided to a physician that does not fit into another category.
Entertainment	Attendance at recreational, cultural, sporting or other events .
Food and Beverage	Food and Beverage.
Travel and Lodging	Travel and Lodging.
Education	This category generally includes payments or transfers of value for classes, activities, programs or events that involve the imparting or acquiring of particular knowledge or skills, such as those used for a profession. This category can include things like textbooks and medical journal articles.
Grant	Payment for different types of research activities, including enrolling patients into studies of new drugs or devices.
Charitable Contribution	Any payment or transfer of value made to an organization with tax-exempt status under the Internal Revenue Code of 1986.
Royalty or License	Royalty or other payment based on sales of products that use a physician's intellectual property.
Current or Prospective Ownership or Investment Interest	Ownership or investment interests currently held by physicians, as well as ownership interests or investments that physicians have not yet exercised.
Serving as Faculty or as a Speaker for an Unaccredited and Non-certified Continuing Educational Program	Compensation for serving as faculty or as a speaker for an unaccredited and non-certified continuing education program.
Serving as Faculty or as a Speaker for an Accredited or Certified Continuing Educational Program	Compensation for serving as faculty or as a speaker for an accredited or certified continuing education program.
Grants	Payment to a physician in support of a specific cause or activity.
Space Rental for Facility Fees	Fees for renting space or facilities.

Data on the total number of physicians, the total number of physicians in office-based practices, the total number of physicians in hospital-based practices, the total number of physicians between specified age brackets, and the total number of male physicians at the state level was obtained from the American Medical Association's (AMA) Physician Characteristics and Distribution in the US 2015 edition. The publication is produced annually with a two-year delay in data availability. The data provided in the 2015 edition was obtained from the AMA's Physician Masterfile which contains records for every physician practicing medicine in the US. Records for each physician are started when the individual begins medical school in the US or when physicians who attended medical school outside the US begin practicing in the US.

The Physician Characteristics and Distribution in the US record book defines physicians engaging in office-based practices as those who are involved in seeing patients within any practice arrangement. Physicians within the hospital-based practice category are physicians contracting with a hospital to provide patient care. The total number of physicians at the state level includes all physician engaged inpatient care (including both office-based and hospital-based practices). Physician ages at the state level and broken into age brackets of below the age of 35, between 36-45 years old, 46-55 years old, 56-65 years old, and older than 65 years old.

Data on the percentage of the state population over 65 years old were obtained from the US Census Bureau. These estimations were obtained using midyear population estimates. Information on the percentage of state population considered obese was obtained from the State of Obesity 2014 Issue Report.[9] The report uses the same criteria as the Center for Disease Control where an individual is considered obese if their Body Mass Index exceeds 30%.

Data on the percentage of the state population without any form of health insurance was obtained from the US Census Bureau's Health Insurance Coverage in the US: 2013. Estimates for health insurance coverage are calculated using the Current Population Survey Annual Social and Economic Supplements. Data on the number of hospitals per state was obtained from the US Census Bureau. Data on accredited medical schools in the US was obtained from the Association of American Medical Colleges. Only medical schools within the US are included in this analysis. A list of all medical schools used in this analysis is provided in an online appendix.

Data on state urbanization rates are for the year 2010 because data for 2013 is unavailable. Figures were obtained from the US Census Bureau. The US Census Bureau defines urbanized areas and urbanized clusters at the state level as the population within a specified geographical area exceeding 50,000 people and at least 2,500 but less than 50,000 residents respectively.

Empirical Approach

Following a similar approach to Reilly (2012), Reilly and Santarre (2013), and Norris et al. (2012), I use the following equation to test the effects of physician concentration on the amount of payments received by physicians from pharmaceutical companies:

$$\text{Log(PaymentAmount)} = \alpha + \beta_1 \text{PhyscianConcentrationX} + \beta_2 \text{Urbanization} + \beta_3 \text{PopulationAbove65} + \beta_4 \text{PrecentObese} + \beta_5 \text{NoInsurance} + \beta_6 \text{Hospitals} + \beta_7 \text{MedicalSchools} + \beta_8 \text{MalePhysician} + \beta_9 \text{PhysiciansAbove65} + \beta_{10} \text{SpecialtyX} + \varepsilon$$

The dependent variable is the logarithm of the payment amount received by a physician in dollars. Following Rose et al. (2015) I take the logarithm of the payments received by physicians to account for outlier payment values. I also, following the approach used by Ross et al. (2015), do not examine payment amounts below the legal minimum amount required to report. Although the data reports payments below the $10 threshold, these values are likely underreported.[10] Payments made to teaching hospitals, research physicians, or technicians are also not included. Because payments in the dataset to teaching hospitals are not assigned to specific physicians (or a

[9] These estimates are for 2013.

