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Regulatory Costs and Market Power

Shikhar Singla

DFG Center for Advanced Studies on the Foundations of Law and Finance | House of Finance | Goethe University
Theodor-W.-Adorno-Platz 3 | 60629 Frankfurt am Main | Germany www.lawfin.uni-frankfurt.de

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Shikhar Singla*

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Abstract

Industry concentration and markups in the US have been rising over the last 3-4 decades. However, the causes remain largely unknown. This paper uses machine learning on regulatory documents to construct a novel dataset on compliance costs to examine the effect of regulations on market power. The dataset is comprehensive and consists of all significant regulations at the 6-digit NAICS level from 1970-2018. We find that regulatory costs have increased by $1 trillion during this period. We document that an increase in regulatory costs results in lower (higher) sales, employment, markups, and profitability for small (large) firms. Regulation driven increase in concentration is associated with lower elasticity of entry with respect to Tobin's Q, lower productivity and investment after the late 1990s. We estimate that increased regulations can explain 31-37% of the rise in market power. Finally, we uncover the political economy of rulemaking. While large firms are opposed to regulations in general, they push for the passage of regulations that have an adverse impact on small firms.

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1 Introduction

The US economy has seen a sharp increase in markups, profitability and market concentration in the last four decades (Grullon et al. (2019), De Loecker et al. (2020)). Increased concentration is associated with decreased labour share, investment, and innovation (Eeckhout (2021), Philippon (2019), Barkai (2020), Gutiérrez and Philippon (2017), Autor et al. (2020)). However, reasons for the increase in concentration and markups are not clear (De Loecker et al. (2020), Grullon et al. (2019), Akcigit and Ates (2021)). In this paper, we investigate if increase in regulatory costs, which often disproportionately impacts small firms, can lead to a rise in market power for large firms.

To study this, we construct a comprehensive regulatory cost measure in US dollars. Regulatory agencies report the industries affected by the regulation and the costs in dollars that the firms will need to spend to comply with the regulation. They also report whether the small firms will be subjected to the regulation. This data is unique, adheres to strict legal guidelines and is not reported in any advanced economy except the US. However, it requires machine learning and data extraction techniques to be captured from the documents. We create the measure for social regulations (e.g., environmental and workplace safety regulations) at the 6-digit NAICS level for small and large firms. Using the measure, we establish two novel facts. We find that regulatory costs have increased by \$1 trillion from 1970 to 2018.

Next, to establish the link between regulations and concentration, we compare small and large firms in the same state and the same industry at the same time. We find that increase in regulatory costs leads to small firms becoming smaller and large firms becoming larger. It also leads to an increase in markups and profitability of very large firms. We test the theory's predictions (Covarrubias et al. (2020)) and find that regulation driven increase in concentration reduces the elasticity of entry to Tobin's Q and negatively correlates with productivity and investment after the late 1990s. This provides evidence of rent seeking due to regulations and is consistent with public choice theories of regulations (Peltzman (1976), Shleifer and Vishny (1993)). Staggered nature of regulations, absence of pre-trends, placebo test with proposed but not finalized regulations, and lowering of competition and productivity after increase in regulations help us rule out explanations like increase in technology, import competition and offshoring. Increase in costs can explain 31-37% of the rise in industry concentration and markups. Finally, we study the content of comments made by firms on the proposed regulations, which can influence the regulations that get passed (Bertrand et al. (2021). We show that large firms oppose regulations on average, but they push for regulations that adversely impact small firms. This suggests large firms can influence regulations in a way that increases their competitive advantage explaining the rise in market power in the last few decades.

Federal rules and regulations that businesses in the US need to comply with have grown exponentially since the 1970s. Crude measures like the number of pages in the Federal Register depict this point (Crews (2002)). Some other measures like counting the number of words that indicate an obligation to comply, such as "shall" or "must" also exhibit a similar pattern (McLaughlin and Sherouse (2019)). In addition, various surveys and anecdotal evidence well establish the increasing burden of regulations. Executive Order (EO) 13771 (2017) directs all rule-making agencies to repeal at least two existing regulations for each new regulation. It further directs agencies that the "total incremental costs of all regulations should be no greater than zero".

Despite the attempts mentioned above and anecdotal evidence, a complete picture of industry-level regulatory costs is lacking especially, on small firms. Most regulations increase fixed costs for firms, and due to lower revenues, an increase in fixed costs can force the small firms to close down more than the large firms. Small firms not being able to take up profitable projects due to financing constraints or invest in R&D and advertising besides a higher exit and lower entry is also a potential mechanism.

Regulators and legislators understand that regulations can place a disproportionate burden on small businesses, which was highlighted in the Regulatory Flexibility Act (RFA) 1980. RFA was passed after the environmental regulation wave of the 1970s made it clear that the impact was higher on small firms. RFA requires agencies to consider the impact of their regulatory proposals on small entities, analyze effective alternatives that minimize small entity impacts, and make their analyses available for public comment.

Measuring regulation by regulation pages or word counts is noisy because many pages have nothing to do with regulation; this measurement method also runs the risk of counting deregulation as an increase in regulation because deregulation is also published. Even more importantly, not all regulations are created equal in their effects on different sectors or the economy as a whole. Finally, length cannot distinguish between social regulations (e.g., workplace safety and environmental regulations) and economic regulations (antitrust, financial, pricing, product or geographic entry regulations).

To test our hypothesis, we need a granular regulatory cost measure that has within-industry (narrowly-defined) variation across small and large firms. Regulatory costs in actual dollars for social regulations and whether the regulations impact small firms are reported in regulations. Regulatory costs conform to uniform government-wide guidelines, are subject to public inspection and are reviewed by an independent team inside the regulatory agency, The Office of Information and Regulatory Affairs (OIRA) (an agency within the Executive

Office of the President) and the SBA. This data is unique and not reported in any advanced economy except the US. We use supervised machine learning and data extraction techniques to create the data from federal regulatory documents for social regulations at the 6-digit NAICS level (most granular industry classification). Costs of economic regulations cannot be determined and hence not provided by regulatory agencies.

We capture the regulatory costs of each regulation from 1970 to 2018. Regulatory costs mainly include costs of machinery or equipment (e.g., for environmentally cleaner production, waste disposal systems, workplace safety equipment such as fire extinguishers) or paperwork costs. We employ supervised machine learning for both classifying the industry the regulation applies to and extracting the costs that a firm needs to spend to comply with the regulation. We use documents given by the regulatory agencies as training documents for both tasks. These are ideal training documents since the ground truth is labeled by the regulatory agency, an expert on the regulation and does not involve any judgements on the part of the researcher. Secondly, since the training documents are a subset of all regulations, they can be used for efficient projection on those regulations where we do not know the affected industries and costs. We use data-extraction techniques to get the labels of regulations from the text as many agencies mention precise detailed costs and the affected industries. We use one-vs-rest logistic regression and transfer learning algorithms for classifying affected industries and extracting costs, respectively. We validate our machine learning models using five-fold cross-validation.

We get annualized regulatory costs (costs that each firm faces in a year to comply with the regulation) of each "economically significant" regulation and add the costs over the years to get total (cumulative) annual regulatory costs for each industry. We use data extraction techniques to get the information on if the regulation impacts the small firms and whether the regulation is economically significant. Using the above steps, we obtain costs per firm for small and large firms within an industry. Although we validate our methodology using internal statistical performance metrics such as area under the curve and correlation, we follow Hassan et al. (2019) and further validate our measure by testing whether it tracks externally verifiable data. Bommarito II and Katz (2017) measure the regulatory ecosystem of the firms by analyzing over 4.5 million references to the US federal acts, regulations and agencies contained within the 10-K filings made by public firms. 10-K reports contain a characterization of a firm's financial performance and its risks, including the regulatory environment in which a company operates. Bommarito II and Katz (2017) measure the regulatory ecosystem of firms for more than 20 years. We find strong linear relationship between our regulatory cost measure and number of references to federal acts, regulations and agencies at the firm level. This further proves credibility of our regulatory cost measure.

We establish several stylized facts with the measure of the regulatory costs. First, the total economy-wide cost of regulations since 1970 has increased by almost 1 trillion dollars, which is roughly 5% of US GDP in 2018. Second, there has been a massive increase in regulation since the late 1990s. Third, we find that the biggest portion of these costs is due to environmental regulations. Fourth, an average small firm faces an average of \$9,093 per employee in our sample period compared to \$5,246 for a large firm. Small firms face higher costs per employee than large firms even after massive attempts from regulators and politicians to keep the burden on small firms to a minimum. Fifth, there is vast heterogeneity in how regulations have impacted small firms compared to large firms across industries.

Regulations affect different industries at different times providing us with cross-sectional and time series variation. This allows us to use a staggered difference-in-difference setup comparing small vs large firms in the same industry at the same time. We leverage the granularity of our regulatory costs data and use Industry × State × Year level fixed effects to compare the firms within the same state and same industry at the same time. This set of fixed effects allows us to show the differential impact of regulatory costs on firms of different sizes while also controlling for any demand shocks to the industry. We begin by testing for the assumption of parallel trends. We compare small firms (treated group) against large firms in an industry (treated industry) which had 100% increase in regulatory costs compared to last year for both small and large firms. We do not find significant differences in trends prior to the increase in regulatory costs.

We find that the there is reduction in the number of establishments, employees, and wages for small establishments. We find that a 100% increase in regulatory costs leads to a 1.2%, 1.4% and 1.9% increase in the number of establishments, employees and wages, respectively, for large firms, whereas it leads to 1.4%, 1.5% and 1.6% decrease in the number of establishments, employees and wages, respectively for small firms when compared within the state-industry-time groups. Results on employees and wages provide evidence that an increase in regulatory costs creates a competitive advantage for large firms. Large firms get larger and small firms get smaller.

We further interact the regulatory costs variable with dummies for all firm size categories. We find that almost all dependent variables decrease for firms with lesser than 100 employees but increase for firms with more than 1000 employees. We find that coefficients progressively increase as firms get larger for all regressions. The smaller the firm, the more competitively disadvantaged it gets, and vice-versa. This provides strong evidence that a sizeable proportion of regulatory costs are fixed. Fixed costs create a competitive disadvantage for small firms. Channels could be a higher exit rate, not being able to take profitable projects due to financial constraints, and not being able to invest in advertising or R&D. A 100% increase in regulatory costs leads to an increased gap in 2.9% in the number of employees between large and small firms. This gap is 7.7% when comparing firms of 1-4 employees and 1000 or more employees.

Grullon et al. (2019) show that most industries in the US have become more concentrated. Increased (decreased) employees and the number of establishments for large (small) firms provide evidence of increased industry concentration due to an increase in regulatory costs (one of the metrics along with markups to measure market power). Our paper provides a cause behind the findings of Grullon et al. (2019). We further validate this by running industry-state level regressions on measures of concentration such as the Herfindahl–Hirschman Index (HHI). We find that as the ratio of costs on small firms to costs on large firms increases, industries become more concentrated. We also perform a placebo test using regulations which were proposed but never finally passed. We employ the same techniques to get the costs of such regulations and find that these regulations did not impact industry level concentration.

Factors like increase in technology, import competition and offshoring could impact market structure. For these factors to affect our estimates, they will have to be correlated with regulatory shocks. We test this using parallel trends and find that there are no changes before the regulatory shocks ruling out these concerns. Although unlikely, these factors could be precisely correlated with regulatory shocks. To address that, we control for productivity to measure the changes in technology, import competition or offshoring and find it does not impact our results. We also perform a placebo test using regulations which were proposed but never finally passed. We do not find any effects from such proposed regulations further alleviating the concern. Finally, as discussed later, all such explanations will lead to higher industry level productivity but we find that increase in regulation is correlated with lower productivity.

De Loecker et al. (2020) show that market power as measured by markups and profit rates has increased considerably in the US. They find that this increase comes from firms in the upper percentiles (75 and 90 percentile firms), whereas the markup of the median firm has remained the same. We use data on markups from De Loecker et al. (2020) and find that an increase in regulatory costs leads to an increase in markups for the upper percentiles, and the coefficient increases as the firms get larger whereas markups remain unchanged for the median firm. A 100% increase in the regulatory costs leads to an increased gap of 4% in markups when comparing firms above 90 and below 50 percentiles. We also test how regulatory costs impact economic profits as an increase in profit rate implies an increase in market power. We find that a 100% increase in regulatory costs leads to 1.2 percentage points increase in the profit rates of firms above 90 percentile. The profitability does not change for the firms below 50 percentile and progressively increase with size like markups. De Loecker et al. (2020) also find that most of the increase in aggregate markups is driven by reallocation of business to firms with higher markups rather than increase in within firm markups. We find that increase in regulatory costs leads to increase in share of large firms but modest increase in their markups. Our results provide an explanation for the findings of De Loecker et al. (2020) and also speak to the emergence of superstar firms (e.g., firms larger than 10,000 employees in size). Autor et al. (2020) find that the dominance of these firms has led to the decline of labor share in the US economy in the last three decades.

An important question is whether the rise in concentration reflects market power and rent seeking or not. As Covarrubias et al. (2020) point out, if lower search costs or an increase in intangible investment (Crouzet and Eberly (2021)), Kwon et al. (2022), De Ridder (2019)) is leading to an increase in concentration, it should be associated with increased productivity ("Good" concentration). On the other hand, if entry costs play a significant role in increasing concentration (Gutiérrez et al. (2021), Corhay et al. (2020b), Gutiérrez and Philippon (2019)), it should be coupled with reduced elasticity of entry to the investment opportunities in the industry and potentially lower productivity and investment ("Bad" concentration). Although regulations raise entry costs, it could lead to good concentration by forcing out unproductive firms and less failures (public interest theory of regulation from Pigou (1938)). Entry costs could screen new entrants to ensure that consumers buy high quality products from desirable sellers.

We follow the predictions of the Q-theory of entry (Clementi and Palazzo (2016), Jovanovic and Rousseau (2001)). The theory states that when investment opportunities measured by Tobin' Q rises in an industry, there is more entry. We find that increased regulations reduce elasticity of entry to Tobin's Q. We further find that regulation driven increase in concentration is negatively correlated with productivity, aggregate industry investment and industry leader investment relative to Tobin's Q and positively correlated with prices. Regulations leading to negative side of concentration further rules out explanations like increase in technology, import competition, intangibles, offshoring etc as these would lead to positive side of concentration i.e., more competition and higher productivity. This pattern is observed after the late 1990s and is in line with the finding that the US economy switched from good to bad concentration around the same time (Covarrubias et al. (2020)). This is due to the fact that small firms faced lower costs compared to large firms before the early 2000s. However, the ratio of costs of small to large firms went well above one after the early 2000s. Overall, there is evidence of undesirable concentration and rent seeking due to regulations.

We follow David et al. (2013) to investigate how much of the increase in market power can be explained by the rise in regulatory costs. We multiply the coefficient with the difference of the mean of the independent variable in our regressions between the first and the last five years of the sample to get the predicted increase in the dependent variable. Then, we divide this number by the actual increase in the dependent variable. Increase in regulatory costs can explain 31-37% of the rise in market power.

Finally, we explore the political economy of rulemaking using comments made by firms on the proposed regulations. The content of these comments influences the regulators and passed final rules (Bertrand et al. (2021). We collect a comprehensive dataset including the vast majority of the comments submitted in the rulemaking process. For each comment, we observe the proposed rule, final rule (if implemented) pertinent to that document, the identity of the commenter, as well as the content of the comment itself. We use supervised machine learning to standardize, clean, match the comments to the firms and determine the position of firms (support or oppose) on regulations. We find that large firms oppose regulations in general. But, they push for regulations which have an adverse impact on small firms. Hence, they are willing to incur a cost that creates a competitive advantage for them.

Public interest theory of regulation (Pigou (1938) states the regulations are imposed to reduce market failures such as low quality products from non-serious producers and externalities such as pollution. It is done to ensure that new companies meet minimum standards. Under the public choice theory (Stigler (1971), Peltzman (1976)), regulation is lobbied by the industry to keep the competitors out and raise incumbents' profits. A second strand of the public choice theory, the tollbooth theory (Shleifer and Vishny (1993), posits that politicians and regulators create regulation to extract rents through campaign contributions and bribes. Our results on regulation leading to lower competition, increase in markups of incumbents and large firms supporting regulations that drive small firms out is consistent with public choice theory of regulation.

Our paper relates to several strands of the literature. Our paper provides an explanation for a growing set of papers that document increased concentration and its impacts. Grullon et al. (2019) show that concentration and profits have increased in most US industries. De Loecker et al. (2020) find that aggregate markups have increased from 21% to 60% since 1980. Gutiérrez and Philippon (2017) link the decrease in corporate investment to the decline in competition. Barkai (2020) and Autor et al. (2020) show that increase in concentration is correlated with decline in labor share. Autor et al. (2020) further document that these empirical patterns are related to rise of superstar firms. Kozeniauskas (2018) concludes that increasing fixed costs either due to regulations or the use of technology is the main explanation for the decline in entrepreneurship. Gutiérrez et al. (2021) and Gutiérrez and Philippon (2019) find that entry costs have risen in the US which has led to lower consumption. Covarrubias et al. (2020) argue that increased concentration has moved from being beneficial in the 1980s and 1990s to harmful after the 2000s. Furman (2015) and Furman (2016) argue that the rise in concentration suggests increased economic rents and barriers to competition. Corhay et al. (2020a) find that higher markups firms have higher expected returns over time and across industries. Liu et al. (2022) theoretically show that a decline in interest rate can induce stronger investment by market leaders compared to market followers leading to higher concentration.

Secondly, we contribute to the literature that aims to understand regulation and its consequences. This topic is the subject of many debates and comprises of many theories, from public interest theories (Pigou (1938), Joskow and Rose (1989), Demsetz (1974)) to public choice theories (Tullock (1967), Stigler (1971), Krueger (1974), Posner (1974), Peltzman (1976), Becker (1983), Shleifer and Vishny (1993)). We estimate the impact of all federal social regulations on important firm and industry level outcomes. Our results shed light on the real effects of regulation and the underlying mechanisms. There is tension in the empirical literature on the impact of regulation on employment that uses federal regulations datasets. Bailey and Thomas (2017) argue that employment declines in industries with rising regulation, but Goldschlag and Tabarrok (2018) argue that regulation does not have an impact on employment. A contribution of our paper is to explain the two sets of findings by unmasking the heterogeneous impact of regulations on small and large firms.

Finally, we contribute to the literature which aims to quantify regulatory burden on firms by providing a comprehensive regulatory costs measure. Existing literature can be classified into two categories. The first category focuses on the text from the regulators and legislators and measures number of rules or words (Porta et al. (1998), Mulligan and Shleifer (2005), Botero et al. (2004), Djankov et al. (2002), McLaughlin and Sherouse (2019), Kalmenovitz (2019)) or its textual complexity (Amadxarif et al. (2019), Colliard and Georg (2020), De Lucio and Mora-Sanguinetti (2021)). These measures either involve subjective judgement or focus on a small subset of regulations such as paperwork hours (Kalmenovitz (2019)). The second set of papers measures how companies reveal to be affected by regulation. For example, industry level spending on compliance occupations (Simkovic and Zhang (2019)) and frequent usage of keywords such as "regulation" (Calomiris et al. (2020), Gong and Yannelis (2018)). These measures lack a ground truth measure to validate with. Quantities in these measures are hard to interpret. Our approach does not suffer from either any of the above mentioned limitations. It is comprehensive and includes all federal regulations. It accounts for the vast heterogeneity across and within narrowly-defined industries and regulations (for example, social vs economic regulations and regulatory vs deregulatory rules), and links the regulated entities to the regulatory agencies. We provide measures in actual dollars which has a direct interpretation. Finally, the measure does not require any human analysis. The metadata of regulations is updated frequently and can be used to calculate regulatory costs at the desired frequency and for subsets of regulations and agencies.

2 Background and Data

2.1 Social Regulations

In the US, federal laws are passed by Congress that delegate authority to regulatory agencies. Regulatory agencies then pass and administer regulations that interpret and implement the law. Federal regulations can be classified into mainly two categories. The first category is economic regulations. These regulations control and limit who can enter a business (product or geographic entry controls) and what prices can a business charge (pricing controls). For example, licensing is required to make certain kinds of products and banks could not operate in states outside of their home state before interstate deregulation. As an example for pricing, prices that the airline companies could charge were regulated. Economic regulations further include antitrust and financial regulations.

Social regulation refers to the broad category of rules governing how any business carries out its activities, with a view to correcting one or more market failures. In other words, rules enforced to ensure firms take into account the externalities of their decisions. For example, unregulated, a manufacturing company may spread harmful pollutants into the air and water, causing harm to society. Governments respond to this problem by setting standards for emissions or by mandating firms to use technologies that capture harmful products before they the waste is released into the environment. The most common social regulations are environmental, workplace safety and food safety.

Regulatory agencies provide estimated implementation and compliance costs for social regulations in actual dollars. These mainly include costs of machinery, equipment or materials e.g., waste disposal systems for environmentally cleaner production, workplace safety equipment such as fire extinguishers, usage of better materials for less energy consumption, usage of lesser harmful chemicals, paperwork/information collection costs such as detailed disclosures of pollutant activity.

The focus of this paper is social regulations since cost numbers cannot be estimated and are not provided by regulatory agencies for economic regulations. Regulatory agencies provide the costs under the Regulatory Impact Analysis (RIA). The RIA framework was issued in Executive Orders 12866 (1993) and 13563 (2011) by President Clinton and President Obama, respectively. Guidance and oversight on the RIA are provided by the Office of Information and Regulatory Affairs (OIRA) within the U.S. Office of Management and

Budget (OMB), which is part of the Executive Office of the President. We discuss in detail the process that the regulatory agencies undertake to arrive at the cost numbers in Section 2.2.

Costs are an ideal way to measure regulations since costs can distinguish between regulatory vs deregulatory rules, economic vs social regulations, and actual regulations vs informative/administrative/correction pages. More importantly, not all regulations are created equal in their effects on different sectors or the economy as a whole which measuring regulation through the number of pages or words assumes. We show in Section 3.2 that the number of words in the regulations does not correlate with regulatory costs in dollars. Furthermore, measuring regulatory costs is not limited to a subset of regulations and does not involve judgement on the part of the researcher (Porta et al. (1998), Mulligan and Shleifer (2005), Botero et al. (2004), Djankov et al. (2002), McLaughlin and Sherouse (2019), Kalmenovitz (2019)).

