Policy Form and Rate Regulation in the Property-Liability Insurance Market

by

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Dedicated to my beloved family

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ABSTRACT

The regulation of financial products plays an important role in U.S. financial markets. While there are benefits to regulation, policymakers must weigh these benefits against the costs. This dissertation studies the costs of complying with policy form and rate regulation in the U.S. property-liability (P/L) insurance market.

In the first chapter, we estimate the cost of complying with regulation by exploiting the rich cross-sectional and time-series variation in regulation, focusing on the regulation of policy forms. The costs of complying with stringent form regulation are significant, approximately 3.1 percent of the general expenses for the average insurer per line of business and year — $1.8 billion for the industry per year. The compliance costs are higher in personal lines of insurance. The burden of these costs falls unevenly on insurers, with the regulatory effects isolated to the firms writing less than $5 million in premiums in a line of business per year.

A potential way to reduce regulatory compliance costs is the use of digital technology to streamline the regulatory process. In Chapter 2, we leverage a quasi-experimental policy change which mandates use of an internet-based flow management tool that enables insurers and regulators to exchange form and rate filing information, and find that digitization lowers the costs of complying with regulation. The average insurer per line of business and year in the highest quartile regarding the proportion of business under the mandate saves 4.8 percent of general expenses. Our results also suggest a fixed cost of adopting the technology, with larger cost-saving accruing to firms that adopt the new technology more widely.

While Chapters 1 and 2 are closely related, the scope of the cost estimation is different in the two chapters. Chapter 1 focuses on the policy form regulation, and it contrasts stringent form regulation with non-stringent form regulation by measuring the *extra* costs of complying with stringent regulation compared to other types of regulation. In Chapter 2, we consider policy form and rate regulation as a whole and measure the costs of complying with all types of regulation. The two chapters complement each other and, in combination, provide empirical evidence of the costs of insurance product regulation.

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1 COMPLIANCE COSTS OF CONTRACT REGULATION

1.1 Introduction

Financial contracts are inherently complex. This complexity may make it difficult for consumers to understand, creating an informational asymmetry between consumers and financial institutions. As a result, financial contracts are often regulated.[1] While the regulation acts as a warranty of the contract for consumers, it is also costly as firms pay filing fees and hire staff, lawyers, and consultants to ensure regulatory compliance. This is particularly relevant in insurance markets, where the costs and delays associated with the regulation of insurance contracts are a subject of policy debate (Harrington 2009). This study measures the costs of complying with stringent contract regulation in the U.S. P/L insurance industry.

The U.S. insurance industry provides an ideal laboratory to study the effects of regulation. In contrast to other financial sectors that are subject to federal regulation, the insurance industry is primarily regulated at the state level. States regulate insurance contracts by validating the contract terms and language, which is often called "policy form regulation" or "form regulation" in the insurance context. States differ in how stringently they regulate policy forms at the line of business and year level, and our identification strategy relies on this variation. Many insurers operate in multiple states and provide insurance in both regulated and unregulated states in the same line of business and year. Many insurers also operate in multiple lines and, because of differences in state form regulation across lines, provide insurance in both regulated and unregulated lines in the same state and year. In addition, insurers operate in multiple years and, because of changes over time in form regulation, provide regulated and unregulated insurance in the same state and line of business. Finally, we leverage an institutional quirk — multi-state insurers can do business in some states on a licensed basis and in other states on an

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[1]The Consumer Financial Protection Bureau, a federal agency set up by the Dodd-Frank Act in 2010, has been actively looking into ways to clarify financial contracts for consumers (CFPB 2015; CFPB 2016).

unlicensed basis, and unlicensed business is free from policy form regulation.

We estimate the costs of complying with stringent form regulation by examining how an insurer's aggregate expenses change with its exposure to stringent regulation. The costs are both economically and statistically significant. For an average firm-line, the costs of complying with stringent form regulation are approximately 3.1 percent of general expenses. This corresponds to about $265,000 per year for an average firm-line observation in the sample, or $1.8 billion per year for the U.S. P/L insurance industry. The costs are isolated to firm-lines with below-average size (measured by net premiums written), indicating compliance is especially costly for small firms and firms with small business volume in a line. In addition, the compliance costs are higher in personal lines of insurance.

This research makes several contributions to the literature. First, it contributes to the research examining the impact of policy form regulation in insurance. Using a state-level data set from a national commercial insurer in 1999, Butler (2002) finds that form regulation slows product innovation, as the time between filing forms with the state and the introduction of the product to the market increases with stringent form regulation. Using the 1994 deregulation of the German P/L insurance market as a natural experiment, Berry-Stölzle and Born (2012) find that policy form regulation does not increase the unit price of insurance above competitive levels at the industry level. They further document that form regulation increases the unit price in highly competitive lines but decreases the price in other lines. We extend this literature by measuring the compliance costs of policy form regulation, leveraging both the cross-sectional and time-series variation in form regulation across states and lines in the U.S. P/L insurance market.

Second, this study adds to the research stream on the costs of insurance regulation. Unlike other financial sectors that are regulated at the federal level, the insurance industry provides a unique opportunity for studying the economics of regulation because it is primarily regulated at the state level, while the majority of the insurance business is interstate (Grace and Phillips 2007). Grace and Klein (2000) find that premiums written in states with a restrictive regulatory environment have no significant effect on insurer expenses, but the number of states in

which an insurer is licensed has a positive and significant effect. Leverty (2012) compares commercial liability insurers with risk retention groups that are exempt from multi-state regulation and finds significant costs associated with duplicative regulation. We advance this stream of research by studying compliance costs of different types of regulation at the firm-line-year level and measuring the regulatory stringency. This granularity allows us to exploit the heterogeneity of regulation across insurers, lines, and time.

In addition, this study is linked to the extensive literature on insurance rate regulation.[2] Prior research has focused on the insurance price under rate regulation and we study the costs of complying with rate regulation. In addition, most of these studies use data aggregated to the state-level in a single line of business, typically automobile,[3] workers' compensation,[4] or homeowner's insurance.[5] This study adds to the literature by examining the compliance costs of rate regulation at the firm-line-year level using all lines of business. Our findings provide mixed evidence regarding whether stringent rate regulation increases insurer expenses.

Finally, we contribute to the research on financial contracts regulation. Prior studies have examined the role of the complexity of contracts in financial market (Célérier and Vallée 2017; Alexandrov 2018) and the regulation of contracts to protect consumers (Campbell et al. 2011; Agarwal et al. 2017; Houdek et al. 2018). We provide empirical evidence showing the costs of contract regulation in an economically significant financial sector.

1.2   Institutional Background

Insurance policies can be difficult to understand. Facing a policy contract with dozens, if not hundreds, of pages filled with definitions, provisions, and exclusions, even a financially sophisticated person might be tempted to skip the details and

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[2]See Dionne and Harrington (2017) for a recent survey.

[3]Grabowski et al. (1989); Cummins et al. (2001);Cummins (2002); Grace and Phillips (2008); Weiss and Choi (2008); Grace et al. (2013).

[4]Carroll and Kaestner (1995); Kwon and Grace (1996); Danzon and Harrington (2001).

[5]Born and Klimaszewski-Blettner (2009); Born and Klein (2016).

sign the paperwork. One of the reasons why we trust that insurers are not taking advantage of us and leaving out important provisions in the contract is state regulation of policy forms, the contractual language that insurers use to describe their policies to consumers. All fifty states in the U.S. and the District of Columbia have their own laws concerning these forms, and the primary purpose is consumer protection. For example, Texas regulates forms "to ensure that the forms are not unjust, unfair, inequitable, misleading, or deceptive,"[6] and Arkansas regulates forms "to establish minimum language and format standards to make property and casualty insurance policies easier to read."[7] Forms can be regulated in various ways, including requiring or prohibiting specific language and terms, and mandating a minimum coverage for a certain type of policy.

Form regulation is conducted through a form filing and review system set up and maintained by the state insurance department. Specifically, filers (insurers, advisory organizations, or third-party filers) file their proposed contract and any other required materials to the regulator for review and approval. The state regulator (insurance commissioner) usually delegates the reviewing task to a team of reviewers, but the regulator makes the final decision. Similarly, insurance rates are regulated by each state using a rate filing and review system, but form and rate regulation are separately structured and administered. While this study focuses on form regulation, we include rate regulation in most analyses to examine the compliance costs of rate regulation as well.

There is a broad spectrum of stringency of form regulation across states, lines of insurance, and years. Some states have a "prior approval" system in which insurers are required to file a proposed insurance policy form with the state and obtain state approval before they can use it on the market. Other states have a "file and use" system where the forms must be filed (but not necessarily approved) before they are used. Some other states adopt a "use and file" system which only requires a form filing within a certain period of the product's initial marketing. Some states do not require any form filing at all. See Table A.1 for a description of the major form filing

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[6]Tex. Ins. Code § 2301.001.

[7]Ark. Code. Ann. § 23-80-302.

systems in the U.S. The stringency of form regulation also differs within a state at the line of business level. In general, personal lines are more stringently regulated than commercial lines. In addition, within a state-line, regulatory stringency varies over time. Within our study period, twenty-two states deregulated their form filing system from prior approval to other types of regulation, for at least one line of insurance. Tables A.2 to A.5 report the distribution of stringent form and rate regulation by state and year for personal and commercial lines of insurance.[8]

Figure 1.1 shows the cross-sectional and time-series variation exploited in this study. It documents the number of lines under stringent form regulation at the beginning (1992) and end (2014) of our study period. The variation in colors across the U.S. in a given year shows the cross-sectional heterogeneity in stringent form regulation among states. A comparison between 1992 and 2014 shows the time-series variation as some states changed how they regulate forms over time. For example, in 1992, Wisconsin regulated the policy forms stringently in 14 lines of insurance while Illinois did not regulate any line stringently. In 2014, Wisconsin stringently regulated only 1 line, while Illinois remained at zero stringently regu-lated lines. Similarly, Figure 1.2 displays the number of lines under stringent rate regulation in 1992 and 2014.

Form regulation comes with costs for both regulators and insurers. Regulators need to spend considerable resources on reviewing thousands of policy forms per year.[9] For insurers, direct compliance costs are incurred throughout the form filing process. Before filing the policy forms, they need to hire staff, consultants, or lawyers to examine the contracts and prepare other materials required by the state. At the filing and reviewing stage, they pay filing fees and communicate with the reviewer when a modification of contract is requested.[10]

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[8]The state form and rate filing system can be different for each line of business, including worker's compensation, medical professional liability, inland marine, and ocean marine. For simplicity, Tables A.2-A.5 report the systems for personal and commercial lines. But even within personal or commercial lines, some lines (e.g. personal auto insurance) may be under more scrutiny than others.

[9]For example, Illinois reviewed 28,926 P/L form filings in 2014 (Illinois Department of Insurance 2014)

[10]Authors' conversations with a former manager at a major national insurer reveal that the insurer has a task force specializing in form filing compliance.

The costs of complying with form regulation are incurred when an insurer introduces a new policy in a line and state. It incurs these costs in each state and each line. There are also costs when an insurer modifies a policy form to accommodate market demand or manage legal risk based on recent court decisions. Insurers can incur these costs every year and even multiple times within a year. Some of the costs of complying with form regulation can be amortized by selling the policy to many policyholders, creating potential for economies of scale.

Form regulation can also incur implicit costs in the commercial insurance market by putting insurers at a disadvantage when competing with alternative risk transfer mechanisms. Butler (2002) compares commercial insurance contracts and security contracts providing the same risk transfer coverage. If the insurance and investment bank subsidiary of the same group offer the insurance and security contracts respectively, only the insurance channel needs to bear the costs of form regulation compliance (including a delay in time-to-market).

A potential consequence of form regulation is product standardization, which may reduce compliance costs over time. It is not uncommon for a multi-state insurer to prepare a form that complies with multiple state regulators to expedite the review process and reduce compliance costs.[11] As a result, a "standard" policy form is adopted by this insurer in a different state. When insurers design new policies, they often refer to the coverage and language of competitors. Therefore, the standard form used by a leading insurer can define the baseline coverage offered by other insurers in the market. In this case, compliance costs can be lower as forms become more standardized. However, policy forms based on a standard policy adopted by different insurers can still deviate considerably from the standard form. For instance, Schwarcz (2011) finds that the homeowner's policy forms offered by the top ten insurers in a state differ significantly in the contract terms and language, even though all of these forms are based on the same standard policy offered by the Insurance Services Office.

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[11]In fact, Insurance Services Office — a private, national organization — maintains standardized forms that serve as the basis for almost all insurance policies. Nevertheless, these standard forms must be modified to conform to various state requirements.

1.3 Data and Sample

1.3.1 Regulatory Stringency Data

We compile a primary data set of the stringency of form and rate regulation at the state-line level, 1992-2014. Information on the form and rate filing systems in each state is collected from the NAIC's Compendium of State Laws on Insurance Topics (1998-2014), the American Institute of Marine Underwriters (2015), and the Inland Marine Underwriters Association (2000, 2014). We update the data using the state statutes and bulletins issued by state insurance commissioners.

We classify a state-line as under stringent form (rate) regulation if the state uses a prior approval form (rate) filing system for that line. This dichotomous approach, while widely adopted approach in the literature (Harrington 2002), could bias downward the estimate of the magnitude of compliance costs in two ways. First, the assortment of approaches to form regulation in the insurance industry is more nuanced than the stringent versus non-stringent categorization. The categorization of non-stringent form regulation includes variations of form regulation (e.g., file and use, use and file), albeit not as severe as prior approval. As a result, the strict categorization involved in this paper (and many others) might bias the results from finding a significant difference between stringent and non-stringent form regulation. Second, this definition is based on how regulation is structured by state statutes rather than how regulation is administered. In practice, regulators can use discretion in administering form regulation, which may be more stringent or more lenient than the statutes. In other words, stringent form regulation is "an attempt to treat" rather than a treatment. For both reasons, our estimate will likely be biased towards zero.

1.3.2 Insurer Data

The U.S. property and liability insurance industry consists of about 3,000 insurers operating in over 30 different product lines of business, including auto liability, commercial multiple peril, workers' compensation, etc. There are large insurers

like Berkshire Hathaway that write business in most, if not all, the product lines across states, as well as numerous small insurers specializes in a single line within a state.

This study uses a data set of all P/L insurers from the National Association of Insurance Commissioners (NAIC) statutory annual report database over a 23-year period, 1992-2014. This database is the most comprehensive source of insurer information available for the U.S. insurance market. For each year, we collect the firm-line level premium and expense data from the Insurance Expense Exhibit and firm-line-state level premium, loss, and expense data from the Exhibit of Premiums and Losses ("State Page"). The Exhibit of Premiums Written (Schedule T) is used to identify whether an insurer is licensed in each state. Unlicensed insurers are exempt from form and rate regulation. We also collect assets, liabilities, and policyholder surplus from the balance sheet at the firm-year level.

Distinct from prior literature in insurance regulation which usually focuses on a single line of business at the firm-year level, this study includes all lines of business in the P/L insurance market, and analyzes data at the firm-line-year level. This approach is advantageous because it allows us to control for unobserved time-invariant firm and line characteristics when studying multi-line insurers.

1.3.3 Measuring Regulatory Compliance Costs

The direct costs of regulatory compliance under form and rate regulation for insurers include the expenses, salaries, and consulting fees associated with making form and rate filings to the state (Grace and Klein 2000; Leverty 2012).

The ideal data for this study would be insurer expenses associated with regulatory compliance at the firm-line-state-year level, since regulatory stringency is applied at the line-state-year level. The NAIC database, however, does not provide a separate category of expenses for regulatory compliance, nor does it break down expenses at the firm-line-state-year level. We address these challenges in two ways.

First, while we do not have a single expense item dedicated to regulatory compliance, all compliance-related expenses are contained in the Acquisitions, Field

Supervisions, and Collection(AFSC) expenses and the general expenses reported by insurers. The AFSC expenses consist of all expenses incurred in the production of new and renewal business, including the operating costs of agencies and branches, writing new policy forms,[12] data processing, clerical, secretarial, office maintenance, supervisory, and executive duties. General expenses are also relevant, because they includes all expenses that are not assigned to other expense groups per the NAIC statutory accounting principles. Therefore, the combination of the AFSC and general expenses captures all the expenses related to an insurer's general operation including compliance costs.

Note that these expenses also include costs that are not linked to regulatory compliance, such as advertising, employee welfare, rent, and equipment, etc. This does not impact the measurement of compliance costs in the fixed effects models, as the models identify the *change* in expenses, rather than the expenses themselves. To accurately measure the compliance costs, we rely on an assumption: changes in the expenses (e.g. rent) that are unrelated to complying with policy form regulation across firms, lines, and time are uncorrelated with the regulatory stringency, which is plausibly true.