[10] Approximately 16% of the payments reported in the dataset were below $10.

group of physicians), it is unclear which factor contributed to the teaching hospital receiving payments.

PhyscianConcentrationX represents the physician's concentration at the state level per 1,000 citizens. Physician concentration is calculated by dividing the total number of physicians by the total state population. This number is then multiplied by 1,000. I calculate physician concentration at the state level for the total number of physicians, the total amount of office-based physicians, and the total of hospital-based physicians.

I include office-based physician to examine the effects of increased physician concentration for a comparatively more competitive area of physician services (McCarthy 1985). I include physicians with hospital-based practices because these physicians likely face a comparatively higher inelastic demand for their services than physicians with office-based practices.[11] I do not include residents or medical students in my measure of hospital-based physicians due to differing rules regarding allowable interactions with pharmaceutical companies (Hopper, Speece, and Musial 1997; Chimonas and Rothman 2005; Greenland 2009).

Urbanization represents the percentage of the state population residing within urbanized areas and urban clusters. Urban concentration may affect the cost for a pharmaceutical company to establish a relationship with a physician and the number of patients a physician serves. Both factors may impact how the physician prescribes. *PopulationAbove65* represents the percentage of state citizens above the age of 65. *PercentObese* represents the percentage of state citizens who qualify as obese. Both demographics are associated with consuming more health care goods.

NoInsurance represents the population of the state's residents without any form of health insurance. Insurance coverage may affect the prescribing practices of a physician which may influence the willingness of a pharmaceutical company to engage in financial transactions. *Hospitals* represents the number of hospitals per state. *MedicalSchools* represents the number of medical schools per state. Although I do not include payments made to teaching hospitals in the analysis, medical schools may constitute an important part of the local physician network which make receiving payments from the pharmaceutical industry comparatively easier.

PercentMale represents the percentage of the state physician population which is male. This variable is calculated by dividing the total number of male physicians by the total number of physicians at the state level. *PhysicianAge65* represents the state physician population 65 years old or older. Because the sex and age of each physician receiving payments is unavailable, I use these measures to assess the impact of physician sex and age on payment amounts received from pharmaceutical companies.

The *SpecialtyX* variable contains binary variables holding a value of 1 if the physician indicated their medical specialty was for: allergy and immunology, anesthesiology, dermatology psychiatry and neurology, urology, internal medicine, surgery, obstetrics and gynecology, preventive medicine, ophthalmology, otolaryngology, pediatrics, and podiatrists. I include these variables to account for the heterogeneous effects of practicing within a medical specialty have on

[11]A hospital-based physician primarily treats patients within an inpatient or outpatient hospital. A patient receiving treatment in a hospital likely has a comparatively more inelastic demand for medical attention than a patient who is not in a hospital.

a physician's ability to obtain payments from a pharmaceutical company. Specialty variable findings are not provided in the empirical analysis to conserve on space. Further explanation regarding how each specialty variable was constructed is available in the online appendix. Summary statistics are provided in Table 2 below.

Table 2. Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
LogPaymentAmount	868684	3.32	1.28	2.30	14.53
TotalPhysicianConcentration	868684	3.41	0.90	2.08	9.05
Office_BasedConcentration	868684	1.92	0.34	1.25	3.43
Hospital_BasedConcentration	868684	0.56	0.82	0.16	3.29
Urbanization	868684	81.80	11.389	38.7	100
PopulationAbove65	868684	0.14	0.09	0.09	0.19
PercentObese	868684	0.28	0.03	0.21	0.35
NoInsurance	868684	0.14	0.05	0.034	0.22
Hospitals	868684	141.79	83.78	7	424
MedicalSchools	868684	5.67	3.49	0	13
MalePhysicians	868684	0.68	0.04	0.57	0.78
PhysicanAgeAbove65	868684	0.03	0.01	0.001	0.05
Allergy/Immunology	868684	0.01	0.08	0	1
Anesthesiology	868684	0.02	0.13	0	1
Dermatology	868684	0.01	0.10	0	1
Psychiatry/Neurology	868684	0.09	0.29	0	1
Urology	868684	0.02	0.14	0	1
InternalMedicine	868684	0.35	0.48	0	1
Surgery	868684	0.08	0.26	0	1
Obstetrics/Gynecology	868684	0.02	0.13	0	1
PreventativeMedicine	868684	0.001	0.03	0	1
Ophthalmology	868684	0.01	0.10	0	1
Otolaryngology	868684	0.01	0.09	0	1
Pediatrics	868684	0.03	0.17	0	1
Podiatrics	868684	0.01	0.09	0	1