2.2 Metadata of Regulations

We collect text, regulatory agency, publication date and the effective date for each final rule/regulation from 1970 to 2018 from the Federal Register, the daily journal of the US government that contains rules, proposed rules, and notices.[1] Federal register is organised in XML files starting from 2000. From 1996 to 2000, this data is available from the Federal Register's website. Before 1996, we use PDF files of the daily federal register and use regular expression searches to extract the text, regulatory agency, publication date and effective date of all final rules.

Next, we describe three related information that each regulation has: whether the regulations impact small firms or not, regulatory costs and whether the regulation is economically significant. Economically significant rules (significant thereafter) are regulations issued by executive branch agencies that meet the following definition in Executive Order 12866: "Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities." The remaining categories under Executive Order 12866 are 1) Other Significant, 2) Substantive, Nonsignificant, 3) Routine and Frequent, and 4) Info./Admin./Other. Each regulatory agency must perform an RIA under this executive order and determine whether the regulation is significant and provide some estimates of the compliance costs. Related to this is the analysis that the agency must perform under the Regulatory Flexibility Act (RFA).

[1] The Federal Register can be accessed here: https://www.federalregister.gov/.

Regulators and legislators understand that regulations can place a disproportionate burden on small businesses. RFA was passed after the environmental regulation wave of the 1970s made it clear that the impact was higher on small firms. RFA requires agencies to consider the impact of their regulatory proposals on small entities, analyze effective alternatives that minimize small entity impacts, and make their analyses available for public comment. The RFA requires agencies to adopt regulations that impose the least burden on small entities or mandate exemptions for small entities. In addition, it requires agencies to examine public policy issues using an analytical process that identifies, among other things, barriers to small business competitiveness and seeks a level playing field for small entities. RFA has received bipartisan support and was strengthened in 1996 by the Small Business Regulatory Enforcement Fairness Act (SBREFA) which provided the small businesses with a right to judicial review of agency compliance with the RFA. In addition, the office of Advocacy under the Small Business Administration (SBA) engages with various federal agencies to reduce the costs of regulations on behalf of small businesses. To summarize, regulatory agencies must provide precise information on whether the regulation is significant and if it impacts small firms substantially. Although measurement error is hard to avoid in these estimates, they conform to uniform guidelines, are subject to public inspection and are reviewed by an independent team inside the agency, SBA and OIRA.

Information on whether the rule will affect small firms and is economically significant or not is provided by the federal register starting in 1996. Before that, we use regular expression search to get this information from the regulatory text. For costs, precise costs in dollars are given for a subset of regulations and we extract them from the XML files. Examples are provided in Section 3.2. Finally, many regulatory agencies provide a list of industries affected by the regulation. We discuss this in detail in Section 3.1.

3 Methodology

In this section, we describe details of our methodology to determine the affected industry and regulatory costs for each regulation. This information on the industries affected is available for a subset of regulations. We use supervised machine learning to predict for regulations that do not have this information from the regulatory agency. Exact regulatory costs can be extracted from some regulatory documents using organised XML files. These documents are then used to learn for other regulations. Supervised machine learning involves training an algorithm from instances where the outcome or the label is known. This algorithm can then be used to predict the label of the documents where we do not know the actual ground truth. Supervised machine learning has direct and interpretable internal statistical performance metrics to validate the methodology but it requires high quality labeled training documents. Documents should be labeled by experts in the field and should clearly correspond to the categories of interest. Finally, training documents should be very similar to the projection documents (documents where we do not know the labels).

We use documents given by the regulatory agencies as training documents for both tasks. These are ideal training documents since the ground truth is labeled by the regulatory agency, an expert on the regulation and does not involve any judgements on the part of the researcher. Secondly, since the training documents are a subset of all regulations, they can be used for efficient projection on those regulations where we do not know the affected industries and costs. We use data extraction techniques to get the labels of regulations from the text as many agencies mention the affected industries. We use one-vs-rest logistic regression and transfer learning algorithms for classifying affected industries and extracting costs, respectively. We validate our machine learning models using five-fold cross-validation.

We describe the methodology for prediction of affected industries and costs in Sections 3.1 and 3.2, respectively. In Section 3.3, we provide details on how data on each regulation is aggregated to an annual 6-digit NAICS industry level costs measure for small and large firms using County Business Patterns Data (CBP).

3.1 Industry Classification of Regulations

Many proposed and final rules mention the industries that the rule could apply to in various contexts, we provide examples using the "Automobile Manufacturing" (NAICS code - 336111) industry:

- Regulatory agency mentions an industry as a potentially affected industry. Example is given in Figure 1.
- Regulatory agency mentions an industry during discussion of costs/paperwork hours or how small business entities are affected. Example is given in Figure 2.
- Comments were received from an industry, and the regulatory agency discusses the comments. Example is given in Figure 3.

NAICS provides a mutually exclusive and exhaustive set of industry codes at various levels of granularity. 2-digit codes are most general, and 6-digit codes are most granular. More granular industries are children of more general industries. Industries have exactly one parent and one or more children. We need labeled documents for 6-digit NAICS codes to train our model.s

We search through the text of all proposed and final rules for exact matches of the full NAICS industry names for all levels of NAICS codes. If a document mentions a parent NAICS code but none of its children, the document is labeled for all 6-digit children for this parent. If the document mentions a 6-digit NAICS code, it is labeled for that code.

We exclude industries like Printing, Information, and Postal Services since these names can be mentioned in the regulations, although the regulations do not apply to these industries. We also exclude regulations from SBA and Office of Personnel Management since both publish documents containing definitions of NAICS industries which are not regulations for the industries (McLaughlin et al. (2017)). Finally, we keep industries for which we find more than five matches in rules and proposed rules.

We get 57,701 rules and proposed rules in our training data that are labeled for at least one 6-digit NAICS code. This is a multilabel classification problem since documents can have more than one label. We follow McLaughlin et al. (2017) and use one-vs-rest logistic regression, which they find is the best performing model for classifying regulations. We vectorize the documents using unigram and bigram counts. We use the code from Pedregosa et al. (2011) and use default parameters for the logistic regression function except for the parameter for regularization strength (C in the python function). We set C as 1000 following McLaughlin et al. (2017).

One model is trained for each industry in the one-vs-rest strategy. We use Receiver Operating Characteristics, also known as the ROC-AUC score, to assess the predictive power of each model (Huang and Ling (2005), Fawcett (2006)). We exclude industries where the ROC-AUC score is lesser than 0.8 (ROC-AUC score is 0.5 and 1 for random and perfect classifiers, respectively) in the five-fold cross-validation. Figure 5 presents area under the curve scores for all industries. This leaves us with 826 6-digit NAICS industries out of 1,065 industries.

Most regulations are labeled negative and very few as positive for all industries. This is called the class imbalance problem. We cannot use the probability threshold of 0.5 to classify a regulation for the negative and positive classes. Instead, we use the probability threshold that maximizes the geometric mean of the accuracy on the positive documents (true positive rate) and the accuracy on the negative documents (1- false positive rate) (Kubat et al. (1997), Barandela et al. (2003)). This threshold seeks the balance between accuracy on both classes. This is standard in classification problems with severe class imbalance.

We report the median of each performance metric for the industries with ROC-AUC scores of more than 0.8 in Table 1. We report the average F1, precision, and recall of the two classes using thresholds obtained from above. Accuracy and ROC-AUC scores are threshold independent and identical for both classes.

We focus on significant rules in this paper. We get information on the category of the regulation (according to Executive Order 12866) from the Unified Agenda of Regulatory and Deregulatory Actions. Unified Agenda is a semiannual compilation of information about regulations. It is published by The Office of Information and Regulatory Affairs (OIRA) under the Office of Management and Budget (OMB) within the Executive Office of the President. We keep regulations from agencies that passed at least five regulations in our sample period to keep the significant regulatory agencies of the US. We also remove the Treasury Department, which formulates economic regulations, which leaves us with 3,035 significant regulations.

We need to find the regulations that apply to each industry. To do this, we train the final model using all of the training documents except the ones that are significant final rules. Then, we classify each regulation as applicable or not for each industry using the probability thresholds obtained from the cross-validation.

3.2 Regulatory Costs

Regulations report costs in dollars under the Regulatory Flexibility Act (RFA) and Paperwork Reduction Act. We searched all significant regulations for words related to costs like "costs", "benefits", "paperwork", "RFA", "Paperwork Reduction Act", etc and extracted the costs from organised XML files. We also collect significant regulations that contain information about costs from the following sources:

- Office of Information and Regulatory Affairs (OIRA) - Annual reports by OIRA to the Congress on benefits and costs of regulations.[2]
- SBA - Annual reports by SBA on the RFA detailing the regulatory compliance costs savings for small businesses due to the RFA.[3]
- American Action Forum (AAF) - a database maintained by the AAF containing regulatory costs of regulations that have such information in them.[4]

We collect annualized costs in dollars mentioned from the above sources. We find 400 significant regulations for which we have an exact annualized cost estimate. These are the costs estimated by the regulatory agency that has formulated the regulation. Annualized

[2]Annual reports by OIRA can be accessed here: https://www.whitehouse.gov/omb/information-regulatory-affairs/reports/.

[3]Annual reports by SBA can be accessed here: https://advocacy.sba.gov/category/resources/annual-report-on-the-rfa/.

[4]The database can be accessed here: https://regrodeo.com/.

costs are costs required annually to comply with the regulations. Costs are estimated as a total for all firms that will need to comply with the rule. Agencies generally use discount rates of 3% and 7% to get the annualized present value of costs. We use the costs with the 7% discount rate for our measure where the agency provides two numbers. Measure and results are very similar if annualized present values using the 3% discount rate are used. If the rule is deregulatory, negative numbers are provided (or savings). In a few cases, agencies provide high and low cost scenarios. We use the average of high and low cost scenario numbers in such cases.

We train (fine-tune) a pre-trained entity recognition model on these 400 regulations using transfer learning. The fine-tuned model is used to extract the costs from other significant regulations where the costs cannot be accessed directly from the XML files.[5] The principle of transfer learning involves reusing a model developed for a task as the starting model for a related task. It is a popular approach in deep learning where pre-trained models are used as starting points in computer vision and natural language processing to develop models for other tasks in the same domain. Pre-trained entity recognition algorithms are trained on a vast amount of data to extract information like names of people, organisations, places, part of speech, terms in a specific field or domain such as in science, medicine, finance, law, etc. In our case, the fine-tuned model extracts sentences consisting of regulatory costs. We then use regular expression searches to get the numbers from these sentences. An example of the extracted costs is provided in Figure 4.

We use five-fold cross-validation and correlation to evaluate our model. We compare our model to using the length of the text of the regulation and regulatory restrictions McLaughlin et al. (2017) as proxies for regulation. We show in Table 2 that our model outperforms the alternative models in predicting the regulatory costs. It also shows that number of words in a regulation cannot predict regulatory costs.

3.3 Regulatory Cost Measure

Using the above steps, we have the cost and the industries that it applies to for each regulation. Whether the regulation affects small businesses or not is provided by the regulatory agency for each regulation in the metadata of the regulation.

We use CBP data to get the number of establishments that need to comply with the regulation. CBP is an annual database providing data on the number of establishments, employment during the week of March 12, and annual payroll at the national and state level.

[5] The original models can be accessed here: `https://spacy.io/`.

Data for establishments is provided by geographic area, 6-digit NAICS industry, and employment size of the establishment. Data is divided into following employee size classes: 1-4, 5-9, 10-19, 20-49, 50-99, 100-249, 250-499, 500-999, 1000 or more employees.

We merge each regulation using the year it was formulated in and the industries it applies to with the CBP data to get the number of establishments that have to comply with the regulation. Definition of a small firm changes with time and industry as provided by the SBA. For most industries, small businesses are classified using the average annual receipts or the average employment of a firm.

If the regulation affects small firms, we include them in calculating the number of establishments to which the regulation applies. We divide by the number of establishments to get the cost per establishment of each regulation. We treat all regulatory costs as fixed costs which only underestimates our coefficients (discussed more in Section 5.1). We classify firms with less than 500 employees as small firms when analyzing the Compustat data. We show in Section 5.1 that the cutoff used to define the small firms does not affect our results.

We add the per establishment costs of all regulations in a year at the industry-size category level. Next, we convert the costs to 2018 dollars to have them on the same scale using the GDP deflator (GDPDEF series from Federal Reserve Economic Data). Finally, we add the costs from 1977 for each year to get a total annual regulatory cost measure at the 6-digit NAICS level for both size categories from 1977 to 2018 (CBP data is only available starting 1977). Since the definition of NAICS industries changes has changed over time, we use concordance weights provided by Eckert et al. (2020) to map all industry data to a consistent set of 2012 NAICS codes. We exclude the financial sector and utility firms as is standard in the literature for this analysis. In our regression analysis, we convert the costs back to the year of the analysis since other variables in the regression are from the corresponding year.

3.4 Validation of Regulatory Costs

Although we validate our methodology using internal statistical performance metrics such as area under the curve and correlation, we follow Hassan et al. (2019) and further validate our measure by testing whether it tracks externally verifiable data. Bommarito II and Katz (2017) measure the regulatory ecosystem of the firms by analyzing over 4.5 million references to the US federal acts, regulations and agencies contained within the 10-K filings made by public firms. 10-K reports contain a characterization of a firm's financial performance and its risks, including the regulatory environment in which a company operates. In total, Bommarito II and Katz (2017) analyze more than 20 years, 30,000 companies, and 160,000

10-K reports to identify more than 4.5 million references to federal acts, regulations and agencies. For example, the 10-K filing of General Motors Company mentions:

> "*In response to a U.S. Supreme Court decision, the EPA was directed to establish a new program to regulate greenhouse gas emissions for vehicles under the Clean Air Act. As a result, in September 2009 the EPA and the NHTSA issued a joint proposal to establish a coordinated national program consisting of new requirements for model year 2012 through 2016 light-duty vehicles that will reduce greenhouse gas emissions under the Clean Air Act and improve fuel economy pursuant to the CAFE standards under the EPCA.*"

Methodology of Bommarito II and Katz (2017) is as follows. References are first identified through standard natural language processing techniques; once a reference fragment is identified, it is then passed through a second stage of normalization. As one example, many filers reference the "Clean Air Act of 1970" however, they do not do so using its full name, as above. Instead, they frequently refer to it as "CAA" or "Clean Air Act". In order to handle this variation, they built a mapping for over potential act references, relying on a combination of the US Code, Wikipedia, and manual review. This mapping is then combined with fuzzy-string matching techniques to correct for spelling mistakes. The result is a high-precision and high-recall extraction of 401 unique acts and regulations and 133 Agencies across the 23-year dataset. In total, they identify more than 4.5 million Act and Agency references contained in 10-K reports over 23 years.

The methodology gives them a firm level measure of regulatory ecosystem. We plot our measure of regulatory costs to the measure of references to acts and regulations in Figure 6. We find a strong linear relationship between the regulatory costs and number of references to acts and regulations. We test this relationship further in Table 3 and find similar results. In Column 2, we use time fixed effects which removes time-specific variation. This implies the measure captures regulatory costs at the firm level. In Column 3, we saturate the specification with firm fixed effects. Statistically significant coefficients in our validation regression therefore implies that our measure captures within firm level variation.

4 Stylized Facts

We capture the regulatory costs of each regulation from 1970 to 2018. Regulatory costs mainly include costs of machinery or equipment (e.g., for environmentally cleaner production, waste disposal systems, workplace safety equipment such as fire extinguishers) or paperwork costs. We use documents given by the regulatory agencies as training documents for both industry classification and costs. We get annualized regulatory costs (costs that each firm faces in a year to comply with the regulation) of each "economically significant" regulation and add the costs over the years to get total annual regulatory costs for each industry. We get costs per establishment for small and large establishments within an industry. Methodology and definition of economically significant regulations are provided in Section 3.

Regulatory costs measure helps us establish several stylized facts. The most striking is the phenomenal increase in regulatory costs. Figure 7 shows that the total economy-wide cost of regulations since 1970 has increased by almost \$1 trillion, which is 5% of US GDP in 2018. This does not include regulations in place before 1970 which were minimal and hence can be taken as total regulatory costs in the US that firms need to spend to comply with federal regulations. This is in line with surveys, anecdotal evidence and crude measures like the number of pages in the Federal Register (Crews (2002)). Some other measures like counting the number of words McLaughlin and Sherouse (2019) that indicate an obligation to comply, such as "shall" or "must" also exhibit a similar pattern. In addition, various surveys and anecdotal evidence well establish the increasing burden of regulations. President Donald Trump signed the Executive Order (EO) 13771 in 2017, which directs all rule-making agencies to repeal at least two existing regulations for each new regulation issued in Financial Year (FY) 2017 and thereafter. It further directs agencies that the "total incremental costs of all regulations should be no greater than zero" in FY 2017. Each agency must also form a regulatory reform task force which must, at a minimum, attempt to identify existing regulations that eliminate jobs or inhibit job creation; are outdated, unnecessary, or ineffective; impose costs that exceed benefits. The regulatory burden was the biggest concern to CEOs in PwC 2018 survey. Our results are in line with these surveys and existing measures.

Second, there has been a massive increase in regulations since the late 1990s. Figure 8 shows the increase in regulatory costs every year. We find that the costs are high in the 1970s which was the era of environmental regulations and remained low in the 1980s which was the decade of deregulation. Costs increased since the late 1990s which was the period of more environmental regulations, workplace safety, food safety and disclosure regulations. The number of significant regulations has substantially increased after the late 1990s as well (Figure 9). In this paper, we do not comment on various supply and demand reasons for these regulations. We take the regulations as given and use state-level variation to establish the relationship between regulations and market power.

Third, we find that the biggest portion of these costs is from environmental regulations. Table 4 shows all the regulatory agencies and the regulatory costs, and the number of regulations. The highest is from environmental regulations followed by transportation regulations. Fourth, smaller firms face higher regulatory costs than large firms even though many regulations are formulated in a way that they do not affect the small firms. An average small firm faces an average of $9,093 per employee in our sample period compared to $5,246 for a large firm. Small firms face higher costs per employee than large firms even after massive attempts from regulators and politicians to keep the burden on small firms to a minimum. Figure 10 plots evolution of ratio of regulatory costs with time. The ratio is below one till the late 1990s. However, it goes above one after that and remains high till the end of the sample. Fifth, there is vast heterogeneity in how regulations have impacted small firms compared to large firms across industries. In manufacturing, small firms face higher costs than large firms. However, in the transportation industry regulatory burden is similar whereas in the retail industry, small firms face lower costs than large firms.

5 Results

5.1 Impact on Firms

Regulations affect different industries at different times providing us with cross-sectional and time series variation. This allows us to use a staggered triple difference-in-difference setup comparing small vs large firms in the same industry at the same time with industries that are not affected with regulation. We estimate assuming the following regression equation:

$$Y_{ijst} = \alpha_{jst} + \alpha_{ijs} + \beta \times log(Regulatory\ Costs_{ijt-1}) + \\ \delta \times log(Regulatory\ Costs_{ijt-1}) \times Size\text{-}Category_i + \epsilon_{ijst} \quad (1)$$

Where Y is log(number of establishments), log(employees) and log(total wages) and where i, j, s and t are size category, industry, state and year, respectively. The industry is as defined by 6-digit 2012 NAICS codes. $Regulatory\ Costs_{ijt-1}$ is the lagged value of total regulatory costs in dollars per establishment in that category. We include Industry $\times$ State $\times$ Year fixed effects. We also include Industry $\times$ State $\times$ Size-Category fixed effects to control for time-invariant characteristics. This set of fixed effects allows us to compare establishments of different sizes within the same industry in the same state at the same time, which is the comparison we want to make to show the differential impact of regulatory costs on establishments of different sizes. These fixed effects also control for demand shocks to an industry. Standard errors are clustered at the industry level. We use CBP data for this analysis which divides the establishments into nine size-categories based on the number of employees.

Our setup is a continuous triple difference. We compare small establishments against large establishments in the same industry and the same state with other industries before and after an increase in regulatory costs. We do not have discrete shocks to regulatory costs and hence no discrete pre or post periods, control or treatment groups. To test the assumption of parallel trends, we define discrete shocks when an industry had more than a 100% increase in regulatory costs compared to last year for both small and large establishments. We compare small establishments (treated group) relative to large establishments in this industry (treated industry) with other industries before and after the 100% increase in regulatory costs. We plot the dynamic treatment effects for each year relative to the shock in Figure 11, 12, 13 using Equation 1 for all variables of interest. There is no significant difference in trends prior to the increase in regulatory costs. CBP data is limited to number of establishments, number of employees and wages. We explore change in firm-level markups in Section 5.2.

Estimating Equation 1 using the continuous regulatory costs, we find that the small establishments see a reduction in the number of establishments, employees and wages (Table 5, Columns 1, 3 and 5). We find that a 100% increase in regulatory costs leads to a 1.2%, 1.4% and 1.9% increase in the number of establishments, employees, wages, respectively, for large establishments, whereas it leads to 1.4%, 1.5% and 1.6% decrease in the number of establishments, employees, wages, respectively for small establishments (sum of two coefficients from Columns 1, 3 and 5) when compared within the state-industry-time groups.[6] Results on employees and wages provide evidence that an increase in regulatory costs creates a competitive advantage for large establishments. Large firms get larger and small firms get smaller.