Specifically, we use the NAIC expense data to construct a general expense ratio, which we use as the dependent variable in our regressions. This ratio is defined as:

$$\textit{General Expense Ratio} = \frac{\text{General Expenses Incurred} + \text{Other AFSC expenses Incurred}}{\text{Net Premiums Written}},$$

Second, since we estimate the costs of complying with stringent regulation at the firm-year and firm-line-year level, we measure an insurer's exposure to treatment, stringent form (rate) regulation at both levels. *Stringent Form (Rate) Proportion* is the proportion of an insurer's direct premiums written in states with stringent form (rate) regulation:

$$\textit{Stringent Form Proportion} = \frac{\text{Direct Premiums Written under Stringent Form Regulation}}{\text{Direct Premiums Written}},$$

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[12]For example, 35.93 Wisconsin administrative code (2017), Ins. 6.30(3)(a)2.c states that the AFSC expenses "shall comprise all expenses incurred wholly or partially in the following activities: …writing policy contracts, and checking and directly supervising the work of policy writers."

$$\textit{Stringent Rate Proportion} = \frac{\text{Direct Premiums Written under Stringent Rate Regulation}}{\text{Direct Premiums Written}}.$$

1.3.4   Sample and Descriptive Statistics

The final sample is an unbalanced panel of 2,813 insurers in 14 lines[13] with 157,531 firm-line-year observations in the years 1992-2014. The data include all lines of property-liability insurance except financial/mortgage guaranty, fidelity/surety, credit, and warranty. In constructing the sample, we exclude firms with negative assets or liabilities and those with policyholder surplus less than $1 million. Risk retention groups are also excluded because they are largely exempt from regulation by nondomiciliary states (Born et al. 2009; Leverty 2012). At the firm-line-year level, we require net premiums written to be at least $100,000 and positive total expenses and general expenses. In some rare cases, the information about form or rate regulatory stringency for a state in a year is missing, and we remove the insurer data in this state-year from the analysis. Loss ratios and expense ratios are winsorized at the first and ninety-ninth percentile to reduce the effect of outliers.

Figure 1.3 shows the distribution of firm-year observations by the number of lines in which an insurer operates. Over three-quarters of the firms write policies in more than one line. Twenty-three percent operate in only one line. At the other end of the spectrum, 0.10 percent of firms operate in all 14 lines of insurance. The mean (median) firm operates in 4.40 (3) lines. Tables A.7-A.8 report the distribution by line of business. For each line of business, we report the number of insurer-year observations that write only that line (Column (1), 1 line). We also report the number of insurer-year observations that write that line and one other line (Column (2), 2 lines). We do this for all 14 lines. In addition to reporting the number of insurer-year observations in each line, we report the percentage of insurer-year observations that write that one line (or that line and one other line, two other lines, and so on). Forty-one percent of the insurers that write Medical Professional Liability (MPL)

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[13]We group lines from the NAIC database into 14 lines based on prior studies (e.g., Deng et al. 2017) with modifications. The categorization of lines is shown in Table A.6.

write only MPL, while fifteen percent write one additional line. Thus, a majority of MPL insurers are specialist insurers that focus on one or two lines. There are also a large number of specialist insureres in workers' compensation, where twenty percent of insurers write only workers' compensation insurance. Multi-line insurers dominate other lines.

Table 1.1 shows the summary statistics at the firm-year level and the firm-line-year level. At the firm-year level, as shown by Panel A, the average firm writes 64% of its premiums under stringent policy form regulation and 31% under stringent rate regulation.[14] The average loss ratio is 0.67, and the average total expense ratio is 0.35. The loss ratio and total expense ratio are adjusted by the present value factor to ensure comparability across lines (Cummins and Danzon 1997; Phillips et al. 1998).[15] About two percent of firm-line observations are from insurers entering a line (in their first or second year) or exiting the line (in their last or second last year).

Panel B shows the summary statistics of the firm-line-year level data, which are used for the main analysis. The average firm-line writes 58% of its premiums under stringent form regulation and 26% under stringent rate regulation. The average loss ratio is 0.76, and the average total expense ratio is 0.34. The average general expense ratio is 0.19, which suggests nearly one-fifth of premiums are spent on the general operation of insurers. With over $550 billion of premiums written in the U.S. P/L insurance market in 2017, the general expenses are economically important ($105 billion). Next, we discuss the empirical strategy to identify the costs of regulatory compliance.

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[14]The average *Stringent Form Proportion* is 0.69 in 1992 and 0.53 in 2014, and the standard deviation is 0.37 in both years, suggesting cross-sectional and time-series variation in insurer exposure to stringent regulation.

[15]Specifically, we apply the Taylor separation (Taylor 1977) to estimate yearly proportions of loss development for each line, using loss data from the A. M. Best Aggregates and Averages and risk-free interest rates from the FRED database of the Federal Reserve Bank of St. Louis.

1.4 Empirical Design

The identification strategy exploits the rich variation in form and rate regulatory stringency across states, lines of business, and time. First, not all states require stringent regulation (i.e., prior approval) of forms or rates. Second, even in the states with a prior approval system, it does not always apply to all lines of insurance. Third, within a state-line there is variation over time. During the study period twenty-two states deregulate by switching from prior approval of forms to non-stringent regulation in at least one line of business. Finally, multi-state insurers may conduct business in some states on a licensed basis and in other states on an unlicensed basis, and unlicensed business is exempt from policy form and rate regulation.

In the following analyses, we first use the firm-year level data to estimate the costs of complying with form regulation, following the common practice by prior studies. Then we exploit the granularity of the data and estimate compliance costs at the firm-line-year level.

1.4.1 Firm-Year Level Analysis

We use the following fixed effects regression model (1.1) to examine the effect of form and rate regulation on the general expense ratio at the firm-year level, where firm and year fixed effects are included. We include the size of the insurers in the model to explore possible economies of scale. We also control for an insurer's entry and exit information because the insurer's costs of complying with regulation are likely quite different when an insurer enters or exits the market.

$$
\begin{aligned}
Y_{it} = \ & \beta_1 \textit{Stringent Form Proportion}_{it} + \beta_2 \textit{Stringent Rate Proportion}_{it} \\
& + \gamma X_{it} + \lambda_i + \theta_t + \epsilon_{it},
\end{aligned}
\tag{1.1}
$$

where Y_{it} is the general expense ratio of firm i in year t. *Stringent Form (Rate) Proportion* measures the proportion of business written under stringent form (rate)

regulation for firm i in year t. X_{it} is a vector of control variables including size (natural logarithm of net premiums written by firm i in year t) and entry and exit behavior of firm i in year t. λ_i and θ_t are the firm and year fixed effects, respectively. ϵ_{it} is a random error term. Standard errors are clustered at the firm level to allow for within-firm correlation of the error term.

The main variable of interest is *Stringent Form Proportion*. *Stringent Rate Proportion* controls for potential correlation between policy form regulation and rate regulation. Firm fixed effects are included to isolate the regulatory effect using only the within-firm variation, controlling for unobserved firm characteristics that are time-invariant. We include year fixed effects to control for any unobserved industry-wide time trend.

β_1 measures the effect of an increase in the proportion of business under stringent form regulation on the general expense ratio for a firm. If β_1 is positive, it suggests compliance costs associated with stringent form regulation are greater than zero. If we find it to be negative, it suggests that stringent form regulation helps insurers save costs of general operations by standardizing contract language and simplifying the product design process. Similarly, a positive and significant β_2 suggests considerable compliance costs associated with stringent rate regulation, while a negative β_2 implies that stringent rate regulation reduces insurers' operational costs.

1.4.2 Firm-Line-Year Level Analysis

While the firm-year level analysis controls for any firm-specific characteristics when identifying the compliance costs of stringent form regulation, it has some limitations. If insurers have different levels of compliance costs in different lines of business, they may choose to write more business in the low-cost lines, which changes their proportion of premiums written under stringent regulation. To mitigate this concern, we exploit the firm-line-year level data for more precise estimates of compliance costs.

We use a fixed effects regression model (1.2) where firm, line, and year fixed

effects are included separately:

$$Y_{ilt} = \beta_1 \textit{Stringent Form Proportion}_{ilt} + \beta_2 \textit{Stringent Rate Proportion}_{ilt}$$
$$+ \gamma X_{ilt} + \lambda_i + \delta_l + \theta_t + \epsilon_{ilt}, \tag{1.2}$$

where Y_{ilt} is the general expense ratio of firm i in line l and year t. *Stringent Form (Rate) Proportion* measures the proportion of business written under stringent form (rate) regulation for firm i in line l and year t. X_{ilt} is a vector of control variables including size (natural logarithm of net premiums written by firm i in line l and year t), loss volatility (standard deviation of the loss ratios in line l, year t), and entry and exit behavior of firm i in line l and year t. $\lambda_i, \delta_l, \theta_t$ are the firm, line, and year fixed effects, respectively. ϵ_{ilt} is a random error term. Standard errors are clustered at the firm level to allow for within-firm correlation of the error term.

We include firm fixed effects to isolate the regulatory effect using only the within-firm variation, controlling for unobserved firm characteristics that are line- and time-invariant. Similarly, we include line and year fixed effects to control for unobserved line characteristics and time trends.

β_1 measures the effect of an increase in the proportion of business under stringent form regulation on the general expense ratio for a firm-line. If β_1 is positive, it suggests compliance costs associated with stringent form regulation are greater than zero. If we find it to be negative, it suggests that stringent form regulation helps insurers save costs of general operations by standardizing contract language and simplifying the product design process. Similarly, a positive and significant β_2 suggests considerable compliance costs associated with stringent rate regulation, while a negative β_2 implies that stringent rate regulation reduces insurers' operational costs.

We estimate two other regressions to identify compliance costs using different sources of variation. While firm fixed effects control for time- and line-invariant firm characteristics, it is possible that differences between firms are not the same across all years or lines. Therefore, we estimate a regression with firm-year and line fixed effects to identify the costs based on insurers that write more than one

line in a year when there is variation in how these lines are regulated. We also estimate a regression with firm-line and year fixed effects to identify the costs based on insurers that write the same line in multiple years, during which the regulatory stringency of that line changes.[16]

The variation used to identify compliance costs is exogenous if two assumptions hold. The first assumption is that states do not change the regulatory system in response to political pressures. For example, state legislators may be influenced if insurers unify and apply political pressure for less regulation. In this case, states with higher compliance costs of form regulation are more likely to switch from stringent to non-stringent systems, and the compliance costs might be underestimated. The second assumption is that the insurers that are more (less) efficient in complying with regulation do not select to operate in state-lines in a systematic way.[17] If this assumption does not hold, the compliance costs might be overestimated or underestimated. Since these potential endogeneities could bias the estimated costs towards zero, our results provide, at least, a lower bound of compliance costs.

1.4.3 Economies of Scale

Once a policy form is approved for use by a regulator, there is no regulatory limit on the number of policies an insurer can sell using this form. Large insurers can amortize their compliance costs among the insurance buyers. Therefore, we hypothesize that there are economies of scale: insurers that sell a large number of policies in a line can spread the fixed costs of compliance across the policyholders and are thereby less affected by stringent regulation. This is also confirmed by previous studies on cost of complying with regulation in general in the insurance (Grace and Klein 2000; Leverty 2012) and the banking industry (Dahl et al. 2016).

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[16]Singleton groups, i.e. groups with only one observation in fixed effects models may lead to incorrect inference (Correia 2015). To verify our findings are robust to the inclusion of singleton groups, we apply a Stata package "reghdfe" to estimate the regressions while eliminating singleton groups iteratively. The results remain unchanged and are available upon request.

[17]A t-test comparing the general expense ratio between the group of firm-lines with *Stringent Form Proportion* above and below the median fails to reject the hypothesis that the average general expense ratios of the two groups are equal, providing supporting evidence for this assumption.

To test the hypothesis, we estimate the following regression with an interaction between *Stringent Form (Rate) Proportion* with *LN(NPW)* (and the other two regressions with different sets of fixed effects):

$$
\begin{aligned}
Y_{ilt} =\ & \beta_1 \textit{Stringent Form Proportion}_{ilt} + \tilde{\beta}_1 \textit{Stringent Form Proportion}_{ilt} \times LN(NPW)_{ilt} \\
& + \beta_2 \textit{Stringent Rate Proportion}_{ilt} + \tilde{\beta}_2 \textit{Stringent Rate Proportion}_{ilt} \times LN(NPW)_{ilt} \\
& + \beta_3 LN(NPW)_{ilt} + \gamma X_{ilt} + \lambda_i + \delta_l + \theta_t + \epsilon_{ilt},
\end{aligned}
$$

$$(1.3)$$

where all variables are defined as in equation (1.2). $\tilde{\beta}_1$ identifies how the effect of stringent form regulation on compliance costs changes with the size of a firm-line (*LN(NPW)*). A positive (negative) $\tilde{\beta}_1$ suggests a larger (smaller) burden of regulatory compliance costs for large firm-lines. If $\tilde{\beta}_1$ is not significantly different from zero, we would conclude that firm-line size does not affect the way in which stringent form regulation raises insurers' general expenses.

1.5 Estimation of Regulatory Compliance Costs

1.5.1 Firm-Year level

The firm-year level regression results show that there are significant compliance costs associated with stringent form regulation. The results are reported in Table 1.2. Regression (1) includes *Stringent Form Proportion*; Regression (2) includes *Stringent Rate Proportion*; and Regression (3) includes both *Stringent Form Proportion* and *Stringent Rate Proportion*.

The primary finding is that there are significant compliance costs for stringent form regulation. The coefficients on *Stringent Form Proportion* are positive and statistically significant in (1) and (3). We interpret the economic impact of stringent form regulation on compliance costs using the coefficient estimate on *Stringent Form Proportion* from Regression (3), 0.023. For the average insurer in the sample with a *Stringent Form Proportion* of 0.64, this coefficient translates to a 0.015 increase in the general expense ratio. This increase corresponds to an effect size of 7.2 percent

with a mean general expense ratio of 0.205. For the average insurer, the costs of complying with stringent form regulation (compared to no stringent regulation at all) are about 1.5 percent of the premiums written.

We also find that there are compliance costs for stringent rate regulation, although it is only significant at the 10% level when controlling for stringent form regulation. For the average insurer in the sample with a *Stringent Rate Proportion* of 0.31, the coefficient estimate of *Stringent Rate Proportion* in Regression (3), Table 1.2 (0.020) translates to a 0.006 increase in the general expense ratio.This increase corresponds to an effect size of 3.0 percent. For the average insurer, the costs of complying with stringent rate regulation (compared to no stringent regulation at all) are about 0.6 percent of the premiums. This finding suggests that the costs of complying with form regulation are greater than for rate regulation.

In addition, there is evidence of economies of scale: the general expense ratio falls as firm size (natural logarithm of the net premiums written) increases. The general expense ratio is significantly lower during the first two years of entry, suggesting expenses build over time. Expenses are higher in the year that an insurer exits the market, likely because when an insurer exits it reduces its premiums written while still incurring expenses.

In summary, the firm-year level estimation suggests that insurers bear economically and statistically significant costs of complying with stringent policy form regulation. Next, we move on to the firm-line-year level analysis, which better exploits the granularity of the firm-line level expense data from the NAIC database.

1.5.2 Firm-Line-Year Level

1.5.2.1 Main Results

Table 1.3 displays the results of regressions on the general expense ratio at the firm-line-year level. Regression (1) includes firm, line and year fixed effects and exploits variation across lines and years within a firm. Regression (2) includes firm-year and line fixed effects and relies on cross-line variation within a firm-year

to identify the effect of stringent form and rate regulation. Regression (3) includes firm-line and year fixed effects and exploits variation across years within a firm-line.

The primary finding is that stringent form regulation increases insurer expenses. The coefficient on *Stringent Form Proportion* is positive and statistically significant with a stable magnitude across all the specifications. We interpret the economic effect of stringent form regulation using the most conservative estimate, 0.010 (the smallest across the three regressions). For an average firm-line observation with a *Stringent Form Proportion* of 0.58, this coefficient translates to a 0.006 increase in the general expense ratio, corresponding to an effect size of 3.1 percent with a mean general expense ratio of 0.19. This translates to about \$265,000 per year for an average firm-line observation, or \$1.8 billion per year for the U.S. P/L insurance industry. Note that the coefficient estimates of *Stringent Form Proportion* are smaller compared to the firm-year level results. The firm-line-year level analysis controls for cross-line differences and yields more accurate estimates.

In contrast to the firm-year level results in Section 1.5.1, the evidence does not support that stringent rate regulation increases expenses. One explanation is the heterogeneity in the average expense level across lines of business. Table 1.4 reports the coefficients on the line of business indicator variables from Regression (1) and (2) in Table 1.3.[18] The results indicate that general expenses vary significantly by line of business. Notably, the lines that are most commonly subject to strict rate regulation (e.g., homeowners, personal auto, and workers' compensation) are also lines with higher expense levels, suggesting that there is potential spurious correlation between stringent rate regulation and expenses. In the firm-line-year level regressions, we address this issue by including the line fixed effects in (1) and (2) and the firm-line fixed effects in (3) that account for the cross-line differences in expenses.

Lastly, there is evidence of economies of scale as firm-line size (*LN(NPW)*) is negatively related to the general expense ratio. The general expense ratio is significantly lower during the first two years of entry into a line and higher in the last

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[18]Because firm-line fixed effects are included, there are no line of business indicator variables in Regression (3).

year before an insurer exits a line, both of which reconcile with our findings at the firm-year level.