The empirical approach first uses ordinary least squares (OLS). I separately test the effects of physician concentration for the total number of physicians, the total number of office-based physicians, and the total number of hospital-based physicians at the state level. I include regression results with and without state fixed effects to account for heterogeneity in state policies which affect the interactions between physicians I then use two-stage least squares (2-SLS) to account for potential endogeneity of the physician concentration variables.[12]

[12] Using the first state approach using each type of physician concentration above as the dependent variable, I found the other regressors contained high explanatory power. This indicates the physician concentration variable is likely endogenous.

I follow a similar method used by Reilly (2012) and Reilly and Santerre (2013) who account for endogeneity of physician concentration using 3 and 5-year lagged physician concentration instruments respectively.[13] The authors intentionally do not use longer lagged periods noting potential weaker correlation to the endogenous variable (Reilly 2012). However, these authors examine the impact of physician concentration on state level growth rates, not on receiving payments from the pharmaceutical industry.

Longer lagged periods may be appropriate instruments when examining the effect of payment amounts received from pharmaceutical companies. While a physician's impact on growth may not be significant over a long period, this may not be true of a physician's ability to obtain payments from pharmaceutical companies. Pharmaceutical companies have held strong ties to physician practices, were frequently involved in research, and made financial contributions to the pharmacy and medical schools since the late 1960's (Stossel 2015). This historical precedent means comparatively longer physician concentration lagged periods may hold stronger explanatory power than the lagged instruments used in the previous literature.

This analysis uses 1-year, 5-year, and 10-year lagged physician concentration instruments for total, office-based, and hospital-based physicians.[14] Physician concentrations for these lagged periods were calculated using the same sources and method mentioned above. I selected these instruments following the method of Ng and Bai (2009) were each lagged variable was tested using the first-stage regression approach. In the first-stage approach, all lagged variables held a t-statistic above 2.50 (the criterion used by the authors).

Empirical Results

As indicated in Table 3, the logarithm of payment amounts received by physician's ranges from 2.30 to 14.53. The large variance in payment amounts reflects the heterogeneity of physician practices, experience, and the environment they practice within attracts comparatively larger or smaller payments made from pharmaceutical companies. Physician concentration, our variable of interest, ranges from approximately 2 physicians per 1,000 state citizens to approximately 9 physicians per 1,000 state citizens for total physicians. Physician concentration for office-based physicians at the state level ranged from approximately1 office-based physician per 1,000 citizens to approximately 3 office-based physicians per 1,000 citizens. Physician concentration of hospital-based physicians at the state level ranged from approximately 0.16 hospital-based physicians per 1,000 citizens to approximately 3 hospital-based physicians per 1,000 citizens. Similarly, a combined mean value of approximately 0.54 for the specialty binary variables indicates over half of the payments made in the dataset were from specialized physicians.

The first set of regressions uses OLS and demonstrates consistent negative statistically significant relationships between physician concentration for total, office-based, and hospital-

[13]Lagged instrumental variables have also been used to account for endogeneity of health insurance providers (Bates, Hillard, and Santerre 2012).