We further interact the regulatory costs variable with dummies for all establishment size categories (one category gets omitted, Table 6). We focus on the sample after 1996 where most data on regulation is provided by the regulatory agency and is least prone to measurement error. We find that coefficients progressively increase as establishments get larger for all regressions. The coefficients with the confidence interval for each size category are presented in Figures 14, 15, 16 for number of establishments, employees and wages, respectively. The effect is negative and significant for establishments with lesser than 100 employees in size. It is not statistically different from zero for establishments with more than 100 employees and less than 1000 employees. It is positive and statistically significant for establishments with more than 1000 employees in size. The smaller the establishment, the more competitively disadvantaged it gets, and vice-versa. This provides strong evidence

[6] Results with State × Year and Industry × Year Fixed effects instead of State × Industry × Year are provided in Table A.1 and very similar.

that a sizeable proportion of regulatory costs are fixed. We present a robustness test by using only regulations that impacted both small and large firms in Figures A.1, A.2, A.3. The plotted coefficients compare firms of different sizes to firms with 1-4 employees. We find that the coefficients are higher compared to using all regulations which further substantiates the fixed costs nature of these regulations. Fixed costs create a competitive disadvantage for small firms. Channels could be a higher exit rate, not being able to take profitable projects due to financial constraint, and not being able to invest in advertising or R&D. A 100% increase in regulatory costs leads to an increased gap in 3.5% (Table 5, Column 4) in the number of employees between large and small establishments. This gap is 7.7% (Table 6, Column 4) when comparing establishments of 1-4 employees and 1000 or more employees.

We also explore the channel where small firms do not shut down but are closer to the shut down condition and more financially constrained due to regulations. We use external financial dependence measure as proposed by Rajan and Zingales (1996) for each industry to test this. We report our findings in Table 7. We find that the interaction term between regulatory costs for small firms and external financial dependence is negative and statistically significant. The results imply small firms have more adverse outcomes in industries where the need for external financing is higher. This points to the channel of firms not being able to take profitable projects and not being able to invest in advertising, R&D or technology due to being more financially constrained due to regulations.

Our results explain the tension in the empirical literature that studies the impact of regulation on employment. Bailey and Thomas (2017) argue that employment declines in industries with rising regulation, but Goldschlag and Tabarrok (2018) find that regulation does not have an impact on employment. We explain the two sets of findings by unmasking the heterogeneous impact of regulations on small and large firms. Grullon et al. (2019) show that most industries in the US have become more concentrated. Increased (decreased) employees and the number of establishments for large (small) establishments provide evidence of increased industry concentration due to an increase in regulatory costs (one of the metrics used to measure market power).

5.2 Alternative Explanations

Factors like increase in technology, import competition and offshoring could impact market structure. For example, new technology (machinery, plants etc.) drives the regulations in an industry (new technology, e.g. could be harmful to the environment) and the market concentration patterns making technology an omitted variable. For these factors to affect our estimates, they will have to be correlated with regulatory shocks. We test this using parallel trends and find that there are no changes before the regulatory shocks ruling out these concerns. We also perform a placebo test using regulations which were proposed but never finally passed presented in Section 5.3. We do not find any effects from such proposed regulations further ruling out any other explanations.

We still address the concern by controlling for productivity of firms since all these explanations will impact firms' productivity. We re-run some of our analysis as before along with new variables such as markups and profitability. We calculate the total factor productivity (TFP) of each firm (Hsieh and Klenow (2009)) using firm-level data from Compustat, which is the part of the productivity of a firm that cannot be explained by capital and labor and factors like technology or offshoring. We control for the second and third lagged TFP of the firm since that could explain the first lagged regulations and the dependent variables. Specifically, we estimate the following regression:

$$\begin{aligned} Y_{it} = \alpha_i + \alpha_{jst} + \beta \times log(Regulatory\ Costs_{jct-1}) + \\ \delta \times log(Regulatory\ Costs_{jct-1}) \times Size\text{-}Category_{it-1} + \\ TFP_{it-2} + TFP_{it-3} + \epsilon_{it} \quad (2) \end{aligned}$$

Where Y is log(sale), log(employees), log(markup), and profit rate and where i, j, s, c and t are firm, industry, state, size-category and year, respectively. We include State $\times$ Industry $\times$ Year fixed effects. This allows us to compare firms of different sizes within the same industry in the same state at the same time. We also include firm fixed effects to time-invariant firm characteristics. Standard errors are clustered at the industry level. Data on wages is very infrequent in Compustat. We focus on the sample after 1996 where most data on regulation is provided by the regulatory agency and is least prone to measurement error.

We interact the regulatory costs variable with dummies for firms of various sizes (we divide the data into firms of employee sizes 1-499, 500-999, 1000-4999, 5000-9999, 10000 or more). We find that employment and sales increase for large firms (we classify firms that have fewer than 500 employees as small firms since Compustat data only has public firms which tend to be larger) and decrease for small firms compared within state-industry-time groups (Table 8, Columns 1 and 2). Coefficients progressively increase as firms get larger same as in Table 6. A 100% increase in regulatory costs leads to an increased gap of 12.2% and 14.7% in sales and the number of employees when comparing firms of 1-500 and 10,000 or more employees. The coefficients with the confidence interval for each size category are presented in Figures 17 and 18 for sales and employees, respectively.

De Loecker et al. (2020) show that market power as measured by markups and profitability has increased considerably in the US. They find that this increase comes from firms in the upper percentiles (75 and 90 percentile firms), whereas the markup of the median firm has remained the same. We use data on markups from De Loecker et al. (2020) and divide our sample into the four percentile groups (1-50, 50-75, 75-90, 90-100). We calculate percentiles according to the sales at the industry-year level. We interact the dummies for each percentile group with regulatory costs (Table 8, Column 3). We find that markups of the firms below the median have not changed as the coefficient is statistically not different from zero (coefficient is 0.003, Table 8, Column 3). An increase in regulatory costs leads to an increase in markups for the upper percentiles, and the coefficient increases as the firms get larger. A 100% increase in the regulatory costs leads to an increased gap of 3.8% in markups when comparing firms above 90 and below 50 percentiles. This results further rules out import competition as an explanation for our findings since import competition is associated with lower markups for firms (Feenstra and Weinstein (2017)). We interpret the magnitudes of our coefficients more in Section 5.5. De Loecker et al. (2020) find that most of the increase in aggregate markups is driven by reallocation of business to firms with higher markups rather than increase in within firm markups. We find that increase in regulatory costs leads to increase in share of large firms but modest increase in their markups. We also test how regulatory costs impact profit rates (data from De Loecker et al. (2020)) as profit rates are the ultimate test of market power (De Loecker et al. (2020)). We find that a 100% increase in regulatory costs leads to 1.2 percentage points increase in profit rates of firms above 90 percentile (Table 8, Column 4). The profitability does not change for the firms below 50 percentile and progressively increases with size like markups. The coefficients with the confidence interval for each percentile group are presented in Figures 19 and 20 for markups and profit rate, respectively. As evident from Figures 17 and 19, most of the effect in change of industry level markups is due to reallocation of market share to large firms rather than within firms increase of markups. Our results provide an explanation for the findings of De Loecker et al. (2020) that firms in upper percentiles have seen a massive rise in market power. Our results also speak to the emergence of superstar firms (e.g., firms larger than 10,000 employees in size). Autor et al. (2020) find that the dominance of these firms has led to the decline of labor share in the US economy in the last three decades.

We find that there are no pre-trends (evident in Figures 11, 12, 13). Although very unlikely, omitted variables like import competition could be precisely correlated with regulatory shocks. To address that, we control for productivity to measure the changes in technology, import competition or offshoring and find it does not impact our results. We also present a placebo test in Section 5.3 using regulations that were proposed but not finalised and do not find any effects. We further discuss the alternative explanations in Section 5.4. Explanations like technology, import competition, intangibles, and offshoring will lead to increase in competition and productivity at the industry level but we find the opposite. This further rules out these explanations.

5.3 Impact on Industry Concentration

Increase in industry concentration has been established in the literature (Grullon et al. (2019), Gutiérrez and Philippon (2017)). As shown in Section 5.1, an increase in regulatory costs leads to an increase (decrease) in sales and the number of employees for large (small) firms. This naturally implies that an increase in regulatory costs leads to an increase in industry concentration. Still, we test for industry-level concentration using the following equation:

$$Y_{jst} = \alpha_{jt} + \alpha_{js} + \alpha_{st} + \beta \times log(Regulatory\ Costs\ Ratio_{jst-1}) + \epsilon_{jst} \tag{3}$$

where j, s and t are industry, state and year, respectively. Y_{jst} are concentration measures and ϵ_{jst} is the error term. *Regulatory Costs Ratio* is defined as follows:

$$Regulatory\ Costs\ Ratio_{jst} = \frac{Regulatory\ Costs_{jt\times small}/Employees_{jt\times small}}{Regulatory\ Costs_{jt\times large}/Employees_{jt\times large}}$$

It is the ratio of regulatory costs per employee for small and large firms. This allows us to exploit two kinds of variation in regulatory costs. First, the differences between the costs that are imposed on small and large firms. Second, since majority of costs are fixed, differences in the existing sizes (measured by the number of employees) of small and large firms. We include Industry × Year and State × Year fixed effects. We compare the same industry at the same time across states with the first set of fixed effects. The second fixed effects control for any time-varying state-level characteristics. We also use Industry × State fixed effects to control for time-invariant characteristics. We calculate various concentration measures at the industry-state level.

We use the share of small establishments by employees, the share in the employment of establishments of more than 1000 employees and the logarithm of the ratio of average large firm size to average small firm size in terms of employees. Results are presented in Table 9. We find that as regulatory costs faced by small firms increase relative to large firms, the share of small firms by employment decreases. Since we use the number of employees in the calculation of both the dependent and independent variables, the relationship might be driven spuriously. To rule this out, we run the same regression using regulations which were proposed but never finally passed. We employ the same techniques to get the costs of such regulations and find that these regulations did not impact industry level concentration (Table 10). This shows that our results are not driven due to scaling the regulatory costs by the number of employees or by alternative explanations like increase in technology, import competition, and offshoring.

To investigate the relationship between HHI and regulatory costs, we use Compustat data since CBP data does not report sales. As preliminary evidence, we plot how the regulatory costs ratio evolves with HHI (Figure 21). An increase in regulatory costs ratio is correlated with an increase in HHI. We also exploit variation across industries and plot the evolution of HHI with regulatory costs for manufacturing, transport and retail industries in Figures 22 to 24, respectively. The manufacturing industry experienced a high increase in regulatory costs in our sample for small firms relative to large firms which translates to higher increase in HHI. Similarly, changes in HHI are corresponding to the changes in the regulatory cost ratios for transportation (remained at the same levels) and retail (decreased) industries. Regression results are provided in Table 11, we find that as small firms face higher costs relative to large firms, HHI increases. We interpret the magnitudes of our coefficients more in Section 5.5. Taken together, our results provide evidence that increased regulations impact small firms negatively leading to higher concentration and markups for large firms.

5.4 Is the Increase in Concentration "Good" or "Bad"?

An important question is whether the rise in concentration reflects market power and rent seeking or not. As Covarrubias et al. (2020) point out, if lower search costs or an increase in intangible investment (Crouzet and Eberly (2021), Kwon et al. (2022), De Ridder (2019)) is leading to an increase in concentration, it should be associated with increased productivity ("Good" concentration). On the other hand, if entry costs play a significant role in increasing concentration (Corhay et al. (2020b), Gutiérrez et al. (2021)), it should be coupled with reduced elasticity of entry to the investment opportunities in the industry and potentially lower productivity and investment ("Bad" concentration). Although regulations raise entry costs, it could lead to good concentration by forcing out unproductive firms and less failures (public interest theory of regulation from Pigou (1938)). Entry costs could screen new entrants to ensure that consumers buy high quality products from desirable sellers.

We follow the predictions of the Q-theory of entry (Clementi and Palazzo (2016), Jovanovic and Rousseau (2001)). The theory states that when investment opportunities measured by Tobin' Q rises in an industry, there is more entry. Covarrubias et al. (2020) find that the elasticity of entry to Tobin's at the industry level US has reduced and in the US economy around the late 1990s and early 2000s. They argue that it potentially reflects the rising influence of economic rents and barriers to competition. We explore the relationship between entry and Tobin's Q. We provide the results in Table 12. We find similar results that the relationship between Tobin's Q (median of the industry) and entry has broken down after the late 1990s and early 2000s (Table 12, Columns 1 and 2). Including the regulatory cost ratio and the interaction between regulatory cost ratio and median Tobin's Q in the regression, we find that higher regulatory costs lead to lower growth in the number of establishments after the late 1990s. We find that the interaction term is negative and statistically significant. This relationship is insignificant before that. The coefficient of the interaction term in Column 3 is positive and marginally significant, suggesting that regulations led to good concentration before the late 1990s. However, the coefficient of the interaction term in Column 4 is negative and statistically significant, hinting that regulations have led to bad concentration after the late 1990s. This is because small firms faced lower costs than large firms before the early 2000s (Figure 10). However, the ratio went well above one after the early 2000s. Overall, we find that the elasticity of entry to Tobin's Q has decreased due to increase in regulations due to increased barriers to entry.

We further follow the predictions of the model devised by Covarrubias et al. (2020) to test whether the increase in concentration driven by regulations is the good kind or bad. The model predicts if the increase in concentration is caused by bad (good) sources, it should be negatively (positively) correlated with productivity, industry investment relative to Tobin's Q, industry leader investment relative to Tobin's Q and positively (negatively) correlated with prices. We find that the investment rate relative to Tobin's Q and the investment rate of the industry leaders (defined as firms with shares higher than the 66th percentile) decreases when the regulatory cost ratio increases (Table 13). This is in line with regulations leading to bad concentration after the early 2000s. This suggests that the channel of decline in long-term interest rates (Liu et al. (2022)) which predicts increase in investment by industry leaders does not explain our results. We further test productivity (measured using TFP) and prices set by firms. We find that regulations and productivity are negatively correlated, whereas firms charge increased prices when regulations increase (Table 14). We also perform a robustness check by measuring productivity using methodology of Olley and Pakes (1992), Levinsohn and Petrin (2003) and Ackerberg et al. (2015) (Table A.2 instead of using the accounting measure of product and revenue productivity and find very similar results.

Interestingly, results point to the bad concentration hypothesis (Columns 2 and 4) after the late 1990s and good concentration before (Columns 1 and 3). This suggests that barriers to entry could have both positive and negative effects on industry composition. We also test how intangible investment changes with regulations. We report our results in Table 15. We find that regulations positively correlate with intangible investment before the late

1990s. However, there is no association between the two after. This further suggests that regulations have led to the undesirable type of concentration. Explanations like technology, import competition, intangibles, and offshoring will lead to increase in competition and productivity at the industry level but we find the opposite. This further rules out these explanations. To sum up, we provide evidence that the increase in regulations has led to rent-seeking behaviour and lower competition due to increased barriers to entry.

5.5 Quantifying the Impact of Regulations on Market Power

We follow David et al. (2013) to investigate how much of the increase in markups and concentration can be explained by the rise in regulatory costs. The regression coefficient for firms above 90 percentile is 0.041 (the sum of 0.038 and 0.003 from Table 8, Column 3). We multiply the coefficient with the difference of the mean of the independent variable in our regressions between the first five years and the last five years of the sample to get the predicted increase in the dependent variable. We divide this number by the actual increase in the dependent variable between the sample's first and last five years. We find that increase in regulatory costs explains 36.9% of the increase in markups for firms above the 90 percentile. Similarly, using coefficients from Table 11, Column 1, we find that regulatory costs explain 30.8% of the rise in the industry concentration as measured by HHI.

We also find that our measure correlates with entry costs shocks estimated by Gutiérrez et al. (2021) (Figure 25). Gutiérrez et al. (2021) find that increase in entry costs in the US from 1995 to 2015 has reduced consumption by five to ten percent through reduced competition. Given regulations can explain the breakdown of relationship between elasticity of entry rate to Tobin's Q (and hence can explain lower competition), it is safe to say that regulations have led to lowering of overall consumption in the US economy for last 2-3 decades.

6 Political Economy of Rulemaking

In this section, we explore the political economy of rulemaking using comments made by firms on the proposed regulations. The content of these comments influences the regulators and passed final rules (Bertrand et al. (2021). We collect a comprehensive dataset including the vast majority of the comments submitted in the rulemaking process. For each comment, we observe the proposed rule, final rule (if implemented) related to that document, the identity of the commenter, as well as the content of the comment itself. The rule-making process starts with a Notice of Proposed Rulemaking (NPRM), which describes the objective of the rule. The NPRM is published in the Federal Register, at which point the agency specifies a period of 30 to 60 days during which comments can be submitted on the proposed rule. This notice and comment process is designed to alleviate the informational problem in federal regulatory agencies.

The source of data on regulatory comments is regulations.gov, a website through which the majority of US federal agencies collect public comments in the notice-and comment phase of rule-making. The regulations.gov API provides a search function for document metadata, which allows us to identify all comments submitted and stored on the site. Our initial comment sample consists of all comments posted to regulations.gov in the years 2003-2018. We use a custom data extraction tool to extract firms names from the comment metadata. The algorithm identified comments authored by firms and we downloaded the full text of these organization comments. We link the firm names extracted from comments to names of firms in Compustat.

We use training corpus from MapLight's database which collects and codes the position (support or oppose) of firms on several regulations and laws. These are ideal training documents in our setup. We train a logistic regression model from these documents. We get the position in terms of support or oppose for the collected regulatory comments of firms. To study the position of large firms, we perform a test of means for regulations that do not impact small firms and those which do impact small firms. We present our findings in Table 16. We find that large firms oppose regulations that do not impact small firms and only impacts large firms with 64.5% probability (Table 16, Column 1). However, they are in favor of regulation with 81.0% probability of regulations that will impact the small firms as well as the large firms (Column 2). The coefficients are statistically significant and high in magnitude. We further include firm and regulation fixed effects to compare within the same firm and the same regulation. We find that comparing within the same regulation, support of a regulation increases with size (Column 5). We also utilise the variation created by costs that each regulation imposes on small vs large firms. Comparing within the same firm and same regulation we find that there is higher support for regulations that impact small firms more. The interaction term between size and the costs imposed on small firms vs large firms is statistically significant (column 6). The Support (opposition) from large firms for regulations that impact (does not impact) small firms can lead to higher (lower) probability of these proposed regulations getting implemented into final rules (Bertrand et al. (2021). This provides evidence that large firms are willing to incur a cost that creates a competitive advantage for them. In sum, results suggest large firms can influence regulations in a way that increases their competitive advantage explaining the rise in market power in the last few decades.

These results are consistent with the public choice theory ((Stigler, 1971), Peltzman (1976)). Public choice theory states regulation is lobbied by the industry to reduce the threat of entry and raise incumbents' rents.

7 Conclusion

Increasing concentration and markups has received widespread attention among researchers and policymakers. The literature has shown impacts of increased concentration such as lower labor share and lower innovation. However, reasons for the increase in concentration and markups have not been well studied. Further, it is not clear whether increase in concentration is a positive development with more productive firms operating in the economy led by lower search costs or intangible capital. Alternatively, is the increase in concentration due to higher barriers to entry leading to lower competition and potentially lower productivity.

In this paper, we examine how changes in regulation have affected market concentration and markups. The channel is that small firms are impacted more by regulations due to fixed costs. To examine how changes in regulatory costs have affected concentration one needs to calculate what the regulatory costs facing an industry really are. We construct a comprehensive database of regulatory compliance cost for regulations like environmental and workplace safety at the most granular industry level for the past 5 decades. Regulators report costs that firms need to spend to comply with a regulation as well industries affected in the regulatory documents.

Regulations affect different industries at different times providing us with cross-sectional and time series variation. This allows us to use a difference-in-difference setup comparing small vs large firms in the same industry at the same time. An increase in regulatory costs lead to lower sales and employment for small firms. We find that Markups and profitability for large firms increase after an increase in regulatory costs. The staggered timing of regulations, absence of any pre-trends and placebo test with regulations that were proposed but not finalized allow us to control for other explanations like increase in import competition, technology and offshoring. We find that that increased regulations can explain 31-37% of the rise in concentration and markups.

We further explore if regulations just weed out the unproductive firms. Or do they lead to decrease in competition by increasing barriers to entry? To test this, we explore the relationship between entry and investment opportunities at the industry level. Intuitively, when investment opportunities measured by Tobin' Q rises in an industry, there is more entry. We find that the elasticity of entry to Tobin's Q has decreased due to increase in regulations due to increased barriers to entry. We also find that productivity and investment decrease due to regulations. This is evidence for increase in market power and threat to competition. This also further rules alternative explanations like increase in import competition, technology and offshoring since these explanations are in line with positive form of concentration. These explanations would not cause a lower elasticity of entry with respect to Tobin's Q and lower productivity.

We further test this using the text of comments made by firms on the regulations. We find that while large firms are opposed to regulations in general, they are in favor for the passage of regulations that have an adverse impact on small firms. This further corroborates that regulations are associated with lowering of competition. Overall, we shed light on the role of regulations in increased trend of market concentration and find support for public choice theory of regulation.

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Figure 1: Example of the agency mentioning an industry as a potentially affected industry

This page from the federal register provides an example of one of the ways we determine that an industry is affected by the regulation. The regulatory agency mentions the "Automobile Manufacturing" as a potentially affected industry. The relevant parts have been shaded in green.

31756 **Federal Register** / Vol. 73, No. 108 / Wednesday, June 4, 2008 / Rules and Regulations

with Indian Tribal Governments (65 FR 67249, November 9, 2000) do not apply to this rule. In addition, This rule does not impose any enforceable duty or contain any unfunded mandate as described under Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) (Public Law 104–4).

This action does not involve any technical standards that would require Agency consideration of voluntary consensus standards pursuant to section 12(d) of the National Technology Transfer and Advancement Act of 1995 (NTTAA), Public Law 104–113, section 12(d) (15 U.S.C. 272 note).

XII. Congressional Review Act

The Congressional Review Act, 5 U.S.C. 801 *et seq.*, generally provides that before a rule may take effect, the agency promulgating the rule must submit a rule report to each House of the Congress and to the Comptroller General of the United States. EPA will submit a report containing this rule and other required information to the U.S. Senate, the U.S. House of Representatives, and the Comptroller General of the United States prior to publication of this rule in the **Federal Register**. This rule is not a ''major rule'' as defined by 5 U.S.C. 804(2).

List of Subjects in 40 CFR Part 180

Environmental protection, Administrative practice and procedure, Agricultural commodities, Pesticides and pests, Reporting and recordkeeping requirements.

Dated: May 12, 2008.

Lois Rossi,

Director, Registration Division, Office of Pesticide Programs.

■ Therefore, 40 CFR chapter I is amended as follows:

PART 180—[AMENDED]

■ 1. The authority citation for part 180 continues to read as follows:

Authority: 21 U.S.C. 321(q), 346a and 371.