1.5.2.2 Heterogeneity with Firm-Line Size

The results in Section 1.5.2.1 indicate economies of scale at the firm-line-year level. To further explore the effect of firm-line size on compliance costs, we report the regression estimates of equation (1.3) and the other two fixed effects regressions in Table 1.5. The results confirm our prediction: the coefficient on the interaction term *Stringent Form Proportion × LN(NPW)* is negative and statistically significant in Columns (1) and (3).

   Figure 1.4 shows the marginal effect of *Stringent Form Proportion* as *LN(NPW)* increases from its minimum to maximum value. The marginal effect is positive and significant when the size of the firm-line is below average. However, as the size of the firm-line increases beyond the average, the marginal effect is not significantly different from zero. The mean firm-line size in the sample is 15.44, which translates to approximately $5.08 million in net premiums written. Therefore, for insurers that write less than $5 million in premiums per year in a line, the impact of stringent form regulation on compliance costs is significant. Insurers writing more than $5 million in premiums can spread the costs of complying with form regulation across their policyholders, due to economies of scale. A similar analysis for stringent rate regulation finds no evidence of stringent rate regulation affecting the general expense ratio at any level of firm-line size.

1.5.2.3 Sub-sample Analyses on Personal and Commercial Lines

Next, we investigate whether the compliance costs of form regulation are concentrated on certain lines of business. For example, Harrington (2000) advocates complete deregulation of policy forms sold to medium and large businesses. It is also relevant to understand whether the compliance costs are different between personal and commercial lines for the consumer welfare purposes, especially as personal lines take up over half of the P/L insurance industry (NAIC 2017).

We re-estimate the firm-line-year level regressions in Columns (1)-(3) in Table 1.3 from Section 1.5.2.1 separately on personal lines and commercial lines. The results for personal lines are reported in Tables 1.6. Table 1.7 shows the results for commercial lines. For personal lines, the coefficient estimate of *Stringent Form Proportion* is positive and statistically significant at the 1% level in all three regressions in Table 1.6. For commercial lines, the coefficient estimate is positive in all the specifications, but only statistically significant in Regression (1). The evidence is consistent with the conventional view that regulation is more stringent in personal lines, thus generating greater compliance costs in personal lines. We interpret the economic effect of stringent form regulation in personal lines using a conservative estimate, 0.029 (the smallest across the three regressions in Table 1.6). For an average firm-line observation with a *Stringent Form Proportion* of 0.77, this coefficient translates to a 0.022 increase in the general expense ratio, representing an effect size of 12.6 percent with a mean general expense ratio of 0.177. Note that the effect size is a much larger estimate compared to the estimate of 3.1 percent from the main analysis, suggesting that compliance costs of policy form regulation in personal lines are of great importance for policy making consideration.

1.5.2.4   Single-State Insurers

As discussed in Section 1.3.2, an empirical challenge of this study is that the insurer data are not available at the state level where the regulation is enforced. The data, however, are available for a subset of our sample: single-state insurers, i.e. firm-lines that only operate in a single state in a year.[19] For this subsample, we can also include state fixed effects to control for any state-level variation that is unrelated to regulatory compliance.

We estimate the following regression on single-state firm-line-year observations:

$$
\begin{aligned}
Y_{ilts} = {} & \beta_1 \textit{Stringent Form Regulation}_{ilst} + \beta_2 \textit{Stringent Rate Regulation}_{ilst} \\
& + \gamma X_{ilst} + \lambda_i + \delta_l + \theta_t + \eta_s + t\eta_s + \epsilon_{ilst},
\end{aligned}
\tag{1.4}
$$

_____

[19]Results are similar when we further require the entire firm only appear in a single state in a year.

where *Stringent Form Regulation*$_{ilst}$ is an indicator variable of whether the firm-line is subject to stringent form regulation in state s in year t. η_s is the state fixed effect, and $t\eta_s$ is a state linear time trend. All other variables are defined as in Section 1.4.2 except for an additional subscript s, denoting the state where a firm-line operates. The standard errors are clustered at the state level to allow for cross-year correlation of the error term within a state (Bertrand et al. 2004).

We estimate two other regressions using different combinations of fixed effects to exploit different sources of variation. While firm fixed effects control for time- and line-invariant firm characteristics, it is possible that differences between firms are not the same across all years or all lines. Therefore, we estimate a regression with firm-year, line, and state fixed effects to identify the costs using insurers that write more than one line in a year when there is variation in how these lines are regulated. Also, we estimate a regression with firm-line, year, and state fixed effects to identify the costs based on insurers that write the same line in multiple years, during which the regulatory stringency of that firm-line changes (mostly via deregulation by the state).

We report the results in Table 1.8. The coefficient on *Stringent Form Regulation* is 0.009 in Regressions (1) and 0.012 in Regression (2). Both are statistically significant at the 10 percent level. The coefficient on *Stringent Form Regulation* in Regression (3) is not significantly different from zero. With 64 percent of the observations under stringent form regulation in this sample, the coefficients in Regression (1) and (2) translates to an effect size of 3.0-4.0 percent with the average general expense ratio at 0.193. The magnitude is close to the estimate of 3.1 percent in our firm-line-year level results in Table 1.3. Therefore, the analysis of single-state observations provides estimates of compliance costs for stringent form regulation that are similar to the economic effects generated by our main analysis, though the estimates are less precise due to a reduction in sample size (from 157,531 to 48,232).

1.5.3 Robustness

1.5.3.1 Falsification Test with Randomized Regulatory Stringency

A potential concern is that the estimated effects of stringent form regulation on general expenses may be spurious. To a large extent, our research design mitigates this concern. The firm fixed effects control for any unobserved firm characteristics that are universal across the lines and years in which the firm operates. The line fixed effects control for the time-invariant differences in insurers' expense structure between lines of business. The year fixed effects control for any industry-wide time trend. Nevertheless, we perform a falsification test in which we falsely assume when and where treatment occurs. This way, we examine the probability that we would find a regulatory effect on expenses of the same size or larger as in our main analysis.

We re-estimate the main specification with placebo treatments of stringent form regulation, constructed using randomly reshuffled regulatory stringency. Given a line of business and a year, we randomly assign the stringency of form regulation to each state following the empirical distribution for the same line-year. For example, if 20 states used stringent form regulation for homeowner's insurance in 1992, we would draw a random sample of 20 states out of the 50 states and Washington D.C., and falsely assume that these 20 states were exactly those regulating homeowner's policy forms stringently in 1992. We repeat the random reshuffling 1,000 times.

Figure 1.5 plots the histogram of the estimated coefficients on the 1,000 placebo treatments of *Stringent Form Proportion* for Regression (1) in Table 1.3. The mean (median) coefficient of the placebo treatments is 0.004 (0.004) with a standard deviation of 0.001. The coefficient is 0.002 at the 1st percentile and 0.007 at the 99th percentile. In contrast, the corresponding estimate in Table 1.3, Column (1) is 0.015, which is 11 standard deviations above the average placebo estimate. The results are similar for Regressions (2) and (3) in Table 1.3 (results available upon request). The falsification tests show that the probability of finding an effect of stringent form regulation on expenses as large as we do by chance is almost zero.

1.5.3.2 Alternative Measures of Exposure to Stringent Regulation

In the main analysis, the key independent variable of the exposure to stringent form regulation for a firm-line observation is measured by the proportion of premiums written in states under stringent regulation. A potential concern is that premiums may be endogenous because they are determined by insurance firms, who may strategically choose the amount of premiums to write in a state based on the regulatory stringency. Firms that can achieve compliance with stringent regulation at lower costs may choose to write more premiums in a state under stringent regulation. Therefore, this endogeneity is expected to bias the estimated costs toward zero, yet significant compliance costs are found in Section 1.5.2.1. Nonetheless, we test the robustness of the main results by using three alternative measures of exposure to stringent regulation.

First, we use the proportion of premiums written in states under stringent regulation in the previous year (a one-year lag variable). Second, when constructing the proportion of premiums in each state, we match the premiums written in the previous year (instead of current year) with the regulatory stringency in the current year. Third, we use the proportion of losses incurred (instead of premiums written) in computing the proportions of business under stringent regulation. The endogeneity concern is alleviated to the extent that the insurer does not have control over the these measures. The results (available upon request) are virtually the same as the main estimates.

1.5.3.3 Insurer Selection of Entering Stringently Regulated State-Lines

A related concern is that insurers that are less cost efficient in regulatory compliance may choose not to operate in states that are subject to stringent regulation. To mitigate this concern, we re-estimate the regressions excluding the firm-line observations with 100% of premiums subject to stringent form regulation (i.e., with a *Stringent Form Proportion* = 1) and those with 0% of premiums subject to stringent form regulation (i.e., with a *Stringent Form Proportion* = 0). The resulting sample includes all firm-line observations that write business in state-lines with stringent

and with non-stringent regulation. The results are reported in Table A.9, and are largely in agreement with the main results. In addition, the regressions on data with *Stringent Form Proportion* to be between 5% and 95% and between 10% and 90% are also estimated, and we find similar results.

1.5.3.4 Influential Lines or Years

To address the potential concern that our findings may be driven by a certain line or year in the data, we re-estimate the regressions while dropping one line of insurance or one year at a time. The estimates (available upon request) remain unchanged, suggesting our results do not rely on a single year or line.

1.5.3.5 Multicollinearity between Form and Rate Regulation

Finally, there is a potential concern is that stringent form and stringent rate regulation often exist in a state-line simultaneously, which reflects the overall regulatory stringency of the state regulator and may lead to bias in our estimation of the effect of stringent form regulation. In our data, the correlations between *Stringent Form Proportion* and *Stringent Rate Proportion* are 0.33 at the firm-year level and 0.37 at the firm-line-year level, suggesting it is unlikely that there is a multicollinearity issue. In addition, we perform robustness checks by estimating regressions in Tables 1.3 and 1.5 on form regulation variables only and on rate regulation variables only. The results are reported in Tables A.10 and A.11. The findings are consistent with our main analyses.

1.5.3.6 Alternative Model Specification

In the main analysis, we follow the approach used in the literature (Grace and Klein 2000; Leverty 2012) and measure expenses using the general expense ratio. To ensure our findings are robust to alternative specification of the functional form, we estimate the following regression:

$$Y_{ilt} = \beta_1 Stringent\ Form\ Proportion_{ilt} + \beta_2 Stringent\ Rate\ Regulation_{ilt}$$
$$+ \gamma X_{ilt} + \lambda_i + \delta_l + \theta_t + \epsilon_{ilt}, \tag{1.5}$$

where Y_{ilt} (LN(General Expenses Incurred + Other AFSC expenses Incurred) of insurer i, in line l and year t is the natural log of the general expenses. We use the same control variables as in Regression (1.2), including *LN(NPW)* to control for the net premiums written by insurer i in line l and year t.

Table A.12 reports the results from estimating (1.5) with three different sets of fixed effects. The findings are consistent with our main analysis. The coefficient on *Stringent Form Proportion* is positive and statistically siginificant at the 1 percent level across all specifications, suggesting stringent form regulation increases the compliance costs of insurers, controlling for the insurer's business volume. Similar to the main analysis, we interpret the economic effect of stringent form regulation using the specification in Column (3). The coefficient on *Stringent Form Proportion* is 0.061 in Column (3), implying that for the average firm-line, increasing *Stringent Form Proportion* from zero to the average level (0.58) leads to an increase of 3.5% expenses. This economic effect is very close to the estimated effect of 3.1% in Section 1.5.2.1. Similar to our main analysis, we do not find a significant effect of stringent rate regulation on compliance costs.

In addition, in Table A.13 we report the regression estimation when including only the form regulation variables in (1)-(3) and only the rate regulation variables in (4)-(6). The results are largely consistent with the results in (1)-(3).

1.6   Conclusion

This study provides the first analysis of compliance costs of contract regulation in the U.S. property-liability insurance industry. It also contributes to the empirical literature on regulation in the financial industry and the economy in general. We analyze an extensive panel data set of the insurers covering all lines of property-

liability insurance and find significant costs of complying with stringent contract regulation. The effects are most significant for small firm-line operations and personal lines of insurance. The findings are robust to falsification tests using randomized treatment of stringent regulation.

It is worth noting that the categorization of stringent regulation in this study is a simplification of the stringency faced by insurers in each state. Also, the regulatory stringency faced by an insurer, constructed using its proportion of business in states under stringent regulation, is an imperfect measure of the insurer's propensity to incur compliance costs. However, these measurement issues will likely bias against this study finding any significant compliance costs. As a result, our estimates of these costs should be considered as a lower bound of the actual compliance costs of policy form regulation.

A potential direction for future research is to explore whether and how stringent policy form and rate regulation change the market structure, especially the level of competition and the distribution of different types of firms (e.g. smaller insurers) in a state and a line of business.

The 3.1% estimate of the effect of stringent form regulation on general expenses need to be interpreted with caution. Although the costs of complying with regulation seem economically meaningful, they may not be unwarranted because of the potential benefits of regulation, including consumer protection and higher insurance demand (Butler 2002). We hope future research will provide an estimate of the benefits of form regulation, which, combined with this study, can help provide a cost-benefit comparison.

Figure 1.1: Number of Lines under Stringent Form Regulation, 1992 and 2014
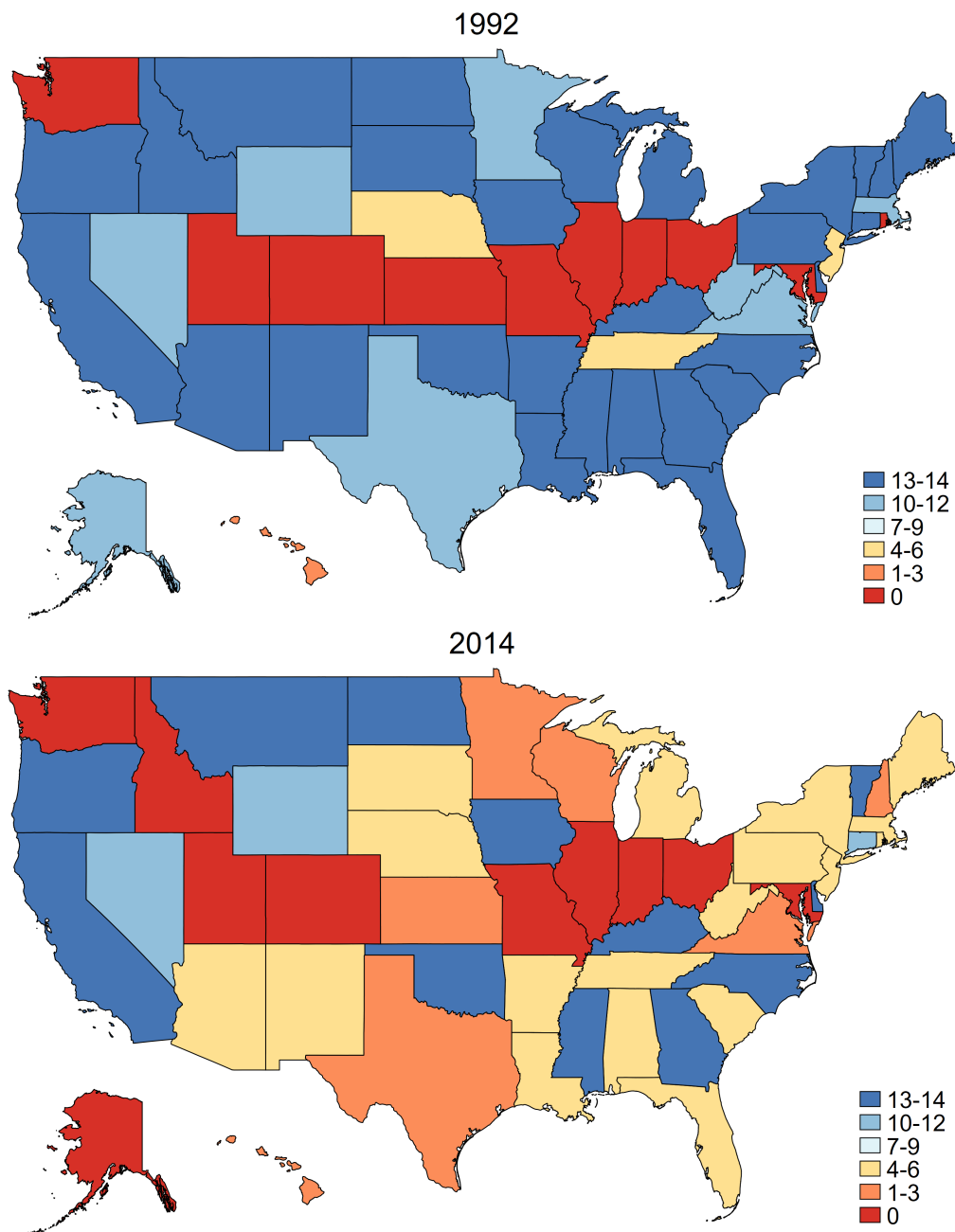
Notes: The figure shows the number of lines under stringent form regulation by state in 1992 and 2014. Data sources: NAIC (1992-2014) and state statutes.