[14] Data on the total amount of physicians, office-based physicians, and hospital-based physicians at the state level before 2001 does not include federally employed physicians. Due to differences in how the number of physicians was calculated, this analysis does not include lagged physicians concentration variables before 2003 (a ten year lag).

based physicians. Specifically, an increase in total physician concentration at the state level of 1 physicians per 1,000 state citizens (approximately 4/5ths of a standard deviation) was associated with approximately a 0.02 point decrease in the logarithm of the amount of payments to physicians (approximately 1/45th of a standard deviation and payment decrease of approximately $1). An increase in of 1 office-based physician per 1,000 citizens at the state level (approximately3 standard deviations) was associated with approximately a 0.06 point decrease in the logarithm of the payment amount received by physicians (approximately 1/20th of a standard deviation and approximately $1.15). An increase in of 1 hospital-based physician per 1,000 citizens at the state level (approximately 4/5ths of a standard deviation) was associated with a 0.006 point decrease in the logarithm of the payment amount received by physicians (approximately 1/60th of a standard deviation payment decrease of approximately $1). Unlike findings in the previous literature, physician populations composed of comparatively more male physicians was associated with decreases in payment amounts where a 4% increase in the percent of males in the physician labor force (approximately 1 standard deviation) was associated with a 0.03-0.02 point decrease in the logarithm of the payment amount.

While the payment amounts are quantitatively small, it is important to recall these values represent reductions in the dollar amount per individual payment. With nearly 900,000 payments recorded above the minimum threshold, these payment decrease amounts constitute considerable decreases in overall funds devoted to influencing physicians. The quantitative impact of these payment reductions is also understated when we consider payment amounts under $10 were not included.

I also used state fixed effects to account for differences in state policies. When these effects were accounted for, only office-based physicians remained statistically significant (the quantitative impact did not change). The changes likely indicate physicians in office-based practices are comparatively more substitutable for pharmaceutical companies. Detailed findings using OLS and state fixed effects are reported in Table 3 below.

Table 3. Total, Office-based, and Hospital-based Practices, OLS and State FE

	Total	Office-Based	Hospital-Based	Total	Office-Based	Hospital-Based
PhysicianConcentration	-0.02***	-0.06***	-0.01***	-0.02	-0.06**	-0.01
	(-5.73)	(-6.59)	(-3.17)	(-1.61)	(-2.61)	(-1.40)
Urbanization	0.00	0.00	0.001	0.00	0.00	0.00
	(0.96)	(1.06)	(0.44)	(0.35)	(0.38)	(0.15)
PopulationAbove65	0.66***	0.65***	0.31**	0.66	0.65 *	0.30
	(5.81)	(5.79)	(2.44)	(1.60)	(1.69)	(0.76)
PercentObese	0.04	-.044	0.18**	0.04	-0.04	0.18
	(0.45)	(-0.47)	(2.07)	(0.14)	(-0.16)	(0.54)
NoInsurance	-0.06	-0.00	0.16***	-0.06	-0.00	0.16
	(-0.91)	(-0.62)	(2.67)	(-0.30)	(-0.02)	(1.02)
Hospitals	0.00	0.000	0.00***	0.00	0.00	0.00
	0.52	(1.26)	(4.20)	(0.20)	(0.51)	(1.47)
MedicalSchools	0.00	-0.00	-0.00**	0.00	-0.00	-0.00
	(0.90)	(-0.62)	(-1.93)	(0.33)	(-0.23)	(-0.65)
MalePhysicians	-0.61***	-0.64***	-0.46***	-0.60*	-0.64 **	-0.47*
	(-6.03)	(-6.35)	(-4.86)	(-1.89)	(-2.06)	(-1.78)
PhysicanAgeAbove65	-0.52**	-0.48**	-0.46*	-0.52	-0.48	-0.47
	(-2.14)	(-1.98)	(-1.86)	(-0.73)	(-0.61)	(-0.54)
Constant	3.55***	3.84***	3.37***	3.55***	3.64***	3.37***
	(43.32)	(42.29)	(46.91)	(15.36)	(17.49)	(18.38)
State Fixed Effects	No	No	No	Yes	Yes	Yes
N	868684	868684	868684	868,684	868,684	868,684
F-stat	1131.59	1131.65	1130.50	331.44	345.15	337.78
R-squared	0.04	0.04	0.04	0.04	0.04	0.04

t-statistics in parentheses where * p<0.1, ** p<0.05 and *** p<0.01. Regressions are reported with robust standard errors. Physician specialty controls are included but not provided in the table.