■ 2. In §180.960, the table is amended by adding alphabetically the following polymer to read as follows:

§ 180.960 Polymers; exemptions from the requirement of a tolerance.

* * * * *

Polymer	CAS No.
* * * *	*
2-oxepanone, homopolymer, minimum number average molecular weight (in amu) 52,000.	24980-41-4
* * * *	*

[FR Doc. E8–11980 Filed 6–3–08; 8:45 am]

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ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 261 and 302

[EPA–HQ–RCRA–2006–0984, FRL–8575–4]

RIN 2050–AG15

Hazardous Waste Management System: Identification and Listing of Hazardous Waste; Amendment to Hazardous Waste Code F019

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: The Environmental Protection Agency (EPA) is amending the list of hazardous wastes from non-specific sources (called F-wastes) by modifying the scope of the EPA Hazardous Waste No. F019 (Wastewater treatment sludges from the chemical conversion coating of aluminum except from zirconium phosphating in aluminum can washing when such phosphating is an exclusive conversion coating process). The Agency is amending the F019 listing to exempt wastewater treatment sludges from zinc phosphating, when such phosphating is used in the motor vehicle manufacturing process, provided that the wastes are not placed outside on the land prior to shipment to a landfill for disposal, and the wastes are placed in landfill units that are subject to or meet the specified landfill design criteria. This final action on the F019 listing does not affect any other wastewater treatment sludges either from the chemical conversion coating of aluminum, or from other industrial sources. Additionally, this rule amends the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) list of Hazardous Substances and Reportable Quantities so that the F019 listing description is consistent with the amendment to F019 under regulations for hazardous wastes from non-specific sources.

DATES: This final rule is effective on July 7, 2008.

ADDRESSES: EPA has established a docket for this action under Docket ID No. EPA–HQ–RCRA–2006–0984. All documents in the docket are listed in the *http://www.regulations.gov* Web site. Although listed in the index, some information is not publicly available, i.e., CBI or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, will be publicly available only in hard copy. Publicly available docket materials are available either electronically in *http://www.regulations.gov* or in hard copy at the OSWER Docket in the EPA Docket Center (EPA/DC), EPA West, Room 3334, 1301 Constitution Avenue, NW., Washington, DC 20460. The EPA/DC Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Reading Room is (202) 566–1744 and the telephone number for the RCRA Docket is (202) 566–0270.

FOR FURTHER INFORMATION CONTACT: For general information, review our Web site at *http://www.epa.gov/epaoswer/hazwaste*. For information on specific aspects of the rule, contact James Michael of the Office of Solid Waste (5304P), U.S. Environmental Protection Agency, 1200 Pennsylvania Avenue, NW., Washington, DC 20460, (E-mail address and telephone number: *michael.james@epa.gov*, (703) 308–8610).

SUPPLEMENTARY INFORMATION:

General Information

Who Is Potentially Affected by This Final Rule?

This final rule could directly affect businesses that generate certain wastes from the manufacturing of motor vehicles in the (1) automobile manufacturing industry and (2) light truck/utility vehicle manufacturing industry (NAICS codes 336111 and 336112, respectively). Other motor vehicle manufacturing industries (e.g., heavy duty truck or motor home manufacturing) are not affected by this rule. The wastes affected by this final rule are wastewater treatment sludges generated from the chemical conversion coating of aluminum using a zinc phosphating process and are currently listed as EPA Hazardous Waste No. F019 (see 40 CFR 261.31). These wastes will not be subject to the F019 listing, provided the wastes are not placed outside on the land prior to the shipment to a landfill for disposal and are either: disposed in a Subtitle D municipal or industrial landfill unit that is equipped with a single clay liner and is permitted, licensed or otherwise authorized by the state; or disposed in a landfill unit subject to, or otherwise meeting, the landfill requirements in § 258.40, § 264.301, or § 265.301. Impacts on potentially affected entities are summarized in Section VI of this Preamble. The ''Regulatory Impact Analysis'' (RIA) for this action presents an analysis of potentially affected entities and is available in the docket

Figure 2: Example of the agency mentioning an industry during discussion of costs

This page from the federal register provides an example of one of the ways we determine that an industry is affected by the regulation. The regulatory agency mentions the "Automobile Manufacturing" during discussion of costs. The relevant parts have been shaded in green.

53452 **Federal Register** / Vol. 74, No. 200 / Monday, October 19, 2009 / Proposed Rules

B. Paperwork Reduction Act

This action does not impose any new information collection burden. Burden is defined at 5 CFR 1320.3(b). This proposed rule is an Agency determination. It contains no new requirements for reporting. The only recordkeeping requirement involves customary business practice. The Office of Management and Budget (OMB) has previously approved the information collection requirements contained in the existing regulations in subpart G of 40 CFR part 82 under the provisions of the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.* and has assigned OMB control numbers 2060–0226 (EPA ICR No. 1596.05). This Information Collection Request (ICR) included five types of respondent reporting and record keeping activities pursuant to SNAP regulations: submission of a SNAP petition, filing a SNAP/TSCA Addendum, notification for test marketing activity, record keeping for substitutes acceptable subject to use restrictions, and record-keeping for small volume uses. This proposed rule requires minimal record-keeping of studies done to ensure that MVAC systems using HFO–1234yf meet the requirements set forth in this rule. Because it is customary business practice that automotive systems manufacturers and automobile manufacturing companies conduct and keep on file failure mode and effect analysis (FMEA) on any potentially hazardous part or system, we believe this requirement will not impose an additional paperwork burden.

C. Regulatory Flexibility Act (RFA)

The RFA generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions.

For purposes of assessing the impacts of today's rule on small entities, small entity is defined as: (1) A small business as defined by the Small Business Administration's (SBA) regulations at 13 CFR 121.201; for NAICS code 336111 (Automobile manufacturing), it is <1000 employees; for NAICS code 336391 (Motor Vehicle Air-Conditioning Manufacturing), it is <750 employees; (2) a small governmental jurisdiction that is a government of a city, county, town, school district or special district with a population of less than 50,000; and (3) a small organization that is any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.

After considering the economic impacts of this proposed rule on small entities, we certify that this action will not have a significant economic impact on a substantial number of small entities. This proposed rule will not impose any requirements on small entities. The requirements of this proposed rule impact car manufacturers and car air conditioning system manufacturers only; none of these businesses qualify as small entities. Additionally, car manufacturers and car air conditioning system manufacturers are not mandated to move to HFO–1234yf MVAC systems. EPA is simply listing HFO–1234yf as an acceptable alternative with use conditions in new MVAC systems. This rule allows the use of this alternative to ozone depleting substances in the MVAC sector and outlines the conditions necessary for safe use. By approving this refrigerant under SNAP, EPA provides additional choice to the automotive industry which, if adopted, would reduce the impact of MVACs on the global environment. This rulemaking does not mandate the use of HFO–1234yf as a refrigerant in new MVACs.

We continue to be interested in the potential impacts of the proposed rule on small entities and welcome comments on issues related to such impacts.

D. Unfunded Mandates Reform Act

This rule does not contain a Federal mandate that may result in expenditures of $100 million or more for State, local, and tribal governments, in the aggregate, or the private sector in any one year. EPA has determined that this rule contains no regulatory requirements that might significantly or uniquely affect small governments. This regulation applies directly to entities that manufacture MVAC systems with the proposed substitute, and not to governmental entities. This proposed rule does not mandate a switch to this substitute, but rather adds to the list of available substitutes from which a manufacturer may choose; consequently, there is no direct economic impact on entities from this rulemaking. Also, production-quality HFO–1234yf MVAC systems are not manufactured yet. Consequently, no change in business practice is required by this proposed rule. This action provides additional technical options allowing greater flexibility for industry in designing consumer products. Thus, this rule is not subject to the requirements of sections 202 or 205 of UMRA.

This rule is also not subject to the requirements of section 203 of UMRA because it contains no regulatory requirements that might significantly or uniquely affect small governments. As noted above, this proposed regulation would not apply to any governmental entity. EPA has determined that this rule does not contain a Federal mandate that may result in expenditures of $100 million or more for State, local, and tribal governments, in the aggregate, or the private sector in any one year.

E. Executive Order 13132: Federalism

Executive Order 13132, entitled "Federalism" (64 FR 43255, August 10, 1999), requires EPA to develop an accountable process to ensure "meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications." "Policies that have federalism implications" is defined in the Executive Order to include regulations that have "substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government."

This proposal does not have federalism implications. It will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132. This regulation applies directly to entities that manufacture MVAC systems with the proposed substitute and not to governmental entities. Thus, Executive Order 13132 does not apply to this rule.

F. Executive Order 13175: Consultation and Coordination With Indian Tribal Governments

This action does not have tribal implications, as specified in Executive Order 13175 (65 FR 67249, November 9, 2000). This proposed rule does not significantly or uniquely affect one or more Indian tribes, the relationship between the Federal Government and Indian tribes, or the distribution of power and responsibilities between the Federal Government and Indian tribes because this regulation applies directly to entities that manufacture MVAC systems with the proposed substitute and not to governmental entities. Thus, Executive Order 13175 does not apply to this action.

Figure 3: Example of the affected industry's comment on the regulation

This page from the federal register provides an example of one of the ways we determine that an industry is affected by the regulation. "Automobile Manufacturing" industry commented on the regulation. The relevant parts have been have been shaded in green.

application and for the permitting authority to approve the permit. The CAA requires that EPA take final action on a PSD permit within one year of the filing with the agency of a complete application. 42 U.S.C. 7475(c). Refineries that are able to avoid major NSR may be required to obtain a state-issued minor NSR permit. Generally, minor NSR permits involve less extensive and/or stringent requirements and have shorter processing times than major NSR permits.

2. Background on NSR Experience Under the Tier 2 Fuel Program

Many of the modifications that refineries are projected to make in order to comply with the proposed Tier 3 fuel program are similar in type, although not necessarily in number or magnitude, to the changes that were needed to comply with the Tier 2 fuel program finalized in 2000. Therefore, information on the Tier 2 experience may assist the public in understanding the permitting issues for the Tier 3 fuel program and in providing comment on possible actions we might undertake to help refineries expeditiously obtain needed permits.

The Tier 2 program was designed to reduce the average sulfur content of gasoline from about 300 ppm to 30 ppm, a reduction of about 90 percent. Anticipating that many refineries would have to make modifications that might trigger the need for NSR permits, we addressed the permitting issue in the proposal for the Tier 2 program, in the final rule, and during implementation. At proposal, we provided background information on the NSR program and its relationship to the types of changes likely to be required at refineries. We had not estimated the number of refineries that might trigger NSR, but we stated that the number could be substantial. We invited comment on a number of actions that EPA, states, and/or refineries could pursue in order to help refineries avoid the need for NSR permits or to obtain permits more expeditiously than might otherwise be the case. These actions included the following:

- Use of plantwide applicability limits, possibly facilitated by new EPA guidance or rules addressing issues specific to refineries.
- Issuance of new federal guidance on streamlining certain major NSR permitting requirements such as control technology and compliance parameters.
- Use of emissions reductions resulting from vehicles operating on lower sulfur gasoline as offsets for refineries seeking Nonattainment NSR permits.
- Use of model permits and permit applications.
- EPA refinery permitting teams.

The Tier 2 proposal also addressed issues related to the Title V permitting program,[360] and requested comments on possible approaches by which refineries might satisfy some NSR and Title V requirements at the same time.

We received comments on refinery permitting issues from the refining industry, the automobile manufacturing industry, state and local agencies that administer air permitting programs, and environmental and community groups. Based on these comments and statutory constraints, we decided that it was not necessary or appropriate to exempt Tier 2 projects from the normally applicable preconstruction review process. We also decided not to pursue the development of guidance on plantwide applicability limits for refineries based on comments suggesting this would be an unproductive effort because of the complexity of refineries. Nonetheless, we concluded that it was useful to add certainty to the anticipated permitting actions and schedules, and to minimize the possibility of delay. Accordingly, EPA took two types of actions to promote these objectives. First, as we are now proposing for Tier 3 (see proposed program flexibilities discussion in V.E.1.-3.), we structured the Tier 2 gasoline sulfur program to allow additional lead time for many refineries (i.e., certain refineries would be able to make desulfurization changes later than the otherwise applicable compliance date to meet Tier 2 requirements). This approach was expected to help address the concerns over the availability of necessary new equipment and permitting backlogs caused by many refineries acting to obtain permits and order equipment within the same time period.Second, we stated our intention to take several actions during implementation of the Tier 2 rule to expedite and impart greater certainty in obtaining necessary major NSR permits (described in more detail below). We also stated our intention to assist states and refiners on a case-by-case basis in their efforts to address any unique permitting problems that might arise and, thus, remedy potential problems that could cause unanticipated delays. We committed to work with refiners and the state/local permitting agencies on a case-by-case basis, where a refinery had unique circumstances that necessitated unique treatment. We clarified that, in our efforts to provide greater certainty and to facilitate more expeditious permitting, we were in no way shortcutting existing opportunities for public participation in making permitting decisions. We encouraged refineries to begin discussions with permitting authorities and to submit permit applications as early as possible.

The final Tier 2 rule identified three key actions that we intended to take (and subsequently took) to provide assistance that would be useful toward helping states issue timely permits to refineries. The first such action was to organize a special EPA team, comprised of Headquarters and Regional Office experts, to track the overall progress in permit issuance and to be available to assist state and local permitting authorities, refineries, and the public upon request to resolve site-specific permitting issues. The team made special efforts to be aware of state and local permitting actions that were underway during the time between the finalization of the Tier 2 program and the compliance time frame. Experience during this period suggested that state and local permitting agencies, as predicted in their comments on the proposed Tier 2 program, were able to process permit applications in a timely manner, without much need for special troubleshooting help from the EPA team. In many cases, the modifications to allow compliance with Tier 2 requirements were subject to only minor NSR permitting requirements rather than major NSR, or those modifications were rolled into another permitting action that was needed for other modifications or expansions due to other technical or market developments. We believe it is reasonable to expect that similar outcomes (refineries not needing major NSR permits) would result in connection with air permitting for the modifications refineries would need to make under the proposed Tier 3 gasoline sulfur program.

The second action we took was to develop new guidance on emission control technology requirements to meet BACT and LAER. We issued this guidance in 2001. It addressed the levels of control that could be reasonably

[360] Title V of the 1990 CAA Amendments requires all major sources and some minor sources of air pollution to obtain an operating permit. A Title V permit contains all air pollution requirements that apply to the source, including emissions limits and monitoring, record keeping, and reporting requirements. It also requires that the source report its compliance status to the permitting authority annually. All existing refineries potentially affected by the proposed Tier 3 fuel standards have Title V permits and, because Title V permits by themselves generally do not establish new applicable requirements, the only implication of the proposed Tier 3 fuel standards would be the "roll-in" of any new NSR permit requirements into existing refinery Title V permits. Permitting agencies have efficient processes to accomplish this that do not delay construction of proposed projects.

Figure 4: Example of regulatory costs mentioned in the regulatory text

This page from the federal register shows an example of regulatory costs mentioned in the text. The relevant parts have been have been shaded in green. We extract these costs from XML files of the federal register.

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DOE's analysis of the national impacts of the adopted standards is described in sections IV.H, IV.K and IV.L of this document.

3. Small, Large, and Very Large Commercial Package Air Conditioning and Heating Equipment and Commercial Warm Air Furnaces

DOE's analyses indicate that energy conservation standards being adopted in this direct final rule for CUAC and CUHP equipment and CWAFs would save a significant amount of energy. Relative to the no-new-standards case, the lifetime energy savings for CUAC and CUHP equipment purchased in 2018–2048 and CWAFs purchased in 2023–2048 amount to 15.0 quads. This represents a savings of 24 percent relative to the energy use of these products in the no-new-standards case.

The cumulative NPV of total consumer costs and savings of the standards for CUACs and CUHPs and CWAFs ranges from $15.5 billion (at a 7-percent discount rate) to $51 billion (at a 3-percent discount rate). This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased product and installation costs for CUACs and CUHPs purchased in 2018–2048 and CWAFs purchased in 2023–2048.

In addition, the standards that are being adopted in this direct final rule are projected to yield significant environmental benefits as a result of the improvement in the conservation of energy. DOE estimates that the standards would result in cumulative GHG emission reductions (over the same period as for energy savings) of 885 million Mt of CO_2, 454 thousand tons of SO_2, 1,675 tons of NO_X, 4,063 thousand tons of CH_4, 10 thousand tons of N_2O, and 1.68 tons of Hg. The cumulative reduction in CO_2 emissions through 2030 amounts to 78 million Mt, which is equivalent to the emissions resulting from the annual electricity use of approximately 10.7 million homes.

The value of the CO_2 reductions is calculated using a range of values per metric ton of CO_2 developed by a Federal interagency working group. The derivation of the SCC values is discussed in section IV.L. Using discount rates appropriate for each set of SCC values, DOE estimates that the net present monetary value of the CO_2 emissions reduction (not including CO_2-equivalent emissions of other gases with global warming potential) is between $5.1 billion and $77 billion, with a value of $25.3 billion using the central SCC case represented by $40.0/t in 2015. DOE also estimates that the net present monetary value of the NO_X emissions reduction to be $1.4 billion at a 7-percent discount rate, and $4.5 billion at a 3-percent discount rate.

Table I–9 summarizes the combined national economic benefits and costs expected to result from the adopted standards for CUACs and CUHPs and CWAF.

TABLE I–9—SUMMARY OF NATIONAL ECONOMIC BENEFITS AND COSTS OF AMENDED ENERGY CONSERVATION STANDARDS FOR SMALL, LARGE, AND VERY LARGE COMMERCIAL PACKAGE AIR CONDITIONING AND HEATING EQUIPMENT AND COMMERCIAL WARM AIR FURNACES *

Category	Present value (billion 2014$)	Discount rate (%)
Benefits		
Operating Cost Savings	23.3	7
	65.9	3
CO_2 Reduction Value ($12.2/t case) **	5.1	5
CO_2 Reduction Value ($40.0/t case) **	25.2	3
CO_2 Reduction Value ($62.3/t case) **	40.8	2.5
CO_2 Reduction Value ($117/t case) **	77.0	3
NO_X Reduction Value †	1.5	7
	4.5	3
Total Benefits ††	50.1	7
	95.6	3
Costs		
Consumer Incremental Installed Costs	7.8	7
	15.0	3
Net Benefits		
Including CO_2 and NO_X Reduction Value ††	42.3	7
	80.6	3

* This table presents the costs and benefits associated with CUACs and CUHPs shipped in 2018–2048 and CWAFs shipped in 2023–2048. These results include benefits to commercial consumers which accrue after 2048. The costs account for the incremental variable and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in preparation for the rule.

** The CO_2 values represent global monetized values of the SCC, in 2014$, in 2015 under several scenarios of the updated SCC values. The first three cases use the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth case represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series incorporate an escalation factor.

† The $/ton values used for NO_X are described in section IV.L.2. DOE estimated the monetized value of NO_X emissions reductions using benefit per ton estimates from the *Regulatory Impact Analysis for the Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants,* published in June 2014 by EPA's Office of Air Quality Planning and Standards. (Available at: *http://www3.epa.gov/ttnecas1/regdata/RIAs/111dproposalRIAfinal0602.pdf.*) See section IV.L.2 for further discussion. Note that the agency is primarily using a national benefit-per-ton estimate for particulate matter emitted from the Electricity Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski et al., 2009). If the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al., 2011), the values would be nearly two-and-a-half times larger. Because of the sensitivity of the benefit-per-ton estimate to the geographical considerations of sources and receptors of emissions, DOE intends to investigate refinements to the agency's current approach of one national estimate by assessing the regional approach taken by EPA's Regulatory Impact Analysis for the Clean Power Plan Final Rule.

†† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to average SCC with 3-percent discount rate ($40.0/t case).

Figure 5: Model performance: area under the curve

This figure plots the area under the curve for all industries. Each dot represent a different industry. The orange line represents the score below which we exclude the industries.

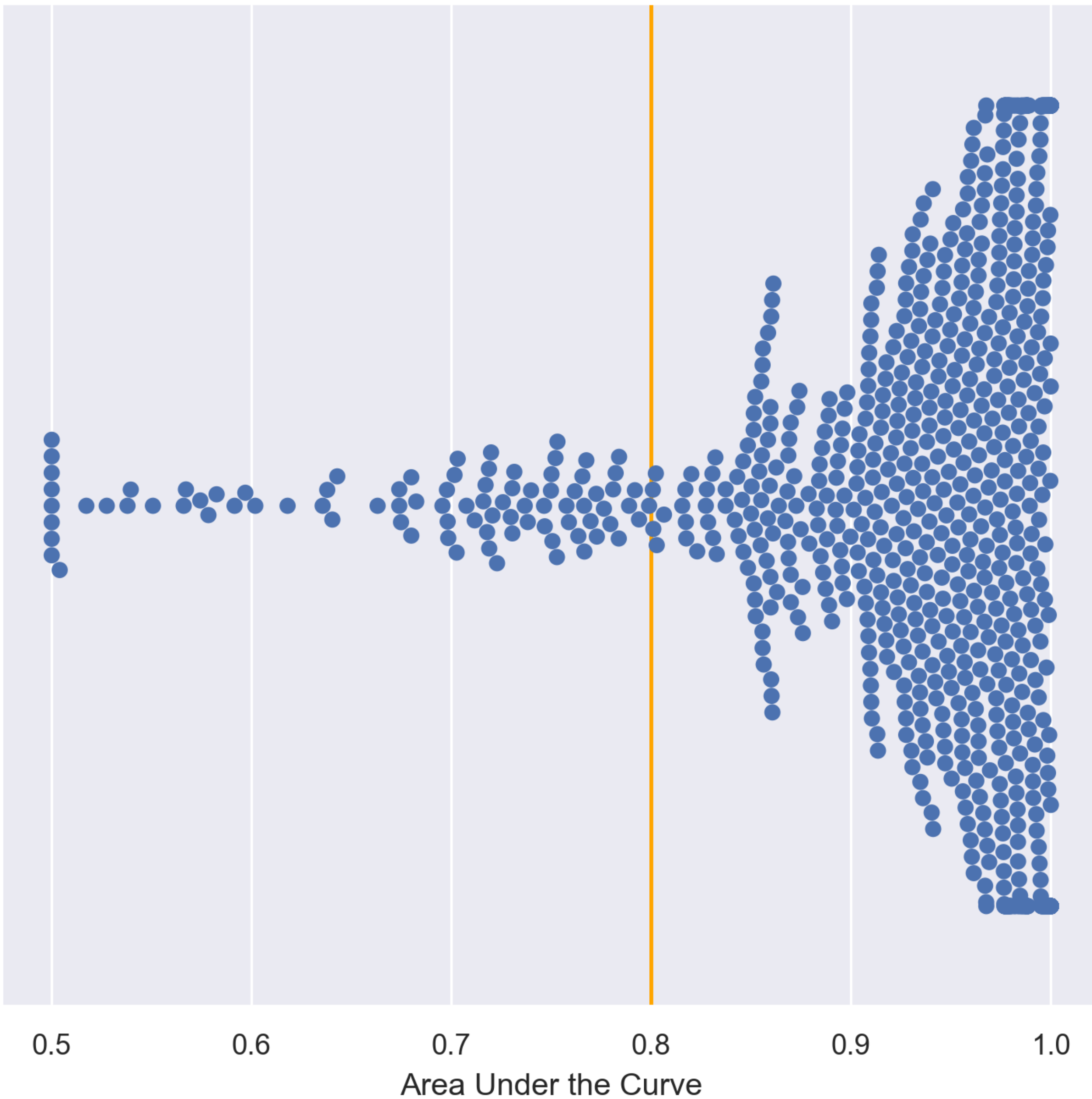

Figure 6: Validation of regulatory costs

This figure shows the relationship between the regulatory costs at the firm level and number of references by firms in 10-K to actual laws, agencies and regulations developed by Bommarito II and Katz (2017).