Figure 1.2: Number of Lines under Stringent Rate Regulation, 1992 and 2014
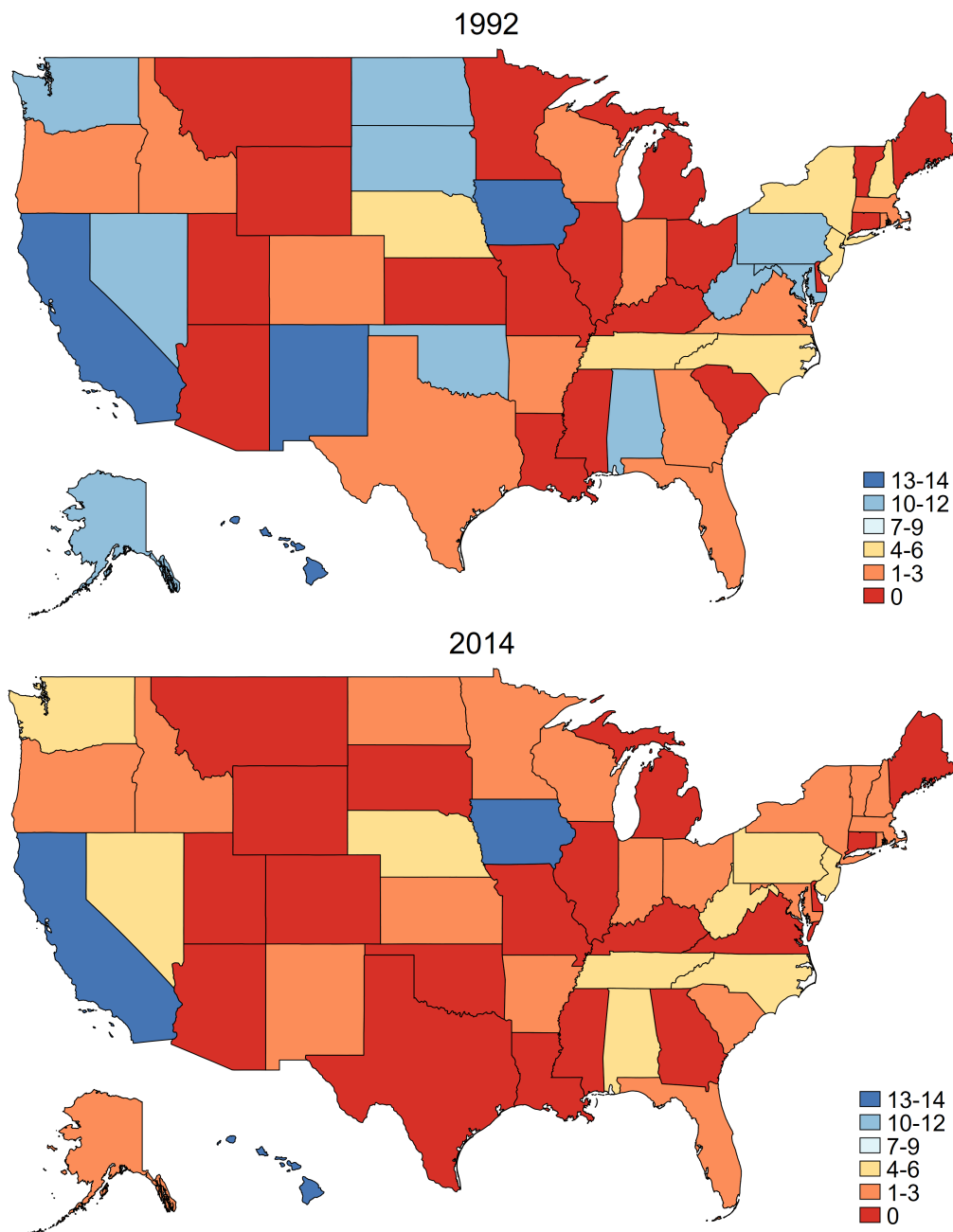
Notes: The figure shows the number of lines under stringent rate regulation by state in 1992 and 2014. Data sources: NAIC (1992-2014) and state statutes.

Figure 1.3: Distribution of Firm-Year Observations by Number of Lines
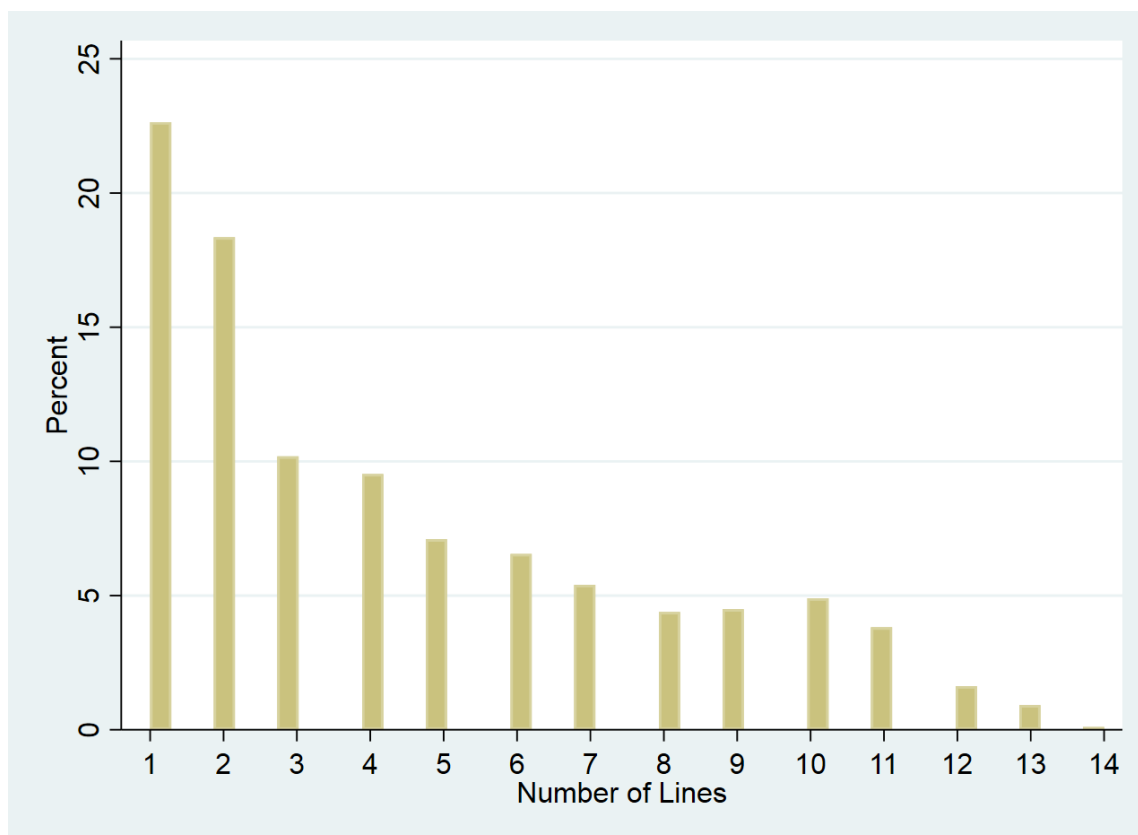
Notes: The figure shows the distribution of firm-year observations by the number of lines. Data sources: NAIC (1992-2014).

Figure 1.4: Marginal Effects of Stringent Form Regulation on General Expense Ratio
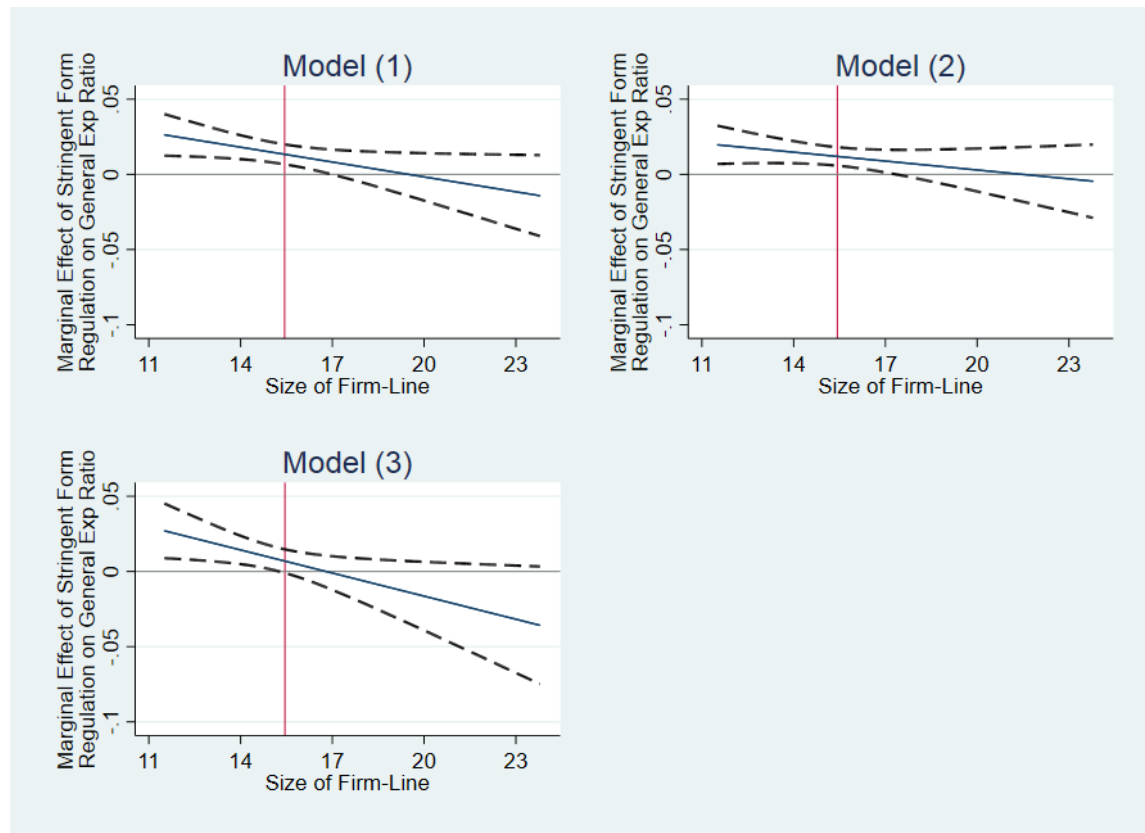
Notes: The figure shows the marginal effect of *Stringent Form Proportion* on the general expense ratio at different levels of firm-line size (*LN(NPW)*) from Models (1)-(3) in Table 1.5. The vertical red line is the mean value of firm-line size. Dashed lines give 95% confidence interval. Data sources: NAIC (1992-2014) and state statutes.

Figure 1.5: Falsification Test Results
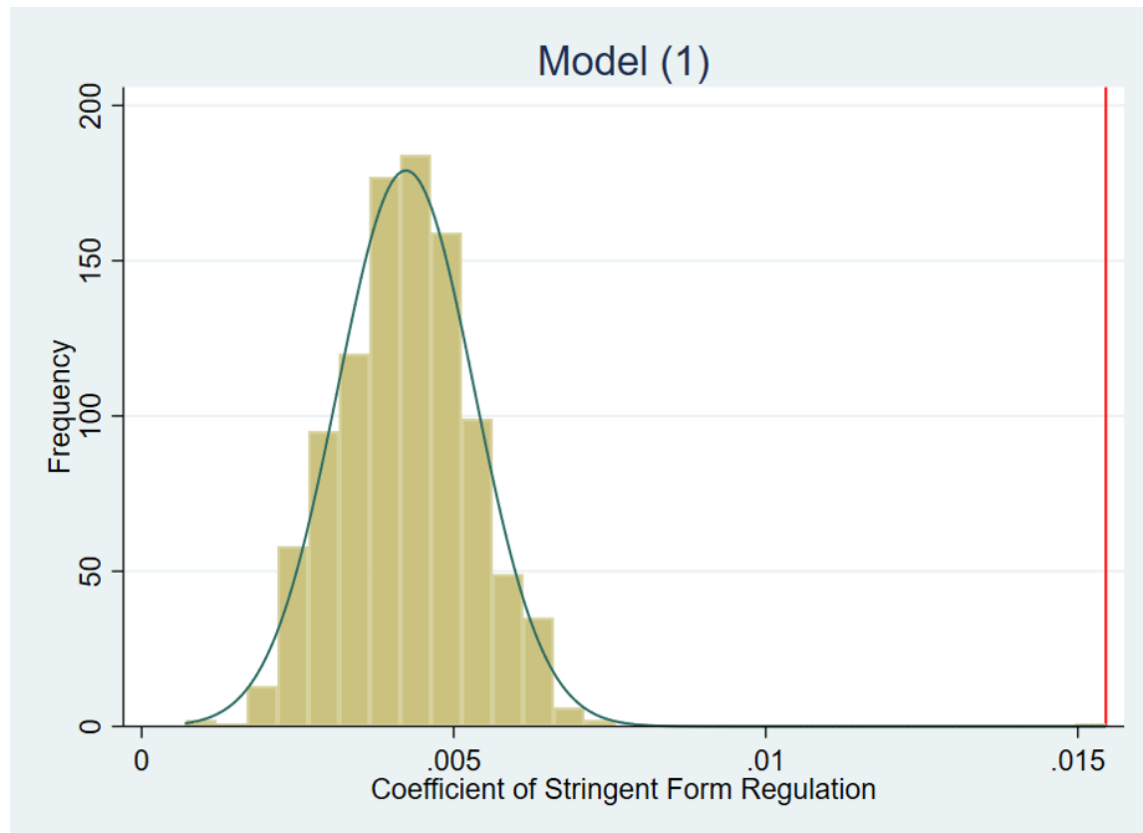
Notes: The figure shows the distribution of coefficient on *Stringent Form Proportion* from 1,000 simulated placebo treatments from Models (1) in Table 1.3. The vertical red line denotes the coefficient estimate of *Stringent Form Proportion* from Table 1.3, Column (1) using the real data. Data sources: NAIC (1992-2014) and authors' simulation.

Table 1.1: Summary Statistics

Panel A: Firm-Year Level

	Mean	SD
Stringent Form Proportion	0.64	0.37
Stringent Rate Proportion	0.31	0.35
Net Premiums Written (MN)	206.78	1117.13
Loss Ratio	0.67	0.20
Total Exp Ratio	0.35	0.17
General Exp Ratio	0.21	0.21
Entry 1st Year	0.02	0.15
Entry 2nd Year	0.02	0.15
Exit Last Year	0.02	0.13
Exit 2nd Last Year	0.02	0.15
Firm-Year Observations	35,412	

Panel B: Firm-Line-Year Level

	Mean	SD
Stringent Form Proportion	0.58	0.39
Stringent Rate Proportion	0.26	0.35
Net Premiums Written (MN)	44.24	329.85
Loss Ratio	0.76	2.75
Total Expense Ratio	0.34	0.15
General Expense Ratio	0.19	0.17
Loss Volatility	1.11	2.50
Entry 1st Year	0.02	0.14
Entry 2nd Year	0.02	0.16
Exit Last Year	0.02	0.14
Exit 2nd Last Year	0.03	0.17
Firm-Line-Year Observations	157,531	

Notes: Panel A shows the mean and standard deviation of main variables at firm-year level (1992-2014). *Stringent Form (Rate) Proportion* is proportion of premiums written under stringent form (rate regulation). *Total Expense Ratio* is the ratio of all underwriting expenses (excluding loss adjustment expenses) to net premiums written. *General Expense Ratio* is the ratio of general expenses to net premiums written. *Entry 1st Year (2nd Year)* equals one if an insurer is in its first (second) year of entry; *Exit Last Year (2nd Last Year)* equals one if an insurer is in its last (second last) year before exiting.

Panel B shows the mean and standard deviation of main variables at firm-line-year level (1992-2014). *Loss volatility* is the standard deviation of loss ratios of all firms in a given line-year. Entry 1st Year (2nd Year) equals one if an insurer is in its first (second) year of entry into a line; Exit Last Year (2nd Last Year) equals one if an insurer is in its last (second last) year before exiting a line. Data sources: NAIC (1992-2014) and state statutes.