To account for endogeneity of physician concentration, the next set of regressions use 2-SLS with 1-year, 5-year, and 10-year lagged physician concentrations for total, office-based, and hospital-based physicians as instruments. This analysis uses the uses a test developed by Montiel Olea and Pflueger (2013) to test the weakness of the instruments. The test is specifically developed for the 2-SLS procedure and is robust to many limitations of other instrumental variable weakness test. As shown by the Montiel-Pflueger F-stat in Table 4, the null hypothesis that the instrument set is weak is rejected for all physician concentration measures. The Kleibergen-Paap LM statistic is also used to test for under-identification of the model. This null hypothesis of under-identification was also rejected for each concentration measure.

The 2-SLS approach yielded many similar results regarding the effects of physician concentration and payment amounts made to physicians from pharmaceutical companies to the first set of regressions. Higher total physicians and total office-based physicians held a negative statistically significant relationship with the logarithm of the payment amount received when controlling for endogeneity. However, hospital-based physician concentration was positively statistically significantly related to the logarithm of payments made to physicians. It is possible the heterogeneity of how hospital-based physicians are compensated, the size of the hospital, and the perceived needed stock of pharmaceuticals may affect what types of interactions hospital-based physicians have with the pharmaceutical industry. I do not assign much explanatory power to this result because the relationship lost statistical significance when state fixed effects were added. Detailed findings using 2-SLS are reported in Table 4.

Table 4. Total, Office-based, and Hospital-based Practices, 2-SLS and State FE

	Total	Office-Based	Hospital-Based	Total	Office-Based	Hospital-Based
PhysicianConcentration	-0.02***	-0.08***	0.02***	-0.02	-0.08***	0.06
	(-5.32)	(-7.27)	(2.82)	(-1.54)	(-2.91)	(1.33)
Urbanization	0.00	0.00	0.00**	-0.00	0.00	0.00
	(0.97)	(1.06)	(2.11)	(-0.02)	(0.15)	(0.21)
PopulationAbove65	0.66***	0.70***	0.86***	0.42	0.48	0.96
	(5.73)	(6.11)	(4.95)	(1.15)	(1.43)	(1.14)
PercentObese	0.66	-0.12	0.53***	-0.12	-0.20	0.35
	(0.56)	(-1.25)	(4.56)	(-0.35)	(-0.64)	(0.71)
NoInsurance	-0.66	-0.04	0.08	0.15	0.10	0.46
	(-0.79)	(-0.57)	(1.40)	(0.48)	(0.41)	(1.22)
Hospitals	0.00	0.00	-0.00	0.00	0.00	-0.00
	(0.60)	(0.91)	(-1.60)	(0.70)	(0.69)	(-0.96)
MedicalSchools	0.00	-0.00	0.00	-0.00	-0.00	-0.00
	(0.82)	(-0.49)	(0.56)	(-0.19)	(-0.11)	(-0.23)
MalePhysicians	-0.60**	-0.68***	-0.40***	-1.39	-1.55	-2.22
	(-5.95)	(-6.74)	(-4.12)	(-1.20)	(-1.28)	(-0.89)
PhysicanAgeAbove65	-0.52**	-0.47*	-0.67***	-1.06	-1.95	-3.33
	(-2.14)	(-1.94)	(-2.68)	(-1.06)	(-1.22)	(-1.01)
Constant	3.54***	3.72***	3.13***	4.38***	4.6***	3.54***
	(42.68)	(41.43)	(35.48)	(3.91)	(3.87)	(42.68)
State Fixed Effects	No	No	No	Yes	Yes	Yes
N	868684	868684	868684	868684	868684	868684
F-stat	1131.37	1132.06	1130.28	290.21	297.01	350.80
Centered R-squared	0.04	0.04	0.04	0.04	0.04	0.04
Kleibergen-Paap LM-stat	5.1e+04	1.4e+05	1.4e+05	13.86	13.15	7.94
Montiel-Pflueger F-stat	6.22e+05	62072.05	42248.34	169.99	26.32	3.55

z-statistics in parentheses where * p<0.1, ** p<0.05 and *** p<0.01. Regressions are reported with robust standard errors. Physician specialty controls are included but not provided in the table.

Additional Specifications

Additional regression were run on Gift and Entertainment payments separately and together to differentiate between payments more likely to serve a rent-seeking role from those payments more likely to serve marketing or research role. I specifically examine Gift and Entertainment payments because these forms of payments, based on their description, do not appear to have any direct marketing or research purpose. The results were spurious and, because they add little explanatory power, are not included in this analysis. However, because gift and entertainment payments combined compose less than 0.005% of the payment sample (3,964 observations), they are unlikely to hold significant explanatory power regarding the financial transactions between physicians and pharmaceutical companies.