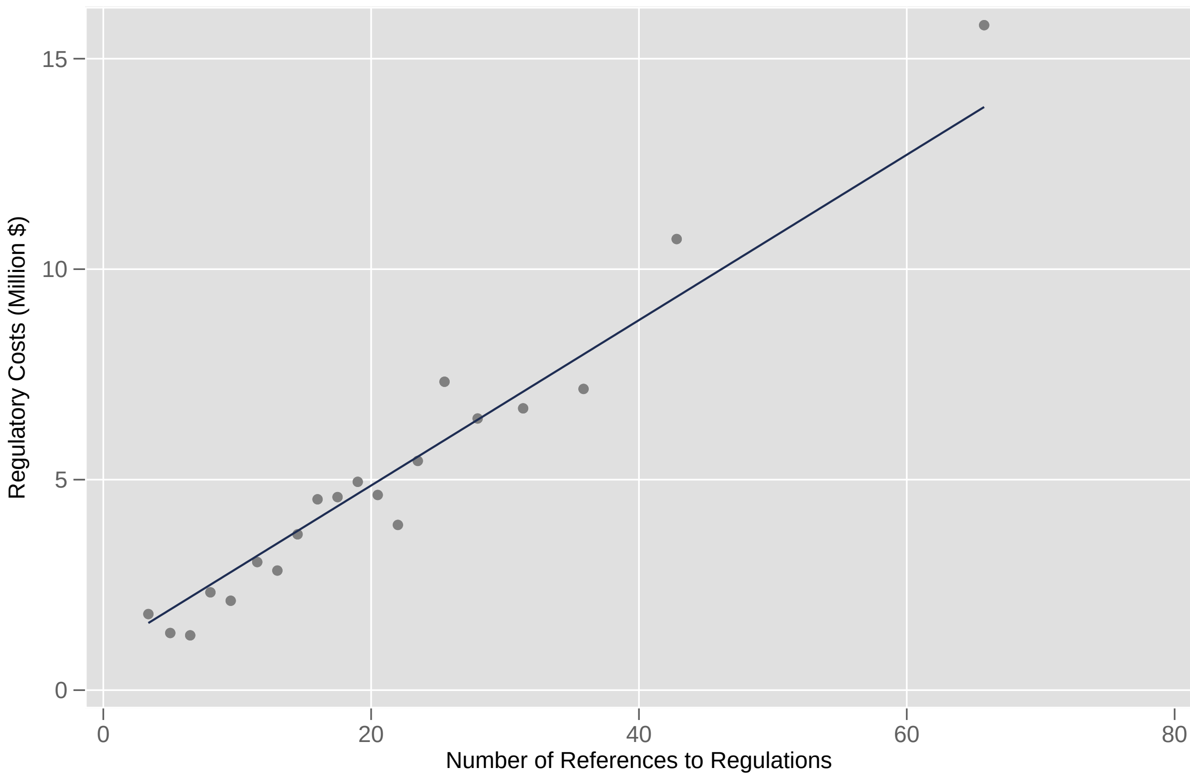

Figure 7: Cumulative regulatory Costs

This figure plots cumulative regulatory costs from 1970 to 2018.

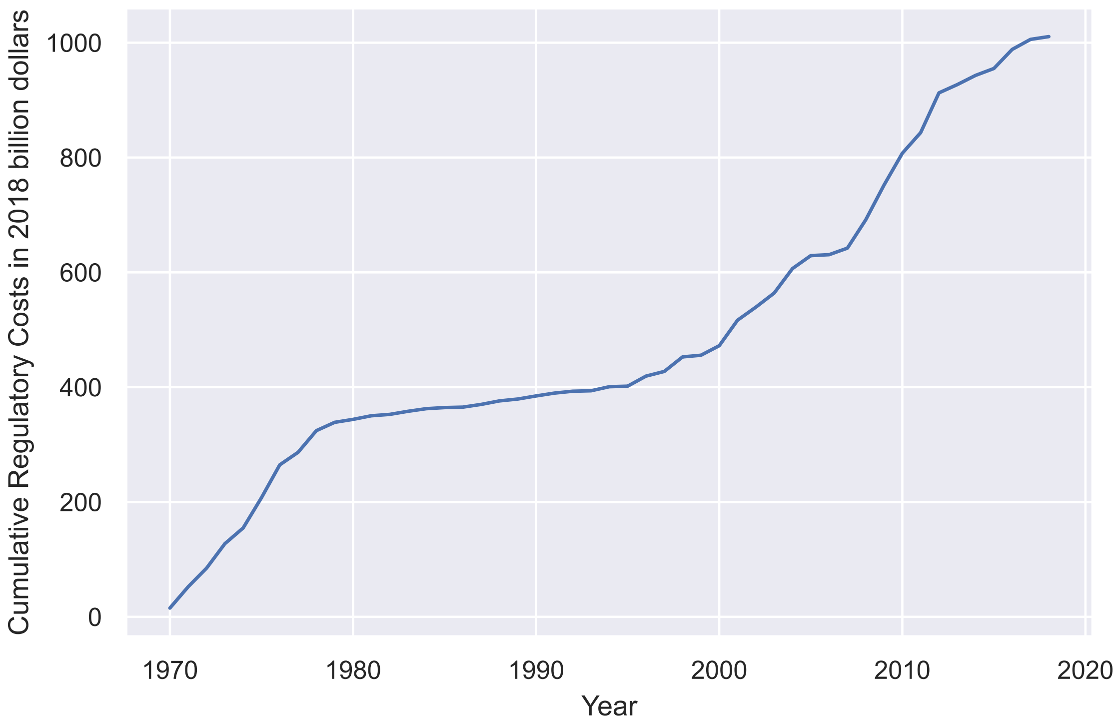

Figure 8: Regulatory costs

This figure plots regulatory costs from 1970 to 2018 for regulations passed in that year.

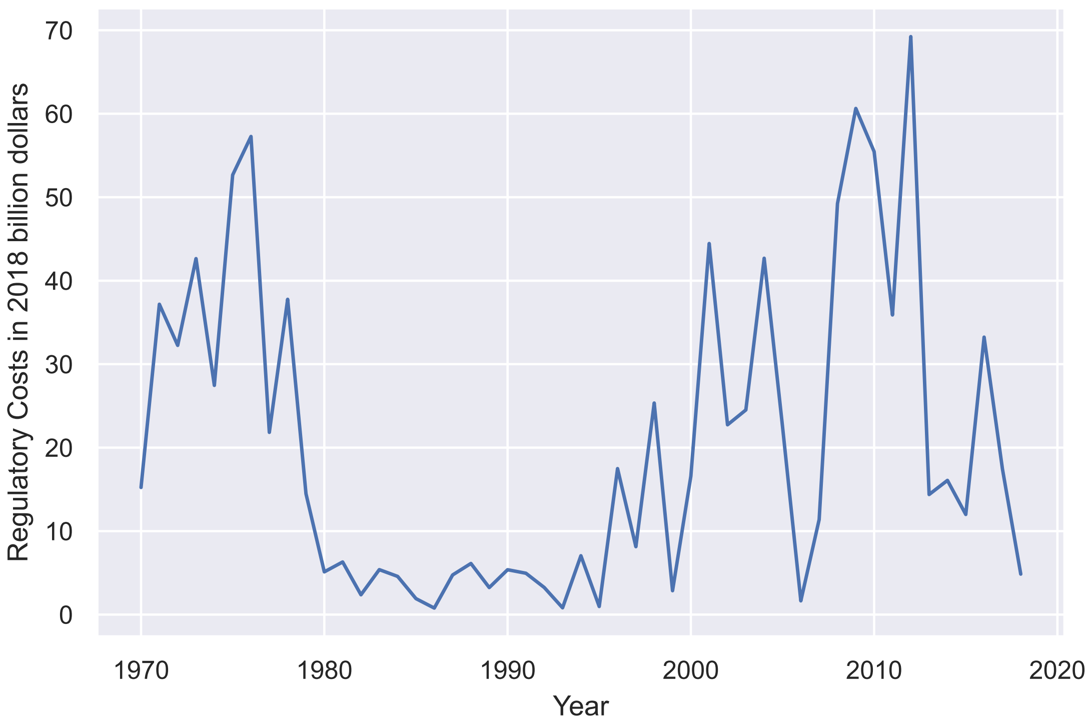

Figure 9: Number of regulations

This figure plots number of new significant regulations from 1970 to 2018.

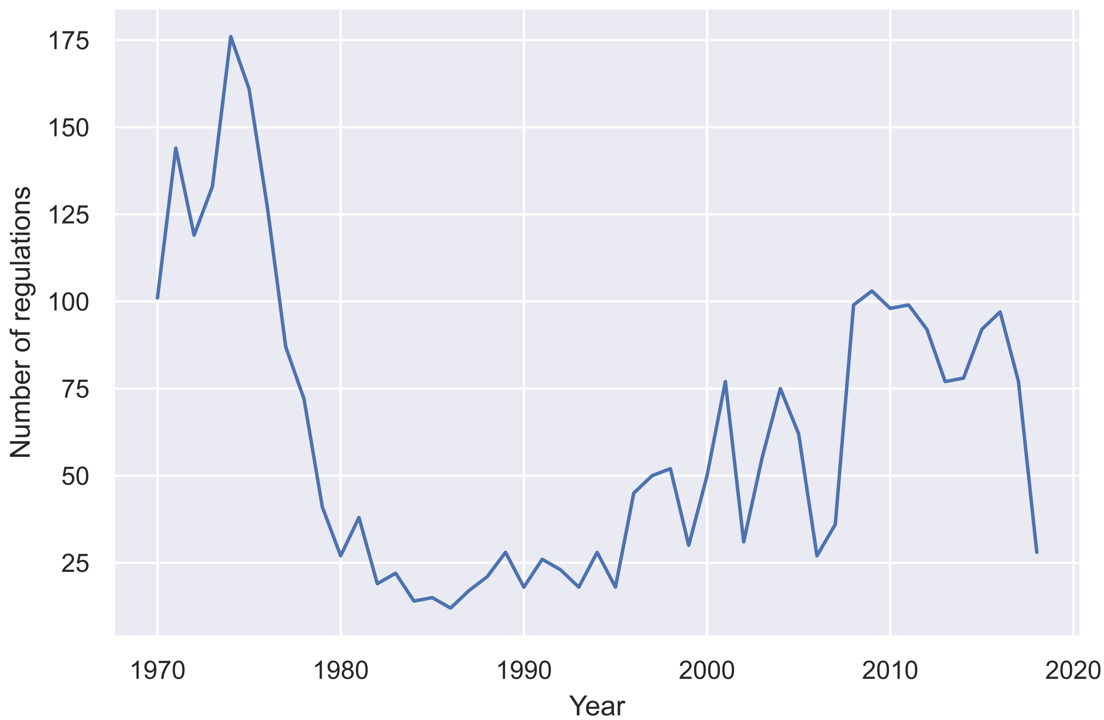

Figure 10: Ratio of regulatory costs for small and large firms

This figure plots ratio of regulatory costs per employee for small firms to large firms from 1977 to 2016.

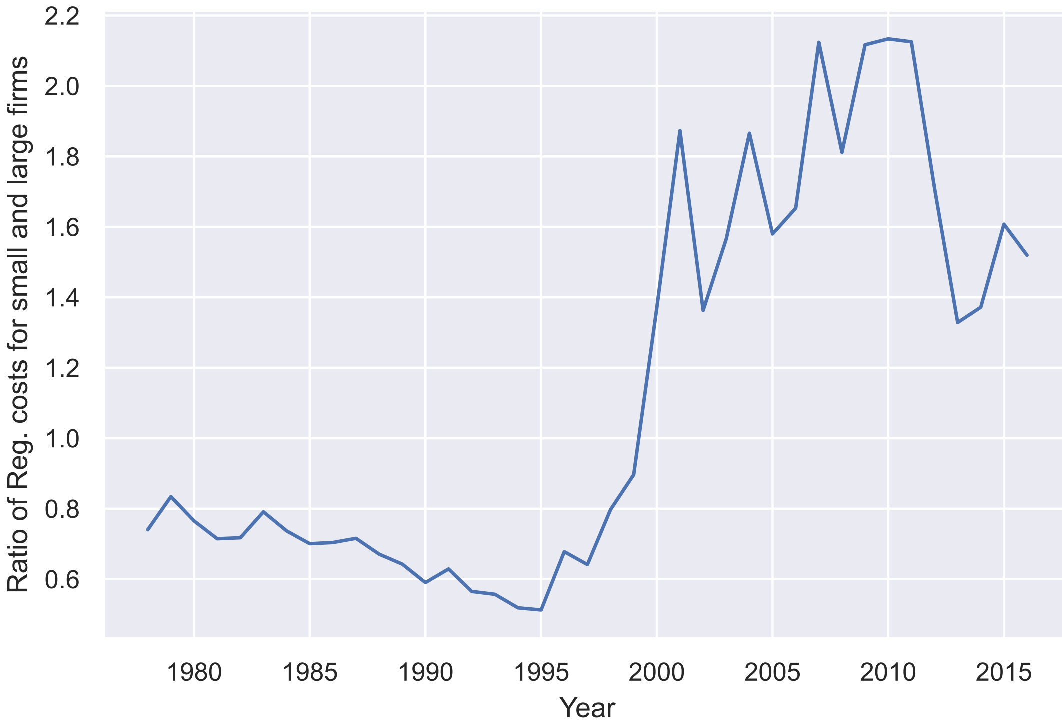

Figure 11: Parallel Trends - Number of Establishments

This figure tests the assumption of parallel trends. Shocks are defined as when an industry had more than a 100% increase in regulatory costs compared to last year for both small and large establishments. We compare small establishments against large establishments in this industry with other industries before and after the increase. N denotes the number of establishments. The dots indicate point estimates, and the vertical lines indicate 95% confidence intervals.

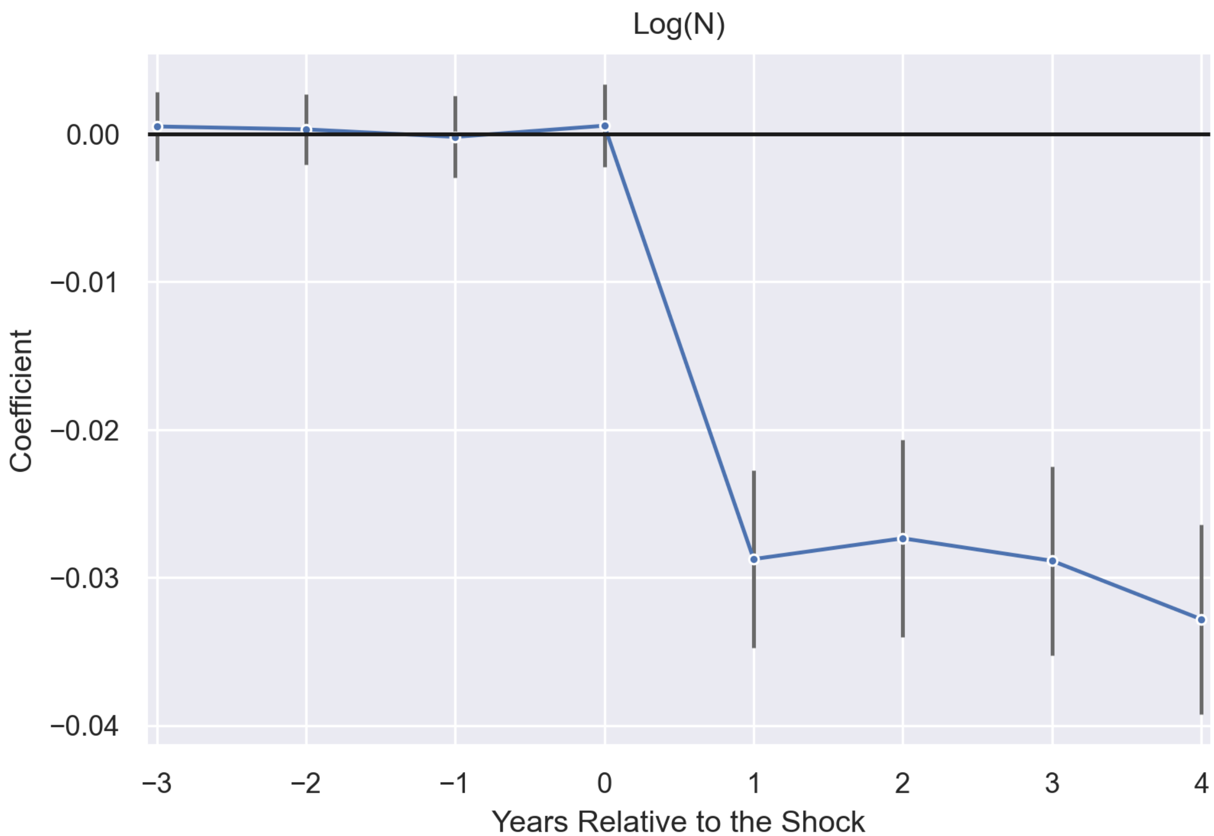

Figure 12: Parallel Trends - Employment

This figure tests the assumption of parallel trends. Shocks are defined as when an industry had more than a 100% increase in regulatory costs compared to last year for both small and large establishments. We compare small establishments against large establishments in this industry with other industries before and after the increase. The dots indicate point estimates, and the vertical lines indicate 95% confidence intervals.

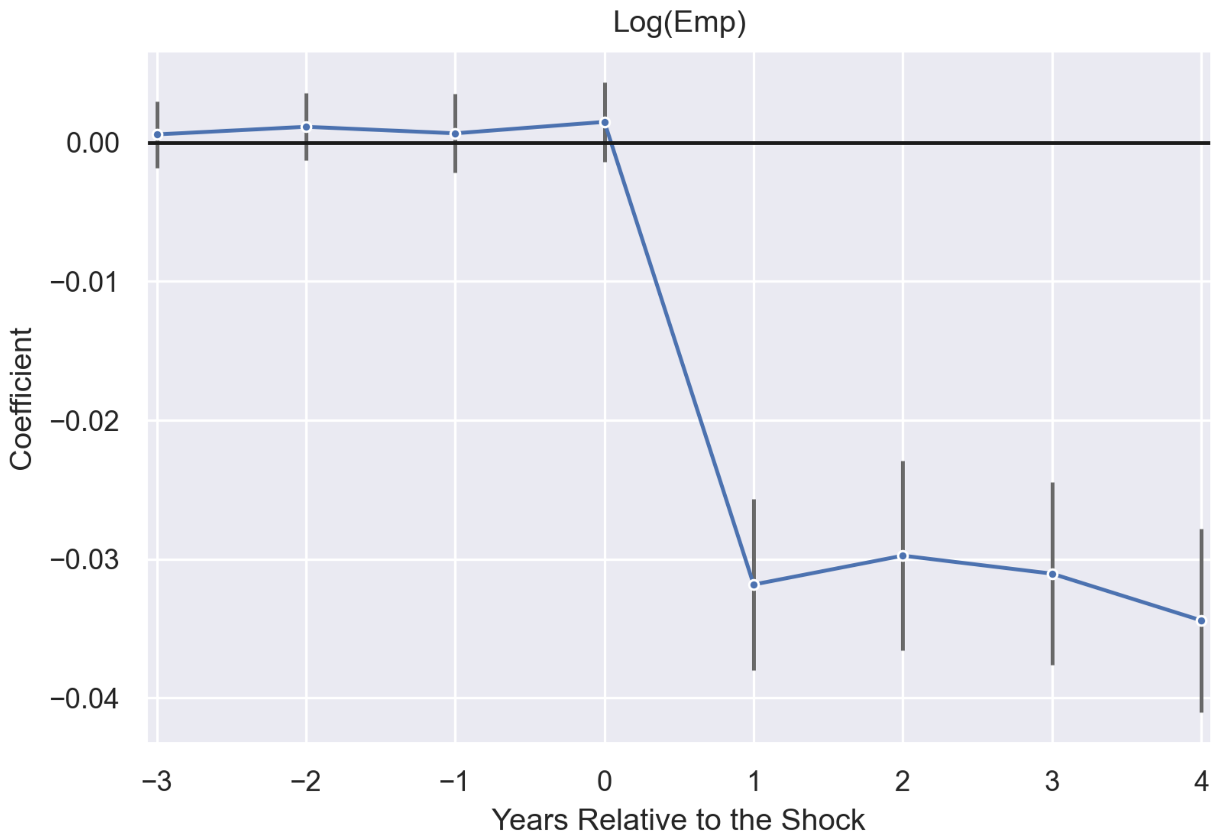

Figure 13: Parallel Trends - Wages

This figure tests the assumption of parallel trends. Shocks are defined as when an industry had more than a 100% increase in regulatory costs compared to last year for both small and large establishments. We compare small establishments against large establishments in this industry with other industries before and after the increase. The dots indicate point estimates, and the vertical lines indicate 95% confidence intervals.

