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Abstract

The effect of disclosure laws on what is being disclosed is typically unknown since data on disclosed activity rarely exist in the absence of disclosure laws. We exploit data from legal settlements disclosing $316 million in payments to 316,622 physicians across the U.S. from 2009-2011. Multiple regression analysis of differences-in-differences and LASSO double-selection models were used. States were classified as having strong, weak, or no disclosure based on data reported only to state authorities or being publicly available. One state, Massachusetts, began releasing payment data on the web during our sample period, allowing separate analysis of physician payments while the cost of disclosing data remained fixed for pharmaceutical companies. Strong disclosure law reduced payments among doctors accepting less than $100 and increased payments among doctors accepting greater than $100. Weak disclosure states were indistinguishable from no disclosure states. The behavioral response to mandatory disclosure is likely due to the public visibility of disclosed data.

Keywords: Physician Payment, Legal/Regulatory Issues, Ethical Issues

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1 Introduction

Spending by the pharmaceutical industry on promotions and marketing in the U.S. grew from $11 billion in 1996 to an estimated $29 billion in 2011 (Donohue et al., 2007), (IMS Health, 2011), with other independent estimates placing the number much higher (Donohue et al., 2007), (IMS Health, 2011), (Kerber, 2004), (Wolfe, 1996), (Gagnon and Lexchin, 2008). Even accounting for direct-to-consumer advertising, 90% of promotional expenditures are directed toward physicians, amounting to between $30,000 and $61,000 per physician each year (Donohue et al., 2007). Although direct payments to physicians, as our data suggests, constitute a small proportion of these promotional expenditures, they have made them the subject of professional and political controversy. There is concern that these transactions may create conflicts of interest that undermine clinical objectivity and public trust in physician recommendations (Wazana, 2000),(Studdert et al., 2004), (Chimonas et al., 2007), (Campbell, 2007).

The prevailing strategy for addressing potential conflicts of interest has been enhancement and enforcement of disclosure (Katz et al., 2003). This is despite a lack of empirical evidence regarding the effects of disclosure on industry-physician financial relationships. Several states have enacted "sunshine laws" that require companies to report payments to physicians (Brennan and Mello, 2007). In Massachusetts, Vermont, and Minnesota, these disclosures are public (Mass. Gen. Laws, ch. 111N, §6; Minn. Stat. §151.461; Vt. Stat. tit. 18, §§4631-2.) and since 2009, many pharmaceutical companies have publicly disclosed payment data for all 50 states (Merrill et al., 2013). Beginning in 2014, the Patient Protection and Affordable Care Act will require reports of all payments from pharmaceutical companies to physicians, with exceptions for items such as drug samples and payments of less than $10 in value. These disclosures will be compiled into a publicly searchable online database (42 C.F.R. §§ 402-3).

Critics of disclosure suggest that these laws stigmatize physicians who maintain collaborative relationships with industry that are essential to innovation and product feedback (Sade, 2011), (Sigworth et al., 2001), that disclosure may have the unintended consequence of greater trust in physicians with larger payments (Loewenstein et al., 2012), (Loewenstein et al., 2011), (Koch and Schmidt, 2010). Moreover, the disclosure laws have limited effects on prescribing behavior (Pham-Kanter et al., 2012) and, as such, merely increase the cost of doing business. However, the effects of disclosure laws on the mediating channel of industry-physician relationships remain unknown.

It is difficult to analyze the effect of disclosure on payments, and no previous study has examined whether payments to physicians from pharmaceutical companies are lower when disclosure is mandatory. Data for this type of comparative empirical analysis are rarely available, and are typically of limited quality (Ross et al., 2007), as data are typically only available for states that have instituted disclosure requirements. One has to rely on self-reported figures for payments in non-disclosure states. We bypass this obstacle by utilizing national data released by pharmaceutical companies due to legal settlements unlikely to have been predicted at the time physicians received payments.

The scope and size of our data also make it a more comprehensive industry-wide analysis. Twelve U.S. pharmaceutical companies representing 42% of total pharmaceutical industry revenues released data on payments from 2009-2011 totaling to $316 million to

316,622 physicians in 50 states and Washington, D.C. States were classified as having strong (3 states), weak (4 states), or no (44 states) disclosure laws based on whether data was reported to state authorities (weak) or was made publicly available (strong). We employ multiple regression and differences-in-differences frameworks to analyze the association between disclosure laws and payments to physicians.

For one state – Massachusetts – state-mandated disclosures first became publicly available during our sample period, allowing separate analyses of the association between disclosure laws and public visibility of disclosed data while the administrative cost of reporting data remained fixed for pharmaceutical companies. This regression discontinuity framework allows a robustness check for our analysis across all states. The results confirm that while the number of payments for physicians goes down, the average amount of large payments, defined as being over $100, increase.

The rest of the paper proceeds as follows. Section 2 presents the model which provides theoretical intuition for the main findings. Section 3 describes the data. Section 4 explains the empirical strategy and threats to the validity of the identification strategy. Section 5 presents the results. Section 6 discusses the findings and presents robustness tests. Section 7 concludes.

2 Model

This section seeks to understand why disclosure law may have behavioral effects. The following is a simple model based on Levonyan (2013) that examines pharmaceutical company payments and scientific publications of paid physicians. The model illustrates the potential impact of disclosure law on physician payments. First, the average payoff to the paid physicians is predicted to increase after mandatory disclosure. Second, low payments to physicians drop out with mandatory disclosure because it is not worth it to the pharmaceutical companies to pay these small payments while bearing the associated costs of disclosure.

Suppose a physician has type θ that measures the effectiveness in increasing pharmaceutical company sales. For example, scientific thought leaders may be more effective at presenting the results of clinical research. The overall output also depends on effort e put forth by the physician, such that the physician succeeds at persuading others with probability $p(e)$ and fails with probability $1 - p(e)$. As standard in the literature, we assume that the payoff function is concave in e ($p' > 0$ and $p'' < 0$). When the project is successful, the payoff is θ, and 0 otherwise. The overall payoff is then given by:

$$Y = \theta p(e)$$

.

The distribution of θ depends on the type of physician. Assume there are two types, with distributions: $F_p(\theta)$ and $F_n(\theta)$, respectively. They capture the intuition that thought leaders, denoted by p are more likely to have larger influence. That is, we assume that $F_p(\theta)$ stochastically dominates $F_n(\theta)$, in a sense that knowing the prior publications will help the pharmaceutical companies target more effective doctors that match with their

goals:

$$F_p(\theta) \leq F_n(\theta)$$

Exerting effort e costs the physician $c(e)$ with standard assumption of convex costs: $c'(e) > 0$, and $c''(e) > 0$. The physician has the outside option of $\bar{u}$. If the payment to the doctor is w, then the payoff structure needs to satisfy the individual rationality (IR):

$$w - c(e) \geq \bar{u}$$

Moreover, we specify that transfers cannot go the opposite way: $w \geq 0$.

The pharmaceutical company's objective, for a given physician type, is to maximize the payoff function:

$$\max_{(w)} \theta p(\tilde{e}) - w$$

subject to,

$$e \in \arg\max_{\tilde{e}} \{w - c(\tilde{e})\}$$

$$w - c(e) \geq \bar{u}$$

If we assume that there is no informational asymmetry (this assumption is relaxed in Levonyan, 2013), the First Best solution would involve maximizing the entire surplus:

$$e^* \in \arg\max_{\tilde{e}} \{\theta p(e) - c(\tilde{e})\}$$

and

$$w = c(e^*) + \bar{u}$$

The First Order Condition will be:

$$\theta p'(e^*) = c'(e^*)$$

$$e^* = e^*(\theta)$$

where $e^{*'} > 0$. Thus, the payoff to the pharmaceutical company will be: $\theta p\left(e^*\right) - c\left(e^*\right) - \bar{u}$. Suppose, θ_0 is the cutoff for non-negative profits:

$$\theta_0 p\left(e\left(\theta_0\right)\right) - c\left(e\left(\theta_0\right)\right) - \bar{u} = 0$$

Then, the proportion of doctors that gets paid will be $1 - F\left(\theta_0\right)$, and the average wage will be:

$$E\left(w\right) = \int_{\theta > \theta_0} [c\left(e^*\left(\theta\right)\right) + \bar{u}] dF = \int_{\theta > \theta_0} c\left(e^*\left(\theta\right)\right) dF + \left(1 - F\left(\theta_0\right)\right) \bar{u}$$

Since F_p stochastically dominates F_n, it is easy to show that:

$$E_p\left(w\right) \geq E_n\left(w\right)$$

Thus, the publishing physicians are being paid more than the non-publishing ones.

Now, consider the effect of disclosure. We assume that such a law increases the cost of each physician for being associated with the pharmaceutical company. Alternatively,

it increases their outside utility, $\bar{u}$, effectively making them more reluctant to accept payments. The new participation constraint becomes:

$$w = c(e^*) + \bar{u} + \alpha$$

where α is the added cost of disclosure. The new setup does not change the optimal First Order Condition, but will raise the cutoff value, θ_0':

$$\theta_0' p\left(e\left(\theta_0'\right)\right) - c\left(e\left(\theta_0'\right)\right) = \bar{u} + \alpha$$

Then, mandatory disclosure has two effects. First, the average payoff to the paid physicians will increase, as for a given physician effort, the payment to physician increases. Second, the cutoff threshold for physicians who receive payments increases, so low payments will drop out.

3 Data

We identified payments to physicians between 2009-2011 using public disclosures from 12 pharmaceutical companies. The combined revenue of the companies represented 42% of U.S. market revenue in 2011 (Table 4). Table 5 summarizes the conditions for each pharmaceutical company disclosing the payments. Two companies made the payments data available because of voluntary disclosure, and data from the remaining 10 companies were available due to legal action – typically as a result of legal settlements with the U.S. Department of Justice. These data were collated and provided by a non-profit journalism organization, ProPublica. We conducted several validaiton of the data. First, we compared this database with data obtained directly from seven pharmaceutical companies (Figure 5). We also excluded voluntarily disclosed data in robustness checks of our specification. Under both cases, the results matched with the original ProPublica data.

Our data contained 579,652 payments made from the third quarter of 2009 to second quarter of 2011. We also excluded 707 payments for which an individual recipient could not be identified. 316,622 physicians and $316 million in payments were represented in our data. Each payment included the name of the pharmaceutical company providing payment, name and address of the physician receiving payment, date, amount, and category of payment. The types of payments are consulting, speaking, research, meals, travel/lodging, items, other, or combination of above categories. If a payment range was specified (e.g., "$10,001-$20,000"), the average reported payment within that range was used. Physician identifiers were created based on the same name (first, last, and middle) and city appearing in multiple disclosure records. For a match across payment records, we required the same first and last name, and either the same middle name (or initial) or city; no other data were available for the match.

Various governmental and non-profit organizations provided data on statewide health and socioeconomic conditions.

We classified state disclosure laws as "strong" if states required payments to physicians to be publicly available, "weak" if states required payments to physicians to be reported to the state but not the general public, and "none" if states did not require reporting of payments to physicians. Table 1 summarizes the strength of disclosure laws by state.

3.1 Outcomes

The main dependent variable was the log of average payments per year, calculated as the total annual amount paid to all physicians in a state each year divided by the number of physicians reported by the AMA to have active licenses in each state ("statewide payments"). Using logs allowed us to evaluate differences in payments across states in relative terms. In additional tests, we examined the share of statewide payments in each category and number of physicians accepting any payment. We also analyzed annual payments to individual physicians among the subset of physicians who accepted at least one payment ("paid physicians") as well as the distribution of payments above and below \$100 – the limit on industry gifts to physicians suggested by both the AMA (American Medical Association, 1992) and Pharmaceutical Researchers and Manufacturers of America (PhRMA) (Pharmaceutical Research and Manufacturers of America, 2009) – and \$1,000.

3.2 Potential Confounders

For each state, the U.S. Census Bureau provided data on population density and the proportion of individuals aged <18 years, >65 years, or with a high school education. The Kaiser Family Foundation provided data on the average number of retail prescriptions per person that were filled at pharmacies in 2011. The US Departments of Labor and Commerce provided data on cost of living, average physician wages, median household income, and the proportion of individuals with health insurance. The AMA and American Hospital Association provided data on the number of physicians and nurses in each state with active licenses, respectively. In robustness checks, we used sparse models to assist in the selection of controls (Appendices 1 and 2) (Belloni et al., 2011), (Belloni et al., 2012).

4 Estimation Framework

Our multiple regression model used the following framework:

$$\log(Y_{st}) = \beta_0 + \beta_1 Law_{st} + \beta_2 Year_t + \beta_3 X_{st} + \epsilon_{st}, \tag{1}$$

where Y_{st} is the ratio of sum of all payments received, over the number of active physicians in state s, year t. Law_{st} are dummy variables indicating strength of disclosure laws in state s, year t (strong, weak, or none (the omitted variable)); $Year_t$ is dummy for each year in our sample; and X_{st} are state and year controls, including the share of payments from each company, the share of payments for each category of payment, and health and socioeconomic controls as described above. We use heteroscedasticity-robust Huber-White standard errors.

For alternative specifications, we also looked at:

$$\log(Y_{ist}) = \beta_0 + \beta_1 Law_{st} + \beta_2 Year_t + \beta_3 X_{st} + \epsilon_{ist} \tag{2}$$

where Y_{ist} is now sum of all payments received by physician i in state s, year t, and the right-hand side variables having the same notation as the aggregate version.

Finally, for the third specification, we looked at:

$$\log(Y_{cst}) = \beta_0 + \beta_1 Law_{st} + \beta_2 Year_t + \beta_3 X_{st} + \epsilon_{cst}, \quad (3)$$

where now Y_{cst} is the sum of category c payments received divided by the sum all payments in state s, and year t.

4.1 Differences-in-differences specification

For the differences-in-differences specification, we used the following framework:

$$\log(Y_{st}) = \beta_0 + \beta_1 \mathbb{1}_M + \beta_2 \mathbb{1}_M Post_t + \beta_3 Post_t + \beta_4 Year_t + \beta_5 X_{st} + \epsilon_{st}, \quad (4)$$

where Y_{st} is the sum of all payments, over the number of active physicians in state s, year t; $\mathbb{1}_M$ is an indicator variable for the state of Massachusetts; $Post_t$ is a dummy when the payment is after 2010; and $Year_t$, and X_{st} are as defined before.

As an alternative specification, we also consider:

$$\log(Y_{ist}) = \beta_0 + \beta_1 \mathbb{1}_M + \beta_2 \mathbb{1}_M Post_t + \beta_3 Post_t + \beta_4 Year_t + \beta_5 X_{st} + \epsilon_{ist}, \quad (5)$$

where Y_{ist} is now sum of all payments received by physician i in state s, year t, and the right-hand side variables having the same notation as the aggregate version.

4.2 Test for normality and Outliers

Payments were bimodal (Figure 4), so we tested for normality and log-normality around both the lower and upper modes. Neither the distribution of log payments around the lower mode (P=0.83) nor around the upper mode (P=0.56) was statistically distinguishable from a normal distribution (using the one-sample Kolmogorov-Smirnov test against the theoretical distribution); however, we rejected the hypothesis that payments in non-log terms were normally distributed (P<0.001 and P=0.047 for the lower and upper modes, respectively). We therefore specified payments in logs.

To reduce the impact of outliers, we replaced the top 0.5% of payments with the 99.5th percentile. We varied this parameter between the top 0.5% and 2.5%, with similar results. Results were robust to eliminating payments reported in ranges.

4.3 Least Absolute Shrinkage and Selection Operator ("LASSO")

Determining which variables to select as controls is a frequent problem in observational studies. Typically, intuition suggests a set of variables that might be important but does not identify exactly which variables are important or the variables' functional forms and interactions. This lack of clear guidance about which variables to use leaves researchers with the problem of attempting to select a sensible set of controls from a potentially vast set of variables. We hope that LASSO may be a useful tool strengthening observational studies in the clinical literature.

The basic problem in estimating the causal impact of disclosure law on pharmaceutical company payments to physicians is that disclosure law is not randomly assigned, and it seems likely that laws are endogenous to factors that are associated with both the strength

of the disclosure law and pharmaceutical company payments. These factors would drive a spurious association between disclosure law and pharmaceutical company payments. Obvious confounding factors include the existence of persistent state-to-state differences in policies, demographics, and culture that are probably related to disclosure laws and the overall level of pharmaceutical company payments to physicians, such as the desirability of physicians to pharmaceutical company marketers or the willingness of physicians to accept payments from pharmaceutical companies.

It is also important to control flexibly for state-to-state differences. Interpreting correlations from our basic specification as causal relies on the belief that there are no higher-order terms of the control variables, no interaction terms, and no additional excluded variables that are associated both to disclosure laws and pharmaceutical company payments to physicians. A causal interpretation also relies on the belief that there is no reverse causality from payments to disclosure laws. While ruling out reverse causality must be made on a priori grounds, justifying the belief of no omitted variables requires more work.

Controlling for a large set of variables is desirable from the standpoint of making the belief underlying the causal interpretation of the disclosure law coefficient. Controlling for omitted variables makes far more plausible the assumption that the disclosure law may be taken as being as good as randomly assigned once the set of variables considered is controlled for. The downside is that controlling for many variables lessens the researcher's ability to identify the effect of interest and thus tends to make estimates far less precise. That is, the researchers are faced with a trade-off between the precision of the estimate and the plausibility of the conditional exogeneity assumption. By including additional controls in the specification, we make the conditional exogeneity assumption more plausible. At the same time, we potentially reduce the precision of our estimate.

The double selection method by LASSO offers a rigorous approach to achieving a balance between exogeneity and precision. LASSO complements the usual careful specification analysis by providing a researcher a simple-to-implement, data-driven way to search for a set of influential confounds from among a sensibly chosen broader set of potential confounding variables. Empirical studies usually rely on a sensitivity analysis to report results for several different sets of controls, in an attempt to show that the parameter of interest is robust to changes in the set of control variables. The tables in our Appendix display such an approach. We also used the sparse econometric model "LASSO" to reduce the concern of omitted confounds. Formally, LASSO modifies ordinary least squares by minimizing the sum of squared errors subject to the sum of the absolute value of all coefficients being less than a constant. This constraint tends to set some coefficients to exactly 0, reducing model complexity by identifying only the most important variables.

Estimation proceeded in two steps. First, LASSO selected the control variables that predict the strength of the disclosure law. This step helps to ensure robustness by finding control variables that are strongly related to the treatment and thus potentially important confounds. Next, LASSO selected control variables that were predictive of payments. This step helped to ensure that we captured important elements in the equation, helping keep the residual variance small as well as intuitively providing an additional chance to find important confounds. LASSO searched among a set of potential confounding factors listed below. The original controls plus LASSO-selected control variables were

then included as independent variables. The list of our potential confounds are as follows: Annual Physician Mean Wage, Number of Paid Physicians, Employment Rate, Number of Physicians, Physicians Per Capita, Number of Nurses, Population, Land Area, Population Density, Percent Under 18, Percent Over 65, Cost of Living Index, Prescribed Drugs Per Capita, Adoption Rate, Percent of Women Aged 25-29, Percent of Women Aged 30-34, Percent of Women Aged 35-39, Percent Hispanic, Percent Non-Hispanic, Percent Insured, Percent of Women Working, High School Completion, Income Per Capita, Percent in Large Firms, Raw Consumer Price Index, Consumer Price Index, Real Income Per Capita, Share of Payments from Each Pharmaceutical Company by Value and by Count, Share of Payments in each Payment Category by Value and by Count, Year Fixed Effects, and all two-way interactions between any of these variables. All data come from government sources and from our data collection.

All results at the state and physician level and at various thresholds were robust to dropping control variables for share of payments from each company and share of payments for each category of payment. Since changes in categories or shift by companies is likely one of the effects of disclosure laws, the relationships became larger and more statistically significant.

Figure 3 displays the cumulative density of payments by strength of disclosure law. The cumulative density line for states with no disclosure law and for states with weak disclosure law indicates that in both groups of states, 90% of the annual payments among paid physicians are below $1000. This can be seen by drawing a vertical line at $1000 on the x-axis. When Massachusetts, Minnesota, and Vermont are averaged, 81% of the physicians in these states were paid less than $1000 annually.

We used data from Massachusetts to compare the distribution of payments by companies in the ProPublica database and by companies not in the ProPublica database. A Wilcoxon-Mann-Whitney test for significant differences in distributions indicates that the two distributions are not significantly different (P=0.20)

5 Results

We next considered the unconditional association between disclosure laws and statewide payments to physicians by examining the raw statistics and plotting the probability density function of payments per active physician. We then used multiple regression models to relate physician payments to the presence of strong, weak, or no disclosure laws, controlling for the pharmaceutical company providing payment, category of payment, year, and controls described above. Using the same methodology, we also estimated the relationship between disclosure laws and the share of payments in each category, and the relationship between disclosure laws and the number of physicians receiving payments. The unit of analysis is the state-year with 153 observations across 3 years.

Next, we analyzed the association between disclosure laws and payments received by physicians at the individual (rather than state) level. We evaluated different thresholds for payments to ascertain the parts of the payment distribution that were associated with disclosure laws. We plotted cumulative distribution functions to consider the proportion of paid physicians in each state that accepted payments above and below $100 and $1,000.

We also plotted cumulative distribution functions including active physicians who did not accept payments. For some figures, we displayed strong-disclosure states individually because the disclosure law enactment dates varied by state. We used a Kolmogorov-Smirnov test for differences in distributions and a multiple regression analysis similar to the aggregate approach. The unit of analysis is physician-year. Some specifications include only physician-years when a physician received >$0 in payments. Other specifications include all active physician-years, assigning $0 to physicians not receiving payments.

One state in our sample, Massachusetts, enacted a strong disclosure law in January 2009, but first publicly released data in November 2010 (Table 1) (Kowalczyk, 2010). To examine the impact of this release, we ran a differences-in-differences analysis that compared the change in payments in Massachusetts pre- versus post-November 2010 with the change in payments in all other states (none of which altered transparency during this time period). Units of analysis are state-year and physician-year.

Table 2 presents summary statistics. 11% of physicians in strong-disclosure states accepted payments, versus 37% and 42% of physicians in states with weak and no disclosure laws, respectively (Figure 1). Among the 316,622 physicians who accepted payments across the U.S., the average annual payment was $1,377 (standard deviation=$6,694).

Adjusted for all controls, statewide payments per physician were 49% lower in strong-disclosure states (95% CI=-0.716,-0.259, P<0.001, Table 3 and Table 6, column 6) than in non-disclosure states. Statewide payments were not significantly lower in weak-disclosure states (coefficient=-0.176, 95% CI=-0.394,0.041, P=0.11) (Table 3 and Table 6, column 6) than in non-disclosure states.

Compared to total payments per category in non-disclosure states, adjusted for all controls, the share of total payments per category in strong-disclosure states was as follows: 10.5% lower share for speaking (P=0.005), 3.1% lower share for meals (P=0.05), and 9.4% higher share for consulting (P<0.001) (Table 6). Weak-disclosure states had, in contrast, a 2.8% higher share of payments for meals and 2.1% lower share of payments for consulting than in non-disclosure states (both P=0.05). A chi-squared test of differences between payment categories by strength of disclosure laws was significant (P<0.001).

Table 3, column 2 (and Table 6, models 7-9) considers the subset of physicians who accepted any payment from pharmaceutical companies. In strong-disclosure states, annual payments among physicians who accepted any payment were 10.1% higher (95% CI=0.0096-0.193, P=0.03) than in non-disclosure states. In weak-disclosure states, annual payments were 8.9% lower (P<0.001) than in non-disclosure states, but the sign of this association was reversed in specifications with fewer controls (Table 6, columns 7-9).

In strong-disclosure states, annual payments among physicians who accepted greater than $100/year were 54% higher (95% CI=0.411-0.674, P<0.001) (Table 3, column 3) than in non-disclosure states. No statistically significant association was observed for strong disclosure laws and the number of physicians who accepted greater than $100/year. However, in strong-disclosure states, roughly 19% of paid physicians accepted payments greater than $1,000, compared with only 10% of physicians in weak-disclosure states and non-disclosure states (Figure 3). States with less time spent under strong disclosure laws had a smaller percentage of paid physicians accepting payments >$1,000.

As seen in Figure 3, Massachusetts – the state with the most recent implementation of a strong disclosure law – exhibited the lowest proportion of paid physicians receiving

payments >$1,000 among strong-disclosure states and diverged least from weak and non-disclosure states in this regard. States under strong disclosure laws for longer periods of time had higher proportions of highly paid physicians. The distributions were significantly different at P=0.001.

No statistically significant association was observed for strong disclosure laws and size of payments among paid physicians who accepted less than or equal to $100/year, but the number of such physicians was 68% lower (95% CI=0.058-1.294, P=0.032) than in non-disclosure states. This association indicated a sharp drop-off of small payments, consistent with Figure 3. When including all physicians (not just those who received payments), annual payments among physicians who accepted less than or equal to $100/year were 41% lower (95% CI=0.343-0.471, P<0.001) (Table 3, column 4). Payments among physicians who accepted less than or equal to $100/year were not significantly different in states with weak versus no disclosure laws.

Following public release of disclosed payments, payments per physician in Massachusetts decreased 36% (P<0.001) (Table 3, column 5) relative to all other states (which did not change publication of disclosures during this time period). The share of Massachusetts payments declined by 7% for speaking and 4% for meals, but rose 9% for research and 1% for consulting (all P<0.001) (Table 9). However, because of the large decrease in payments per physician overall, the absolute amount within each of the categories was reduced.

Although not statistically significant, the number of Massachusetts physicians receiving any payment and payments <$100 declined 34% (P=0.112) and 13% (P=0.125), respectively. Payments among Massachusetts physicians who accepted >$100/year increased 69% (P<0.001) while payments among those who accepted <$100/year decreased by 6.9% (P<0.001) (Table 3, columns 6-7) relative to all other states.

6 Discussion

This study presents, to our knowledge, the first large-scale analysis of observed associations between disclosure law and physician relationships with industry.

Strong disclosure laws were associated with a 49% lower statewide annual average of payments to physicians and 74% lower proportion of physicians receiving payments. These decreases might be considered an intended result of disclosure legislation. However, among physicians who accepted any payment, annual payments were 10% higher in strong-disclosure states, and payments were 54% higher among physicians who accepted more than $100/yr.

Physicians in strong-disclosure states were less likely to accept payments for speaking and for meals and more likely to accept payments for research activities and consulting. These observations suggest that rather than stigmatizing physician-industry research relationships, public disclosure of payments may instead encourage explicit and formal delineation of physician-industry relationships around research and development activities. Alternatively, whether this reflects a substantive shift in the nature of physician-industry relationships or a shift in categorization is unclear, as contract terms are typically private and may include provision of promotional or marketing support (Steinbrook, 2009).

Little association was observed between payments to physicians and disclosure laws that did not mandate disclosure of payments to the public. This finding may explain the limited effects of disclosure laws in West Virginia and Maine on prescribing behavior in two drug classes observed in a recent study (Pham-Kanter et al., 2012). The disclosure requirements in the Affordable Care Act, however, are more similar to the strong disclosure laws in our study.

Our results shed light on whether the effects of disclosure law are mediated through administrative costs imposed on industry or through willingness to accept payments among physicians. First, strong and weak disclosure imposes similar administrative costs. Second, the changes observed in Massachusetts after public release of disclosures were similar to the smaller payments noted for strong disclosure states. These results suggest that the reduction of incidental payments was due to decreased willingness among physicians to accept payments and that the cost of compliance with disclosure requirements did not significantly reduce industry willingness to maintain payment relationships with physicians.

Third, higher payments for paid physicians were observed when physician payments were publicly visible. This result is consistent with physician-level factors such as compensation demanded for increased public visibility and associated reputational costs (Sigworth et al., 2001) or a "compensation race" driven by physicians demanding more for their contracts, the availability of information on colleagues' compensation, and a sense of entitlement (Lichter, 2008) or being under-paid (Preker, 2007).

We only had data from 12 pharmaceutical companies; however, they included 7 of the 10 largest firms in the U.S. market, making their activities relevant even if not representative of smaller pharmaceutical firms. Lower payments per physician in strong disclosure states were observed for each of the 12 companies regardless of its size.

Changes in disclosure laws were not randomly assigned, yet the main results were similar using both cross-sectional and longitudinal variation. We examined the experience of Massachusetts before and after the state publicly released data on pharmaceutical company payments to physicians. We employed advanced statistical techniques for strengthening cross-sectional studies by using LASSO, a sparse model, to select control variables predictive of the strength of disclosure law and control variables predictive of payments. Results were similar in both the raw data and multiple regressions that included controls. We cannot verify whether pharmaceutical companies assigned the most relevant payment category to transactions. Additionally, we cannot evaluate the accuracy of our algorithm to identify the same physician across transactions.

7 Conclusion

State-mandated public disclosure of pharmaceutical payments to physicians was associated with lower statewide average payment per physician, but higher payments among the subset of physicians with industry relationships. Shifts in the proportion of payments for speaking and meals into payments for consulting or research were associated with public disclosure of pharmaceutical payments to physicians. State-mandated disclosures of payments that were not released to the public were not associated with differences in payments. Aggregated to the state level, physicians in states with strong disclosure laws

receive less payment than states with none. This can be attributed to the fact that most doctors in those states don't receive any payment at all. Among the physicians receiving any payment there is an overall increase in physician payments in states with strong disclosure laws relative to states with no laws. Physicians getting <$100 experience a great decrease relative to the amounts received by physicians getting <$100 in states without legislation and those with more than $100 receive an increase. Physicians receiving trivial amounts appear to be turning away the trivial amounts. Physician payments appear to concentrate among physicians receiving over $100, in the categories of consulting and research and away from travel and meals. Many hope that disclosure policies will result in more evidence-based prescribing decisions, better patient outcomes, and decreases in total expenditures on prescription drugs – the fastest growing component of health care costs. Our ongoing research investigates the effects of pharmaceutical company payments on prescribing behavior and patient outcomes.

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Table 1. States Mandating Disclosure of Pharmaceutical Company Payments to Physicians

State	Effective Date	Information Disclosed	Restrictions on Access	Source
Disclosure Laws With Public Reporting ("Strong")				
Massachusetts	Jul 2009	Payments from drug companies and medical device makers to health care providers	None, but first publicly released in Nov 2010	17
Minnesota	Jan 1997	Payments of >$100 from wholesale drug manufacturers to practitioners	Generally public, but some information is subject to trade secret and other restrictions	18
Vermont	Jun 2002	Payments from prescription drug companies to health care providers	None	19
Disclosure Laws Without Public Reporting ("Weak")				
West Virginia	Apr 2009	Payments of $100 from drug companies to health care providers, for the purpose of advertising prescription drugs	Confidential	36
District of Columbia	Jul 2004	Payments for seminars, informational programs, trips and travel; food, entertainment, or gifts valued at >$25; anything provided to a health care professional for less than market value.	Confidential, except for aggregate data	37
Maine	Jan 2006	Payments for seminars, informational programs, trips and travel; food, entertainment, or gifts valued at >$25; anything provided to a health care professional for less than market value.	Confidential, except for aggregate data	38
California	Jan 2005	Pharmaceutical companies must self-impose an annual limit on marketing expenses to health care professionals	No disclosure requirement	39
No Disclosure Laws*				
Ohio	Proposed bill	Proposed bill would require pharmaceutical manufacturers to submit annual reports listing gifts to physicians who are authorized to prescribe drugs	Not specified	40
Federal (U.S.)	Mar 13	All payments and transfers of value. Pre-empts state laws that are similar or weaker than this provision.	None	41

*Analyzed as part of No Disclosure group, but noteworthy

[38] Title 22: HEALTH AND WELFARE. Subtitle 2: HEALTH. Part 5: FOODS AND DRUGS. Chapter 603: PRESCRIPTION DRUG ACCESS HEADING: PL 1999, C. 786, PT. A, §3 (NEW). Subchapter 4: PRESCRIPTION DRUG PRACTICES HEADING: PL 2003, C. 456, §1 (NEW). §2699. Prescription drug practices
(REPEALED).
[39] California Health and Safety Code. Section 119400-119402.
[40] Ohio Senate, Senate Bill 79.
[41] 42 USC 1320a-7h.

Table 2. Summary Statistics for Pharmaceutical Company Payments to Physicians, by Strength of Disclosure Laws, 2009-2011.

Variable	Category	Strength of Disclosure Laws		
		With Public Reporting ("Strong")	Without Public Reporting ("Weak")	None
N States		3	4	44
N Active Physicians*		43,820	109,041	646,630
N Paid Physicians		6,689	38,209	271,724
N Payments		11,039	69,759	498,147
Number of Physicians Accepting Any Payment / Number of Active Physicians (%)**		10.73	36.56	42.31
Average Annual Statewide Payments / Number of Active Physicians				
$	Consulting	33.52	15.92	18.91
	Speaking	130.34	233.09	255.71
	Research	30.91	35.30	68.49
	Meals	3.91	24.37	26.18
	Travel/Lodging	12.60	14.76	16.34
	Items	0.82	2.43	2.88
	Other	3.94	8.66	12.62
	Total	**220.85**	**334.40**	**411.45**
Average Annual Payments / Physician, Among Physicians Who Accepted Any Payment				
$	Consulting	1046.49	314.79	282.96
	Speaking	3692.35	2909.10	2855.72
	Research	1030.37	150.26	207.20
	Meals	43.87	67.51	56.77
	Travel/Lodging	203.49	79.63	53.92
	Items	7.20	4.47	4.20
	Other	354.05	466.93	470.89
	Total	**2436.35**	**1466.84**	**1340.24**
Share of Statewide Payments				
%	Consulting	15.38	5.79	5.05
	Speaking	53.59	64.28	61.74
	Research	22.23	13.94	18.92
	Meals	1.33	7.03	5.58
	Travel/Lodging	4.11	3.38	3.01
	Items	0.17	0.38	0.45
	Other	2.53	4.05	4.26
Year	2009	7.32	3.49	3.59
	2010	64.33	60.95	61.65

2011	28.35	35.56	34.75
Statewide Variables			
Real Income Per Capita ($)*	29,781	29,095	26,782
Average Physician Wage ($)	194,797	190,758	188,748
Cost of Living Index	115.32	121.33	102.86
Population < 18 y (%)	21.99	21.59	24.25
Population ≥ 65 y (%)	13.59	13.58	13.05
≥ High School Education (%)	90.84	85.24	87.12
Health Insurance (%)	76.96	68.28	71.11
Number of Retail Prescriptions Filled at Pharmacies (Person/Year)	12.23	13.15	12.14
Population Density (Thousands/Square Mile)	249.10	2298.41	162.06
Number of Physicians with Active Licenses	14,607	27,260	14,696
Number of Nurses with Active Licenses	43,933	67,815	45,775

*Data for 2010.
**Average per state.

Figure 1. Distribution of Payments To Physicians, 2009-2011.

Figure 1A: Probability Density of Annual Payments Per Active Physician ($)

Figure 1B: Cumulative Density of Payments To Physicians Who Accepted Payments ($)

Figure 1C: Proportion of Paid Physicians

Figure 1A

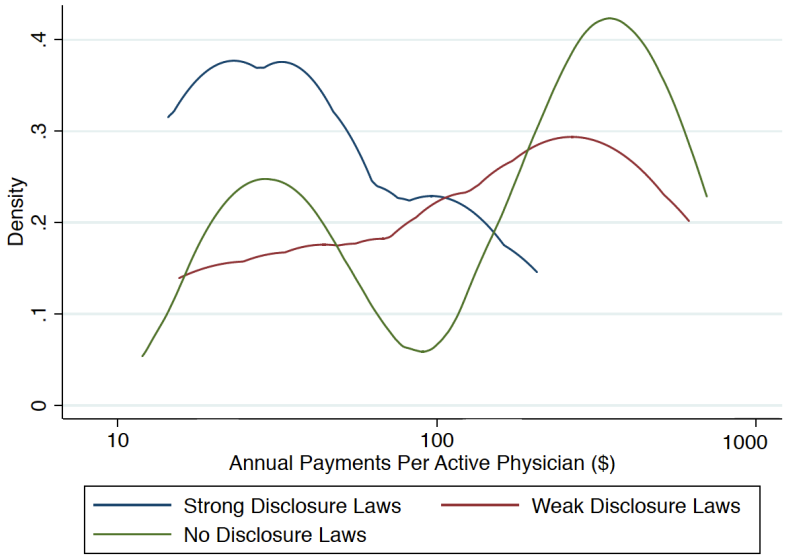


Figure 1B

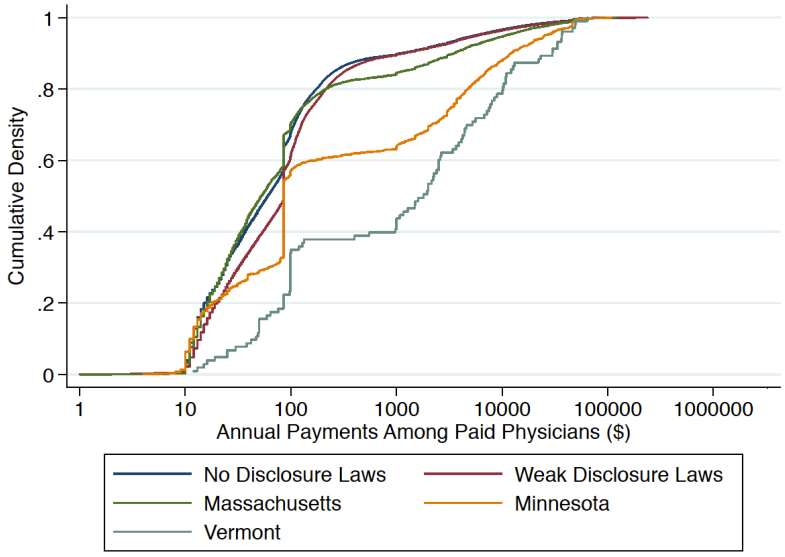


Figure 1C

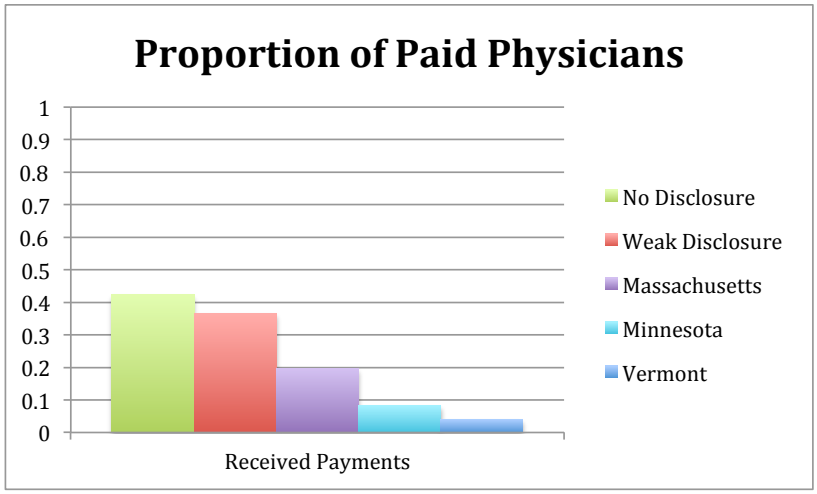
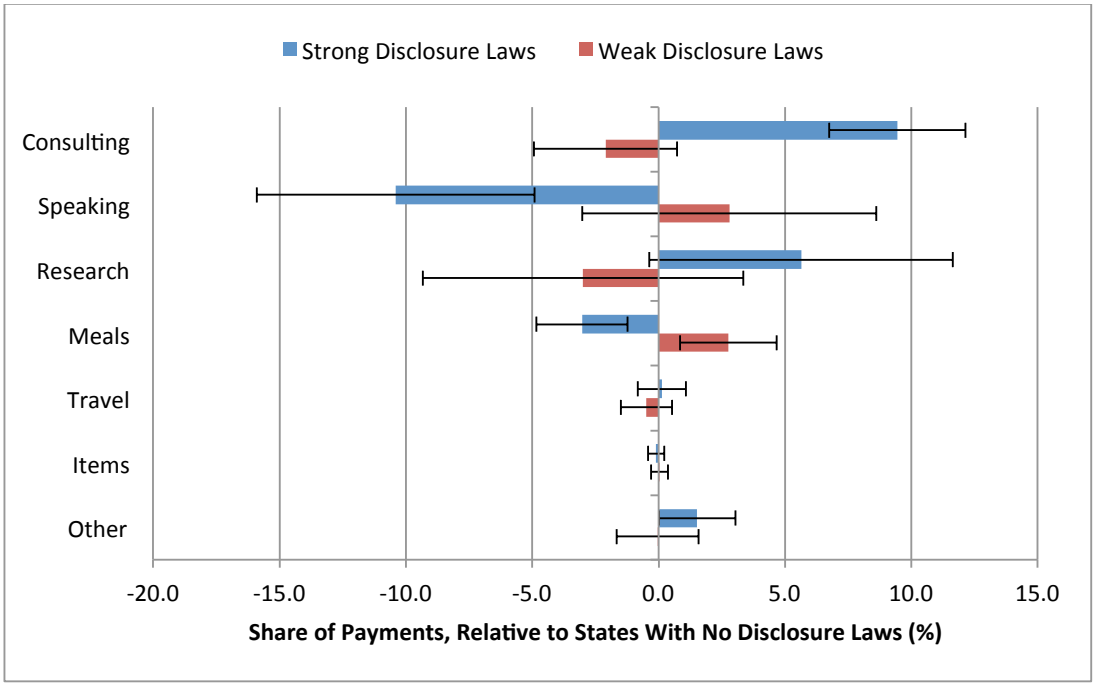


Figure 2. Relationship Between Disclosure Laws and Category of Payments, State Level, 2009-2011.*



*Error bars show 95% CI. Results adjusted for company, year, and statewide demographics.

Appendix 1. Disclosure of Pharmaceutical Company Payments to Physicians

Panel A: Size of Database, May 2012

Company	**Revenue ($ Billion, 2011)**	**Market Capitalization ($ Billion, May 2, 2012)**
Allergan	5.42	29.37
AstraZeneca	33.59	56.25
Cephalon*	18.31	43.08
Eli Lilly	24.29	47.86
EMD Serono**	N/A	N/A
GlaxoSmithKline	43.93	117.82
Johnson & Johnson	65.03	179.03
Merck	48.05	119.79
Novartis	58.57	151.26
Pfizer	67.43	171.7
Valeant	2.46	16.79
ViiV**	N/A	N/A
Total of Companies in Data	**367.08**	**932.95**
Size of Pharmaceutical Market	869.85	2,090.00
Market Share	**42.2%**	**44.6%**

*Data shown for Teva, which acquired Cephalon in 2011.

*Private company; data not available.

**Owned by GlaxoSmithKline and Pfizer.

Sources:
Global Industry Classification Standard. Health Care-Pharmaceuticals-Pharmaceuticals. New York, NY: MSCI and Standard and Poor's, 1999. Accessed at http://www.msci.com/products/indices/sector/gics/, May 2, 2012.
Bloomberg LP, Accessed at www.bloomberg.com, May 2, 2012.

Panel B: Categories of Payments Reported by Companies Currently Disclosing Payments to Physicians (Source[42-53])				
Company	**Payments Disclosed**	**Reason**	**Effective Date**	**Expiration Date**
Allergan	**Phase I**: Payments for speaking, meals, and advisory boards of the Sales, Marketing, and Medical Affairs divisions. **Phase II**: All payments and transfers of value.	Legal settlement for alleged off-label marketing and illegal payments to physicians to induce prescriptions of Botox.	Phase I: 9/1/10 Phase II: 9/1/11	8/30/15
AstraZeneca	**Phase I**: Speaker fees. **Phase II**: Payments for consulting, speaking, meals, travel, research, certain educational items, royalties and license fees, and ownership and investment interests, when made directly or indirectly by AstraZeneca's US business.	Legal settlement for alleged off-label marketing and illegal payments to physicians to induce prescriptions of Seroquel.	Phase I: 8/31/10 Phase II: 8/31/11	4/27/15
Cephalon (Acquired by Teva-2011)	**Phase I**: Payments for speaking, meals, and advisory boards of the Sales, Marketing, and Medical Affairs divisions. **Phase II**: All payments and transfers of value.	Legal settlement for alleged off-label marketing of Gabitril, Actiq and Provigil.	Phase I: 1/31/10 Phase II: 3/31/11	9/26/13
Eli Lilly	**Phase I**: Payments for speaking, meals, and advisory boards of the Sales, Marketing, and Medical Affairs divisions. **Phase II**: All payments and transfers of value.	Guilty plea in criminal lawsuit and settlement in civil lawsuit for alleged off-label marketing of Zyprexa.	Phase I: 8/1/09 Phase II: 8/1/10	1/14/14
EMD Serono	All payments and transfers of value	Legal settlement for alleged illegal payments to physicians to induce prescriptions of Rebif.	7/1/11	4/20/15
GlaxoSmith Kline	**Phase I**: Payments for consulting and speaking. **Phase II**: Added payments for clinical research to lead investigators.	Voluntary	Phase I: 4/1/09. Phase II: 1/1/10.	None
Johnson & Johnson	All payments and transfers of value from Johnson & Johnson's US businesses	Voluntary	6/30/10	None
Merck	**Phase I**: Payments for speaking. **Phase II**: All payments and transfers of value.	**Phase I**: Voluntary. **Phase II**: Legal settlement for alleged off-label marketing of Vioxx.	Phase I: 9/1/09. Phase II: 6/1/12	11/22/16
Novartis	**Phase I**: Payments for speaking. **Phase II**: All payments and transfers of value, except for research, development, and clinical investigations. **Phase III**: All payments and transfers of value.	Legal settlement for alleged illegal marketing and remuneration to physicians to induce prescriptions of Diovan, Zelnorm, Sandostatin, Exforge, and Tekturna.	Phase I: 3/31/11 Phase II: 3/1/12 Phase III: 3/1/13	9/29/15
Pfizer	All payments and transfers of value	Guilty plea for misbranding Bextra and legal settlement for alleged illegal payments to physicians to induce prescriptions of Bextra, Geodon, Zyvox, and Lyrica.	3/31/10	8/31/14
Valeant	All payments and transfers of value	Guilt plea to violation of U.S. Anti-Kickback Statute and legal settlement for alleged illegal payments to physicians to induce prescriptions of Cardizem.	4/30/10	9/11/14
ViiV	Speaking and consulting fees to lead investigators. Includes payments from Pfizer and GlaxoSmithKline, which own ViiV.	Part of Pfizer settlement (above)	1/1/10	8/31/14

[42] Settlement Agreement Between United States and Allergan, United States ex rel. Amy M. Lang and Charles J. Rushin v. Allergan, Inc., Civ. No. 1:07-cv-1288-WSD (N.D. Ga., 2010), available at http://www.taf.org/botox-final-settlement-2010.pdf.

[43] Settlement Agreement Between United States and AstraZeneca, Inc., United States of America ex rel. James Wetta v. AstraZenec 3479, available at http://www.justice.gov/usao/pae/Pharma-Device/astrazeneca_settlementagreement.pdf.
[44] Biopharmaceutical Company, Cephalon, to Pay $425 Million & Enter Plea to Resolve Allegations of Off-Label Marketing, available http://www.justice.gov/opa/pr/2008/September/08-civ-860.html.
[45] Settlement Agreement Between United States and Eli Lilly, United States of America ex rel. Robert Rudolph, et al., v. Eli Lilly and C available at http://www.justice.gov/usao/pae/News/2009/jan/lillysignedsettlementagreement.pdf.
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[47] GSK, Commitment to Transparency and Access, available at http://us.gsk.com/html/responsibility/transparency-access.html.
[48] Johnson & Johnson Transparency in Our Business Activities, available at http://www.jnj.com/connect/about-jnj/our-citizenship/trans activities.
[49] Settlement Agreement Between United States and Merck & Co., Inc., United States of America v. Merck Sharp & Dohme Corp., Cr http://www.justice.gov/usao/ma/news/2011/November/20111114024353852.pdf.
[50] Settlement Agreement Between United States and Novartis, United States et al. ex rel. Austin and Montgomery v. Novartis Pharma 8:03-cv-1551-T-30-TGW, available at http://www.justice.gov/usao/pae/News/2010/Sept/novartis_settleagreement.pdf.
[51] Settlement Agreement Between United States and Pfizer, United States et al. ex rel. Blair Collins v. Pfizer, Inc., Civ. No. 04-11780-
[52] Valeant Pharmaceuticals Int'l., Quarterly Report Pursuant to Section 13 or 15(d) of the Securities and Exchange Act of 1934 (Form
[53] ViiV Healthcare, Payment to US Healthcare Professionals for Research and Development Activity, available at http://www.viivhealt us/corporate-ethics/payments-to-healthcare-professionals.aspx?sc_lang=en.

Appendix 3. Complete Results and Robustness Checks for Table 3 (Relationship Between Disclosure Laws and Payments to Physicians, 2009-2011).

Payments Specified in Logs

Multiple Regression Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)***	**(7)**	**(8)**	**(9)***
Unit of Analysis	State-Year						Physician-Year		
Dependent Variable	Log Annual Payments Per Active Physician ($)						Log Annual Payments Among Paid Physicians ($)		
Independent Variable									
Strong Disclosure Laws	-1.309***	-0.898***	-0.923***	-0.992***	-1.029***	-0.488***	0.373***	0.366***	0.101*
P	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0304
(95% CI)	(-1.923, -0.696)	(-1.337, -0.459)	(-1.373, -0.472)	(-1.491, -0.492)	(-1.473, -0.584)	(-0.716, -0.259)	(0.325 - 0.421)	(0.304 - 0.428)	(0.00959 - 0.193)
Weak Disclosure Laws	-0.198	-0.127	-0.249	-0.264*	-0.195*	-0.176	0.205***	-0.0145	-0.0880***
P	0.586	0.540	0.068	0.011	0.029	0.111	<0.001	0.431	<0.001
(95% CI)	(-0.913, 0.518)	(-0.534, 0.281)	(-0.516, 0.0183)	(-0.465, -0.0624)	(-0.369, -0.0207)	(-0.394, 0.0412)	(0.188 - 0.222)	(-0.0505 - 0.0216)	(-0.130 - - 0.0458)
Company (Share of Payments; Omitted Company is Allergan)									
AstraZeneca		37.52***	29.06***	3.390	-0.207	2.716		0.502	6.306***
P		<0.001	<0.001	0.444	0.958	0.256		0.432	<0.001
(95% CI)		(17.56, 57.48)	(14.51, 43.60)	(-5.342, 12.12)	(-7.924, 7.511)	(-1.997, 7.429)		(-0.749, 1.752)	(3.589, 9.024)
Cephalon		21.88***	16.81***	5.904*	-1.219	-3.745		0.0428	5.263***
P		<0.001	<0.001	0.0255	0.623	0.0712		0.943	<0.001
(95% CI)		(13.11, 30.65)	(10.86, 22.76)	(0.737, 11.07)	(-6.109, 3.671)	(-7.820, 0.329)		(-1.122, 1.207)	(2.643, 7.883)
EMD Serono		22.11***	16.13***	8.261*	1.626	0.202		10.97***	5.608
P		<0.001	<0.001	0.0122	0.541	0.911		<0.001	0.145
(95% CI)		(9.276, 34.95)	(8.000, 24.26)	(1.830, 14.69)	(-3.625, 6.877)	(-3.359, 3.763)		(4.514, 17.42)	(-1.933, 13.15)
Eli Lilly		76.25	-19.43	-15.06	-3.975	-11.18		-0.287	6.403***
P		0.0702	0.419	0.462	0.821	0.415		0.624	<0.001
(95% CI)		(-6.362,	(-66.83,	(-55.41,	(-38.74,	(-38.28,		(-1.437,	(3.767,

	P	0.00680	0.00107	0.0762	0.717	0.956	0.174	<0.001
	(95% CI)	(4.589, 28.14)	(5.053, 19.67)	(-0.552, 10.88)	(-6.355, 4.381)	(-3.637, 3.847)	(-1.961, 0.355)	(2.721, 7.985)
	Johnson & Johnson	15.01*	13.50***	5.885*	-0.489	-0.114	-0.775	4.697***
	P	0.0138	<0.001	0.0469	0.851	0.949	0.231	<0.001
	(95% CI)	(3.104, 26.91)	(6.070, 20.94)	(0.0825, 11.69)	(-5.648, 4.670)	(-3.643, 3.416)	(-2.044, 0.493)	(2.011, 7.383)
	Merck	35.37***	30.53***	7.092	-0.835	3.681	-1.979**	5.355***
	P	<0.001	<0.001	0.141	0.830	0.440	0.00682	<0.001
	(95% CI)	(16.68, 54.07)	(18.78, 42.28)	(-2.374, 16.56)	(-8.537, 6.867)	(-5.731, 13.09)	(-3.413, -0.545)	(2.457, 8.253)
	Novartis	12.81*	14.19***	3.580	-1.265	0.242	-0.0493	5.793***
	P	0.0204	<0.001	0.229	0.649	0.896	0.948	<0.001
	(95% CI)	(2.010, 23.62)	(6.808, 21.58)	(-2.278, 9.438)	(-6.745, 4.216)	(-3.402, 3.885)	(-1.541, 1.443)	(2.915, 8.672)
	Pfizer	21.59**	19.34***	4.409	-1.083	-0.578	-0.328	5.484***
	P	0.00409	<0.001	0.211	0.699	0.783	0.575	<0.001
	(95% CI)	(6.967, 36.21)	(9.639, 29.03)	(-2.531, 11.35)	(-6.621, 4.456)	(-4.727, 3.571)	(-1.474, 0.818)	(2.854, 8.114)
	Valeant	18.94**	14.34***	6.759*	0.0621	0.236	0.954	7.022**
	P	0.00170	<0.001	0.0243	0.982	0.898	0.631	0.00329
	(95% CI)	(7.238, 30.63)	(6.868, 21.82)	(0.891, 12.63)	(-5.255, 5.379)	(-3.408, 3.879)	(-2.933, 4.841)	(2.340, 11.70)
	ViiV	52.35*	14.98	17.93	3.537	2.438	0.565	6.815***
	P	0.0417	0.370	0.131	0.649	0.767	0.554	<0.001
	(95% CI)	(1.999, 102.7)	(-17.99, 47.94)	(-5.404, 41.27)	(-11.83, 18.90)	(-13.87, 18.75)	(-1.307, 2.436)	(3.797, 9.832)
Category (Share of Payments; Omitted Category is Consulting)								
	Items		-29.68*	-28.29***	-12.05*	-2.768	-13.61***	-17.92***
	P		0.0306	<0.001	0.0301	0.663	<0.001	<0.001
	(95% CI)		(-56.54, -2.816)	(-41.59, -15.00)	(-22.93, -1.181)	(-15.33, 9.798)	(-16.02, -11.19)	(-21.42, -14.42)
	Meals		8.018***	4.319*	3.330*	2.972**	1.067***	-2.869*
	P		<0.001	0.0191	0.0277	0.00898	<0.001	0.0183
	(95% CI)		(4.889, 11.15)	(0.719, 7.918)	(0.371, 6.288)	(0.759, 5.184)	(0.599, 1.534)	(-5.251, -0.486)
	Other		-2.197	-0.845	-3.130*	0.763	0.538	-5.491***
	P		0.281	0.652	0.0473	0.535	0.158	<0.001
	(95% CI)		(-6.212, 1.819)	(-4.550, 2.859)	(-6.223, -0.0373)	(-1.666, 3.192)	(-0.208, 1.284)	(-8.115, -2.866)
	Research		1.482	-0.627	-1.413	1.283	1.282***	-4.665***
	P		0.162	0.543	0.146	0.0997	<0.001	<0.001
	(95% CI)		(-0.602, 3.566)	(-2.660, 1.407)	(-3.324, 0.498)	(-0.249, 2.814)	(0.943, 1.621)	(-7.071, -2.258)
	Speaking		-0.713	-0.666	-1.850*	-0.376	1.527***	-5.115***
	P		0.516	0.475	0.0201	0.707	<0.001	<0.001
	(95% CI)		(-2.879, 1.453)	(-2.508, 1.175)	(-3.405, -0.295)	(-2.358, 1.606)	(1.172, 1.882)	(-7.548, -2.683)
	Travel		-2.654	-9.825**	-6.686*	-0.499	1.177*	-3.630**
	P		0.465	0.00528	0.0478	0.814	0.0134	0.00574
	(95% CI)		(-9.821, 4.513)	(-16.68, -2.975)	(-13.31, -0.0654)	(-4.699, 3.701)	(0.244, 2.110)	(-6.206, -1.055)
Year (Relative to payments in 2011)								
	2009			-1.556***	-1.305***	-0.406	4.800***	2.276***
	P			<0.001	<0.001	0.627	<0.001	<0.001
	(95% CI)			(-2.466, -0.646)	(-2.015, -0.595)	(-2.061, 1.248)	(4.681, 4.919)	(1.765, 2.786)
	2010			1.108***	1.038***	0.819	0.818***	0.407***
	P			<0.001	<0.001	0.315	<0.001	<0.001
	(95% CI)			(0.603, 1.613)	(0.641, 1.435)	(-0.790, 2.429)	(0.745, 0.891)	(0.264, 0.549)
Demographics								
	Household Income ($)				2.10e-05	-1.09e-05	2.01e-06	7.90e-06*
	P				0.177	0.538	0.432	0.0102
	(95% CI)				(-9.61e-06, 5.16e-05)	(-4.58e-05, 2.41e-05)	(-3.00e-06, 7.01e-06)	(1.87e-06, 1.39e-05)
	Average Physician Wage ($)				-2.03e-06	-2.06e-07	5.04e-07*	3.30e-07
	P				0.0679	0.809	0.0144	0.125
	(95% CI)				(-4.21e-06, 1.52e-07)	(-1.89e-06, 1.48e-06)	(1.00e-07, 9.07e-07)	(-9.14e-08, 7.52e-07)
	Cost of Living Index				-0.000647	-0.00129	0.00366***	0.00346***
	P				0.808	0.524	<0.001	<0.001
	(95% CI)				(-0.00591, 0.00462)	(-0.00531, 0.00272)	(0.00279, 0.00453)	(0.00238, 0.00454)
	% Population < 18 y				9.842***	1.443	-1.615***	0.720

P	<0.001	0.619	0.000493	0.182
(95% CI)	(4.709, 14.97)	(-4.297, 7.182)	(-2.524, -0.707)	(-0.339, 1.779)
% Population ≥ 65 y	4.350	-0.154	-0.282	-3.176**
P	0.0804	0.939	0.478	0.00113
(95% CI)	(-0.535, 9.234)	(-4.145, 3.837)	(-1.059, 0.496)	(-5.088, -1.265)
% Unemployment	0.0210	0.0282	0.00562**	0.00583*
P	0.0673	0.404	0.00696	0.0180
(95% CI)	(-0.00152, 0.0436)	(-0.0385, 0.0948)	(0.00154, 0.00970)	(0.00100, 0.0107)
% ≥ High School Education	-0.996	-1.875	-1.425***	-0.773***
P	0.382	0.0695	<0.001	<0.001
(95% CI)	(-3.245, 1.253)	(-3.902, 0.152)	(-1.838, -1.012)	(-1.201, -0.344)
% Health Insurance	0.894	1.202	0.0692	0.296
P	0.160	0.0562	0.512	0.205
(95% CI)	(-0.358, 2.145)	(-0.0324, 2.437)	(-0.138, 0.276)	(-0.161, 0.753)
Annual Prescription Drugs Filled at Pharmacies/Person	0.0849***	0.0251	-0.0119***	0.0975***
P	<0.001	0.439	<0.001	<0.001
(95% CI)	(0.0455, 0.124)	(-0.0390, 0.0891)	(-0.0182, -0.00561)	(0.0686, 0.127)
Population Density	1.09e-05	0.000463*	-6.38e-07	3.72e-05**
P	0.743	0.0150	0.938	0.00505
(95% CI)	(-5.47e-05, 7.65e-05)	(9.18e-05, 0.000835)	(-1.68e-05, 1.55e-05)	(1.12e-05, 6.32e-05)
Number of Active Physicians	-9.23e-06	-3.88e-06	-1.19e-06	-2.03e-06
P	0.166	0.562	0.358	0.147
(95% CI)	(-2.23e-05, 3.87e-06)	(-1.71e-05, 9.37e-06)	(-3.71e-06, 1.34e-06)	(-4.77e-06, 7.14e-07)
Number of Active Nurses	3.45e-06	1.35e-06	9.10e-07*	1.56e-06**
P	0.139	0.567	0.0453	0.00144
(95% CI)	(-1.14e-06, 8.04e-06)	(-3.33e-06, 6.04e-06)	(1.92e-08, 1.80e-06)	(6.00e-07, 2.52e-06)

LASSO (see Appendix 2)	-	-	-	-	-	Yes	-	-	Yes
N	153	153	153	153	153	153	425,787	425,787	425,787
R^2	0.062	0.862	0.924	0.952	0.974	0.990	0.002	0.207	0.215
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

*Denotes model shown in Table 3.

* P<0.05, **P<0.01, ***P<0.001.

Appendix 4. Complete Results for Figure 1 (Relationship Between Disclosure Laws and Category of Payments, State Level, 2009-2011).

Dependent Variable: Payment Amounts in Each Category as a Percent of Total Payments in Each State and Year

Multiple Regression Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
	Consulting	Speaking	Research	Meals	Travel	Items	Other
Independent Variable							
Strong Disclosure Laws	0.0943***	-0.105**	0.0558	-0.0306*	0.00157	-0.00103	-0.0154
P	<0.001	0.00149	0.118	0.0146	0.779	0.485	0.116
(95% CI)	(0.0491, 0.140)	(-0.169, -0.0409)	(-0.0143, 0.126)	(-0.0550, -0.00614)	(-0.00950, 0.0127)	(-0.00396, 0.00189)	(-0.0347, 0.00385)
Weak Disclosure Laws	-0.0212*	0.0281	-0.0297	0.0277*	-0.00488	0.000355	-0.000336
P	0.0217	0.245	0.262	0.0261	0.181	0.818	0.962
(95% CI)	(-0.0393, -0.00316)	(-0.0196, 0.0758)	(-0.0819, 0.0225)	(0.00335, 0.0521)	(-0.0121, 0.00230)	(-0.00269, 0.00340)	(-0.0143, 0.0136)
Company (Share of Payments; Omitted Company is Allergan)							
AstraZeneca	-0.0609	-0.258	-0.513	-0.189	0.227	-0.0158	-0.189
P	0.904	0.858	0.700	0.625	0.149	0.888	0.445
(95% CI)	(-1.060, 0.939)	(-3.117, 2.600)	(-3.143, 2.116)	(-0.952, 0.574)	(-0.0823, 0.536)	(-0.237, 0.206)	(-0.678, 0.300)
Cephalon	0.263	0.883	-1.004	-0.117	0.204*	-0.00434	-0.225
P	0.394	0.421	0.275	0.561	0.0437	0.946	0.140
(95% CI)	(-0.346, 0.873)	(-1.280, 3.046)	(-2.817, 0.810)	(-0.516, 0.281)	(0.00580, 0.401)	(-0.132, 0.123)	(-0.524, 0.0744)
EMD Serono	0.223	0.0238	-0.259	-0.258	0.353**	-0.0429	-0.0391
P	0.512	0.983	0.784	0.243	0.00110	0.506	0.793
(95% CI)	(-0.449, 0.895)	(-2.128, 2.176)	(-2.128, 1.610)	(-0.694, 0.178)	(0.144, 0.561)	(-0.170, 0.0843)	(-0.333, 0.255)
Eli Lilly	3.472	-3.644	-6.381	4.360	-0.326	0.288	2.231
P	0.239	0.536	0.445	0.116	0.808	0.232	0.0910
(95% CI)	(-2.339, 9.283)	(-15.25, 7.964)	(-22.85, 10.09)	(-1.085, 9.805)	(-2.980, 2.328)	(-0.187, 0.763)	(-0.361, 4.823)
GlaxoSmithKline	0.293	0.0182	-0.0216	-0.342	0.306**	-0.0679	-0.186
P	0.371	0.987	0.982	0.118	0.00338	0.301	0.218

(95% CI)	(-0.352, 0.937)	(-2.161, 2.198)	(-1.885, 1.842)	(-0.772, 0.0883)	(0.103, 0.509)	(-0.197, 0.0614)	(-0.482, 0.111)
Johnson & Johnson	0.279	0.232	-0.174	-0.264	0.283**	-0.0613	-0.294
P	0.390	0.834	0.853	0.228	0.00607	0.354	0.0549
(95% CI)	(-0.361, 0.919)	(-1.954, 2.417)	(-2.039, 1.690)	(-0.696, 0.167)	(0.0824, 0.484)	(-0.192, 0.0690)	(-0.594, 0.00629)
Merck	0.266	1.633	-1.624	-0.500	0.663***	-0.164	-0.274
P	0.622	0.262	0.225	0.115	<0.001	0.0715	0.295
(95% CI)	(-0.800, 1.332)	(-1.234, 4.499)	(-4.258, 1.010)	(-1.123, 0.124)	(0.307, 1.020)	(-0.343, 0.0146)	(-0.791, 0.242)
Novartis	0.219	1.054	-1.097	-0.296	0.374***	-0.0558	-0.198
P	0.526	0.353	0.250	0.163	<0.001	0.389	0.235
(95% CI)	(-0.461, 0.899)	(-1.184, 3.291)	(-2.974, 0.780)	(-0.713, 0.122)	(0.184, 0.565)	(-0.183, 0.0719)	(-0.527, 0.130)
Pfizer	-0.0386	0.631	-0.441	-0.0524	0.252	0.0257	-0.376
P	0.917	0.605	0.688	0.845	0.0951	0.738	0.0782
(95% CI)	(-0.774, 0.697)	(-1.778, 3.039)	(-2.614, 1.732)	(-0.582, 0.477)	(-0.0445, 0.549)	(-0.126, 0.178)	(-0.795, 0.0430)
Valeant	0.262	0.222	-0.371	-0.208	0.387***	-0.0596	-0.232
P	0.418	0.839	0.691	0.338	<0.001	0.357	0.127
(95% CI)	(-0.376, 0.900)	(-1.937, 2.381)	(-2.211, 1.469)	(-0.638, 0.221)	(0.188, 0.586)	(-0.187, 0.0681)	(-0.532, 0.0673)
ViiV	3.026	-4.224*	1.230	0.592	0.0748	-0.248	-0.450
P	0.162	0.0469	0.617	0.749	0.927	0.118	0.449
(95% CI)	(-1.236, 7.288)	(-8.388, -0.0594)	(-3.622, 6.081)	(-3.065, 4.248)	(-1.535, 1.684)	(-0.561, 0.0641)	(-1.624, 0.723)
Year (Relative to payments in 2011)							
2009	0.0561*	0.339***	-0.441***	-0.0526***	-0.0238**	0.000926	0.121***
P	0.0172	<0.001	<0.001	<0.001	0.00118	0.791	<0.001
(95% CI)	(0.0101, 0.102)	(0.242, 0.437)	(-0.541, -0.340)	(-0.0818, -0.0235)	(-0.0380, -0.00962)	(-0.00598, 0.00783)	(0.0933, 0.148)
2010	0.0474	0.00784	-0.0782	-0.0320	-0.0105	0.00330	0.0621***
P	0.112	0.897	0.189	0.0757	0.207	0.363	<0.001
(95% CI)	(-0.0111, 0.106)	(-0.111, 0.127)	(-0.195, 0.0390)	(-0.0674, 0.00335)	(-0.0269, 0.00588)	(-0.00386, 0.0105)	(0.0336, 0.0906)
Demographics							
Household	5.00e-06	-1.84e-06	4.14e-07	-1.70e-06	-8.92e-07	-5.81e-07*	-4.25e-07

Income ($)							
P	0.0599	0.669	0.931	0.266	0.295	0.0129	0.714
(95% CI)	(-2.12e-07, 1.02e-05)	(-1.03e-05, 6.65e-06)	(-9.07e-06, 9.89e-06)	(-4.72e-06, 1.31e-06)	(-2.57e-06, 7.88e-07)	(-1.04e-06, -1.25e-07)	(-2.72e-06 - 1.87e-06)
Average Physician Wage ($)	-1.12e-07	2.79e-07	-2.03e-07	2.21e-08	4.64e-08	1.91e-08	7.49e-05
P	0.459	0.324	0.491	0.828	0.413	0.185	0.632
(95% CI)	(-4.10e-07, 1.86e-07)	(-2.79e-07, 8.37e-07)	(-7.83e-07, 3.78e-07)	(-1.79e-07, 2.23e-07)	(-6.53e-08, 1.58e-07)	(-9.25e-09, 4.75e-08)	(-0.000234 - 0.000384)
Cost of Living Index	-0.000524	0.000826	-0.00167*	0.00119***	-4.67e-05	0.000137*	0.000435
P	0.0619	0.138	0.0169	<0.001	0.575	0.0219	0.677
(95% CI)	(-0.00107, 2.64e-05)	(-0.000268, 0.00192)	(-0.00303, -0.000304)	(0.000523, 0.00186)	(-0.000211, 0.000118)	(2.01e-05, 0.000253)	(-0.00163 - 0.00250)
% Population < 18 y	-0.0921	-0.706	0.855	0.0914	-0.180	-0.0606	0.103
P	0.855	0.334	0.293	0.655	0.139	0.115	0.321
(95% CI)	(-1.091, 0.907)	(-2.147, 0.736)	(-0.747, 2.457)	(-0.313, 0.495)	(-0.419, 0.0590)	(-0.136, 0.0150)	(-0.101 - 0.306)
% Population ≥ 65 y	0.167	-0.959	1.349	-0.312	-0.162	-0.143*	-0.0193
P	0.704	0.236	0.132	0.164	0.158	0.0342	0.721
(95% CI)	(-0.701, 1.035)	(-2.552, 0.634)	(-0.411, 3.109)	(-0.753, 0.129)	(-0.389, 0.0641)	(-0.274, -0.0108)	(-0.126 - 0.0872)
% Unemployment	0.00175	-0.000553	-0.000200	-0.000849	-0.000140	-0.000472**	0.00132
P	0.360	0.878	0.960	0.431	0.801	<0.001	0.324
(95% CI)	(-0.00201, 0.00551)	(-0.00767, 0.00656)	(-0.00798, 0.00758)	(-0.00298, 0.00128)	(-0.00124, 0.000957)	(-0.000825, -0.000120)	(-0.00132 - 0.00396)
% ≥ High School Education	-0.154	-0.244	0.0740	0.111	0.0501	0.0555	0.0769
P	0.429	0.502	0.840	0.300	0.400	0.0592	0.707
(95% CI)	(-0.538, 0.230)	(-0.962, 0.473)	(-0.652, 0.800)	(-0.100, 0.322)	(-0.0674, 0.168)	(-0.00220, 0.113)	(-0.327 - 0.481)
% Health Insurance	0.0220	0.228	-0.0827	-0.163**	0.0475	-0.0317	0.0470
P	0.815	0.202	0.655	0.00821	0.0857	0.0570	0.815
(95% CI)	(-0.164,	(-0.124,	(-0.448,	(-0.283, -	(-0.00677,	(-0.0643,	(-0.350 -

	0.208)	0.580)	0.283)	0.0429)	0.102)	0.000954)	0.444)
Annual Prescription Drugs Filled at Pharmacies/Person	-0.000817	0.00381	-0.00511	0.00101	-0.000225	-3.02e-05	1.47e-07
P	0.770	0.416	0.295	0.512	0.798	0.926	0.952
(95% CI)	(-0.00633, 0.00470)	(-0.00544, 0.0131)	(-0.0147, 0.00452)	(-0.00203, 0.00406)	(-0.00196, 0.00151)	(-0.000669, 0.000609)	(-4.65e-06 - 4.95e-06)
Population Density	5.75e-06	-8.14e-06	9.20e-06	-9.00e-06**	2.65e-06*	-4.16e-07	-4.02e-07
P	0.0904	0.557	0.442	0.00217	0.0113	0.414	0.560
(95% CI)	(-9.20e-07, 1.24e-05)	(-3.55e-05, 1.92e-05)	(-1.44e-05, 3.28e-05)	(-1.47e-05, -3.31e-06)	(6.12e-07, 4.70e-06)	(-1.42e-06, 5.87e-07)	(-1.76e-06 - 9.57e-07)
Number of Active Physicians	1.91e-06	-3.91e-06	4.81e-06	-2.77e-06***	6.90e-07	-3.09e-07	1.51e-07
P	0.0628	0.105	0.0553	0.000550	0.0507	0.0804	0.540
(95% CI)	(-1.03e-07, 3.92e-06)	(-8.66e-06, 8.29e-07)	(-1.11e-07, 9.74e-06)	(-4.32e-06, -1.22e-06)	(-2.22e-09, 1.38e-06)	(-6.56e-07, 3.79e-08)	(-3.34e-07 - 6.35e-07)
Number of Active Nurses	-6.04e-07	1.26e-06	-1.52e-06	8.60e-07**	-2.49e-07*	9.80e-08	-5.58e-08
P	0.103	0.129	0.0715	0.00234	0.0458	0.107	0.541
(95% CI)	(-1.33e-06, 1.24e-07)	(-3.69e-07, 2.89e-06)	(-3.18e-06, 1.35e-07)	(3.12e-07, 1.41e-06)	(-4.94e-07, -4.72e-09)	(-2.15e-08, 2.17e-07)	(-2.36e-07 - 1.24e-07)
N	153	153	153	153	153	153	153
R^2	0.617	0.871	0.866	0.825	0.738	0.685	0.855
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000

* P<0.05, **P<0.01, ***P<0.001

Appendix 5: Relationship Between Disclosure Laws and Distribution of Payments to Physicians, 2009-2011.*

Multiple Regression Model	**(1)**	**(2)**	**(3)**	**(4)**
Unit of Analysis	Physician-Year	State-Year	Physician-Year	State-Year
Dependent Variable	Annual Payments Among Physicians ≤$100/yr	Number of Physicians Accepting ≤$100/yr	Annual Payments Among Physicians >$100/yr	Number of Physicians Accepting >$100/yr
Units	Log $	Log	Log $	Log
Independent Variable				
Disclosure Laws With Public Reporting ("Strong")	-0.0192	-0.676*	0.543***	-0.396
P	0.600	0.0322	<0.001	0.0528
(95% CI)	(-0.0910 - 0.0526)	(-1.294 - - 0.0588)	(0.411- 0.674)	(-0.796 - 0.00495)
Disclosure Laws Without Public Reporting ("Weak")	0.0498***	-0.303	0.0363	-0.483**
P	<0.001	0.150	0.343	0.00581
(95% CI)	(0.0222 - 0.0774)	(-0.718 - 0.112)	(-0.0387 - 0.111)	(-0.823 - - 0.143)
N	286768	153	139019	153
R^2	0.054	0.989	0.172	0.958

*Adjusted for company providing payment, category of payment, year, and statewide demographics.

Appendix 6: Relationship Between Disclosure Laws and Payments, Differences-in-Differences, 2009-2011.*

Dependent Variable: Payment Amounts Total and in Each Category as a Percent of Total Payments in Each State and Year

Differences-in-Differences Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Annual Payment Per Active Physician	Research	Consulting	Meals	Travel	Speaking	Items	Other
Units	Log $	%	%	%	%	%	%	%
Independent Variable								
Massachusetts	0.150***	0.143***	0.176***	-0.0899***	0.0378***	-0.195***	-0.0277***	-0.0310***
P	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
(95% CI)	(0.113 - 0.186)	(0.128 - 0.157)	(0.173 - 0.180)	(-0.0941 - -0.0857)	(0.0355 - 0.0402)	(-0.205 - -0.186)	(-0.0282 - -0.0271)	(-0.0333 - -0.0287)
Year > 2010	2.023***	0.386***	-0.0474***	0.0891***	0.0317***	-0.368***	0.00458***	-0.0960***
P	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
(95% CI)	(1.855 - 2.190)	(0.341 - 0.432)	(-0.0630 - -0.0319)	(0.0728 - 0.106)	(0.0245 - 0.0390)	(-0.399 - -0.337)	(0.00212 - 0.00703)	(-0.107 - -0.0851)
Massachusetts * Year > 2010	-0.356***	0.0865***	0.0105*	-0.0422***	-0.0197***	-0.0702***	-0.00133	0.0322***
P	<0.001	<0.001	0.0486	<0.001	<0.001	<0.001	0.128	<0.001
(95% CI)	(-0.465 - -0.247)	(0.0436 - 0.129)	(6.63e-05 - 0.0209)	(-0.0548 - -0.0296)	(-0.0268 - -0.0126)	(-0.0985 - -0.0419)	(-0.00306 - 0.000396)	(0.0253 - 0.0392)
N	153	153	153	153	153	153	153	153

*Adjusted for dummy indicators for each state and year.