Food and Beverage payments compose the vast majority of the payment sample (87%) and were also examined separately from other types of payments. Sub-sampling to only include Food and Beverage payments using the 2-SLS approach outlined above yielded similar results found when examining all payment types using the 2-SLS. Total and office-based concentration held statistically significant negative relationships to the logarithm of Food and Beverage payments made to physicians. Hospital-based physician concentration held a positive (weakly) statistically significant relationship with the logarithm of Food and Beverage payments made to physicians.

Physician concentration at the metropolitan statistical area level (following the US Census Bureau's distinction) was also tested. Because these results were also spurious, which areas constituted metropolitan statistical areas changed over the periods examined, and most of the variables used in this analysis are not available at the examined scale they are not included in this analysis. The percent of the state population composed of Black and Hispanic individuals was also examined to test if comparatively larger minority populations would affect pharmaceutical companies' willingness to make payments to physicians. These variables added little explanatory power and are excluded from the analysis. Finally, physician age brackets including physicians under the age of 35, between 35-44, between 45-54, and between 55-64 years old were also examined to test the effect of various ages (or stages of career) affected the physicians

Conclusion

The recent systematic release of data containing the dollar amount of payments made to physicians from pharmaceutical companies has led to a reemergence of concerns over the potential for conflicts of interest to affect the health care market. This essay examines the payments made to physicians from pharmaceutical companies using a rent-seeking framework. This framework examines pharmaceutical companies engaging in rent-seeking activities where physicians are the rent-providing parties. This framework allows us to recast the literature in terms of wasteful rent-seeking behavior from pharmaceutical companies. The framework also allows us to examine which factors work to reduce resources devoted to rent-seeking from pharmaceutical companies.

Using OLS, state fixed effects, 2-SLS, and controlling for 13 separate physician concentrations this essay examines the relationship between physician concentration for total, office-based, and hospital-based concentration at the state level and the logarithm of payment

amounts received by physicians. I hypothesize that as the number of rent-providers (physicians) increases per state capita; less resourced are devoted (dollar amounts spent per physician) from rent-seekers (pharmaceutical companies). The analysis finds a consistent statistically significant negative relationship between physician concentration for total physicians and office-based physicians at the state level and the logarithm of the payment amount received by a physician. The results for hospital-based physicians were mixed. This relationship was maintained when examining food and beverage payments specifically which constitute a large majority the payments examined. This relationship indicates, in many cases, higher concentrations of physicians works to reduce the payment amounts physicians receive from the pharmaceutical industry.

Although the relationship between physician concentration and payment amounts physicians receive from pharmaceutical companies contributes to the literature, the analysis is limited in providing implications regarding rent-seeking between physicians and the pharmaceutical industry. Because differentiating between payment which serves a rent-seeking and a productive role in advancing the pharmaceutical companies position, it is unclear what component of the payment reductions accompanied by higher physician concentration reduces welfare decreasing exchanges. The analysis also does not control for comparatively more influential physician's ability to obtain payments which limit the analysis' ability to control for outlier payment variables.[15]

Despite these limitations, the empirical findings still provide important implications. As it is likely some of the financial transactions between pharmaceutical companies and physicians intend to obtain favors, the empirical relationship between concentration and payment amounts provides an important insight into the rent-providing and rent-seeking relationship between physicians and pharmaceutical companies. The importance of this relationship is further solidified when we acknowledge payment could serve both roles.

While this essay provides new insights into the financial relationship between pharmaceutical companies and physicians, additional research is necessary. A more thorough examination of what kind of payments are more and less likely to serve rent-seeking roles would greatly improve our understanding of the wasteful aspects of the physician and pharmaceutical company relationships. Incorporating measures of heterogeneous state level regulations on medical practices would also provide additional insights regarding which regulations work to promote or deter financial transactions with pharmaceutical companies. When more data becomes available, using a panel would also likely provide a more robust analysis.

[15] Comparatively more influential physicians are sometimes referred to as "Key Opinion Leaders" (Rodwin 2013; Stossel 2015).

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