Figure 14: Differential impact of regulatory costs on firms - Number of Establishments

This figure shows how regulatory costs impact firms of different sizes. The dependent variable is the logarithm of number of establishments. Coefficients are from Table 6, Column 2. The dots indicate point estimates, and the vertical lines indicate 95% confidence intervals.

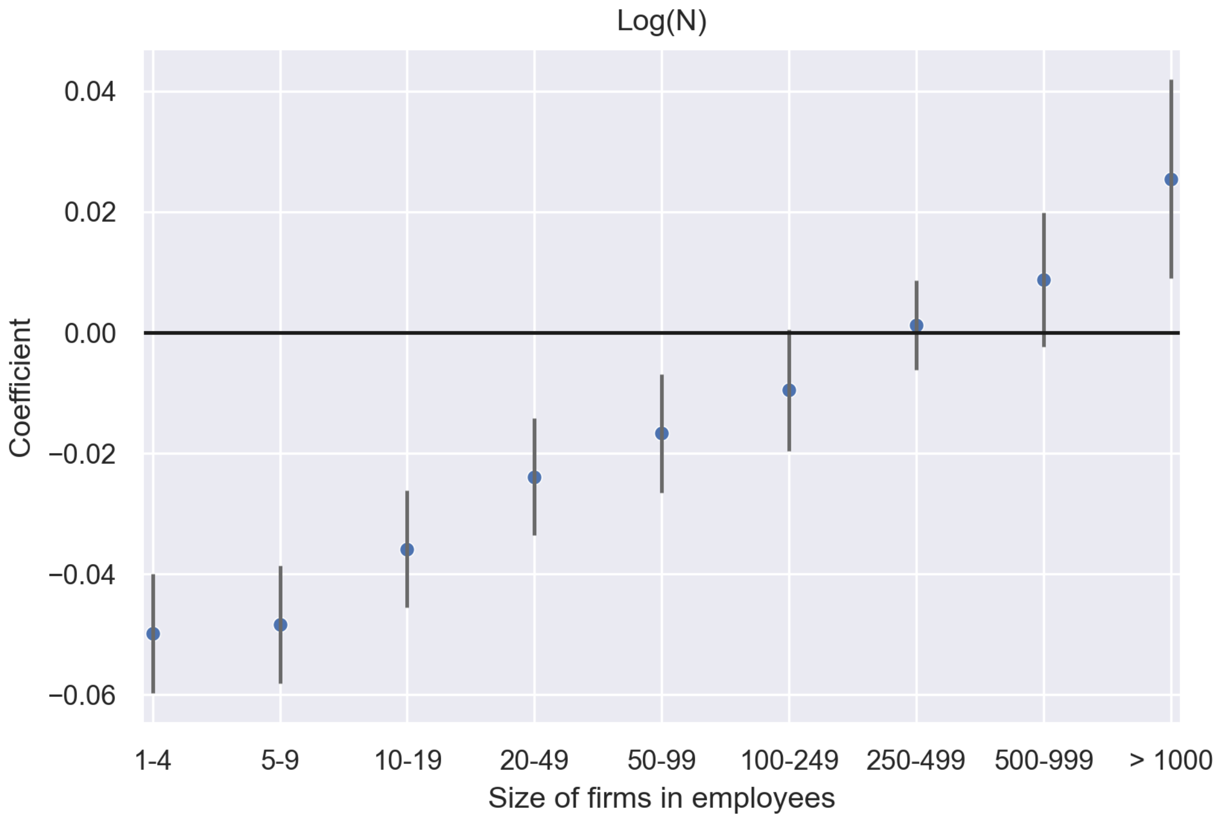

Figure 15: Differential impact of regulatory costs on firms - Employees

This figure shows how regulatory costs impact firms of different sizes. The dependent variable is the logarithm of number of employees. Coefficients are from Table 6, Column 4. The dots indicate point estimates, and the vertical lines indicate 95% confidence intervals.

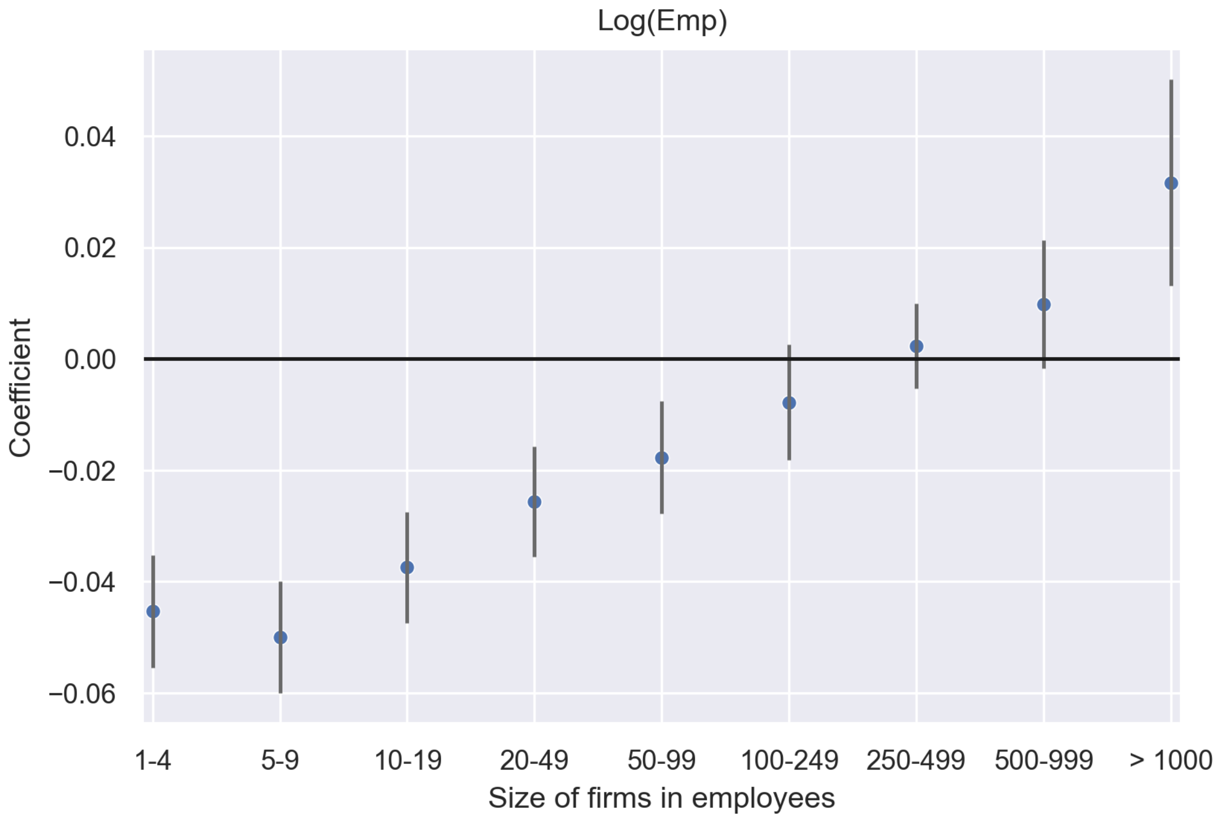

Figure 16: Differential impact of regulatory costs on firms - Wages

This figure shows how regulatory costs impact firms of different sizes. The dependent variable is the logarithm of wages. Coefficients are from Table 6, Column 6. The dots indicate point estimates, and the vertical lines indicate 95% confidence intervals.

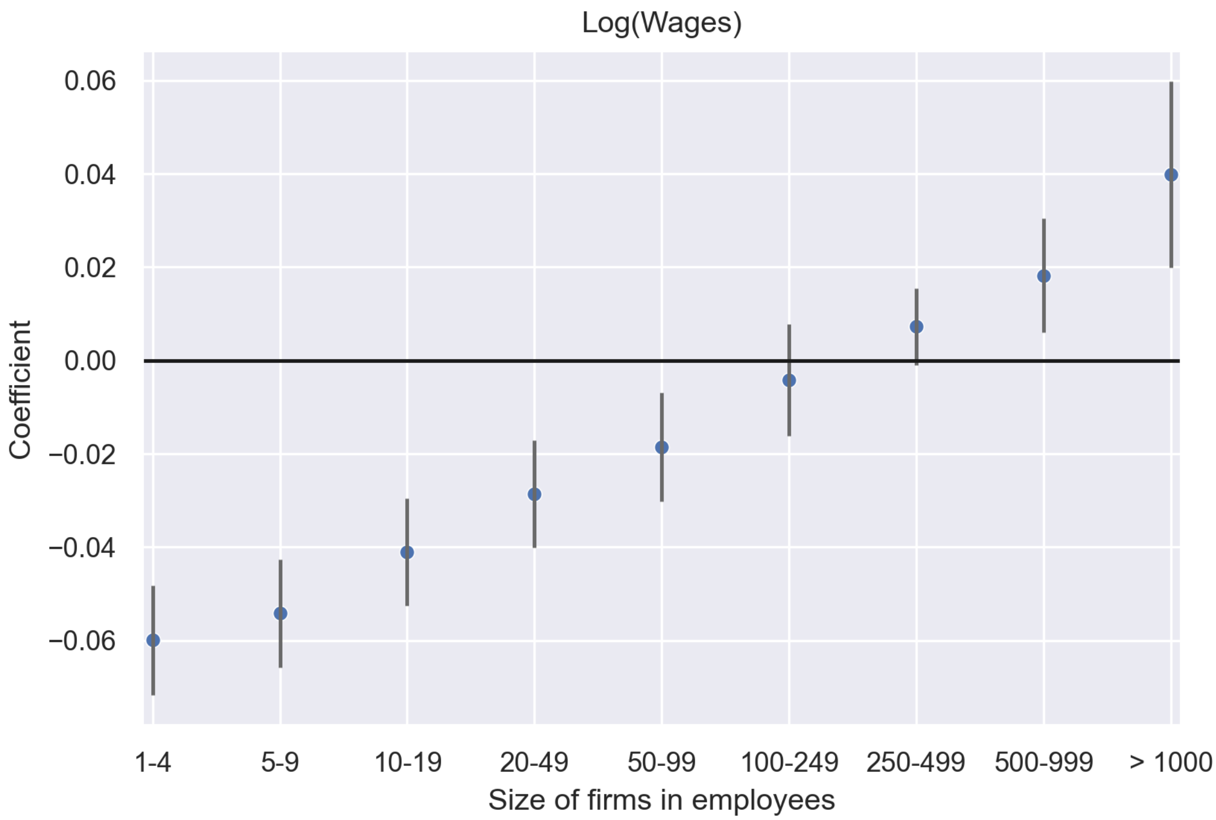

Figure 17: Differential impact of regulatory costs on public firms - Sales

This figure shows how regulatory costs impact firms of different sizes. The dependent variable is the logarithm of sales. The dots indicate point estimates, and the vertical lines indicate 95% confidence intervals.

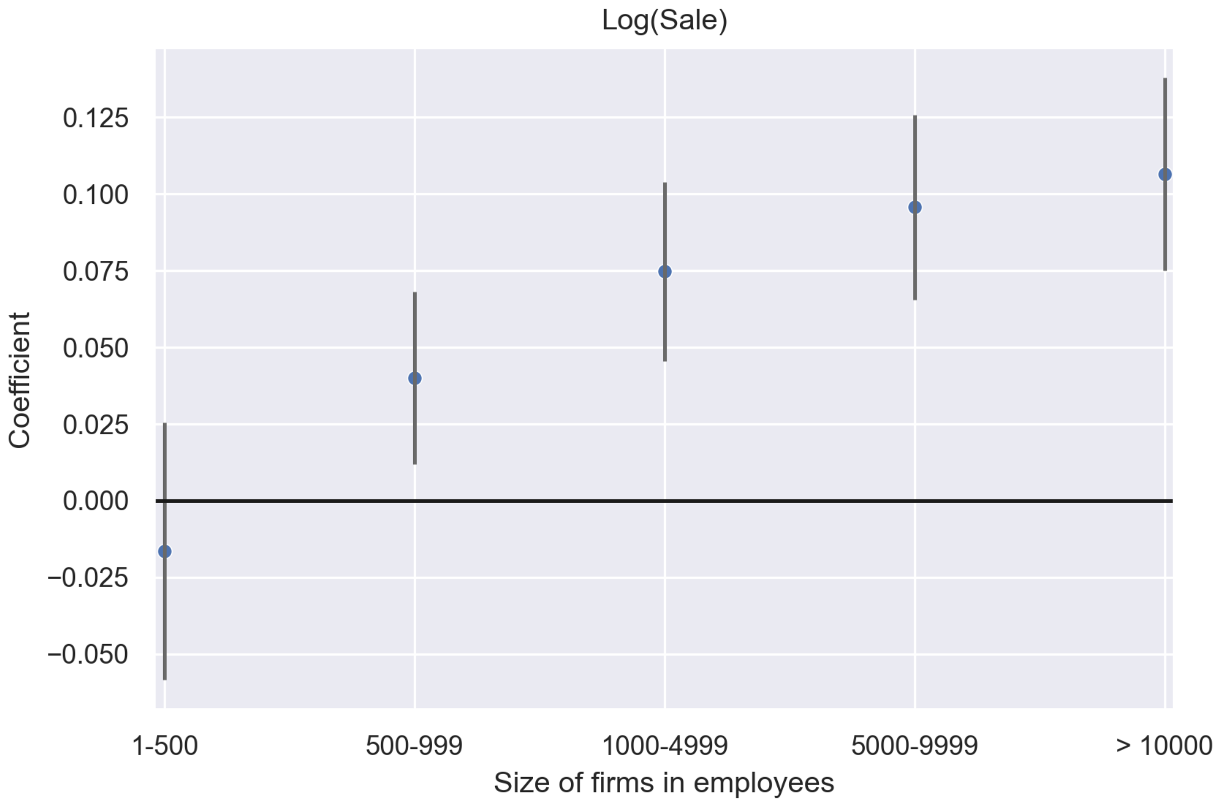

Figure 18: Differential impact of regulatory costs on public firms - Employees

This figure shows how regulatory costs impact firms of different sizes. The dependent variable is the logarithm of employees. The dots indicate point estimates, and the vertical lines indicate 95% confidence intervals.

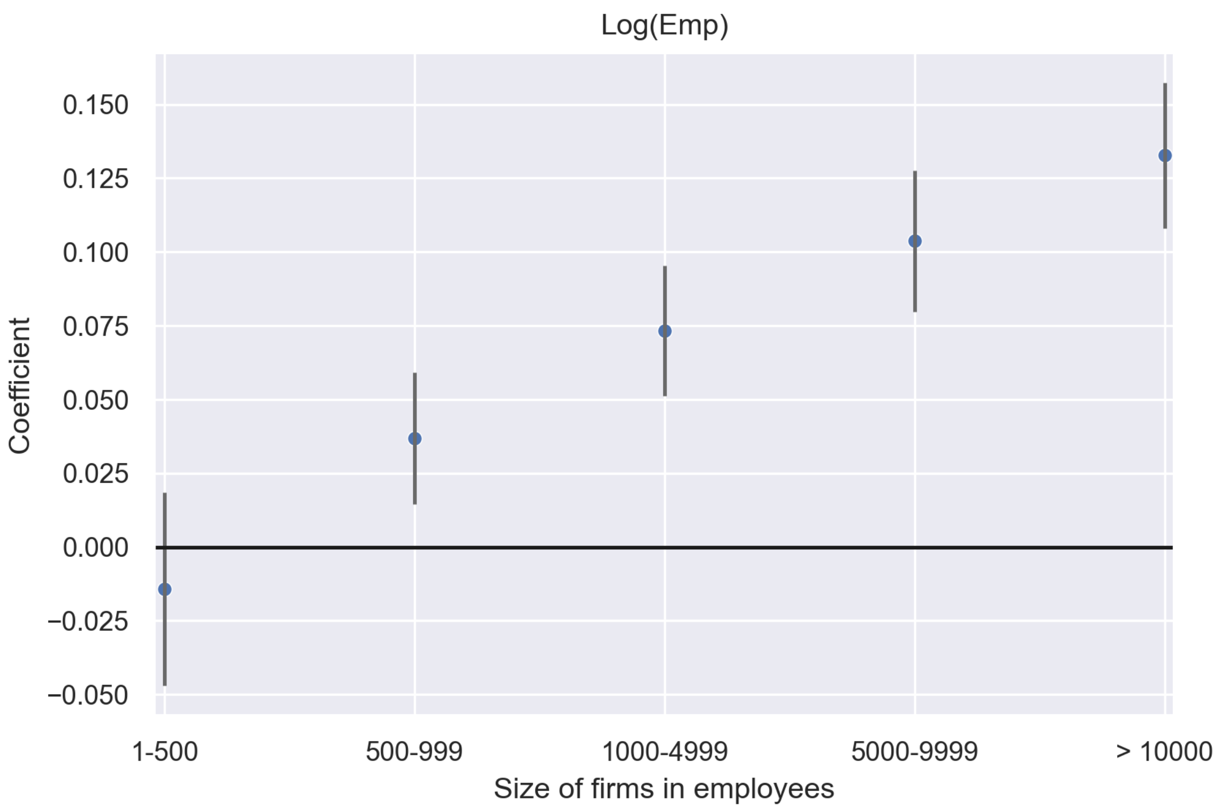

Figure 19: Differential impact of regulatory costs on public firms - Markups

This figure shows how regulatory costs impact firms of different sizes. The dependent variable is the logarithm of markups. The dots indicate point estimates, and the vertical lines indicate 95% confidence intervals.

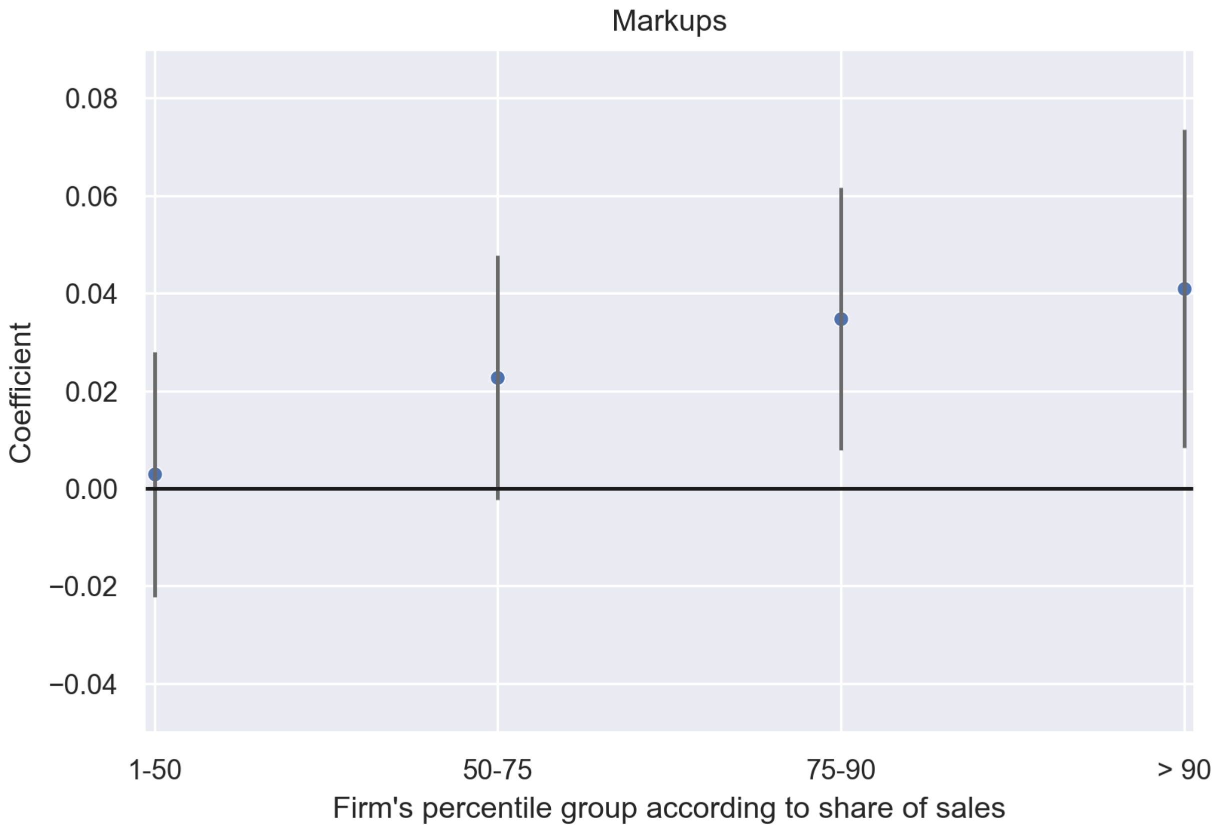

Figure 20: Differential impact of regulatory costs on public firms - Profitability

This figure shows how regulatory costs impact firms of different sizes. The dependent variable is the profit rate. The dots indicate point estimates, and the vertical lines indicate 95% confidence intervals.