Table 1.2: Effects of Stringent Form Regulation on General Expense Ratio: Firm-Year Level

	Fixed Effects		
	(1)	(2)	(3)
	Firm+Year	Firm+Year	Firm+Year
Stringent Form Proportion	0.029**		0.023*
	(0.011)		(0.012)
Stringent Rate Proportion		0.027**	0.020*
		(0.011)	(0.011)
Firm Size	-0.115***	-0.115***	-0.115***
	(0.005)	(0.005)	(0.005)
Entry 1st Year	-0.030**	-0.031**	-0.030**
	(0.013)	(0.013)	(0.013)
Entry 2nd Year	-0.014	-0.015*	-0.015
	(0.009)	(0.009)	(0.009)
Exit Last Year	0.037***	0.037***	0.037***
	(0.012)	(0.012)	(0.012)
Exit 2nd Last Year	-0.006	-0.006	-0.006
	(0.008)	(0.008)	(0.008)
Mean of Dependent Variable	0.205	0.205	0.205
R-squared	0.646	0.646	0.646
Firm-Year Observations	35,412	35,412	35,412

Notes: The table shows the results of fixed effect regressions of the general expense ratio with firm level observations (1992-2014). *Stringent Form (Rate) Proportion* is the proportion of premiums written under stringent form (rate) regulation. *Firm Size* is the natural logarithm of the net premiums written by an insurer in a year. *Entry 1st Year (2nd Year)* equals one if the insurer is in its first (second year) of entering the market, and *Exit Last (2nd Last Year)* equals one if the insurer is in its last (second last) year before exiting the market. Robust standard errors are clustered at the firm level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 1.3: Effects of Stringent Form Regulation on General Expense Ratio: Firm-Line-Year Level

	Fixed Effects		
	(1)	(2)	(3)
	Firm+Line+Year	Firm-Year+Line	Firm-Line+Year
Stringent Form Proportion	0.015***	0.013***	0.010**
	(0.004)	(0.004)	(0.004)
Stringent Rate Proportion	0.002	-0.003	0.007
	(0.003)	(0.003)	(0.005)
Firm-Line Size	-0.031***	-0.021***	-0.066***
	(0.001)	(0.001)	(0.002)
Loss Volatility	-0.000	0.000*	-0.000
	(0.000)	(0.000)	(0.000)
Entry 1st Year	-0.025***	-0.034***	-0.037***
	(0.005)	(0.005)	(0.006)
Entry 2nd Year	-0.016***	-0.022***	-0.015***
	(0.004)	(0.004)	(0.004)
Exit Last Year	0.023***	-0.012*	0.027***
	(0.006)	(0.006)	(0.006)
Exit 2nd Last Year	-0.001	-0.010**	0.005
	(0.004)	(0.005)	(0.004)
Mean of Dependent Variable	0.187	0.187	0.187
R-squared	0.442	0.756	0.614
Firm-Line-Year Observations	157,531	157,531	157,531

Notes: The table shows the results of fixed effect regressions of the general expense ratio with firm-line level observations (1992-2014). *Stringent Form (Rate) Proportion* is the proportion of premiums written under stringent form (rate) regulation. *Firm-Line Size* is the natural logarithm of the net premiums written by an insurer in a line. *Loss Volatility* is the standard deviation of loss ratios of all firms in a given line-year. *Entry 1st Year (2nd Year)* equals one if the insurer is in its first (second year) of entering a line, and *Exit Last (2nd Last Year)* equals one if the insurer is in its last (second last) year before exiting a line. Robust standard errors are clustered at the firm level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 1.4: Cross-line Heterogeneity in General Expense Ratio: Firm-Line-Year Level

	Fixed Effects	
	(1)	(2)
	Firm+Line+Year	Firm-Year+Line
Commercial Auto Physical Damage	-0.032***	-0.022***
	(0.002)	(0.002)
Commercial Multiple Peril	0.033***	0.026***
	(0.003)	(0.002)
Homeowners/ Farmowners	0.032***	0.023***
	(0.003)	(0.003)
Inland Marine	-0.020***	-0.008***
	(0.003)	(0.003)
Medical Professional Liability	-0.003	-0.011
	(0.008)	(0.007)
Other Liability	0.025***	0.026***
	(0.003)	(0.003)
Ocean Marine	-0.026***	-0.017**
	(0.007)	(0.007)
Products Liability	-0.034***	-0.021***
	(0.004)	(0.004)
Private Passenger Auto Liability	0.027***	0.014***
	(0.003)	(0.003)
Private Passenger Auto Physical Damage	0.007**	-0.000
	(0.003)	(0.003)
Special Liability	0.036***	0.045***
	(0.011)	(0.012)
Special Property	0.009***	0.013***
	(0.003)	(0.003)
Workers' compensation	0.013***	0.004*
	(0.003)	(0.003)
Mean of Dependent Variable	0.187	0.187
R-squared	0.442	0.756
Firm-Line-Year Observations	157,531	157,531

 Notes: The table shows the coefficients on the line of business indicator variables in the fixed effect regressions of the general expense ratio with firm-line level observations (1992-2014) in Table 1.3. The reference group is Commercial Auto Liability. Robust standard errors are clustered at the firm level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 1.5: Effects of Stringent Form Regulation and Firm-Line Size on General Expense Ratio

	Fixed Effects		
	(1) Firm+Line +Year	(2) Firm-Year +Line	(3) Firm-Line +Year
Stringent Form Proportion	0.064**	0.042*	0.086**
	(0.025)	(0.026)	(0.037)
Stringent Form Prop. × Firm-Line Size	-0.003**	-0.002	-0.005**
	(0.002)	(0.002)	(0.002)
Stringent Rate Proportion	0.058**	0.022	0.040
	(0.028)	(0.029)	(0.040)
Stringent Rate Prop. × Firm-Line Size	-0.004**	-0.002	-0.002
	(0.002)	(0.002)	(0.003)
Firm-Line Size	-0.028***	-0.020***	-0.062***
	(0.001)	(0.001)	(0.003)
Firm-Line Controls	Yes	Yes	Yes
Mean of Dependent Variable	0.187	0.187	0.187
R-squared	0.443	0.756	0.614
Firm-Line-Year Observations	157,531	157,531	157,531

Notes: The table shows the results of fixed effect regressions of the general expense ratio with firm-line level observations (1992-2014). *Stringent Form (Rate) Proportion* is the proportion of premiums written under stringent form (rate) regulation. *Firm-Line Size* is the natural logarithm of the net premiums written by an insurer in a line. Firm-line level controls include loss volatility in the line-year and entry and exit behaviors of an insurer in a line. Robust standard errors are clustered at the firm level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 1.6: Effects of Stringent Form Regulation on General Expense Ratio: Personal Lines

	Fixed Effects		
	(1)	(2)	(3)
	Firm+Line+Year	Firm-Year+Line	Firm-Line+Year
Stringent Form Proportion	0.034***	0.033*	0.029***
	(0.010)	(0.019)	(0.011)
Stringent Rate Proportion	0.007	-0.001	0.006
	(0.007)	(0.009)	(0.008)
Firm-Line Size	-0.052***	-0.027***	-0.068***
	(0.003)	(0.004)	(0.004)
Loss Volatility	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Entry 1st Year	-0.045***	-0.059***	-0.046***
	(0.010)	(0.015)	(0.011)
Entry 2nd Year	-0.011	-0.037***	-0.007
	(0.008)	(0.014)	(0.008)
Exit Last Year	0.016*	-0.045*	0.019**
	(0.009)	(0.024)	(0.009)
Exit 2nd Last Year	-0.005	-0.006	-0.002
	(0.006)	(0.015)	(0.006)
Mean of Dependent Variable	0.177	0.177	0.177
R-squared	0.557	0.917	0.622
Firm-Line-Year Observations	47,443	47,443	47,443

Notes: The table shows the results of fixed effect regressions of the general expense ratio with firm-line level observations in personal lines of insurance (1992-2014). *Stringent Form (Rate) Proportion* is the proportion of premiums written under stringent form (rate) regulation. *Firm-Line Size* is the natural logarithm of the net premiums written by an insurer in a line. *Loss Volatility* is the standard deviation of loss ratios of all firms in a given line-year. *Entry 1st Year (2nd Year)* equals one if the insurer is in its first (second year) of entering a line, and *Exit Last (2nd Last Year)* equals one if the insurer is in its last (second last) year before exiting a line. Robust standard errors are clustered at the firm level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 1.7: Effects of Stringent Form Regulation on General Expense Ratio: Commercial Lines

	Fixed Effects		
	(1)	(2)	(3)
	Firm+Line+Year	Firm-Year+Line	Firm-Line+Year
Stringent Form Proportion	0.010*	0.011	0.007
	(0.005)	(0.009)	(0.005)
Stringent Rate Proportion	0.003	-0.012	0.007
	(0.007)	(0.009)	(0.008)
Firm-Line Size	-0.036***	-0.026***	-0.066***
	(0.002)	(0.002)	(0.003)
Loss Volatility	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Entry 1st Year	-0.025***	-0.031***	-0.033***
	(0.007)	(0.008)	(0.007)
Entry 2nd Year	-0.022***	-0.025***	-0.022***
	(0.006)	(0.006)	(0.006)
Exit Last Year	0.029***	-0.019**	0.027***
	(0.008)	(0.010)	(0.008)
Exit 2nd Last Year	0.005	-0.008	0.007
	(0.005)	(0.007)	(0.005)
Mean of Dependent Variable	0.194	0.194	0.194
R-squared	0.455	0.782	0.611
Firm-Line-Year Observations	79,158	79,158	79,158

 Notes: The table shows the results of fixed effect regressions of the general expense ratio with firm-line level observations in commercial lines of insurance (1992-2014). *Stringent Form (Rate) Proportion* is the proportion of premiums written under stringent form (rate) regulation. *Firm-Line Size* is the natural logarithm of the net premiums written by an insurer in a line. *Loss Volatility* is the standard deviation of loss ratios of all firms in a given line-year. *Entry 1st Year (2nd Year)* equals one if the insurer is in its first (second year) of entering a line, and *Exit Last (2nd Last Year)* equals one if the insurer is in its last (second last) year before exiting a line. Robust standard errors are clustered at the firm level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 1.8: Effects of Stringent Form Regulation on General Expense Ratio: Single-State Firm-Lines

	Fixed Effects		
	(1) Firm+Line+Year +State	(2) Firm-Year+Line +State	(3) Firm-Line+Year +State
Stringent Form Regulation	0.009**	0.012*	0.001
	(0.004)	(0.007)	(0.005)
Stringent Rate Regulation	0.006	-0.001	0.014***
	(0.004)	(0.006)	(0.005)
Firm-Line Size	-0.034***	-0.018***	-0.083***
	(0.002)	(0.003)	(0.003)
Loss Volatility	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Entry 1st Year	-0.021**	-0.031**	-0.036**
	(0.009)	(0.014)	(0.014)
Entry 2nd Year	-0.014**	-0.016**	-0.013*
	(0.005)	(0.007)	(0.007)
Exit Last Year	0.021***	0.002	0.018**
	(0.007)	(0.010)	(0.008)
Exit 2nd Last Year	-0.002	-0.001	0.000
	(0.005)	(0.006)	(0.005)
State-Specific Time Trends	Yes	Yes	Yes
Mean of Dependent Variable	0.193	0.193	0.193
R-squared	0.548	0.861	0.713
Firm-Line-Year Observations	48,232	48,232	48,232

Notes: The table shows the results of fixed effect regressions of the general expense ratio with firm-line level observations (1992-2014) on firm-line observations that operated in a single state in a year. *Stringent Form (Rate) Regulation* is an indicator variable of stringent form (rate) regulation. *Firm-Line Size* is the natural logarithm of the net premiums written by an insurer in a line. *Loss Volatility* is the standard deviation of loss ratios of all firms in a given line-year. *Entry 1st Year (2nd Year)* equals one if the insurer is in its first (second year) of entering a line, and *Exit Last (2nd Last Year)* equals one if the insurer is in its last (second last) year before exiting a line. Robust standard errors are clustered at the state level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

2 DOES TECHNOLOGY ADOPTION SAVE REGULATORY COMPLIANCE COSTS?

2.1 Introduction

In the past decades, digitization and the internet have impacted almost all economic activities and reduced a variety of economic costs. Besides the commercial world, government regulators are increasingly adopting digital technology to make the regulatory process more efficient. Yet new technology requires additional investment in human capital for both the regulator and the regulated entity, and it remains an open question whether technology adoption reduces the cost of regulation, at least in the short term. In this study, we estimate the impact of technology adoption on the costs of complying with product regulation in the U.S. property-liability (P/L) insurance market by exploiting quasi-experimental variation in when states adopt the technology.

The U.S. insurance industry provides an ideal laboratory to study the effects of regulation. The industry is large – with $534 billion of direct premiums written in 2016, it comprises 2.88% of U.S. GDP[1]) – and heavily regulated – about half of the lines of insurance are subject to product regulation.[2] In contrast to other financial sectors that are subject to federal regulation, the insurance industry is primarily regulated at the state level and states experiment with different forms of regulation. A major action by state insurance regulators is the review and approval of insurance rates and policy forms, and there are substantial costs associated with complying with these regulations as we found in Chapter 1. As part of the National Association of Insurance Commissioners (NAIC)'s "Speed to Market" initiative, the NAIC developed an online platform for regulatory compliance, the System for Electronic Rate and Form Filing (SERFF). SERFF is a web-based flow management

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[1]Data source: Federal Insurance Office (2017); Bureau of Economic Analysis (2017).

[2]Authors' calculation based on the U.S. insurer data (1992-2014). A line of insurance is classified as regulated if the insurer is required to obtain regulatory approval of their rating plans or policy forms prior to using them.

tool that enables insurers and regulators to exchange product filing and review information within the application.[3] The objective of SERFF is to standardize the form and rate filing process, improve regulatory efficiency, and save financial and human resources for both regulators and insurers. Twenty-eight states mandated the adoption of SERFF, at different times, between 2007 and 2014.

This study exploits the variation in when and if states mandate the use of SERFF for insurer rate and product filings to cleanly identify the effect of technology on the costs of complying with regulation. While there may be heterogeneity in regulatory compliance costs across insurers, lines of business, states, and years, we argue that the adoption of SERFF is plausibly exogenous to other factors along these dimensions. Our empirical strategy uses fixed effects regression models to isolate the compliance costs from other operating expenses incurred by firms over 23 years, 1992-2014. As insurance firms may be heterogeneous in their ability to minimize compliance costs, firm fixed effects control for the average compliance costs of each firm. The compliance costs may also vary by the line of business (e.g., auto liability or homeowners insurance), and line fixed effects control for the average compliance costs of each line. Finally, compliance costs may vary over time, and year fixed effects control for the average compliance costs for each year.

This study makes three contributions to the literature. First, while there is extensive research on how regulation affects the regulated entity's technology adoption in environmental economics and financial economics (Popp et al. 2010; Böhme et al. 2015), little research has been conducted on how the adoption of technology by regulators impacts market participants. This study provides empirical evidence on whether a mandate to use technology for regulatory purposes reduces the costs of complying with regulation. Second, this study adds to the literature on the costs of insurance regulation. Several studies document substantial costs associated with state insurance regulation (Grace and Klein 2000; Pottier 2011; Leverty 2012). We extend this literature by estimating how the introduction of digital technology affects the costs of complying with regulation. Finally, this study also joins the

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[3]SERFF also houses other Speed to Market tools, including the Uniform Product Coding Matrices and Uniform Transmittal Documents.

broad literature on the economics of digitization (e.g., Goldfarb et al. 2015; Goldfarb and Tucker 2019) and provides additional evidence on whether the adoption of information technology reduces firm's operating costs in an economically important industry.

2.2 Institutional Background

2.2.1 Policy Form and Rate Filing System

In this section, we discuss the institutional features of the U.S. P/L insurance industry that make it an ideal environment to study the compliance costs of regulation and technology adoption.[4] In the U.S., insurance is regulated at the state level. Each state has an insurance department that oversees the regulation of insurance. A substantial part of insurance regulation focuses on the rates and policy forms of insurance policies to ensure they comply with state laws and are reasonable and fair for consumers.

The regulation of policy forms and rates is conducted through a filing system in each state. The process starts with a filer (an insurer or third-party consultant) submitting the proposed rates and policy form to the regulator. Then the insurance department will review the rate and form filing information and decide whether to approve the filing or request further. The state insurance commissioner has the ultimate authority.[5]

Traditionally, the state filing system is paper-based and it creates substantial compliance costs and inefficiency. Numerous documents need to be copied and mailed between the filer and the regulator. This is especially true for multi-state

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[4]See Klein (2005) for an extensive discussion on insurance regulation in the U.S.

[5]As described in Section 1.2, the timeline of filing and approval differs by state. In states with a prior-approval system, the insurer must receive the regulator's approval before the policy can be used in the market. In states with a file-and-use system, a policy can be used in the market without the regulator's approval, but the insurer must file the rates and forms a certain number of days prior to using the policy. In states with a use-and-file system, the filing only needs to be done after the use of the policy. In almost every state, a filing is required for a policy to be used.

insurers who need to make a separate filing in each state in which they operate for the same policy.

2.2.2 SERFF

To improve the efficiency of insurer filing the policy forms and rates with regulators, state regulators and the NAIC started a "Speed to Market for Insurance Products" initiative in the mid-1990s. The initiative led to the establishment of the System for Electronic Rate and Form Filing (SERFF) in 1998. SERFF is an internet platform designed to streamline the rate and form filing and review process. The NAIC has promoted SERFF as a major Speed to Market tool since its first product release.

SERFF replaces the traditional paper-based system by digitizing the entire filing process. Filers log onto SERFF, identify the filing requirements promulgated by each state, and submit an electronic filing to the regulator with all supporting documents uploaded in a digital format. The regulator receives the filing on SERFF and can start reviewing them instantly. In the case where a change is needed, the regulator can contact the filer using a messaging system in SERFF, and the filer can make changes and submit a revised filing in SERFF. In short, SERFF provides a one-stop interface for regulators and insurers to exchange information and complete rate and form filings electronically.

When the first version of SERFF was released in 1998, eight states and sixteen insurers participated. A total of 294 filings were made in 1998. In 2000, an enhanced version of SERFF was released and it quickly expanded across the states in the early 2000s. By the end of 2004, SERFF was accepted in 49 states and the District of Columbia and over 1,400 insurers were licensed to use SERFF. Many states have mandated the use of SERFF for insurance rate and form filings. Under a SERFF mandate, insurers can no longer make paper filings and must file their proposed rates and forms via SERFF. Between 2007 and 2016, 31 states have enacted SERFF mandate in P/L insurance. Florida is the only state that does not accept SERFF, as it adopts its own electronic filing system named I-File (later replaced by the Insurance Regulation Filing System (IRFS)).

On the one hand, SERFF has several advantages over the traditional filing system. First, SERFF improves the efficiency of the information exchange by providing a single online platform for insurers and regulators to communicate, manage, and store product filings electronically. Insurers no longer need to mail hard copies of product information to the regulator and wait for a response in the mail. Second, SERFF makes insurer compliance more manageable, as insurers have easy access to the current filing requirements promulgated by the state, which helps insurers submit more accurate and complete filings. Moreover, SERFF is particularly helpful to multi-state insurers, as they can comply with the regulations in different states in a much easier fashion and even use a single filing if it meets the regulatory requirements of those states. Industry reports suggest the adoption of SERFF leads to considerable cost savings, including a reduction in internal IT and database maintenance costs and product filing worker hours (NAIC 2016).

On the other hand, insurers incur fixed and variable costs when they transition from the traditional filing method to SERFF. For an insurer to implement SERFF, it needs to spend resources on staff training and possibly upgrade its technology. Also, insurers pay a filing fee for each filing they make, either on a pay-as-you-go basis or paying for a "block" of filings at a lower price in advance.[6] Insurers vary in when (and to what extent) they transfer to SERFF from the traditional method. Some insurers (e.g., the sixteen original participating firms) implement SERFF as soon as it becomes available and well before SERFF is mandated, while other insurers implement SERFF when it is mandated. Some multi-state insurers that are subject to a SERFF mandate in some states but not others may implement SERFF in the states with mandates, but not in the others, while other multi-state insurers completely transfer to SERFF once they are subject to a SERFF mandate in one state.

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[6]As of May 2019, the pay-as-you-go rate is $13.50 per filing, and the prepaid rate is $9.50/$8.00/$6.50 per filing for a block of 500/1,000/1,500 filings.

2.3 Data and Sample

2.3.1 Regulation and SERFF Data

We obtain information on which states mandate SERFF and the effective dates of the mandate from the official NAIC-SERFF website.[7] Table A.14 shows the states that mandate SERFF and the year of enactment. To be consistent with our annual insurer data, we classify the SERFF mandate at the year level; if the mandate comes into effect in the middle of year t, we define the first year of the mandate to be t+1. The classification at the year level may introduce measurement error, which would bias us against finding any significant SERFF effect on insurers.

2.3.2 Insurer Data

We compile a data set of all U.S. property and liability insurers from the National Association of Insurance Commissioners (NAIC) statutory annual report database over 23 years, 1992-2014. This database is the most comprehensive source of insurer information available for the U.S. insurance market. For each year, we collect the firm-line level premium and expense data from the Insurance Expense Exhibit and firm-line-state level premium data from the Exhibit of Premiums and Losses ("State Page"). The Exhibit of Premiums Written (Schedule T) is used to identify whether an insurer is licensed in a state. Unlicensed insurers are exempt from product regulation and thus not affected by SERFF mandate.

2.3.3 Measuring Regulatory Compliance Costs

The direct costs of regulatory compliance under form and rate regulation for insurers include the expenses, salaries, and consulting fees associated with making form and rate filings to the state (Grace and Klein 2000; Leverty 2012).

The ideal data for studying compliance costs of product regulation would be insurer expenses associated with regulatory compliance at the firm-line-state-year

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[7]https://www.serff.com/documents/serff_participation_mandates.pdf.

level since the SERFF mandate is applied at the state-year level. The NAIC database, however, does not provide a separate category of expenses for regulatory compliance, nor does it break down expenses at the firm-line-state-year level. We address these challenges in two ways.

First, while we do not have a single expense item dedicated to regulatory compliance, all compliance-related expenses are contained in the Acquisitions, Field Supervisions, and Collection(AFSC) expenses and the general expenses reported by insurers. The AFSC expenses consist of all expenses incurred in the production of new and renewal insurance business, including operating costs of agencies and branches, writing new policy forms, data processing, clerical, secretarial, office maintenance, supervisory, and executive duties. General expenses are also relevant because they include all expenses that are not assigned to other expense groups per the NAIC statutory accounting principles. Therefore, the combination of the AFSC and general expenses captures all the expenses related to an insurer's general operation including compliance costs.

Note that these expenses also include costs that are not linked to regulatory compliance, such as advertising, employee welfare, rent, and equipment. This does not impact the measurement of compliance costs in the fixed effects models, as the models identify the *change* in expenses, rather than the expenses themselves. To accurately measure the compliance costs, we rely on an assumption: changes in the expenses (e.g., rent) that are unrelated to complying with product regulation across firms, lines, and time are uncorrelated with the SERFF mandate enforced by the state, which is plausibly true.

Specifically, we use the NAIC expense data to construct a general expense ratio, which we use as the dependent variable in our regressions. This ratio is defined as:

$$\textit{General Expense Ratio} = \frac{\text{General Expenses Incurred} + \text{Other AFSC expenses Incurred}}{\text{Net Premiums Written}},$$

Second, since we estimate the costs of complying with product regulation at the firm-year and firm-line-year level, we measure an insurer's exposure to treatment, the SERFF mandate at both levels. *SERFF Proportion* is the proportion of an insurer's

direct premiums written in states with SERFF mandate.

We note that using the SERFF mandate rather than the actual insurer usage of SERFF will likely bias the estimated effect of SERFF towards zero. This is because an insurer may start using SERFF voluntarily before the mandate. In this case, the mandate will not impact this insurer, and our estimates will be biased against finding a significant influence of SERFF on insurer expenses, even if they exist.

2.3.4 Sample and Descriptive Statistics

Our final sample is an unbalanced panel of insurers in 14 lines of insurance[8] from 1992 to 2014, with a total of 2,813 insurers and 157,531 firm-line-year observations. The data include all lines of property-liability insurance except financial/mortgage guaranty, fidelity/surety, credit, and warranty. In constructing the sample, we exclude firms with negative assets or liabilities and those with policyholder surplus less than $1 million. Risk retention groups are also excluded because they are mostly exempt from regulation by nondomiciliary states (Born et al. 2009; Leverty 2012). At the firm-line-year level, we require net premiums written to be at least $100,000 and positive total expenses and general expenses. Expense ratios are winsorized at the first and ninety-ninth percentile to reduce the effect of outliers.

Table 2.1 presents the summary statistics. Panel A shows the summary statistics at the firm-year level, and Panel B shows the summary statistics at the firm-line-year level. At the firm-year level, 21 percent of the observations have at least some business under the SERFF mandate, and the average proportion of SERFF business (measured by direct premiums written) is 0.08. The average loss ratio is 0.67, and the average total expense ratio is 0.35. The loss ratio and total expense ratio are adjusted by present value factors to ensure comparability across lines (Cummins and Danzon 1997; Phillips et al. 1998).[9] At the firm-line-year level, 20 percent of the

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[8]We group lines from the NAIC database into 14 lines based on prior studies (e.g., Deng et al. 2017) with modifications. The categorization of lines is shown in Table A.6.

[9]Specifically, we apply the Taylor separation (Taylor 1977) to estimate yearly proportions of loss development for each line, using loss data from the A. M. Best Aggregates and Averages and risk-free interest rates from the FRED database of the Federal Reserve Bank of St. Louis.

observations have at least some business under SERFF mandate, and the average proportion of SERFF business is 0.08. The average loss ratio is 0.76, and the average general expense ratio is 0.19, indicating that about one-fifth of premiums represent insurer operating expenses, including regulatory compliance costs.

2.4 Empirical Design

Ensuring compliance with product regulation can be costly to insurers, and a stated goal of technology adoption in regulation is to improve efficiency and reduce costs (NAIC 2016). It remains an open question of whether technology adoption reduces regulatory compliance costs. On the one hand, a new system with more advanced technology may streamline the regulatory process and reduce the human and financial resources spent on regulatory compliance. On the other hand, the regulated entity may need to spend resources on learning and adjusting to the new system. We provide empirical evidence on whether the mandated use of SERFF in the insurance market reduces regulatory compliance costs.

2.4.1 Empirical Strategy

The identification strategy exploits the quasi-experimental shock of the mandated use of SERFF for insurance product regulation (i.e., rate and form filings). Twenty-eight states mandated SERFF in the P/L insurance market from 2007 to 2014. The cross-sectional and time-series variation in these mandates, combined with the exogenous nature the mandates establishes causality. Additional variation results from multi-state insurers being able to do business in some states on a licensed basis and in other states on an unlicensed basis, and only licensed business is subject to product regulation. As a result, unlicensed business does not involve using SERFF at all, providing additional variation in an insurer's exposure to SERFF.

An empirical challenge for identification is that we do not know how multi-state insurers adopt SERFF when only part of the insurer's business is subject to a SERFF mandate. Suppose an insurer operates in Georgia and Kansas. Georgia mandated

the use of SERFF in 2007, while Kansas mandated it in 2009. In 2007, the insurer could use SERFF for its filings in both states or use SERFF in Georgia only. Insurers will adopt different strategies for implementing SERFF.

To address this challenge, we construct two independent variables, *Any SERFF* and *SERFF Proportion* to measure the impact of the SERFF mandate on insurers. *Any SERFF* captures the effect when an insurer has at least some business under a SERFF mandate, while *SERFF Proportion* measures the proportion of an insurer's business under a SERFF mandate.

An insurers's implementation of SERFF may also vary by the line of business. For example, insurers operating in lines with greater regulatory scrutiny may transition to SERFF sooner than those in lines with less stringent regulation. Therefore, we analyze the effect of the SERFF mandate on insurer expenses at two levels, the firm-year level and the firm-line-year level. At the firm-year level, an insurer is treated as a whole and the estimation is based on the assumption that the insurer does not adopt different strategies for implementing SERFF across lines. At the firm-line-year level, the unit of analysis is a firm-line observation, and the estimation is based on the assumption that an insurer's strategy for implementing SERFF in one line is independent of its strategy in another line. We recognize that neither assumption holds perfectly in the real world and the reality may lie somewhere in between. Therefore, these two frameworks complement each other and when combined they provide an upper and a lower bound of the estimate of SERFF's effect on insurer expenses.

Our coefficient estimates on the effect of technology adoption may be biased towards zero for two reasons. First, some insurers transition to SERFF before the SERFF mandate is enacted. Second, insurers in Florida may use other digital platforms to file rates and policy forms, but our measures of technology adoption only captures the use of SERFF. In both cases, there will be measurement errors that would bias us against finding any significant effect of technology adoption on insurer expenses.

2.4.1.1 Firm-Year Level Analysis

First, we conduct the analysis at the firm-year level, using fixed effects regression models to isolate the impact of the SERFF mandate on insurer's costs of complying with product regulation. As there can be heterogeneity in insurer ability to minimize compliance costs, we include firm fixed effects to control for the average costs of each firm and year fixed effects to control for yearly shocks on compliance costs in the industry. We estimate the following regression:

$$Y_{it} = \beta_1 Any\ SERFF_{it} + \gamma X_{it} + \lambda_i + \theta_t + \epsilon_{it}, \tag{2.1}$$

where Y_{it} is the general expense ratio of firm i in year t. $Any\ SERFF_{it}$ is an indicator variable of whether firm i has any business in a state that mandates SERFF in year t; X_{it} is a vector of control variables including size (natural logarithm of net premiums written by firm i in year t) and entry and exit behavior for firm i in year t; λ_i, θ_t are firm and year fixed effects, respectively; and ϵ_{it} is the error term. The standard errors are clustered at the firm level to allow within-firm correlations.

The variable of interest is $Any\ SERFF$. It is possible that a SERFF mandate forces an insurer to fully adopt SERFF in all the states where it writes business, and thus this variable captures the primary effect of the SERFF mandate. A positive coefficient β_1 is consistent with the hypothesis that technology adoption increases compliance costs, and a negative coefficient β_1 would imply that technology adoption reduces compliance costs. If the coefficient β_1 is not significantly different from zero, it suggests that either SERFF mandate does not have a significant impact on the compliance costs, or the cost-saving effects are canceled out by the additional learning and adjusting costs for SERFF adoption.

It is also possible that multi-state insurers do not adopt SERFF all at once, but rather gradually switch to SERFF as it is mandated in the states in which they operate. To investigate whether this is the case, we estimate the following regression with the variable of interest to be $SERFF\ Proportion$.

$$Y_{it} = \beta_2 SERFF\ Proportion_{it} + \gamma X_{it} + \lambda_i + \theta_t + \epsilon_{it}, \tag{2.2}$$

where *SERFF Proportion*$_{it}$ measures the proportion of business that is subject to SERFF mandate for firm i and year t; all other variables are defined in the same way as in Regression 2.1.

A positive coefficient β_2 is consistent with the hypothesis that technology adoption increases compliance costs, and a negative coefficient β_2 would imply that technology adoption reduces compliance costs. If the coefficient β_2 is not significantly different from zero, we would conclude that the proportion of business under SERFF mandate does not affect the compliance costs for insurers.

2.4.1.2 Firm-Line-Year Level Analysis

While the firm-year level analysis captures the SERFF effect on compliance costs for an insurer as a whole, a multi-line insurer may implement SERFF differently across lines. To explore the cross-line heterogeneity within a firm, we use the firm-line-year level data to estimate the following regressions, adding line fixed effects to control for the average compliance costs within each line of business:

$$Y_{ilt} = \beta_1 Any\ SERFF_{ilt} + \gamma X_{ilt} + \lambda_i + \delta_l + \theta_t + \epsilon_{ilt}, \tag{2.3}$$

$$Y_{ilt} = \beta_1 SERFF\ Proportion_{ilt} + \gamma X_{ilt} + \lambda_i + \delta_l + \theta_t + \epsilon_{ilt}, \tag{2.4}$$

where Y_{ilt} is the general expense ratio of firm i in line l and year t. *Any SERFF*$_{ilt}$ is an indicator variable of whether firm i has any business in a state that mandates SERFF in line l and year t; X_{ilt} is a vector of control variables including size (natural logarithm of net premiums written by firm i in line l and year t) and entry and exit behavior for firm i in line l and year t; λ_i, δ_l, and θ_t are firm, line, and year fixed effects, respectively; and ϵ_{ilt} is the error term. The standard errors are clustered at the firm level to allow within-firm correlations.

2.5 Effects of Technology Adoption on Regulatory Compliance Costs

2.5.1 Firm-Year Level Results

Table 2.2 shows the results of the firm-year level regressions. The primary finding is that SERFF reduces insurer expenses. In Regression (1), the coefficient on Any SERFF is negative and statistically significant at the 10 percent level. Given that the average expense ratio in the sample is 0.205, the coefficient implies that mandate for SERFF in at least one state in which an insurer operates lowers the average insurer's expense ratio by 5.85% (-0.012/0.205 = -5.85%). In Regression (2), the coefficient on SERFF Proportion is negative and statistically significant at the 5 percent level, suggesting a negative relationship between the proportion and insurer expenses.

To explore the possibility of a nonlinear effect of SERFF Proportion, we include SERFF Proportion Squared in Regression (3). The coefficients on SERFF Proportion and SERFF Proportion Squared are -0.099 and 0.083 respectively, and both coefficients are statistically significant at the 5 percent level. The fitted quadratic function of SERFF Proportion is a U-shaped curve, which achieves a minimum at 0.596 (0.099/(2*0.083) = 0.596). Thus, the expense saving effect of SERFF is the strongest when an insurer's SERFF Proportion equals 0.596.

In Regression (4), we further explore the effects of different proportions of SERFF business by regressing the general expense ratio on quartile indicator variables of SERFF Proportion, and the reference group is the insurers who have no business that is subject to a SERFF mandate. The coefficients on the second, third, and fourth quartile of SERFF proportion are -0.016, -0.025, and -0.018, and statistically significant at the 10, 1, and 5 percent levels, respectively. Pairwise F-tests show that the coefficients on Q2, Q3, and Q4 are statistically significantly different from Q1 at the 5 percent level, while these three coefficients are not significantly different from each other. If an insurer's SERFF proportion is in the fourth quartile of the distribution (which is a SERFF proportion between 0.64 and 1), its expenses are, on average, lower than an insurer that has no business that is subject to a SERFF

mandate by 0.018, an effect size of 8.78%.

In Regressions (5)-(8), we add the proportions of business in each line of insurance to control for possible heterogeneity across lines within a firm-year. The results are robust to the inclusion of insurer business mix. We also find evidence of economies of scale in regulatory compliance, as the coefficient on *Firm Size* is negative and statistically significant. Also, we find a positive and significant effect of the number of states on general expenses, which is consistent with previous literature on the costs of complying with multiple insurance regulators (Grace and Klein 2000; Leverty 2012).

2.5.2   Firm-Line-Year Level Results

Table 2.3 shows the results of the firm-line-year level regressions. SERFF reduces regulatory compliance costs when an insurer writes a large proportion of business in states with a SERFF mandate. In Regression (1), after controlling for differences in the strategy for implementing SERFF by line, the coefficient on *Any SERFF* is not statistically different from zero, which suggests that the SERFF mandate in at least one state in which an insurer operates does not have a significant effect on its compliance costs. In Regression (2), the coefficient of SERFF Proportion is -0.012 and statistically significant at the 5 percent level, suggesting a negative relationship between the proportion of business under SERFF mandates and insurer expenses.

To explore the possibility of a nonlinear effect of proportion, we include SERFF Proportion Squared in Regression (3). The coefficients on SERFF Proportion and SERFF Proportion Squared are -0.028 and 0.016 respectively. While neither of them is statistically significant (possibly due to their correlation), a joint F-test rejects the hypothesis that both coefficients equal to zero (p-value = 0.04), suggesting that the inclusion of these two variables provides power in explaining the general expense ratio.

In Regression (4), which includes the four quartiles of SERFF Proportion, the coefficient on the indicator of the first quartile (SERFF Proportion between 0 and 0.10) is 0.009 and statistically significant at the 5 percent level. The coefficient on

the indicator of the fourth quartile (SERFF Proportion between 0.64 and 1) is -0.009 and statistically significant at the 10 percent level. Pairwise F-tests show that the coefficient on the first quartile indicator is significantly different from other quartiles at the 5 percent level, and the second, third, and fourth quartile indicators do not differ from each other. Compared to an insurer who does not have any business under a SERFF mandate, the general expense ratio of the average insurer with a proportion of SERFF business that is in the fourth quartile (SERFF Proportion between 0.64 and 1) is lower by 0.009, an effect size of 4.81% (0.009/0.187 = 4.81%). This translates to about $400,000 per year for an average firm-line observation in the fourth quartile.

In Regressions (5)-(8), we add the square of *Number of States* to control for possible nonlinear effects of the number of states on compliance costs. The results are largely unchanged, except that the coefficient on *SERFF QT=1* is not significantly different from zero in Regression (8). Overall, the results suggest that there are fixed costs associated with adopting the technology, but cost savings emerge as SERFF is implemented more widely by the insurer.

2.6   Conclusion

This chapter examines a quasi-natural state-level experiment of technology adoption in product regulation in the U.S. P/L insurance industry. We find evidence suggesting that mandated use of an internet application, SERFF, reduces insurer expenses. The effect of SERFF mandate seems to be nonlinear: it imposes additional costs when the insurer starts using SERFF for product filings, and the expense savings appear after the insurer applies SERFF on a sufficiently large proportion of business.

At the firm-year level, the estimated cost savings of SERFF for an average firm in the fourth quartile of the distribution of business subject to a SERFF mandate is 8.78%, and on the firm-line-year level the estimate is 4.81%. A possible explanation of the difference between these two estimates is that we do not know to what extent insurers implement SERFF differently across lines. If insurers always implement

SERFF simultaneously across all the lines that they write in, the estimate of 8.78% might be closer to the real effect size, but if insurers implement SERFF differently across lines, the estimate of 4.81% would be more reliable. Thus, these estimates represent the upper and lower bound of the cost-saving effect associated with SERFF. Both estimates indicate that digitization significantly reduces the costs of complying with regulation.

Table 2.1: Summary Statistics

Panel A: Firm-Year Level		
	Mean	SD
Any SERFF	0.21	0.40
SERFF Proportion	0.08	0.22
Net Premiums Written (MN)	206.34	1115.33
Loss Ratio	0.67	0.19
Total Expense Ratio	0.35	0.17
General Expense Ratio	0.20	0.21
Firm-Year Observations	35,440	

Panel B: Firm-Line-Year Level		
	Mean	SD
Any SERFF	0.20	0.40
SERFF Proportion	0.08	0.22
Net Premiums Written (MN)	44.24	329.85
Loss Ratio	0.76	2.75
Total Expense Ratio	0.34	0.15
General Expense Ratio	0.19	0.17
Firm-Line-Year Observations	157,531	

Notes: Panel A shows the mean and standard deviation of main variables at firm-year level (1992-2014). *Any SERFF* is an indicator of whether the insurer writes business under SERFF mandate. *SERFF Proportion* is the proportion of premiums written under SERFF mandate. *Total Expense Ratio* is the ratio of all underwriting expenses (excluding loss adjustment expenses) to net premiums written. *General Expense Ratio* is the ratio of general expenses to net premiums written. *Entry 1st Year (2nd Year)* equals one if an insurer is in its first (second) year of entry; *Exit Last Year (2nd Last Year)* equals one if an insurer is in its last (second last) year before exiting.

Panel B shows the mean and standard deviation of main variables at firm-line-year level (1992-2014). Entry 1st Year (2nd Year) equals one if an insurer is in its first (second) year of entry into a line; Exit Last Year (2nd Last Year) equals one if an insurer is in its last (second last) year before exiting a line. Data sources: NAIC (1992-2018).

Table 2.2: Effects of SERFF Mandate on General Expense Ratio: Firm-Year Level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Any SERFF	-0.012*				-0.013*			
	(0.006)				(0.006)			
SERFF Proportion		-0.021**	-0.099***			-0.018**	-0.099***	
		(0.009)	(0.036)			(0.009)	(0.036)	
SERFF Proportion Sq.			0.083**				0.086**	
			(0.036)				(0.036)	
SERFF QT=1				-0.000				-0.002
				(0.007)				(0.007)
SERFF QT=2				-0.016*				-0.018**
				(0.009)				(0.009)
SERFF QT=3				-0.025***				-0.025***
				(0.010)				(0.010)
SERFF QT=4				-0.018**				-0.016**
				(0.008)				(0.008)
Firm Size	-0.117***	-0.117***	-0.117***	-0.117***	-0.118***	-0.118***	-0.118***	-0.118***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Number of States	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
% of Business in Each Line	No	No	No	No	Yes	Yes	Yes	Yes
Entry & Exit	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean of Dependent Variable	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.205
R-squared	0.646	0.646	0.646	0.646	0.648	0.648	0.649	0.648
Firm-Year Observations	35,540	35,540	35,540	35,540	35,540	35,540	35,540	35,540

Notes: The table shows the results of fixed effect regressions of the general expense ratio with firm-year level observations (1992-2014). *Any SERFF* is an indicator of whether the insurer writes business under SERFF mandate. *SERFF Proportion* is the proportion of premiums written under SERFF mandate. *Firm Size* is the natural logarithm of the net premiums written by an insurer in a year. *Number of States* counts the number of states where a firm makes product filings. Robust standard errors are clustered at the firm level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2.3: Effects of SERFF Mandate on General Expense Ratio: Firm-Line-Year Level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Any SERFF	-0.001				-0.002			
	(0.004)				(0.004)			
SERFF Proportion		-0.012**	-0.028			-0.013**	-0.034*	
		(0.005)	(0.018)			(0.005)	(0.018)	
SERFF Proportion Sq.			0.016				0.022	
			(0.017)				(0.017)	
SERFF QT=1				0.009**				0.007
				(0.004)				(0.004)
SERFF QT=2				-0.003				-0.005
				(0.005)				(0.005)
SERFF QT=3				-0.005				-0.006
				(0.005)				(0.005)
SERFF QT=4				-0.009*				-0.010**
				(0.005)				(0.005)
Firm-Line Size	-0.035***	-0.035***	-0.035***	-0.035***	-0.035***	-0.035***	-0.035***	-0.035***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Number of States	0.002***	0.002***	0.002***	0.002***	0.003***	0.003***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of States Sq.					-0.000***	-0.000***	-0.000***	-0.000***
					(0.000)	(0.000)	(0.000)	(0.000)
Entry & Exit	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Line Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean of Dependent Variable	0.187	0.187	0.187	0.187	0.187	0.187	0.187	0.187
R-squared	0.446	0.446	0.446	0.447	0.447	0.447	0.447	0.447
Firm-Line-Year Observations	157,531	157,531	157,531	157,531	157,531	157,531	157,531	157,531

Notes: The table shows the results of fixed effect regressions of the general expense ratio with firm-line-year level observations (1992-2014). *Any SERFF* is an indicator of whether the insurer writes business under SERFF mandate. *SERFF Proportion* is the proportion of premiums written under SERFF mandate. *Firm-Line Size* is the natural logarithm of the net premiums written by an insurer in a line and year. *Number of States* counts the number of states where a firm makes product filings in a line. Robust standard errors are clustered at the firm level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

A   APPENDIX

Table A.1: Description of Major Form Filing Systems

Type	Description
Prior Approval	Forms must be filed with and approved by the state regulator before they can be used. There may be a "deemer" policy, which means forms are considered approved if not denied within a certain number of days.
File and Use	Forms must be filed with the state regulator a certain number of days prior to their use. Approval is not required.
Use and File	Forms must be filed with the state regulator within a certain number of days after they have been used.
File Only	Forms need to be filed but the deadline of the filing is not specified by statute.
No Filing	Forms are not required to be filed.

Notes: The table shows the description of major form filing systems in the U.S. P/L insurance market. Data sources: NAIC (1992-2014) and state statutes.

Table A.2: Classification of State Form Regulation Stringency in Personal Lines, 1992-2014

State	Stringent Form Regulation	Non-stringent Form Regulation	State	Stringent Form Regulation	Non-stringent Form Regulation
Alabama	1992-2014		Montana	1992-2014	
Alaska	1992-2005	2006-2014	Nebraska	1992-2014	
Arizona	1992-2014		Nevada	1992-2014	
Arkansas	1992-2014		New Hampshire	1992-2014	
California	1992-2014		New Jersey	1992-2014	
Colorado		1992-2014	New Mexico	1992-2014	
Connecticut	1992-2014		New York	1992-2014	
Delaware	1992-2014		North Carolina	1992-2014	
District of Columbia		1992-2014	North Dakota	1992-2014	
Florida	1992-2014		Ohio		1992-2014
Georgia	1992-2014		Oklahoma	1992-2014	
Hawaii		1992-2014	Oregon	1992-2014	
Idaho	1992-1994	1995-2014	Pennsylvania	1992-2014	
Illinois		1992-2014	Rhode Island[1]	1998-2014	
Indiana		1992-2014	South Carolina	1992-2014	
Iowa	1992-2014		South Dakota	1992-2014	
Kansas		1992-2014	Tennessee	1992-2014	
Kentucky	1992-2014		Texas	1992-2014	
Louisiana	1992-2014		Utah		1992-2014
Maine	1992-2014		Vermont	1992-2014	
Maryland		1992-2014	Virginia	1992-2014	
Massachusetts	1992-2014		Washington		1992-2014
Michigan	1992-2014		West Virginia	1992-2014	
Minnesota	1992-2014		Wisconsin	1992-2008	2009-2014
Mississippi	1992-2014		Wyoming	1992-2014	
Missouri		1992-2014			

1. Data missing during 1992-1997.

Notes: The table shows the classification of State Form Regulation Stringency in Personal Lines, 1992-2014. Personal lines are: homeowners/farmowners, private passenger auto liability, and private passenger auto physical damage. Stringent form regulation is identified by a prior approval form filing system. Data sources: NAIC (1992-2014) and state statutes.

Table A.3: Classification of State Form Regulation Stringency in Commercial Lines, 1992-2014

State	Stringent Form Regulation	Non-stringent Form Regulation	State	Stringent Form Regulation	Non-stringent Form Regulation
Alabama	1992-2001	2002-2014	Montana	1992-2014	
Alaska	1992-2004	2005-2014	Nebraska		1992-2014
Arizona	1992-1998	1999-2014	Nevada	1992-2014	
Arkansas	1992-1999	2000-2014	New Hampshire	1992-1998	1999-2014
California	1992-2014		New Jersey		1992-2014
Colorado		1992-2014	New Mexico	1992-2005	2006-2014
Connecticut	1992-2014		New York	1992-2011	2012-2014
Delaware	1992-2014		North Carolina	1992-2014	
District of Columbia		1992-2014	North Dakota	1992-2014	
Florida	1992-2014		Ohio		1992-2014
Georgia	1992-2014		Oklahoma	1992-2014	
Hawaii		1992-2014	Oregon	1992-2014	
Idaho	1992-1994	1995-2014	Pennsylvania	1992-1995	1996-2014
Illinois		1992-2014	Rhode Island[1]	1998	1999-2014
Indiana		1992-2014	South Carolina	1992-2002	2003-2014
Iowa	1992-2014		South Dakota	1992-2004	2005-2014
Kansas		1992-2014	Tennessee		1992-2014
Kentucky	1992-2014		Texas	1992-2006	2007-2014
Louisiana	1992-1999	2000-2014	Utah		1992-2014
Maine	1992-1999	2000-2014	Vermont	1992-2014	
Maryland		1992-2014	Virginia	1992-2000	2001-2014
Massachusetts	1992-2004	2005-2014	Washington		1992-2014
Michigan	1992-2002		West Virginia	1992-2005	2006-2014
Minnesota	1992-1994		Wisconsin	1992-2008	2009-2014
Mississippi	1992-2014		Wyoming	1992-2014	
Missouri		1992-2014			

1. Data missing during 1992-1997.

Notes: The table shows the classification of State Form Regulation Stringency in Commercial Lines, 1992-2014. Commercial lines are: special property, commercial multiple peril, other liability, products liability, commercial auto liability, commercial auto physical damage, and special liability. Stringent form regulation is identified by a prior approval form filing system. Data sources: NAIC (1992-2014) and state statutes.

Table A.4: Classification of State Rate Regulation Stringency in Personal Lines, 1992-2014

State	Stringent Rate Regulation	Non-stringent Rate Regulation	State	Stringent Rate Regulation	Non-stringent Rate Regulation
Alabama	1992-2014		Montana		1992-2014
Alaska	1992-2005	2006-2014	Nebraska	1992-2014	
Arizona		1992-2014	Nevada	1992-2014	
Arkansas[1]		1994-2014	New Hampshire	1992-2003	2004-2014
California	1992-2014		New Jersey	1992-2014	
Colorado		1992-2014	New Mexico	1992-2007	2008-2014
Connecticut		1992-2014	New York		1992-2014
Delaware		1992-2014	North Carolina	1992-2014	
District of Columbia		1992-2014	North Dakota	1992-2007	2008-2014
Florida		1992-2014	Ohio		1992-2014
Georgia		1992-2014	Oklahoma		1992-2014
Hawaii	1992-2014		Oregon		1992-2014
Idaho		1992-2014	Pennsylvania	1992-2014	
Illinois		1992-2014	Rhode Island		1992-2014
Indiana		1992-2014	South Carolina[3]	1995-2004	2005-2014
Iowa	1992-2014		South Dakota	1992-2004	2005-2014
Kansas[2]	1997-1999	2000-2014	Tennessee	1992-2014	
Kentucky		1992-2014	Texas		1992-2014
Louisiana		1992-2014	Utah		1992-2014
Maine		1992-2014	Vermont		1992-2014
Maryland	1992-1997	1998-2014	Virginia		1992-2014
Massachusetts		1992-2014	Washington	1992-2014	
Michigan		1992-2014	West Virginia	1992-2014	
Minnesota		1992-2014	Wisconsin		1992-2014
Mississippi		1992-2014	Wyoming		1992-2014
Missouri		1992-2014			

1. Data missing during 1992-1993.
2. Data missing during 1992-1996.
3. Data missing during 1992-1994.

Notes: The table shows the classification of State Rate Regulation Stringency in Personal Lines, 1992-2014. Personal lines are: homeowners/farmowners, private passenger auto liability, and private passenger auto physical damage. Stringent rate regulation is identified by a prior approval rate filing system. In a few states, auto insurance is sometimes regulated differently from other personal lines. Data sources: NAIC (1992-2014) and state statutes.

Table A.5: Classification of State Rate Regulation Stringency in Commercial Lines, 1992-2014

State	Stringent Rate Regulation	Non-stringent Rate Regulation	State	Stringent Rate Regulation	Non-stringent Rate Regulation
Alabama	1992-2001	2002-2014	Montana		1992-2014
Alaska	1992-2005	2006-2014	Nebraska		1992-2014
Arizona		1992-2014	Nevada	1992-1993	1994-2014
Arkansas[1]		1994-2014	New Hampshire		1992-2014
California	1992-2014		New Jersey		1992-2014
Colorado		1992-2014	New Mexico	1992-2007	2008-2014
Connecticut		1992-2014	New York		1992-2014
Delaware		1992-2014	North Carolina		1992-2014
District of Columbia	1991-2000	2001-2014	North Dakota	1992-2007	2008-2014
Florida		1992-2014	Ohio		1992-2014
Georgia		1992-2014	Oklahoma	1992-1999	2000-2014
Hawaii	1992-2014		Oregon		1992-2014
Idaho		1992-2014	Pennsylvania	1992-1998	1999-2014
Illinois		1992-2014	Rhode Island		1992-2014
Indiana		1992-2014	South Carolina[3]	1995-1999	2000-2014
Iowa	1992-2014		South Dakota	1992-2004	2005-2014
Kansas[2]		1997-2014	Tennessee		1992-2014
Kentucky		1992-2014	Texas		1992-2014
Louisiana		1992-2014	Utah		1992-2014
Maine		1992-2014	Vermont		1992-2014
Maryland	1992-1997	1998-2014	Virginia		1992-2014
Massachusetts		1992-2014	Washington	1992-1996	1997-2014
Michigan		1992-2014	West Virginia	1992-2005	2006-2014
Minnesota		1992-2014	Wisconsin		1992-2014
Mississippi		1992-2014	Wyoming		1992-2014
Missouri		1992-2014			

1. Data missing during 1992-1993.
2. Data missing during 1992-1996.
3. Data missing during 1992-1994.

Notes: The table shows the classification of State Rate Regulation Stringency in Commercial Lines, 1992-2014. Commercial lines are: special property, commercial multiple peril, other liability, products liability, commercial auto liability, commercial auto physical damage, and special liability. Stringent rate regulation is identified by a prior approval rate filing system. In a few states, auto insurance is sometimes regulated differently from other commercial lines. Data sources: NAIC (1992-2014) and state statutes.

Table A.6: Line of Insurance Category

Line Group	Line of Insurance in the Sample	Orignial Line in NAIC Data	Note
Personal	Homeowners/ Farmowners	Farmowners multiple peril	
		Homeowners multiple peril	
	Private Passenger Auto Liability	Private passenger auto no-fault (personal injury protection)	
		Other private passenger auto liability	
	Private Passenger Auto Physical Damage	Privatepassenger auto physical damage	
Commercial	Special Property	Fire	
		Allied lines	
		Earthquake	
		Glass	
		Burglary and theft	
	Commercial Multiple Peril	Commercial multiple peril (non-liability portion)	
		Commercial multiple peril (liability portion)	
	Financial /Mortgage Guaranty	Mortgage guaranty	Not used
		Financial guaranty	Not used
	Other Liability	Other liability	
		Other liability - occurrence	
		Other liability - claims made	
	Products Liability	Products Liability	
	Commercial Auto Liability	Commercial auto no-fault (personal injury protection)	
		Other commercial auto liability	
	Commercial Auto Physical Damage	Commercial auto physical damage	
	Fidelity/Surety	Fidelity	Not used
		Surety	Not used
	Special Liability	Aircraft (all perils)	
		Boiler and machinery	
	Credit	Credit	Not used
	Warranty	Warranty	Not used
Workers' comp	Workers' compensation	Workers' compensation	
Med Mal	Medical Professional Liability	Medical Professional Liability	
Ocean Marine	Ocean Marine	Ocean Marine	
Inland Marine	Inland Marine	Inland Marine	

Notes: The table shows the categorization of lines of insurance in this study.

Table A.7: Distribution of Firm-Year Observations by Line - Part I

Line of Business	Number of Lines							
	1	2	3	4	5	6	7	Total
Commercial Auto Liability	295	382	726	1,303	1,145	1,377	1,323	13,499
% of Firms in Commercial Auto Liability	2%	3%	5%	10%	8%	10%	10%	100%
Commercial Auto Physical Damage	111	318	506	1,171	1,012	1,296	1,228	12,466
% of Firms in Commercial Auto Physical Damage	1%	3%	4%	9%	8%	10%	10%	100%
Commercial Multiple Peril	337	496	1,114	1,333	1,222	1,181	1,270	13,644
% of Firms in Commercial Multiple Peril	2%	4%	8%	10%	9%	9%	9%	100%
Homeowners / Farmowners	769	1,366	1,824	1,567	1,329	1,283	1,239	15,781
% of Firms in Homeowners / Farmowners	5%	9%	12%	10%	8%	8%	8%	100%
Inland Marine	380	417	609	1,205	1,443	1,623	1,437	13,639
% of Firms in Inland Marine	3%	3%	4%	9%	11%	12%	11%	100%
Medical Professional Liability	1,282	476	112	121	96	123	139	3,121
% of Firms in Medical Professional Liability	41%	15%	4%	4%	3%	4%	4%	100%
Other liability	1,038	1,088	1,174	1,429	1,615	1,703	1,539	15,897
% of Firms in Other liability	7%	7%	7%	9%	10%	11%	10%	100%
Ocean Marine	145	102	120	137	105	156	270	2,755
% of Firms in Ocean Marine	5%	4%	4%	5%	4%	6%	10%	100%
Products Liability	28	92	124	195	281	335	405	4,751
% of Firms in Products Liability	1%	2%	3%	4%	6%	7%	9%	100%
Private Passenger Auto Liability	234	3,211	1,222	1,437	1,076	1,290	1,077	15,765
% of Firms in Private Passenger Auto Liability	1%	20%	8%	9%	7%	8%	7%	100%
Private Passenger Auto Physical Damage	207	3,297	1,269	1,421	1,112	1,320	1,076	15,897
% of Firms in Private Passenger Auto Physical Damage	1%	21%	8%	9%	7%	8%	7%	100%
Special Liability	52	32	77	84	79	99	87	1,759
% of Firms in Special Liability	3%	2%	4%	5%	4%	6%	5%	100%
Special Property	850	1,446	1,535	1,685	1,610	1,658	1,562	17,142
% of Firms in Special Property	5%	8%	9%	10%	9%	10%	9%	100%
Workers' compensation	2,377	417	529	556	585	632	879	11,415
% of Firms in Workers' compensation	21%	4%	5%	5%	5%	6%	8%	100%
Total	8,105	13,140	10,941	13,644	12,710	14,076	13,531	157,531

Notes: The table shows for each line of business the distribution of insurers by the total number of lines an insurer operates in during the same year (number of lines 1 to 7). Data source: NAIC (1992-2014).

Table A.8: Distribution of Firm-Year Observations by Line - Part II

Line of Business	8	9	10	11	12	13	14	Total
				Number of Lines				
Commercial Auto Liability	1,366	1,545	1,735	1,359	578	328	37	13,499
% of Firms in Commercial Auto Liability	10%	11%	13%	10%	4%	2%	0%	100%
Commercial Auto Physical Damage	1,323	1,517	1,701	1,352	571	323	37	12,466
% of Firms in Commercial Auto Physical Damage	11%	12%	14%	11%	5%	3%	0%	100%
Commercial Multiple Peril	1,304	1,457	1,643	1,346	576	328	37	13,644
% of Firms in Commercial Multiple Peril	10%	11%	12%	10%	4%	2%	0%	100%
Homeowners / Farmowners	1,143	1,424	1,631	1,294	554	321	37	15,781
% of Firms in Homeowners / Farmowners	7%	9%	10%	8%	4%	2%	0%	100%
Inland Marine	1,189	1,380	1,679	1,343	569	328	37	13,639
% of Firms in Inland Marine	9%	10%	12%	10%	4%	2%	0%	100%
Medical Professional Liability	141	118	118	123	126	109	37	3,121
% of Firms in Medical Professional Liability	5%	4%	4%	4%	4%	3%	1%	100%
Other liability	1,145	1,247	1,647	1,330	577	328	37	15,897
% of Firms in Other liability	7%	8%	10%	8%	4%	2%	0%	100%
Ocean Marine	210	202	250	325	398	298	37	2,755
% of Firms in Ocean Marine	8%	7%	9%	12%	14%	11%	1%	100%
Products Liability	421	400	575	1,106	439	313	37	4,751
% of Firms in Products Liability	9%	8%	12%	23%	9%	7%	1%	100%
Private Passenger Auto Liability	1,022	1,318	1,647	1,313	554	327	37	15,765
% of Firms in Private Passenger Auto Liability	6%	8%	10%	8%	4%	2%	0%	100%
Private Passenger Auto Physical Damage	1,028	1,323	1,639	1,299	547	322	37	15,897
% of Firms in Private Passenger Auto Physical Damage	6%	8%	10%	8%	3%	2%	0%	100%
Special Liability	102	150	129	185	349	297	37	1,759
% of Firms in Special Liability	6%	9%	7%	11%	20%	17%	2%	100%
Special Property	1,348	1,471	1,700	1,341	572	327	37	17,142
% of Firms in Special Property	8%	9%	10%	8%	3%	2%	0%	100%
Workers' compensation	826	920	1,446	1,321	562	328	37	11,415
% of Firms in Workers' compensation	7%	8%	13%	12%	5%	3%	0%	100%
Total	12,568	14,472	17,540	15,037	6,972	4,277	518	157,531

Notes: The table shows for each line of business the distribution of insurers by the total number of lines an insurer operates in during the same year (number of lines 8 to 14). Data source: NAIC (1992-2014).

Table A.9: Effects of Stringent Form Regulation on General Expense Ratio: Excluding Firm-Lines with 100% or 0% Stringent Regulation

	Fixed Effects		
	(1)	(2)	(3)
	Firm+Line+Year	Firm-Year+Line	Firm-Line+Year
Stringent Form Proportion	0.013**	0.016***	0.005
	(0.005)	(0.006)	(0.006)
Stringent Rate Proportion	0.001	-0.004	0.001
	(0.005)	(0.005)	(0.007)
Firm-Line Size	-0.034***	-0.026***	-0.065***
	(0.002)	(0.002)	(0.003)
Loss Volatility	0.000	0.001**	0.000
	(0.000)	(0.000)	(0.000)
Entry 1st Year	-0.042***	-0.045***	-0.053***
	(0.012)	(0.013)	(0.014)
Entry 2nd Year	-0.029***	-0.033***	-0.031***
	(0.008)	(0.007)	(0.009)
Exit Last Year	0.054***	-0.017	0.050***
	(0.011)	(0.012)	(0.011)
Exit 2nd Last Year	0.008	-0.008	0.009
	(0.006)	(0.008)	(0.006)
Mean of Dependent Variable	0.182	0.182	0.182
R-squared	0.450	0.728	0.629
Firm-Line-Year Observations	85,226	85,226	85,226

 Notes: The table shows the results of fixed effect regressions of the general expense ratio with firm-line level observations, excluding those firm-lines under 100% or 0% stringent form regulation (1992-2014). *Stringent Form (Rate) Proportion* is the proportion of premiums written under stringent form (rate) regulation. *Firm-Line Size* is the natural logarithm of the net premiums written by an insurer in a line. *Loss Volatility* is the standard deviation of loss ratios of all firms in a given line-year. *Entry 1st Year (2nd Year)* equals one if the insurer is in its first (second year) of entering a line, and *Exit Last (2nd Last Year)* equals one if the insurer is in its last (second last) year before exiting a line. Robust standard errors are clustered at the firm level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.10: Effects of Stringent Form/Rate Regulation on General Expense Ratio: Firm-Line-Year Level

	Fixed Effects					
	(1) Firm+Line +Year	(2) Firm-Year +Line	(3) Firm-Line +Year	(4) Firm+Line +Year	(5) Firm-Year +Line	(6) Firm-Line +Year
Stringent Form Proportion	0.016***	0.012***	0.012***			
	(0.003)	(0.004)	(0.004)			
Stringent Rate Proportion				0.006*	0.001	0.009*
				(0.003)	(0.003)	(0.005)
Firm-Line Size	-0.031***	-0.021***	-0.066***	-0.031***	-0.021***	-0.066***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
Loss Volatility	-0.000	0.000*	-0.000	-0.000	0.000**	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Entry 1st Year	-0.025***	-0.034***	-0.037***	-0.026***	-0.034***	-0.037***
	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)
Entry 2nd Year	-0.016***	-0.022***	-0.015***	-0.016***	-0.022***	-0.016***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Exit Last Year	0.023***	-0.011*	0.027***	0.023***	-0.011*	0.027***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Exit 2nd Last Year	-0.001	-0.010**	0.005	-0.000	-0.010*	0.005
	(0.004)	(0.005)	(0.004)	(0.004)	(0.005)	(0.004)
Mean of Dependent Variable	0.187	0.187	0.187	0.187	0.187	0.187
R-squared	0.442	0.756	0.614	0.442	0.756	0.614
Firm-Line-Year Observations	157,531	157,531	157,531	157,531	157,531	157,531

Notes: The table shows the results of fixed effect regressions of the general expense ratio with firm-line level observations (1992-2014). *Stringent Form (Rate) Proportion* is the proportion of premiums written under stringent form (rate) regulation. *Firm-Line Size* is the natural logarithm of the net premiums written by an insurer in a line. *Loss Volatility* is the standard deviation of loss ratios of all firms in a given line-year. *Entry 1st Year (2nd Year)* equals one if the insurer is in its first (second year) of entering a line, and *Exit Last (2nd Last Year)* equals one if the insurer is in its last (second last) year before exiting a line. Robust standard errors are clustered at the firm level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.11: Effects of Stringent Form/Rate Regulation and Firm-Line Size on General Expense Ratio

	Fixed Effects					
	(1) Firm+Line +Year	(2) Firm-Year +Line	(3) Firm-Line +Year	(4) Firm+Line +Year	(5) Firm-Year +Line	(6) Firm-Line +Year
Stringent Form Proportion	0.083***	0.050**	0.097***			
	(0.024)	(0.024)	(0.036)			
Stringent Form Prop. × Firm-Line Size	-0.005***	-0.003*	-0.006**			
	(0.002)	(0.002)	(0.002)			
Stringent Rate Proportion				0.082***	0.039	0.071*
				(0.027)	(0.027)	(0.040)
Stringent Rate Prop. × Firm-Line Size				-0.005***	-0.002	-0.004
				(0.002)	(0.002)	(0.003)
Firm-Line Size	-0.028***	-0.020***	-0.063***	-0.030***	-0.020***	-0.065***
	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.003)
Firm-Line Controls	Yes	Yes	Yes	Yes	Yes	Yes
Mean of Dependent Variable	0.187	0.187	0.187	0.187	0.187	0.187
R-squared	0.443	0.756	0.614	0.442	0.756	0.614
Firm-Line-Year Observations	157,531	157,531	157,531	157,531	157,531	157,531

Notes: The table shows the results of fixed effect regressions of the general expense ratio with firm-line level observations (1992-2014). *Stringent Form (Rate) Proportion* is the proportion of premiums written under stringent form (rate) regulation. *Firm-Line Size* is the natural logarithm of the net premiums written by an insurer in a line. Firm-line level controls include loss volatility in the line-year and entry and exit behaviors of an insurer in a line. Robust standard errors are clustered at the firm level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.12: Effects of Stringent Form and Rate Regulation on LN(General Expenses)

	Fixed Effects		
	(1)	(2)	(3)
	Firm+Line+Year	Firm-Year+Line	Firm-Line+Year
Stringent Form Proportion	0.081***	0.059***	0.061***
	(0.018)	(0.021)	(0.022)
Stringent Rate Proportion	-0.003	-0.019	0.038
	(0.018)	(0.019)	(0.024)
Firm-Line Size	0.888***	0.930***	0.740***
	(0.005)	(0.005)	(0.009)
Controls	Yes	Yes	Yes
Mean of Dependent Variable	13.506	13.506	13.506
R-squared	0.916	0.961	0.943
Firm-Line-Year Observations	157,531	157,531	157,531

Notes: The table shows the results of fixed effect regressions of the natural log of general expenses with firm-line level observations (1992-2014). *Stringent Form (Rate) Proportion* is the proportion of premiums written under stringent form (rate) regulation. *Firm-Line Size* is the natural logarithm of the net premiums written by an insurer in a line. Firm-line level controls include loss volatility in the line-year and entry and exit behaviors of an insurer in a line. Robust standard errors are clustered at the firm level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.13: Effects of Stringent Form/Rate Regulation on LN(General Expenses)

	Fixed Effects					
	(1) Firm+Line +Year	(2) Firm-Year +Line	(3) Firm-Line +Year	(4) Firm+Line +Year	(5) Firm-Year +Line	(6) Firm-Line +Year
Stringent Form Proportion	0.080***	0.053***	0.069***			
	(0.017)	(0.019)	(0.021)			
Stringent Rate Proportion				0.020	-0.001	0.053**
				(0.017)	(0.018)	(0.024)
Firm-Line Size	0.888***	0.930***	0.740***	0.888***	0.930***	0.740***
	(0.005)	(0.005)	(0.009)	(0.005)	(0.005)	(0.009)
Controls on Firm-Line Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Mean of Dependent Variable	13.506	13.506	13.506	13.506	13.506	13.506
R-squared	0.916	0.961	0.943	0.916	0.961	0.943
Firm-Line-Year Observations	157,531	157,531	157,531	157,531	157,531	157,531

Notes: The table shows the results of fixed effect regressions of the natural log of general expenses with firm-line level observations (1992-2014). *Stringent Form (Rate) Proportion* is the proportion of premiums written under stringent form (rate) regulation. *Firm-Line Size* is the natural logarithm of the net premiums written by an insurer in a line. Firm-line level controls include loss volatility in the line-year and entry and exit behaviors of an insurer in a line. Robust standard errors are clustered at the firm level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.14: SERFF Mandate Year for P/L Insurance by State

State	Mandate Year
AL	2008
AR	2011
AZ	2016
CA	2015
CO	2009
CT	2011
DC	2008
DE	2008
GA	2007
IA	2008
IL	2012
KS	2009
MA	2009
ME	2010
MI	2009
MN	2008
MO	2016
NE	2010
NH	2008
NJ	2009
NM	2010
NV	2011
OH	2010
OK	2010
RI	2008
SC	2012
SD	2007
UT	2008
VT	2009
WA	2009
WV	2009

Notes: The table shows the year when SERFF is mandated for property-liability insurance product filing across states that have mandated SERFF by April 2018. Data Source: NAIC (2018)

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