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Measuring Regulation: A Labor Task-Based Approach

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1 Introduction

Many economic studies use regulatory shocks to investigate causal relations between economic variables. Proper use of such shocks requires that the regulation is effectively enforced and impacts the regulated entity. Hence, measuring whether a regulation is impactful can be essential for such research designs, especially when the endogenous variable cannot be directly measured or observed. Yet, existing measures of regulation primarily focus on a supply-side approach, such as counting words in the Code of Federal Regulations. Supply-side approaches measure inputs of regulation and may not capture the impact of regulation: more words do not always translate into more stringent regulation, and it is challenging to account for regulatory impact when regulations can come from multiple sources including federal, state, local, judicial, and industry self-enforcement.[1]

In this paper, we propose a new approach that infers the impact of regulation based on the response of the regulated entity. This approach is analogous to the idea of using patent citations or stock market reactions to infer the economic importance of innovation (Kogan et al. (2017)). In particular, we develop a novel index of regulation, *Regulation Index*, based on the percentage of an industry's labor costs dedicated to performing regulation-related tasks.[2] This Regulation Index can indicate regulation intensity assuming that firms spend resources on regulation-related tasks to reduce the risks of legal liability or penalties from regulatory infractions. Under this assumption, a profit-maximizing firm responds to regulation by spending resources until the marginal benefit of such spending (i.e., reduced expected penalties and liability) equals the marginal cost of compli-

[1]Some empirical works that use the supply-side measures overcome these challenges by focusing on specific types of regulations the impact of which can be quantified from the underlying texts. For instance, Djankov et al. (2002) measure regulation of entry barriers across countries by focusing on fees, procedural steps and delays for starting new businesses.

[2]We define regulation-related tasks formally in Section 3. Examples of regulation-related tasks include "verify that transportation and handling procedures meet regulatory requirements" for agricultural inspectors, and "monitor establishment activities to ensure adherence to all state gaming regulations ..." for gaming surveillance officers.

ance (Becker (1968)). Thus, *ceteris paribus*, more stringent regulations with severer penalties and stricter enforcement will induce firms to spend more on regulation-related tasks.

Our Regulation Index has several potential advantages compared to supply-side measures that count restrictive words in regulations. First, our Regulation Index is not confined to specific sources of regulations, such as the Code of Federal Regulations that many text-based measures focus on. Rather, it can pick up any source of regulation including state, local, judicial, and even industry self-regulation. Second, the Regulation Index can better detect impactful regulations that require industry compliance because such regulations are likely to induce firms to spend more on regulation-related tasks. Third, our Regulation Index can more clearly identify deregulation because profit-maximizing firms can reduce spending on compliance tasks after deregulation. In contrast, text-based measures struggle to distinguish deregulation from increased regulation because both can increase the length of regulation texts.

To construct the Regulation Index, we first obtain an occupation's tasks as well as a weight of each task's importance for the occupation from the O*Net database. We classify a task as *regulation-related* if the task's statement includes keywords related to regulations. We next compute the share of regulation-related tasks for each occupation, weighted by the task's importance. Finally, we create an industry's Regulation Index by aggregating the share of regulation-related tasks for all occupations in the industry, weighted by each occupation's labor costs in the industry.[3] By using occupations' labor costs as weights, our Regulation Index can naturally be interpreted as the proportion of an industry's labor costs paid to perform regulation-related tasks. This procedure results in the Regulation Index for over 270 industries for each year from 1990 to 2017.

We conduct extensive validity tests of our Regulation Index measure. First, we observe that the Regulation Index, which captures mainly an industry's in-

[3]We obtain employment and wage rate of each occupation within each industry from the publicly-available Occupational Employment Statistics (OES) data from the Bureau of Labor Statistics. An occupation's labor costs is the production of employment and wage rate.

house spending on regulation-related tasks, is positively correlated with the industry's outsourced legal spending. This correlation is significant both across industries and across time within an industry. Such complementarity between in-house and outsourced spending is reassuring because it indicates that our Regulation Index is likely to move together with an industry's total compliance costs.

Second, we explore the response of our Regulation Index to three industry-specific regulatory shocks through case studies. First, we consider deregulation of the oil & gas extraction industry under the Energy Policy Act (EPAct) of 2005. Next, we track re-regulation of the industry after the BP Deepwater Horizon oil spill in 2010. Finally, we consider regulation of financial industries under the Dodd-Frank Act of 2010. For comparison, we also show responses to these shocks for one of the most comprehensive supply-side measures of regulation—the RegData measure created by Al-Ubaydli and McLaughlin (2017).

Our Regulation Index produces robust results to all three shocks—declining after deregulation and increasing following regulation for the regulated industries. In contrast, the RegData measure generates mixed results. In particular, the RegData measure struggles to identify deregulation and to distinguish which sub-sectors in the financial industry are most heavily regulated by the Dodd-Frank Act.

Given that our goal is to propose not only a new industry-level measure, but also a new methodology to detect the intensity of regulation, we further validate our methodology at the firm level *within each industry*. We explore the enactment of the Sarbanes-Oxley Act (SOX) in 2002 which increased regulations on financial reporting and internal controls primarily for publicly traded firms but not for privately held firms. We use establishment-occupation level OES microdata to compare the Regulation Index of establishments owned by publicly traded firms to establishments in the same industry and state, and with similar employment size, that are owned by privately held firms. We find strong evidence that after the enactment of SOX, the Regulation Index increased dramatically for publicly traded firms compared to privately held industry peers.

While our response-based approach overcomes several limitations of the supply-side approach, our measure does not comprehensively reflect the full cost of regulation. First, although labor compliance costs on average account for a majority of direct regulation costs, specific regulations that clearly mandate capital expenditures, such as purchasing pollution abatement equipment, may entail minimal changes in labor costs.[4] Second, regulations that clearly prohibit a specific line of business, such as a ban on advertising tobacco products on broadcast television, may cause industries to terminate lines of business rather than spend resources on compliance. However, if industries can replace banned products with close substitutes, our measure may still capture certain compliance costs related to such bans.[5] Third, regulations that directly create barriers to entry, such as licensing requirements, may affect potential entrants more than incumbents and thus can be underestimated by our measure.

The rest of this paper is organized as follows. Section 2 discusses previous attempts to measure regulatory complexity and burdens and the limitations of those attempts. Section 3 explains our data and methods of constructing the Regulation Index. Section 4 validates the Regulation Index using regulatory and deregulatory shocks that affect different industries or different types of firms within an industry differently. Section 5 concludes.

2 A Review of Existing Measures of Industry Regulation

At least four approaches to measuring regulation have historically been used.

The first approach is text-based. It involves a quantitative measure of codified

[4] A survey of 577 U.S. manufacturers by the National Association of Manufacturers (NAM) in 2014 shows that 68% of direct regulatory costs are from labor costs devoted to compliance and 13% are from capital investments (see Crain and Crain (2014)).

[5] Product bans within the U.S. are often limited in scope and contain exemptions that enable industries to replace banned products with close substitutes. For example, interest rate ceilings on deposit accounts did not prohibit substantially similar money market accounts offering higher interest rates.

text such as statutes or regulations. Goff (1996), Dawson and Seater (2013), and Mahoney (2019) count words in the U.S. Code or in the Code of Federal Regulations (CFR). Al-Ubaydli and McLaughlin (2017) developed "RegData" to further improve identification of regulations by counting restrictive words in the CFR such as "shall", "must", "may not", "prohibited", and "required".

These text-based measures provide the first set of measures of regulation for a panel of industries over a long time-series. The use of these measures is widespread. Yet, one may be concerned about this text-based approach in that more words or more restrictive words in regulation do not necessarily reflect the burdensomeness of regulation or the enforcement of regulation. First, one restrictive word may be more or less burdensome depending on the context.[6] Second, regulatory texts may still grow in length because of *deregulation* or regulations that benefit the industry. Third, a regulation that is later overturned by case law may still remain in the regulatory texts but have little impact.

The remaining three approaches focus on specific industries or specific time periods and therefore can hardly be generalized across all industry-years. Specifically, the second approach involves an examination of regulatory resources such as head counts or budgets of particular federal regulatory agencies (Goff (1996) and Jackson (2007)). The third approach involves quantifying regulatory enforcement actions, inspections, or other activities (Gray and Shadbegian (1993)). The fourth approach tracks barriers to entry such as licensing requirements and anti-competitive pricing floors within particular markets.[7]

Another concern with all these measures is that they are tied to specific sources of regulation. Hence, they do not reflect regulations from other sources, such as from private rights of action enforced by plaintiffs' lawyers, from self-regulatory

[6]For an obvious example, a regulation which says "You may not do A through Z" is both shorter and more burdensome than a regulation that says "You may not do A, nor may you do B, unless any of the following exceptions apply".

[7]Studies that measure barriers to entry typically focus on cross-country or cross-state comparisons without industry-specific detail (Nicoletti and Scarpetta (2003), Bassanini and Ernst (2002), Djankov et al. (2002), Aghion et al. (2010), among many others). Nicoletti and Scarpetta (2003) use this approach to measure industry regulation in a single year, 1998.

organizations such as the Financial Industry Regulatory Authority or securities exchanges, from common law created by the judiciary, from state or local laws and regulations, and from rules in other leading jurisdictions that affect U.S. firms (See e.g., Agrawal (2013) and Macey and Miller (1991)).

In summary, we believe a new measure of regulation is needed that (i) can better assess the impact of regulations and identify deregulation, (ii) can reflect industries' regulation from multiple sources, and (iii) is available at the detailed industry level on an annual-basis for over a decade. Our Regulation Index aims to fill this gap.

3 Constructing the Regulation Index

We construct an industry Regulation Index based on the proportion of an industry's labor costs paid to perform regulation-related tasks—principally performed by legal and compliance occupations. The following example illustrates our methodology. After the example, we discuss our methodology and data in greater detail. Imagine an industry that hires only two workers working in two different occupations. The first occupation pays $20 per hour for performing two different tasks, neither of which is regulation-related, while the second occupation pays $40 per hour for performing two different tasks, one of which is regulation-related. The regulation-related task is one third as important (or is performed one third as frequently) as the other task for the second occupation. We then compute the industry's labor costs for performing regulation-related tasks as $10 ($40 $\times$ 1/4) and the industry's total labor costs as $60 ($20 + $40). The industry's Regulation Index is the ratio of the two costs: 0.17 ($10/$60).

More formally, we construct our industry Regulation Index following three steps. In the first step, we identify "regulation-related" tasks through textual analysis of the O*Net 23.1 database—a dictionary of occupations maintained by the U.S. Department of Labor. We obtain task statements for 964 occupations classified under the 8-digit Standard Occupational Classification (SOC) codes. Each

occupation is associated with between 4 (shampooers) and 40 (special education teachers for elementary schools) tasks, with an average of 22 tasks per occupation. Importantly, each task is assigned several values by occupational experts or incumbents to indicate how important the task is for the occupation or how frequently the task is performed. Our baseline approach assigns a fixed set of tasks for each occupation. In the Internet Appendix, we also allow for changes in the task nature of each occupation over time by using historical versions of the O*Net database. The results are essentially unchanged.

We identify a task as regulation-related if its statement (usually a one-sentence description) includes one or more of the following keywords: *compliance, complied, complies, comply, complying, safety, codes, law, laws, lawsuit, lawsuits, legal, legalities, legality, legislate, legislated, legislates, legislating, legislation, legislature, ordinance, ordinances, regulatory, regulation, regulations, statute, statutes, statutory.* We then manually examine the statements to rule out false positives such as statements that mention computer programming codes. This procedure identifies 833 regulation-related tasks out of a total 19,612 tasks in the O*Net database.

Table 1 lists several examples of the regulation-related tasks. Such examples include "verify that transportation and handling procedures meet regulatory requirements" for agricultural inspectors, or "Interpret safety regulations for others interested in industrial safety [...]" for health and safety engineers.

[TABLE 1 ABOUT HERE]

In the second step of constructing our Regulation Index, we compute the importance of regulation-related tasks for each occupation, which we label as "regulatory-task intensity" (RTI) for the occupation, by averaging all tasks for each occupation weighted by their importance value discussed above. Weighting by frequency of tasks performed by each occupation instead of importance gives very similar results. We further aggregate RTIs to occupations at the 6-digit SOC level for future use. To be conservative and ensure that we are capturing spending on intensive performance of regulation-related tasks, we further clas-

sify occupations as "regulation-related occupations" if their RTIs are above 0.2; that is, occupations with over 20% of their tasks (weighted by importance) are regulation-related occupations. We set RTI for all the other occupations at zero so that spending on occupations that perform minimal regulation-related tasks are not included in our calculation of the Regulation Index.

Table 2 lists the RTI for all the 20 regulation-related occupations.[8] We see regulation-related occupations can largely be divided into legal-related occupations, such as lawyers and law clerks, and compliance-related occupations, such as compliance officers and financial examiners.

[TABLE 2 ABOUT HERE]

In the third step, we compute the proportion of each industry's labor costs paid to perform regulation-related tasks.[9] We use the Occupational Employment Statistics (OES) data from the Bureau of Labor Statistics (BLS), which provides information on head counts and mean hourly wages for each occupation within each industry.[10] The OES data use the 5-digit OES occupational classification, with 828 detailed occupation definitions before 1999, and use the 6-digit Standard Occupational Classification (SOC), with 896 detailed occupation definitions in 1999 and subsequent years. We match the RTI for each 6-digit SOC occupation in

[8]Because we are interested in private sector response to regulation, we then excluded occupations that have RTI above 0.2 but are employed only by the government from our list of regulation-related occupations, including Administrative Law Judges, Adjudicators, and Hearing Officers (SOC code 23-1021) and Judges, Magistrate Judges and Magistrates (SOC code 23-1023), and Fish and Game Wardens (SOC code 33-3031). We also exclude Managers, All Other (SOC code 11-9199) since it is unclear what exact type of managers are included in this occupation.

[9]In the Internet Appendix, we also examine a version of Regulation Index by dividing an industry's labor costs paid to perform regulation-related tasks by the industry's revenue. This alternative version accounts for time-variation in the industry's labor share and produces very similar results to our baseline Regulation Index.

[10]This data is constructed based on surveys of 1.2 million establishments in the U.S. over 3-year cycles, covering 62% of total national employment from 1990 to 2016. Every six months, the OES program selects a panel of 200,000 establishments that are nationally representative. Most establishments are surveyed once every three years to reduce respondent burden. Then, the OES program aggregates information from the last three years (six panels) to produce statistics of the occupational composition within each industry.

the later sample, and we construct the RTI for the 5-digit OES occupation using a crosswalk from the SOC and OES, provided by the BLS. Lastly, we compute an industry's Regulation Index as the percentage of labor costs paid to perform regulation-related tasks as follows:

$$\text{Regulation Index}_i = \frac{\sum_j RTI_j \times emp_{i,j} \times wage_{i,j}}{\sum_j emp_{i,j} \times wage_{i,j}} \times 100, \tag{1}$$

where RTI_j is the RTI for occupation j, $emp_{i,j}$ and $wage_{i,j}$ are the number of employees and hourly wages for occupation j in industry i.[11]

The OES data use the 3-digit Standard Industry Code (SIC), with 378 industry classifications before 2002, and use the 4-digit North American Industry Classification System (NAICS), with 290 industry classifications starting from 2002. Because we are focusing on regulation of private industries, we exclude industry categories which provide legal or compliance work as their primary source of revenue or function: legal services (i.e., law firms), accounting firms, government administration, courts, and central banking. Consistent with the literature (Song et al. (2018)), we also exclude educational institutions.

Industries differ substantially in their Regulation Index in the cross-section. Lightly regulated retail industries generally have Regulation Index values close to zero, but highly regulated industries such as financial and energy industries, as shown in Table 3, can have a Regulation Index ranging from 0.70 to 3.21 in 2016. Figure 1 plots the time-series of our Regulation Index aggregated across all private industries, weighted by industries' total labor costs. We observe that the Regulation Index increased dramatically from 0.19 in 2002 to 0.30 in 2016.[12] Table

[11]OES treats annual wages as hourly wages multiplied by 2,080. Hence, using either hourly wages or annual wages does not affect our Regulation Index measure. The OES data do not have wage information before 1998. Therefore, for years before 1998, we estimate the hourly wages from the Census Current Population Survey Merged Outgoing Rotation Groups (CPS-MORG) following Zhang (2019) and Tuzel and Zhang (2018).

[12]Such increase corresponds to an increase in nominal spending on regulation-related tasks by private industries from $2 billion in 2002 to $18 billion in 2016. As a reference, the total lobbying spending by all industries in 2016 is $ 3.2 billion according to OpenSecret. OES data starts to use the NAICS industry classification after 2002. Hence, our Regulation Index can be linked to other variables, most of which use the NAICS classification, after 2002. Given that many other

4 provides the pooled summary statistics of the Regulation Index at the NAICS 4-digit industry level during 2002-2016. The average industry has a Regulation Index of 0.17 with a standard deviation of 0.33.

[TABLE 3 ABOUT HERE]
[TABLE 4 ABOUT HERE]
[FIGURE 1 ABOUT HERE]

4 Validation of Regulation Index

4.1 Relation with Other Regulation-related Measures

We examine the relations between our Regulation Index and three other measures concerning regulation as a first-pass to validate our measure. We discuss these relations below.

4.1.1 Relation with Outsourced Legal Services

Our Regulation Index by construction captures an industry's in-house spending on regulation-related tasks. Firms may also outsource legal work to law firms and such spending on outsourced legal services can also be part of the firms' response to regulation. Chayes and Chayes (1985) show that firms with more outside legal work typically also have larger in-house legal and compliance groups. If in-house and outsourced spending are correlated, we can be more confident that our measure based on in-house spending is likely to function as an indicator of the total regulatory intensity.

To examine the relation between the Regulation Index and outsourced legal spending, we construct a measure of outsourced legal spending for 64 industries using the input-output table from the Bureau of Economic Analysis. For each year, we compute an industry's reliance on outsourced legal services as a percent-

variables are available until 2016, our empirical analyses focus on the period of 2002 to 2016.

age: the ratio of its costs on legal services input to its total input costs. Because our Regulation Index is based on OES surveys which aggregate data through a 3-year moving average, we measure an industry's outsourced legal spending in a similar fashion by averaging the percentages across $t-2$ to t. Lastly, we aggregate our Regulation Index from the NAICS 4-digit level to the BEA industry level, weighted by the detailed industries' total labor costs.

We find a positive correlation of 0.42 between outsourced legal services and our Regulation Index during 2002-2016. Panel A of Table 5 shows that this relation is statistically significant. The additional finding in the cross-section that industries with high Regulation Indexes also have high outsourced legal spending reinforces Chayes and Chayes (1985)'s findings using earlier data. Moreover, we also find a positive relation between in-house and outsourced spending in the time-series within an industry while controlling for time trend, suggesting that the two variables tend to move together over time. In light of the strong positive relation between in-house and outsourced spending on regulation-related tasks, we are confident that our Regulation Index can be a valid proxy for industries' regulatory intensity.

Figure 2 shows the time-series of aggregated outsourced legal spending for private industries in the U.S. from 1992 to 2017. Note that in addition to an upward trend, outsourced legal spending exhibits pronounced counter-cyclicality—it increased dramatically during the 2008-2009 Great Recession. This difference in cyclicality between outsourced legal spending and our Regulation Index could be because legal services such as bankruptcy, restructuring and litigation, which are counter-cyclical, tend to be outsourced to law firms whereas regulatory compliance tends to be handled in house.

[FIGURE 2 ABOUT HERE]

4.1.2 Relation with Text-based RegData Measure of Regulation

The RegData measure of regulation, first introduced in Al-Ubaydli and McLaughlin (2017), has become a popular proxy for regulation in recent years. Despite the widespread use of this measure, as we discussed in Section 2, we believe our Regulation Index can better assess the burdensomeness of regulations to industry and better detect deregulation than the text-based RegData measure. In addition, it is possible that RegData may also include regulations that are favorable to the industry (or "captured" by industry), whereas our Regulation Index more selectively measures regulations that are burdensome to the industry. We analyze these differences in greater detail in Section 4.2.

With that said, for regulations that are not captured by industry and are highly burdensome, we believe both RegData and our Regulation Index, by measuring the enactment and reactions to regulations, respectively, should reflect regulatory intensity on industries. To compare the Regulation Index and RegData, we obtain the NAICS 4-digit RegData version 3.1 from QuantGov.org and merge the measure with our Regulation Index.[13] We see in Panel B of Table 5 that the two measures are significantly positively correlated both across industries and within industries. In addition, Figure 3 shows that the aggregated RegData for all private industries also exhibits an upward trend which is similar to the trend of our Regulation Index.

[FIGURE 3 ABOUT HERE]

4.1.3 Relation with Lobbying Spending

Lobbying is a way industries can influence regulators to encourage regulation that is more favorable (or less harmful) to lobbying firms. *A Priori*, the relation

[13]RegData provides a balanced panel for 134 industries out of over 300 NAICS 4-digit industries. We focus on these identified industries in our main text when analyzing the effects of RegData. The results are similar if we include the rest of the industries in our analyses and regard them as unregulated, i.e., we impute the RegData measure for those industries as zero.

between lobbying spending and our Regulatory Index could go either way. If consumer demand for regulation is fixed, more industry lobbying spending can reduce the passage of burdensome regulations, which would reduce observed regulatory intensity on lobbying industries (Peltzman (1976)). However, if regulatory intensity would change over time holding industry lobbying constant, for example if consumers demand more regulations on banks after the financial crisis in 2008 and 2009, then firms might spend more on lobbying activities to limit the increase in regulatory intensity, yet still face increased regulation and therefore have incentives to also spend more on regulation-related tasks.

We obtain industries' annual lobbying spending from the Center for Responsive Politics (CRP) and create a matching Regulation Index for 207 broader industries available in the lobbying data.[14] Panel C of Table 5 shows that lobbying spending and the Regulation Index are positively correlated in the cross-section, i.e., industries that spend more on lobbying activities also spend more on regulation-related tasks. When examining the time-series by including industry fixed effects, we see an insignificant relation between the two. Hence, for a given industry, increased lobbying spending sometimes corresponds to more realized regulatory intensity, other times corresponds to less as we discussed earlier.

[TABLE 5 ABOUT HERE]

4.2 Validation based on Industry-Specific Regulatory Shocks

After validating our Regulation Index by comparing it with other regulation-related measures, we next examine whether our Regulation Index can pick up large regulatory shocks to industries. Our test of sensitivity to regulatory shocks has two prongs. As an initial test, we expect to see our Regulation Index go up for an industry after a large industry-specific regulatory shock, and to fall after industry-specific deregulation. If major regulatory shocks are burdensome

[14]The CRP lobbying data categorizes industries based on the SIC codes. We crosswalk our NAICS industry codes to the SIC codes using a crosswalk from Fort and Klimek (2018).

and less susceptible to regulatory capture, then failure of the Regulation Index to respond, or responses in the wrong direction would falsify our measure.

As an additional test, we demonstrate advantages of our measure over text-based measures in earlier literature. As we discussed in Section 3, our Regulation Index has potential advantages in distinguishing high-impact regulations from low-impact ones and distinguishing legal changes that are deregulatory from those that increase regulatory burdens. Specifically, we compare our measure to the most recent version of RegData, a text-based measure of regulation.

We identify regulatory shocks in the oil & gas extraction industry and in the financial industry to use as case studies. For the oil & gas extraction industry, we consider deregulation under the Energy Policy Act of 2005 and re-regulation following the Deepwater Horizon oil spill of 2010, and for the financial industry, we examine the Dodd-Frank Act of 2010. We examine how our industry Regulation Index responds to the shocks.

To distinguish regulatory shocks from trends, we identify a control industry or group of industries that exhibit parallel trends to the treated industry with respect to the Regulation Index prior to the regulatory shocks. We construct the control group based on input-output relations. Specifically, we select the top downstream industries as control industries if they use a significant amount of the treated industry's output as their inputs. Downstream industries share close economic ties with the upstream treated industry. Thus, both industries may be affected by similar economic and regulatory forces prior to the shocks.[15] One challenge with this approach is that the control group may also be affected by the new regulatory shocks. If so, we will be less likely to detect significant differences between the treated and control groups post-treatment. In this sense, our selection of control industries is conservative.

[15]While intuitive, choosing control industries based on input-output relations offers no guarantee that the treated and control industries will exhibit parallel trends in the Regulation Index during the pre-treatment periods. We examine this necessary condition empirically when analyzing each regulatory shock.

4.2.1 Energy Policy Act and Deregulation of Oil & Gas Industries

The Energy Policy Act of 2005 (EPAct) deregulated domestic oil & gas production with the intention of increasing production by reducing environmental regulations. EPAct exempted oil & gas extraction from some requirements under the Safe Drinking Water Act and Clean Water Act, preempted state and local regulations relating to oil & gas extraction, refining, storage and transportation, exempted hydraulic fracturing from regulation by the Environmental Protection Agency (except when diesel fuel is injected into the ground), streamlined environmental review of oil, gas, and coal extraction leases on federal lands, and deregulated oil, gas and coal leases on Indian lands by removing the requirement of approval from the Secretary of the Interior (Holt and Glover (2006)).

Our treated industry is oil & gas extraction (NAICS 2111). Using input-output data from BEA, we observe that the top 10 detailed industries that use a significant among of oil & gas products as inputs in 2007 are from the following 3 broader industries: petroleum and coal products manufacturing (NAICS 3241), natural gas distribution (NAICS 2212), and basic chemical manufacturing (NAICS 3251).[16] We thus select the above three industries as the control group.

As shown in Figure 4, there were parallel trends of Regulation Index for the oil & gas extraction industries and its control industries before the enactment of the EPAct. After 2005, there is a dramatic decline in the Regulation Index for oil & gas extraction relative to the control industries. This decline in the Regulation Index for oil & gas extraction is consistent with contemporary interpretation of the EPAct as deregulatory for those industries. From 2005 to 2008, the oil & gas industry reduced regulation-related labor costs by $ 56 million; while the control industries *increased* regulation-related labor costs by $40 million.[17]

In contrast, the RegData regulation measure based on counting restrictive words of the CFR does not detect the decline in regulation for oil & gas extraction

[16]The input-output Account Data from BEA provides information at the detailed industry level for only 2007 and 2012. See https://www.bea.gov/industry/input-output-accounts-data.

[17]This implies that for our measure, reductions in legal and compliance costs due to deregulation under the EPAct dominate labor spending to understand the EPAct.

either in absolute terms or relative to control industries. Perhaps not surprisingly, RegData measure shows an increase in regulation of oil & gas extraction after the EPAct is signed into law. We interpret this as evidence that the Regulation Index is better able to distinguish regulation from deregulation than other measures based on counting words in legal documents.

[FIGURE 4 ABOUT HERE]

4.2.2 BP Oil Spill and Re-regulation of Oil & Gas Industries

On April 20, 2010, the BP Deepwater Horizon, an offshore oil rig near the Mississippi River Delta, exploded and subsequently sank, killing 11 workers and injuring 17. As a result of the explosion, the uncapped Macondo oil well discharged millions of gallons of oil into the Gulf of Mexico before the well was sealed nearly 3 months later, making it the largest marine oil spill to date. The spill caused extensive damage to marine and wildlife habitats, as well as to the fishing and tourism industries.

In response, President Obama issued Executive Order 13543 on May 21st, 2010, which formed a National Commission to investigate the spill and provide recommendations for improving the safety of offshore oil drilling. The National Commission report (Graham and Reilly (2011)), published in January 2011, blamed the disaster on lax regulatory oversight, political interference with regulators' autonomy and a lack of resources for inspections, insufficient policy emphasis on environmental protection, and expedited permitting and plan approvals. The report specifically faulted exemptions from environmental review of offshore drilling in certain parts of the Gulf of Mexico, which were enacted to stimulate production.

As a result, on January 1st, 2011, the White House issued Executive Order 13547, which called for environmental conservation and science-driven decision-making with respect to management of coastal and ocean resources. According to

the Bureau of Ocean Energy Management, the new rules were "the most aggressive and comprehensive reforms to offshore oil & gas regulation and oversight in U.S. history."[18]

We examine the treatment effect of re-regulation following the oil spill on the oil & gas extraction industry (NAICS 2111). We choose the three industries identified in Section 4.2.1 to maintain consistency.

In Panel A of Figure 5, we observe strong parallel trends for our treatment and control industries prior to the oil spill and a dramatic increase in the Regulation Index for the oil & gas extraction industry afterwards. From 2010 to 2014, the Oil & Gas Industry increased regulation-related labor costs by $ 212 million, while the control industries *reduced* regulation-related labor costs by $11.5 million. Yet, in Panel B, we observe that while the RegData measure for the oil & gas extraction industry increased after 2010, the increase cannot be differentiated from the increase in the control industries.

[FIGURE 5 ABOUT HERE]

4.2.3 Dodd-Frank Act and Regulation of Financial Industries

The Dodd-Frank Act was enacted in 2010 following the 2007-2008 financial crisis. The financial crisis started after spikes in defaults on subprime and non-prime mortgages eroded the solvency of many systemically important financial institutions. Many financial institutions were unable to absorb large, sudden losses without either restructuring their debts or obtaining rescue financing and liquidity support because the financial institutions were highly leveraged (see Beltratti and Stulz (2012), Simkovic (2009), Yellen (2011), among many others). In addition, the crisis also raised concerns about possible misconduct by financial institutions (Egan et al. (2019)) such as misreporting the quality of mortgage loans that were securitized (Piskorski et al. (2015) and Griffin and Maturana (2016)) and

[18] See https://www.boem.gov/regulatory-reform/.

possible misconduct when selling complex financial products to retail investors (Chang et al. (2015)). Both policy makers and consumers demanded stricter regulation of financial institutions, resulting in the Dodd-Frank Act.

Dodd-Frank burdened financial institutions by pressuring them to reduce risk-taking. Such pressures included stricter underwriting standards for residential mortgages, limits on highly leveraged business loans, increased capital requirements for Systemically Important Financial Institutions (SIFIs) and central clearing parties and exchanges, and increased compliance, reporting, and risk management obligations for bank holding companies and central clearing parties and exchanges. Derivatives dealers were required to move many traditionally bilateral derivatives contracts to exchanges or central clearing parties. Many broker-dealers were compelled to justify their trading activity as falling within one of several exemptions to a new ban on proprietary trading. Dodd-Frank also created a new Consumer Financial Protection Bureau (CFPB) within the Federal Reserve, which was relatively independent from Congressional control. The CFPB was authorized to focus on consumer lending and other retail financial products.

We define the financial industry as industries with NAICS codes starting with 52 (Finance and Insurance) or 5511 (Offices of Bank Holding Companies), excluding central banking such as the Federal Reserve System (NAICS code 5211), which effectively functions as a quasi-governmental provider of regulation. We then aggregate our NAICS 4-digit Regulation Index for the financial industry weighted by each detailed industry's labor costs (employment multiplied by hourly wages).

We identify control industries based on the Use Table of the input-output Accounts Data provided by the U.S. Bureau of Economic Analysis (BEA). The BEA Use Table provides the dollar value of financial services that are used as inputs in industries at 6-digit NAICS level in 2007. Among the top 10 industries that use financial services the most, 8 industries are financial and 2 are real estate. Since financial industries are treated industries, we select real estate industries

as our control group. Real estate includes industries with NAICS codes starting with digits 531 (real estate leasing and sales) and 236 (real estate construction). An additional advantage of using real estate as the control group is that both financial and real estate industries experienced significant contraction during the Great Recession.

Figure 6 shows that the Regulation Indexes for financial and real estate industries were parallel before the enactment of Dodd-Frank in 2010. However, after the enactment of Dodd-Frank, the Regulation Index increased substantially faster for financial than for real estate. This divergence is economically significant: from 2011 to 2016, the financial industry spent an additional 0.19 percent of its total labor spending on performing regulation-related tasks, which is equivalent to 2.2 billion dollars annually. In contrast, the real estate industry spent an additional 0.03 percent of labor spending on regulation-related tasks, which is equivalent to 0.16 billion dollars.[19] RegData also shows a larger increase in regulation in financial industries than in real estate industries after Dodd-Frank.[20]

[FIGURE 6 ABOUT HERE]

Although Dodd-Frank broadly affected the financial industry, the literature suggests that some sub-sectors of the financial industry were likely more affected than others.

Credit Intermediaries Credit intermediaries were required to verify prospective residential mortgage borrowers' ability to repay their loans (Bubb and Krishnamurthy (2014)). The CFPB also discouraged aggressive lending and collection practices in consumer mortgages, student loans, credit cards, etc. In addition,

[19]The total labor costs for performing regulation-related tasks in the financial industry are $4.42 billion and $6.64 billion in 2011 and 2016, respectively. The total labor costs for performing regulation-related tasks in the real estate industry are $0.39 billion and $0.54 billion in 2011 and 2016, respectively. OES computes annual wage as hourly wage multiplied by 2,080 hours per year. In unreported tests, we find that OES's estimates of industry annual labor costs is highly comparable with the industry annual payroll data from the Census Bureau.

[20]In untabulated tests, we confirm that the increases in both the Regulation Index and RegData are statistically significant after Dodd-Frank.

the Federal Reserve used its authority under Dodd-Frank to limit banks from extending leveraged loans to corporate borrowers (Federal Reserve System et al. (2013) and Adrian (2014)).

Exchanges and Clearinghouses Under the derivatives push-out rule, the clearing of many swaps and derivatives was to be moved from an over-the-counter market operated by banks to exchanges or central clearing parties. In turn, these clearinghouses were subject to regulations mandating heightened risk management, transparency, and capitalization requirements (Bernanke (2011) and Kress (2011)).

Bank Holding Companies Dodd-Frank imposed new reporting, risk management, and compliance requirements for bank holding companies. These include higher capital requirements for Systemically Important Financial Institutions (SIFIs) and obligations to draft plans for restructuring these institutions if they become insolvent (Gordon and Muller (2011)). Bank holding companies were also restricted from engaging in proprietary trading under the Volcker rule (Whitehead (2011)) and restricted from investing in private equity or hedge funds.

Broker-Dealers The Volcker rule only applies to broker-dealers that are affiliated with bank holding companies. Such affiliated broker-dealers are limited from engaging in proprietary trading. However, the Volcker rule exempted many types of assets such as treasuries and sovereign debt from restrictions on proprietary trading, and included relatively broad exemptions for trading that can be characterized as "market-making". Many have argued that it is difficult to distinguish "market-making" from proprietary trading (Duffie (2012)), casting doubts on the impact of the Volcker rule on broker-dealers (Kroszner and Strahan (2011)). Thus, Dodd-Frank may not be as burdensome for broker-dealers as for above-mentioned financial institutions.

Insurance Companies In practice, Dodd-Frank did very little to increase regulation of the insurance industry (Zaring (2018)). Specifically, the three largest insurance companies were briefly designated as SIFIs, which were subject to macro-prudential regulations and heightened capital requirements. However, such designations were tenuous and short-lived.[21] Dodd-Frank also created a Federal Insurance Office to coordinate with European insurance regulators, but the FIO has relatively little authority over domestic insurers (Zaring (2018)).

Overall, the literature suggests that the impact of Dodd-Frank was likely to be significantly higher on credit intermediaries and exchanges than on broker-dealers and insurance companies. Consistent with these qualitative assessments, Figure 7 shows that before and after Dodd-Frank, our Regulation Index went up most dramatically for non-depository and depository credit intermediation, followed by security and commodity exchanges, and went up less for insurance carriers and securities brokers. However, RegData shows a dramatic increase in regulation for insurance carriers, which can be due to RegData's inclusion of regulations that are ineffective due to court rulings and concessions made by regulators. In addition, RegData does not have information for securities and commodities brokers.

[FIGURE 7 ABOUT HERE]

4.3 Within-Industry Validation using the Sarbanes-Oxley Act

Our previous analyses demonstrated the performance of the Regulation Index using regulatory shocks that affected some industries more than others. In this section, we validate our measure through comparisons *within industry*, using reg-

[21]The Financial Stability Oversight Council's (FSOC) attempt to designate large insurers as SIFIs in 2013 and 2014 was swiftly defeated in court by insurance industry victories in the MetLife case in 2016 (Brewin (2014)). In 2014, Congress relieved insurance companies of Dodd-Frank regulations which would have held insurance companies to the more stringent capital adequacy and accounting standards that applied to banks (Webel (2014)). In 2017, FSOC removed remaining large insurers such as Prudential and AIG from its list of non-Bank SIFIs.

ulations that affected publicly traded firms more than those that were privately held.

The Sarbanes-Oxley Act of 2002 (SOX) was enacted following accounting scandals at large publicly traded firms including Enron and WorldCom. SOX sought to improve the accuracy of financial reporting and the reliability of internal controls at publicly traded companies by requiring senior executives at such firms to personally certify the accuracy of corporate financial reports and adequacy of internal controls, mandating stricter internal controls and enhanced reporting of off-balance sheet transactions, and increasing criminal penalties for financial fraud (Coates IV (2007)). SOX also sought to increase outside scrutiny and oversight by enhancing independence of auditors and securities analysts and protecting whistle blowers from retaliation.

Many of the key provisions of SOX apply exclusively to publicly traded companies listed in the United States. Studies suggest that the costs of SOX compliance were substantial (Zhang (2007), Linck et al. (2009), and Iliev (2010)) and may have discouraged companies from remaining public (Engel et al. (2007)) or listing in the U.S. (Piotroski and Srinivasan (2008)). In addition, small public firms, those with public float less than $75 million, were repeatedly granted exemptions from and delays in compliance (Gao et al. (2009) and Iliev (2010)).

The greater impact of SOX on publicly traded firms provides an additional test of our methodology of measuring the intensity of regulation *across industries*: specifically we test whether the same method can detect the differential impact of regulations on categories of firms *within the same industry*. We compare changes in the Regulation Index at publicly traded firms to changes in the Regulation Index for a matched sample of private firms after SOX was enacted. Specifically, we use the establishment-level microdata from the Bureau of Labor Statistics.[22] In addition to including the number of employees and average wages for each occupation in the establishment, the micro-data also provides the state in which

[22]The BLS aggregates establishment-level microdata to produce the publicly available industry-level data used elsewhere in this paper.

the establishment is located, the establishment's industry affiliation, and the establishment's parent's employer ID number (EIN) and legal and trade names . The microdata covers each establishment once every three years. We therefore construct a sample that includes three cohorts of establishments that were surveyed before and after SOX passage: in 1999 and 2002 (cohort 1), in 2000 and 2003 (cohort 2), and in 2001 and 2004 (cohort 3). Given our focus on publicly traded firms, we exclude establishments owned by government or with less than 20 employees.

We determine whether each establishment is owned by a publicly traded firm or a privately held firm by matching the establishment's legal and trade names and employer identification number (EIN) to firms in the Compustat database following Zhang (2019).[23] These procedures result in a final sample of 221,628 establishment-year observations from 1999 to 2004. About 20% of the establishments are owned by publicly traded firms and the remaining 80% are owned by privately held firms.

We then run regressions at the establishment level using the following difference-in-differences specification:

$$\begin{aligned} Reg.Index_{e,t} &= \beta Public_{e,t} \times Post\ SOX_t + \gamma Public_{e,t} \\ &\quad + FE_e + FE_{EmpBin \times Ind \times Year} + FE_{State \times Year} + \epsilon_{e,t} \end{aligned} \tag{2}$$

where $RegIndex_{e,t}$ is the Regulation Index of the establishment e in year t. The Establishment Regulation Index is constructed using the same methodology that created the industry Regulation Index in Section 3. $Public_{e,t}$ is a dummy variable that equals one if the establishment is owned by a publicly traded firm, and zero if the establishment is owned by a privately held firm. $Post\ SOX_t$ is a dummy

[23]The Compustat database only provides the headquarters' EIN for each firm. However, some firms may have multiple EINs. Failure to identify all EINs with common ownership would incorrectly identify some establishments owned by publicly traded firms as private, and hence would bias us towards finding non-results. To mitigate this concern, we supplement our matching of establishments to firms using legal and trade names as well as EINs. For more details, see Zhang (2019).

variable that equals zero if the year is in 1999-2001 and one if the year is 2002-2004.[24] FE_e represents establishment fixed effects which enables us to examine changes in each establishment's Regulation Index before and after SOX.

We also control for fixed effects that include a full interaction of year, SIC 3-digit industry codes, and four employment-size bins. Employment-size bins are defined as (20, 49), (50, 99), (100, 199), and above 200. These fixed effects improve matching of our SOX-treated publicly traded firms and our control group of private firms by ensuring that we compare only establishments within the same industry, with similar employment size, and in the same year. To further control for political and economic heterogeneities across states, we also include state and year fixed effects.

Table 6 shows the results. In Column (1), we find that after SOX was enacted, publicly traded firms shifted an additional 0.022% of their labor spending toward regulation-related tasks compared to privately held control firms within the same industry and size bins. The magnitude of this increase in the Regulation Index is substantial, equal to about an 8 percent increase in regulation-related labor spending.[25]

As noted above, SOX affects large public firms more than small public firms because of exemptions for small public firms. We follow the literature (Gao et al. (2009) and Iliev (2010)) and define small public firms as those with a public float less than $75 million and the rest as large public firms. In Columns (2) and (3) we observe that most of the effects of SOX on publicly traded firms' Regulation Index are driven by large firms, and the effects on small firms are indistinguishable from zero.

Because SOX focused on auditing and financial reporting, SOX may have the largest impact on the headquarters of a firm rather than its satellite and branch offices. OES does not label whether establishments are headquarters or branches,

[24]SOX was enacted in July 2002. The 2002 OES survey was collected in mainly early 2003 when the survey asks establishments to provide data on their occupational employment as of November 2002. Thus, we regard 2002 as post-SOX.

[25]Prior to the enactment of SOX, the average establishment in our sample spent 0.28% of its labor costs on regulation-related tasks.

but we hypothesize that the effect of SOX would be strongest on establishments located in the same state as the public firms' headquarters. Column (4) confirms this hypothesis: the point estimate increases to 0.061%.

To better understand the timing of publicly traded firms' response to SOX, in Figure 8, we shows the differences in the Regulation Index between establishments of publicly traded firms and matched private firms in each year from 1999 to 2004 using the sample in Column (4) of Table 6. We find that the difference is indistinguishable from zero before 2001, suggesting that the Regulation Index for public and private firms moved in parallel before SOX. After SOX, the difference immediately increased to about 0.14% in 2002 (a 50 percent increase compared to sample mean) and afterwards.

[TABLE 6 ABOUT HERE]
[FIGURE 8 ABOUT HERE]

5 Conclusion

Regulation is challenging to quantify uniformly due to its tremendous variation across industries with respect to form, content, and enforcement. In this study, we propose a new methodology to detect the intensity of regulations based on the percentage of an industry's labor costs paid to perform regulation-related tasks. We hypothesize that this measure reflects the intensity of regulations that incentivize firms to spend on compliance to avoid legal liability or regulatory sanctions. More stringent regulations with severer penalties and stricter enforcement will induce firms to spend disproportionately more on regulation-related tasks and thus to have a higher *Regulation Index*.

We validate our methodology by studying the enactments of several well-known laws and policy shocks that changed regulation intensity for firms within specific industries or for publicly traded firms within each industry. We show that our industry-level Regulation Index increases for the finance industry after

the Dodd-Frank Act, increases for the oil & gas industry after the BP Deepwater Horizon oil spill, and decreases for the oil & gas industry after the deregulation following the Energy Policy Act. We also show that the Regulation Index increases dramatically for publicly traded firms compared to privately held firms following enactment of the Sarbanes-Oxley Act. In summary, compared to text-based measures that count words in regulations, our Regulation Index reflects broader sources of regulation, can better detect the impact of regulations, and can better distinguish deregulation from regulation.

More generally, our approach of measuring regulation based on responses of the regulated entity offers a new indicator for policy makers to continuously monitor the impact of their regulations. In addition, our Regulation Index can also serve as a useful tool for economic studies that investigate causation between economic variables through changes in regulation. Using our measure to study how regulation affects various economic outcomes related to industrial organization can be an interesting line of future research.

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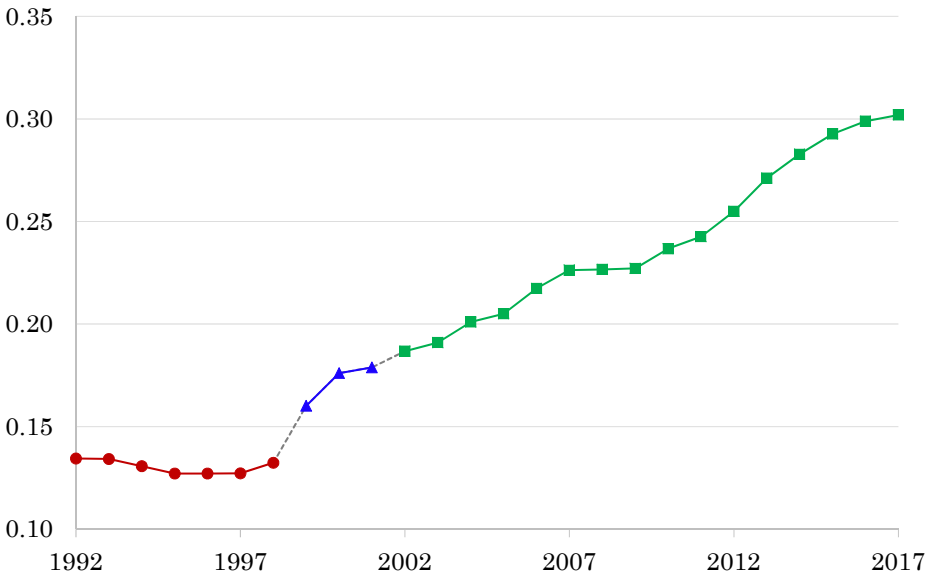


Figure 1: Regulation Index for Private Industries. Regulation Index is defined in Section 3. Different colored lines and different shaped line markers indicate shifting occupational and industry classifications by the underlying OES data. Prior to 1999, OES used its own internal occupation codes. In 1999, OES began classifying occupations using the Standard Occupation Classification. At the aggregate level there are no large jumps during the transition. We exclude detailed industries with year-to-year jumps in reporting or non-reporting of regulation-related occupations, which account for roughly 16 percent of observations. In 2002, OES changed from classifying industries using the Standard Industrial Classification to using the North American Industry Classification System. We exclude educational institutions and industry categories which provide legal or compliance work as their primary source of revenue or function: legal services, accounting firms, government administration, courts, and central banking.

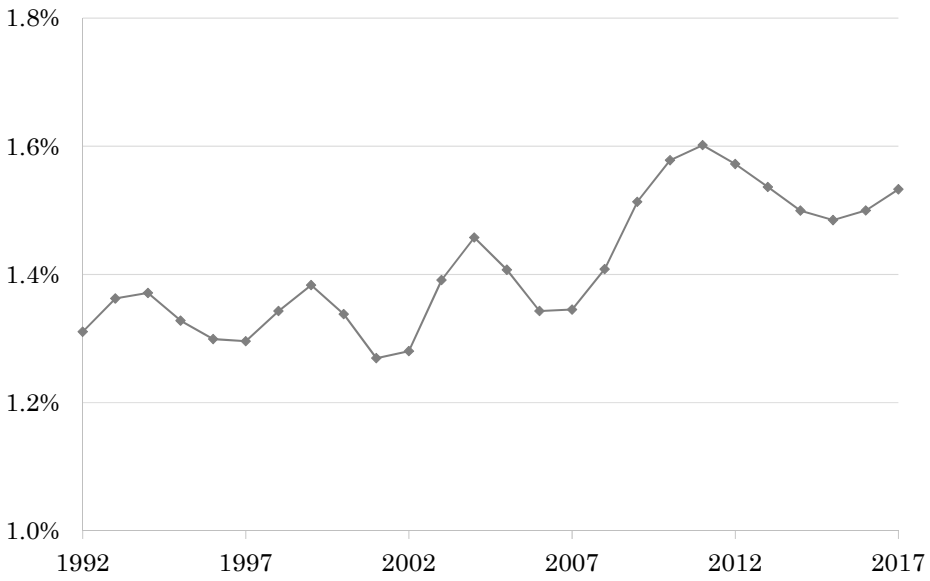


Figure 2: Outsourced Legal Spending for Private Industries. An industry's outsourced legal spending is "legal services" expenditures presented as a percentage of total input costs based on the input-output table from the Bureau of Economic Analysis. We smooth the graph by computing an industry's outsourced legal spending in year t as the moving-average of the percentages from $t-2$ to t. We aggregate the outsourced legal spending for all private industries using each industry's total input costs as weight.

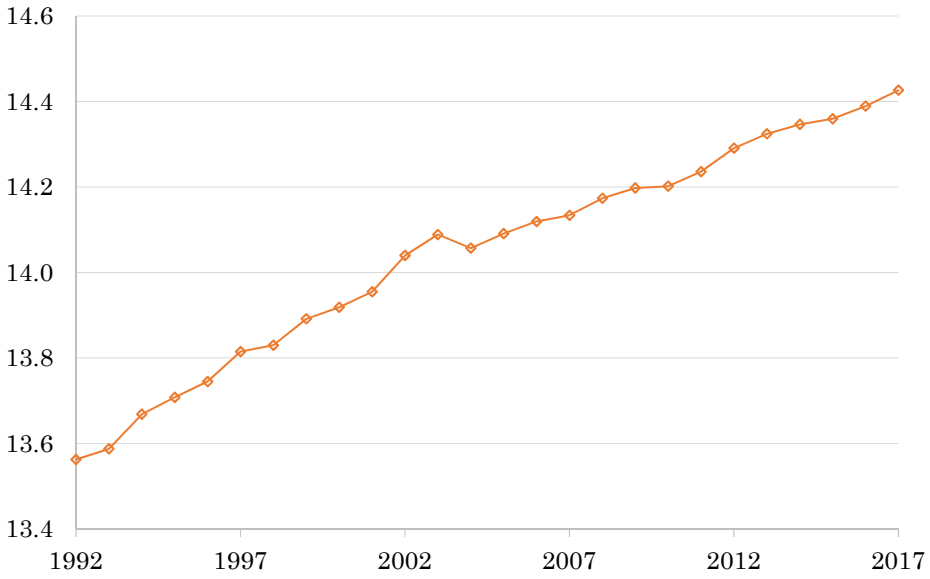


Figure 3: Text-based RegData Regulation Measure for Private Industries. RegData is the natural logarithm of the number of restrictive words in the Code of Federal Regulations applicable to the industry based on Al-Ubaydli and McLaughlin (2017). We exclude educational institutions and industry categories which provide legal or compliance work as their primary source of revenue or function: legal services, accounting firms, government administration, courts, and central banking.

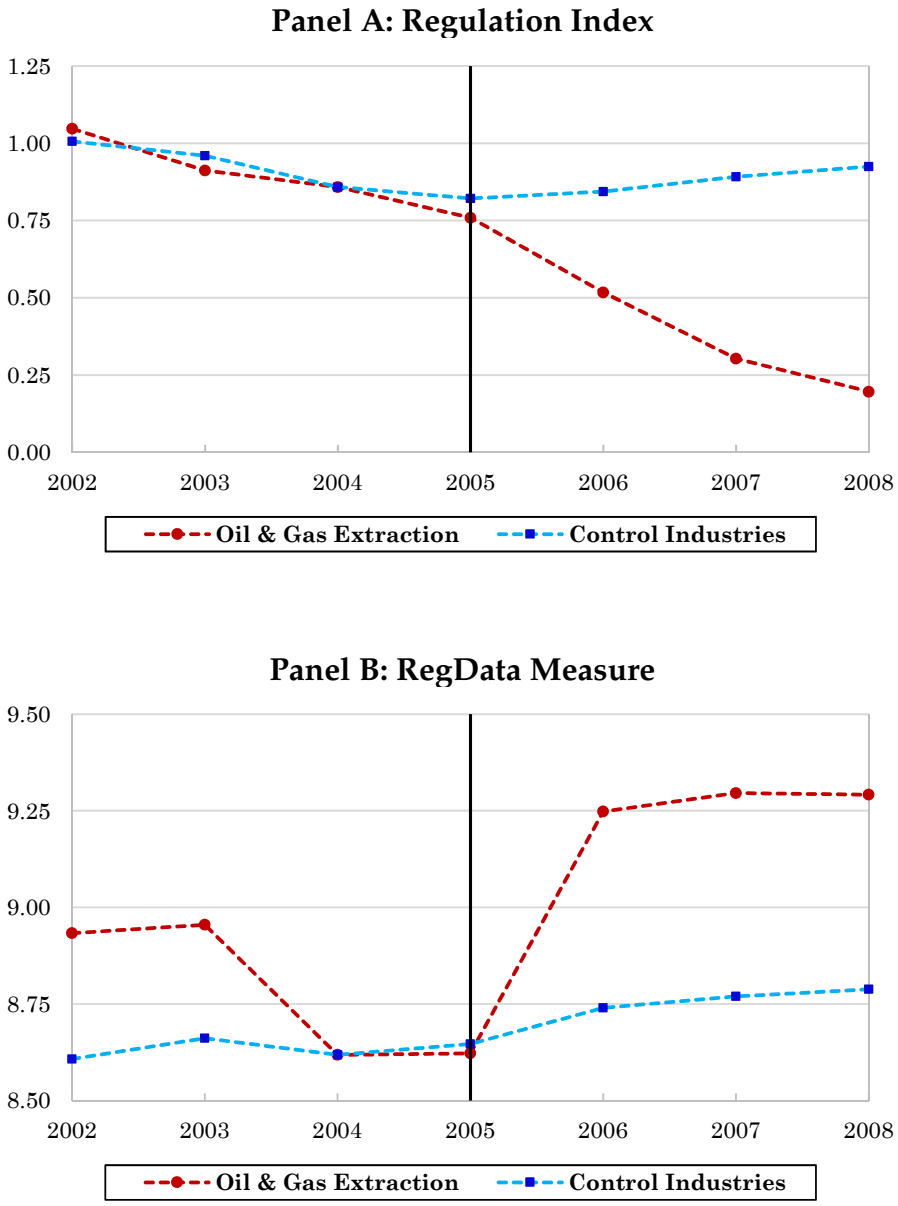


Figure 4: Energy Policy Act and Deregulation of Oil & Gas Extraction Industries. Panel A plots the Regulation Index of oil & gas extraction industries and control industries before and after the Energy Policy Act of 2005 (EPAct). Panel B plots the counter party graph using the RegData regulation measure. Classification of oil & gas extraction industries and control industries are discussed in Section 4.2.1. Regulation Index is defined in Section 3. RegData is the natural logarithm of the number of restrictive words in the Code of Federal Regulations applicable to the industry based on Al-Ubaydli and McLaughlin (2017). To ease comparisons around the time of treatment, the lines have been shifted vertically so that they have the same value in the year before the treatment. This value in the year before the treatment is the average of the regulation measures across the treated and control industries in that year. The difference between the two lines after the treatment, minus the difference between the two lines before the treatment reflects the difference-in-difference estimation.

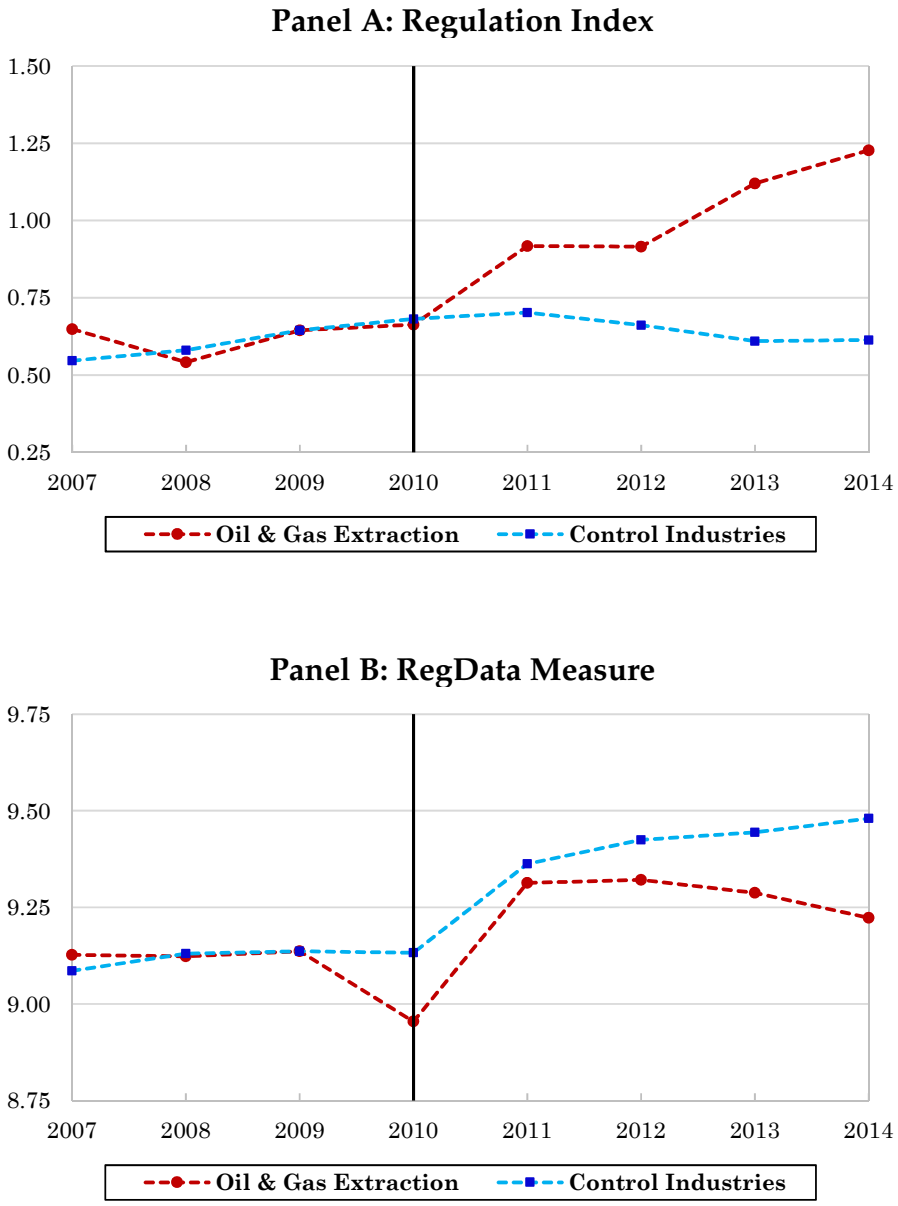


Figure 5: BP Oil Spill and Re-regulation of Oil & Gas Extraction Industries. Panel A plots the Regulation Index of oil & gas extraction industries and control industries before and after two President Executive Orders following the BP Deepwater Horizon oil spill in 2010. Panel B plots the counter party graph using the RegData regulation measure. Classification of oil & gas extraction industries and control industries are discussed in Section 4.2.1. Regulation Index is defined in Section 3. RegData is the natural logarithm of the number of restrictive words in the Code of Federal Regulations applicable to the industry based on Al-Ubaydli and McLaughlin (2017). To ease comparisons around the time of treatment, the lines have been shifted vertically so that they have the same value in the year before the treatment. This value in the year before the treatment is the average of the regulation measures across the treated and control industries in that year. The difference between the two lines after the treatment, minus the difference between the two lines before the treatment reflects the difference-in-difference estimation.

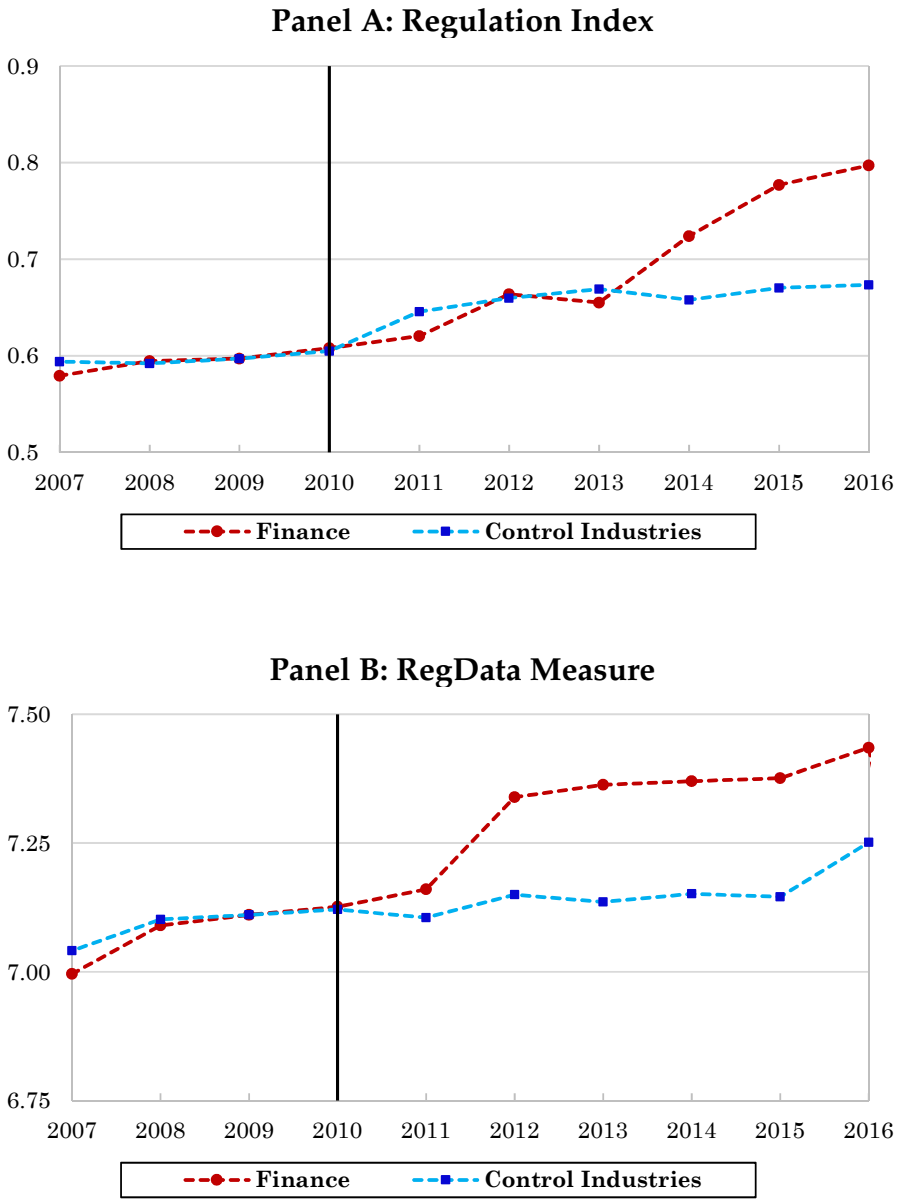


Figure 6: Dodd-Frank Act and Regulation of Financial Industries. Panel A plots the Regulation Index of financial industries and control industries before and after the enactment of the Dodd-Frank Act of 2010. Panel B plots the counter party graph using the RegData regulation measure. Classification of finance industries and control industries are discussed in Section 4.2.3. Regulation Index is defined in Section 3. RegData is the natural logarithm of the number of restrictive words in the Code of Federal Regulations applicable to the industry based on Al-Ubaydli and McLaughlin (2017). To ease comparisons around the time of treatment, the lines have been shifted vertically so that they have the same value in the year before the treatment. This value in the year before the treatment is the average of the regulation measures across the treated and control industries in that year. The difference between the two lines after the treatment, minus the difference between the two lines before the treatment reflects the difference-in-difference estimation.

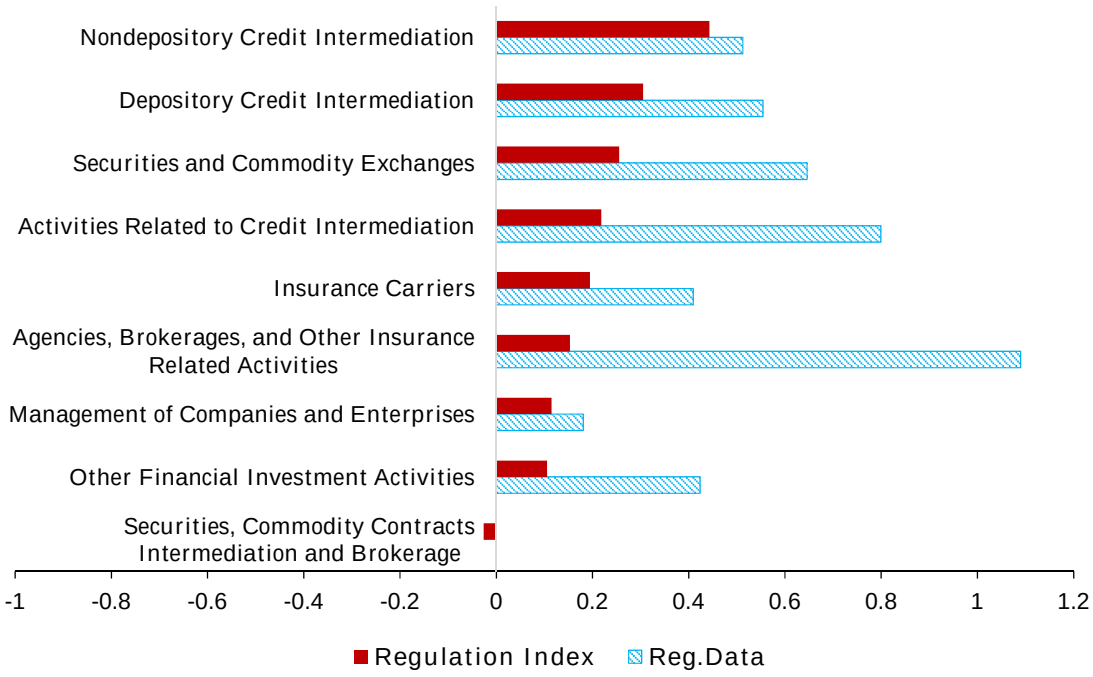


Figure 7: Changes in Regulation Index for Financial Sub-sectors before and after Dodd-Frank (2007-2009 vs. 2014-2016). This figure reports the changes in average Regulation Index and RegData regulation measure before and after Dodd-Frank. We regard 2007-2009 as the pre-treatment period and 2014-2016 as the post-treatment period. Industry titles in the figure correspond to the financial sub-sectors defined based on the NAICS 4-digit industry classification. Regulation Index is defined in Section 3. RegData is the natural logarithm of the number of restrictive words in the Code of Federal Regulations applicable to the industry based on Al-Ubaydli and McLaughlin (2017).

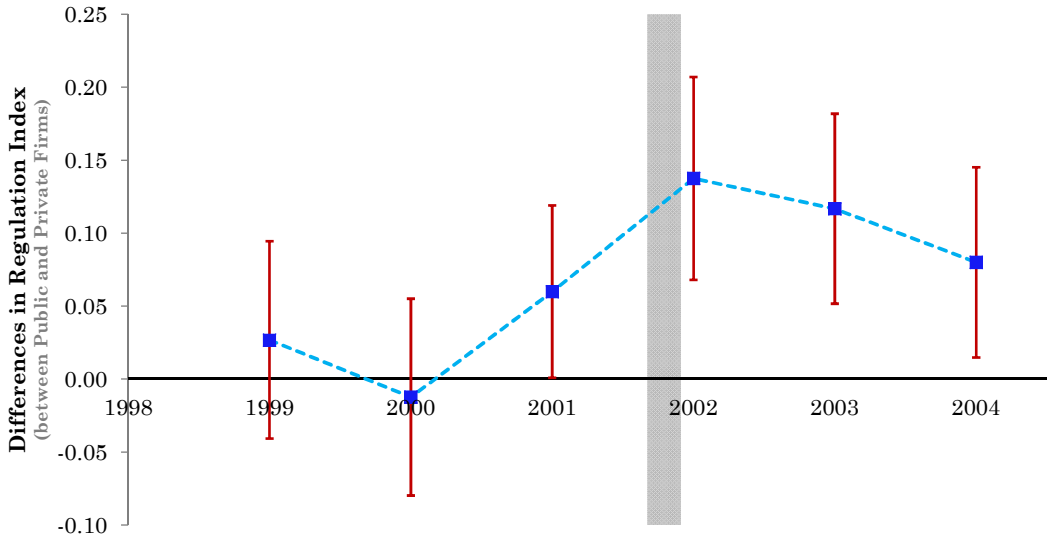


Figure 8: Differences in Regulation Index for publicly traded and privately held firms before and after the Sarbanes-Oxley Act of 2002. This figure reports the estimated differences between the Regulation Index for publicly traded firms and matched privately held firms during 1999-2004 using microdata of the Occupational Employment Statistics Survey from the Bureau of Labor Statistics. See more details on sample selection in Section 4.3. In each year, establishments of publicly traded firms are matched with establishments of privately held firms in the same group based on SIC 3-digit industry classification and four employment bins. Employment bins are defined as (20, 49), (50, 99), (100, 199), and above 200. We require publicly traded firms' establishments to be located in the same state as the firms' headquarters state. The blue squares represent the estimated differences in the Regulation Index between establishments of publicly traded firms and establishments of matched privately held firms. Regulation Index is defined in Section 3. The red vertical bars indicate 95% confidence intervals. The intersection of the 95% confidence intervals and the x-axis in 1999 and 2000 suggests that the Regulation Index for public and private firms moved in parallel before the Sarbanes-Oxley Act.

Table 1: Examples of Regulation-related Tasks

This table provides a selected list of tasks that are related to regulation. We identify tasks as regulation-related using textual analyses of statements of all tasks for occupations in the O*Net database. See Section 3 for more details of our methodology. *Task* is the statement of a task. *Occupation* is the occupation that the performs the task. *Import.* is the importance of the task to the occupation, which is a measure between 1 and 5. The tasks are sorted by the labor costs of the associated occupations in 2016.

Task	Occupation	Import.
Interpret laws, rulings and **regulations** for individuals and businesses.	Lawyers	4.26
Research and **keep informed** of pertinent information and developments in areas such as EPA **laws** and **regulations**.	Compliance Officers	4.05
Monitor construction activities to ensure that environmental **regulations** are not violated.	Construction and Building Inspectors	3.91
Review and **analyze** new, proposed, or revised **laws**, **regulations**, policies, and procedures to interpret their meaning and determine their impact.	Financial Examiners	3.83
Determine whether land-related documents can be registered under the relevant **legislation** such as the Land Titles Act.	Title Examiners, Abstractors, and Searchers	3.56
Determine the effects of **regulatory** limitations on land use projects.	Urban & Regional Planners	4.00
Interpret safety **regulations** for others interested in industrial safety, such as safety engineers, labor representatives, and safety inspectors.	Health and Safety Engineers	3.82
Inspect food processing areas to ensure compliance with government **regulations** and standards for sanitation, safety, quality, and waste management standards.	Food Scientists and Technologists	4.27
Inspect and test fire protection or fire detection systems to verify that such systems are installed in accordance with appropriate **laws**, codes, **ordinances**, **regulations**, and standards.	Fire Inspectors	4.28
Verify that transportation and handling procedures meet **regulatory** requirements.	Agricultural Inspectors	4.36
Monitor establishment activities to ensure adherence to all state gaming **regulations** and company policies and procedures.	Gaming Surveillance Officers & Gaming Investigators	4.75

Table 2: Regulatory-Task Intensity for Regulation-Related Occupations

This table reports the regulatory-task intensity score (RTI) for regulation-related occupations. We compute the RTI score for each occupation as the proportion of an occupation's regulation-related tasks weighted by the task's importance for that occupation. See Table 1 and Section 3 for more details on regulation-related tasks. An occupation has 25 tasks on average. Occupations with RTI above 0.2 are regarded as regulation-related occupations. We exclude occupations that are only employed by governmental entities since our research focuses on private industries. OES data uses 5-digit occupation codes (*OES Codes*) before 1998, and 6-digit Standard Occupational Classification codes (*SOC Codes*) in 1998 and later years.

Occupation	OES Codes	SOC Codes	RTI
Legal-Related Occupations			
Lawyers	28108	23-1011	0.45
Paralegals and Legal Assistants	28305, 28399	23-2011	0.51
Law Clerks	28302	23-2092	0.36
Title Examiners, Abstractors, and Searchers	28311, 28308	23-2093	0.24
Legal Secretaries	55102	43-6012	0.32
Compliance-Related Occupations			
Compliance Officers	21911	13-1041	0.36
Financial Examiners	21911	13-2061	0.41
Agricultural Inspectors	21911	45-2011	0.23
Construction and Building Inspectors	21908	47-4011	0.49
Food Scientists and Technologists	24305	19-1012	0.33
Health and Safety Engineers, Except Mining	21911, 22132	17-2111	0.43
Urban and Regional Planner	27105	19-3051	0.22
First-Line Supervisors of Police and Detectives	61005	33-1012	0.30
Fire Inspectors and Investigators	63002	33-2021	0.29
First-Line Supervisors of Fire Fighting	61002	33-1021	0.21
Police and Sheriff's Patrol Officers	63014	33-3051	0.29
Transit and Railroad Police	63038	33-3052	0.28
Nuclear Engineers	22117	17-2161	0.22
Parking Enforcement Workers	63021	33-3041	0.23
Gaming Surveillance Officers & Gaming Investigators	63035	33-9031	0.21

Table 3: Top 20 Industries with Highest Regulation Index in 2016

This table reports the top 20 NAICS 4-digit industries sorted by their Regulation Indexes in 2016. The Regulation Index (*Reg.Index*) is the percent of labor costs that the industry pays for regulation-related tasks. See Section 3 for more details of our methodology.

Industry	NAIC	Reg.Index
Energy		
Oil & Gas Extraction	2111	1.89
Electric Power Generation, Transmission and Distribution	2211	1.16
Natural Gas Distribution	2212	1.15
Pipeline Transportation of Natural Gas	4862	0.76
Financial		
Securities and Commodity Exchanges	5232	3.21
Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	5331	1.70
Insurance Carriers	5241	1.67
Management of Companies and Enterprises	5511	1.33
Other Financial Investment Activities	5239	1.26
Nondepository Credit Intermediation	5222	1.03
Depository Credit Intermediation	5221	0.86
Insurance and Employee Benefit Funds	5251	0.85
Securities and Commodity Contracts Intermediation and Brokerage	5231	0.75
Activities Related to Credit Intermediation	5223	0.74
Other Investment Pools and Funds	5259	0.70
Pharma		
Pharmaceutical and Medicine Manufacturing	3254	0.89
Professional		
Architectural, Engineering, and Related Services	5413	1.16
Business, Professional, Labor, Political, and Similar Organizations	8139	1.13
Social Advocacy Organizations	8133	1.10
Scientific Research and Development Services	5417	0.96

Table 4: Summary Statistics

This table reports summary statistics of the industry-year panel for industries with the Regulation Index available during 2002-2016. Section 4.1 provides the data source for each variable. *Regulation Index* is the percent of labor costs that the industry pays for regulation-related tasks following equation (1). *Outsourced Legal Service* is the three-year moving average of the percentage of the industry's intermediary input costs that are paid for legal services. *Text-based RegData* is the natural logarithm of the number of restrictive words in the Code of Federal Regulations (CFR) applicable to the industry based on Al-Ubaydli and McLaughlin (2017). *Lobbying Spending* is the natural logarithm of the industry spending on lobbying.

Variable	n	Mean	S.D.	Min	P50	Max
Regulation-related variables						
Regulation Index	4371	0.17	0.33	0	0.04	3.42
Outsourced Legal Spending	943	1.5	1.26	0.04	1.04	5.18
Text-based RegData	2093	8.41	1.44	5.03	8.34	11.43
Lobbying Spending	2196	14.36	2.6	0	14.69	19.04

Table 5: Relation between Regulation Index and other Measures

This table reports results of regressing three different regulation-related measures on the Regulation Index at the industry-year level. *Reg.Index* is the percent of labor costs that the industry pays for regulation-related tasks. *Outsourced Legal Service* is the three-year moving average (from $t-2$ to t) of the percentage of the industry's input costs that are paid for legal services from Bureau of Economic Analysis data. *Text-based RegData* is the natural logarithm of the number of restrictive words in the CFR applicable to the industry based on Al-Ubaydli and McLaughlin (2017). *Lobbying Spending* is the natural logarithm of the industry spending on lobbying from the Center for Responsive Politics data. NAICS 4-digit Regulation Indexes are aggregated to the corresponding industry classifications of the dependent variables for regressions. Columns (1) to (3) report results of OLS, cross-sectional, and time-series regressions. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. Sample period is from 2002 to 2016.

Regression Spec.:	Pooled: OLS	Cross-Section: Year FE	Time-Series: Ind. FE + Year Trend
	(1)	(2)	(3)
Panel A. Outsourced Legal Service			
Reg.Index	1.54^{***}	1.54^{***}	0.19^{**}
	(0.10)	(0.10)	(0.09)
Observations	1,005	1,005	1,005
Adjusted R^2	0.18	0.17	0.94
Panel B. Text-based RegData			
Reg.Index	0.65^{***}	0.62^{***}	0.05^{*}
	(0.09)	(0.09)	(0.03)
Observations	1,792	1,792	1,792
Adjusted R^2	0.03	0.03	0.99
Panel C. Lobbying Spending			
Reg.Index	1.63^{***}	1.59^{***}	-0.54
	(0.14)	(0.14)	(0.35)
Observations	2,267	2,267	2,267
Adjusted R^2	0.06	0.07	0.71

Table 6: Response of Public Firms to the Sarbanes-Oxley Act of 2002

This table reports establishments' response to the Sarbanes-Oxley Act (SOX) of 2002 for publicly traded firms and matched private firms. The analysis uses microdata of the Occupational Employment Statistics Survey from the Bureau of Labor Statistics, which surveys each establishment every 3 years. Our sample includes three cohorts of establishments that were surveyed in 1999 and 2002 (cohort 1), in 2000 and 2003 (cohort 2), and in 2001 and 2004 (cohort 3). *Public* is a dummy variable that equals one if the establishment is owned by a publicly traded firm, and zero if the establishment is owned by a privately held firm. *Post SOX* is a dummy variable that equals zero if the year is 1999-2001 and one if the year is 2002-2004. We exclude establishments with less than 20 employees. All regressions have establishment fixed effects, state-year fixed effects, and fixed effects that include a full interaction of SIC 3-digit industry codes, year, and four employment bins. Employment bins are defined as (20, 49), (50, 99), (100, 199), and above 200. Column (1) uses the full sample of establishments. Columns (2) and (3) use subsamples of establishments from large and small publicly traded firms based on whether the firms' public float is above or below $75 million (Gao et al. (2009) and Iliev (2010)). Column (4) uses public firms' establishments only if the establishments are located in the same state as the firm's headquarters state. Heteroscedasticity-consistent standard errors are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

	Full Sample			Only HQ-State
	All Firms	Large Firms	Small Firms	All Firms
	(1)	(2)	(3)	(4)
Public	−0.019	−0.100**	0.042	−0.069
	(0.031)	(0.050)	(0.037)	(0.065)
Public×Post SOX	0.022**	0.034***	0.005	0.061***
	(0.010)	(0.012)	(0.014)	(0.023)
Establishment FE	Yes	Yes	Yes	Yes
State×Year FE	Yes	Yes	Yes	Yes
EmpBin×Ind×Year FE	Yes	Yes	Yes	Yes
Observations	201,478	180,638	174,046	165,554
Adjusted R^2	0.886	0.892	0.892	0.893

Internet Appendix

IA.1 Robustness to Variations in Constructing Regulation Index

In this section, we explore two variations of our methodology for constructing the baseline Regulation Index in Section 3 and examine the robustness of our baseline results to these alternative versions of the Regulation Index.

IA.1.1 Time-Variation in Occupations' Tasks

We first examine whether regulation-related occupations (see Table 2) change their task focuses over time.[26] In this variation, we take advantage of the yearly availability of the O*Net data to account for time-variation in tasks that an occupation performs.

We download the historical versions of the O*Net database released in each year from 2002 to 2017. We apply the methodology in Section 3 to identify regulation-related tasks using keyword matching followed by manual screening. Using historical tasks and the historical importance weight of each task for each occupation, we construct a time-varying regulation-intensity score (RTI) for the regulation-related occupations from 2002-2017.[27] We then use equation (1) to compute each industry's labor spending on regulation-related tasks in each year while allowing each occupation to have time-varying RTIs. We label this version of Regulation Index as $Reg.Index^{TV}$.

[26] Hershbein and Kahn (2018) find that firms require higher skills when posting jobs for routine-cognitive occupations after the 2008-2009 Great Recession.

[27] The importance weights of tasks for occupations progressively become available in the O*Net database from 2002 to 2007. When an occupation misses its task weights in earlier years, we use the occupation's first available RTI to impute the occupation's RTI in the earlier years.

IA.1.2 Time-Variation in Labor Share

The second variation of our methodology is to divide an industry's labor spending on regulation-related tasks by the industry's revenue rather than by its total labor spending. Karabarbounis and Neiman (2014) shows that the labor share of the US corporate sector progressively declined from 63% to 58% during 1990-2012. Such decline is partially attributed to automation and outsourcing (Autor and Acemoglu (2011)). A more recent study by Hartman-Glaser et al. (2019) argues that the decline of labor share occurs only among the very largest corporations but not in average firms. If firms proportionately substitute labor with capital when performing each task, our Regulation Index still stands as a good measure of each industry's percentage spending on regulation-related tasks. However, if firms disproportionately automate and outsource tasks that are not related to regulation, such as clerical or production tasks, our Regulation Index can artificially increase even when regulatory intensity remains constant. On the other hand, if firms respond to regulation by using more machines than labor to perform regulation-related tasks, then our Regulation Index will not be able to pick up such a response and will underestimate regulatory intensity.

We examine the possibility of such over and understatement by creating a version of our Regulation Index in which the percentage of an industry's labor spending on regulation-related tasks is scaled by its total *revenue*. To do so, we obtain an industry's total labor spending and total revenue from the Census Bureau's Statistics of U.S. Businesses (SUSB) for 2002, 2007 and 2012.[28] We measure each industry's labor share as the industry's labor spending divided by the industry's revenue in the SUSB data for each of the three years for which data is available. We then linearly extrapolate each industry's labor share for other years between 2002 and 2012, assuming the decline of labor share in each industry is linear. For years beyond 2012, we do not have any information on industry revenue. We thus use each industry's 2012 labor share to proxy for its labor share in

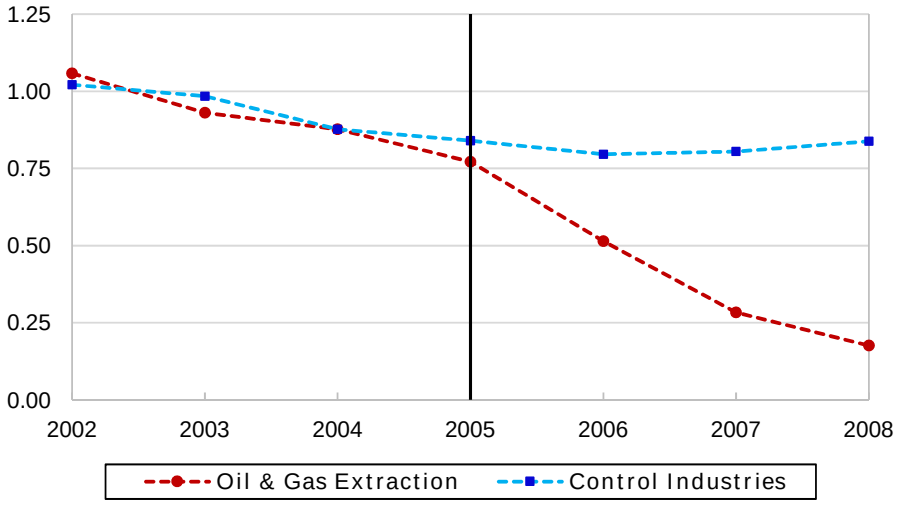
[28]The Census Bureau surveys each industry's revenue every five years. Data for 2017 are expected to be published in 2020 to 2021

years beyond 2012. Finally, we create the alternative measure after adjusting for labor share by multiplying our baseline Regulation Index by the industry's labor share. We label this alternative measure as $Reg.Index^{LS}$.

Figure IA.1, IA.2, and IA.3 show that the aforementioned two variations–accounting for changing occupational tasks and changing labor share–make little change to inferences of regulation intensity based on our baseline Regulation Index. These findings are consistent with relatively slow changes in occupational tasks and the decline of labor share. Hence, such variations are usually dominated by the policy shocks in our case studies.

[FIGURE IA.1 ABOUT HERE]
[FIGURE IA.2 ABOUT HERE]
[FIGURE IA.3 ABOUT HERE]

Panel A: Robustness to Time-Varying Occupation RTI using *Reg.Index*^{TV}



Panel B: Robustness to Time-Varying Labor Share using *Reg.Index*^{LS}

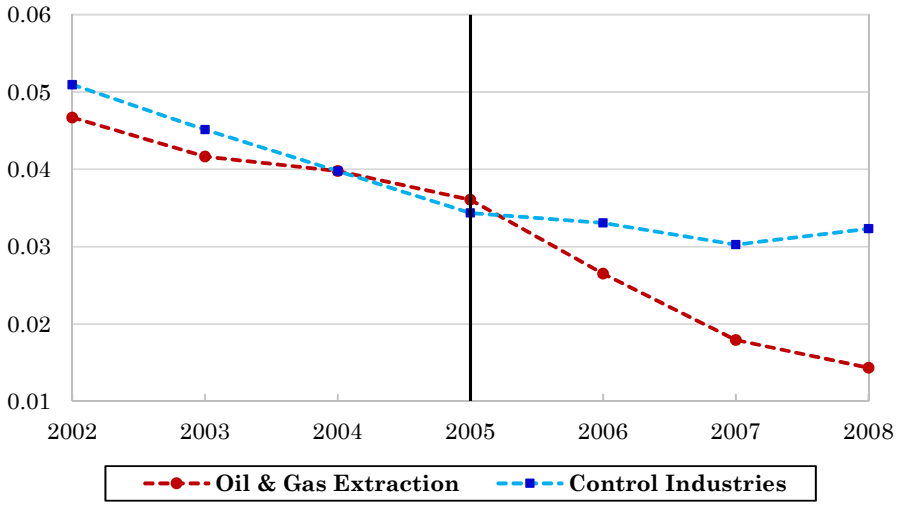
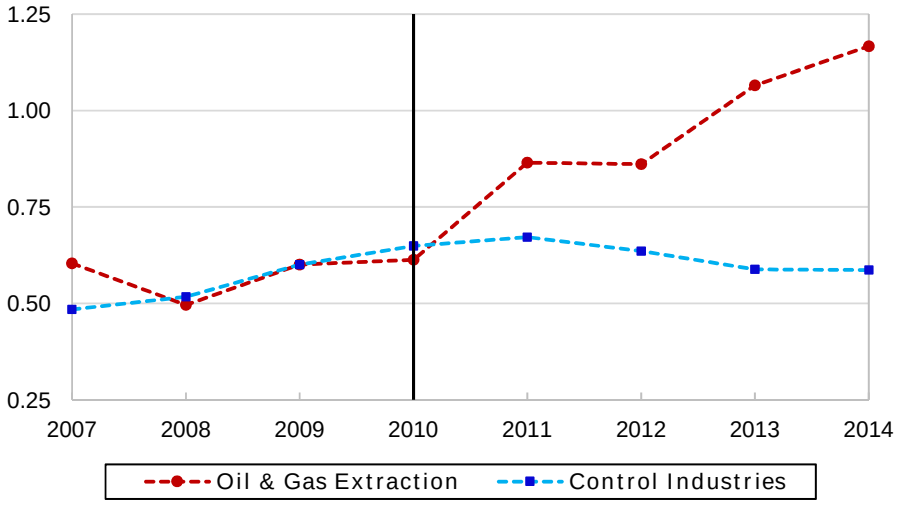


Figure IA.1: Energy Policy Act and Deregulation of Oil & Gas Extraction Industries. This figure plots the Regulation Index of oil & gas extraction industries and control industries before and after the Energy Policy Act of 2005 (EPAct) using two alternative measures of our baseline Regulation Index. Panel A reports the plot using the measure *Reg.Index*^{TV} which accounts for time-variation in each occupation's tasks. Panel B reports the plot using the measure *Reg.Index*^{LS} which accounts for the decline of labor share over time. To ease comparisons around the time of treatment, the lines have been shifted vertically so that they have the same value in the year before the treatment. This value in the year before the treatment is the average of the regulation measures across the treated and control industries in that year. The difference between the two lines after the treatment, minus the difference between the two lines before the treatment reflects the difference-in-difference estimation.

Panel A: Robustness to Time-Varying Occupation RTI using *Reg.Index*^{TV}



Panel B: Robustness to Time-Varying Labor Share using *Reg.Index*^{LS}

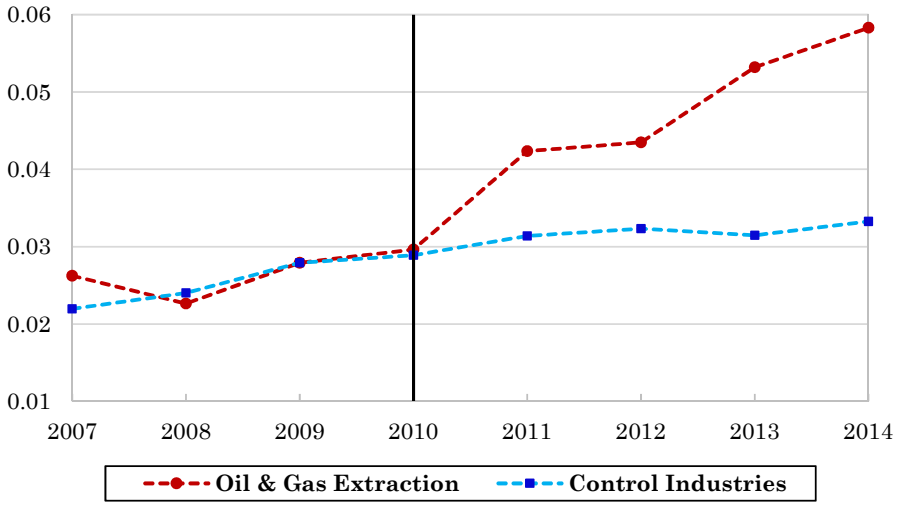
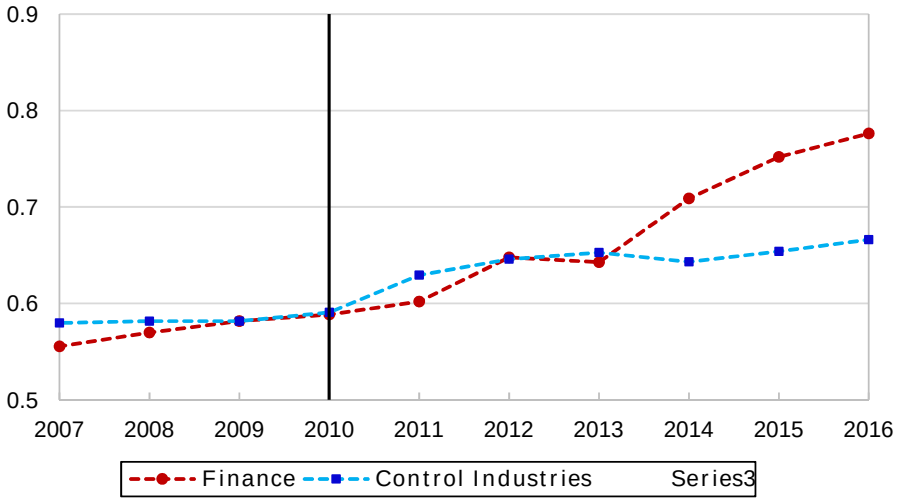


Figure IA.2: BP Oil Spill and Re-regulation of Oil & Gas Extraction Industries. This figure plots the Regulation Index of oil & gas extraction industries and control industries before and after two President Executive Orders following the BP Deepwater Horizon oil spill in 2010 using two alternative measures of our baseline Regulation Index. Panel A reports the plot using the measure *Reg.Index*^{TV} which accounts for time-variation in each occupation's tasks. Panel B reports the plot using the measure *Reg.Index*^{LS} which accounts for the decline of labor share over time. To ease comparisons around the time of treatment, the lines have been shifted vertically so that they have the same value in the year before the treatment. This value in the year before the treatment is the average of the regulation measures across the treated and control industries in that year. The difference between the two lines after the treatment, minus the difference between the two lines before the treatment reflects the difference-in-difference estimation.

Panel A: Robustness to Time-Varying Occupation RTI using *Reg.Index*^{TV}



Panel B: Robustness to Time-Varying Labor Share using *Reg.Index*^{LS}

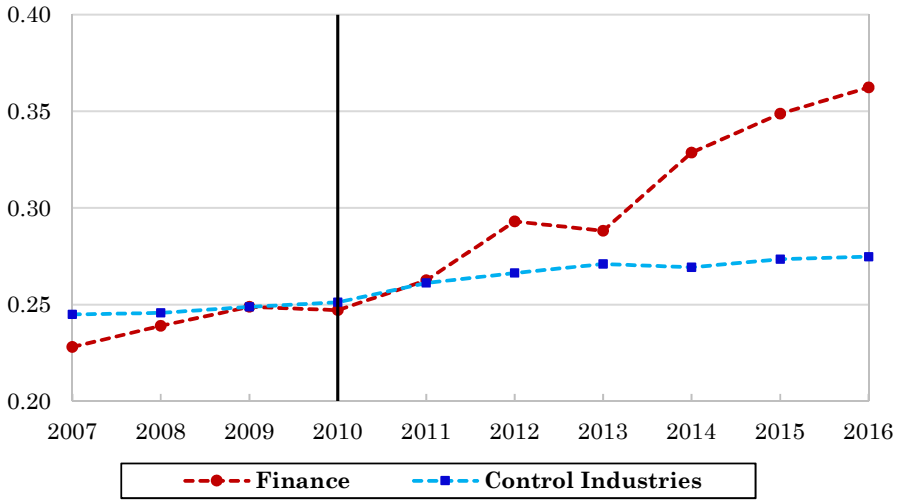


Figure IA.3: Dodd-Frank Act and Regulation of Financial Industries. This figure plots the Regulation Index of financial industries and control industries before and after the enactment of the Dodd-Frank Act of 2010 using two alternative measures of our baseline Regulation Index. Panel A reports the plot using the measure *Reg.Index*^{TV} which accounts for time-variation in each occupation's tasks. Panel B reports the plot using the measure *Reg.Index*^{LS} which accounts for the decline of labor share over time. To ease comparisons around the time of treatment, the lines have been shifted vertically so that they have the same value in the year before the treatment. This value in the year before the treatment is the average of the regulation measures across the treated and control industries in that year. The difference between the two lines after the treatment, minus the difference between the two lines before the treatment reflects the difference-in-difference estimation.