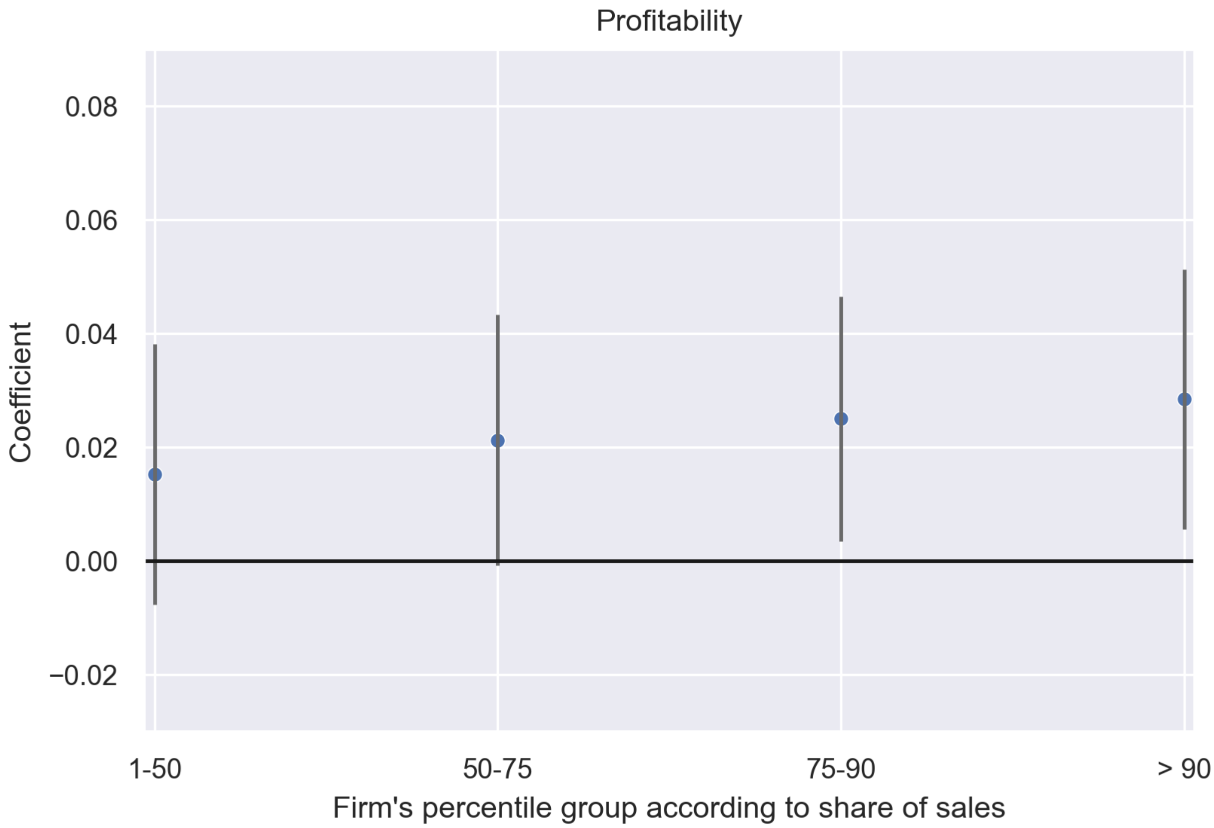

Figure 21: Regulatory costs and industry concentration: all industries

This figure plots evolution of HHI and ratio of regulatory compliance costs faced by small firms to large firms over time in all industries.

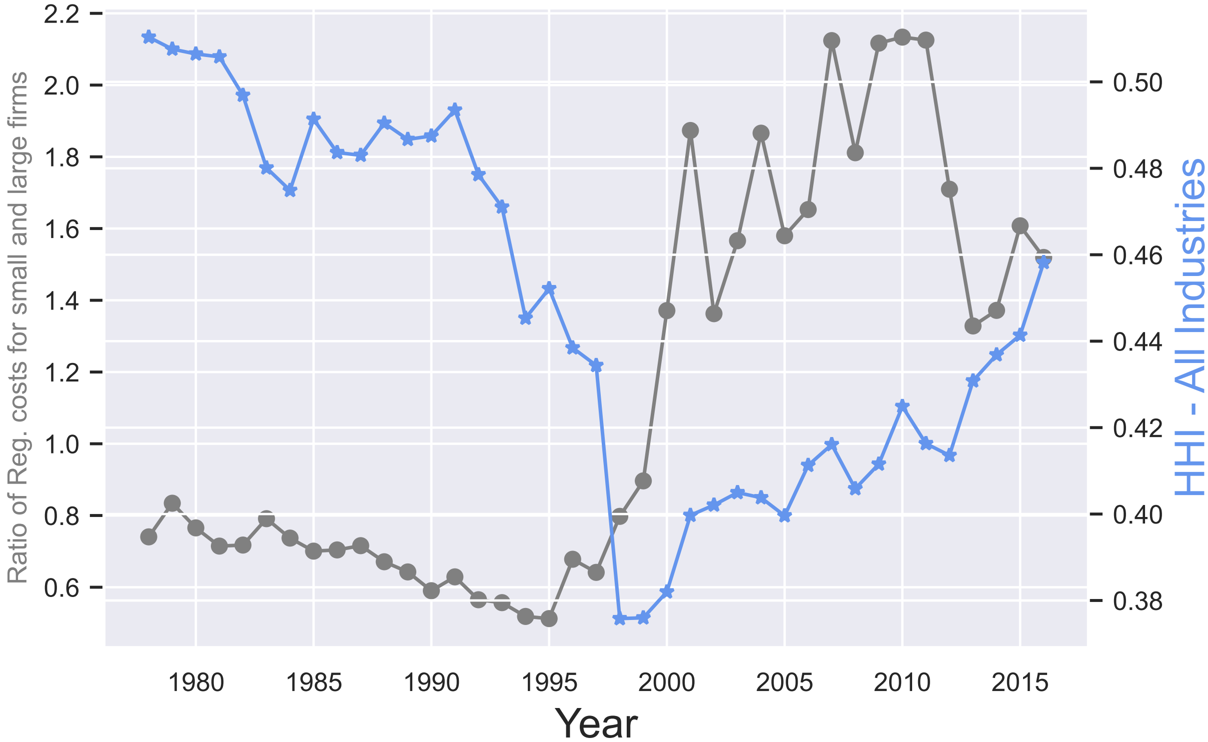

Figure 22: Regulatory costs and industry concentration: manufacturing industry

This figure plots evolution of HHI and ratio of regulatory compliance costs faced by small firms to large firms over time in the manufacturing industry.

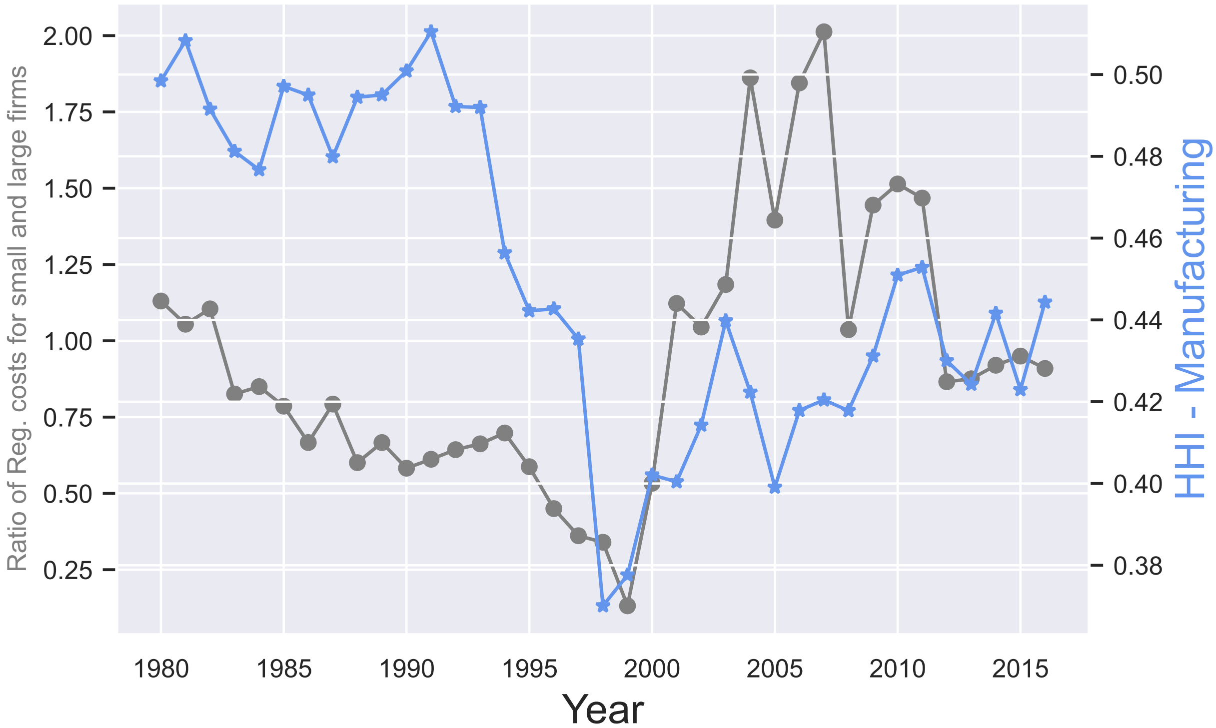

Figure 23: Regulatory costs and industry concentration: transport industry

This figure plots evolution of HHI and ratio of regulatory compliance costs faced by small firms to large firms over time in the transport industry.

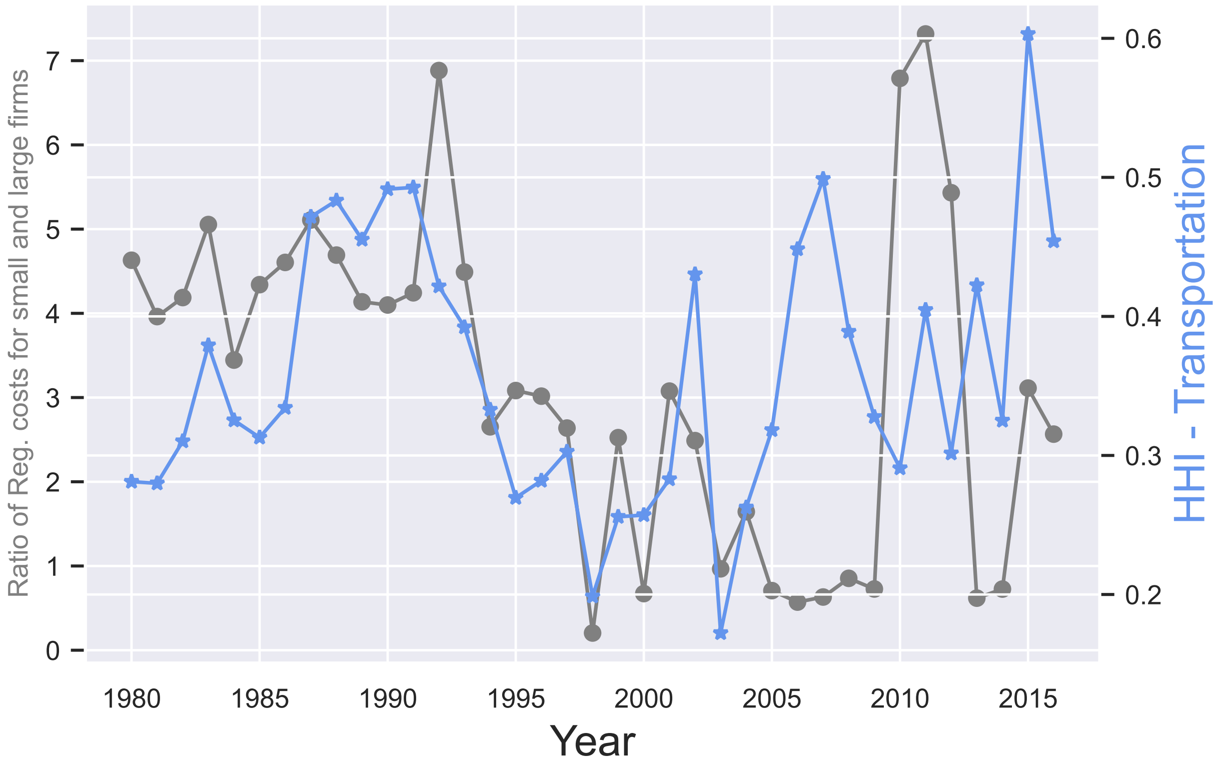

Figure 24: Regulatory costs and industry concentration: retail industry

This figure plots evolution of HHI and ratio of regulatory compliance costs faced by small firms to large firms over time in the retail industry.

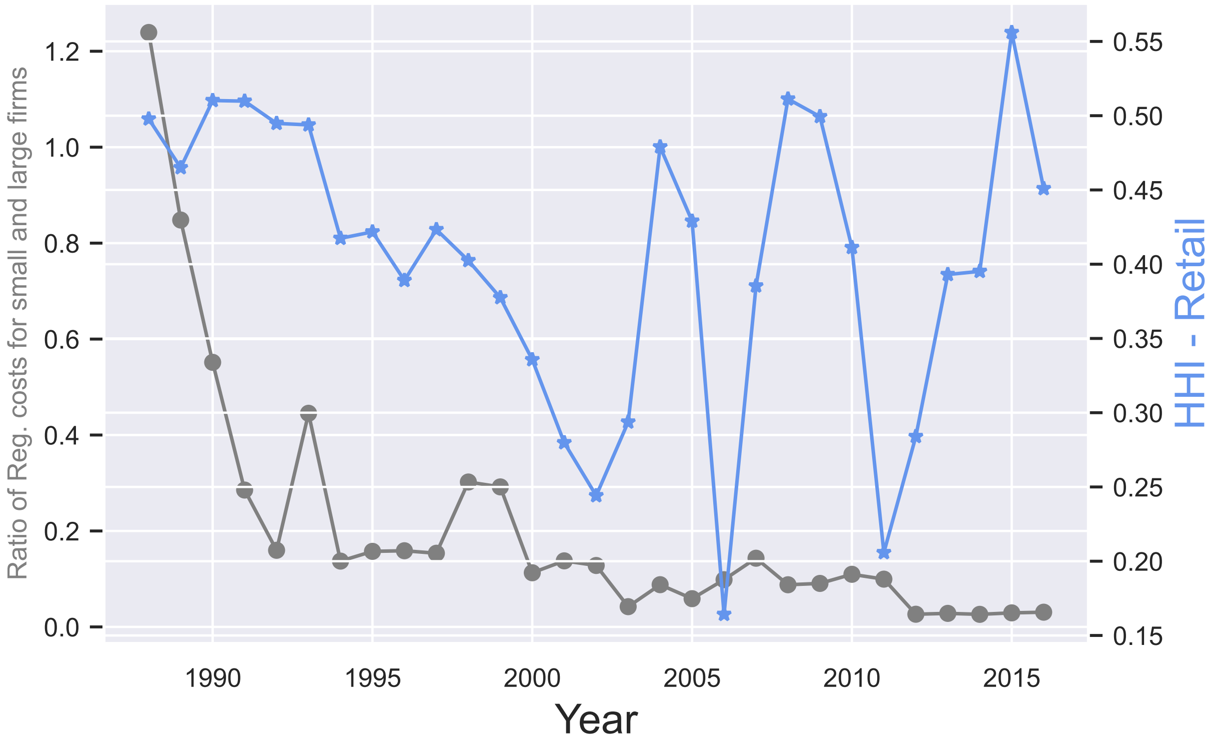

Figure 25: Regulatory costs and entry cost shocks

This figure plots evolution of entry costs shocks (Gutiérrez et al. (2021)) and ratio of regulatory compliance costs faced by small firms to large firms over time.

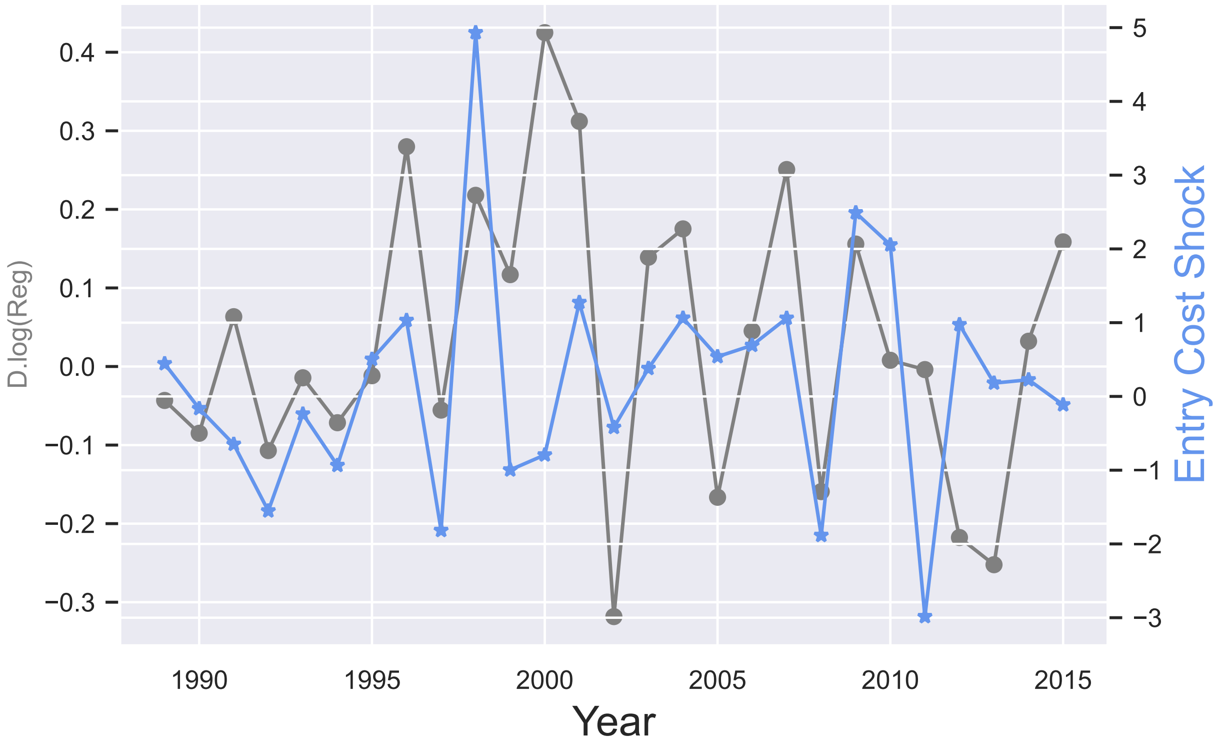

Table 1: Median performance metrics of affected industry classification models

This table shows the median performance metrics of industries that have ROC-AUC scores of more than 0.8. We use five-fold cross validations to evaluate the models.

F1	0.633
Precision	0.587
Recall	0.832
Accuracy	0.999
ROC-AUC	0.974

Table 2: Performance of various models in predicting regulatory costs

This table shows the performance of our model (1-NN) compared to other models in predicting regulatory costs. Our sample is 400 regulations where we have the regulatory cost information. We use five-fold cross validated correlation to evaluate the models.

Model	correlation
Our Methodology	0.758
Length of the regulatory text	0.247
Regulatory restrictions as used in McLaughlin et al. (2017)	0.142

Table 3: Validation of regulatory costs

This figure shows the relationship between the regulatory costs at the firm level and number of references by firms in 10-K to actual laws, agencies and regulations developed by Bommarito II and Katz (2017). The standard errors are clustered at the industry level. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

	Regulatory Costs (Million Dollars)		
	(1)	(2)	(3)
Number of References to Regulations	0.196***	0.153***	0.024**
	(0.011)	(0.013)	(0.012)
Adj. R-squared	0.00662	0.00833	0.771
Obs.	50,372	50,372	49,254
Year FE	No	Yes	Yes
Firm FE	No	No	Yes

Table 4: Regulatory costs by regulatory agency

This table shows the regulatory costs in 2018 billion dollars of ten regulatory agencies which implemented regulations with the highest total costs in our sample and the number of regulations by those agencies.

Agency	Costs in Billions	Number of regulations
Environmental Protection Agency	264.04	621
National Highway Traffic Safety Administration	96.18	231
Energy Department	90.94	146
Interior Department	76.35	115
Justice Department	73.23	158
Health and Human Services Department	53.55	445
Labor Department	47.09	164
Agriculture Department	43.08	233
Defense Department	41.14	146
Homeland Department	25.06	156

Table 5: Impact of regulatory costs on firms

This table shows how regulatory costs impact firm level variables. The dependent variables are the logarithm of number of establishments, employment and wages in Columns 1, 2 and 3, respectively. *Small Establishment* is a dummy for small establishments. *Regulatory Costs* is regulatory compliance costs in dollars at the Industry × Size-Category level. The standard errors are clustered at the industry level. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

	log(N)		log(Emp)		log(Wages)	
	(1) 1977-2016	(2) 1996-2016	(3) 1977-2016	(4) 1996-2016	(5) 1977-2016	(6) 1996-2016
Log(Regulatory Costs)	0.012***	0.005	0.014***	0.006*	0.019***	0.012***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Log(Regulatory Costs) × Small Firm	-0.026***	-0.033***	-0.029***	-0.035***	-0.035***	-0.044***
	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.005)
Adj. R-squared	0.983	0.978	0.968	0.970	0.969	0.966
Obs.	1,442,464	674,283	1,442,464	674,283	1,442,464	674,283
Industry × State × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × State × Size-Category FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 6: Impact of regulatory costs on firms: differential impact

This table shows how regulatory costs impact firm level variables for firms of different sizes. The dependent variables are the logarithm of number of establishments, employment and wages in Columns 1, 2 and 3, respectively. Variables with E represent dummies constructed for the respective ranges in terms of employees. *Reg. Costs* is regulatory compliance costs in dollars at the Industry × Size-Category level. The standard errors are clustered at the industry level. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

	log(N)		log(Emp)		log(Wages)	
	(1)	(2)	(3)	(4)	(5)	(6)
log(Reg. Costs)	-0.055***	-0.050***	-0.050***	-0.045***	-0.064***	-0.060***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)
log(Reg. Costs) × 5≤ E ≤9	0.003**	0.001	-0.004***	-0.005***	0.007***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
log(Reg. Costs) × 10≤ E ≤19	0.015***	0.014***	0.008***	0.008***	0.020***	0.019***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
log(Reg. Costs) × 20≤ E ≤49	0.027***	0.026***	0.021***	0.020***	0.034***	0.031***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
log(Reg. Costs) × 50≤ E ≤99	0.037***	0.033***	0.030***	0.028***	0.044***	0.041***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
log(Reg. Costs) × 100≤ E ≤249	0.043***	0.040***	0.039***	0.037***	0.058***	0.056***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
log(Reg. Costs) × 250≤ E ≤499	0.060***	0.051***	0.055***	0.048***	0.074***	0.067***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
log(Reg. Costs) × 500≤ E ≤999	0.069***	0.059***	0.064***	0.055***	0.086***	0.078***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)
log(Reg. Costs) × E >1000	0.086***	0.075***	0.088***	0.077***	0.110***	0.100***
	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)	(0.011)
Adj. R-squared	0.978	0.978	0.971	0.971	0.967	0.967
Obs.	740,025	674,283	740,025	674,283	740,025	674,283
Industry × Year FE	Yes	-	Yes	-	Yes	-
State × Year FE	Yes	-	Yes	-	Yes	-
Industry × State × Year FE	No	Yes	No	Yes	No	Yes
Industry × State × Size-Category FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 7: Impact of regulatory costs on firms - external financial dependence

This table shows how regulatory costs impact firm level variables. The dependent variables are the logarithm of number of establishments, employment and wages in Columns 1, 2 and 3, respectively. *Small Establishment* is a dummy for small establishments. *Regulatory Costs* is regulatory compliance costs in dollars at the Industry × Size-Category level. The standard errors are clustered at the industry level. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

	log(N)		log(Emp)		log(Wages)	
	(1) 1977-2016	(2) 1996-2016	(3) 1977-2016	(4) 1996-2016	(5) 1977-2016	(6) 1996-2016
Log(Regulatory Costs) × Small Firm	-0.0288***	-0.0458***	-0.0314***	-0.0471***	-0.0391***	-0.0557***
	(0.003)	(0.004)	(0.003)	(0.005)	(0.003)	(0.005)
Log(Regulatory Costs) × Small Firm × External Financial Dependence	-0.0006*	-0.0001**	-0.0006*	-0.0001***	-0.0006*	-0.0001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R-squared	0.983	0.978	0.970	0.971	0.971	0.966
Obs.	1,212,223	573,818	1,212,223	573,818	1,212,223	573,818
Industry × State × Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Industry × State × Size-Category FEs	Yes	Yes	Yes	Yes	Yes	Yes

Table 8: Impact of regulatory costs on firms: controlling for change in technology

This table shows how regulatory costs impact firm level variables controlling for the change in technology. The dependent variables are the logarithm of sales, employment and markups in Columns 1, 2 and 3, respectively. Variables with E and S represent dummies constructed for the respective ranges in terms of employees and percentile groups according to share of sales. *Reg. Costs* is regulatory compliance costs in dollars at the firm level. The standard errors are clustered at the industry level. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

	log(Sale)	log(Emp)	log(Markup)	Profit Rate
	(1)	(2)	(3)	(4)
log(Reg. Costs)	0.040***	0.037***	0.003	-0.002
	(0.014)	(0.011)	(0.013)	(0.014)
log(Reg. Costs) $\times$ E <500	-0.056***	-0.051***		
	(0.010)	(0.008)		
log(Reg. Costs) $\times$ 1000$\geq$ E <5000	0.035***	0.036***		
	(0.006)	(0.004)		
log(Reg. Costs) $\times$ 5000$\geq$ E <10000	0.056***	0.067***		
	(0.008)	(0.006)		
log(Reg. Costs) $\times$ E $\geq$10000	0.066***	0.096***		
	(0.010)	(0.008)		
log(Reg. Costs) $\times$ 50$\leq$ S <75			0.020***	0.009*
			(0.005)	(0.005)
log(Reg. Costs) $\times$ 75$\leq$ S <90			0.032***	0.012**
			(0.008)	(0.006)
log(Reg. Costs) $\times$ S $\geq$90			0.038***	0.014**
			(0.011)	(0.006)
Adj. R-squared	0.929	0.962	0.568	0.261
Obs.	12,136	12,086	12,103	12,103
Firm Fixed Effects	Yes	Yes	Yes	Yes
State $\times$ Industry $\times$ Year Fixed Effects	Yes	Yes	Yes	Yes
TFP Controls	Yes	Yes	Yes	Yes

Table 9: Impact of regulatory costs on industry concentration

This table shows how regulatory costs impact industry concentration. *Regulatory Cost Ratio* and dependent variables are defined in Section 5.3. The standard errors are clustered at the industry level. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

	Share of small est.		Share of >1000 est.		log(large est/small est)	
	(1)	(2)	(3)	(4)	(5)	(6)
Log(Regulatory Cost Ratio)	-0.020***	-0.019***	0.030***	0.028***	0.221***	0.208***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.006)	(0.006)
Adj. R-squared	0.773	0.787	0.686	0.716	0.651	0.671
Obs.	238,001	237,906	238,001	237,906	238,001	237,906
Ind × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Ind × State FE	Yes	Yes	Yes	Yes	Yes	Yes
State × Year FE	No	Yes	No	Yes	No	Yes

Table 10: Impact of regulatory costs on industry concentration: placebo

This table presents a placebo test of the variables in Table 9. *Regulatory Cost Ratio* and dependent variables are defined in Section 5.3. Regulatory costs are calculated using regulations that were proposed but were not passed as final rules. The standard errors are clustered at the industry level. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

	Share of small est.	Share of >1000 est.	log(large est/small est)
	(1)	(2)	(3)
Log(Regulatory Cost Ratio)	0.002	0.000	-0.004
	(0.003)	(0.003)	(0.010)
Adj. R-squared	0.782	0.702	0.614
Obs.	237,906	237,906	237,906
Ind × Year FE	Yes	Yes	Yes
Ind × State FE	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes

Table 11: Impact of regulatory costs on industry concentration: firm level data

This table shows how regulatory costs impact industry concentration using Compustat data. *Regulatory Cost Ratio* and dependent variables are defined in Section 5.3. The standard errors are clustered at the industry level. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

	Sale HHI		Share of small firms		Share of >1000 firms		log(large firm/small firm)	
	(1) 1977-2016	(2) 1996-2016	(3) 1977-2016	(4) 1996-2016	(5) 1977-2016	(6) 1996-2016	(7) 1977-2016	(8) 1996-2016
Log(Regulatory Cost Ratio)	0.013***	0.010**	-0.004***	-0.003**	0.013***	0.006**	0.141***	0.125***
	(0.004)	(0.005)	(0.001)	(0.001)	(0.003)	(0.003)	(0.033)	(0.038)
Adj. R-squared	0.744	0.792	0.609	0.617	0.603	0.609	0.725	0.748
Obs.	4,298	2,125	4,298	2,125	4,298	2,125	4,298	2,125
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3-digit NAICS Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 12: Regulatory costs and relationship between Tobin's Q and entry

This table shows how regulatory costs and relationship between median Tobin's Q at the industry level and entry are related (Covarrubias et al. (2020)). *Regulatory Cost Ratio* is defined in Section 5.3. The standard errors are clustered at the industry level. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

	Entry Rate			
	(1) 1977-1995	(2) 1996-2016	(3) 1977-1995	(4) 1996-2016
Median(Q)	0.0053***	0.0002***	0.0042***	-0.0002
	(0.0012)	(0.0000)	(0.0012)	(0.0002)
Log(Regulatory Cost Ratio)			0.0261	-0.0035
			(0.0726)	(0.0398)
Log(Regulatory Cost Ratio) × Median(Q)			0.0051*	-0.0001**
			(0.0027)	(0.0000)
Adj. R-squared	0.819	0.803	0.804	0.800
Obs.	6,659	5,808	5,366	5,173
Industry Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes

Table 13: Regulatory costs and investment

This table shows how regulatory costs and investment relative to Tobin's Q of the industry and industry leaders are related. *Regulatory Cost Ratio* is defined in Section 5.3. The standard errors are clustered at the industry level. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

	Industry Investment Rate		Leader Investment Rate	
	(1)	(2)	(3)	(4)
	1977-1995	1996-2016	1977-1995	1996-2016
Log(Regulatory Cost Ratio)	199.681	-671.012**	199.479	-672.695**
	(179.662)	(317.697)	(179.662)	(317.626)
R-squared	-0.0194	0.0172	-0.0195	0.0172
Obs.	2,570	2,501	2,570	2,501
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

Table 14: Regulatory costs and productivity

This table shows how regulatory costs and productivity of firms and prices set by them are related. *Regulatory Cost Ratio* is defined in Section 5.3. The standard errors are clustered at the industry level. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

	TFP		Price	
	(1) 1977-1995	(2) 1996-2016	(3) 1977-1995	(4) 1996-2016
Log(Regulatory Cost Ratio)	0.003*	-0.007***	-0.012***	0.021***
	(0.002)	(0.002)	(0.004)	(0.004)
R-squared	0.923	0.525	0.966	0.611
Obs.	3,963	4,078	3,963	4,078
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

Table 15: Regulatory costs and intangible investment

This table shows how regulatory costs impact intangible investment of firms. *Regulatory Cost Ratio* is defined in Section 5.3. The standard errors are clustered at the industry level. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

	Intangibles	
	(1)	(2)
	1977-1995	1996-2016
Log(Regulatory Cost Ratio)	0.051*	-0.010
	(0.030)	(0.027)
R-squared	0.919	0.863
Obs.	2,447	2,474
Year FE	Yes	Yes
Industry FE	Yes	Yes

Table 16: Position of firms on regulations

This table shows how position of large firms on regulation is related to the type of regulation. The standard errors are clustered at the regulation level. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

	Probability of Support			
	Regulation does not impact small firms	Regulations impacts small firms		
	(1)	(2)	(3)	(4)
Large Firm	-0.645***	0.810**		
	(0.181)	(0.346)		
Log(Employee)			0.471***	0.525***
			(0.131)	(0.133)
Log(Employee) × Log(Regulatory Cost Ratio)				0.098**
				(0.043)
Obs.	2,971	6,877	6,074	6,049
Firm Fixed Effects	-	-	Yes	Yes
Regulation Fixed Effects	-	-	Yes	Yes

Internet Appendix for:

"Regulatory Costs and Market Power"

Appendix A Additional Figures and Tables

Figure A.1: Differential impact of regulatory costs on firms - Number of Establishments

This figure shows how regulatory costs impact firms of different sizes compared to firms with 1-4 employees. The dependent variable is the logarithm of number of establishments. Regulations are restricted to those which impact both small and large firms. The dots indicate point estimates, and the vertical lines indicate 95% confidence intervals.

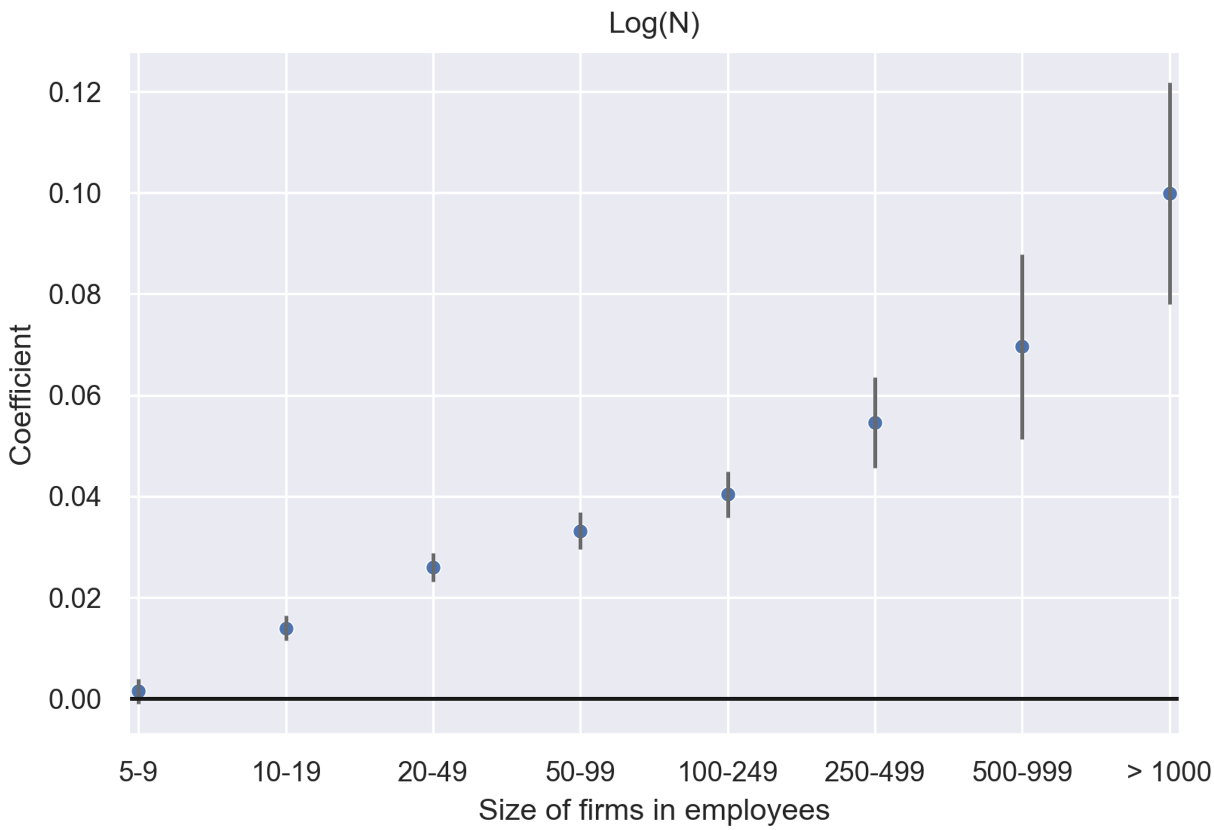

Figure A.2: Differential impact of regulatory costs on firms - Employees

This figure shows how regulatory costs impact firms of different sizes compared to firms with 1-4 employees. The dependent variable is the logarithm of employees. Regulations are restricted to those which impact both small and large firms. The dots indicate point estimates, and the vertical lines indicate 95% confidence intervals.

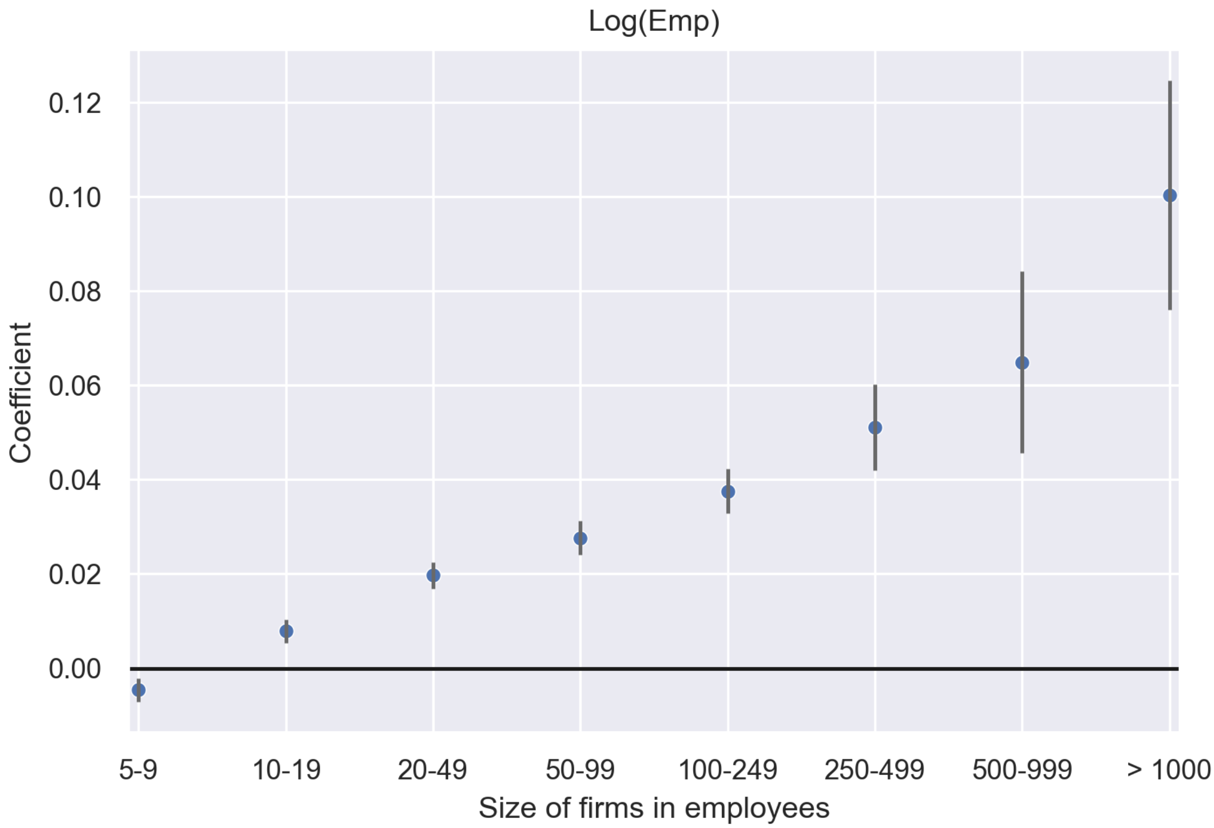

Figure A.3: Differential impact of regulatory costs on firms - Wages

This figure shows how regulatory costs impact firms of different sizes compared to firms with 1-4 employees. The dependent variable is the logarithm of wages. Regulations are restricted to those which impact both small and large firms. The dots indicate point estimates, and the vertical lines indicate 95% confidence intervals.

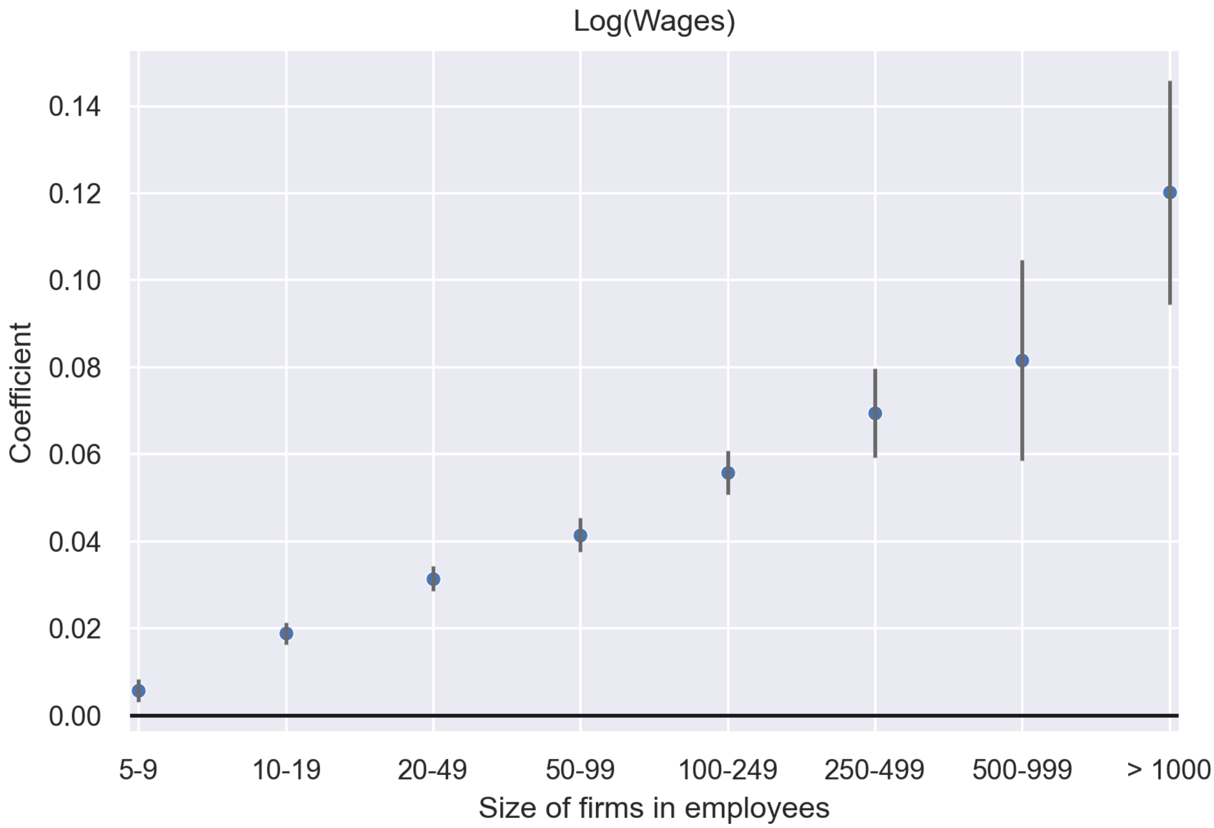

Table A.1: Impact of regulatory costs on firms: alternative specification

This table shows how regulatory costs impact firm level variables. The dependent variables are the logarithm of number of establishments, employment and wages in Columns 1, 2 and 3, respectively. *Small Establishment* is a dummy for small establishments. *Regulatory Costs* is regulatory compliance costs in dollars at the Industry × Size-Category level. The standard errors are clustered at the industry level. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

	log(N)		log(Emp)		log(Wages)	
	(1) 1977-2016	(2) 1996-2016	(3) 1977-2016	(4) 1996-2016	(5) 1977-2016	(6) 1996-2016
Log(Regulatory Costs)	0.015***	0.009**	0.018***	0.010***	0.023***	0.015***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)
Log(Regulatory Costs) × Small Establishment	-0.028***	-0.042***	-0.030***	-0.043***	-0.036***	-0.051***
	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.005)
Adj. R-squared	0.982	0.978	0.968	0.971	0.968	0.966
Obs.	1,564,077	740,025	1,564,077	740,025	1,564,077	740,025
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × State × Size-Category FE	Yes	Yes	Yes	Yes	Yes	Yes

Table A.2: Regulatory costs and productivity

This table shows how regulatory costs and productivity of firms and prices set by them are related. *Regulatory Cost Ratio* is defined in Section 5.3. The standard errors are clustered at the industry level. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

	TFP - Olley and Pakes (1992) with Ackerberg et al. (2015) Correction		TFP - Levinsohn and Petrin (2003) with Ackerberg et al. (2015) Correction	
	(1)	(2)	(3)	(4)
	1977-1995	1996-2016	1977-1995	1996-2016
Log(Regulatory Cost Ratio)	-0.0004	-0.0039***	0.0003	-0.0024*
	(0.003)	(0.001)	(0.003)	(0.001)
R-squared	0.809	0.878	0.838	0.886
Obs.	2,570	2,501	2,570	2,501
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes