THE RELATIONSHIP BETWEEN REGULATORY FORM & PRODUCTIVITY:

AN EMPIRICAL APPLICATION TO AGRICULTURE

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Contents

About the Report

Under a cooperative agreement with the United States Department of Agriculture, the George Washington University Regulatory Studies Center produced this four-chapter report detailing the findings of its research on the relationship between regulation and agricultural productivity. This report does not represent an official position of the GW Regulatory Studies Center, the George Washington University, or the United States Department of Agriculture.

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Established in 2009, the GW Regulatory Studies Center is an academic center of the George Washington University and its Trachtenberg School of Public Policy and Public Administration. The Center's mission is to improve regulatory policy through research, education, and outreach. The Center is a leading source for applied scholarship in regulatory issues, and a training ground for anyone who wants to understand the effects of regulation and ensure that regulatory policies are designed in the public interest.

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Foreword

This report provides a framework to examine the cumulative impact of regulation on productivity growth in certain industries within production agriculture. The impacts of regulations on those parties that are regulated are not easily measured when considering the totality of regulatory programs addressing a specific industry. The relationship between regulation and productivity growth is complex in part because regulations are not monolithic and may take many different forms. It is of interest whether one particular form constrains productivity more than other forms. To shed light on that, this report classifies regulatory restrictions according to the form the regulation takes. The regulatory taxonomy developed here is an innovative concept that provides a new level of understanding of regulatory tools employed to regulate production agriculture.

Some of the most interesting findings of the report—different relationships between growth in regulatory restrictions and productivity growth in crop-based agriculture based on different regulatory forms—are directly related to developing and applying the regulatory taxonomy to a set of regulations. Prior to this project, I have not seen a descriptive analysis of the relative frequency of regulatory forms used in agriculture. This is also the first empirical analysis of the relationship between regulatory form and productivity growth in various crop-based agricultural segments of which I am aware.

The analysis conducted here first had to enumerate the set of regulations affecting the agricultural sector. The Code of Federal Regulations (CFR) does not provide a catalog of regulated parties by industrial code to easily distinguish the regulations likely to affect a particular industry.

Examining the impact of a suite of regulations affecting an industry requires some method of accounting for the restrictions inherent in each separate regulation and summing up the restrictions contained in the entire suite. The sheer number of regulations contained in the CFR makes such an analysis a daunting task if each regulation must be individually read, coded for the industries affected and the restrictions contained within it. Application of artificial intelligence (AI) provides a means to identify relevant regulations for an industry and to provide a measure of regulatory restrictions.

This report uses RegData 3.1,[i] a set of databases providing total words and counts of restrictive words within CFR parts, to provide a measure of the regulatory restrictions. RegData uses machine learning to associate the various CFR parts with particular North American Industry Classification System (NAICS) codes. This solves the problem both of identifying relevant CFR parts for production agriculture and measuring the regulatory restrictions. It also provides the methodology for empirically representing the regulatory restrictions and CFR parts associated with various NAICS codes in production agriculture.

[i] Patrick A. McLaughlin and Oliver Sherouse, "RegData US 3.1 Annual (dataset)," QuantGov, accessed December 21, 2018. https://quantgov.org/regdata-us/.

Thus, this report contains the first comprehensive list of which I am aware of the regulations or CFR parts likely to affect production agriculture.

The report is not without its limitations. It is the first application of machine learning and AI to estimate regulatory constraints on agriculture. Future researchers will want to carefully examine the list of regulations associated with agricultural NAICS codes as generated by RegData. An additional, alternative method of associating industries with CFR parts may provide a more tightly defined list of regulations. Refining the list of restrictive words currently counted in RegData will provide for more nuanced analyses, perhaps allowing a more inclusive empirical analysis of regulatory forms. For example, words such as "records" or "recordkeeping" or "reports" may signal regulatory restrictions associated with the "monitoring, reporting, and verification" (MRV) form of regulations that are currently not explicitly tracked in RegData. It may be that the appearance of these words within a certain number of other modifying words provides a better estimate of regulatory restriction than simply counting the number of occurrences. Similar sets of words could be developed for other regulatory forms.

Although there are some aspects of the AI protocol used that could be refined or modified, I believe that these results are a proof of concept that AI can facilitate research into regulatory impact and analysis that would not have been possible five or ten years ago. This mirrors similar findings from the application of AI to legal research where a cottage industry has sprung up to provide litigation analytics such as statistics of a particular court or judge ruling on a motion.

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Executive Summary

Government regulation of private actors can address market failures or respond to compelling public needs. Agencies analyze individual regulations' expected impacts before they are issued, but less is understood about the effect of regulations on economic growth. Numerous studies have attempted to examine this relationship, focusing on different economic indicators such as productivity, entrepreneurship, and innovation. However, the results are often inconclusive or directly contradictory to one another. In the agriculture sector, regulation may affect productivity growth through various channels, but empirical evidence is scarce. This report attempts to shed light on the relationship between regulation and agricultural productivity through both theoretical discussion and empirical analysis. In particular, the report highlights the importance of considering different *forms* of regulation—defined by the particular policy mechanisms adopted—in examining the impact of regulation. The report consists of four chapters.

Chapter 1 focuses on theoretical foundations for understanding the relationship between regulation and economic growth, with an emphasis on productivity growth in the agriculture sector. It presents the various mechanisms through which regulation can affect productivity growth, both in the economy generally, and in the agriculture sector. It finds that empirical research examining the impact of regulation on productivity growth is often hampered by the difficulty of measuring regulation in a meaningful way. Despite various attempts to measure regulation from different perspectives (e.g., page counts, agency budgets, etc.), empirical findings regarding regulatory impacts are inconclusive. More importantly, although there is widespread recognition that the form a regulation takes can affect its outcomes and costs, no studies have differentiated the economic effects of different regulatory instruments in a systematic way.

Chapter 2 presents a Taxonomy of Regulatory Forms that may help fill the gaps in the literature and enable more research to account for regulatory form when examining its economic impacts. The Taxonomy is designed to be a comprehensive catalogue of regulatory instruments that apply to regulations across areas. It contains three tiers of regulatory forms, from broad classification distinguishing economic, social, transfer, and administrative regulations, to a more detailed taxonomy of specific policy instruments, such as rationing and quotas, performance standards, labeling requirements, and monetary transfers. The chapter discusses the economic rationale behind each form, the characteristics that define them, and illustrative examples.

Chapter 3 applies the Taxonomy to regulations affecting the agricultural sector. As a critical part of the analysis, the research team at the GW Regulatory Studies Center implemented a rigorous coding procedure to classify more than 700 parts in the *Code of Federal Regulations* by the regulatory forms defined in the Taxonomy. The chapter presents a descriptive analysis of the coding results and examines trends and patterns across agencies and over time. It finds that command-and-control, transfer, and administrative regulations are the most prevalent forms of regulation in the agricultural sector. Among the agencies that issued the most relevant regulations, the U.S. Department of Agriculture relied on very different regulatory forms than the Environmental Protection Agency and Food and Drug Administration. During the period between 1970 and 2017, the reliance on different regulatory forms

presented different trends over time. In general, regulation increasingly relied on social regulatory instruments while decreasing reliance on transfer regulations.

Chapter 4 presents an empirical analysis that attempts to assess whether different forms of regulation have different effects on productivity growth in agriculture. Using the coding results of the relevant regulations and data from 25 agricultural industry segments for the 1971-2017 period, the chapter examines the relationship between growth in regulations that take different forms and growth in land productivity as measure by crop yield. The econometric findings suggest that growth in total regulation has a negative relationship with land productivity growth (i.e., yield growth), and the relationship differs depending on the form of regulation. Specifically, growth in command-and-control, administrative, and entry-and-exit regulations is negatively associated with yield growth. Under the command-and-control and entry-and-exit regulations, growth in monitoring, reporting and verification requirements, permitting, and certification has the largest negative relationship with yield growth. Meanwhile, growth in transfer and information-based regulations has a positive relationship with yield growth.

Annex I applies a useful innovation from machine learning techniques to verify the results from the econometric models in Chapter 4. It briefly explains the method and illustrates specific results. They support the conclusion that growth in some forms of growth is negatively associated with yield growth even when non-parametric methods and large model ensembles are used to avoid possible model specification errors and to assess model uncertainty. Annex II presents a list of the CFR parts examined in this research. It identifies regulations that are likely to affect crop and/or animal production based on different data screens.

This report provides preliminary evidence that different forms of regulation can have different effects on agricultural productivity. If increasing farm productivity is a goal of regulatory reform, decision-makers can most effectively accomplish this goal by focusing on the forms of regulation shown to have negative effects on productivity. Regulation could potentially be less burdensome on the economy, or even enhance economic growth, if regulators find ways to accomplish important public goals by replacing forms of regulation that diminish productivity with forms that have no effect or increase productivity. The Taxonomy of Regulatory Forms presented in the report enables classification of regulations in any area, so future research can extend similar analysis to sectors other than agriculture or other economic outcomes such as output growth and employment.

CHAPTER 1:

Regulation & Economic Growth

Theoretical Foundations & Empirical Findings in Agriculture

Daniel R. Pérez & Zhoudan Xie

Numerous studies have examined the impact of regulation on economic growth or on relevant industries, but the results are often inconclusive and sometimes directly contradict one another. This also applies to the agriculture sector. For instance, theories suggest that regulation can affect agricultural productivity through various channels, but empirical evidence is neither adequate nor consistent. Additionally, these measures and accompanying empirical studies either narrowly focus on a specific type of regulation (e.g., pollution permits, pesticide bans) or fail to consider the total amount of regulatory activity. We propose a more robust method for measuring regulation—namely by supplementing existing measures with the policy instruments or "forms" that a regulation employs to achieve its intended policy outcomes.

This chapter begins by summarizing scholarship on the economic effects of regulation and then focuses on the literature linking regulation and productivity. Section III reviews available proxies for measuring regulation, their strengths and weaknesses, and section IV reviews studies that have focused on measuring the effect of regulation on agricultural productivity. Section IV explores why the policy instruments used to effectuate a regulation (i.e., the regulation's form) may be a key determinant of its economic effects, and Section V concludes.

I. Regulation and the Economy

Scholarship assessing the economic effects of regulation has produced mixed results. Experts generally agree that government intervention via regulation may be appropriate in cases where markets fail to efficiently allocate resources—referred to as market failures, which are traditionally categorized as externalities, public goods, monopoly/market power, and asymmetric information.[1] In theory, regulatory

[1] U.S. Office of Management and Budget (OMB), *Circular A-4: Regulatory Analysis*, September 17, 2003; Susan E. Dudley and Jerry Brito, *Regulation: A Primer* (Washington, DC: The George Washington University Regulatory Studies Center and The Mercatus Center at George Mason University, 2012), 12-14.

intervention corrects—or at least ameliorates—these market failures (e.g., by increasing the amount of information held by consumers or internalizing the costs of externalities). Nonetheless, even where regulations are estimated to generate net benefits, regulatory actions often affect the economy in substantive ways that are not fully considered by existing analyses (e.g., by creating or reducing barriers to entrepreneurship, affecting productivity and innovation, affecting capital investment, affecting the level of research and development, etc.).[2] Economists note that such market distortions will likely be larger in the absence of clear evidence of a market failure.[3]

Measuring the relationship between regulation and productivity, for example, is problematic partly because measuring both regulation and indicators of economic performance is challenging. Existing approaches to measuring regulation primarily rely on quantifying certain attributes of regulation (e.g., the number of regulations in effect) or measuring various industry responses to regulation (e.g., staff hours dedicated to complying with reporting requirements). These measures are summarized in part IV of this chapter. Given the inherent complexity of both regulations themselves and the context in which they operate, such measures are often blunt proxies that are of questionable validity for generating rigorous, empirical evidence of the economic effects of regulation.

Numerous scholars suggest that regulation often limits economic growth—particularly regulation with overly prescriptive mandates on regulated entities—while others suggest that regulation might actually drive[4] innovation. As a result, the outcome of the complex interactions between regulation and the economy remains hotly debated by both academics and practitioners. The academic literature lacks consensus regarding the relationship between regulation and economic outcomes, such as entrepreneurship, productivity, overall market dynamism, and employment.

Studies attempt to relate regulation to market dynamism, often using startup rates in the private sector to measure job creation and destruction, or employment measures (e.g., unemployment rates). Here, regulation can affect firm entry and exit in various ways. For instance, regulators might require approval in the form of occupational licensing before an individual is allowed to practice a given trade or regulators might impose compliance costs that force businesses to exit the market. One notable example of a study that measures the impact of regulations on entrepreneurship is the World Bank's annual Doing Business report which currently estimates performance indicators for over 190 countries with respect to

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[2] Justice Stephen Breyer notes that regulators often have "tunnel vision" due to the narrow, siloed nature of subject matter expertise and agency structure. *See* Stephen Breyer, *Breaking the Vicious Circle: Toward Effective Risk Regulation* (Cambridge, Mass.: Harvard University Press, 1995), 11.

[3] OMB 2003. *See also*: Clifford Winston, *Government Failure versus Market Failure* (Washington, DC: AEI-Brookings Joint Center for Regulatory Studies, 2006).

[4] On the Porter Hypothesis, *see* Michael E. Porter and Claas Van Der Linde, "Toward a New Conception of the Environment-Competitiveness Relationship," *Journal of Economic Perspectives* 9, no. 4 (1995): 97-118. For a critique of the Porter Hypothesis, *see* Karen Palmer, Wallace E. Oates, and Paul R. Portney, "Tightening Environmental Standards: The Benefit-Cost or the No-Cost Paradigm?" *The Journal of Economic Perspectives* 9, no. 4 (1995): 119-132.

their respective ease of doing business. This includes the extent to which a country's regulatory environment contributes or hinders entrepreneurship.[5]

The relationship between entrepreneurship—the creation of new businesses—and economic growth, is well established.[6] As one economist notes:

> Entrepreneurs create new businesses, and new businesses in turn create jobs, intensify competition, and may even increase productivity through technological change. High measured levels of entrepreneurship will thus translate directly into high levels of economic growth.[7]

Constraints on entry and exit in the market directly affect competition among firms, which affects the quantity and quality of goods and services provided, the prices paid by consumers, etc. Some forms of regulation (particularly, antitrust) can preserve or increase competition in certain contexts.[8] For example, the U.S. Federal Trade Commission (FTC) regulates "unfair methods of competition" and bars company mergers "when the effect may be substantially to lessen competition or to tend to create a monopoly."[9]

Nonetheless, even studies using similar methods and data generate contradictory or inconclusive findings regarding the relationship between regulation and market dynamism. For instance, Goldschlag and Tabarrock find no evidence suggesting a link between U.S. federal regulation and the overall decline in U.S. market dynamism.[10] However, a paper by Bailey and Thomas—using the same measure of regulation—finds increases in regulation to be associated with a reduction in the number of new firms and the rate of employment growth between 1998 and 2011.[11]

Two studies using on-budget costs as their measure of regulation—retrieved from the same dataset—also find contradictory evidence on the link between regulation and employment. Beard et al found that "each million dollar increase in the regulatory budget costs the economy 420 private sector jobs"[12]

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5 The World Bank, "Doing Business: Measuring Business Regulations," accessed December 21, 2018, http://www.doingbusiness.org/.

6 Sandra E. Black and Philip E. Strahan, "Entrepreneurship and Bank Credit Availability," *The Journal of Finance* 57, no. 6 (2002): 2807-833.

7 Zoltan Acs, "How Is Entrepreneurship Good for Economic Growth?" *Innovations: Technology, Governance, Globalization* 1, no. 1 (2006): 97-107.

8 Niamh Dunne, "Between Competition Law and Regulation: Hybridized Approaches to Market Control," *Journal of Antitrust Enforcement* 2, no. 2 (2014): 225-69.

9 Federal Trade Commission, "Competitive Effects," accessed December 21, 2018, https://www.ftc.gov/tips-advice/competition-guidance/guide-antitrust-laws/mergers/competitive-effects.

10 Nathan Goldschlag and Alex Tabarrok, "Is Regulation to Blame for the Decline in American Entrepreneurship?" *Economic Policy* 33, no. 93 (2018): 5-44.

11 James B. Bailey and Diana W. Thomas, "Regulating Away Competition: The Effect of Regulation on Entrepreneurship and Employment," *Journal of Regulatory Economics* 52, no. 3 (2017): 237-254.

12 Thomas Randolph Beard, George S. Ford, Hyeongwoo Kim, and Lawrence J. Spiwak, "Regulatory Expenditures, Economic Growth and Jobs: An Empirical Study," *Phoenix Center Policy Bulletin*, no. 28. (2011): 1-20.

while a study by Sinclair and Vesey found the same variation in on-budget costs to have no statistically significant effect on employment.[13]

Similarly, in a review of the economics literature, Coglianese and Carrigan find a lack of evidence to authoritatively state whether regulation reduces or increases the overall number of jobs in the U.S.[14] Other scholars suggest that this observation could be the result of regulation simultaneously destroying and creating jobs (i.e., the net effect could effectively be zero).[15]

Regardless of the economic outcome measures used to understand regulations' effects, papers include caveats concerning the difficulties inherent in measuring regulation and relevant economic outcomes.[16] This paper focuses on productivity, particularly agricultural productivity, as the economic measure of interest. The next section of this chapter discusses the link between regulation and productivity.

II. Regulation and Productivity

Numerous studies focused on the sources of economic growth have found that growth in productivity is the major driver of long-run economic growth.[17] Productivity refers to the efficiency with which a production process converts inputs into outputs. It can be measured as single factor productivity or total factor productivity (TFP). Single factor productivity calculates the ratio of output to any single input used. Examples include labor productivity—output per unit of labor, and land productivity—output per unit of land. However, an increase in productivity of a single input does not necessarily reflect improved productive efficiency, since it may be a result of increased use of other inputs. TFP, on the other hand, measures the efficiency of all inputs in production and thus can determine whether there is a net saving in real costs per unit of output.[18] TFP growth is therefore considered a more informative measure of economic growth and is widely used in economic research.[19] A long convention in economics is to

[13] Tara M. Sinclair and Kathryn Vesey, "Regulation, Jobs, and Economic Growth: An Empirical Analysis," GW Regulatory Studies Center Working Paper, March 2012, https://regulatorystudies.columbian.gwu.edu/sites/g/files/zaxdzs1866/f/downloads/032212_sinclair_vesey_reg_jobs_growth.pdf.

[14] Cary Coglianese and Christopher Carrigan, "The Jobs and Regulation Debate," in *Does Regulation Kill Jobs?*, edited by Cary Coglianese, Adam M. Finkel, and Christopher Carrigan (Philadelphia, PA: University of Pennsylvania Press, 2013).

[15] Wayne B. Gray and Ronald J. Shadbegian, "Do the Job Effects of Regulation Differ with the Competitive Environment?," in *Does Regulation Kill Jobs? ?*, edited by Cary Coglianese, Adam M. Finkel, and Christopher Carrigan (Philadelphia, PA: University of Pennsylvania Press, 2013).

[16] John W. Dawson and John J. Seater, "Federal Regulation and Aggregate Economic Growth," *Journal of Economic Growth* 18, no. 2 (2013): 137-177.

[17] Moses Abramovitz, "Resource and Output Trends in the United States Since 1870," *The American Economic Review* 46, no. 2 (1956): 5-23; John W. Kendrick, "Productivity Trends: Capital and Labor," *The Review of Economics and Statistics* 38, no. 3 (1956): 248-257; Robert M. Solow, "A Contribution to the Theory of Economic Growth," *The Quarterly Journal of Economics* 70, no. 1 (1956): 65-94.

[18] Kendrick 1956.

[19] *Ibid*.

calculate TFP growth as a residual—the portion of the growth in outputs not explained by the growth in inputs, widely known as the "Solow residual."[20]

When examining the impact of regulation, studies often use technical change or innovation as a proxy for productivity growth. Although there are other factors affecting the performance of productivity,[21] macroeconomists generally agree that technical progress—reflecting the know-how or knowledge needed for production processes—is the major source of permanent growth in productivity.[22] Technical change is often separated into two components, disembodied technical change (e.g., the effects of better management practices, organizational change, and general knowledge), and embodied technical change—that embodied in new physical capital (e.g., advances in the quality or design between two vintages of the same capital asset).[23] Productivity growth measured as a residual only captures disembodied technical change, and yet productivity growth and technical change are often used interchangeably as a dependent variable in the literature studying the impact of regulation.

Regulation can have both direct and indirect effects on productivity and technical change. A direct effect can occur when regulations increase cost or forbid a particular innovation.[24] For example, product and labor market regulations can prohibit the use or transfer of certain products or labor, thereby restricting the most efficient use of inputs. Regulations unduly guided by the precautionary principle can restrict the development and diffusion of new technologies, disincentivize innovation, and thus inhibit productivity growth.[25]

Regulation's indirect effects on productivity and innovation may be greater than its direct effects. For example, George C. Eads suggests four channels through which regulation can influence technical change in the private sector:

1. Regulation may divert resources that otherwise might be used to fund research.
2. Regulation may change the firm's ability to calculate the payoffs to investments in research and development.

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[20] Solow 1956.

[21] Other factors affecting TFP includes rate and scale of production. For example, Salter (1969) decomposes TFP into technical change, technological change, efficiency, returns to scale, and economies of scale. *See* W. E. G. Salter, *Productivity and Technical Change* (Cambridge: Cambridge University Press, 1969). For a detailed discussion on the measurement of productivity, *see also* Organisation for Economic Co-operation and Development (OECD), "Measuring Productivity: Measurement of Aggregate and Industry-level Productivity Growth," OECD Manual 2001, http://www.oecd.org/sdd/productivity-stats/2352458.pdf.

[22] Paul Romer, "Endogenous Technological Change," *Journal of Political Economy* 98, no. 5 (1990): S71-S102; Susanto Basu, John G. Fernald, and Matthew D. Shapiro, "Productivity Growth in the 1990s: Technology, Utilization, or Adjustment?" NBER Working Paper Series, National Bureau of Economic Research, 2001.

[23] Organisation for Economic Co-operation and Development (OECD), *OECD Compendium of Productivity Indicators 2017* (Paris: OECD Publishing, 2017).

[24] National Academy of Sciences (NAS), *Impact of Regulation on Industrial Innovation* (Washington, DC: The National Academies Press, 1979).

[25] Adam D. Thierer, *Permissionless Innovation: The Continuing Case for Comprehensive Technological Freedom* (Arlington, VA: Mercatus Center at George Mason University, 2016).

3. Regulation may alter the proportion of benefits that are properly classifiable (from the viewpoint of the firm) as "externalities," and this may change the nature of research the firm is likely to undertake.
4. Regulation may change the optimal institutional patterns for performing certain types of research.[26]

Eads's first two arguments are often reflected in the literature as negative effects of regulation on innovation, mostly resulting from *compliance burden* and *regulatory uncertainty*. First, regulation creates compliance costs for regulated entities. For example, if a regulation requires a firm to install certain equipment, the firm may divert its capital that might have been used for innovative products to meet regulatory requirements.[27] Moreover, such compliance burden can vary by the design of regulation. If a regulation specifies particular technologies, designs, or specifications firms must adopt, firms will have to bear the associated costs to satisfy regulatory requirements; on the other hand, a more flexible regulation that specifies an end goal without indicating how firms should achieve it can encourage firms to innovate on more cost-effective approaches for compliance.[28]

Regulation can also create lags and uncertainties that may inhibit the firm's ability to anticipate the payoffs to research and development (R&D) investments. Unlike other types of investments, investments in R&D and innovation entail high probability of failure and large variance in rates of return.[29] Without certainty in the regulatory environment, firms are not able to assess risks and opportunities to make investment decisions on new technologies.[30] Further, lagged regulatory processes can lead to delays in firms' investment decisions as they wait to gather more information and gain assurances about future regulatory changes.[31]

Nevertheless, the last two channels suggested by Eads imply possible positive regulatory effects on productivity growth and innovation. Examples mostly involve environmental regulations stimulating innovation in pollution control techniques or new products or processes that bring less harm to the environment.[32] This follows Michael Porter's discussion on environmental regulation and industry competitiveness—widely known as the "Porter hypothesis."[33] In their study, Porter and van der Linde argue that properly designed environmental regulations can stimulate innovation that may partially offset

[26] George C. Eads, "Regulation and Technical Change: Some Largely Unexplored Influences," *The American Economic Review* 70, no. 2 (1980): 50-54.

[27] NAS 1979.

[28] Christopher Carrigan and Elise Harrington, "Choices in Regulatory Program Design and Enforcement," Penn Program on Regulation, June 2015, https://www.law.upenn.edu/live/files/4706-carriganharrington-ppr-researchpaper062015pdf.

[29] NAS 1979.

[30] Alfred A. Marcus, "Policy Uncertainty and Technology Innovation," *The Academy of Management Review* 6, no. 3 (1981): 443-448.

[31] Jun Ishii and Jingming Yan, "Investment under Regulatory Uncertainty: U.S. Electricity Generation Investment Since 1996," Center for the Study of Energy Markets (CSEM) Working Paper Series, University of California Energy Institute, 2004.

[32] Eads 1980; NAS 1979.

[33] Porter and van der Linde 1995.

or even exceed their compliance costs.[34] The most compelling arguments in the Porter hypothesis are probably that: 1) regulation directs firms' attention to resource inefficiencies and potential technological improvements; 2) regulation raises firms' corporate awareness; and 3) regulation creates pressure to innovate.[35] The central idea behind such innovation-spurring effects is that regulation creates various incentives for firms to invest in technologies that can either help them comply with the regulation in a more cost-effective way or create certain new products or processes that are exempt from regulatory requirements.[36] However, as Porter and van der Linde emphasize in their study, the design of regulation matters: regulations that can foster innovation must set clear goals but allow flexible approaches, provide market incentives to seed and spread innovations, and leave as little uncertainty as possible at every stage.[37]

Given that theories lead to different predicted effects of regulation on productivity and innovation, it is not clear which effects dominate in different circumstances. After all, the various effects might work together in complex ways and should not be segmented.[38] To further understand the relationship between regulation and productivity, empirical evidence is desirable. However, efforts in this direction often stumble due to the difficulty of measuring regulation.

III. Methods for Measuring Regulation

Empirical analyses employ various measures of regulation including counts (e.g., number of words or pages added to the Code of Federal Regulations), estimated compliance costs, and composite metrics (i.e., indices created by combining various indicators). This section catalogues several of the approaches commonly taken in empirical analyses of regulation.

A. Volume of Regulation

One approach to measuring regulation is to collect data about regulatory volume over time (i.e., either the *stock* of regulations "on the books" or the *flow* of new regulations). Such measures include the number of pages in a country's regulatory code (such as the *Code of Federal Regulations* (CFR) in the

[34] Porter and van der Linde 1995.

[35] Other arguments developed by Porter and van der Linde (1995) include: "regulation reduces the uncertainty that investments to address the environment will be valuable;" "regulation levels the transitional playing field;" and "regulation is needed in the case of incomplete offsets" (p. 100).

[36] Stewart (2010) calls these two types of innovation as compliance innovation or circumventive innovation. *See* Luke A. Stewart, "The Impact of Regulation on Innovation in the United States: A Cross-Industry Literature Review," Information Technology & Innovation Foundation, June 2010, https://itif.org/publications/2011/11/14/impact-regulation-innovation-united-states-cross-industry-literature-review.

[37] Porter and van der Linde 1995.

[38] René Kemp, Keith Smith, and Gerhard Becher, "How should we study the relationship between environmental regulation and innovation?," The European Commission JRC-IPTS, 2000.

U.S.),[39] the number of pages in state-level regulatory codes,[40] and the number of regulations published each year.[41] One advantage of using these metrics is that they provide useful time series data for analysis. Nonetheless, this approach is often unsatisfactory because it fails to capture any variation in content (i.e., regulations can affect regulated entities and the economy in substantively different ways depending on their design). For example, Dawson and Seater estimate the effect of regulation on aggregate economic growth using the number of pages in the CFR as their measure of regulation but note the following:

> We…unavoidably are limited to some kind of counting measure of the volume of regulation. A counting measure obviously is imperfect in that two identical values may comprise regulations of different types and, even within a given type, may represent regulations of different stringency.[42]

More recently, scholars have attempted to capture more of this variation within their measures of regulation.

B. Restrictive Words

One notable attempt to improve upon page or regulation counts is RegData—a tool that counts the number of restrictive words (e.g., "must" or "shall") in the CFR.[43] RegData allows for time series analysis similar to volume counts but attempts to distinguish among regulations based on the number of restrictions they impose. Nonetheless, similar to measuring volume, this approach lacks precision in differentiating between one regulation and another; a necessary simplifying assumption is required—namely, that each "must" or "shall" imposes uniform, incremental mandates on regulated entities. Scholars have also attempted to capture how restrictive a regulation is by directly comparing particular requirements (i.e., changes in maximum allowable levels), but such approaches are limited in application to particular regimes.[44]

C. Compliance Costs

Several studies use the cost of complying with regulatory requirements as their measure of regulation. For instance, numerous studies of environmental regulation rely on data from the Pollution Abatement

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[39] Cary Coglianese, "Empirical Analysis and Administrative Law," *University of Illinois Law Review* 2002, no. 4: 1111-1138. John W. Dawson and John J. Seater, "Federal Regulation and Aggregate Economic Growth," *Journal of Economic Growth* 18, no. 2 (2013): 137-177.

[40] Casey B. Mulligan and Andrei Shleifer, "The Extent of the Market and the Supply of Regulation," *The Quarterly Journal of Economics* 120, no. 4 (2005): 1445-1473.

[41] Clyde Wayne Crews, Jr., "Ten Thousand Commandments," Competitive Enterprise Institute, 2018, https://cei.org/10KC.

[42] Dawson and Seater 2013.

[43] Omar Al-Ubaydli and Patrick A. Mclaughlin, "RegData: A Numerical Database on Industry-specific Regulations for All United States Industries and Federal Regulations, 1997-2012," *Regulation & Governance* 11, no. 1 (2017): 109-123.

[44] Richard Damania, Per G. Fredriksson, and John A. List, "Trade liberalization, corruption, and environmental policy formation: theory and evidence," *Journal of Environmental Economics and Management* 46, no. 3 (2003): 490-512.

Costs and Expenditures (PACE) survey administered by the U.S. Census Bureau which collected U.S. industry capital expenditures and operating costs associated with pollution abatement activities.[45] Berman and Bui use plant-level data on abatement technology investments made by oil refineries.[46] Given the lack of robust data on private sector compliance costs, economists also measure regulation using the difference between the purchase prices of inputs in production and their shadow price—an estimate of the domestic input price undistorted by regulation.[47] Finally, in cases where abatement expenditure data are not available, studies often use proxies related to enforcement efforts, including inspection reporting or spending by regulatory agencies.[48]

D. On-budget Costs

Dudley and Warren track federal regulatory agency expenditures and staffing devoted to "developing, administering and enforcing regulation"[49] and several studies have used these data to estimate the effect of regulation on macroeconomic performance. For instance, Beard et al. used these on-budget data to estimate the relationship between regulation and economic performance (e.g., economic growth, private sector job creation).[50] As noted above, Sinclair and Vesey conducted similar econometric analysis with these data and reached different conclusions.[51]

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[45] The U.S. Census Bureau conducted the PACE survey annually between 1973 and 1994. EPA funded a PACE survey to collect data on expenditures in 1999 and 2005. For more on PACE data and its empirical applications, *see* Randy A. Becker and Ronald J. Shadabegian, "A Change of PACE: Comparing the 1994 and 1999 Pollution Abatement Costs and Expenditures Surveys," *Journal of Economic and Social Measurement* 30, no. 1 (2005): 63-95. *See also* Adam B. Jaffe and Karen Palmer, "Environmental Regulation and Innovation: A Panel Data Study," Review of Economics and Statistics 79, no. 4 (1997): 610-619; Wayne B. Gray, "The Cost of Regulation: OSHA, EPA and the Productivity Slowdown," American Economic Association 77, no. 5 (1987): 998-1006; Meryem Saygili, "Pollution Abatement Costs and Productivity: Does the Type of Cost Matter?," Letters in Spatial and Resource Sciences 9, no. 1 (2016): 1-7.

[46] Eli Berman and Linda T.M. Bui, "Environmental regulation and productivity: Evidence from oil refineries," Review of Economics and Statistics 83, no. 3 (2010): 498–510.

[47] Daan P. van Soest, John A. List, and Tim Jeppesen, "Shadow Prices, Environmental Stringency, and International Competitiveness," European Economic Review 50, no. 5 (2006): 1151-1167.

[48] Ebru Alpay, Steven Buccola, and Joe Kerkvliet, "Productivity Growth and Environmental Regulation in Mexican and U.S. Food Manufacturing," American Journal of Agricultural Economics 84, no. 4 (2002): 887-901; Gray 1987; Charles Dufour, Paul Lanoie, and Michel Patry, "Regulation and Productivity," Journal of Productivity Analysis 9, no. 3 (1998): 233-247; Paul Lanoie, Michel Patry, and Richard Lajeunesse, "Environmental Regulation and Productivity: Testing the Porter Hypothesis," Journal of Productivity Analysis 30, no. 2 (2008): 121-128; R. J. Shadbegian and W. B. Gray, "Spatial Patterns in Regulatory Enforcement: Local Tests of Environmental Justice," in *The Political Economy of Environmental Justice*, edited by H. S. Banzhaf. Stanford (CA: Stanford University Press, 2012).

[49] Susan Dudley and Melinda Warren, "Regulator's Budget: More for Homeland Security, Less for Environmental Regulation," The George Washington University Regulatory Studies Center, 2008, https://regulatorystudies.columbian.gwu.edu/fy-2019-regulators-budget-more-homeland-security-less-environmental-regulation.

[50] Thomas Randolph Beard, George S. Ford, Hyeongwoo Kim, and Lawrence J. Spiwak, "Regulatory Expenditures, Economic Growth, and Jobs: An Empirical Study," *Phoenix Center Policy Bulletin*, no 28 (2011): 1-20.

[51] Sinclair and Vesey 2012.

E. Composite Measures

Studies also combine various indicators related to regulation to form composite measures of regulation—normally indexes—for use in empirical analyses. For example, Goff designed his Effective Regulation Index to measure the regulatory burden on regulated entities complying with environmental regulations in the U.S. by combining the number of pages in the *Federal Register* with additional variables including the number of staff employed at the Environmental Protection Agency and the percentage of lawyers in the U.S. population.[52] Levinson generated an industry-adjusted index of state environmental compliance costs.[53] Simkovic and Zhang construct an index of compliance costs using firm expenditures on employees whose primary task is ensuring compliance with regulation.[54] Other approaches involve the use of extensive survey data along with expert judgements to create indices of overall regulatory intensity.

One advantage of composite measures is their generalizability—often allowing for cross-country comparisons using consistent methodologies to analyze changes over time. For example, in 2003, the World Bank began publishing its Doing Business report, which measures regulations affecting small and medium-sized enterprises. As of 2018, the report covers 190 countries using 11 sets of indicators (e.g., labor market regulation, ease of starting a business) and combines survey data and empirical measures of relevant country laws and regulations to generate quantitative metrics for each country's regulatory environment.[55]

Finally, studies have also combined various indices to create composite indices of regulation.[56] For instance, Loayza et al. combine six separate sources: 1) *Doing Business* (The World Bank Group); 2) *Index of Economic Freedom* (The Heritage Foundation); 3) *Economic Freedom of the World* (The Fraser Institute), 4) *Labor Market Indicators Database* (M. Rama and R. Artecona 2000); 5) *The Corporate Tax Rates Survey* (KPMG) and 6) *International Country Risk Guide* (The PRS Group).

IV. Application to Agriculture

Total agricultural output growth in the U.S. is mainly driven by productivity growth, along with agricultural input growth and short-term shocks.[57] This section discusses the mechanisms by which

[52] Brian Goff (editor), *Regulation and Macroeconomic Performance* (Boston: Kluwer, 1996).

[53] Arik Levinson, "An Industry-Adjusted Index of State Environmental Compliance Costs," NBER paper, 2001, http://www.nber.org/chapters/c10607.pdf.

[54] Michael Simkovic and Miao Ben Zhang, "Measuring Regulation," January 2019, https://ssrn.com/abstract=3205589.

[55] The World Bank 2018.

[56] Norman V. Loayza, Ana Maria Oviedo, and Luis Servén, "Regulation and Macroeconomic Performance," The World Bank Policy Research Working Paper No. 3469, 2005, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=643682.

[57] Sun Ling Wang, Paul Heisey, David Schimmelpfennig, and Eldon Ball, "Agricultural Productivity Growth in the United States: Measurement, Trends, and Drivers," Economic Research Service, U.S. Department of Agriculture, ERR-189, July 2015.

regulation can stimulate or stifle productivity growth in agriculture and summarizes empirical findings about the relationship between regulation and agricultural productivity in the literature.

A. Mechanism

A report published by the Economic Research Service of the U.S. Department of Agriculture (USDA) specifies the major sources of agricultural TFP growth (Figure 1).[58] In this framework, productivity growth is driven by changes in input quality, which can be affected by embodied technical change, farming practices, and farmers' education levels and health conditions.[59] Technical change, or innovation, is mainly due to R&D funded by public or private sectors, which can be enhanced by extension activity and infrastructure.[60] Similarly, Gopinath and Roe state that productivity growth in agriculture can be attributed to four major sources: public investment in agricultural R&D, public expenditures on infrastructure, private investment in R&D, and technological advances in material inputs such as fertilizers and chemicals.[61]

Regulation influences different factors that affect agricultural productivity growth. First, regulation can affect innovation by diverting and encouraging public and private R&D investments in the agriculture sector. Aligning with Eads's arguments, regulations setting stringent and inflexible standards for producers and processors of agricultural commodities can generate substantial compliance costs that may cause them to divert time and resources from innovative activities to compliance efforts. For example, the Food and Drug Administration's Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption are intended to reduce microbiological hazards that can lead to food-borne illness by setting various requirements related to agricultural water quality, biological soil amendments, the presence of domesticated and wild animals on produce fields, worker training and health and hygiene, and equipment, tools, and buildings.[62] However, these standards also result in significant costs to covered farms and are especially burdensome for smaller farms.[63]

On the other hand, there are many existing regulations that can encourage agricultural R&D investments. For example, regulations that authorize technology transfer from the government to private sector partners can increase firms' payoffs to investments in related R&D and thus promote private-sector R&D investment. The Agricultural Research Service administers various technology transfer programs for all intramural research conducted by USDA through collaborative research agreements and licenses and

[58] *Ibid*.

[59] *Ibid*.

[60] *Ibid*.

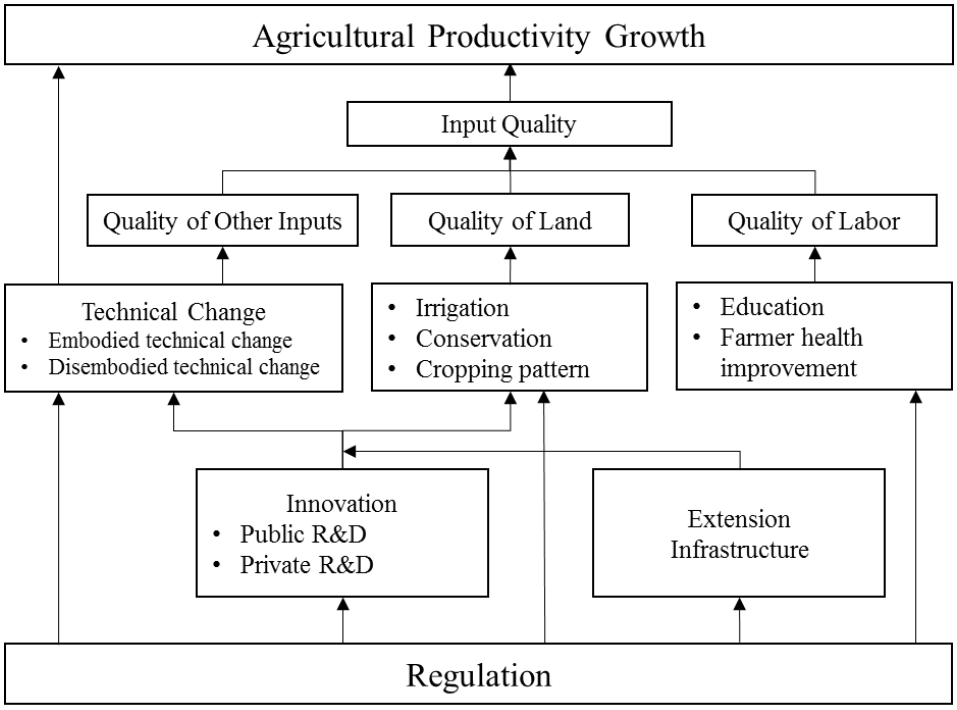
[61] Munisamy Gopinath and Terry L. Roe, "Sources of Sectoral Growth in an Economy Wide Context: The Case of U.S. Agriculture," *Journal of Productivity Analysis* 8, no. 3 (1997): 293-310.

[62] Center for Food Safety and Applied Nutrition, "Food Safety Modernization Act (FSMA) - FSMA Final Rule on Produce Safety," U S Food and Drug Administration Home Page, accessed December 21, 2018, https://www.fda.gov/food/guidanceregulation/fsma/ucm334114.htm.

[63] According to FDA's estimates, the compliance costs could consume up to 6 percent of a farm's annual food sales. Sofie E. Miller and Cassidy B. West, "Small Farms, Big Costs," *Regulation* (Fall 2013): 9-10.

public-private partnerships.[64] Further, regulations authorizing certain loan and subsidy programs can also increase firms' incentives to invest in specific types of agricultural R&D. For example, government subsidies for biofuel stimulate market demand for biofuel, spurring private-sector R&D investment in the biofuel industry supply chain including manufacturing of agricultural inputs as well as farming of corn, sugarcane, and rapeseed.[65]

Figure 1: Regulation Affecting Sources of Agricultural Productivity Growth



Note: This diagram is an adapted version of the diagram in Wang et al. 2015 (p. 2).[66] The original diagram shows sources of agricultural output growth, and this diagram extracts sources of productivity growth and incorporates the component of regulation. It is just to illustrate how regulation can affect various sources of agricultural productivity growth but not to present a complete framework of all possible mechanisms.

Second, regulation can affect agricultural input quality by encouraging or constraining certain operations. The quality of land is largely influenced by practices of irrigation, conservation, and cropping patterns,[67] which are often subject to regulatory requirements. USDA's Farm Service Agency and Natural Resources Conservation Services administer a variety of voluntary conservation programs that

[64] Agricultural Research Service, U.S. Department of Agriculture (ARS), "Office of Technology Transfer," last modified October 9, 2018, https://www.ars.usda.gov/office-of-technology-transfer/.

[65] Keith O. Fuglie, Paul W. Heisey, John L. King, Carl E. Pray, Kelly Day-Rubenstein, David Schimmelpfennig, Sun Ling Wang, and Rupa Karmarkar-Deshmukh, "Research Investments and Market Structure in the Food Processing, Agricultural Input, and Biofuel Industries Worldwide," Economic Research Service, U.S. Department of Agriculture, Economic Research Report Number 130, November 2011.

[66] Wang et al. 2015

[67] Wang et al. 2015.

aim to preserve land quality, such as the Conservation Reserve Program, Conservation Stewardship Program, and Environmental Quality Incentives Program.[68] These programs provide subsidies for farmers to encourage adoption of certain conservation practices and cropping patterns, leading to better land quality that could drive productivity growth. For example, the Conservation Stewardship Program pays eligible farmers to install and maintain conservation practices and adopt resource-conserving crop rotations.[69]

The quality of labor depends on farmer education and health.[70] Agricultural labor is also constrained by regulations setting minimum wage, overtime, and recordkeeping standards, which may contribute to labor productivity.[71] Also, relevant workplace safety and health regulations can affect labor quality through both education and farmer health. For example, the Agricultural Worker Protection Standard requires training for farmworkers on pesticide handling and specific measures to decrease pesticide exposure incidents (e.g. providing and maintaining required personal protective equipment to handlers, and monitoring handlers using highly toxic pesticides).[72]

Regulations prohibiting the use of certain intermediate inputs, although intended to protect the environment and public safety, may force the use of less efficient inputs, thereby mitigating productivity growth. Examples include pesticide bans and restrictions on genetically modified crop cultivation. For instance, the Insect Resistance Management requires farmers planting a Bt crop[73] to maintain a refuge which plants a non-Bt variety of the crop and prescribes methods for the use of non-Bt insecticide treatments on the refuge.[74] While these requirements may have the effect of enhancing agricultural productivity by mitigating insect resistance in the long run, they might also inhibit short-run productivity growth.

Third, regulation can affect knowledge extension activities and agricultural infrastructure. A wide range of government services and knowledge sharing programs are implemented through rulemaking. For

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[68] Susan E. Dudley, Lydia Holmes, Daniel R. Pérez, Aryamala Prasad, and Zhoudan Xie, "Transatlantic Approaches to Agriculture Policy," The George Washington University Regulatory Studies Center, Transatlantic Agriculture & Regulation Working Paper Series: No. 3, October 2017, https://regulatorystudies.columbian.gwu.edu/transatlantic-approaches-agriculture-policy-transatlantic-agriculture-regulation-working-paper.

[69] Natural Resources Conservation Service, U.S. Department of Agriculture (NRCS), "Conservation Stewardship Program," accessed December 21, 2018, https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/.

[70] Wang et al. 2015.

[71] U.S. Department of Labor, "Wage and Hour Division (WHD)," accessed December 21, 2018, https://www.dol.gov/whd/ag/ag_flsa.htm.

[72] U.S. Environmental Protection Agency (EPA), "Agricultural Worker Protection Standard (WPS)," accessed December 21, 2018, https://www.epa.gov/pesticide-worker-safety/agricultural-worker-protection-standard-wps.

[73] A Bt (*Bacillus thuringiensis*) crop is a crop that has "been genetically altered to produce proteins that are harmful to certain insect pests." *See* U.S. Environmental Protection Agency (EPA), "Insect Resistance Management for Bt Plant-Incorporated Protectants," accessed December 21, 2018, https://www.epa.gov/regulation-biotechnology-under-tsca-and-fifra/insect-resistance-management-bt-plant-incorporated.

[74] *Ibid*.

example, a regulation sets policy and procedures for the Natural Resources Conservation Service to administer a snow survey and water supply forecast program, which provides agricultural water users with water supply forecasts and a snow resource database to enable them to plan for efficient water management.[75] Moreover, the USDA Rural Development provides loans and grants to help build utilities and telecommunications infrastructure and facilities in rural areas.[76]

Many other policies and regulations could affect agricultural productivity growth. Some are clearly designed to drive productivity growth directly, while others may have an indirect impact. A small body of literature provides some empirical evidence on the impact of regulation on agricultural productivity growth.

B. Empirical Findings

Much of the research studying the impact of agricultural regulation focuses on output levels,[77] farm revenue or income,[78] industry structures,[79] and farmers' financial decision-making behavior.[80] A small body of scholarship studies the relationship between regulation and agricultural productivity and/or technical change, but the empirical findings are mixed.

Consistent with the Porter Hypothesis, a few studies find a positive correlation between environmental regulations and technical change in farms. Using data on the productivity of Swiss farms from 1991 to 2006, Bokusheva et al. find that the introduction of environmental regulations had a positive effect on technical change: farmers began to look for technological options for maintaining high productivity of input use by increasing the effectiveness of input utilization.[81] In the U.S., Njuki and Bravo-Ureta

[75] Code of Federal Regulations, Title 7, Part 612, Snow Surveys and Water Supply Forecasts.

[76] Rural Development, U.S. Department of Agriculture, "Programs & Services," accessed December 21, 2018, https://www.rd.usda.gov/programs-services.

[77] Jorge Fernandez-Cornejo, Sharon Jans, and Mark Smith. "Issues in the Economics of Pesticide Use in Agriculture: A Review of the Empirical Evidence," Review of Agricultural Economics 20, no. 2 (1998): 462-488; Jeremy G. Weber and Nigel Key, "How much Do Decoupled Payments Affect Production? An Instrumental Variable Approach with Panel," *American Journal of Agricultural Economics* 94, no. 1 (2012): 52-66.

[78] Janet Carpenter, Leonard Gianessi, and Lori Lynch, "The Economic Impact of the Scheduled U.S. Phaseout of Methyl Bromide," National Center for Food and Agricultural Policy, February 2000; Terry M. Dinan, Michael Salassi, and Craig Simons, "Farm-level Impacts of Recent and Proposed Environmental Regulations on Selected Farm Types," *Agribusiness* 7, no. 2 (1991): 115-133.

[79] Stefan Kersting, Silke Hüttel, and Martin Odening, "Industry Dynamics under Production Constraints—The Case of the EU Dairy Sector," Economic Modelling 55 (2016): 135-151.

[80] Jaclyn D. Kropp and Ani L. Katchova, "The Effects of Direct Payments on Liquidity and Repayment Capacity of Beginning Farmers," Agricultural Finance Review 71, no. 3 (2011): 347-365; David Ubilava, Barry J. Barnett, Keith H. Coble, and Ardian Harri, "The SURE Program and Its Interaction with Other Federal Farm Programs," *Journal of Agricultural and Resource Economics* 36, no. 3 (2011): 630-648.

[81] Raushan Bokusheva, Subal C. Kumbhakar, and Bernard Lehmann, "The Effect of Environmental Cross Compliance Regulations on Swiss Farm Productivity," The 84th Annual Conference of the Agricultural Economics Society in Edinburgh, March 30-31, 2010, https://ageconsearch.umn.edu/bitstream/91828/2/98Bokusheva_Kumbkakar_lehman.pdf.

observe that regulating greenhouse gas emission from dairy farming is associated with a 5 percentage-point increase in average technical efficiency because of the structural change in the dairy industry that brings cost advantages from economies of scale.[82]

On the other hand, studies generally find a negative impact of marketing orders (e.g., quotas or minimum prices) on agricultural productivity. Gillespie et al. find that the implementation of milk quotas in Europe is associated with a general decrease in TFP of Irish dairy farms and a slowdown in productivity growth.[83] Slade and Hailu examine dairy farms in the Canadian province of Ontario and New York State, and find that farms operating under milk quotas in Ontario (relative to no milk quotas in New York State) have lower cost efficiency on average, primarily accounted for by a low allocative efficiency rather than technical efficiency.[84] Similarly, Frick and Sauer find that the abolition of milk quotas is associated with resource allocation toward more productive farms in Germany.[85]

Income supports and subsidies are generally negatively associated with farm productivity and technical change. For example, Mary finds that agricultural subsidies had a negative impact on farm-level TFP in French crop farms between 1996 and 2003.[86] Sipiläinen and Kumbhakar find mixed effects of income support on technical change in European dairy farms from 1997 to 2003: the payment is positively associated with technical change in Denmark but negatively associated with technical change in Finland and Sweden.[87]

Research studying the cumulative impact of regulation on agricultural productivity is very limited. An exception is a study conducted by Russell, Crespi and Langemeier.[88] They measure the total amount of regulation issued by USDA and EPA during the period of 1997 to 2012, using the restrictive word count

[82] Eric Njuki and Boris E, Bravo-Ureta, "The Economic Costs of Environmental Regulation in U.S. Dairy Farming: A Directional Distance Function Approach," *American Journal of Agricultural Economics* 97, no. 4 (2015): 1087-1106.

[83] Patrick Gillespie, Cathal O'Donoghue, Stephen Hynes, Fiona Thorne, and Thia Hennessy, "Milk Quota and the Development of Irish Dairy Productivity: a Malmquist Index Using a Stochastic Frontier Approach," International Association of Agricultural Economists (IAAE) 2015 Conference, August 9-14, 2015, Milan, Italy 2015, https://ageconsearch.umn.edu/record/211684?ln=en.

[84] Peter Slade and Getu Hailu, "Efficiency and Regulation: A Comparison of Dairy Farms in Ontario and New York State," *Journal of Productivity Analysis* 45, no. 1 (2015): 103-115.

[85] Fabian Frick and Johannes Sauer, "Deregulation and Productivity: Empirical Evidence on Dairy Production," *American Journal of Agricultural Economics* 100, no. 1 (2018): 351-378.

[86] Sebastien Mary, "Assessing the Impacts of Pillar 1 and 2 Subsidies on TFP in French Crop Farms," *Journal of Agricultural Economics* 64, no. 1 (2013): 133-144.

[87] Timo Sipiläinen and Subal C. Kumbhakar, "Effects of Direct Payments on Farm Performance: The Case of Dairy Farms in Northern EU Countries," University of Helsinki, Department of Economics and Management, Discussion Papers n:o 43, 2010.

[88] Levi A. Russell, John M. Crespi, and Michael R. Langemeier, "Agricultural Productivity Growth and Regulation," Draft of First Submission *Public Choice*, August 2015, https://ag.purdue.edu/commercialag/Documents/Resources/Agricultural-Policy/General%20Farm%20Policy/2015_08_31_Langemeier_Agricultural_Productivity_Growth.pdf.

from RegData[89] as well as regulatory agency expenditures from Dudley and Warren,[90] and find negative effects on state-level farm productivity.[91]Empirical studies have mostly focused on a specific set of regulations (e.g., quotas, income support), partially due to the challenges of measuring regulation. Such studies cannot usually draw conclusions on the cumulative impact of regulation on economic growth, since they include only a small subset of all regulations. Research like that conducted by Russell, Crespi and Langemeier attempt to measure the total amount of relevant regulation but it does not distinguish between different forms of regulation.

V. Incorporating the Form of Regulation

A wide body of research illustrates that the *form* a regulation takes—the particular policy instruments it employs—combined with the *context* in which it operates matters a great deal for its prospects for successfully achieving desired social outcomes.[92] For instance, in a thorough treatment of the attributes that constitute "smart regulation," Gunningham and Sinclair observe that regulations make use of various combinations of policy instruments to achieve social goals and note that not all instruments are complementary and that their appropriateness is largely dependent on contextual factors.[93] The authors state that "…the task of answering the question of which particular combinations are complementary, which are counterproductive and which are context-specific is complex" while noting that certain combinations are likely to produce suboptimal economic or social outcomes.[94] Coglianese notes that regulators have a "large array of instruments available" to choose from and identifies four characteristics likely to create disparate impacts on regulated entities.[95] Richards states that:

[89] Omar Al-Ubaydli and Patrick McLaughlin, "RegData:Anumerical database on industry-specific regulations for all United States industries and federal regulations, 1997–2012," *Regulation & Governance* 11 (2017): 109-123.

[90] Dudley and Warren 2018.

[91] Russell, Crespi and Langemeier 2015.

[92] *See* Carrigan and Harrington 2015. For additional research detailing both regulatory form and the importance of context, *see* Coglianese, Cary, Jennifer Nash, and Todd Olmstead, "Performance-Based Regulation: Prospects and Limitations in Health, Safety, and Environmental Protection." Administrative Law Review 55, no. 4 (2003): 705-729; Neil Gunningham, Peter N. Grabosky, and Darren Sinclair, *Smart Regulation: Designing Environmental Policy* (Oxford: Clarendon Press, 1998); Cameron Hepburn, "Regulation by Prices, Quantities, or Both: A Review of Instrument Choice," Oxford Review of Economic Policy 22, no. 2 (2006): 226-247; Wallace Oates and William Baumol, "The Instruments for Environmental Policy," in *Economic Analyses of Environmental Problems*, edited by Edwin S. Mills (Cambridge, MA: National Bureau of Economic Research, 1975); Jeffrey L. Pressman and Aaron B. Wildavsky, *Implementation: How Great Expectations in Washington are Dashed in Oakland* (Berkeley, California: University of California Press, 1973). Alfons Weersink, John Livernois, Jason Shogren, and James Shortle, "Economic Instruments and Environmental Policy in Agriculture," *Canadian Public Policy* 24, no. 3 (1998): 309-327.

[93] Neil Gunningham and Darren Sinclair, "Smart Regulation," in *Regulatory Theory: Foundations and Applications*, edited by Peter Drahos (Canberra: ANU Press, 2017).

[94] *Ibid*, p. 139.

[95] Cary Coglianese, "Engaging Business in the Regulation of Nanotechnology," in *Governing Uncertainty : Environmental Regulation in the Age of Nanotechnology*, edited by Christopher J. Bosso (Washington, DC: RFF Press, 2010).

One consistent message from the environmental economics literature is that incentive-based instruments are a more cost-effective means to achieve environmental goals than alternative policy instruments such as technology-based standards.[96]

Economic theories of regulation predict that economic forms of regulations that set price or quantity constraints or limit competition adversely affect innovation and create more unnecessary economic distortions than regulations that provide information or set performance standards.[97] The Office of Management and Budget's guidance to federal regulatory agencies includes a "presumption against economic regulation," noting that "government actions can be unintentionally harmful, and even useful regulations can impede market efficiency."[98]

In light of both economic theory and actual experience, a particularly demanding burden of proof is required to demonstrate the need for…price controls in competitive markets; production or sales quotas in competitive markets; mandatory uniform quality standards for goods or services if the potential problem can be adequately dealt with through voluntary standards or by disclosing information of the hazard to buyers or users; or controls on entry into employment or production, except (a) where indispensable to protect health and safety (e.g., FAA tests for commercial pilots) or (b) to manage the use of common property resources (e.g., fisheries, airwaves, Federal lands, and offshore areas).[99]

Prior to the deregulation of the 1980's in the U.S., the National Research Council encouraged policymakers to consider choosing regulatory forms that used market-oriented approaches to generate consumer health and safety protections in a cost-effective manner.[100] More recently, Hepburn suggested that economic theory should function as an important input for policymakers given the vastly different economic outcomes possible from different policy instruments.[101] His work considers the interaction between different forms of policy intervention and various contextual characteristics including the expected level of market uncertainty, the time-frame of the policy, and the enforcement costs related to

[96] Kenneth R. Richards, "Framing Environmental Policy Instrument Choice," Duke Environmental Law & Policy Forum 10, no. 2 (2000): 221-285.

[97] For example, Loayza *et al.* (2005) states that "on analytical grounds, certain types of regulation—such as those designed to enhance competition in goods or financial markets—should be expected to exert beneficial effects on economic performance, rather than adverse ones" (p. 4). *See also* Leora Klapper, Luc Laeven, and Raghuram Rajan, "Entry Regulation as a Barrier to Entrepreneurship," Journal of Financial Economics 82, no. 3 (2006): 591-629; OECD, "Annex 2: Regulatory Alternatives," in *Regulatory Policies in OECD Countries: From Interventionism to Regulatory Governance* (Paris: OECD Publishing); OMB 2003; George J. Stigler, "The Theory of Economic Regulation," *The Bell Journal of Economics and Management Science* 2, no. 1 (1971): 3-21. For additional scenarios on the benefits of shifting towards more efficient policy instruments, *see* Winston 2006.

[98] OMB 2003, p. 265.

[99] *Ibid*.

[100] NAS 1979, pp. 25, 34, 53.

[101] Cameron Hepburn, "Regulation by Prices, Quantities, or Both: A Review of Instrument Choice." *Oxford Review of Economic Policy* 22, no. 2 (2006): 226-247.

different regulatory approaches. Finally, regulations—regardless of their form—can be either voluntary or mandatory, a distinction which is also likely to affect outcomes.[102]

Although it is widely accepted that different regulatory forms affect the economy in substantively different ways, our survey of the peer-reviewed literature on regulation indicates that there is currently no systematic framework for classifying regulations by form. Existing work by other scholars guided our definitions and classifications, but we found existing taxonomies were not satisfactory for several reasons. Most were not generalizable across issue areas; some were too theoretical to apply directly as a framework for empirical research; some included policy instruments unrelated to regulation; and others excluded certain forms of regulation from their taxonomies based on normative claims regarding which subset of policy instruments they considered were appropriate to use within a particular policy area.[103]

The discussion by Gunningham and Sinclair on smart regulation includes an overview of various types of regulatory policy instruments available to policymakers. However, the authors limit their treatment to a broad classification of five general policy attributes: 1) command-and-control regulation, 2) economic instruments, 3) self-regulation, 4) voluntarism, and 5) information strategies.[104] Hepburn engages in a valuable theoretical discussion of several conditions under which it might be appropriate to consider the use of certain regulatory approaches over others; nonetheless, his classification of regulations is limited to identifying a subset that affect prices, quantities, or both.[105]

Coglianese illustrates several important contextual factors to consider when choosing among regulatory policy instruments, including a discussion on the differences between voluntary and mandatory approaches; he provides a list of various regulatory forms but limits his accounting primarily to the category of social regulations.[106] Richards similarly identifies various characteristics of regulations—primarily in the area of environmental regulation. However, his framework is limited to high-level distinctions, such as whether a regulation has to do with information or abatement or if it regulates price or quantity.[107]

Other studies engage in a more robust classification of different regulatory forms but limit the scope of their inquiry to certain industries or policy issues. For instance, Stavins identifies several discrete regulatory forms within the broader categories of command-and-control and market-based instruments,

[102] Carrigan and Harrington 2015.

[103] Interestingly, most of the literature we surveyed tended to focus on policy instruments for environmental regulation. *See*, for instance: Robert N. Stavins, "Policy Instruments for Climate Change: How Can National Governments Address a Global Problem?," University of Chicago Legal Forum 1997 (1997): 293-329. *See also* Weersink et al. 1998. On policy instruments, s*ee* Kenneth R. Richards, "Framing Environmental Policy Instrument Choice," *Duke Environmental Law & Policy Forum* 10, no. 2 (2000): 221-285. For a discussion on theoretical frameworks, *see* Peter Drahos, *Regulatory Theory: Foundations and Applications* (Canberra: ANU Press, 2017). *See also* Hepburn 2006.

[104] Gunningham and Sinclair 2017, pp. 140-141.

[105] Hepburn 2006.

[106] Coglianese 2010.

[107] Richards 2000.

but he limits his identification strategy to policy instruments appropriate for environmental regulation (specifically related to climate change).[108]

VI. Conclusion: The Need for a Taxonomy of Regulatory Forms

Despite the strong interest in understanding regulation's effects on economic outcomes, and an extensive literature focused on measuring those impacts, the results are inconclusive. One of the key limitations to meaningful analysis is the quality of the available proxies for regulation. On the micro level, it is widely accepted that regulatory form can have a large impact, not only on how cost-effectively it achieves desired goals, but its broader economic consequences. However, such nuances are hard to capture in broader, macro-level analyses.

To add more sophistication to existing regulatory measures, the GW Regulatory Studies Center, in cooperation with the U.S. Department of Agriculture, has developed a three-tiered Taxonomy of Regulatory Forms and applied it to regulations affecting the agriculture sector. The following chapters of this report describe that Taxonomy, and use it to examine the relationship between regulation and agricultural productivity.

[108] Stavins 1997.

CHAPTER 2:

A Taxonomy of Regulatory Forms

Daniel R. Pérez, Aryamala Prasad, & Zhoudan Xie

Regulations involve the use of complex policy instruments with the potential to generate substantial benefits and costs for the public. However, as discussed in Chapter 1, satisfactory understanding of the effects of regulation remains scarce. Different types of regulation—such as price controls, disclosure requirements, or performance standards—work differently and can be expected to have different effects on benefits, costs, and other economic factors. An accurate understanding of the effects of regulation, therefore, requires an understanding of how different forms of regulation achieve intended and unintended outcomes. To further this understanding, we propose a framework to classify regulations in a systematic and comprehensive manner by the form they take. Regulatory form in this paper refers to the particular regulatory policy instruments employed to achieve a desired end.

We combine economic rationales for regulation with regulatory designs to develop a three-tiered taxonomy to facilitate classification of regulatory forms. The first tier contains four broad categories of regulations. Each category of regulation is designed to include a set of second-tier policy instruments that government agencies employ to achieve intended outcomes. The third tier allows for identification of greater nuance between policy instruments within the same category. For instance, command-and-control regulations might specify in detail the particular procedures that regulated entities must follow to comply, while others might only specify a required outcome to be achieved—leaving regulated entities with greater flexibility.

This taxonomy is the first comprehensive typology of regulation by form that can be applied to regulations across policy areas. We expect the taxonomy to be useful for practitioners as well as researchers to better understand the relationship between regulatory activity and public outcomes. Chapters 3 and 4 of this report employ the taxonomy empirically to estimate the effects of regulation on input productivity of land in agriculture.

In keeping with the taxonomy's broad applicability across policy areas, this chapter includes discussion of several forms not found in our agricultural dataset—detailed in Chapter 3—or not used to regulate

agriculture (e.g., certificate-of-need regulations). However, this chapter provides examples of each form as it relates to agriculture whenever possible. We define regulations to include "all administrative laws or rules…by which the federal government implements laws and agency objectives."[1]

I. Overview of the Taxonomy

The taxonomy contains three tiers of regulatory forms. The first tier corresponds to four categories of regulations: 1) economic, 2) social, 3) transfer, and 4) administrative. Economic regulations affect firm behavior with the primary goal of addressing market power by directly constraining who can participate in a market, and prices they can charge. Social regulations, on the other hand, mainly address externalities and information asymmetries related to issues of health, safety, security, and the environment.[2] In contrast, transfer and administrative regulations differ from economic and social regulation in their intended goals and intended outcomes. Transfer regulations specify monetary support or technical services provided by the government to address a specified public need while administrative regulations are procedural regulations with which only government agencies are obligated to comply.

The second tier focuses on a set of regulatory forms nested within each first-tier category based on a wide scope of regulatory designs. For example, economic regulations themselves may take various forms including those that regulate price, quantity, entry & exit, and service quality.[3] Social regulations include command-and-control, market-based, and information-based regulations. The third tier contains more narrowly-specified regulatory forms nested within each second-tier form. For instance, command-and-control regulations include performance standards, means-based standards, monitoring, reporting and verification requirements, permitting, pre-market notice, pre-market approval, and prohibitions. Altogether, there are 36, third-tier forms of regulation in the taxonomy.

Our logic for designing the taxonomy with three tiers is that this approach provides flexibility for different purposes. For example, scholars interested in comparisons of specific regulatory forms, such as means-based versus performance standards, can use third-tier forms to classify regulation, whereas those interested in higher-level comparisons can easily aggregate third-tier forms into second or first tier (i.e., to study differences between command-and-control and market-based instruments or between economic and social regulation—more broadly). The Appendix to this chapter presents the complete taxonomy, including each form's definition and select examples. The following sections discuss each form in greater detail.

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1 Susan E. Dudley and Jerry Brito, *Regulation: A Primer* (George Washington University Regulatory Studies Center and Mercatus Center at George Mason University, 2012), 1. https://regulatorystudies.columbian.gwu.edu/sites/g/files/zaxdzs1866/f/downloads/RegulatoryPrimer_DudleyBrito.pdf.

2 Susan Dudley and Melinda Warren, "Regulators' Budget: More for Homeland Security, Less for Environmental Regulation," The George Washington University Regulatory Studies Center, May 2018, https://regulatorystudies.columbian.gwu.edu/fy-2019-regulators-budget-more-homeland-security-less-environmental-regulation.

3 Dudley and Brito 2012.

II. Economic Regulation

Economic regulation includes regulatory forms that generally limit who can enter a business and what prices they may charge.[4] Regulators set prices, establish mandates regarding the quantity of goods and services, control market entry and exit, and set parameters related to service quality. The primary efficiency justification for economic regulation is market power,[5] particularly in cases where markets can be served at lowest cost by a single firm—a "natural monopoly"—and so competition cannot be relied upon to regulate rates and terms of service.[6] Another common public policy justification for economic regulation separate from the efficiency justification is that fairness requires that all customers should have access to at least a minimum level of service at "reasonable" rates and terms of service.[7] Finally, economic regulation (particularly the use of antitrust) can preserve or increase competition in certain contexts.[8]

The earliest example in the U.S. of a federal entity established to use economic regulation is the Interstate Commerce Commission—created by Congress in 1887 to regulate railroad rates in an attempt to lower prices.[9] Interestingly, evidence suggests that economic regulation of the railroad industry had the unintended effect of inflating prices as a result of reduced competition—which benefited regulated entities "at the expense of consumers."[10]As the railroad example demonstrates, economic regulation can serve as government protection for cartels in markets where competition is possible.[11] Experts in both government and academia shifted over time towards preferring alternative policy tools, such as opening markets to competition where competition is possible, confining monopoly regulation to segments of the industry still believed to be natural monopolies, and regulating monopolies' prices instead of their profits to provide superior incentives for innovation.[12] Figure 1 presents an overview of our typology of second- and third-tier forms of economic regulation.

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4 Robert Litan, "Regulation," Econlib, accessed May 06, 2019, https://www.econlib.org/library/Enc/Regulation.html.

5 U.S. Office of Management and Budget (OMB), "Regulatory Analysis," September 17, 2003, 4-5, accessed November 12, 2018, https://obamawhitehouse.archives.gov/omb/circulars_a004_a-4/.

6 William J. Baumol, John C. Panzar, and Robert D. Willig, *Contestable Markets and the Theory of Industry Structure* (San Diego: Harcourt Brace Jovanovich, 1988), 17.

7 Brian F. Mannix, "Regulatory Subsidies: A Primer," The George Washington University Regulatory Studies Center, Working Paper March 2012, 6, https://regulatorystudies.columbian.gwu.edu/regulatory-subsidies-primer.

8 Niamh Dunne, "Between Competition Law and Regulation: Hybridized Approaches to Market Control," *Journal of Antitrust Enforcement* 2, no. 2 (2014): 225-269.

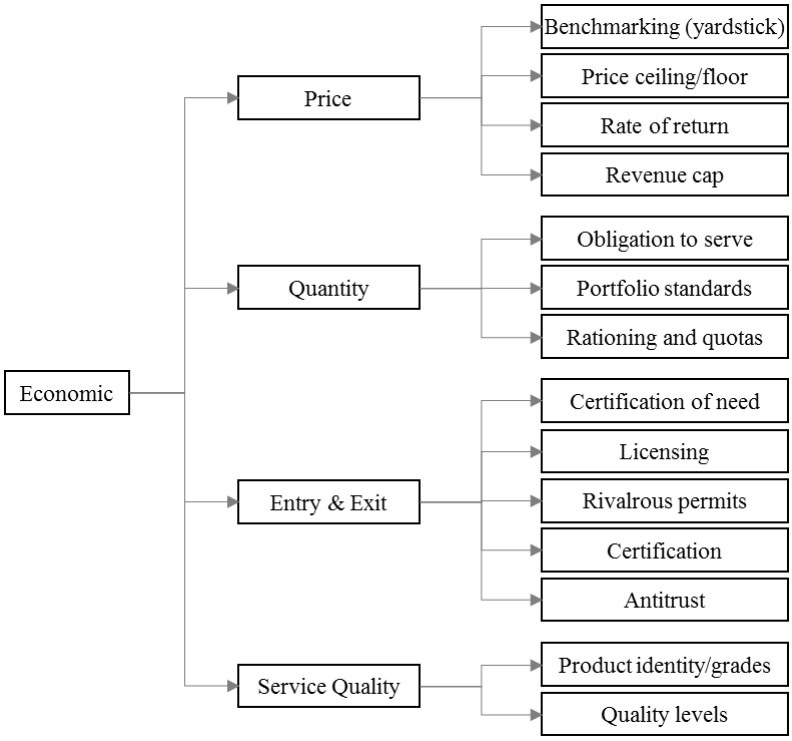
9 Susan E. Dudley, "Improving Regulatory Accountability: Lessons from the Past and Prospects for the Future," *Case Western Reserve Law Review* 65, no. 4 (2015): 1027-1057.

10 *Ibid*, 1033.

11 United States, Transportation Research Board, *Modernizing Freight Rail Regulation* (Washington, DC: National Academy of Sciences, 2015), 16. Describing how provisions of the Interstate Commerce Act were intended to stabilize railroad cartel pricing agreements that frequently broke down prior to federal regulation.

12 Robert W. Crandall and Jerome Ellig, *Economic Deregulation and Customer Choice: Lessons for the Electric Industry* (Fairfax, VA.: George Mason University, Center for Market Processes, 1997); Dudley 2015; Clifford Winston,

Figure 1: Forms of Economic Regulation



A. Price

Price regulations include instruments that set maximum or minimum prices. These take four third-tier forms: 1) benchmarking, 2) price ceiling/floor, 3) rate of return, and 4) revenue cap. Benchmarking limits prices by reference to a specific standard—such as the prevailing wage rate or prices within an area. Examples include the prevailing wage provisions for agricultural employers under the Fair Labor Standards Act and the Centers for Medicare & Medicaid Services regional rates and benchmarks for pharmaceuticals and medical services. Price ceilings and floors are a form of regulation that sets the lowest or highest price that can be charged for a product.[13] A commonly-observed example of this form would be rent control regulation specifying the maximum price a landlord may charge for a housing unit.[14] In the agriculture sector, Federal Milk Marketing Orders (FMMOs), authorized by the Agricultural Marketing Agreement Act, "assure dairy farmers a reasonable minimum price for their milk throughout the year."[15]

Government Failure versus Market Failure: Microeconomics Policy Research and Government Performance (Washington, D.C: Brookings Institution Press, 2006).

[13] Michael M. Murphy, "Price Controls and the Behavior of the Firm," *International Economic Review* 21, no. 2 (1980): 285-291.

[14] Richard Arnott, "Rent Control," *The New Palgrave Dictionary of Economics and the Law*, 2002.

[15] Agricultural Marketing Service, U.S. Department of Agriculture (AMS), "Federal Milk Marketing Orders," accessed November 8, 2018, https://www.ams.usda.gov/rules-regulations/moa/dairy.

The final two forms of price regulation often apply to monopolies.[16] The first is rate-of–return regulation—a form in which regulators set prices designed to give the regulated firm the opportunity to earn a "reasonable" rate of return on its capital. A common example of rate-of-return regulations occurs in the setting of electricity rates by state public service commissions.[17] Rate-of-return regulation often inhibits efficiency and innovation for several reasons. First, if the regulated firm's authorized rate of return exceeds its cost of capital, it has an incentive to use too much capital because more investment means more profit. Second, the firm has little incentive to cut costs or innovate because it will be penalized for this performance with lower rates at the next rate case.

The second form, revenue cap regulation, sets a limit on the total revenue an entity can receive from its customer base—that is, the entity's revenue is capped regardless of changes in customer demand (i.e., in the case of utilities, increased customer use of electricity would not result in greater total revenue). Studies suggest that this approach reduces the incentives for firms to increase energy use—which may run counter to a regulator's desired outcome (i.e., achieving reductions in aggregate consumption)—relative to rate-of-return regulation.[18]

B. Quantity

In place of setting prices, regulators can also attempt to control the quantity of goods and services provided.[19] Quantity regulation take the following forms: 1) obligation to serve, 2) portfolio standards, and 3) rationing and quotas. The obligation to serve is a form of regulation requiring firms to make their products and/or services available to the general public—usually at predetermined rates. For example, railroads, telephone companies, and some trucking companies have historically been obliged to offer their services to the public, and in some cases they could not even discontinue service to particular locations without regulatory approval.[20]

Portfolio standards specify a ratio of particular inputs or outputs that regulated entities must achieve. For example, regulators could mandate that a certain percentage of energy be produced from qualifying renewable energy sources (often requiring an increasing percentage over time).[21] This form of regulation

[16] Our sample of regulations affecting agriculture in the U.S. (detailed in Chapter 3) did not include any of these forms of regulation.

[17] Steve Kihm, Janice Beecher, and Ronald L. Lehr, Regulatory Incentives and Disincentives for Utility Investments in Grid Modernization, report no. 8, Lawrence Berkeley National Laboratory, May 2017, http://ipu.msu.edu/wp-content/uploads/2017/09/LBL-FEUR-Regulation-and-Incentives-2017.pdf.

[18] Ian Alexander and Chris Shugart, "Risk, Volatility and Smoothing: Regulatory Options for Controlling Prices." World Bank and European Bank for Reconstruction and Development (1999), 11. For additional information on FERC's energy offer cap regulation, see: https://www.ferc.gov/industries/electric/indus-act/rto/energy-price-formation.asp.

[19] Edward L. Glaeser and Andrei Shleifer, "A Reason for Quantity Regulation," *American Economic Review* 91, no. 2 (2001): 431-435; Mannix 2012; Dudley and Brito 2012.

[20] John Bauer, "The Concepts of Capital and Income in the Regulation of Utilities," *The Accounting Review* 12, no. 1 (1937): 22-29; Transportation Research Board 2015, 23.

[21] Fredric C. Menz, "Green Electricity Policies in the United States: Case Study," *Energy Policy* 33, no. 18 (2005): 2398-2410.

is often applied to electricity generation but can also affect other producers. For example, the Environmental Protection Agency (EPA) implements the Renewable Fuel Standard (RFS) program, which mandates refiners or importers of gasoline and diesel fuel to use an increasing volume of renewable fuel to displace petroleum-based fuel.[22] Portfolio standards can also target outputs—such as setting a goal for the number of mortgages generated for consumers purchasing units deemed "affordable housing."[23]

Rationing and quotas are regulatory forms that limit the number or monetary value of goods or services purchased or produced. They are often imposed to limit the quantity of international imports or exports of specific goods throughout a specified timeframe. For instance, an import quota can restrict foreign competition in an effort to boost domestic production.[24] In other circumstances, the government might establish quotas to limit the production of certain goods to reduce negative externalities.[25] The National Oceanic and Atmospheric Administration issues hundreds of rules each year to set annual catch limits for different fish species to prevent overfishing.[26]

C. Entry & Exit

In addition to controlling prices or quantities to manage market power, governments also use economic regulation to control entry & exit of participants in a market.[27] These regulatory forms include: 1) certificate of need, 2) licensing, 3) rivalrous/exclusive permits, 4) certification, and 5) antitrust. The first four forms create entry barriers, ostensibly to protect health, safety, or common environmental resources, but which help market incumbents enforce and maintain market power.[28] Antitrust policy, on the other hand, aims to restrain the creation of market power that might hamper fair competition in a market.

Certificate-of-need regulation requires entities to obtain approval from the government prior to the acquisition, expansion, or creation of facilities or equipment.[29] The government determines whether the action in question fulfills a "need" for a specified community.[30] Certificate-of-need regulation is

[22] U.S. Environmental Protection Agency (EPA), "Overview for Renewable Fuel Standard," June 07, 2017, accessed November 15, 2018, https://www.epa.gov/renewable-fuel-standard-program/overview-renewable-fuel-standard.

[23] Federal Housing Finance Agency, "2018-2020 Enterprise Housing Goals," accessed November 16, 2018, https://www.fhfa.gov/SupervisionRegulation/Rules/Pages/2018-2020-Enteprise-Housing-Goals.aspx.

[24] Don Clark, "Nontariff Measures and U.S. Imports From Western Hemisphere Developing Countries," *Social and Economic Studies* 48, no. 3 (1999): 137-152.

[25] Austan Goolsbee, Steven D. Levitt, and Chad Syverson, *Microeconomics* (New York, NY: Worth Publishers Macmillan Learning, 2016).

[26] Federal Register, "Fisheries of the Northeastern United States; Golden Tilefish Fishery; 2019 Specifications," *Federal Register* October 26, 2018, accessed November 10, 2018, https://www.federalregister.gov/d/2018-23431.

[27] Simeon Djankov et al., "The Regulation of Entry," *The Quarterly Journal of Economics* 117, no. 1 (2002): 1-37.

[28] Goolsbee et al. 2016.

[29] Our sample of regulations affecting agriculture in the U.S. (detailed in Chapter 3) did not include any of these forms of regulation.

[30] Jon M. Ford and David L. Kaserman, "Certificate-of-Need Regulation and Entry: Evidence from the Dialysis Industry," *Southern Economic Journal* 59, no. 4 (1993): 783-791.

commonly employed at the state level to regulate healthcare facilities. New York enacted the first certificate-of-need program in 1964, and other states followed.[31] By the 1980s, all states except Louisiana had implemented some form of certificate of need regulations, requiring government approval before a facility could expand, offer additional services, or purchase certain equipment.[32] Proponents originally advanced the use of certificate-of-need regulation as a way to reduce costs and increase quality—stating that underutilized facilities would result in increased medical costs borne by patients.[33] Nonetheless, a growing body of evidence suggests that this form of regulation is not effective in achieving its desired outcomes and may even result in higher costs and limit access to care—even for those living in rural areas.[34] Notably, this form of regulation was not observed in the sample of agricultural regulations examined in this study.

Licensing regulations require government approval to practice a profession or operate a business. A license is typically granted to individuals or facilities. For example, states may require occupational licenses for individuals to legally operate a particular business (i.e., to practice medicine), but regulators can also specify particular services that can be provided within a profession. The Department of Health and Human Services (HHS) regulates the kinds of services that different medical professionals can provide; EPA licensing requirements regulate "any person who applies or supervises the use of restricted use pesticides;"[35] and USDA regulates the types of establishments allowed to produce biological products intended for the treatment of animals under the Virus-Serum-Toxin Act by granting licenses to qualified establishments.[36]

Rivalrous/exclusive permits are similar to licensing with one important exception: the allocation of a permit to one party precludes another party from obtaining the same permit.[37] Examples of this form include FCC licenses for broadcast spectrum use or Federal Aviation Administration (FAA) regulation of runway slots for airplanes.[38]

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[31] Matthew D. Mitchell, "Certificate-of-Need Laws: Are They Achieving Their Goals?" George Mason University, Mercatus Center, working paper April 2017, https://www.mercatus.org/system/files/mercatus-mitchell-con-qa-mop-v1.pdf.

[32] Matthew D. Mitchell and Christopher Koopman, "40 Years of Certificate-of-Need Laws Across America," Mercatus Center, April 19, 2018, https://www.mercatus.org/publication/40-years-certificate-need-laws-across-america.

[33] Daniel Sherman, *The Effect of State Certificate-of-need Laws on Hospital Costs: An Economic Policy Analysis* (Washington, D.C.: Bureau of Economics, Federal Trade Commission, 1988), https://www.ftc.gov/reports/effect-state-certificate-need-laws-hospital-costs-economic-policy-analysis.

[34] Mitchell 2017.

[35] EPA, "How to Get Certified as a Pesticide Applicator," November 15, 2018, accessed May 06, 2019, https://www.epa.gov/pesticide-worker-safety/how-get-certified-pesticide-applicator.

[36] Animal and Plant Health Inspection Service, U.S. Department of Agriculture (APHIS), "Veterinary Biologics," accessed November 10, 2018, https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/veterinary-biologics.

[37] Djankov et al. 2002.

[38] FAA, "Slot Administration," last modified October 16, 2018, https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/slot_administration/.

Certification is a form of regulation that requires products or services to be routinely certified—usually via on-site inspection by regulators or approved third parties—prior to entering the market.[39] For instance, USDA's Food Safety and Inspection Service inspects all poultry and raw meat (including imported products) sold in interstate commerce[40] while USDA's Animal and Plant Health Inspection Service (APHIS) certifies that plants have been treated for quarantine pests prior to interstate movement.[41]

Finally, antitrust regulations seek to promote competition in markets—oftentimes by restricting collusion, the creation of cartels, or mergers that would create substantial market power.[42] In the U.S., the Federal Trade Commission (FTC) and Department of Justice (DOJ) Antitrust Division are the federal antitrust regulatory agencies; examples of this form include regulations under the Hart-Scott-Rodino Antitrust Improvements Act, which require companies to submit a detailed filing with FTC and DOJ before being allowed to proceed with large mergers and acquisitions.[43, 44] Examples of antitrust relevant to agriculture include many of USDA's regulations implementing industry-specific rules intended to promote competition and fair trade practices in the livestock, meat, and poultry markets under the Packers and Stockyards Act.[45] For example, USDA's Grain Inspection, Packers and Stockyards Administration (GIPSA) regulates trade practices to ensure that they do not restrict or limit competition between packers and dealers.[46]

D. Service Quality

The final category of economic regulation includes regulatory forms that affect service quality: 1) product identity or grades, and 2) quality levels. These regulations attempt to ensure the quality of the goods and services provided. Product identity or grades are regulatory forms that categorize products into official grades or classes recognized by regulators based on measurable attributes. For example, USDA establishes grade standards for fruits, which are used to determine how they can be labeled and

[39] Peter Drahos, Regulatory Theory: Foundations and Applications (Canberra: ANU Press, 2017), 734.

[40] Food Safety and Inspection Service, U.S. Department of Agriculture (FSIS), "Inspection & Grading of Meat and Poultry: What Are the Differences?," accessed May 06, 2019, https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/production-and-inspection/inspection-and-grading-of-meat-and-poultry-what-are-the-differences_/inspection-and-grading-differences.

[41] Animal and Plant Health Inspection Service, U.S. Department of Agriculture (APHIS), "FRSMP Frequently Asked Questions for Importers," accessed May 06, 2019, https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/frsmp/ct_importers_faqs.

[42] W. Kip Viscusi, Joseph E. Harrington Jr., and John M. Vernon, *Economics of Regulation and Antitrust* 4th. Ed. (Cambridge, MA; MIT Press, 2018), 69-75.

[43] Public law 94-435.

[44] Federal Trade Commission, "Premerger Notification Program," last modified April 04, 2019, https://www.ftc.gov/enforcement/premerger-notification-program.

[45] National Agricultural Law Center, "Packers and Stockyards Overview," accessed April 15, 2019, https://nationalaglawcenter.org/overview/packers-and-stockyards/.

[46] AMS, "Packers & Stockyards Division," accessed April 15, 2019, https://www.gipsa.usda.gov/psp/psp.aspx.

their eligibility to be sold in markets.[47] An alternative to regulating the measureable attributes of a particular good, is regulating quality levels—which specify a level or standard of service defined by regulators.[48] One example is FCC regulation of local exchange telephone company service quality which outlines company performance with respect to responsiveness to network failures and other customer complaints.[49]

III. Social Regulation

Social regulation includes policy instruments that aim to address public health, safety, and environmental concerns by intervening in markets more indirectly than economic regulation. These forms tend to address market failures such as information asymmetries and externalities by clarifying property rights, reducing risks, and disclosing information. Command-and-control regulations, market-based regulations, and information-based regulations are the most common forms of social regulation. Command-and-control regulations and market-based regulations tend to address externalities, whereas information-based regulations aim to reduce information asymmetries. The key distinction between command-and-control and market-based regulations is the degree of government intervention and the degree to which incentives are relied on to drive outcomes. Figure 2 presents an overview of our classification of second- and third-tier forms of social regulation.

A. Command-and-Control

Command-and-control regulations include forms that set standards or limits on what is allowable (or not allowable) with varying levels of specificity regarding how a regulated entity can comply with the requirement.[50] These forms include: 1) monitoring, reporting, and verification requirements, 2) means-based standards, 3) performance standards, 4) permitting, 5) pre-market notice, 6) pre-market/pre-manufacture approval, and 7) prohibitions.

Monitoring, reporting, and verification require regulated entities to periodically maintain and/or share data with regulators. Monitoring includes either direct measures (e.g., tons of methane emitted) or proxy measures (e.g., number of cattle processed) for an outcome of interest to a regulator. Reporting is the administrative process wherein a regulated entity aggregates the data, informs the regulator how it derived the data, and oftentimes forwards the data to the regulator (i.e., the regulated entity incurs some cost in the form of paperwork and/or reporting requirements); this process normally involves a

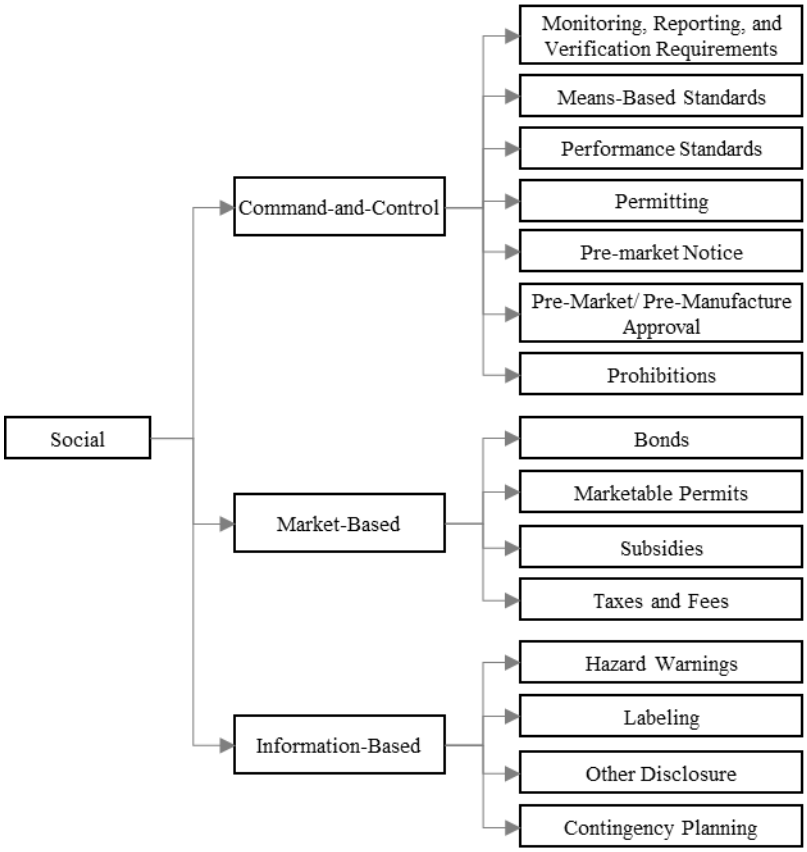
[47] Food and Nutrition Service, U.S. Department of Agriculture (FNS), "Specifications & U.S. Grade Standards," accessed April 15, 2019, https://www.fns.usda.gov/fdd/specifications-us-grade-standards.

[48] Our sample of regulations affecting agriculture in the U.S. (detailed in Chapter 3) did not include any of these forms of regulation.

[49] Marcelo Resende and Luís Otávio Façanha, "Price-cap Regulation and Service-quality in Telecommunications: An Empirical Study," *Information Economics and Policy* 17, no. 1 (2005): 1-12.

[50] Christopher Carrigan and Elise Harrington, "Choices in Regulatory Program Design and Enforcement," Penn Program on Regulation, June 2015, https://www.law.upenn.edu/live/files/4706-carriganharrington-ppr-researchpaper062015pdf.

Figure 2: Forms of Social Regulations



standardized procedure specified by regulation. Finally, verification involves detecting errors in reporting and is oftentimes performed by a third party.[51] For example, EPA's National Pollutant Discharge Elimination System (NPDES) requires regulated entities to electronically report data relevant to EPA's implementation of the Clean Water Act (CWA);[52] the Food and Drug Administration (FDA) requires regulated entities that manufacture or process human food for consumption to conduct monitoring, reporting, and verification of various practices under its Preventive Controls for Human Food regulations (e.g., food allergen controls, sanitation controls).[53]

Means-based standards specify technologies to be used, or that prescribe detailed procedures, methods, and practices to be employed by regulated entities.[54] For example, the Food and Drug Administration's (FDA) current good manufacturing practice regulations for animal food specify measures and test

[51] Valentin Bellassen et al., "Monitoring, reporting and verifying emissions in the climate economy." *Nature Climate Change* 5, no. 4 (2015): 319-328.

[52] EPA, "NPDES EReporting," last modified January 10, 2018, https://www.epa.gov/compliance/npdes-ereporting.

[53] U.S. Food & Drug Administration (FDA), "Key Facts about Preventive Controls for Human Food," accessed May 6, 2019, https://www.fda.gov/files/food/published/Key-Facts-about-Preventive-Controls-for-Human-Food.pdf.

[54] Cary Coglianese, "The Limits of Performance-Based Regulation" *University of Michigan Journal of Law Reform* 50, no. 3 (2017): 525-563.

methods to limit contamination.[55] Means-based standards also often include regulatory requirements specifying the design features of a particular object.[56]

Performance standards specify a desired outcome (e.g., emissions level) but grant a measure of flexibility to the regulated entity regarding how to achieve the outcome. This approach is less prescriptive than means-based standards.[57] For example, under the Clean Air Act (CAA), EPA sets pollutant emissions or concentration levels without mandating the use of a particular technology. Of course, regulators can specify performance standards with differing levels of stringency; for instance, performance standards that can only realistically be achieved by using a particular technology might act as a *de facto* means-based standard since the regulated entity is not actually given increased flexibility in achieving the outcome.[58]

Permitting is a regulatory form wherein a regulator grants permission to do something that would otherwise be prohibited.[59] It is usually used to address externalities. For example, under the National Pollutant Discharge Elimination System (NPDES), EPA issues permits to approve exceptions to prohibitions against discharging "pollutants" through a "point source" into a "water of the United States" under the Clean Water Act.[60].

Pre-market notice and pre-market/pre-manufacture approval regulations impose conditions that business entities must meet prior to introducing their products to market. Pre-market notice requires regulated entities to notify regulators prior to introducing products into the market but does not require the regulator's approval. In contrast, pre-market/pre-manufacture approval regulations are generally considered more stringent since they require regulatory approval—more closely approximating a precautionary approach— prior to introducing products into the market.[61] For example, section 5 of the Toxic Substances Control Act (TSCA) requires regulated entities to provide EPA with a pre-manufacture notice at least 90 days prior to the manufacture of certain chemicals (pre-market notice), whereas FDA requires certain medical devices to undergo evaluation of product safety and effectiveness before

[55] Code of Federal Regulations, Title 21, Part 507, "Current Good Manufacturing Practice, Hazard Analysis, and Risk-Based Preventive Controls for Food for Animals."

[56] Carrigan and Harrington 2015.

[57] Cary Coglianese, Jennifer Nash, and Todd Olmstead, "Performance-Based Regulation: Prospects and Limitations in Health, Safety, and Environmental Protection," *Administrative Law Review* 55, no. 4 (2003): 705-729.

[58] *Ibid*.

[59] Eric Biber and J.B. Ruhl, "The Permit Power Revisited: The Theory and Practice of Regulatory Permits in the Administrative State," *Duke Law Journal* 133 (2014): 13-121; Biber and Ruhl "Designing Regulatory Permits" ACUS Final Report, 2015, https://www.acus.gov/report/licensing-and-permitting-final-report.

[60] EPA, "NPDES Permit Basics," last modified July 25, 2018, https://www.epa.gov/npdes/npdes-permit-basics.

[61] Ed Soule, "The Precautionary Principle and the Regulation of U.S. Food and Drug Safety," *The Journal of Medicine and Philosophy* 9, no. 3 (2004): 333-350.

allowing them to be sold in the market and APHIS requires commercial entities to receive approval prior to introducing genetically engineered products into the environment (pre-market approval).[62]

Another form of command-and-control regulation is a prohibition. This form bans the use of a product or act without exception (i.e., the regulator will not issue a permit under any circumstance). For example, dichlorodiphenyltrichloroethane (DDT) was a commonly used pesticide until EPA prohibited its use in 1972—thus requiring businesses to find other pesticides or pest-control methods.[63]Another example are the regulations implementing the Horse Protection Act which prohibit the use of chains, boots, or action devices on horses at horse shows, exhibitions, or auctions.[64]

B. Market-based

In contrast to command-and-control regulations, market-based regulations rely on market signals instead of specified commands to achieve regulatory goals.[65] A normative goal of market-based regulation is to leverage market forces (e.g., price signals) to increase the efficiency of policy interventions intended to ameliorate market failures.[66] These regulations usually provide material incentives to encourage or discourage certain behaviors of regulated entities; this approach is also referred to as incentive-based regulation. Market-based regulations include: 1) bonds, 2) marketable permits, 3) subsidies, and 4) taxes and fees.

Bonds require companies to set aside an amount deemed by regulators to be commensurate with the risk introduced by a firm's economic activity.[67] This form of regulation is meant to internalize the social costs of potential externalities into a firm's resource allocation decisions.[68] For example, the Farm Service Agency requires grain and rice warehouse operators to post bonds as a financial assurance to the agency as a condition of receiving a license or authorization under United States Warehouse Act.[69]

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[62] EPA, "Filing a Pre-manufacture Notice with EPA," last modified October 24, 2018, https://www.epa.gov/reviewing-new-chemicals-under-toxic-substances-control-act-tsca/filing-pre-manufacture-notice-epa; Center for Devices and Radiological Health, "Premarket Approval (PMA),", accessed April 15, 2019, https://www.fda.gov/medicaldevices/deviceregulationandguidance/howtomarketyourdevice/premarketsubmissions/premarketapprovalpma/; Tadlock Cowan and Kristina Alexander, *Deregulating Genetically Engineered Alfalfa and Sugar Beets: Legal and Administrative Responses* (Washington, DC: Library of Congress, 2012).

[63] National Pesticide Information Center, "DDT: General Fact Sheet," National Pesticide Information Center, 1999, http://npic.orst.edu/factsheets/ddtgen.pdf.

[64] APHIS, "Horse Protection Act," accessed April 15, 2019, https://www.aphis.usda.gov/aphis/ourfocus/animalwelfare/hpa.

[65] Carrigan and Harrington 2015, 8.

[66] Winston 2006.

[67] Carrigan and Harrington 2015, 16.

[68] Jason F. Shogren, Joseph A. Herriges, and Ramu Govindasamy, "Limits to Environmental Bonds," *Ecological Economics* 8, no. 2 (1993): 109-133.

[69] Farm Service Agency, U.S. Department of Agriculture (FSA), "WA-402: Licensing Agreement for Grain and Rice Warehouse Operators," accessed April 15, 2019, https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/Comm-Operations/pdf/WA402.pdf.

Another example of this regulatory form is the U.S. Department of Energy's bonding requirements for natural gas producers, which requires producers to "post bonds that can be used to pay for [future] claims made against the company."[70]

Another market-based instrument—generally used to reduce externalities in an environmental context—is marketable permits. These are permits or allowances (e.g., the amount of greenhouse gas emissions allowed for a year, or the amount of lead per unit of gasoline refined) which regulated entities can trade with other private parties.[71] This approach has been implemented in the U.S. for different purposes, including the early EPA trading programs for air emissions from stationary sources under the CAA in the late 1970s, the lead trading program for gasoline in 1980s, and the acid rain program for sulfur dioxide (SO_2) emissions from the electric industry in the 1990s.[72]

Subsidies are payments the government makes to individuals, businesses, or other entities to incentivize certain behaviors. For instance, in the agriculture sector, farmers often receive subsidies for engaging in environmentally-sensitive farming protection practices through USDA's conservation programs.[73]

Finally, taxes and fees generally refer to environmental —or Pigovian—taxes on market activities that generate negative externalities (e.g., a penalty imposed on polluters in proportion to the amount of pollution they discharge). The taxes and fees are set to internalize the externalities by offsetting the difference between the private and social cost of production.[74] A carbon tax is one example of this approach.[75]

C. Information-based

Information-based regulation requires regulated entities to disclose information to the public—particularly in cases where one party in a transaction has more information about the product or service in question than the other party.[76] Oftentimes these regulatory forms are used to increase the provision

[70] Lucas W. Davis, "Bonding Requirements for U.S. Natural Gas Producers," *Review of Environmental Economics and Policy* 9, no. 1 (2015): 128-144.

[71] Administrative Conference of the United States (ACUS), "Administrative Conference Recommendation 2017-4: Marketable Permits," ACUS, December 2017, https://www.acus.gov/sites/default/files/documents/Recommendation%202017-4%20%28Marketable%20Permits%29.pdf.

[72] A. Denny Ellerman and David Harrison, Jr., "Emissions Trading in the U.S.: Experience, Lessons, and Considerations for Greenhouse Gases," Pew Center on Global Climate Change Report, May 2003, http://web.mit.edu/globalchange/www/PewCtr_MIT_Rpt_Ellerman.pdf.

[73] NRCS, "Natural Resources Conservation Service," accessed April 15, 2019, https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/.

[74] Drahos 2017, 729.

[75] Gilbert E. Metcalf and David A. Weisbach, "The Design of a Carbon Tax," *Harvard Environmental law Review* 33, no. 2 (2009): 499-556.

[76] Carrigan and Harrington 2015, 22.

of information with the goal of increasing market efficiency.[77] Such regulations include: 1) hazard warnings, 2) labeling, 3) other disclosure, and 4) contingency planning.

Regulatory agencies can mandate the use of hazard warnings to disclose information about dangers and threats related to a particular substance or process. This form often requires entities to use recognizable symbols (e.g., skull and crossbones) to make consumers or workers more aware of various risks associated with products or work environments.[78] For instance, the Occupational Health and Safety Administration's (OSHA) Hazard Communication Final Rule establishes regulations requiring chemical manufacturers and importers to provide hazard information to employers and workers,[79] while EPA's Agricultural Worker Protection Standard requires regulated entities "notify workers about pesticide-treated areas so they can avoid inadvertent exposures."[80]

Labeling is another form of regulation that requires regulated entities to include certain information on products sold to consumers. For example, the Nutrition Labeling and Education Act requires foods to be labeled for certain nutritional content, calories, etc. Another example is USDA's regulation requiring foods to be labeled as to country of origin.[81]

Regulations may also include other disclosures; these forms generally require public disclosures of information, but the purpose is not as well-specified as either hazard warnings or labeling. For example, the Toxics Release Inventory—created pursuant to section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA)—requires facilities to disclose data to the public related to toxic chemical releases and prevention activities at both industrial and federal facilities.[82]

A final form of information-based regulation is contingency planning. This typically requires regulated entities to identify potential hazards related to their operations, construct plans for risk mitigation, and make the contingency plan available to the public. Also referred to as management-based regulation, contingency planning requires firms to design their own risk-management plans but does not mandate

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77 Todd J. Zywicki, "Market-Reinforcing versus Market-Replacing Consumer Finance Regulation," in *Reframing Financial Regulation*, edited by Hester Peirse and Benjamin Klutsey (Arlington, VA: Mecatus Center, 2016); George A. Akerlof, "The Market for "Lemons": Qualitative Uncertainty and Market Mechanisms," *The Quarterly Journal of Economics* 84, no. 3 (1970): 488-500; Stephen Breyer, *Regulation and Its Reform* (Cambridge, MA: Harvard University Press, 1982).

78 W. Kip Viscusi, Wesley Alexander Magat, and Joel Huber, "Informational Regulation of Consumer Health Risks: An Empirical Evaluation of Hazard Warnings," *RAND Journal of Economics* 17, no. 3, (1986): 351-365.

79 U.S. Department of Labor, "OSHA Fact Sheet: Hazard Communication Standard Final Rule," accessed April 16, 2019, https://www.osha.gov/dsg/hazcom/HCSFactsheet.html.

80 EPA, "Agricultural Worker Protection Standard (WPS)," last modified January 30, 2019, https://www.epa.gov/pesticide-worker-safety/agricultural-worker-protection-standard-wps.

81 AMS, "Country of Origin Labeling (COOL)," accessed April 16, 2019, https://www.ams.usda.gov/rules-regulations/cool.

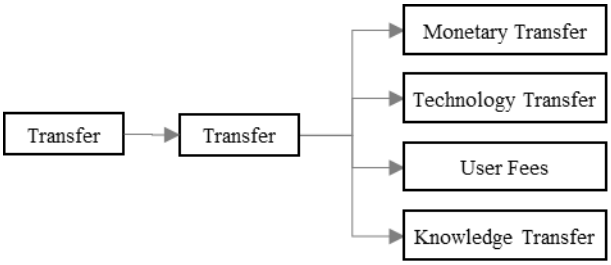
82 EPA, "Toxics Release Inventory (TRI) Program," last modified May 03, 2019, https://www.epa.gov/toxics-release-inventory-tri-program.

implementation of specific procedures.[83] One example of contingency planning are the regulations that implement the Bureau of Safety and Environmental Enforcement's Safety and Environmental Management Systems.[84] Another example are the regulations implementing the Federal Select Agent Program—jointly administered by the Centers for Disease Control and APHIS—requiring certain entities handling biologic agents to "have a written contingency plan for unexpected shipments…of select agents and toxins."[85]

IV. Transfer Regulation

Transfer regulations establish entitlements that channel resources (e.g., money, knowledge) to beneficiaries with redistributive implications. Regulations of this form are distinguishable from other shifts in resources, such as subsidies, because they target a public goal instead of motivating behavior or attempting to correct market failures.[86] Four forms qualifying as transfers are: 1) monetary transfer, 2) technology transfer, 3) user fees, and 4) knowledge transfer. Figure 3 presents an overview of our typology of second- and third-tier forms of transfer regulation.

Figure 3: Forms of Transfer Regulation



A. Monetary Transfer

These regulations channel government funds to beneficiaries who are entitled based on certain criteria. For instance, this includes regulations that implement disaster assistance payments and income support payments to farmers. The Noninsured Crop Disaster Assistance Program is an example of a monetary transfer program in the agriculture sector. While there may be other policy reasons for these (including distributional effects), OMB Circular A-4 indicates that from a social welfare economics perspective,

[83] Carrigan and Harrington 2015.

[84] Bureau of Safety and Environmental Enforcement, "Safety and Environmental Management Systems (SEMS) Fact Sheet," accessed April 16, 2019, https://www.bsee.gov/site-page/fact-sheet.

[85] Centers for Disease Control and Prevention (CDC) and Animal and Plant Health Inspection Service (APHIS), "Federal Select Agent Program," accessed April 17, 2019, https://www.selectagents.gov/.; 7 CFR 331.11.

[86] Eric A. Posner, "Transfer Regulations and Cost-Effectiveness Analysis." *Duke Law Journal* 53, no. 1 (2003): 1067-1110; Philip Saunders, Judith Markland, and Benjamin Wurzburger, "Transfer Payments and Inflation," *Proceedings of the Academy of Political Science* 33, no. 3 (1979): 68-81; David Levi-Faur, "The Welfare State: A Regulatory Perspective," *Public Administration* 92, no. 3 (2014): 599-614.

monetary transfers do not generate changes in aggregate social welfare (i.e., a $1 million benefit to farmers is also a $1 million cost to taxpayers).[87]

B. Technology Transfer

Technology transfer refers to the transfer of existing or newly developed technology by government to private sector entities generally through patenting or licensing—which can be either exclusive or non-exclusive. The purpose of such transfers is to encourage adoption of successful innovations resulting from government research and development units. For instance, USDA's Agricultural Research Service (ARS) contains an Office of Technology Transfer that licenses ARS technologies to the private sector and academia.[88]

C. User Fees

Regulatory forms classified as user fees involve the provision of services by the government or government authorized entities in exchange for payment. User fees are distinguishable from general taxes because the latter do not confer or guarantee a specific government benefit or public good. They also differ from taxes and fees that are designed to reduce externalities (e.g., a carbon tax). Tax scholars often refer to user fees as falling in the category of "benefit taxes."[89] One common example of user fees includes the use of tolls to allow users to access particular highways; another would be the requirement for the public to pay a user fee to visit a national park. USDA's APHIS "charges user fees to recover the costs of conducting agriculture quarantine inspections at U.S. ports of entry."[90]

It is worth noting that regulatory user fees are not restricted only to fees collected at the time of a specific service. For instance, the U.S. Government Accountability Office (GAO) notes that regulatory user fees might also be collected from "an entire industry at regular intervals as prescribed by…regulation."[91]

For example, research and promotion boards for individual agricultural industries overseen by the Agricultural Marketing Service conduct research and promotion activities to maintain and expand

[87] The United States Office of Management and Budget (2003). OMB also notes that these transfers "may impose real costs on society to the extent that they cause people to change behavior, either by directly prohibiting or mandating certain activities, or, more often, by altering prices;" Anthony E. Boardman, et al., *Cost-Benefit Analysis: Concepts and Practice*, 5th Edition (Cambridge University Press, 2018); Posner 2003.

[88] ARS, "Office of Technology Transfer," accessed April 16, 2019, https://www.ars.usda.gov/office-of-technology-transfer/.

[89] David G. Duff, "Benefit Taxes and User Fees in Theory and Practice." *The University of Toronto Law Journal* 54, no. 4 (2004): 391-447.

[90] APHIS, "APHIS User Fees," accessed April 15, 2019, https://www.aphis.usda.gov/aphis/ourfocus/business-services/User_Fees/APHIS_User_Fees.

[91] U.S. Government Accountability Office (GAO), "Federal User Fees: Key Considerations for Designing and Implementing Regulatory Fees," GAO, September 16, 2015, https://www.gao.gov/products/GAO-15-718.

markets by collecting specified annual assessments from farmers, ranchers, and agricultural businesses in the relevant industries.[92]

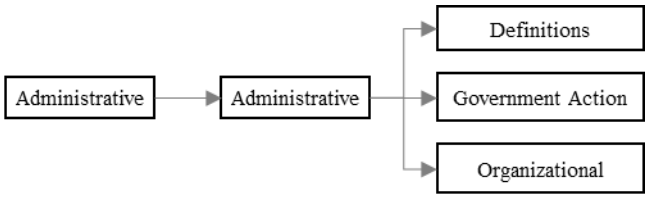
D. Knowledge Transfer

This form of regulation requires the government to disseminate technical knowledge (e.g., soil survey results) at no direct cost to recipients. Government can share information such as weather-related data or respond to a specific request under the Freedom to Information Act. For instance, the Natural Resources Conservation Service (NRCS) is responsible for coordinating with state-level agriculture agencies to provide the public with data produced by the National Cooperative Soil Survey, which includes soil maps and data for over 95 percent of U.S. counties.[93]

V. Administrative Regulation

Administrative regulations require action on the part of a government agency but do not, themselves, impose any requirements on entities from the public (i.e., in essence, the regulated entity is the government itself rather than the public). These regulations often describe definitions of general terms used in subsequent regulations, specify the administrative procedures a government entity must follow, or prescribe organizational structure or membership of a government entity. Administrative regulations are often standalone parts of the CFR that are not accompanied by text referencing additional regulatory forms (i.e., they do not contain text describing a regulatory form used to implement a requirement). As shown in Figure 4 our taxonomy does not distinguish a second tier for administrative regulation, but does have three third-tier forms.

Figure 4: Forms of Administrative Regulations



A. Definition

Regulatory text often defines the meaning of general terms employed by relevant regulations. In the U.S., these definitions are often included as a distinct part in the *Code of Federal Regulations* (CFR); therefore, it is included as a separate category. For example, 50 CFR 1 under General Provisions issued by the Fish and Wildlife Service (FWS) defines the term "Service" (referring to FWS) which is then used in 50 CFR 3 in text prohibiting discrimination by contractors "upon any land under the control….of

[92] AMS, "Research & Promotion," accessed April 17, 2019, https://www.ams.usda.gov/rules-regulations/research-promotion.

[93] NRCS, "Web Soil Survey Home," accessed April 17, 2019, https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm.

the Service."[94] It is worth noting that not all definitions sections in the CFR fit the narrow definition of administrative forms—that they "do not impose *any* requirements on entities from the public." For instance, definitions may, themselves, list which entities will be regulated or even how a government agency will regulate (i.e., what forms of regulation will apply).[95]

B. Government Action

These rules establish procedure, specify processes, or describe entitlements that apply to agencies or government personnel. For instance, Title 5 of CFR on the Office of Personnel Management includes several rules related to civil service or internal administrative process with which government agencies must comply. Such rules are classified as government action because they are internal to the agency; there is no specific requirement for the public.

C. Organizational

Certain administrative regulations specify the organizational structure and functions of a government agency or a government authorized entity. For example, 7 CFR 2 specifies delegations of authority by the Secretary of Agriculture and general officers to various agencies and offices in USDA. Similarly, 29 CFR 4002 establishes the location, board structure, meeting requirements, and emergency procedures of the Pension Benefit Guaranty Corporation—a self-funded entity created by the Employee Retirement Income Security Act of 1974.

VI. Voluntary vs. Mandatory Regulation

We also classified each of the different forms in the taxonomy as either mandatory or voluntary. Depending on the regulatory context, regulators may opt for either a voluntary or mandatory regulatory approach; by definition, voluntary approaches impose less stringent requirements on regulated entities.[96] Typically, command-and-control regulations are mandatory, and a violation would lead to penalties or sanctions (e.g., fines). In contrast, subsidy and transfer programs tend to be voluntary, as participants have the freedom to choose whether to enroll. Nevertheless, regulators sometimes use voluntary approaches to address issues traditionally addressed by mandatory regulations. For instance, the ENERGY STAR program is a voluntary labeling scheme launched by EPA to improve energy efficiency through labels containing information on a product's average energy consumption.[97] Although participation is not mandatory, companies receive a benefit when they can market their products as ENERGY STAR certified.

[94] See Chapter 3 of this report for a detailed description of our coding strategy for definitions.
[95] See Appendix C: Coding Q&A, Q1 of this report.
[96] Kathleen Segerson, "Mandatory versus Voluntary Approaches to Food Safety" *Agribusiness* 15, no. 1 (1999): 53-70.
[97] Energy Star, "ENERGY STAR Overview," accessed April 15, 2019, https://www.energystar.gov/about.

VII. Conclusion

This taxonomy is the first comprehensive typology of regulation, by form (i.e., policy instrument) that can be applied to regulations across policy areas. Our approach addresses several shortcomings of existing taxonomies, which may not be generalizable across issue areas, are too theoretical to apply directly to empirical research, or involve a limited range of policy instruments. We expect the taxonomy to help better understand the relationship between regulatory activity and public outcomes. The remainder of this report applies this taxonomy to regulations affecting the agriculture sector.

Appendix: Taxonomy of Regulatory Forms

First Tier	Second Tier	Third Tier	Definition	Example
Economic	Price	Benchmarking (or yardstick regulation)	A limit placed on prices by reference to benchmarks, such as prevailing wage or prices within an area or product segment.	Prevailing wage provisions for agricultural employers under the Fair Labor Standards Act; Centers for Medicare and Medicaid Services' pharmaceuticals and medical services.
		Price ceiling/floor	A price control on the highest/lowest price that can be charged for a product.	Federal Milk Marketing Orders; Rent control.
		Rate of return	A form of price setting regulation where governments determine the fair rate of return allowed to be charged by a monopoly.	The Federal Communication Commission's (FCC) rate of return for local exchange carrier to determine common line rates.
		Revenue cap	A limit on the amount of total revenue received by a company operating within an industry; this generally applies to utility companies who are monopolists.	The Federal Energy Regulatory Commission's regulations related to energy offer caps.
	Quantity	Obligation to serve	A regulation requiring companies to make their services/products available to the general public at rates determined to be "reasonable."	Regulations under the Communications Act of 1934, telephone companies; rail and bus services.
		Portfolio standards	A regulation that requires the increased production of energy from renewable energy sources.	Renewable portfolio standards; renewable fuel standards.
		Rationing and quotas	A regulation that limits the number, or monetary value, of goods: it generally applies to limits in international imports or exports during a particular time period and occasionally to limits in interstate commerce; and it also includes catch limits in fishing and hunting.	U.S. tariff rate quotas for imports; peanut marketing quotas (7CFR 729).
	Entry & Exit	Certificate of need	A requirement before proposed acquisitions, expansions, or creation of facilities to affirm that the plan fulfills the needs of a community as decided by a government entity.	State-level requirements for approval before providing medical services.
		Licensing	A license granted by the government is required to legally practice a profession, operate a business, or produce and market specific products.	EPA licensing requirements for pesticide applicators (40 CFR 152); The Department of Health and Human Services' requirements regarding the services that different medical professionals can provide; occupational licensing (often at the state level).

First Tier	Second Tier	Third Tier	Definition	Example
		Rivalrous/exclusive permits	Permission is required to enter the market, and allocation to one party precludes other party.	Broadcast spectrum license; airline landing slots.
		Certification	A requirement that products be routinely approved before introduction to the market.	Inspection of eggs; USDA certification and inspection of meat products (7 CFR 57).
		Antitrust	A regulation that promotes fair competition (restrict collusion/cartels).	Regulations under the Hart-Scott-Rodino Antitrust Improvements Act (16 CFR 801, 802); regulations implementing the Packers and Stockyards Act (9 CFR 201.70).
	Service Quality	Product Identity or Grades	Products categorized into official grades/classes recognized by the government based on measurable attributes.	USDA Agricultural Marketing Service's Grades & Standards for fruits or beef.
		Quality levels	Level/Standard of service is defined by regulators in case of price cap regulation.	FCC regulation of local exchange companies.
Social	Command-and-Control	Monitoring, reporting and verification (MRV) requirement	Requirements that specifically require reporting data to the government and often involves substantial recordkeeping by businesses.	Electronic reporting of National Pollutant Discharge Elimination System (NPDES) (40 CFR 127); the Food and Drug Administration's (FDA) requirements related to Preventive Controls for Human Food.
		Performance standards	"A performance standard specifies the outcome required but leaves the concrete measures to achieve that outcome up to the discretion of the regulated entity."[a] This includes technology-based performance standards.	The Environmental Protection Agency's (EPA) performance standards; FDA's performance standards for growing, harvesting, packing and holding of produce for human consumption.
		Means-based standards	A requirement that specifies technologies that must be used, or prescribes specific procedures, methods, and practices that must be performed. It is also known as prescriptive standards, specification standards, design standards, or technology-based standards.[b]	CPSC's animal testing policy; requiring Vehicle-to-vehicle communications (V2V) in highly automated vehicles; the Animal and Plant Health Inspection Service's viruses, serums, toxins, and analogous products regulations (e.g., 9 CFR 109).
		Permitting	"An administrative agency's statutorily authorized, discretionary, judicially reviewable, granting of permission to do that which would otherwise be statutorily prohibited".[c] Usually for environmental protection; can include conditions for operation.	National Pollutant Discharge Elimination System (NPDES).

First Tier	Second Tier	Third Tier	Definition	Example
		Pre-market notice	A requirement to notify a regulator prior to manufacture but not to receive approval prior to introduction into the market.	Regulations under the Toxic Substances Control Act; EPA notification requirements for concentrated aquatic animal production (40 CFR 451).
		Pre-market/pre-manufacture approval	A requirement to receive regulatory approval prior to initiating the manufacture or marketing of a product.	FDA's approval of medical devices or drugs required prior to sale; EPA's pesticide registration requirements (40 CFR 152).
		Prohibitions	The official or legal prohibition of a product or an act, without exceptions (i.e. no permits accepted).	EPA's ban of the pesticide DDT; acts prohibited on a National Wildlife Refuge.
	Market-based	Bonds	A requirement for regulated entities to post a bond prior to engaging in any activity that might cause negative impacts.[d]	Bonding requirements for natural gas production and cottonseed warehouses.
		Marketable permits	Tradable allowances or permits. Mostly used in an environmental context.	Marketable permits applied to fisheries; SO2; lead (carbon).
		Subsidies	Benefits given to an individual, business or institution to incentivize certain behavior (changes resource allocation vs. transfer which is intended to change resource distribution).	USDA's conservation programs.
		Taxes and fees	Fees on polluters that penalize them in proportion to the amount they discharge.	Carbon taxes.
	Information-based	Hazard warnings	A requirement to disclose information concerning the hazards and identities of a subject. Often involves the requirement to use recognizable symbols (e.g. skull and crossbones).	The Occupational Safety and Health Administration's Hazard Communication Final Rule, requiring information disclosure on hazardous chemicals to employees; EPA's Worker Protection Act regulations.
		Labeling	A requirement for labels that bear certain information on products sold.	Nutrition Labeling and Education Act (NLEA), nutrition labelling for foods; Country of Origin Labeling (COOL); Appliance & vehicle efficiency stickers, pesticide labels.
		Other disclosure	Information disclosure requirements other than labeling or hazard warnings. Distinguished from other information disclosures because the intended recipient is not directly affected either as a consumer or worker.	Toxics Release Inventory; Community Right-to-Know; EPA's procedures and requirements for plant incorporated pesticides.

First Tier	Second Tier	Third Tier	Definition	Example
		Contingency planning	A requirement for regulated entities to engage in planning and data gathering to realize regulatory goals, which typically includes identifying the hazards in operations and actions to take to mitigate the risks while it does not require any specific outcomes or actions.[e]	Safety and Environmental Management System (SEMS) rules (oil and gas development); EPA's Chemical Accident Prevention Provisions (40 CFR 68).
Transfer	Transfer	Monetary transfer	Includes income support/payments to farmers/businesses. Distinguished from "subsidies" because it targets a need versus motivating a behavior.	Dairy Disaster Assistance Payment Program; Food Stamps (7 CFR 786).
		Technology transfer	Technologies transferred from the government to a private sector partner, generally through patenting and licensing (including exclusive and non-exclusive licensing).	USDA Agricultural Research Service's technology transfer programs.
		User fees	A payment is required in exchange for certain services.	Peanut Board fees in exchange for marketing/research.
		Knowledge transfer	A regulation that requires agencies to share certain information (e.g. manuals, data, survey results) with the public for free, usually upon request.	Regulations on soil surveys (7 CFR 611); snow surveys and water supply forecasts (7 CFR 612).
Administrative	Administrative	Definitions	A CFR part that only contains definitions of terms.	The Fish and Wildlife Service's definitions under General Provisions (50 CFR 1).
		Government action	A regulation that requires government agencies to take certain actions or comply with certain standards without any requirements for the public.	Regulations requiring Natural Resources Conservation Service to collect, provide and interpret data on water supply forecasts (7 CFR 612).
		Organizational	A CFR part that only describes the organization and functions of an institution.	Regulations on the administrative structure and functions of Farm Service Agency state and county committees (7 CFR 7).

[a] Cary Coglianese, Jennifer Nash, and Todd Olmstead, "Performance-Based Regulation: Prospects and Limitations in Health, Safety and Environmental Protection," *Administrative Law Review* 55, no. 4 (2003): 705-729.

[b] Coglianese 2017.

[c] Biber and Ruhl 2015.

[d] Carrigan and Harrington 2015.

[e] *Ibid*.

CHAPTER 3:

Unpacking the Forms of Regulation Affecting Agricultural Industries

Aryamala Prasad, Zhoudan Xie, Daniel R. Pérez, & Julie Balla

The Taxonomy of Regulatory Forms facilitates classification of regulations in a systematic manner by form—the particular policy mechanism used to achieve a desired end. In this chapter, we discuss an application of the Taxonomy to regulations affecting the agriculture sector. The objective of this chapter is to identify the forms these regulations take, examine their trends and patterns across agencies and over time, and create a unique dataset that enables econometric analysis of the impact of different regulatory forms.

Application of the Taxonomy involves analyzing regulations to identify the specific mechanisms they employ to achieve intended outcomes. For example, introducing tolerance levels for pesticide residues is a form of performance standard intended to reduce human exposure to pesticides. We identified a set of regulations that were most relevant to agriculture, and used qualitative coding techniques to generate a dataset that classifies regulations according to form. Specifically, we use the RegData[1] database created by the Mercatus Center at George Mason University to identify a sample of 709 parts in the Code of Federal Regulations (CFR) related to the crop and animal production industries defined in the North American Industry Classification System (NAICS). We then used content analysis to analyze and code the sample CFR parts into different regulatory forms.

We used the created dataset to conduct cross-sectional and longitudinal analyses to identify patterns and trends in the adoption of different regulatory forms across agencies and over time. We focused our agency-level analysis on regulations published by the U.S. Department of Agriculture (USDA), Environmental Protection Agency (EPA), and Food and Drug Administration (FDA), because these agencies are most relevant to agricultural regulations. It is worth noting that the patterns and trends presented in this chapter are representative of the selected sample, which includes regulations

[1] Patrick A. McLaughlin and Oliver Sherouse, "RegData US 3.1 Annual (dataset)," QuantGov, accessed December 21, 2018. https://quantgov.org/regdata-us/.

estimated to be highly relevant to the selected industries according to RegData (i.e., our sample is not an exhaustive list of regulations affecting these industries).[2]

I. Data

We collected data from three main sources: CFR, NAICS and RegData. The CFR data included the regulatory text codifying federal rules; the NAICS coding system allowed for identification of relevant industries; we utilized metrics in RegData to identify CFR parts relevant to agriculture. The following sections explain each of the data sources in detail.

A. Code of Federal Regulations

The CFR is the codification of the general and permanent rules that federal executive departments and agencies publish in the Federal Register.[3] It provides a complete text of agency regulations organized by Title, Volume, Chapter and Part. Each title represents a subject area of federal regulation, such as agriculture, energy, and commercial practices. For example, Chapter I of Title 7 on Agriculture is associated with the Agricultural Marketing Service—located within USDA. We selected and analyzed our sample of regulations at the CFR part level, because a part contains rules on a single program or function that is likely to take a single or limited number of forms.

We referred to the digitized annual edition of the CFR as the source of regulatory text for CFR parts included in this study.[4] If a CFR part identified in RegData did not appear in the digitized annual edition of the CFR, we used the most recent year that was available in the HeinOnline database. The sample contains various titles related to animal and crop industries identified by NAICS code.

B. North American Industry Classification System

The U.S., Canadian and Mexican statistical agencies jointly developed NAICS codes for collection and publication of statistical data resulting in comparable economic estimates across jurisdictions. Federal agencies have adopted the NAICS classification system for use in regulatory purposes, such as developing regulatory flexibility analyses and economic analyses. It covers 20 sectors and 1,057 industries classified according to their production processes.[5] NAICS applies a hierarchical structure to identify relationships between industries. As shown in Table 1, hierarchical digit codes rank groups within Sector, Subsector, Industry Group, NAICS industry, and National Industry.

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[2] To test the robustness of our results to this sample of regulations, we applied our econometric analysis to a subset of CFR parts developed through expert judgment.

[3] U.S. National Archives and Records Administration, "About the Code of Federal Regulations," National Archives. August 8, 2018, accessed December 21, 2018. https://www.archives.gov/federal-register/cfr/about.html.

[4] U.S. Government Publishing Office, "Code of Federal Regulations (Annual Edition)." Govinfo, accessed December 21, 2018. https://www.gpo.gov/fdsys/browse/collectionCfr.action?collectionCode=CFR.

[5] Executive Office of the President, "North American Industry Classification System," Office of Management and Budget, accessed December 21, 2018. https://www.census.gov/eos/www/naics/2017NAICS/2017_NAICS_Manual.pdf.

Table 1: Example of NAICS Classification

Groups	# of Digits	Code	Industry Name
Sector	2-digit	11	Agriculture, Forestry, Fishing and Hunting
Subsector	3-digit	111	Crop Production
Industry Group	4-digit	1111	Oilseed and Grain Farming
NAICS Industry	5-digit	11111	Soybean Farming
National Industry	6-digit	111110	Soybean Farming

Agricultural activities generally fall under NAICS 11, which includes crop production (111), animal production (112), forestry and logging (113), fishing, hunting and trapping (114), and support activities for agriculture and forestry (115). In this study, we focus on crop and animal production industries, covering most segments under NAICS 111, 112, and 115. As described in detail in the following Sampling Strategy section, we selected our sample based on 4-digit NAICS codes within these industries. Appendix A shows a list of NAICS industries covered.

C. RegData 3.1

RegData is a dataset that quantifies federal regulations using text-analysis and machine-learning algorithms.[6] In 2012, the Mercatus Center released its first version of the dataset. RegData 3.1 is the latest version that includes regulations published in the CFR from 1970 through 2017.

RegData 3.1 provides three measures of regulation. First, it counts the total number of words in regulatory text to quantify the volume. Second, it counts five restrictive words "shall," "must," "may not," "required," and "prohibited" as proxies for binding constraints imposed on regulated entities. Third, it estimates the probability that a body of regulatory text is relevant to a particular NAICS industry at the 2-6 digit level using machine-learning algorithms.[7] For example, by analyzing the text in a CFR part, RegData might estimate that the part has an 80 percent chance of being relevant to oilseed and grain farming (NAICS 1111), and a 30 percent chance of being relevant to other crop farming (NAICS 1119). The probabilities for a CFR part do not add up to one because the relevance to each industry at each NAICS digit level is estimated individually. Hence, RegData allows us to identify the most relevant CFR parts to the industries of interest.

[6] McLaughlin and Sherouse 2018

[7] The estimates of industry relevance in RegData are accomplished by supervised learning. Simply speaking, the computer is first trained to learn about a set of regulations from the Federal Register that are known to be relevant to certain industries, and then analyzes the CFR text to estimate its probabilities to be relevant to each industry using the "knowledge" it has learned from the training document. For more information on their methodologies, *see* Al-Ubaydli, Omar and Patrick A. McLaughlin, "RegData: A Numerical Database on Industry-Specific Regulations for All US Industries and Federal Regulations, 1997-2012," *Mercatus Working Paper*, 2014, https://www.mercatus.org/system/files/McLaughlin-RegData.pdf.

II. Qualitative Coding

A. Sampling Strategy

We relied on the relevance estimates in RegData to identify the CFR parts relevant to animal and crop production industries. In that process, we found that estimates for 4-digit NAICS industries revealed a level of detail that was appropriately specific and accurate for our analysis. Using estimates for a higher level of industries would not separate crop and animal production from certain other industries; for example, NAICS 115 (support activities for agriculture and forestry) includes both support activities for crop and animal production and forestry. Using estimates for a greater than 4-digit NAICS industries would forego a certain level of accuracy, as we generally find that a relevance estimate becomes less accurate when it comes to a specific industry.[8] As a result, we narrowed the list of industries down to 12 NAICS 4-digit industries covering crop and animal production (Appendix A).

Because the relevance estimate in RegData is a continuous variable (i.e., probability between 0 and 1), we applied a single threshold of 0.2 to select relevant CFR parts. That is, a CFR part is included in the sample as long as it has a relevance estimate equal to or larger than 0.2 to any of the 12 industries in any year between 1970 and 2017 in RegData. We selected the threshold of 0.2 considering two factors. First, we needed a large enough sample size such that the sample CFR parts were representative of the regulations affecting these industries. Second, an unduly low threshold would generate a large sample but include too many irrelevant regulations. To balance the tradeoff, we tested several thresholds, including 0.5, 0.3, 0.2, and 98th percentile within each industry. Finally, we consulted subject-matter experts in USDA to evaluate the validity of the resulting samples.[9] As a result, we adopted the threshold of 0.2 and generated a sample of 714 unique CFR parts from RegData. However, we found that five parts among the 714 parts did not exist in CFR in the years indicated by RegData,[10] so we removed these from the sample, resulting in a sample of 709 CFR parts.

During our sampling process, we discovered a few limitations in relying on RegData to select the sample. First, the industry relevance metric does not always accurately measure the actual relevance. Some CFR parts are associated with a high relevance to one agricultural activity but have a very low

[8] We consulted the developers of RegData at the Mercatus Center on this issue. Their explanation suggests that for certain industries, they might not have sufficient samples in the training document, such that the computer simply does not "know" enough about the relationship between the industry and relevant regulatory text.

[9] These subject matter experts identified several CFR parts identified by RegData for which relevance to agriculture is unclear. As discussed in the next chapter, we conducted robustness checks using this more refined data set.

[10] Initially RegData misidentified about 30 CFR parts in years when those parts were merely *Reserved* but not in use. After correcting the time periods in which the part existed between 1970 and 2017, we were still left with five parts that were identified by RegData but did not exist in CFR in any year between 1970 and 2017, which are: 3 CFR 5, 5 CFR 26, 7 CFR 2000, 21 CFR 1353, and 26 CFR 350. We excluded them from the sample. According to our discussion with the Mercatus Center, this type of error in RegData is mostly a result of inaccurate reading of CFR text by the programming software. This problem is more likely to occur to the CFRs published before 1996, as the reading of these CFRs is based on scanned hard copies.

relevance estimate to other agricultural sectors to which the CFR part is applicable. For example, RegData estimates 9 CFR 53 (Title 9, Part 53) on foot and mouth disease of livestock and poultry to be more relevant to aquaculture than cattle ranching and farming. Inaccuracy in the estimates also leads to identifying some irrelevant regulations as highly relevant as well as missing CFR parts likely to be relevant. For example, RegData shows an unduly high relevance value for a few parts in Title 5, which relates to regulating administrative personnel, to certain crop production activities. Second, RegData relies on CFR parts from different sources for computerized text analysis. The electronic CFR parts are available from 1996 onwards, and the CFR parts published prior to 1996 are scanned from hard copies. In the digitization process, some text is missing for 1996. This change is evident in some of the graphs shown in the descriptive analysis where the trend in CFR parts appears unusual between 1994 and 1997.

Although we recognize the aforementioned issues with RegData and the resulting sample, it is unlikely to bias our analysis because the errors are random. Measurement errors can bias statistical analyses in different directions if they are systematically correlated with the true value of the variable. For example, self-reported height and weight are often biased in a certain direction and thus could bias results in clinical practices and epidemiological studies.[11] However, when the errors are random (i.e., sometimes lower and sometimes higher than the true value), their mean will skew toward zero and thus not correlate with the true value.[12] In the case of the relevance estimates in RegData, the errors result from the computer's inaccurate "knowledge" about the relevance of a piece of regulatory text to an industry, which can sometimes lead to overestimates of the relevance (e.g., misreading phrases describing mortgage loans as relevant to agricultural loans) and sometimes underestimates of the relevance (e.g., misreading phrases describing inspection of eggs as not relevant to the chicken egg production industry). Therefore, the measurement errors in the relevance estimates in RegData are very likely to be random and uncorrelated with the true value. Nonetheless, random measurement errors could add more "noises" in a statistical analysis, leading to attenuation bias which reduces the likelihood of finding statistically significant results.

A desirable approach to select a sample of relevant regulations would be to survey individual firms within each industry over the U.S. to ask which regulations they need to comply with. However, this would require a vast amount of cost, time, and human resources, and could introduce different biases. As a check on the accuracy of RegData's relevance estimates, policy experts in USDA read through all the CFR parts identified by RegData in the sample and assessed whether each part is likely to affect

[11] Mariana Seijo, Nicole Minckas, Gabriela Cormick, Daniel Comande, Agustin Ciapponi, and Jose M. Belizan. "Comparison of Self-reported and Directly Measured Weight and Height Among Women of Reproductive Age: a Systematic Review and Meta-analysis," *Nordic Federation of Societies of Obstetrics and Gynecology* 97 (2018): 429-439.

[12] Sholom Wacholder, "When Measurement Errors Correlate with Truth: Surprising Effects of Nondifferential Misclassification," *Epidemiology* 6, no. 2 (March 1995): 157-161.

crop and animal production.[13] This yielded a smaller sample of regulations, which we used to conduct robustness checks described in the next chapter. The econometric analysis supports the robustness of our approach. Given that human judgment can also generate errors, as there are no objective criteria for deciding whether a CFR part is applicable to an industry, we believe that relying on RegData's estimates to select the sample of agriculture-related regulations is the most defensible available approach for the purposes of our research.

B. Coding Process

The Taxonomy of Regulatory Forms[14] defines the coding framework and structure we applied. We analyzed and coded CFR parts based on the most specific categories of regulatory forms in the Taxonomy (i.e., third-tier forms). A CFR part can include multiple third-tier forms because different requirements may be mentioned in various subparts. For example, 7 CFR 305 on Phytosanitary Treatments is associated with four regulatory forms: monitoring, reporting and verification (MRV), performance standards, permitting, and certification. In our approach, a CFR part could have maximum of five regulatory forms.

The coding team consisted of four coders who applied a consensus-coding approach for content analysis of the 709 CFR parts. For each part, two coders independently read and coded the regulatory text using the third-tier regulatory forms defined in the Taxonomy. The two coders then discuss the assigned codes to address discrepancies and reach an agreement. If the coders could not reach consensus, a third coder read and coded the CFR part independently, resulting in a consensus by a majority of coders.

One assumption we made in coding the regulations is that the forms of a CFR part do not change over time. That is, a CFR part with four regulatory forms in 2017 is assumed to also have four regulatory parts in 1970. When we analyzed the content of a CFR part, we referred to the version of the CFR in the latest year it existed. For example, 7 CFR 410 was published in the CFR between 1970 and 1991 and was removed in 1992, so we referred to the 1991 version of the CFR for content analysis of the part. In such cases where a CFR part was removed or relocated (i.e., the part number changed) in some year during the 1970-2017 period of our analysis, we can capture the change by combining the regulatory form with the word count of the part. However, when the content of a CFR part was amended, we assume that the regulatory forms it employs did not change. This assumes that a change in regulatory forms would usually result in substantial changes in the regulation, with a corresponding different part number. This was a necessary simplifying assumption that could be lifted if machine-learning tools were used to code the parts in all annual versions of CFR.

[13] The USDA experts also identified some likely missing regulations that were not identified by RegData. However, these regulations were not included in our analysis for the sake of methodological consistency, because they were not a result of a systematic review of all regulations outside the sample. .

[14] See Chapter 2 of this report.

To assess consistency among coders, we used Cohen's kappa measure to assess inter-rater reliability. The agreement rate between the first two independent coders is 79.58 percent with a Kappa score of 0.60. As per the accepted scale,[15] the level of agreement for the first round of coding is moderate. The reliability improved as the two independent coders discussed the disagreements to reach consensus on final classifications.

Throughout the coding process, the team followed multiple steps to ensure reliability in qualitative coding. First, in the beginning of the process, the team, along with a former regulatory practitioner with deep knowledge of regulatory forms, separately coded a small, randomly selected subset of CFR parts as part of testing and training. The team discussed the issues emerging from the training to reach a consistent understanding of coding principles before starting to code our entire sample. Second, the team developed a codebook to further reduce arbitrariness in assigning codes. This codebook is attached as Appendix C to this chapter. We updated the codebook regularly to record the decision process and include examples on coding regulations with multiple interpretations. It specifies criteria to differentiate between similar regulatory forms such as permitting and licensing, and means-based and performance-based standards. These steps ensure that the qualitative coding is reliable and replicable.

III. Descriptive Analysis

Classifying regulations by form provides an understanding of the patterns and trends in regulatory actions adopted by different agencies over time. This section presents a summary of regulatory forms based on cross-sectional and longitudinal analyses. Cross-sectional analysis presents the prevalence of different regulatory forms in the sample of CFR parts and compares the prevalence across selected agencies. Longitudinal analysis shows changes in the forms of sample regulations from 1970 through 2017.[16]

A. Cross-sectional Analysis

1. Overall Prevalence of Forms

The 709 CFR parts were classified by third-tier regulatory form; on average, a CFR part in our sample takes 1.6 regulatory forms. The majority of the CFR parts (432 parts, 61 percent) rely on only one form, and only one percent of the parts (7 parts) involve five forms. Figure 1 presents the ten most prevalent regulatory forms, both at the second and third tier, in the sample.[17] Command-and-control regulation is the most prevalent second-tier form in the sample regulations affecting crop and animal production, followed by transfer and administrative regulations. Command-and-control regulation

[15] Mary L. McHugh, "Interrater Reliability: The Kappa Statistic," *BioChem Med* 22, no. 3 (2012): 276-282

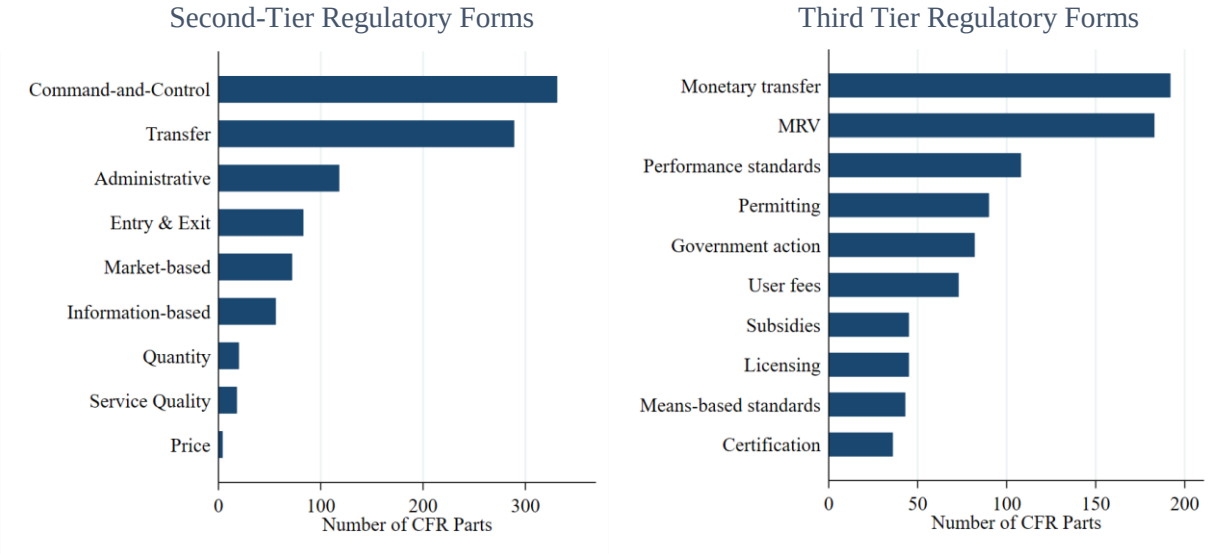
[16] As mentioned above, the forms of a CFR part only refer to the forms in the latest version of the part. Accordingly, the over-time trends only show changes in these forms.

[17] A complete list of regulatory forms is presented in Appendix B.

mostly takes the form of MRV, performance standards, and permitting at the third tier. Transfer is mostly attributable to monetary transfer, which takes first place among the third-tier forms.

Given the focus on agriculture, it is reasonable to find monetary transfer as the most prevalent form of regulation; it appears in nearly 200 CFR parts. Monetary transfer is defined as regulations requiring the government to offer financial support to certain entities such as farmers and ranchers. Examples include the Sugar Beet Disaster Program (7 CFR 1481) and Combined Crop Insurance (7 CFR 426). MRV requirements are the second most dominant regulatory form, appearing in 182 CFR parts. It is noteworthy that MRV is so prevalent partially because it is often a secondary form associated with other regulatory forms in a CFR part. For example, the Federal Seed Act regulations (7 CFR 201) mandate that entities maintain a complete record of the origin of seeds in addition to labeling and certification requirements.

Figure 1: The Most Prevalent Regulatory Forms



2. Cross-agency Comparison

Table 2 presents a list of the top five departments and agencies issuing regulations in the sample. Out of 709 CFR parts, nearly half of the parts are from USDA, followed by the Department of the Interior (DOI), Department of Health and Human Services (HHS), EPA, and the Department of Housing and Urban Development. Regulations associated with DOI mostly fall within the Bureau of Indian Affairs, the Bureau of Land Management, the Fish and Wildlife Service, and the Office of Surface Mining Reclamation and Enforcement. HHS is among the top five departments because FDA promulgates a substantial number of agriculture-related regulations.

USDA agencies issue most of the regulations in our sample. As presented in Table 2, the Agricultural Marketing Service (AMS), Federal Crop Insurance Corporation (FCIC), Commodity Credit Corporation (CCC), Animal and Plant Health Inspection Service (APHIS), and Farm Service Agency (FSA) have the largest number of CFR parts.

Table 2: Top Five Departments and Agencies Issuing Regulations in the Sample

Department	Number of CFR Parts
Department of Agriculture	337
Department of the Interior	106
Department of Health and Human Services	48
Environmental Protection Agency	44
Department of Housing and Urban Development	34

Agency	Number of CFR Parts
Agricultural Marketing Service, USDA	65
Federal Crop Insurance Corporation, USDA	56
Commodity Credit Corporation, USDA	47
Animal and Plant Health Inspection Service, USDA	43
Farm Service Agency, USDA	35

We also compare the regulatory forms most commonly used by USDA, EPA, and FDA in the dataset RegData identified, given their significance in regulating the agriculture sector. The three agencies use different forms of regulations, but command-and-control and entry-and-exit regulations are dominant across all three entities (Figures 2-4). Notably, transfer is the most prevalent regulatory form in USDA regulations but not in those of EPA or FDA, while information-based regulation is prevalent in regulations of both EPA and FDA but not in USDA.

Figure 2: The Most Prevalent USDA Regulatory Forms

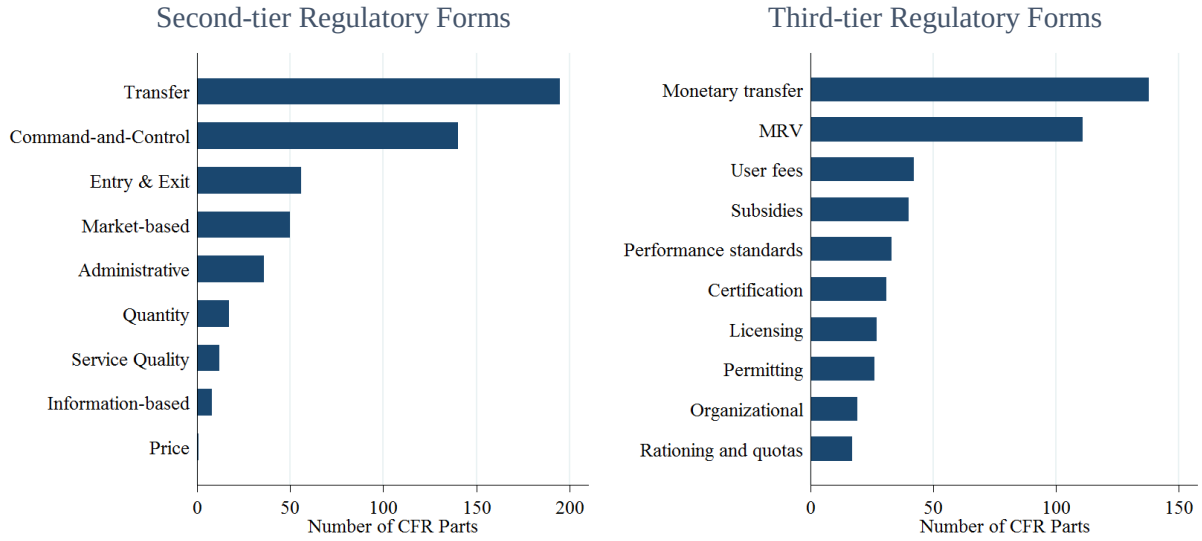


Figure 2 shows that USDA adopts diverse forms of regulation. Transfer, primarily monetary transfer, is the most prevalent form in the set of USDA regulations identified. User fees also contribute to the dominant place of transfers in USDA regulations, covering a large number of AMS regulations that authorize boards and committees for each commodity that provide research and promotion services in exchange for annual assessments from relevant handlers. Command-and-control regulation is a major form in USDA regulations because of prevalent MRV requirements in agricultural activities such as recordkeeping for pesticide use. In addition, subsidy is also a relatively prevalent form, as USDA issues regulations authorizing various subsidy programs for conservation practices. Unlike the overall

regulation trend (Figure 1), performance standards are not among the top three forms in USDA regulations.

Figure 3: The Most Prevalent EPA Regulatory Forms

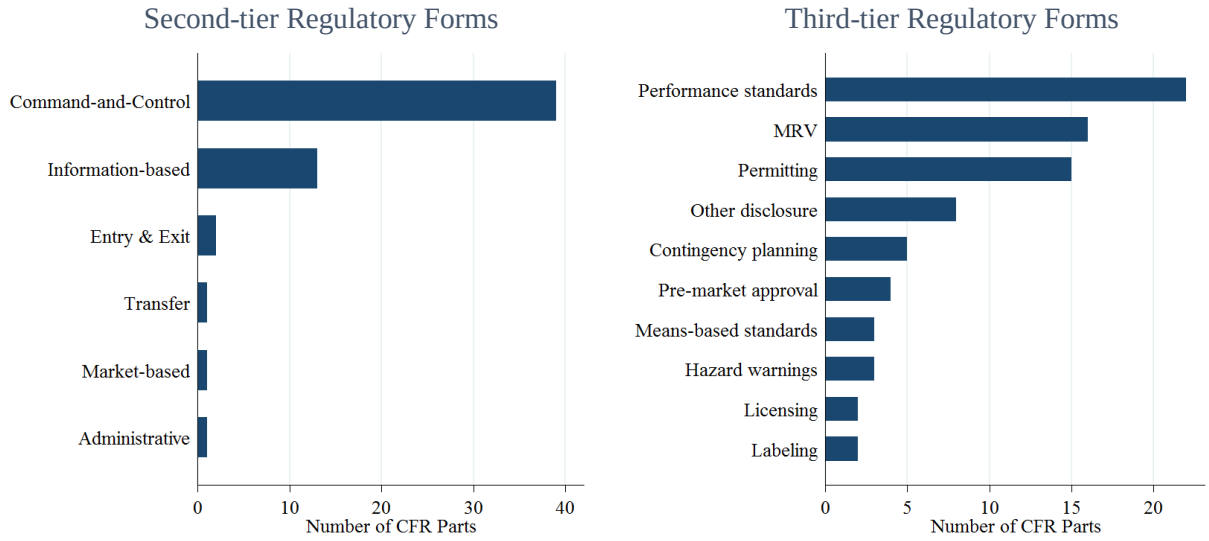
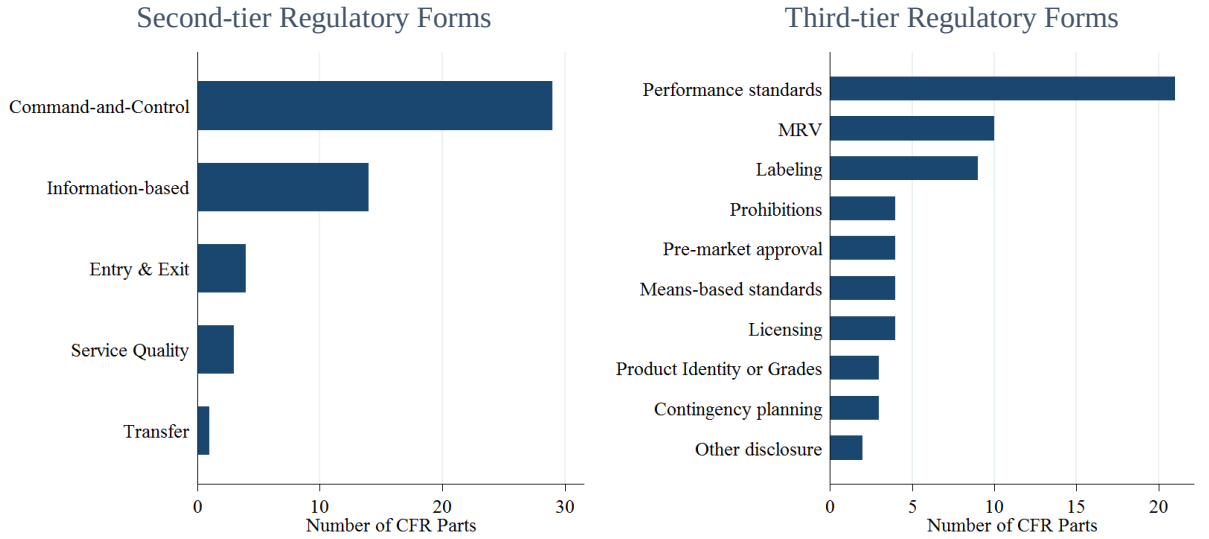


Figure 4: The Most Prevalent FDA Regulatory Forms



The primary forms in EPA regulations are command-and-control and information-based regulations (Figure 3). In particular, performance standards are the most common regulatory form, and labeling is the least. This is not surprising given that EPA's agricultural regulations focus on setting standards for pesticide use, hazardous substances, and toxic pollutants. Permitting requirements are also common in EPA regulations, including National Pollutant Discharge Elimination System (NPDES), and Experimental Use Permits. MRV requirements often accompany these performance standards and permitting requirements.

Similar to EPA, FDA relies heavily on command-and-control and information-based regulations (Figure 4). It issues a large number of performance standards, mostly related to the use of food

additives, harvesting and packing produce, and residues of new animal drugs in food. MRV and labeling requirements also appear in the regulations related to the same issues.

The above analysis presents a summary of regulatory forms in the 709 sample CFR parts. However, some CFR parts were removed, amended, or added during the 1970-2017 period. A cross-sectional analysis does not capture these changes over time. Therefore, a longitudinal analysis is necessary to see how these regulatory forms evolved during the past few decades.

B. Longitudinal Analysis

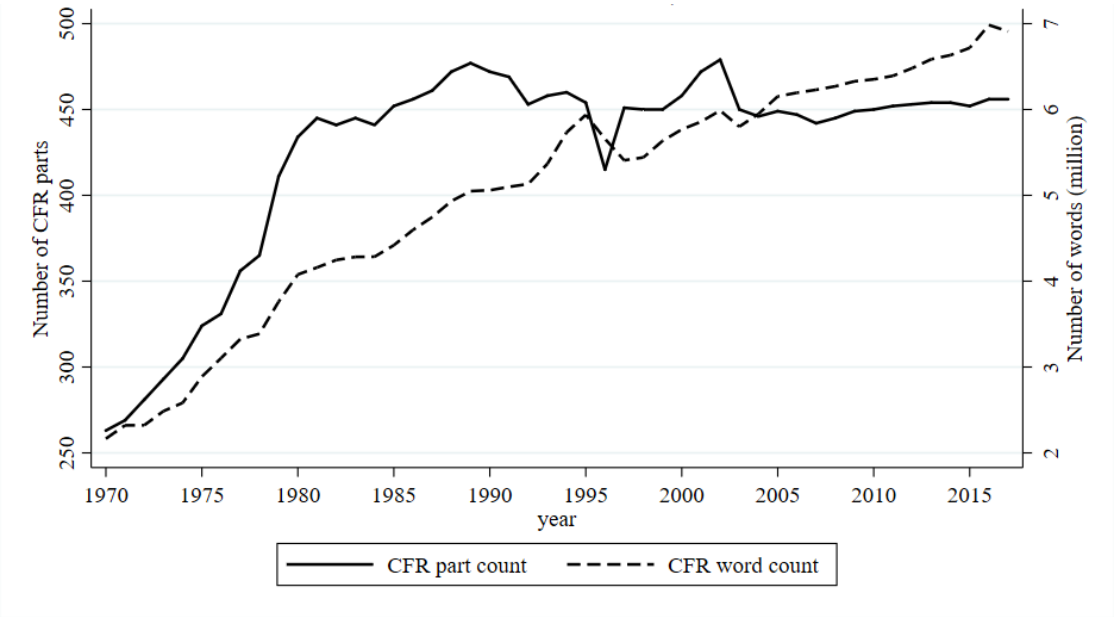
We combine the data on regulatory forms with total word counts in RegData 3.1 for longitudinal analysis. Specifically, we sum up the total word counts of all the CFR parts in our sample that take a regulatory form in a given year to measure the quantity of regulation of that form in that year, assuming that the forms taken by a regulation remain unchanged over time. We use the total word count as a measure rather than the number of CFR parts because word count can capture, to some extent, substantial amendments to the content of a CFR part. For example, if a CFR part was amended in a year, leading to a reduction of 500 words from 1,000 words, the word count can reflect the change but counting the number of CFR parts would not. Also, we use the total word count rather than the restrictive word count because the form of regulation may have a correlation with the use of restrictive words. For example, a market-based regulation is likely to have less restrictive words than a command-and-control regulation, so counting restrictive words associated with these two forms may systematically bias the comparison. In this section, we first examine the time trend of total regulation in the sample, and then compare the trends of different regulatory forms at first, second, and third tier.

1. Total regulation

Figure 5 shows the changes in the number of CFR parts and associated word counts during the 1970-2017 period. Only 263 of the 709 CFR parts existed in 1970; the number increased to 456 in 2017. Accordingly, the number of words increased from 2 million to 7 million. Although the number of CFR parts has not increased substantially since 1990, the word count has continued increasing over time. The number of CFR parts and words appear to decrease sharply in 1996, however, as mentioned above, we speculate that it reflects an error in the data source rather than an actual change in regulation, because the source of regulatory text in RegData changes from hard copies to digitalized editions for 1996 CFR and onward, whereas the digitized edition of the 1996 CFR is missing certain titles and parts.[18] In general, the time trend of all the sample regulations suggests that regulations affecting crop and animal production increased substantially over the 1970-2017 period.

[18] U.S. Government Publishing Office. "Code of Federal Regulations (Annual Edition)." Govinfo, accessed December 21, 2018. https://www.gpo.gov/fdsys/browse/collectionCfr.action?collectionCode=CFR.

Figure 5: Overall Trend of Relevant Regulations



2. First-tier forms

In our analysis of first-tier forms, we compared economic, social, transfer, and administrative regulations. Given the overall increasing trend in the quantity of total regulation, the absolute quantity of each regulatory form also increased during the 1970-2017 period. To compare the trends between regulatory forms, we examine the change in the proportion of the word count associated with a regulatory form in the total word count of all the sample CFR parts, which indicates an increase or decrease in the relative reliance on the form in the regulations relevant to crop and animal production. When a CFR part has multiple forms, we attribute all the words in the part to each form it takes. Therefore, the percentages of all forms in a given year always exceed 100.

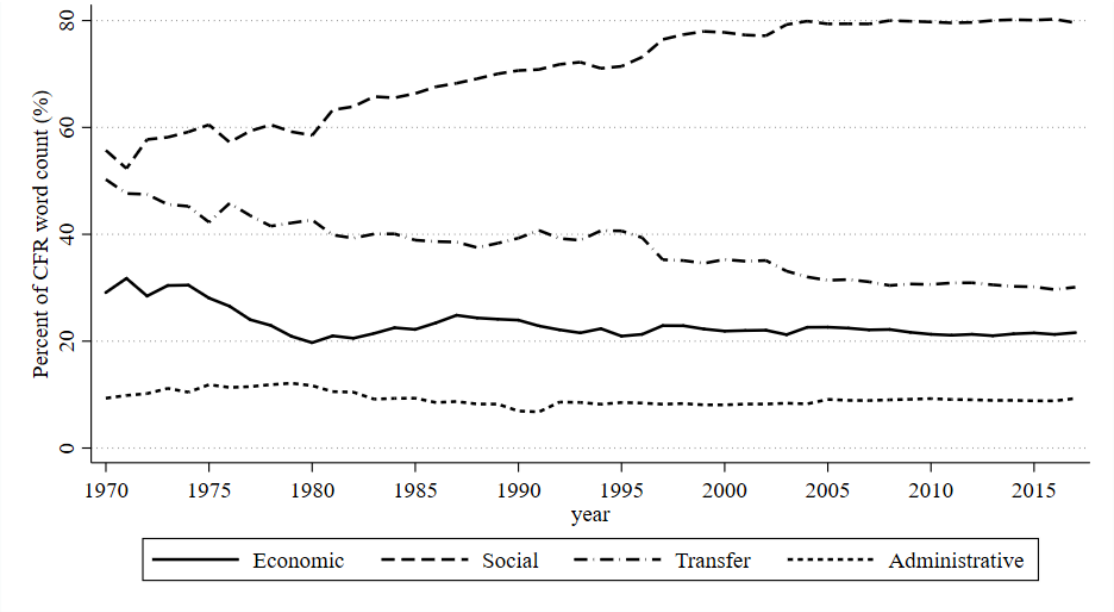
As shown in Figure 6, social regulations have accounted for a larger percentage of the total in recent years. The percentage of word counts related to social regulations increased by more than 24 percentage points between 1970 and 2017, whereas the percentage of word counts associated with economic regulations decreased by 8 percentage points in the same period. The word count related to transfer regulations decreased from 50 percent to 30 percent, while administrative regulations remained mostly constant during the time.

The trend is consistent with the overall regulatory development in recent U.S. history. Social regulations addressing issues related to public health, safety and the environment have increased, whereas economic regulations directly controlling price, quantities, or quality have decreased in many markets.[19] Further, the substantial decrease in transfer regulations cannot be separated from the

[19] Susan E. Dudley and Melinda Warren, "FY 2019 Regulators' Budget: More for Homeland Security, Less for Environmental Regulation," The George Washington University Regulatory Studies Center, May 2018, accessed

movement in agricultural policies. Transfer regulations mostly referred to USDA price and income support programs, which had been at the core of agricultural policy in the U.S. since 1933.[20] After the passage of the Food and Agricultural Act of 1965, agricultural policy started to move toward a more market-oriented direction, represented by reduced price supports, introduction of target prices and deficiency payments, and decoupled income supports.[21]

Figure 6: Economic, Social, Transfer, and Administrative Regulations



3. Second-tier forms

In our analysis of second-tier forms, we compare regulatory forms nested within economic and social regulations. This reveals the variation within the first-tier forms. Second-tier analysis only applies to economic and social regulations because transfer and administrative regulations have only one category at the second tier.

Price, Quantity, and Entry-and-Exit Regulations

As shown in Figure 7, entry-and-exit regulation is the primary form of economic regulation applied to crop and animal production. Approximately 15 percent of the sample CFR parts included an attempt to manage market entry and exit in 1970, and the proportion increased to nearly 20 percent during the time period. Regulations controlling quantities of goods related to crop and animal production existed in more than 10 percent of the sample regulations in 1970, but the proportion has decreased since

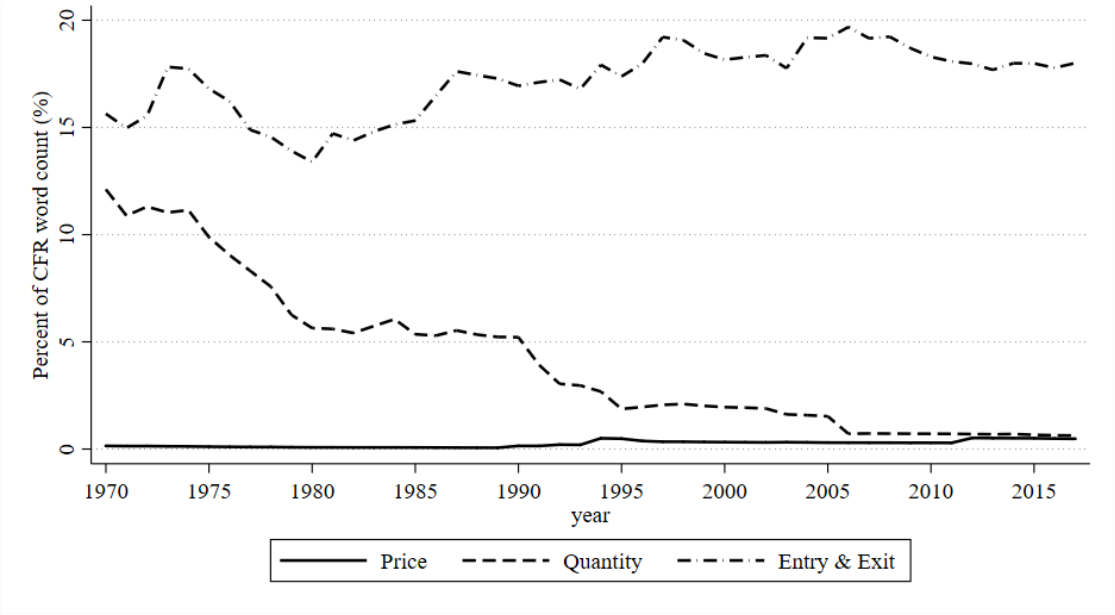
December 21, 2018, https://regulatorystudies.columbian.gwu.edu/fy-2019-regulators-budget-more-homeland-security-less-environmental-regulation

[20] Carolyn Dimitri, Anne Effland, and Neilson Conklin, "The 20th Century Transformation of U.S. Agriculture and Farm Policy," *Economic Information Bulletin* (June 2005), accessed December 21, 2018, https://ageconsearch.umn.edu/bitstream/59390/2/eib3.pdf.

[21] *Ibid*.

then—reaching a level close to zero in 2017 due to removal of the regulations controlling quantities of goods related to crop and animal production from our sample. Price regulation was not a primary form of economic regulation at any time during 1970-2017.

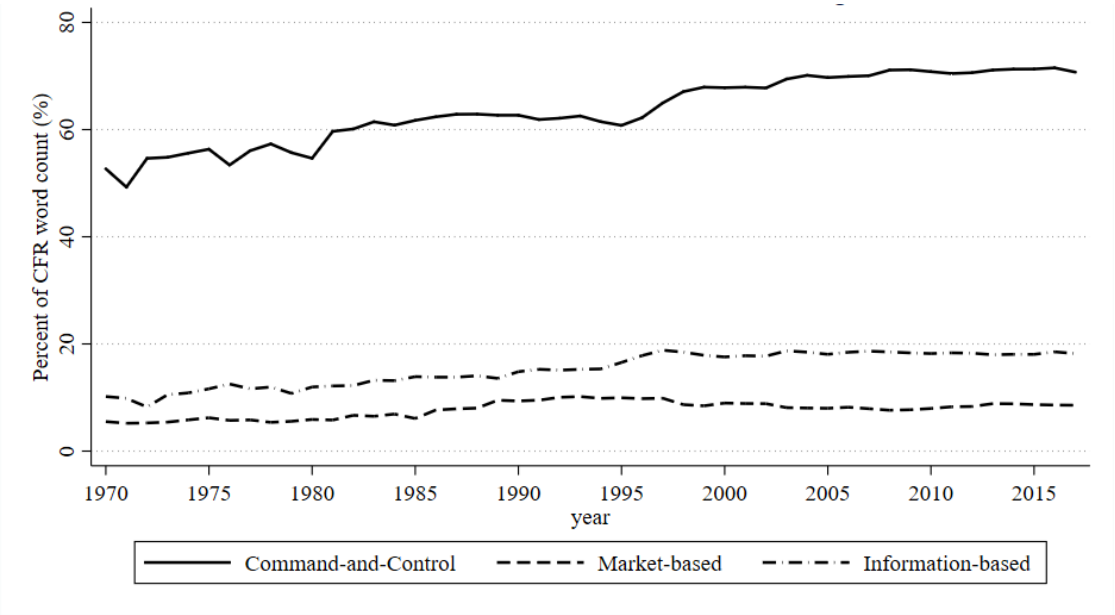
Figure 7: Price, Quantity, and Entry-and-Exit Regulations



Command-and-Control, Market-based & Information-based Regulations

Given that social regulation is the most prominent form of regulation, we analyze specific trends to identify variation between command-and-control, market-based, and information-based regulations.

Figure 8: Command-and-Control, Market-based, and Information-based Regulations



All the three forms of regulation reflect a slightly increasing trend (Figure 8). Command-and-control regulation is the primary form of social regulation and also the most prevalent form among all the sample CFR parts. The proportion of word counts associated with command-and-control regulation in all sample parts increased by 18 percentage points between 1970 and 2017. The proportion of information-based regulation increased by 8 percentage-points, and market-based regulation slightly increased by 3 percentage-points. Compared to the forms of economic regulation, all forms of social regulation experienced a more smooth and consistent trend.

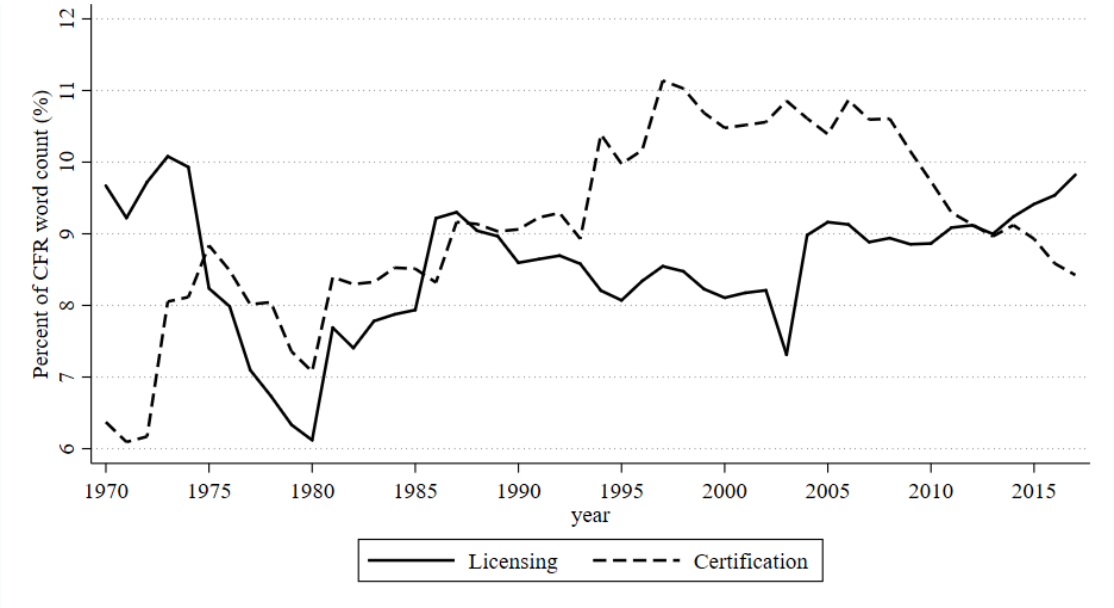
4. Third-tier forms

In our analysis of third-tier forms, we compare the trends between similar regulatory forms. The most comparable regulatory forms include licensing and certification, performance and means-based standards, permitting and prohibition, and subsidies and monetary transfer. We also analyze changes in MRV requirements given its overall prevalence in the sample regulations, as well as voluntary regulations.

Licensing & Certification

Licensing and certification are two regulatory forms of entry-and-exit regulation. They are both prevalent forms in the sample regulations as shown in Figure 1. The two forms have some similarities in that they both require government approval of certain operations. Licensing requires an individual or a facility to be approved to practice a profession or operate a business, while certification requires products to be routinely approved to enter a market or transported. As shown in Figure 9, the percentage of word counts associated with the two forms fluctuated between 6 and 12 percent during the time period.

Figure 9: Licensing and Certification



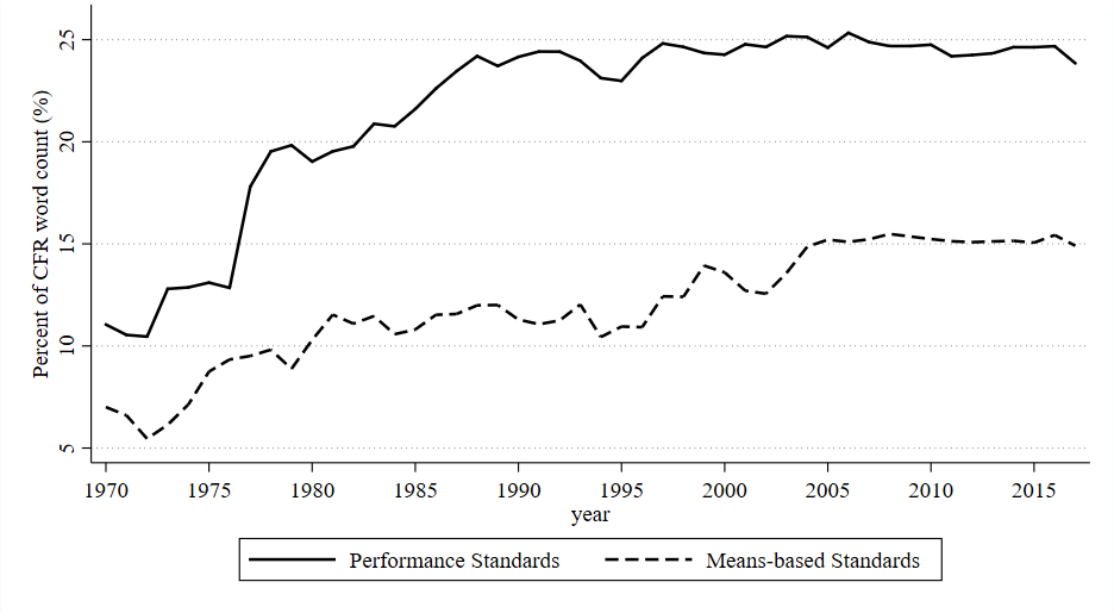
Performance & Means-based Standards

Performance and means-based standards both presented an increasing trend over 1970-2017 in terms of the percentage of word counts in all sample CFR parts (Figure 10). Performance and means-based standards are different in terms of the discretionary powers given to regulated entities. Performance standards define the required outcomes without prescribing the means to achieve them, whereas means-based standards require regulated entities to follow specific procedures, methods or practices.

Performance standards increased from 11 percent to 24 percent from 1970 to 2017, and most of the increase occurred between 1970 and 1988. The biggest jumps occurred in 1973 and 1977, where word counts increased by 22 percent and 38 percent respectively compared to a previous year. Means-based standards increased from 7 percent to 15 percent at a relatively constant growth rate from 1970 to 2017.

In general, performance standards have consistently been a more prevalent form than means-based standards in regulating animal and crop production. The gap between the two was relatively small between 1970 and 1976 and started to expand following the substantial increase in performance standards in 1977. This gap continued to expand until 1996, and it started to close after that. Still, agencies rely more on performance standards than means-based standards in agricultural regulations today.

Figure 10: Performance and Means-based Standards

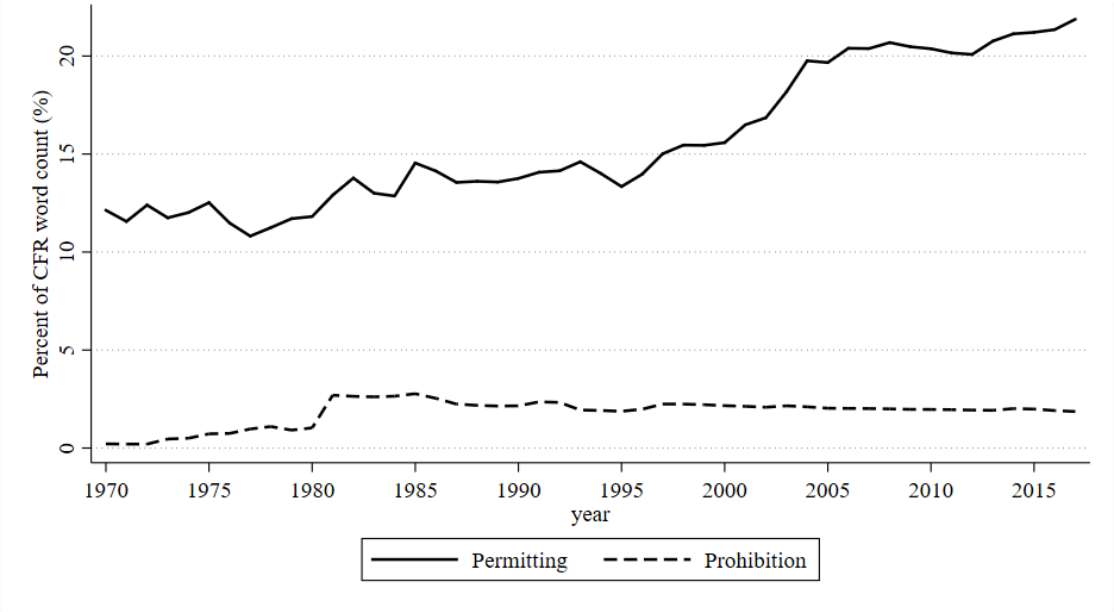


Prohibition & Permitting

Permitting has been more common than prohibition (Figure 11). For permitting, the percentage of word counts increased considerably, reflecting a change from 12 percent to 22 percent between 1970 and 2017. The percentage of word counts related to prohibition remained mostly constant, except the

sudden increase in 1981 due to addition of two CFR parts in that year: 7 CFR 800, general regulations related to grain inspections, and 50 CFR 36, Alaska national wildlife refuges.

Figure 11: Permitting and Prohibition

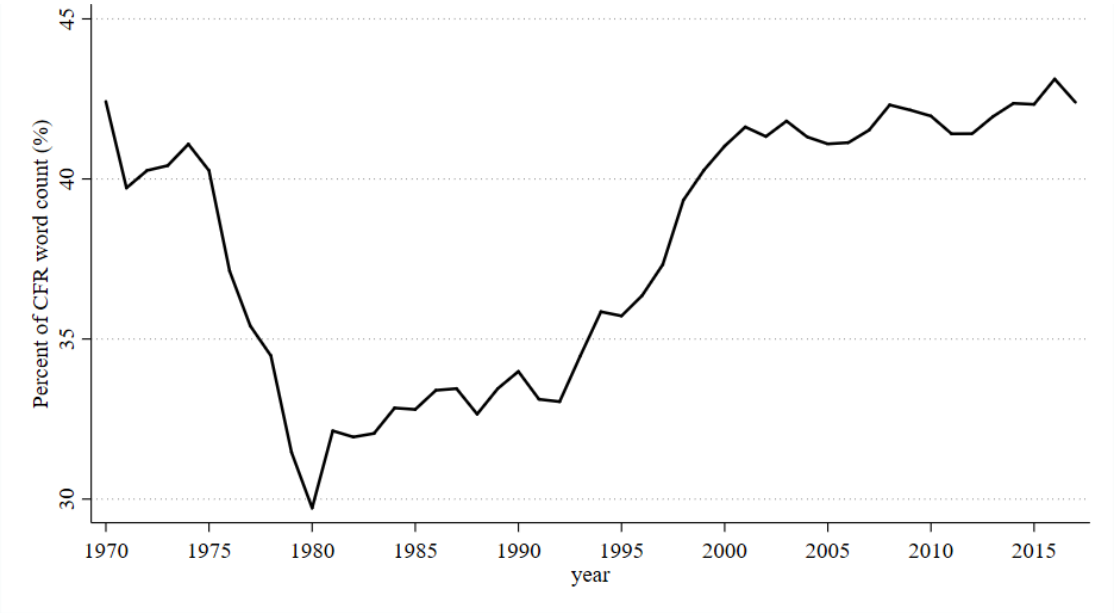


Monitoring Verification and Reporting

MRV is one of the most common regulatory forms in our sample. As shown in Figure 12, around 30-40 percent of the sample regulations include an MRV requirement. The percentage of word counts related to MRV requirements experienced dramatic decreases and increases between 1970 and 2017. From 1970 to 1980, the percentage decreased from 42 percent to 30 percent.[22] After that, it started to increase slowly. In 2001, it regained its 1980 level and remained mostly constant since then.

[22] Note that it does not mean the amount of regulation containing MRV requirements decreased substantially during 1970-1980. The fact that we use the percentage of word count as a measure suggests the trend in the relative reliance on each form in the regulations relevant to crop and animal production, rather than the absolute level of regulation containing each form. In fact, the total word count in the regulations related to MRV requirements increased constantly over the period of 1970-2017. The percentage decreased between 1970 and 1980 mainly because the regulations not containing MRV requirements increased rapidly in terms of total word count during that period.

Figure 12: Monitoring, Reporting and Verification Requirements

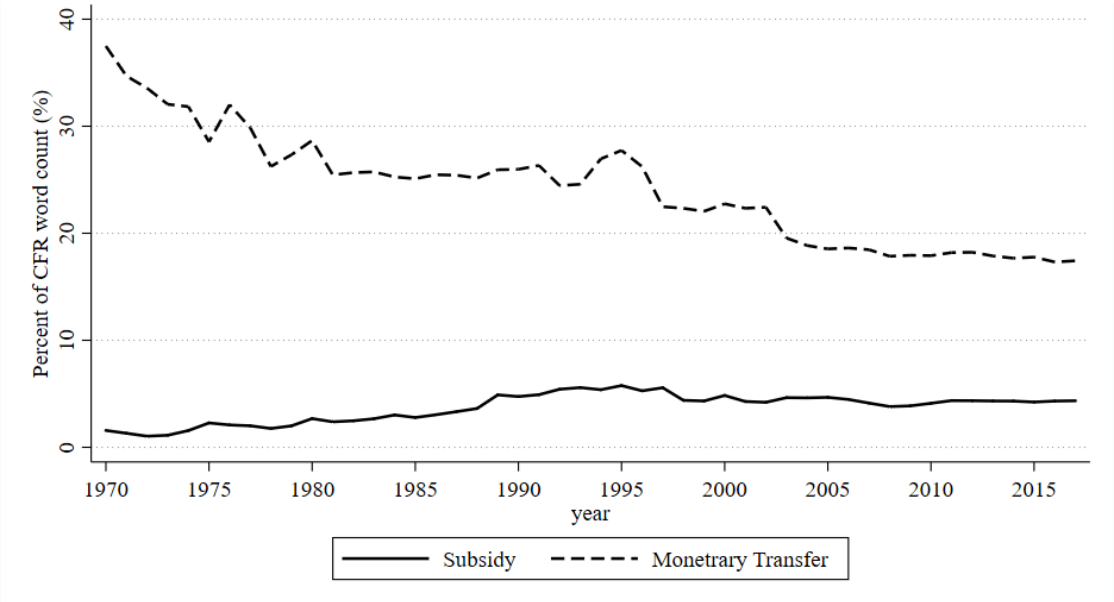


Subsidies & Monetary Transfer

In our Taxonomy, monetary transfers and subsidies are similar in the sense that regulated entities receive financial support from the government. However, subsidies are intended to incentivize certain behavior such as environmental conservation, while monetary transfers target a specific public need, such as disaster assistance for crop.

As shown in Figure 13, monetary transfer decreased continuously over the 1970-2017 time period, which is consistent with the overall trend of transfer regulation. The percentage of subsidies increased slightly from 1.6 percent to 4.4 percent.

Figure 13: Subsidies and Monetary Transfer

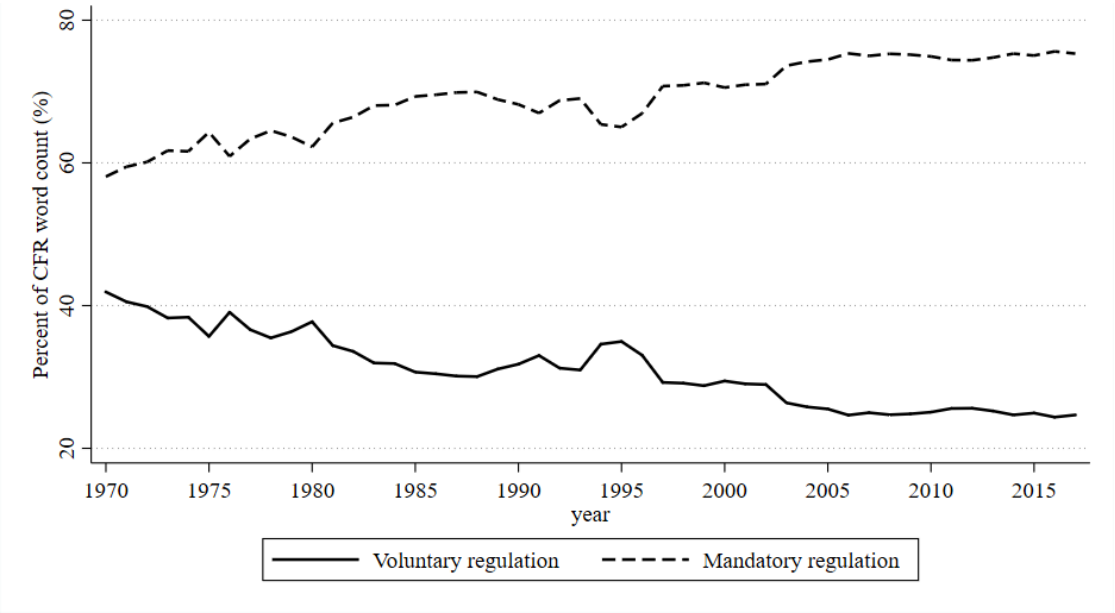


5. Voluntary Regulation

In addition to classifying each sample CFR part by the regulatory forms it takes, we also assessed whether the regulatory requirements included in the CFR part were voluntary or mandatory. For example, a part describing USDA's conservation programs can be considered voluntary because farmers have the freedom to choose whether to participate in these programs, although a strong incentive to participate may exist for some voluntary programs given the substantial co-benefit participation would bring.[23] On the other hand, a part describing pesticide tolerances is mandatory because compliance with tolerances is required for all relevant entities and noncompliance would lead to penalties.

Among the 709 sample CFR parts, nearly 65 percent (455 parts) contain mandatory regulatory requirements, and 35 percent (254 parts) include voluntary requirements. Incorporating the temporal changes in the corresponding parts, we see that the proportion of word counts associated with voluntary regulation decreased over the 1970-2017 period (Figure 14). This is mostly due to the shift in regulatory focus from transfer regulations to other regulatory forms in agricultural regulation as discussed above.

Figure 14: Voluntary and Mandatory Regulations



[23] Given the fact that U.S. farmers are highly dependent on the government's income and price support, the material incentives provided by certain "voluntary" programs, such as maintaining eligibility to receive income support payments or cost share programs for land improvements, are so strong that farmers are unlikely to opt out in order to maintain their business.

IV. Conclusion

In this chapter we discuss our approach for applying the Taxonomy of Regulatory Forms to regulations affecting crop and animal production. We analyze the text of a sample of relevant regulations to create a dataset that classifies each regulation according to the forms it takes. We then combine the dataset with the quantitative measure of regulation (i.e., total word count) in RegData to explore the cross-sectional and longitudinal trends in the prevalence of and reliance on each form of regulation.

The cross-sectional analysis indicates that command-and-control and transfer regulations are the most common second-tier regulatory forms. The prevalence of third-tier regulatory forms differs across agencies. Monetary transfer is the top regulatory form in USDA regulations, while performance standards are more prevalent in EPA and FDA regulations. However, MRV, a third-tier form classified under command-and-control regulation, is the dominant regulatory form of all three agencies' regulations.

We also conduct a longitudinal analysis to present the changes in reliance on each regulatory form, as measured by the percentage of words associated with a form in all sample regulations, across the three relevant agencies between 1970 and 2017. Trends in regulatory forms are consistent with the overall regulatory trends in the U.S., namely, an increasing emphasis on social regulation relative to economic regulation.[24] Specifically, we observe that the percentage of word count associated with social regulation increased, but there is a decline in the percentage of word count associated with economic and transfer regulations. Within social regulation, the largest increasing trend was in the reliance on command-and-control regulation, followed by information-based regulation. Further, we examine price, quantity, and entry-and-exit regulations to understand trends within economic regulation: only regulations related to quantities of goods experienced a substantial decrease. Lastly, we look at the third-tier regulatory forms to identify changes at a more specific level. We observe that the percentage of words associated with performance standards, means-based standards, permitting, and MRV regulations increased over time, while monetary transfer became a less common form during the 1970-2017 period.

Overall, the analysis provides an overview of the forms of agriculture-related regulations. In the next chapter we use the dataset to understand the association between crop productivity and different forms of regulation.

[24] Dudley and Warren 2018.

Appendix A: Relevant Crop and Animal Industries

3-Digit NIACS	NAICS Title	4-Digit NAICS	NAICS Title
111	Crop Production	1111	Oilseed and Grain Farming
		1112	Vegetable and Melon Farming
		1113	Fruit and Tree Nut Farming
		1114	Greenhouse, Nursery, and Floriculture Production
		1119	Other Crop Farming
112	Animal Production	1121	Cattle Ranching and Farming
		1122	Hog and Pig Farming
		1123	Poultry and Egg Production
		1124	Sheep and Goat Farming
		1129	Other Animal Production
115	Support Activities for Agriculture and Forestry	1151	Support Activities for Crop Production
		1152	Support Activities for Animal Production

Appendix B: Frequency of Third-tier Forms of Regulations in Sample CFR Parts

Seq.	Form of Regulation	Frequency
1	Monetary transfer	192
2	Monitoring, reporting and verification	183
3	Performance standards	108
4	Permitting	90
5	Government action	82
6	User fees	73
7	Licensing	45
8	Subsidies	45
9	Means-based standards	43
10	Certification	36
11	Organizational	29
12	Bonds	26
13	Labeling	22
14	Knowledge transfer	20
15	Other disclosure	20
16	Rationing and quotas	18
17	Product Identity or Grades	17
18	Contingency planning	15
19	Prohibitions	15
20	Technology transfer	15
21	Definitions	9
22	Pre-market/pre-manufacture approval	9
23	Hazard warnings	6
24	Exemption	4
25	Pre-market notice	4
26	Antitrust	2
27	Benchmarking (or yardstick regulation)	2
28	Certificate of need	1
29	Marketable permits	1
30	Obligation to serve	1
31	Portfolio standards	1
32	Price ceiling/floor	1
33	Quality levels	1
34	Rate of return	1
35	Revenue cap	1
36	Rivalrous/exclusive permits	1
37	Taxes and fees	1

Appendix C: Coding Q&A

This appendix is part of the Codebook to record the important decision-making processes we used to code certain regulatory forms. This is to ensure the duplicability of the coding process.

Q1. Almost all CFR parts include relevant definitions and government responsibilities, should we include the *Definitions* and *Government Action* forms in those CFR parts?

Examples: 7 CFR 7; 7 CFR 8

Answer: No. That is not what we intend to capture in the *Definitions* and *Government Action* forms. The three administrative forms (*Definitions*, *Government Action*, and *Organizational*) are to identify the CFR parts that do not create any direct burden for the public. In other words, we classify a CFR part as an administrative form if the part describes definitions, government actions, or organizational structures only, without mentioning any requirements for regulated entities.

Q2. If a CFR part does not describe any specific regulatory requirements but refers to another part (e.g. "this part adopts regulations/standards in [another CFR part]"), should we classify this part as the forms in the referred CFR?

Examples: 2 CFR 3000 adopts the OMB guidance in 2 CFR 180. The 2 CFR 3000 does not describe any specific requirements, but includes a brief introduction and multiple references to 2 CFR 180.

Answer: Yes. For instance, in the above example, we also refer to 2 CFR 180 to classify the part. However, this does not mean that we always read through the referred/linked CFR part(s). Many CFR parts contain references to other CFR parts. We decide on a case-by-case basis whether the requirements described in the referred part comprise a major regulatory form in this part.

Q3. Monitoring, reporting and verification (MRV) requirements are included in many regulations, should we always consider it as a regulatory form?

Examples: 6 CFR 27; 7 CFR 30; 7 CFR 46; 40 CFR 127

Answer: MRV requirements are generally used as a means of enforcement of other forms of regulation. We have reached a consensus to include the form *MRV* as long as the CFR part has specific language on MRV requirements. However, we try to capture the major forms of the regulation in addition to MRV requirements. We expect that *MRV* will often be accompanied by at least another regulatory form, which could be permitting, subsidies, etc.

Q4. How should we classify CFR parts describing administrative regulations, application procedures, appeal procedures, rules of practice, etc.?

Examples: 7 CFR 11; 7 CFR 202; 7 CFR 279; 7 CFR 614

Answer: Although these provisions are sometimes included in the same part as specific regulatory requirements or program details, they are in many cases listed in separate parts. To ensure consistency, we always refer to the specific regulations/programs for classification of these parts. The rationale is that, without the corresponding regulations/programs, applicants/participants/other regulated entities would not have to comply with the procedures described in these parts. For

example, if there is a CFR part that describes the appeals process for government decisions regarding eligibility for a subsidy program, we code as *Subsidies*—not as *Government Action*.

Q5. Do we classify regulatory requirements for agencies or government officials described in a CFR part?

Examples: 9 CFR 557 includes MRV requirements for program inspectors, not regulated entities; 50 CFR 36 includes information disclosure requirement for the agency, not regulated entities.
Answer: No. In general, a regulation always includes government responsibilities. Since our analysis is to examine the regulatory impacts on regulated industries, we do not focus on regulatory requirements for agencies or government officials. As mentioned in Q1, *Government Action* is used only if a CFR part describes government responsibilities only and does not create direct requirements for regulated entities.

Q6. What is the difference between *Licensing*, *Certification*, and *Permitting*?

Examples: *Licensing*: EPA licensing for pesticide applicators; *Certification*: 7 CFR 57, Inspection of Eggs; *Permitting*: NPDES and NEPA.
Answer: *Licensing* generally applies to CFR parts detailing occupational licensing or licenses for the kinds of services a professional may provide (e.g. what treatments require a doctor). *Certification* is used in cases where a CFR part details a recurring need for approval on a case-by-case basis before a product is allowed to be marketed (e.g. routine inspection of produce or meat). *Permitting* is used in cases where a prior determination to prohibit something was made, but there is a process for asking the government to permit the activity (usually context specific); for example, NEPA or permit granted for interstate movement of GMOs.

Q7. How do we classify performance/means-based standards associated with *Licensing* or *Permitting*?

Examples: 50 CFR 36; 50 CFR 622
Answer: When performance or means-based standards are listed as conditions for obtaining a permit or criteria for determining program eligibility, we do not classify them separately as a major form. However, if the CFR part specifies certain performance/means-based standards for licensed operators or permitted operations, we classify the forms separately (i.e., *Performance Standards* or *Means-based Standards*).

Q8. How do we classify regulations that define commodity standards and grades?

Examples: 7 CFR 28; 7 CFR 30; 7 CFR 52; 7 CFR 54
Answer: Regulations related to commodity standards and grades are classified as *Product Identity or Grades*.

Q9. What is the form of regulation for crop insurance programs?

Examples: 7 CFR 400; 7 CFR 402; 7 CFR 407; 7 CFR 457
Answer: Typically, crop insurance programs are classified as *Monetary Transfer*. Such programs are also often voluntary.

Q10. There are several farm loan programs and financial guarantees. How do we classify such regulations?

Examples: 7 CFR 761, 762, 763, 764

Answer: Disaster loans or any other types of loans for income support are classified as *Monetary Transfer*. However, if a loan program is intended to support conservation practices, it is classified as *Subsidies*. A CFR part may be classified as both *Monetary Transfer* and *Subsidies* based on the specific programs included in the regulation.

Q11. How do we classify cooperative agreements?

Examples: 7 CFR 550

Answer: Cooperative agreements are classified as *Technology Transfer*.

Q12. Some regulations establish commodity research and promotion boards (e.g., National Peanut Board) for various commodities. What are the criteria for classifying the form of regulation?

Example: 7 CFR 1216

Answer: We classify regulations related to commodity research and promotion boards as *User Fees* if the boards primarily collect "assessments" from domestic producers in exchange for promotion and research services. However, if the CFR part includes requirements that to go beyond collecting a fee (e.g., setting marketing orders), then we classify further as appropriate according to categories specified in the taxonomy.

Q13. What is the difference between *Technology Transfer*, *Knowledge Transfer*, and *User Fees*?

Examples: 7 CFR 611; 7 CFR 612

Answer: If a part specifies that a fee/payment is required in exchange for agency services (either voluntary or mandatory), the part is classified as *User Fees*. If an agency is required to provide knowledge (e.g. technical information, brochures, data etc.) to the public for free, usually upon request, the part is classified as *Knowledge Transfer*. On the other hand, *Technology Transfer* tends to be performed through formal patenting and licensing.

Q14. If a CFR part is about grants given to states for implementing certain programs, do we classify it as a *Transfer*?

Answer: For grants provided to states and territories to implement certain programs, we identify the form(s) of the programs for which the fund is used, whenever possible. In many cases, grant funds are used as *Subsidies*, *Monetary Transfer*, or *Technology Transfer*.

Q15. What is the difference between *Performance Standards* and *Means-based Standards*?

Examples: 16 CFR 1500; 21 CFR 4; 21 CFR 112

Answer: If a regulation prescribes specific procedures, methods, or practices to be performed, it is classified as *Means-based Standards*; examples include CPSC's animal testing policy (16 CFR 1500) and FDA's standards for the growing, harvesting, packing, and holding of produce for human consumption (21 CFR 112). On the other hand, if a regulation specifies outcomes to be achieved or avoided without specifying how firms meet the outcome, then it is classified under

Performance Standards, even if the outcome itself was determined based on what available technology could achieve.

Q16. How do we classify environmental impact consideration required for agency actions (e.g. NEPA)?

Examples: 18 CFR 707; 21 CFR 25; 24 CFR 55

Answer: According to NEPA, agencies are required to consider environmental impacts in their actions (e.g. spending money or making a permitting decision). Although it looks like a requirement for the agency, it actually implies significant regulatory burden for the affected entities and their projects. So, the part is classified as the form of NEPA requirements, i.e., *Permitting*.

Q17. What is the form of registration requirements?

Examples: 21 CFR 207; 27 CFR 18

Answer: We typically classify registration as *MRV*.

Q18. Some regulations include training requirements for regulated entities. How do we assess the form of regulation for such requirements?

Examples: 30 CFR 254

Answer: If the purpose of the training requirement is to prepare for and respond to potential hazards (e.g., oil spill), we classify it as *Hazard Warning*. If the training requirement is for obtaining a license or permit, we classify it as *Licensing* or *Permitting*.

CHAPTER 4:

Does the Form of Regulation Matter?

An Empirical Analysis of Regulation & Land Productivity Growth

Zhoudan Xie

Scholars have generally found that regulation has a negative impact on productivity growth.[1] However, few studies have examined the cumulative impact of regulation on agricultural productivity, and none has distinguished among different forms of regulation. Although different forms of regulation—particularly alternatives to traditional command-and-control regulation—have received extensive discussion in the literature in terms of their relative effectiveness in achieving regulatory objectives, their impacts on productivity have not been systematically examined.

In the previous chapters of this report, we have reviewed the literature studying regulation and productivity, introduced the Taxonomy of Regulatory Forms that can potentially be used to classify all regulations according to the forms they take, and presented an application of the taxonomy to agriculture-related regulation and the trends of different forms across agencies and over time. In this chapter, we conduct empirical analysis to assess whether different forms of regulation have different effects on productivity growth. Using data from 25 agricultural industries for the period of 1971-2017, we examine the relationship between growth in regulation and growth in land productivity. In particular, we attempt to answer two questions: (1) What is the relationship between growth in agriculture-related regulation and growth in agricultural productivity? (2) Does the relationship vary depending on the form of regulation?

[1] e.g., Wayne B. Gray, "The Cost of Regulation: OSHA, EPA and the Productivity Slowdown," *American Economic Review* 77, no. 5 (December 1987): 998-1006; Adam B. Jaffe and Karen Palmer, "Environmental Regulation and Innovation: A Panel Data Study," *Review of Economics and Statistics* 79, no. 4 (November 1997): 610-619; Meryem Saygili, "Pollution Abatement Costs and Productivity: Does the Type of Cost Matter?," *Letters in Spatial and Resource Sciences* 9 (September 2014): 1-7; Bentley Coffey, Patrick A. McLaughlin, and Pietro Peretto, "The Cumulative Cost of Regulations." Mercatus Working Paper, Mercatus Center at George Mason University, Arlington, VA, April 2016; John W. Dawson and John J. Seater, "Federal Regulation and Aggregate Economic Growth," *Journal of Economic Growth* 18, no. 2 (January 2013): 137-177. See more discussions in Chapter 1 of this report.

Our findings suggest that growth in total regulation has a negative relationship with land productivity growth (i.e., yield growth), and the relationship differs depending on the form of regulation. Growth in some forms of regulation (e.g. command-and-control, entry-and-exit) are negatively associated with yield growth, while others (e.g. transfer, information-based) have a positive association.

The chapter is structured as follows. Section I describes the measures of agricultural productivity growth and regulation we use in the empirical analysis. Section II discusses the baseline model for examining the relationship between productivity growth and regulation growth. Section III explains the data sources and the approaches we use to construct key variables. Section IV presents results from the baseline model. Section V walks through a series of robustness checks of the baseline results. Section VI summarizes the findings and discusses implications as well as limitations of the analysis. The appendix includes additional illustrative tables and full regression results.

I. Land Productivity and Regulation

A. Measuring agricultural productivity growth

Productivity measures how much output a production process generates given a certain level of inputs. It is typically calculated as the ratio of output to inputs. Depending on what inputs are considered, there are various measures of agricultural productivity. The most comprehensive measure is multi-factor productivity, or total factor productivity (TFP), which considers the contribution of all inputs including land, labor, capital, and intermediate goods.[2] Although there is not a uniform approach for measuring TFP,[3] the Economic Research Service (ERS) of the U.S. Department of Agriculture (USDA) estimates agricultural TFP in the U.S.[4] and other countries.[5] The U.S. productivity accounts provide estimates of TFP growth at the national and state levels, giving a comprehensive measure of productivity growth in U.S. agriculture.

However, computation of TFP at a more disaggregated level requires additional data. Existing estimates of agricultural TFP are mostly focused on the sectoral level. Sub-sectoral (e.g., industry or commodity-specific) productivity estimates are not usually available due to data limitations.[6] Given that many farms

[2] Sun Ling Wang, Paul Heisey, David Schimmelpfennig, and Eldon Ball, "Agricultural Productivity Growth in the United States: Measurement, Trends, and Drivers," Economic Research Service, U.S. Department of Agriculture, ERR-189, July 2015.

[3] Arymala Prasad and Zhoudan Xie, "Agricultural Productivity and the Impact of Regulation," The George Washington University Regulatory Studies Center, Transatlantic Agriculture & Regulation Working Paper Series: No. 2, 2017.

[4] Economic Research Service, U.S. Department of Agriculture (ERS), "Agricultural Productivity in the U.S.," last modified April 4, 2018, https://www.ers.usda.gov/data-products/agricultural-productivity-in-the-us/.

[5] ERS, "International Agricultural Productivity," last modified October 15, 2018, https://www.ers.usda.gov/data-products/international-agricultural-productivity/.

[6] Alejandro Nin, Channing Arndt, Thomas W Hertel, and Paul V Preckel, "Bridging the Gap Between Partial and Total Factor Productivity Measures Using Directional Distance Functions," *American Journal of Agricultural Economics* 85, no. 4 (November 2003): 928-942.

are diversified with multiple-commodity production,[7] it is technically difficult to allocate the use of each input precisely to the production of each commodity.[8] For example, if a farm has three operators and produces four commodities in a year, how much labor should we count toward each commodity, in the absence of comprehensive data that indicate how employees allocate their time? Such data challenges limit our capability to conduct industry-level analyses using TFP.

Alternatively, a more straightforward and widely used measure is single factor productivity, or partial factor productivity, which refers to output per unit of a single input such as labor, land, or capital. An advantage of single factor productivity is that it is self-explanatory and requires less data and computation power. The standard measures of single factor productivity in agriculture are land productivity (e.g., yield per acre) and labor productivity (e.g., output per worker). Land productivity is more commonly used as a measure of commodity-level productivity, as it is relatively easy to attribute the use of land to different commodity crops compared to labor.

For the reasons considered above, we use growth in crop yield as a measure of agricultural productivity growth. It reflects a useful aspect of productivity growth and is suitable for an industry-level analysis.[9]

B. Measuring regulation

As discussed in Chapter 1, the biggest challenge to incorporating regulation as an explanatory variable in economic analysis is finding a valid measure of the cumulative amount of regulation.[10] Measures of regulation used in the existing literature are mostly limited to government agencies' regulatory spending, or some measure of the amount of regulatory text—such as the word or page volume of a regulation. Several studies use spending by regulatory agencies to estimate the cumulative impact of regulation on various outcomes such as income growth and entrepreneurship,[11] economic freedom,[12] and state-level agricultural productivity.[13] However, government spending to develop and enforce regulations may not correlate well with the economic costs of those regulations, which are largely borne by producers and

7 Robert A. Hoppe, "Structure and Finances of U.S. Farms: Family Farm Report, 2014 Edition," U.S. Economic Research Service, Department of Agriculture, EIB-132, December 2014.

8 Nin et al. 2003.

9 As with all measures, these should be interpreted with caution. Changes in production tend to first occur on the most marginal land, so events that could lead to reduced production of a particular crop often remove the lowest yielding land from the equation, resulting in a *higher* average yield when calculated across a large geography.

10 Maeve P. Carey, "Methods of Estimating the Total Cost of Federal Regulations," Congressional Research Service Report No. R44348, January 2016, https://fas.org/sgp/crs/misc/R44348.pdf.

11 Noel D. Campbell, Kirk C. Heriot, and Andres Jauregui, "State Regulatory Spending: Boon or Brake for New Enterprise Creation and Income?" *Economic Development Quarterly* 24, no. 3 (2010): 243-250.

12 Noel D. Campbell, Alex Fayman, and Kirk C. Heriot, "Including U.S. State Government Regulation in the Economic Freedom of North America Index," *The Journal of Private Enterprise* 25, no. 2 (2010): 165-186.

13 Levi A. Russell, John M. Crespi, and Michael R. Langemeier, "Agricultural Productivity Growth and Regulation," Draft of First Submission *Public Choice*, August 2015, https://ag.purdue.edu/commercialag/Documents/Resources/Agricultural-Policy/General%20Farm%20Policy/2015_08_31_Langemeier_Agricultural_Productivity_Growth.pdf.

consumers and not reflected in fiscal budgets.[14] For example, certain forms of regulation involving stringent requirements may require little regulatory spending to develop and enforce.[15]

A more widely used set of measures quantifying the total amount of regulatory activity is the page or word count of regulations. The number of pages in the Federal Register is one of the first proxy measures popular among scholars and practitioners, as the Federal Register documents agencies' daily regulatory actions.[16] However, the page count in the Federal Register is by no means an accurate measure of regulation since it includes both proposed and final rules, as well as items other than rulemakings such as notices of public meetings and availability of guidance documents.[17] One alternative measure is the number of pages in the *Code of Federal Regulations* (CFR). Dawson and Seater use it to examine regulatory impacts on aggregate economic growth.[18] However, CFR page counts can still be an inaccurate measure, since a disproportionate number of diagrams or tables on certain pages of the CFR makes pages less comparable with each other.[19] For that reason, word count is considered to be a more precise measure. A relevant example is the Mulligan and Shleifer study using the number of kilobytes of unannotated state statutes to quantify the amount of law.[20] Yet similar concerns arise about whether a longer or shorter regulation implies more or less regulatory burden.

RegData developed by the Mercatus Center at George Mason University provides a more precise measure—"regulatory restrictions" by counting the number of command words (i.e., "shall," "must," "may not," "required," and "prohibited") in the CFR.[21] The underlying idea is that these command words reflect the extent to which regulations constrain or expand regulated entities' legal choices.[22] Further, RegData's estimates of the applicability of regulatory text in a CFR part[23] to specific industries have

[14] Susan Dudley and Melinda Warren, "Regulator's Budget: More for Homeland Security, Less for Environmental Regulation," The George Washington University Regulatory Studies Center, May 2018, https://regulatorystudies.columbian.gwu.edu/fy-2019-regulators-budget-more-homeland-security-less-environmental-regulation.

[15] Prasad and Xie 2017.

[16] Maeve P. Carey, "Counting Regulations: An Overview of Rulemaking, Types of Federal Regulations, and Pages in the Federal Register," Congressional Research Service Report No. R43056, October 2016; Clyde Wayne Crews, Jr., "Ten Thousand Commandments: An Annual Snapshot of the Federal Regulatory State," *Competitive Enterprise Institute*, 2011, https://cei.org/issue-analysis/ten-thousand-commandments-2011; Bentley Coffey, Patrick A. Mclaughlin, and Robert D. Tollison, "Regulators and Redskins," *Public Choice* 153, no. 1-2 (2011): 191-204.

[17] Carey 2016.

[18] Dawson and Seater 2013.

[19] Omar Al-Ubaydli and Patrick A. Mclaughlin, "RegData: A Numerical Database on Industry-specific Regulations for All United States Industries and Federal Regulations, 1997-2012," *Regulation & Governance* 11, no. 1 (2017): 109-123.

[20] Casey B. Mulligan and Andrei Shleifer, "The Extent of the Market and the Supply of Regulation," *The Quarterly Journal of Economics* 120, no. 4 (November 2005): 1445-1473.

[21] Patrick A. McLaughlin and Oliver Sherouse, "RegData US 3.1 Annual (dataset)," QuantGov, accessed December 21, 2018. https://quantgov.org/regdata-us/.

[22] Al-Ubaydli and Mclaughlin 2017.

[23] "Part" is a unit of the CFR. The CFR is structured into 50 titles according to subject matter categories, and then broken down into chapters, parts, sections, and paragraphs (*see* https://www.archives.gov/files/federal-register/tutorial/tutorial_060.pdf). See more discussion in Chapter 3.

enabled an emerging body of industry-specific empirical studies on the effects of regulation in the U.S. For example, Goldschlag and Tabarrok use regulatory restrictions to examine the relationship between federal regulation and patterns in the creation of business startups and the pace of job reallocation.[24] Similarly, other studies examine the relationship of regulatory restrictions with manufacturing investment,[25] value added to GDP by industries,[26] consumer prices,[27] and industry productivity growth.[28] Although it is questionable whether every regulatory restriction in the CFR has the same effect on the economy, this approach provides an innovative and informative measure of regulation that addresses some of the problems with previous measures.

Nevertheless, aggregate measures of regulation developed thus far have not quantified separate forms of regulation. As discussed in Chapter 1 of this report, there are good theoretical reasons to believe that different forms of regulation have heterogeneous effects, but empirical studies have not compared forms in a systematic way due to the lack of data. To remedy this problem, we create a new dataset classifying a large number of CFR parts by their forms following the qualitative coding procedure described in Chapter 3. We then combine it with the RegData restrictions to construct a new measure of restrictions for different forms of regulation. Section III discusses the specific approach we employ to construct the variable.

II. Model

The baseline econometric model consists of three specifications. First, we examine the relationship between growth in total regulation and growth in crop yield. Given that crops have specific growing seasons and regulations usually require some time (typically from several months to a couple of years) for implementation and compliance, regulations are likely to have lagged effects on crop yield.[29] Hence, we lag the regulation variables by a year in the model. We then examine the relationship between growth in different regulatory forms and yield growth. Regulatory forms are defined in the Taxonomy of Regulatory Forms introduced in Chapter 2. We perform the analysis for all the second-tier and selected third-tier forms. Third, we add each industry's exposure to natural disasters into the model as a control variable.

[24] Nathan Goldschlag and Alex Tabarrok, "Is Regulation to Blame for the Decline in American Entrepreneurship?" *Economic Policy* 33, no. 93 (January 2018): 7-44.

[25] Brandon Pizzola, "Business Regulation and Business Investment: Evidence from US Manufacturing 1970–2009," *Journal of Regulatory Economics* 53, no. 3 (May 11, 2018): 243-255.

[26] Bentley, McLaughlin, and Peretto 2016.

[27] Dustin Chambers, Courtney A. Collins, and Alan Krause, "How Do Federal Regulations Affect Consumer Prices? An Analysis of the Regressive Effects of Regulation," *Public Choice* 180, no. 1 (2019): 57-90 .

[28] John Fernald, Robert E. Hall, James H. Stock, and Mark W. Watson, "The Disappointing Recovery of Output after 2009," National Bureau of Economic Research, Working Paper 23543, June 2017, accessed October 9, 2019, doi: 10.3386/w23543.

[29] We also show regression results using both unlagged and lagged regulation variables, which support our claim on lagged regulatory effects.

A. Total regulation

The first econometric specification is as follows:

$$\boldsymbol{YG_{i,t} = \beta_1 TRG_{i,t-1} + \mu_i + \gamma_1 trend_t + \gamma_2 trend_t^2 + \varepsilon_{i,t}} \quad (1)$$

where i is the ith 6-digit NAICS industry,[30] t is the tth year, $YG_{i,t}$ ($yield\_growth_{i,t}$) is the weighted average of the annual growth rate in yield of all crops related to industry i in year t, $TRG_{i,t-1}$ ($total\_reg\_growth_{i,t-1}$) is the annual growth rate of regulatory restrictions in all CFR parts relevant to industry i in year $t-1$, μ_i is the 6-digit NAICS industry fixed effects (FE), $trend_t$ is time trend, $trend_t^2$ is time trend squared, and $\varepsilon_{i,t}$ is the error term.

We convert crop yield and regulatory restrictions into growth rates to ensure that both variables are stationary. By including industry FE, we control for unobserved industry-specific, time-invariant characteristics that affect an industry's yield growth. The time trend variable controls for unobserved factors affecting yield growth that are a function of time; it is typically used to rule out possible spurious relationships between the dependent and independent variables if they have a common trend over time. For example, studies have used time trend as a proxy of technological change in estimating production functions.[31] The time trend squared variable simply allows the function of time to be non-linear.

B. Regulatory form

In the second specification, we add the growth in regulatory restrictions for a specific regulatory form to the model:

$$\boldsymbol{YG_{i,t} = \beta_1 RFG_{i,t-1} + \beta_2 TRG_{i,t-1} + \mu_i + \gamma_1 trend_t + \gamma_2 trend_t^2 + \varepsilon_{i,t}} \quad (2)$$

where $RFG_{i,t-1}$ ($regform\_growth_{i,t-1}$) is the annual growth rate of regulatory restrictions in the CFR parts that take a particular regulatory form as coded in the taxonomy (e.g., command-and-control regulation) for industry i in year $t-1$.

We keep the total restriction growth in the specification to control for the effects of regulatory forms other than the form of interest (i.e., $RFG_{i,t-1}$) on yield growth.[32] Here we use growth in total restrictions

[30] We use 6-digit NAICS industry as the unit of analysis in the econometric analysis, because most of the 6-digit NAICS industries come down to the commodity level, allowing us to precisely link each industry to relevant crops when we measure the yield growth for each industry.

[31] Thomas F. Cooley and Edward C. Prescott, "Systematic (Non-Random) Variation Models: Varying Parameter Regression: A Theory and Some Applications," *Annals of Economic and Social Measurement* 2, no. 4 (October 1973): 463-473.

[32] Since total restrictions also include the restrictions associated with the particular form of interest in the model, we test for multicollinearity on RFG_i and TRG_i and do not find any signs of multicollinearity: the VIF is slightly larger than 1 in all individual industries.

rather than growth in restrictions for all other forms, because it will keep all specifications for different regulatory forms identical except for $RFG_{i,t-1}$, which enables direct comparisons of coefficients on $RFG_{i,t-1}$ among forms. However, we conduct a robustness check replacing the total restriction growth with other restriction growth to examine the sensitivity of results.

C. Controlling for disaster risk

A potentially important factor that is not controlled for by industry FE and time trend is the effect of natural disasters on yield growth. Since different commodity crops are cultivated in different regions, it is very likely that yield growth of different industries is affected differently by natural disasters. Although natural disasters are less likely to be correlated with most of the regulatory forms, an exception might be transfer regulation, which includes disaster assistance payment programs and crop insurance policies. Thus, controlling for disasters can reduce possible endogeneity in certain forms of regulation. The specification is as following:

$$\boldsymbol{YG_{i,t} = \beta_1 RFG_{i,t-1} + \beta_2 TRG_{i,t-1} + \beta_3 Disaster_{i,t} + \mu_i + \gamma_1 trend_t + \gamma_2 trend_t^2 + \varepsilon_{i,t}} \qquad (3)$$

where $Disaster_{i,t}$ is industry i's exposure to natural disasters in year t.

In the next section, we discuss how we obtain the data and construct the variables in the econometric specifications.

III. Data

We employ a set of industry-year panel data, covering 25 crop production industries during the 1971-2017 period. The industries are defined by 6-digit code in the North American Industry Classification System (NAICS). Most of the industries are very specific, such as soybean farming and wheat farming, which allows us to link individual commodities to industries. In this section, we explain the process followed to construct three key variables in the econometric analysis: yield growth, growth in restrictions for regulatory forms, and disaster risk.

A. Crop yield

We obtain crop yield data from USDA's National Agricultural Statistics Service (NASS). The original yield data are at the commodity level (e.g. soybean, corn, rice). To convert them to industry level, we create a crosswalk to link individual commodities to 6-digit NAICS codes based on the definitions in the 2017 NAICS Manual (Appendix A).[33] Since many 6-digit NAICS industries are very specific, such as soybean farming (111110) and wheat farming (111140), they are only linked to one or two commodities.

[33] Executive Office of the President, Office of Management and Budget, *North American Industry Classification System*, 2017, https://www.census.gov/eos/www/naics/2017NAICS/2017_NAICS_Manual.pdf.

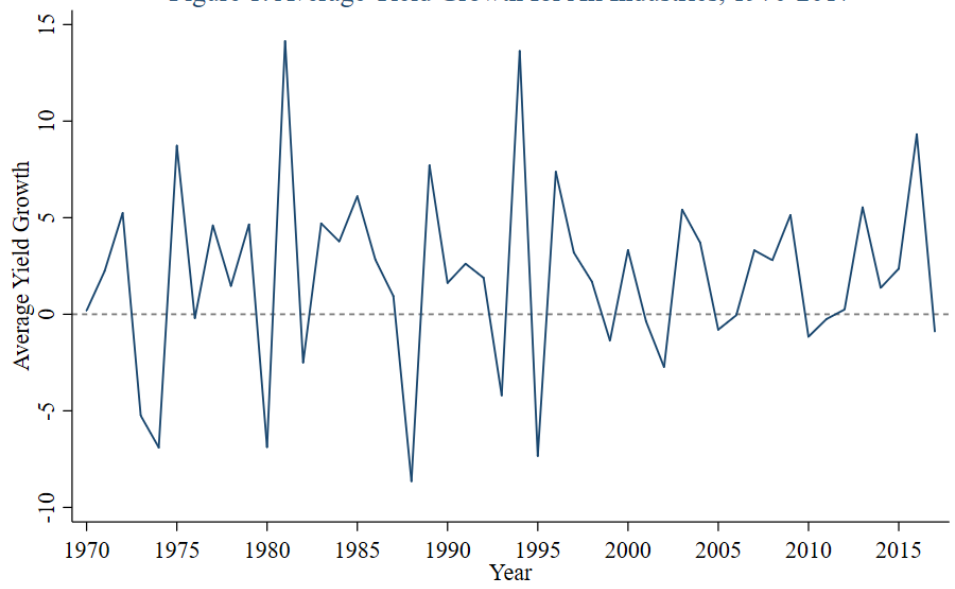
Others are broader, such as citrus (except orange) groves (111320) and tree nut farming (111335), which link to multiple commodities.

Yield is measured in unit of crops per acre of land, such as bushels per acre and tons per acre. The unit is not uniform across commodities because of different conventional measures for different commodities used by USDA.[34] Thus, we calculate the annual growth of yield at the commodity level first, and then use a weighted average to aggregate the yield growth of the relevant commodities into the industry level. Using a weighted average rather a simple average takes into account the relative importance of commodities within an industry. The calculation is as following:

$$\boldsymbol{yield\_growth_{i,t}} = \sum_{\boldsymbol{j=1}}^{\boldsymbol{n}} \boldsymbol{\omega_{j,t}} \cdot \boldsymbol{yield\_growth_{j,t}}$$

where j is the jth commodity linked to industry i, $yield\_growth_{j,t}$ is the annual growth rate in the yield of commodity j in year t, $\omega_{j,t}$ is the weight equal to the ratio of commodity j's production (measured in dollars) to the total production of all the n commodities linked to industry i in year t.

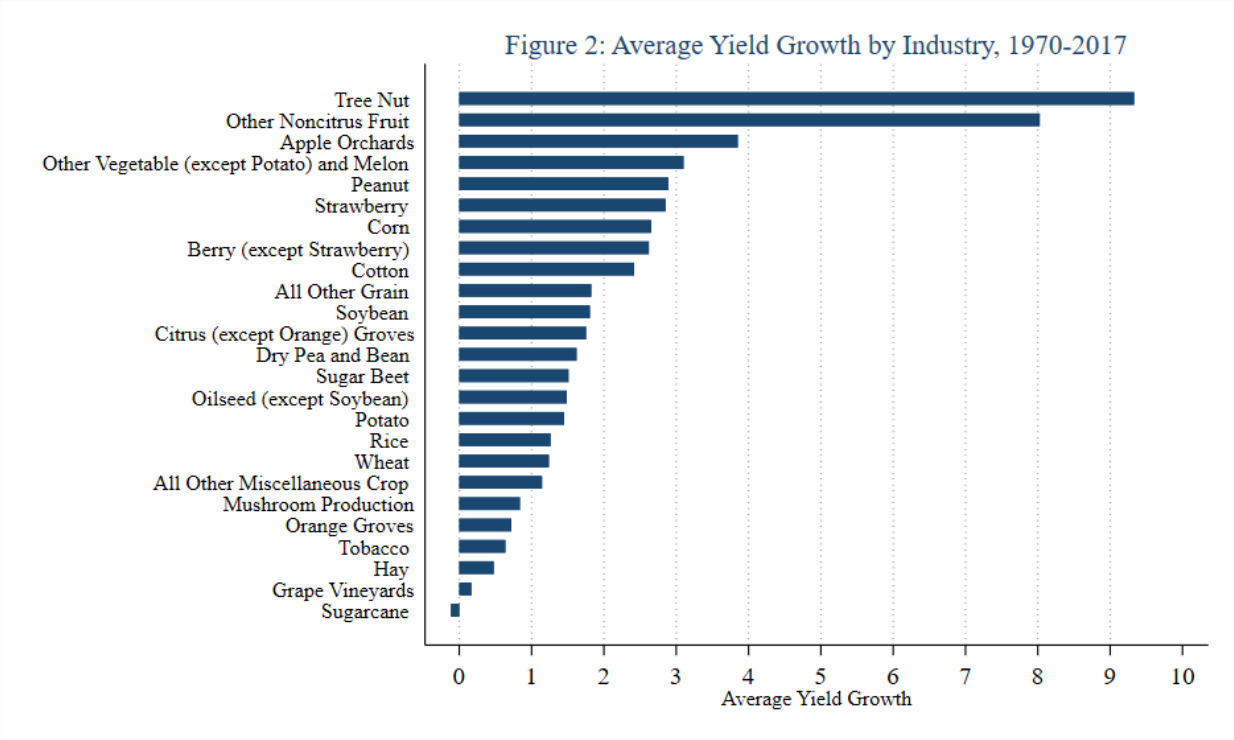
Figure 1: Average Yield Growth for All Industries, 1970-2017



The constructed variable shows that the average annual growth in crop yield is 1.97 percent (Figure 1). The largest increase is 14.15 percent in 1981, and the largest decrease is -8.64 percent in 1988. The fluctuation becomes smoother in the period after 2000. Figure 2 shows the average annual yield growth for each industry during the period of 1971-2017. All the industries achieved a positive average annual

[34] Economic Research Service, U.S. Department of Agriculture (ERS), "Weights, Measures, and Conversion Factors for Agricultural Commodities and Their Products," last modified June 1, 1992, https://www.ers.usda.gov/publications/pub-details/?pubid=41881.

growth in relevant crop yield, except for sugarcane farming which experienced an average annual decrease of -0.12 percent.



B. Regulatory form

As described in detail in Chapter 3, we conduct qualitative coding to identify the regulatory forms corresponding to parts in the CFR. To link CFR parts to industries, we rely on the relevance estimates in RegData 3.1. The relevance estimates indicate the probability of a CFR part being relevant to a given industry, so it is a continuous rather than a dummy variable. However, during the qualitative coding process, we also find that some of the relevance estimates may not accurately reflect a CFR part's applicability to an industry.[35] Therefore, we only use these estimates to identify the sample CFR parts relevant to an industry, rather than using it as an indicator to measure changes of regulation for the industry over time. In particular, we consider a CFR part to be relevant to an industry for the entire period it existed as long as it has a relevance value equal to or larger than 0.2 to the industry in any year. This is also consistent with our sample selection threshold. As a result, we identify 661 unique CFR parts relevant to the 25 crop production industries.[36]

Next, since in our dataset a CFR part has up to five regulatory forms, we divide the number of restrictive words (i.e., restrictions) in a part in a given year by the number of forms it takes (i.e., we assume a part

[35] *See* Chapter 3 of this report.

[36] The original sample we coded for forms includes 709 CFR parts, as described in Chapter 3, because it also includes parts estimated to be relevant to animal production industries.

with 100 restrictions and 5 forms to have 20 restrictions per form). Since it is technically difficult (and perhaps impossible) to identify which portion of the text in a CFR part is associated with a particular form, we assume that the restrictions in a part are equally distributed across its forms. We acknowledge that this assumption may seem arbitrary and create some uncertainty in the results, so we also conduct robustness checks using an alternative approach that distributes all the restrictions in a part to every form it takes (i.e., we assume a part with 100 restrictions and 5 forms to have 100 restrictions per form).

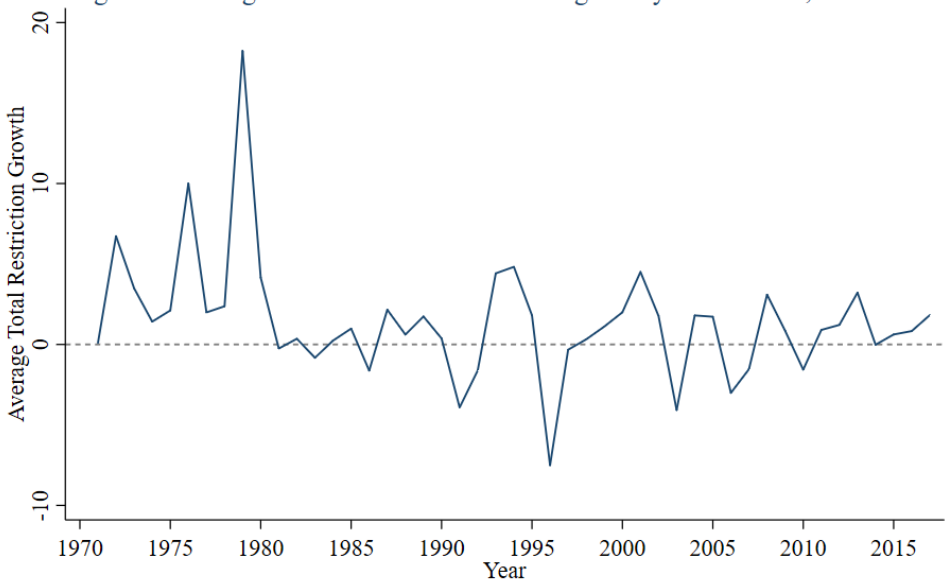
To estimate restrictions for each regulatory form at the industry level, we sum up the restrictions in the industry-relevant CFR parts that take a given regulatory form in a given year. The following example illustrates our approach:

Table 1: An Example of Distributing Restrictions by Form

Industry	Year	Relevant parts	Restrictions	Regulatory forms	Total restrictions	Restrictions for form 111	Restrictions for form 112	Restrictions for form 113
111110	2017	1 CFR 1	10	111	10 + 50 + 20 = 80	10 + 50/2 = 35	50/2 + 20/2 = 35	20/2 = 10
		1 CFR 2	50	111, 112				
		1 CFR 3	20	112, 113				

Finally, we calculate the annual growth in total restrictions and in restrictions for each regulatory form by industry and year. Over all the 25 industries, the average annual growth in total relevant restrictions is 1.44 percent, and the average growth does not vary substantially by industry. Total restrictions presented a continuous increasing trend before 1980, and started to fluctuate afterwards.

Figure 3: Average Annual Growth in Total Regulatory Restrictions, 1970-2017



C. Disaster risk

We define the disaster risk of an industry as its relevant commodities' exposure to natural disasters in a given year. We use data on the geographical distribution of crop cultivations from NASS and declarations of natural disasters in the Federal Emergency Management Agency (FEMA) database. First, we collect data on area planted for each commodity at the state and county level over the study period from NASS and calculate the percentage of area planted in a state or county in the total area planted of the commodity over the U.S. Then we multiply the percentage by the number of natural disasters in the state or county according to FEMA declarations, and sum all states or counties up for a commodity. The calculation is as follows:

$$disaster_{j,t} = \sum_{k=1}^{m} \frac{area_{k,t}}{total\_area_{j,t}} \cdot disaster_{k,t}$$

where j is the jth commodity linked to industry i, k is the kth state or county where commodity j was planted, $disaster_{j,t}$ is the disaster risk for commodity j in year t, $disaster_{k,t}$ is the number of natural disasters declared in state or county k in year t, $area_{k,t}$ is the area planted of commodity j in state or county k in year t, $total\_area_{j,t}$ is the total area planted of commodity j in the U.S. in year t.

Finally, we generate an industry-level measure of disasters by aggregating the commodity-level disaster risk using the same approach we use for yield growth:

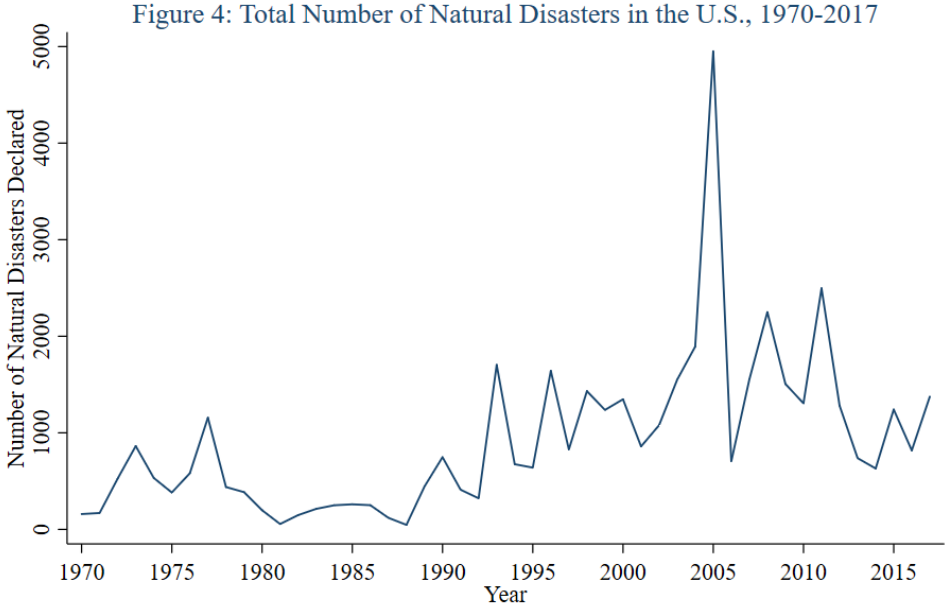
$$disaster_{i,t} = \sum_{j=1}^{n} \omega_{j,t} \cdot disaster_{j,t}$$

where $\omega_{j,t}$ is the weight equal to the ratio of commodity j's production (measured in dollars) to the total production of all the n commodities linked to industry i in year t.

The FEMA disaster declarations contain various incident types such as drought, fire, flood, snow, and storm since 1953. Therefore, it captures most of the possible extreme natural conditions that might affect crop production during our study period.[37] Figure 4 shows the total number of disasters declared in 50 states and the District of Columbia over the period of 1971-2017. Of these, severe storm, hurricane, and flood are the most frequently declared disasters. Year 2005 marks a peak due to a large number of hurricanes during the Atlantic hurricane season—known as the most active Atlantic hurricane season in recorded history.

[37] Note that FEMA declarations do not capture USDA disasters due to early frost or drought conditions. For example, the FEMA database does not cover agricultural droughts in the Midwest (such as in 1988 or 2012) or the ones in the Southeast in the early 1990s. In that sense, disaster declarations by the Secretary of Agriculture might be a better data source for identifying disaster risk for commodities. However, there is no archive of past declarations by the Secretary spanning the timeframe of interest.

Figure 4: Total Number of Natural Disasters in the U.S., 1970-2017



Disaster declarations also present a disproportionate geographical distribution. Texas, Missouri, Kentucky, and Virginia have the most declarations, while Wyoming and Nevada have the least.[38] The geographical distribution of disasters and crop cultivation results in varied levels of disaster risks for different commodities and industries. Although county-level area planted data might be more precise for assessing how much a commodity was affected by natural disasters in a given year, county-level data are only available for field crops. Hence, we use state-level data in the baseline model and use county-level data in a robustness check. Still, state-level area planted data are only available for the crops associated with 19 of the 25 industries in our sample, and county-level data are only available for 12 industries.

Table 2 shows the summary statistics of the primary variables.

[38] The District of Columbia, Delaware, and Hawaii have even less declarations, but they are less comparable to the other states because of their substantially smaller geographical area.

Table 2: Summary Statistics

Variable	Description	Obs	Mean	S.D.	Min	Max
Dependent Variable						
yield_growth	Annual growth rate in the yield of the crops associated with an industry in a year	962	1.98	13.74	-60.00	200.00
Control Variable						
disaster_state	Disaster risk an industry was exposed to in a year, calculated by state-level disaster data	715	27.09	38.59	0.00	502.76
disaster_county	Disaster risk an industry was exposed to in a year, calculated by county-level disaster data	553	0.26	0.32	0.00	2.52
Total Regulation						
total_reg_growth	Annual growth rate in regulatory restrictions in all CFR parts relevant to an industry in a year	1,175	1.44	3.96	-9.51	21.27
Second-tier Regulatory Form (Regform_growth)						
Price	Annual growth rate in regulatory restrictions in the CFR parts that take the particular regulatory form for an industry in a year	1,139	8.13	48.51	-100.00	352.63
Quantity		1,175	-2.99	15.04	-80.09	27.57
Entry-and-exit		1,175	3.28	7.24	-12.90	50.15
Service quality		1,175	1.11	12.77	-54.78	83.42
Command-and-control		1,175	2.92	6.56	-8.99	44.21
Market-based		1,175	5.30	14.49	-32.18	74.46
Information-based		1,175	3.03	13.27	-70.28	152.96
Transfer		1,175	0.05	6.25	-18.44	36.55
Administrative		1,175	1.07	8.20	-41.34	53.86
Third-tier Regulatory Form (Regform_growth)						
Licensing	Annual growth rate in regulatory restrictions in the CFR parts that take the particular regulatory form for an industry in a year	1,175	3.54	9.24	-23.17	55.64
Certification		1,175	1.99	9.15	-27.48	84.40
Monitoring, reporting and verification		1,175	1.88	4.81	-21.31	18.58
Performance standards		1,175	4.66	19.00	-15.14	139.63
Permitting		1,175	4.02	6.85	-17.09	60.20
Pre-market notice and approval		1,118	4.70	30.99	-66.51	360.81
Means-based standards		1,175	9.43	39.37	-89.49	559.18
Prohibitions		1,165	68.30	664.88	-100.00	8870.00

IV. Results

In this section, we present the results from the baseline specifications. In short, we find a statistically significant, negative relationship between total regulatory restriction growth and yield growth. The relationship differs depending on the form of regulation. In particular, growth in command-and-control, entry-and-exit, and administrative regulations shows a negative relationship with yield growth, while growth in transfer and information-based regulations demonstrates a positive relationship with yield growth.

A. Total regulation

In general, the growth in total regulatory restrictions in a year has a statistically significant, negative relationship with the growth in crop yield in the following year. As shown in columns (1), (3), (5) and (7) of Table 3, the results of baseline specification (1) show that a one percentage-point increase in regulatory restriction growth is associated with an approximately 0.28 percentage-point decrease in crop yield growth. The relationship is robust in OLS, industry FE, and industry FE with time trend specifications.

To verify the assumption of lagged effects of regulation, we also add total restriction growth with no lags to the specification. As seen in columns (2), (4), (6) and (8) of Table 3, results do not change for lagged restriction growth, the current year's restriction growth has no statistically significant relationship with productivity growth. This implies that specifications with the lagged restriction growth provide a better fit. We also run regressions that lag the restriction variable by two years, but this specification does not fit the data as well as the one-year lag.

As Table 2 shows, the average annual growth rate of crop yield is 2 percent, so a 0.28 percentage-point relationship between regulation growth and yield growth might not be so small. However, note that the R-squared in these regressions is low, which suggests that variables in the regression explain only a small portion of the variation in yield growth; many other factors not included in the regressions also affect yield growth.[39]

[39] Examples include the quality of land, the quality and quantity of other inputs, and technical changes. See Chapter 1 for a discussion on drivers of productivity growth.

Table 3: Yield Growth and Total Restriction Growth

Dependent Variable: yield_growth	(1) OLS	(2) OLS	(3) OLS + Time Trend	(4) OLS + Time Trend	(5) Industry FE	(6) Industry FE	(7) Industry FE + Time Trend	(8) Industry FE + Time Trend
L.total_reg_growth	-0.2672**	-0.2598**	-0.2895**	-0.2868**	-0.2634***	-0.2563***	-0.2863***	-0.2838***
	(0.021)	(0.025)	(0.023)	(0.024)	(0.005)	(0.009)	(0.008)	(0.008)
total_reg_growth		-0.0459		-0.0812		-0.0444		-0.0792
		(0.642)		(0.502)		(0.542)		(0.290)
time			-0.1092	-0.1437			-0.0962	-0.1299
			(0.431)	(0.358)			(0.235)	(0.124)
time2			0.0020	0.0025			0.0016	0.0022
			(0.454)	(0.373)			(0.308)	(0.200)
Constant	2.3720***	2.4270***	3.5709**	4.1276*	2.3667***	2.4202***	3.5044***	4.0494***
	(0.000)	(0.000)	(0.049)	(0.065)	(0.000)	(0.000)	(0.001)	(0.000)
Observations	928	928	928	928	928	928	928	928
R-squared	0.006	0.006	0.006	0.007	0.006	0.006	0.006	0.006
Prob > F	0.0213	0.0674	0.1270	0.2110	0.0050	0.0060	0.0240	0.0302
Number of industries					25	25	25	25

Robust p-value in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

B. Regulatory form

To examine whether the relationship between regulatory restriction growth and yield growth varies by the form of regulation, we run the baseline specification (2) for all second-tier and select third-tier regulatory forms as defined in the Taxonomy of Regulatory Forms in Chapter 2. Because the taxonomy is intended to cover all forms of regulation, some third-tier forms are not applicable to regulations affecting crop farming industries, such as rate of return, certificate of need, and taxes and fees. As a result, we have few or no CFR parts that take these forms in the sample. Therefore, we only focus on forms with a relatively high frequency (see Appendix B).

1. Second-tier forms

Second-tier regulatory forms include price, quantity, entry-and-exit, service quality, command-and-control, market-based, information-based, transfer, and administrative regulations. Chapter 2 specifies the definitions and examples of each form. Similar to total restriction growth, we run regressions in OLS, OLS with time trend, industry FE, and industry FE with time trend on restriction growth for each regulatory form. Table 4 presents the results for all second-tier forms from the industry FE with time trend specification (see all results in Appendix C-1). The results suggest that the relationship between regulatory restriction growth and yield growth differs by regulatory form. In particular, growth in restrictions associated with command-and-control, entry-and-exit, and administrative regulations have a statistically significant negative relationship with yield growth, while growth in restrictions associated with transfer and information-based regulations has a statistically significant positive relationship with yield growth. The results are consistent in OLS and other specifications.

Column (5) of Table 4 shows that a one percentage-point increase in the growth of command-and-control regulatory restrictions is associated with approximately 0.3 percentage-point decrease in yield growth. Also, column (3) shows that a one percentage-point increase in the growth of entry-and-exit regulatory restrictions is associated with approximately 0.14 percentage-point decrease in yield growth. Although the coefficient on entry-and-exit restrictions is only marginally significant (p-value = 0.054) in the industry FE with time trend, it is statistically significant at the 0.05 or 0.01 level in all the other specifications. As shown in column (9), a one percentage-point increase in the growth of administrative regulatory restrictions is associated with approximately 0.13 percentage-point decrease in yield growth.

On the other hand, column (8) shows that a one percentage-point increase in the growth of restrictions for transfer regulation is associated with an approximately 0.35 percentage-point increase in yield growth. Also, column (7) indicates that a one percentage-point increase in the growth of information-based regulatory restrictions is associated with an approximately 0.09 percentage-point increase in yield growth.

Table 4: Yield Growth and Restriction Growth for Second-tier Regulatory Forms (Industry FE + Time Trend Model)

Dependent Variable: yield_growth	(1) **Price**	(2) **Quantity**	(3) **Entry-and-Exit**	(4) **Service Quality**	(5) **Command-and-Control**	(6) **Market-based**	(7) **Information-based**	(8) **Transfer**	(9) **Administrative**
L.regform_growth	0.0084	0.0098	-0.1363*	-0.0331	-0.3041***	0.0124	0.0950**	0.3490**	-0.1330***
	(0.395)	(0.632)	(0.054)	(0.425)	(0.005)	(0.828)	(0.012)	(0.021)	(0.006)
L.total_reg_growth	-0.2981***	-0.2962**	-0.1941**	-0.2875***	0.0809	-0.2978***	-0.2981***	-0.6845***	-0.2467**
	(0.006)	(0.012)	(0.014)	(0.007)	(0.406)	(0.009)	(0.006)	(0.007)	(0.010)
time	-0.0886	-0.0916	-0.0603	-0.0947	-0.1360	-0.0833	-0.1822*	-0.1170	-0.0815
	(0.284)	(0.232)	(0.445)	(0.244)	(0.107)	(0.409)	(0.087)	(0.150)	(0.300)
time2	0.0014	0.0016	0.0008	0.0016	0.0021	0.0015	0.0033	0.0018	0.0012
	(0.418)	(0.309)	(0.622)	(0.336)	(0.188)	(0.411)	(0.108)	(0.259)	(0.454)
Constant	3.5067***	3.4778***	3.6102***	3.5784***	4.4921***	3.2645**	4.0987***	4.4914***	3.6136***
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.032)	(0.001)	(0.000)	(0.000)
Observations	918	928	928	928	928	928	928	928	928
R-squared	0.007	0.006	0.010	0.007	0.015	0.006	0.013	0.017	0.012
Prob > F	0.0292	0.0376	0.0478	0.0236	0.0386	0.0362	0.0036	0.0454	0.0278
Number of industries	25	25	25	25	25	25	25	25	25

Robust p-value in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Coefficients on the other regulatory forms are not statistically significant and very close to zero, so we cannot draw any conclusions on these forms.

Comparing the relative magnitude of the coefficients, a preliminary finding is that the negative relationship between total regulatory restriction growth and yield growth is mostly attributed to the growth in command-and-control regulation, entry-and-exit regulation, and administrative regulation. However, we also notice that the standard deviations of the restriction growth for different forms are very different, ranging from 6.25 to 48.51 (Table 2). So, a one percentage-point increase in a form may not be equivalent to a one percentage-point increase in another form, which would make the coefficients not directly comparable. Therefore, we also compare the R-squared values across different forms to examine which forms explain a larger proportion of the variation in yield growth. This is possible because in these specifications, everything is equal except the particular form of interest.

As shown in Table 5, although the R-squared values are generally small, they generate a consistent ranking of forms over all specifications. Among the forms that are negatively associated with yield growth, growth in command-and-control, administrative, and entry-and-exit regulations explains a larger proportion of the variation in yield growth than the other forms. Growth in transfer, and information-based regulations has a stronger association with yield growth in the positive direction.

Table 5: A comparison of Robust R-squared

	Sign of the Coefficient	R-squared			
		OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
Transfer	Positive	0.016	0.017	0.016	0.017
Command-and-Control	Negative	0.014	0.015	0.014	0.015
Information-based	Positive	0.012	0.013	0.012	0.013
Administrative	Negative	0.011	0.012	0.012	0.012
Entry-and-Exit	Negative	0.011	0.011	0.01	0.01
Price	Positive	0.007	0.007	0.007	0.007
Service Quality	Negative	0.007	0.007	0.007	0.007
Market-based	Positive	0.006	0.006	0.006	0.006
Quantity	Positive	0.006	0.006	0.006	0.006

The R-squared values are from regression results in Appendix C-1. The OLS specification corresponds to the second OLS specification in Appendix C-1, which controls for total restriction growth.

2. Third-tier forms

Given our results on second-tier forms, we further analyze whether specific regulatory forms contribute more to the negative or positive relationship between the broader forms and yield. Here we focus on all the third-tier forms under command-and-control regulation, including monitoring, reporting, and verification (MRV) requirements, performance standards, permitting, pre-market notice and approval, means-based standards, and prohibitions, as well as select third-tier forms under entry-and-exit

regulation, including licensing and certification. We focus on these forms for two reasons. First, these forms are more applicable to regulations affecting the crop production industries; in other words, they all have a higher frequency in the sample (Appendix B). Second, the forms under command-and-control regulation and entry-and-exit regulation are more different in nature, so a comparison of them is of more general research interest. For example, scholars often compare performance-based regulation with means-based regulation.[40] In contrast, forms under transfer regulation, including monetary transfer, technology transfer, user fees, and knowledge sharing are more similar in terms of regulatory objectives and the level of flexibility given to regulated entities.

As a result, we find that growth in certification requirements has a larger and statistically significant, negative relationship with yield growth, compared to licensing requirements. The coefficient in column (2) indicates that a one percentage-point increase in the growth of regulatory restrictions for certification is associated with approximately 0.11 percentage-point decrease in yield growth. Under command-and-control regulation, growth in MRV requirements has the largest and statistically significant negative relationship with yield growth. As seen in Column (3), a one percentage-point increase in the growth of MRV regulatory restrictions is associated with approximately 0.23 percentage-point decrease in yield growth. Similar to the second-tier form results, the signs and significance of the coefficients are consistent in OLS and other specifications (see all results in Appendix C-2).

[40] Christopher Carrigan and Cary Coglianese, "The Politics of Regulation: From New Institutionalism to New Governance," *Annual Review of Political Science* 14, no. 1 (2011): 107-129; Cary Coglianese, "The Limits of Performance-Based Regulation," *University of Michigan Journal of Law Reform* 50, no. 3 (2017): 525-563.

Table 6: Yield Growth and Restriction Growth for Third-tier Regulatory Forms (Industry FE + Time Trend Model)

Dependent Variable: yield_growth	(1) **Licensing**	(2) **Certification**	(3) **MRV**	(4) **Performance standards**	(5) **Permitting**	(6) **Pre-market notice & approval**	(7) **Means-based standards**	(8) **Prohibitions**
L.regform_growth	-0.0554	-0.1076**	-0.2272***	-0.0438	-0.0138	-0.0015	-0.0145	-0.0005
	(0.151)	(0.019)	(0.003)	(0.196)	(0.936)	(0.873)	(0.139)	(0.146)
L.total_reg_growth	-0.2732***	-0.2309**	-0.1558*	-0.1567	-0.2777**	-0.2523**	-0.2876***	-0.2814***
	(0.008)	(0.015)	(0.079)	(0.169)	(0.036)	(0.018)	(0.007)	(0.010)
time	-0.1089	-0.0198	-0.0850	-0.1113	-0.0943	-0.1733**	-0.0915	-0.0888
	(0.181)	(0.819)	(0.290)	(0.182)	(0.268)	(0.033)	(0.253)	(0.282)
time2	0.0018	0.0002	0.0015	0.0018	0.0016	0.0029*	0.0015	0.0015
	(0.274)	(0.929)	(0.345)	(0.273)	(0.374)	(0.078)	(0.353)	(0.374)
Constant	3.9081***	2.9395***	3.5911***	3.8010***	3.5445***	4.5268***	3.6766***	3.5376***
	(0.000)	(0.003)	(0.000)	(0.000)	(0.002)	(0.000)	(0.001)	(0.001)
Observations	928	928	928	928	928	891	928	923
R-squared	0.007	0.011	0.011	0.008	0.006	0.005	0.008	0.006
Prob > F	0.0501	0.0415	0.0093	0.0528	0.0319	0.0597	0.0208	0.0294
Number of industries	25	25	25	25	25	25	25	25

Robust p-value in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

C. Controlling for disaster risk

Controlling for disaster risk, the relationships found above all become stronger. As shown in column (1) of Table 7, the coefficient on total restriction growth is still statistically significant at the 0.01 level, and the magnitude increases from 0.28 to 0.37 in the negative direction after controlling for disaster risk.

The coefficients on restriction growth for individual regulatory forms remain statistically significant and mostly become larger in terms of the magnitude. Table 7 shows that, holding the level of disaster risk constant, the coefficient on growth in command-and-control regulatory restrictions is still statistically significant at the 0.01 level, and the magnitude increases from 0.30 to 0.41 in the negative direction. The coefficient on entry-and-exit restriction growth becomes statistically significant at the 0.05 level (which was only statistically significant at the 0.1 level before), and the magnitude increases from 0.14 to 0.18 in the negative direction. Further, a one percentage-point increase in the growth of transfer restrictions is associated with 0.51 percentage-point increase in yield growth after controlling for disaster risk, compared to 0.35 before.

The negative relationship between growth in certification and MRV restrictions and yield growth is also reinforced in terms of both significance and magnitude when controlling for disaster risk (Table 8). The coefficient on certification restriction growth becomes statistically significant at the 0.01 level (compared to 0.05 level before) and increases from 0.11 to 0.15 in the negative direction. The negative relationship between MRV restriction growth and yield growth also increases from 0.23 to 0.33. The most outstanding change is on the relationship between growth in permitting and yield growth. The coefficient on permitting restriction growth was close to zero and not statistically significant before but becomes -0.18 and statistically significant at the 0.01 level after controlling for disaster risk. The relationship between growth in prohibitions and yield growth also becomes statistically significant, but the magnitude is still very small (-0.0006).

Table 7: Yield Growth and Restriction Growth, Controlling for Disaster (Industry FE + Time Trend Model)

Dependent Variable: yield_growth	(1) **Total**	(2) **Price**	(3) **Quantity**	(4) **Entry-and-Exit**	(5) **Service Quality**	(6) **Command-and-Control**	(7) **Market-based**	(8) **Information-based**	(9) **Transfer**	(10) **Administrative**
L.regform_growth		0.0109	0.0025	-0.1753**	0.0119	-0.4081***	-0.0449	0.0931**	0.5073***	-0.1319**
		(0.413)	(0.916)	(0.024)	(0.679)	(0.002)	(0.117)	(0.034)	(0.001)	(0.045)
L.total_reg_growth	-0.3668***	-0.3783***	-0.3695**	-0.2490***	-0.3667***	0.1261	-0.3248**	-0.3772***	-0.9384***	-0.3263***
	(0.006)	(0.004)	(0.012)	(0.008)	(0.006)	(0.318)	(0.011)	(0.005)	(0.001)	(0.005)
disaster_state	-0.0320***	-0.0303***	-0.0320***	-0.0270***	-0.0319***	-0.0282***	-0.0322***	-0.0301***	-0.0228**	-0.0314***
	(0.001)	(0.001)	(0.001)	(0.007)	(0.001)	(0.002)	(0.001)	(0.002)	(0.014)	(0.001)
Time	-0.0493	-0.0447	-0.0480	-0.0148	-0.0500	-0.1181	-0.0969	-0.1340	-0.1037	-0.0240
	(0.641)	(0.678)	(0.632)	(0.884)	(0.636)	(0.270)	(0.429)	(0.328)	(0.321)	(0.815)
time2	0.0012	0.0010	0.0012	0.0003	0.0013	0.0021	0.0019	0.0028	0.0017	0.0006
	(0.562)	(0.669)	(0.555)	(0.901)	(0.552)	(0.324)	(0.426)	(0.285)	(0.405)	(0.768)
Constant	3.7282***	3.7205***	3.7204***	3.9422***	3.7009***	5.1954***	4.6082***	4.2384***	5.2905***	3.6541***
	(0.003)	(0.004)	(0.003)	(0.002)	(0.003)	(0.000)	(0.005)	(0.005)	(0.001)	(0.003)
Observations	685	685	685	685	685	685	685	685	685	685
R-squared	0.022	0.024	0.022	0.032	0.022	0.044	0.024	0.032	0.051	0.029
Prob > F	0.0002	0.0004	0.0002	0.0003	0.0003	0.0004	0.0003	0.0002	0.0006	0.0002
Number of industries	19	19	19	19	19	19	19	19	19	19

Robust p-value in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Yield Growth and Restriction Growth, Controlling for Disaster (Industry FE + Time Trend Model)

Dependent Variable: yield_growth	(1) **Licensing**	(2) **Certification**	(3) **MRV**	(4) **Performance standards**	(5) **Permitting**	(6) **Pre-market notice & approval**	(7) **Means-based standards**	(8) **Prohibitions**
L.regform_growth	-0.0586	-0.1517***	-0.3331***	-0.0465	-0.1827***	-0.0030	-0.0098	-0.0006**
	(0.166)	(0.002)	(0.000)	(0.272)	(0.006)	(0.775)	(0.141)	(0.043)
L.total_reg_growth	-0.3520***	-0.2944**	-0.1730	-0.2336*	-0.2438**	-0.3420**	-0.3636***	-0.3693***
	(0.006)	(0.011)	(0.119)	(0.097)	(0.020)	(0.010)	(0.006)	(0.005)
disaster_state	-0.0285***	-0.0349***	-0.0340***	-0.0317***	-0.0296***	-0.0304***	-0.0310***	-0.0324***
	(0.007)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)
time	-0.0699	0.0600	-0.0341	-0.0681	-0.0320	-0.1060	-0.0471	-0.0532
	(0.512)	(0.591)	(0.743)	(0.524)	(0.746)	(0.294)	(0.653)	(0.612)
time2	0.0014	-0.0009	0.0011	0.0014	0.0006	0.0021	0.0011	0.0012
	(0.503)	(0.698)	(0.609)	(0.506)	(0.766)	(0.308)	(0.591)	(0.561)
Constant	4.1924***	3.0000**	3.9124***	4.0742***	4.3378***	4.4692***	3.8174***	3.8975***
	(0.003)	(0.013)	(0.002)	(0.002)	(0.002)	(0.000)	(0.003)	(0.002)
Observations	685	685	685	685	685	659	685	685
R-squared	0.024	0.036	0.036	0.025	0.032	0.019	0.023	0.023
Prob > F	0.0003	0.0003	0.0001	0.0002	0.0004	0.0001	0.0003	0.0000
Number of industries	19	19	19	19	19	19	19	19

Robust p-value in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

V. Robustness Checks

We perform various robustness checks to assess the sensitivity of the baseline results. Appendix D reports the results.

(1) Using an alternative approach to distribute restrictive word counts by form

In the baseline analysis, we distribute the restrictive word count in a CFR part to regulatory forms by equally dividing the word count by the number of forms the part takes. However, we establish this assumption due to technical difficulty rather than theoretical foundation, and we acknowledge that this approach might over-count certain regulatory forms while under-counting others. To check the sensitivity of the results to this assumption, we use an alternative approach to construct the *regform_growth* variables by assuming all the restrictive word count in a CFR part is associated with all the forms it takes. That is, if a CFR part has X number of restrictive words and Y number of regulatory forms, the word count distributed to each of the Y form will be X.

Columns (1) in Appendix D-1 and D-2 contain the results from the industry FE and time trend specification, controlling for disaster risk. The results reveal similar relationships between yield growth and restriction growth for second-tier regulatory forms. On the third-tier forms, the coefficients on certification, MRV, permitting, and prohibition also reveal the same signs and similar magnitude to the baseline results. In addition, the coefficient on means-based regulation become statistically significant, although the magnitude is small (around 0.02).

(2) Adjusting restrictions for MRV

During our coding process as described in Chapter 2, we notice that many regulations contain MRV requirements. Unlike other forms of regulation, MRV requirements are often used as a secondary regulatory form that attempts to ensure the compliance with another form of regulation. Due to our word distribution strategy, it is likely that the restriction growth for MRV is picking up the effects of other forms of regulation. If that is the case, the relationship between MRV restriction growth and yield growth may be over-estimated. To test this, we remove MRV as a form from the coding results for CFR parts unless it is a stand-alone form for a part, and then use the same approach to distribute word counts and calculate restriction growth. For example, if a CFR part is coded as means-based standards and MRV requirements, we remove MRV and consider means-based standards as the only form for the part. Although this adjustment would likely under-estimate the relationship between MRV and yield growth, it is important to see whether this changes the coefficients on other regulatory forms.

As observed in column (2) of Appendix D, adjusting MRV restrictions diminishes the magnitude of coefficients on MRV as well as the command-and-control regulation it accompanies, but has little impact on the other forms of regulation. The results imply that counting MRV as a major regulatory form like others does not obscure the association between other forms and yield growth. In other words, we can likely attribute explanatory power to the baseline results for MRV.

(3) Using total word counts instead of restrictive word counts

Since some forms of regulation generally use more restrictive words than others (e.g., command-and-control regulation compared to market-based regulation), the form itself might be correlated with the restrictive word count. Hence, in this test, we construct the *total_reg_growth* and *regform_growth* variables by using total word counts rather than restrictive word counts in CFR parts.[41] The calculation follows the same approach as restrictive word counts in the baseline analysis.

As shown in columns (3) of Appendix D, using total word counts does not affect the relationships found in the baseline analysis, except for information-based regulation, whose coefficient is no longer statistically significant. Further, the results show a statistically significant coefficient on performance standards, indicating that a one percentage-point increase in the restriction growth for performance standards is associated with approximately 0.15 percentage-point decrease in yield growth.

(4) Controlling for county-level disaster risk

In the baseline analysis, we use state-level area planted data to assess a commodity's exposure to natural disasters. In this test, we use county-level area planted data to construct the disaster variable. County-level data should capture a commodity's disaster risk in a more precise way, but the data are only available for field crops, so it reduces the number of industries in the econometric analysis.

Results are in column (4) of Appendix D, showing that controlling for county-level disaster risk reinforces most of the relationships (i.e., keeping the statistical significance and increasing the magnitude of the coefficients). A difference it makes is that restriction growth for market-based regulation shows a significantly negative relationship with yield growth (with a magnitude of 0.07). The negative relationship on performance standards also becomes statistically significant.

(5) Controlling for other regulation growth instead of total regulation growth

In the baseline specifications, we control for total restriction growth when looking at individual regulatory forms, for the sake of direct comparisons of coefficients across forms. Since the purpose of adding the control variable is to hold constant the effects of other regulatory forms on yield growth, it is more intuitive to use restriction growth for all regulations except the regulatory form of interest (i.e., the independent variable of interest) instead of total restriction growth.

As seen in column (5) of Appendix D, all the relationships found in the baseline analysis hold in this test. Although the coefficients on market-based regulation and means-based standards from the industry FE and time trend specification are marginally significant, they are not robust in other specifications

[41] However, Ellig and McLaughlin (2016) find that restrictions yield a better fit than word counts when examining the relationship between rail safety regulations and railroad safety outcome measures. *See* Jerry Ellig and Patrick McLaughlin, "The Regulatory Determinants of Railroad Safety," *Review of Industrial Organization* 49, no. 2 (2016): 371-398.

such as OLS and industry FE only. However, similar to the previous tests, the relationship between restriction growth for performance standards and yield growth becomes significantly negative in all specifications.

(6) Using expert judgment to exclude irrelevant CFR parts

As discussed in Chapter 3, we rely on RegData's estimates of industry relevance to select the sample of regulations affecting agricultural activities. We notice that, among the 661 CFR parts that are estimated to be relevant to at least one crop, some parts do not seem to have a clear linkage to any agriculture activity. For example, 5 CFR 792 (Federal Employees' Health, Counseling, and Work/Life Programs) and 10 CFR 11 (Criteria and Procedures for Determining Eligibility for Access to or Control over Special Nuclear Material) can hardly affect crop production. Therefore, to examine whether our estimates are biased by these "irrelevant" regulations, we conduct a robustness check by using only a subset of the sample regulations that are theoretically likely to affect crop production. We select this subset relying on expert judgement from USDA.[42] According to the expert judgement, there are 196 of the 661 CFR parts that are unlikely to be related to agriculture, so the subset sample includes 465 CFR parts.

Using the same regression models as the baseline analysis, the results using the 465 parts are shown in column (6) of Appendix D. The results are generally consistent with the baseline results. Growth in entry-and-exit and command-and-control regulatory restrictions still shows a statistically significant negative relationship with yield growth, and the magnitude is even larger than the results using 661 parts. The same is true for the positive association between growth in information-based and transfer regulations and yield growth. With regard to the third-tier regulatory forms, growth in regulatory restrictions associated with certification and MRV still has a statistically significant, and larger, relationship with yield growth. The negative coefficient on licensing becomes marginally significant. An exception is prohibition. The results show a statistically significant, positive association between growth in regulatory restrictions related to prohibition and yield growth. This is different from the baseline results and results from all the other robustness checks, where prohibition only has a close-to-zero coefficient; this result also conflicts with theory. An explanation may be that eliminating the irrelevant parts by expert judgement reduces the sample size, leaving only seven CFR parts that take a form of prohibition in the sample. The small sample size reduces the statistical power of the analysis, making the statistically significant result not reflect a true effect.[43]

To summarize the results of the robustness checks, the relationships between yield growth and restriction growth for command-and-control, entry-and-exit, administrative, transfer, and information-based regulations found in the baseline analysis are robust. Changing different assumptions and control

[42] A team of agricultural experts in USDA went through the 661 CFR parts and marked those that are unlikely to be related to agriculture. The subset sample excludes these marked parts from the 661 parts.

[43] Katherine S. Button, John P. A. Ioannidis, Claire Mokrysz, Brian A. Nosek, Jonathan Flint, Emma S. J. Robinson, and Marcus R. Munafò, "Power Failure: Why Small Sample Size Undermines the Reliability of Neuroscience," *Nature Reviews Neuroscience* 14 (May 2013): 365-376.

variables in the analysis changes the magnitude of some coefficients but does not change the sign or significance. In addition, three of the five tests above suggest a significantly negative association between restriction growth for performance standards and yield growth.

VI. Discussion and Conclusion

In this study, we analyze the relationship between growth in regulations that take different forms and growth in land productivity. We use growth in crop yield as a measure of land productivity growth for 25 agricultural industries from 1971 to 2017. To quantify regulation, we use the count of restrictive words in CFR from RegData and combine it with our classification of regulatory forms. We aggregate restrictive word counts of each individual regulation into total restrictions for each industry based on the industry relevance estimates in RegData. In the econometric model, we add industry fixed effects and time trend variables to control for certain unobserved factors affecting yield growth. In addition, we control for the disaster risk to which each industry was exposed in each year. We also conduct a series of robustness checks to test the sensitivity of the baseline results. In this section, we summarize our findings and discuss the implications and limitations of the results.

A. Implications

The econometric analysis has at least two implications. First, it suggests that growth in total regulatory restrictions has a negative relationship with growth in crop yield. Second, the relationship differs depending on regulatory forms. If increasing farm productivity is a goal of regulatory reform, decision-makers can most effectively accomplish this goal by focusing on the forms of regulation shown to have negative effects on productivity. And regulatory reform could potentially be a "win-win," if decision-makers find ways to accomplish important public goals by replacing forms of regulation that diminish productivity with forms that have no effect or increase productivity.

With respect to specific regulatory forms, we find that growth in command-and-control regulation has the largest negative relationship with yield growth. Command-and-control regulation is a traditional form of regulation, commonly used in regulating environmental and safety issues. It typically prescribes actions, technologies, or targets that regulated entities must implement or comply with.[44] Command-and-control regulation has been frequently viewed as costly or inflexible relative to market-based or information-based regulation.[45] Our finding is consistent with this theoretical view.

Under command-and-control regulation, growth in MRV requirements and permitting has the largest negative relationship with yield growth. MRV requirements are inherent in many agriculture-related regulations,[46] and our empirical finding suggests that they might impose a substantial burden on

[44] Christopher Carrigan and Elise Harrington, "Choices in Regulatory Program Design and Enforcement," Penn Program on Regulation, June 2015, https://www.law.upenn.edu/live/files/4706-carriganharrington-ppr-researchpaper062015pdf.

[45] Carrigan and Coglianese 2011.

[46] See Chapter 3 for the frequency of each regulatory form.

productivity growth. Although scholars have often argued that performance standards bring more flexibility than means-based standards since regulated entities are allowed to adopt the most cost-effective technology to achieve required targets,[47] we do not find empirical evidence for that in our analysis.

As a form of economic regulation, entry-and-exit regulation is extremely costly for business start-ups,[48] and our findings suggest that it might also have a negative impact on yield growth. Under entry-and-exit regulation, growth in certification requirements has a larger negative relationship with yield growth than licensing. This might suggest that licensing is a more flexible regulatory form than certification. The findings are consistent with our definitions of the two forms, in which certification requires inspection and approval every time a relevant operation is conducted, while licensing is granted to a person who can conduct relevant operations at any authorized location at any time during the authorized period.

Further, growth in transfer regulation is associated with a large positive relationship with yield growth. Transfer regulation includes monetary transfer from government to farmers, technology transfer from government to farmers, user fees required for government services, and knowledge sharing between government and farmers. They are all intended to support farmers' incomes or farming activities, and thus can stimulate productivity growth. However, one factor that might introduce endogeneity is that certain disaster payment and crop insurance programs are a response to a low yield in a previous growing season. Hence, such programs are almost always associated with higher yields in subsequent years after the disaster has passed. For that reason, the positive relationship between growth in transfer regulation and yield growth is likely to be overestimated. Nonetheless, it does not mean that the positive estimates are completely meaningless. Controlling for disaster risk in the model has at least reduced part of the endogeneity problem, although FEMA disaster declarations may not capture all the disastrous events affecting crops or other factors that reduced yields and triggered a transfer program. Also, disaster payment and crop insurance programs in response to low yields are only one type of transfer regulations; other types of monetary transfers, technology transfers, and knowledge sharing may actually have productivity enhancing effects.

Growth in information-based regulation has a small positive association with yield growth. One explanation may be that requirements such as hazard warning and contingency planning improve workplace safety and help regulated entities recognize the risks inherent in their operations, eventually increasing productivity. Scholars sometimes refer to this approach as management-based regulation. For example, Carrigan and Harrington argue that "The fact that management-based regulation requires an

[47] Carrigan and Coglianese 2011; Michael E. Porter and Claas Van Der Linde, "Toward a New Conception of the Environment-Competitiveness Relationship," *Journal of Economic Perspectives* 9, no. 4 (Fall 1995): 97-118.

[48] Simeon Djankov, Rafael La Porta, Florencio Lopez-de-Silanes, and Andrei Shleifer, "The Regulation of Entry," National Bureau of Economic Research, Working Paper 7892, September 2000, accessed October 16, 2018, doi: 10.3386/w7892.

examination of certain risks or problems may encourage firms to leverage this investment and identify opportunities for additional modifications to operations" (p. 19).[49]

B. Limitations and Caveats

The interpretation of the results is subject to certain limitations and caveats. First, the extent to which restrictive word counts can accurately measure the actual restrictiveness of regulation is still not determined. It is possible that certain stringent regulations use few restrictive words. Hence, growth in restrictive word counts might not be sufficiently equivalent to growth in the amount of regulation or regulatory burden. However, as discussed in section I, this measure addresses many important concerns with previous measures, captures an important aspect of cumulative changes in regulation, and is arguably an improvement even if it is not a perfect measure. In addition, the robustness check of using total word counts also rules out the possibility that the results are confounded by the correlation between the use of restrictive words and regulatory forms.

Second, as discussed in Chapter 3, although the machine learning techniques used in RegData have enabled processing of a large amount of regulatory text, their accuracy needs to be further verified and improved. Because of our reliance on RegData estimates to select the regulation sample, we might have included some regulations that are not applicable to the crop production industries or omitted some important ones in our sample. This could potentially introduce measurement errors in growth of regulatory restrictions, which might lead to biases on our coefficient estimates. Nevertheless, there is no evidence that these errors are systematically correlated with the true value of growth in regulatory restrictions. Hence, the measurement errors tend to increase the statistical noise that leads to attenuation bias in our analysis where the coefficient would skew toward zero.[50] In other words, the statistically significant association between growth in regulatory forms and yield growth is actually understated—rather than overstated—in the regression models. The robustness check using a subset of the sample identified by expert judgement also bolsters this point. Yet, the interpretation of the results that are not statistically significant needs more careful treatment due to the possible attenuation bias; that is, the regulatory forms that do not have a statistically significant coefficient in the regressions may actually have an association with yield growth. Future research can further improve the analysis by selecting a more precise sample of relevant regulations to each industry based on improved estimates of industry relevance.

Third, as shown in Appendix B, price, service quality, and quantity regulations are not as prevalent as the other forms in our sample. The number of relevant CFR parts that take any of these forms is less than or equal to 20 in this empirical analysis, which might be a too small sample for meaningful statistical analysis. Therefore, the fact that we do not find any statistically significant results for these forms does not necessarily mean that they do not have any impact on yield growth. Future research can expand the

[49] See more detailed discussion on management-based regulation in Coglianese and Lazer 2003.

[50] Sholom Wacholder, "When Measurement Errors Correlate with Truth: Surprising Effects of Nondifferential Misclassification," *Epidemiology* 6, no. 2 (March 1995): 157-161.

sample to include more regulations that take these forms to understand their relationships with yield growth.

Fourth, the R-squared values in the regressions are small, which suggests that the variation in regulatory restriction growth only explains a limited portion of the variation in yield growth. There are many other factors that affect land productivity growth such as weather conditions (not disastrous events but rainfall amounts, rainfall timing, temperature, etc.), the quality of land, the quantity and quality of other inputs, and technical change. Therefore, the results found in this analysis do not have much predictive power in predicting how yield growth would change given a change in regulatory restrictions. After all, the objective of this analysis is not to build a forecasting model for yield growth, but to present some preliminary empirical evidence on the relationship between growth in different forms of regulation and yield growth. The estimates in our analysis would only be biased by omitting variables if the omitted explanatory variables are simultaneously correlated with both regulatory form growth and yield growth and none of the factors seems to have such attribute.

Finally, the relationship found here indicates correlation rather than causation. This study provides preliminary results suggesting the possibility that different forms of regulation can affect productivity growth in different ways. Further research is required to explore what causal relationship exists between regulation and productivity.

Future research can further refine the analysis by addressing these limitations. Moreover, as discussed above, TFP growth is typically a better measure of productive efficiency than single factor productivity. Future studies can develop measures of agricultural TFP growth at the industry level and adopt more sophisticated macroeconomic models to investigate the impact of regulation on economic growth in the agriculture sector. Finally, since the Taxonomy of Regulatory Forms enables classification of any regulation, similar analysis can be extended to sectors other than agriculture or other economic outcomes such as innovation, output growth, and employment. Overall, research incorporating different regulatory forms as an explanatory variable into well-established macroeconomic models may add great value to understanding economic growth.

Appendix A: Industry-Commodity Crosswalk

NAICS 4-digit	NAICS 6-digit	NAICS title	Commodity Equivalent
1111	111110	Soybean Farming	Soybeans
	111120	Oilseed (except Soybean) Farming	Canola, flaxseed, rapeseed, safflower, sunflower
	111130	Dry Pea and Bean Farming	Beans (field crop), peas (field crop), lentils
	111140	Wheat Farming	Wheat
	111150	Corn Farming	Corn
	111160	Rice Farming	Rice
	111199	All Other Grain Farming	Barley, oats, rye, sorghum
1112	111211	Potato Farming	Potatoes
	111219	Other Vegetable (except Potato) and Melon Farming	Artichokes, asparagus, beans (vegetable), broccoli, cabbage, carrots, cauliflower, celery, cucumbers, garlic, lettuce, melons, onions, peas (vegetable), peppers, pumpkins, spinach, squash, sweet corn, sweet potatoes, tomatoes, beets, Brussel sprouts, eggplant, escarole & endive, ginger root, greens, okra, radishes
1113	111310	Orange Groves	Oranges
	111320	Citrus (except Orange) Groves	Grapefruit, lemons, limes, tangelos, tangerines, k-early citrus, temples
	111331	Apple Orchards	Apples
	111332	Grape Vineyards	Grapes
	111333	Strawberry Farming	Strawberries
	111334	Berry (except Strawberry) Farming	Blackberries, blueberries, boysenberries, cranberries, raspberries, caneberries, loganberries
	111335	Tree Nut Farming	Almonds, hazelnuts, macadamias, pecans, pistachios, walnuts
	111339	Other Noncitrus Fruit Farming	Apricots, avocados, bananas, cherries, coffee, dates, figs, kiwifruit, nectarines, olives, papayas, peaches, pears, plums, prunes, pineapples, guavas,
1114	111411	Mushroom Production	Mushrooms
1119	111910	Tobacco Farming	Tobacco
	111920	Cotton Farming	Cotton
	111930	Sugarcane Farming	Sugarcane
	111940	Hay Farming	Hay, haylage
	111991	Sugar Beet Farming	Sugarbeets
	111992	Peanut Farming	Peanuts
	111998	All Other Miscellaneous Crop Farming	Hops, mint
Total # of 6-digit NAICS industries: 25			

Appendix B: Frequency of Regulatory Forms

Second-tier Form	Frequency	Third-tier Form	Frequency
Price	3	Benchmarking (or yardstick regulation)	2
		Price ceiling/floor	1
		Rate of return	0
		Revenue cap	0
Quantity	18	Obligation to serve	1
		Portfolio standards	0
		Rationing and quotas	17
Entry & Exit	81	Certificate of need	0
		Licensing	43
		Rivalrous/exclusive permits	1
		Certification	35
		Antitrust	2
Service Quality	17	Product Identity or Grades	17
		Quality levels	0
Command-and-Control	423	Monitoring, reporting and verification (MRV) requirement	176
		Performance standards	103
		Permitting	83
		Pre-market notice and approval	12
		Means-based standards	38
		Prohibitions	11
Market-based	68	Bonds	23
		Marketable permits	0
		Subsidies	45
		Taxes and fees	0
Information-based	58	Hazard warnings	6
		Labeling	21
		Other disclosure	17
		Contingency planning	14
Transfer	283	Monetary transfer	186
		Technology transfer	13
		User fees	68
		Knowledge transfer	16
Administrative	104	Definitions	7
		Government action	72
		Organizational	25
Total instances of regulatory forms: 1,059			

The sample includes 661 CFR parts. Each part can have up to five regulatory forms. They total sum up to 1,059 instances of regulatory forms. This table shows the frequency of each form in the sample. A frequency of one means that one CFR part in the sample contains that form.

Appendix C: Complete Baseline Results

Appendix C-1: Yield Growth and Restriction Growth for Second-tier Regulatory Forms (All Results)

Dependent Variable: yield_growth	Price Regulation					Quantity Regulation				
	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
L.regform_growth	0.0074	0.0082	0.0084	0.0079	0.0084	-0.0084	0.0140	0.0122	0.0118	0.0098
	(0.480)	(0.433)	(0.429)	(0.393)	(0.395)	(0.718)	(0.578)	(0.625)	(0.572)	(0.632)
L.total_reg_growth		-0.2755**	-0.3012**	-0.2709***	-0.2981***		-0.2840**	-0.3018**	-0.2774**	-0.2962**
		(0.018)	(0.019)	(0.004)	(0.006)		(0.023)	(0.024)	(0.010)	(0.012)
time			-0.1025		-0.0886			-0.1031		-0.0916
			(0.461)		(0.284)			(0.458)		(0.232)
time2			0.0017		0.0014			0.0019		0.0016
			(0.511)		(0.418)			(0.475)		(0.309)
Constant	1.9504***	2.3223***	3.5560**	2.3189***	3.5067***	1.9799***	2.4385***	3.5381*	2.4225***	3.4778***
	(0.000)	(0.000)	(0.050)	(0.000)	(0.001)	(0.000)	(0.000)	(0.050)	(0.000)	(0.000)
Observations	918	918	918	918	918	928	928	928	928	928
R-squared	0.001	0.007	0.007	0.007	0.007	0.000	0.006	0.006	0.006	0.006
Prob > F	0.4800	0.0499	0.1800	0.0111	0.0292	0.7180	0.0693	0.2210	0.0115	0.0376
Number of industries				25	25				25	25

Dependent Variable: yield_growth	Entry-and-Exit Regulation					Service Quality Regulation				
	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
L.regform_growth	-0.1735***	-0.1404**	-0.1404**	-0.1352**	-0.1363*	-0.0329	-0.0321	-0.0322	-0.0325	-0.0331
	(0.004)	(0.017)	(0.026)	(0.047)	(0.054)	(0.331)	(0.340)	(0.346)	(0.431)	(0.425)
L.total_reg_growth		-0.1713	-0.1945	-0.1717***	-0.1941**		-0.2661**	-0.2906**	-0.2625***	-0.2875***
		(0.138)	(0.114)	(0.008)	(0.014)		(0.022)	(0.023)	(0.005)	(0.007)
time			-0.0711		-0.0603			-0.1078		-0.0947
			(0.606)		(0.445)			(0.437)		(0.244)
time2			0.0011		0.0008			0.0019		0.0016
			(0.687)		(0.622)			(0.474)		(0.336)
Constant	2.5607***	2.6897***	3.6716**	2.6734***	3.6102***	2.0370***	2.4005***	3.6445**	2.3960***	3.5784***
	(0.000)	(0.000)	(0.043)	(0.000)	(0.000)	(0.000)	(0.000)	(0.045)	(0.000)	(0.001)
Observations	928	928	928	928	928	928	928	928	928	928
R-squared	0.008	0.011	0.011	0.010	0.010	0.001	0.007	0.007	0.007	0.007
Prob > F	0.0038	0.0082	0.0411	0.0168	0.0478	0.3310	0.0331	0.1310	0.0091	0.0236
Number of industries				25	25				25	25

Robust p-value in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Coefficients on fixed effects are omitted.

Appendix C-1 (Continued)

Dependent Variable: yield_growth	Command-and-Control Regulation					Market-based Regulation				
	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
L.regform_growth	-0.2487***	-0.2954***	-0.3068***	-0.2920***	-0.3041***	-0.0141	0.0165	0.0127	0.0169	0.0124
	(0.001)	(0.004)	(0.003)	(0.006)	(0.005)	(0.759)	(0.758)	(0.813)	(0.738)	(0.828)
L.total_reg_growth		0.1056	0.0810	0.1047	0.0809		-0.2894**	-0.3012**	-0.2859**	-0.2978***
		(0.509)	(0.623)	(0.271)	(0.406)		(0.046)	(0.042)	(0.010)	(0.009)
time			-0.1480		-0.1360			-0.0960		-0.0833
			(0.291)		(0.107)			(0.494)		(0.409)
time2			0.0024		0.0021			0.0018		0.0015
			(0.353)		(0.188)			(0.507)		(0.411)
Constant	2.7190***	2.7085***	4.5499**	2.6997***	4.4921***	2.0749***	2.3216***	3.3261**	2.3148***	3.2645**
	(0.000)	(0.000)	(0.013)	(0.000)	(0.000)	(0.000)	(0.000)	(0.046)	(0.000)	(0.032)
Observations	928	928	928	928	928	928	928	928	928	928
R-squared	0.014	0.014	0.015	0.014	0.015	0.000	0.006	0.006	0.006	0.006
Prob > F	0.0005	0.0020	0.0113	0.0088	0.0386	0.7590	0.0698	0.2210	0.0153	0.0362
Number of industries				25	25				25	25

Dependent Variable: yield_growth	Information-based Regulation					Transfer Regulation				
	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
L.regform_growth	0.0855**	0.0848**	0.0937**	0.0868***	0.0950**	0.0361	0.3435**	0.3507***	0.3405**	0.3490**
	(0.027)	(0.025)	(0.023)	(0.009)	(0.012)	(0.663)	(0.011)	(0.008)	(0.021)	(0.021)
L.total_reg_growth		-0.2650**	-0.3017**	-0.2604***	-0.2981***		-0.6464***	-0.6895***	-0.6395***	-0.6845***
		(0.022)	(0.018)	(0.005)	(0.006)		(0.001)	(0.000)	(0.007)	(0.007)
time			-0.1940		-0.1822*			-0.1284		-0.1170
			(0.184)		(0.087)			(0.351)		(0.150)
time2			0.0035		0.0033			0.0021		0.0018
			(0.199)		(0.108)			(0.423)		(0.259)
Constant	1.7518***	2.1167***	4.1599**	2.1043***	4.0987***	2.0080***	2.9088***	4.5397***	2.8993***	4.4914***
	(0.000)	(0.000)	(0.023)	(0.000)	(0.001)	(0.000)	(0.000)	(0.010)	(0.000)	(0.000)
Observations	928	928	928	928	928	928	928	928	928	928
R-squared	0.006	0.012	0.013	0.012	0.013	0.000	0.016	0.017	0.016	0.017
Prob > F	0.0272	0.0028	0.0184	0.0038	0.0036	0.6630	0.0028	0.0113	0.0130	0.0454
Number of industries				25	25				25	25

Robust p-value in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Coefficients on fixed effects are omitted.

Appendix C-1 (Continued)

Dependent Variable: yield_growth	Administrative Regulation				
	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
L.regform_growth	-0.1435**	-0.1264**	-0.1273**	-0.1309***	-0.1330***
	(0.015)	(0.039)	(0.034)	(0.006)	(0.006)
L.total_reg_growth		-0.2246*	-0.2516*	-0.2194***	-0.2467**
		(0.063)	(0.057)	(0.009)	(0.010)
time			-0.0945		-0.0815
			(0.493)		(0.300)
time2			0.0015		0.0012
			(0.565)		(0.454)
Constant	2.1481***	2.4387***	3.6638**	2.4361***	3.6136***
	(0.000)	(0.000)	(0.039)	(0.000)	(0.000)
Observations	928	928	928	928	928
R-squared	0.007	0.011	0.012	0.012	0.012
Prob > F	0.0151	0.0044	0.0182	0.0073	0.0278
Number of industries				25	25

Robust p-value in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Coefficients on fixed effects are omitted.

Appendix C-2: Yield Growth and Restriction Growth for Third-tier Regulatory Forms (All Results)

Dependent Variable: yield_growth	**Licensing**					**Certification**				
	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
L.regform_growth	-0.0699	-0.0534	-0.0574	-0.0508	-0.0554	-0.1270***	-0.1123***	-0.1114***	-0.1078**	-0.1076**
	(0.125)	(0.241)	(0.248)	(0.156)	(0.151)	(0.000)	(0.002)	(0.003)	(0.014)	(0.019)
L.total_reg_growth		-0.2478**	-0.2759**	-0.2451***	-0.2732***		-0.2201*	-0.2319*	-0.2191***	-0.2309**
		(0.033)	(0.029)	(0.006)	(0.008)		(0.063)	(0.075)	(0.008)	(0.015)
time			-0.1223		-0.1089			-0.0285		-0.0198
			(0.382)		(0.181)			(0.841)		(0.819)
time2			0.0021		0.0018			0.0004		0.0002
			(0.426)		(0.274)			(0.889)		(0.929)
Constant	2.2397***	2.5237***	3.9864**	2.5114***	3.9081***	2.2702***	2.5410***	2.9832*	2.5303***	2.9395***
	(0.000)	(0.000)	(0.040)	(0.000)	(0.000)	(0.000)	(0.000)	(0.100)	(0.000)	(0.003)
Observations	928	928	928	928	928	928	928	928	928	928
R-squared	0.002	0.007	0.008	0.007	0.007	0.008	0.012	0.012	0.011	0.011
Prob > F	0.1250	0.0409	0.1400	0.0180	0.0501	0.0003	0.0003	0.0023	0.0109	0.0415
Number of industries				25	25				25	25

Dependent Variable: yield_growth	**Monitoring, Reporting & Verification**					**Performance Standards**				
	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
L.regform_growth	-0.2778***	-0.2251**	-0.2237**	-0.2292***	-0.2272***	-0.0608**	-0.0436	-0.0461	-0.0410	-0.0438
	(0.005)	(0.046)	(0.047)	(0.003)	(0.003)	(0.022)	(0.143)	(0.131)	(0.219)	(0.196)
L.total_reg_growth		-0.1431	-0.1608	-0.1371*	-0.1558*		-0.1301	-0.1534	-0.1345	-0.1567
		(0.283)	(0.265)	(0.070)	(0.079)		(0.292)	(0.234)	(0.218)	(0.169)
time			-0.0983		-0.0850			-0.1242		-0.1113
			(0.476)		(0.290)			(0.375)		(0.182)
time2			0.0018		0.0015			0.0021		0.0018
			(0.481)		(0.345)			(0.427)		(0.273)
Constant	2.5616***	2.6521***	3.6582**	2.6521***	3.5911***	2.2724***	2.3753***	3.8731**	2.3699***	3.8010***
	(0.000)	(0.000)	(0.043)	(0.000)	(0.000)	(0.000)	(0.000)	(0.036)	(0.000)	(0.000)
Observations	928	928	928	928	928	928	928	928	928	928
R-squared	0.009	0.011	0.011	0.011	0.011	0.007	0.008	0.008	0.007	0.008
Prob > F	0.0049	0.0089	0.0438	0.0039	0.0093	0.0219	0.0493	0.1730	0.0200	0.0528
Number of industries				25	25				25	25

Robust p-value in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Coefficients on fixed effects are omitted.

Appendix C-3: Yield Growth and Restriction Growth for Second-tier Regulatory Forms, Controlling for Disaster (All Results)

Dependent Variable: yield_growth	Price Regulation					Quantity Regulation				
	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
L.regform_growth	0.0120	0.0130	0.0113	0.0114	0.0109	-0.0287	0.0015	0.0028	0.0020	0.0025
	(0.373)	(0.334)	(0.405)	(0.368)	(0.413)	(0.270)	(0.958)	(0.919)	(0.936)	(0.916)
L.total_reg_growth		-0.3833***	-0.3776***	-0.3754***	-0.3783***		-0.3788***	-0.3686**	-0.3716***	-0.3695**
		(0.003)	(0.006)	(0.002)	(0.004)		(0.007)	(0.011)	(0.007)	(0.012)
disaster_state	-0.0242**	-0.0291***	-0.0306***	-0.0300***	-0.0303***	-0.0265***	-0.0300***	-0.0321***	-0.0307***	-0.0320***
	(0.014)	(0.004)	(0.005)	(0.000)	(0.001)	(0.008)	(0.003)	(0.004)	(0.000)	(0.001)
time			-0.0783		-0.0447			-0.0815		-0.0480
			(0.606)		(0.678)			(0.594)		(0.632)
time2			0.0019		0.0010			0.0022		0.0012
			(0.518)		(0.669)			(0.465)		(0.555)
Constant	2.6964***	3.3396***	3.7454**	3.3689***	3.7205***	2.7841***	3.4901***	3.7443**	3.5024***	3.7204***
	(0.000)	(0.000)	(0.029)	(0.000)	(0.004)	(0.000)	(0.000)	(0.029)	(0.000)	(0.003)
Observations	685	685	685	685	685	685	685	685	685	685
R-squared	0.010	0.025	0.026	0.024	0.024	0.008	0.022	0.024	0.021	0.022
Prob > F	0.0314	0.0010	0.0058	0.0002	0.0004	0.0156	0.0010	0.0060	0.0001	0.0002
Number of industries				19	19				19	19

Dependent Variable: yield_growth	Entry-and-Exit Regulation					Service Quality Regulation				
	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
L.regform_growth	-0.2347***	-0.1858***	-0.1767***	-0.1758**	-0.1753**	0.0035	0.0052	0.0093	0.0102	0.0119
	(0.000)	(0.001)	(0.004)	(0.018)	(0.024)	(0.905)	(0.849)	(0.739)	(0.721)	(0.679)
L.total_reg_growth		-0.2458*	-0.2468*	-0.2458***	-0.2490***		-0.3773***	-0.3655***	-0.3696***	-0.3667***
		(0.053)	(0.068)	(0.002)	(0.008)		(0.004)	(0.008)	(0.002)	(0.006)
disaster_state	-0.0224**	-0.0262**	-0.0275**	-0.0271***	-0.0270***	-0.0251**	-0.0299***	-0.0321***	-0.0306***	-0.0319***
	(0.031)	(0.014)	(0.017)	(0.001)	(0.007)	(0.012)	(0.004)	(0.004)	(0.000)	(0.001)
time			-0.0468		-0.0148			-0.0834		-0.0500
			(0.759)		(0.884)			(0.583)		(0.636)
time2			0.0012		0.0003			0.0022		0.0013
			(0.689)		(0.901)			(0.454)		(0.552)
Constant	3.5077***	3.7887***	3.9506**	3.7834***	3.9422***	2.8348***	3.4774***	3.7308**	3.4806***	3.7009***
	(0.000)	(0.000)	(0.021)	(0.000)	(0.002)	(0.000)	(0.000)	(0.030)	(0.000)	(0.003)
Observations	685	685	685	685	685	685	685	685	685	685
R-squared	0.028	0.033	0.034	0.032	0.032	0.007	0.022	0.024	0.022	0.022
Prob > F	0.0000	0.0000	0.0002	0.0001	0.0003	0.0402	0.0013	0.0067	0.0001	0.0003
Number of industries				19	19				19	19

Robust p-value in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Coefficients on fixed effects are omitted.

Appendix C-3 (Continued)

Dependent Variable: yield_growth	Command-and-Control Regulation					Market-based Regulation				
	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
L.regform_growth	-0.3459***	-0.4102***	-0.4120***	-0.4004***	-0.4081***	-0.0785**	-0.0442	-0.0434	-0.0418	-0.0449
	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.018)	(0.220)	(0.230)	(0.101)	(0.117)
L.total_reg_growth		0.1438	0.1321	0.1386	0.1261		-0.3187**	-0.3249**	-0.3150***	-0.3248**
		(0.333)	(0.383)	(0.264)	(0.318)		(0.025)	(0.026)	(0.007)	(0.011)
disaster_state	-0.0296***	-0.0286***	-0.0287***	-0.0294***	-0.0282***	-0.0293***	-0.0316***	-0.0324***	-0.0324***	-0.0322***
	(0.004)	(0.005)	(0.008)	(0.000)	(0.002)	(0.004)	(0.003)	(0.004)	(0.000)	(0.001)
time			-0.1501		-0.1181			-0.1291		-0.0969
			(0.330)		(0.270)			(0.404)		(0.429)
time2			0.0031		0.0021			0.0028		0.0019
			(0.306)		(0.324)			(0.351)		(0.426)
Constant	3.9550***	3.9164***	5.1987***	3.9180***	5.1954***	3.3325***	3.6623***	4.6051***	3.6684***	4.6082***
	(0.000)	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)	(0.008)	(0.000)	(0.005)
Observations	685	685	685	685	685	685	685	685	685	685
R-squared	0.043	0.044	0.046	0.043	0.044	0.015	0.024	0.026	0.023	0.024
Prob > F	0.0000	0.0000	0.0001	0.0002	0.0004	0.0020	0.0006	0.0037	0.0001	0.0003
Number of industries				19	19				19	19

Dependent Variable: yield_growth	Information-based Regulation					Transfer Regulation				
	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
L.regform_growth	0.0837*	0.0828**	0.0910**	0.0871**	0.0931**	0.0675	0.5147***	0.5138***	0.4998***	0.5073***
	(0.051)	(0.044)	(0.040)	(0.027)	(0.034)	(0.333)	(0.000)	(0.000)	(0.001)	(0.001)
L.total_reg_growth		-0.3747***	-0.3762***	-0.3659***	-0.3772***		-0.9308***	-0.9444***	-0.9069***	-0.9384***
		(0.004)	(0.006)	(0.002)	(0.005)		(0.000)	(0.000)	(0.001)	(0.001)
disaster_state	-0.0240**	-0.0288***	-0.0303***	-0.0294***	-0.0301***	-0.0234**	-0.0238**	-0.0236**	-0.0245***	-0.0228**
	(0.015)	(0.005)	(0.006)	(0.000)	(0.002)	(0.019)	(0.023)	(0.036)	(0.001)	(0.014)
time			-0.1655		-0.1340			-0.1345		-0.1037
			(0.304)		(0.328)			(0.373)		(0.321)
time2			0.0038		0.0028			0.0027		0.0017
			(0.231)		(0.285)			(0.362)		(0.405)
Constant	2.5343***	3.1783***	4.2498**	3.1693***	4.2384***	2.7939***	4.0834***	5.2797***	4.0704***	5.2905***
	(0.000)	(0.000)	(0.016)	(0.000)	(0.005)	(0.000)	(0.000)	(0.002)	(0.000)	(0.001)
Observations	685	685	685	685	685	685	685	685	685	685
R-squared	0.015	0.030	0.034	0.031	0.032	0.008	0.053	0.054	0.051	0.051
Prob > F	0.0044	0.0001	0.0004	0.0001	0.0002	0.0279	0.0000	0.0000	0.0002	0.0006
Number of industries				19	19				19	19

Robust p-value in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Coefficients on fixed effects are omitted.

Appendix C-3 (Continued)

Dependent Variable: yield_growth	Administrative Regulation				
	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
L.regform_growth	-0.1675***	-0.1414**	-0.1345**	-0.1341**	-0.1319**
	(0.002)	(0.012)	(0.018)	(0.040)	(0.045)
L.total_reg_growth		-0.3323**	-0.3242**	-0.3270***	-0.3263***
		(0.012)	(0.022)	(0.002)	(0.005)
disaster_state	-0.0256***	-0.0299***	-0.0316***	-0.0307***	-0.0314***
	(0.010)	(0.003)	(0.004)	(0.000)	(0.001)
time			-0.0560		-0.0240
			(0.711)		(0.815)
time2			0.0016		0.0006
			(0.602)		(0.768)
Constant	2.9935***	3.5377***	3.6579**	3.5479***	3.6541***
	(0.000)	(0.000)	(0.031)	(0.000)	(0.003)
Observations	685	685	685	685	685
R-squared	0.019	0.030	0.032	0.029	0.029
Prob > F	0.0003	0.0000	0.0003	0.0001	0.0002
Number of industries				19	19

Robust p-value in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Coefficients on fixed effects are omitted.

Appendix C-4: Yield Growth and Restriction Growth for Third-tier Regulatory Forms, Controlling for Disaster (All Results)

Dependent Variable: yield_growth	Licensing					Certification				
	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
L.regform_growth	-0.0932**	-0.0660	-0.0605	-0.0591	-0.0586	-0.1714***	-0.1511***	-0.1490***	-0.1491***	-0.1517***
	(0.036)	(0.139)	(0.217)	(0.109)	(0.166)	(0.000)	(0.000)	(0.000)	(0.001)	(0.002)
L.total_reg_growth		-0.3491***	-0.3503**	-0.3443***	-0.3520***		-0.3183**	-0.2940**	-0.3132***	-0.2944**
		(0.008)	(0.011)	(0.003)	(0.006)		(0.016)	(0.038)	(0.003)	(0.011)
disaster_state	-0.0220**	-0.0274**	-0.0289**	-0.0283***	-0.0285***	-0.0283***	-0.0320***	-0.0345***	-0.0333***	-0.0349***
	(0.034)	(0.010)	(0.015)	(0.001)	(0.007)	(0.005)	(0.002)	(0.002)	(0.000)	(0.001)
time			-0.1042		-0.0699			0.0259		0.0600
			(0.492)		(0.512)			(0.867)		(0.591)
time2			0.0024		0.0014			0.0001		-0.0009
			(0.415)		(0.503)			(0.979)		(0.698)
Constant	3.0603***	3.5929***	4.2249**	3.5881***	4.1924***	3.2872***	3.7783***	3.0331*	3.8023***	3.0000**
	(0.000)	(0.000)	(0.016)	(0.000)	(0.003)	(0.000)	(0.000)	(0.078)	(0.000)	(0.013)
Observations	685	685	685	685	685	685	685	685	685	685
R-squared	0.012	0.024	0.026	0.023	0.024	0.026	0.036	0.037	0.036	0.036
Prob > F	0.0030	0.0004	0.0024	0.0001	0.0003	0.0000	0.0000	0.0000	0.0001	0.0003
Number of industries				19	19				19	19

Dependent Variable: yield_growth	Monitoring, Reporting & Verification					Performance Standards				
	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
L.regform_growth	-0.3969***	-0.3218***	-0.3282***	-0.3300***	-0.3331***	-0.0803**	-0.0507	-0.0481	-0.0467	-0.0465
	(0.000)	(0.003)	(0.002)	(0.000)	(0.000)	(0.011)	(0.145)	(0.176)	(0.267)	(0.272)
L.total_reg_growth		-0.1960	-0.1740	-0.1839*	-0.1730		-0.2225*	-0.2278*	-0.2269*	-0.2336*
		(0.193)	(0.269)	(0.063)	(0.119)		(0.087)	(0.095)	(0.091)	(0.097)
disaster_state	-0.0293***	-0.0310***	-0.0339***	-0.0320***	-0.0340***	-0.0291***	-0.0305***	-0.0319***	-0.0313***	-0.0317***
	(0.004)	(0.002)	(0.002)	(0.000)	(0.001)	(0.004)	(0.003)	(0.004)	(0.000)	(0.001)
time			-0.0689		-0.0341			-0.1011		-0.0681
			(0.646)		(0.743)			(0.507)		(0.524)
time2			0.0021		0.0011			0.0024		0.0014
			(0.483)		(0.609)			(0.424)		(0.506)
Constant	3.7458***	3.9096***	3.9373**	3.9364***	3.9124***	3.2953***	3.5075***	4.0962**	3.5189***	4.0742***
	(0.000)	(0.000)	(0.022)	(0.000)	(0.002)	(0.000)	(0.000)	(0.019)	(0.000)	(0.002)
Observations	685	685	685	685	685	685	685	685	685	685
R-squared	0.032	0.035	0.037	0.035	0.036	0.023	0.026	0.027	0.025	0.025
Prob > F	0.0000	0.0000	0.0001	0.0000	0.0001	0.0013	0.0011	0.0060	0.0001	0.0002
Number of industries				19	19				19	19

Robust p-value in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Coefficients on fixed effects are omitted.

Appendix C-4 (Continued)

Dependent Variable: yield_growth	Permitting					Pre-market Notice & Approval				
	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
L.regform_growth	-0.2433***	-0.1937***	-0.1852***	-0.1836***	-0.1827***	-0.0041	-0.0033	-0.0031	-0.0034	-0.0030
	(0.000)	(0.006)	(0.009)	(0.005)	(0.006)	(0.674)	(0.738)	(0.757)	(0.751)	(0.775)
L.total_reg_growth		-0.2375*	-0.2407*	-0.2379***	-0.2438**		-0.3399**	-0.3420**	-0.3320***	-0.3420**
		(0.069)	(0.085)	(0.009)	(0.020)		(0.012)	(0.017)	(0.008)	(0.010)
disaster_state	-0.0262**	-0.0290***	-0.0301***	-0.0297***	-0.0296***	-0.0258**	-0.0301***	-0.0314***	-0.0301***	-0.0304***
	(0.011)	(0.006)	(0.007)	(0.000)	(0.002)	(0.010)	(0.004)	(0.004)	(0.000)	(0.002)
time			-0.0646		-0.0320			-0.1432		-0.1060
			(0.675)		(0.746)			(0.458)		(0.294)
time2			0.0016		0.0006			0.0032		0.0021
			(0.606)		(0.766)			(0.372)		(0.308)
Constant	3.8323***	4.0362***	4.3595**	4.0170***	4.3378***	2.9712***	3.5191***	4.5526*	3.5079***	4.4692***
	(0.000)	(0.000)	(0.012)	(0.000)	(0.002)	(0.000)	(0.000)	(0.054)	(0.000)	(0.000)
Observations	685	685	685	685	685	659	659	659	659	659
R-squared	0.029	0.034	0.034	0.032	0.032	0.007	0.019	0.022	0.018	0.019
Prob > F	0.0000	0.0000	0.0003	0.0002	0.0004	0.0363	0.0033	0.0162	0.0002	0.0001
Number of industries				19	19				19	19

Dependent Variable: yield_growth	Means-based Standards					Prohibitions				
	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend	OLS	OLS	OLS + Time Trend	Industry FE	Industry FE + Time Trend
L.regform_growth	-0.0134	-0.0111	-0.0094	-0.0104	-0.0098	-0.0007**	-0.0007**	-0.0006**	-0.0007**	-0.0006**
	(0.113)	(0.156)	(0.231)	(0.104)	(0.141)	(0.021)	(0.023)	(0.036)	(0.038)	(0.043)
L.total_reg_growth		-0.3711***	-0.3624***	-0.3640***	-0.3636***		-0.3762***	-0.3679***	-0.3686***	-0.3693***
		(0.004)	(0.009)	(0.002)	(0.006)		(0.004)	(0.008)	(0.002)	(0.005)
disaster_state	-0.0242**	-0.0291***	-0.0312***	-0.0300***	-0.0310***	-0.0260***	-0.0308***	-0.0326***	-0.0315***	-0.0324***
	(0.016)	(0.005)	(0.005)	(0.000)	(0.002)	(0.009)	(0.003)	(0.003)	(0.000)	(0.001)
time			-0.0808		-0.0471			-0.0861		-0.0532
			(0.595)		(0.653)			(0.571)		(0.612)
time2			0.0021		0.0011			0.0022		0.0012
			(0.481)		(0.591)			(0.462)		(0.561)
Constant	2.9313***	3.5501***	3.8388**	3.5576***	3.8174***	2.9179***	3.5597***	3.9139**	3.5666***	3.8975***
	(0.000)	(0.000)	(0.025)	(0.000)	(0.003)	(0.000)	(0.000)	(0.023)	(0.000)	(0.002)
Observations	685	685	685	685	685	685	685	685	685	685
R-squared	0.008	0.023	0.025	0.022	0.023	0.009	0.024	0.026	0.023	0.023
Prob > F	0.0138	0.0004	0.0029	0.0001	0.0003	0.0049	0.0001	0.0010	0.0000	0.0000
Number of industries				19	19				19	19

Robust p-value in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Coefficients on fixed effects are omitted.

Appendix D: Robustness Checks

Appendix D-1: Yield Growth and Restriction Growth for Second-tier Regulatory Forms (Industry FE + Time Trend Model)

Dependent Variable: yield_growth	Price Regulation						Quantity Regulation					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
L.regform_growth	0.0058	0.0107	0.0064	-0.0019	0.0106	0.0091	0.0012	-0.0013	0.0125	0.0085	-0.0113	0.0224
	(0.740)	(0.421)	(0.294)	(0.846)	(0.426)	(0.406)	(0.961)	(0.956)	(0.651)	(0.738)	(0.598)	(0.320)
L.total_reg_growth	-0.3726***	-0.3785***	-0.4079***	-0.3725***		-0.3439***	-0.3679**	-0.3652**	-0.4123***	-0.3833***		-0.3792***
	(0.004)	(0.004)	(0.003)	(0.006)		(0.004)	(0.011)	(0.014)	(0.008)	(0.007)		(0.006)
L.other_reg_growth					-0.3779***						-0.3488**	
					(0.004)						(0.015)	
disaster_state	-0.0315***	-0.0304***	-0.0305***		-0.0303***	-0.0353***	-0.0320***	-0.0320***	-0.0327***		-0.0318***	-0.0370***
	(0.001)	(0.001)	(0.001)			(0.000)	(0.001)	(0.001)	(0.001)			(0.000)
disaster_county				-3.0146**						-2.9863**		
				(0.018)	(0.001)					(0.019)	(0.001)	
Constant	3.7498***	3.7280***	3.5948***	3.3615**	3.7196***	2.6584***	3.7262***	3.7324***	3.5882***	3.3381**	3.6909***	2.6678***
	(0.003)	(0.003)	(0.003)	(0.010)	(0.004)	(0.003)	(0.003)	(0.003)	(0.002)	(0.010)	(0.003)	(0.001)
Observations	685	685	685	531	685	685	685	685	685	531	685	685
R-squared	0.022	0.024	0.024	0.024	0.024	0.020	0.022	0.022	0.020	0.024	0.022	0.019
Prob > F	0.0003	0.0004	0.0001	0.0257	0.0004	0.0000	0.0003	0.0002	0.0001	0.0247	0.0002	0.0000
Number of industries	19	19	19	12	19	19	19	19	19	12	19	19

Dependent Variable: yield_growth	Entry-and-Exit Regulation						Service Quality Regulation					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
L.regform_growth	-0.1644**	-0.1957**	-0.2346***	-0.2285***	-0.1893**	-0.2625**	0.0125	0.0093	0.0463	-0.0024	0.0051	0.0087
	(0.027)	(0.012)	(0.006)	(0.005)	(0.020)	(0.015)	(0.660)	(0.704)	(0.354)	(0.939)	(0.857)	(0.761)
L.total_reg_growth	-0.2785***	-0.2264**	-0.1508	-0.2309**		-0.1524	-0.3660***	-0.3657***	-0.3884***	-0.3747***		-0.3360***
	(0.007)	(0.012)	(0.136)	(0.025)		(0.171)	(0.006)	(0.006)	(0.004)	(0.006)		(0.006)
L.other_reg_growth					-0.2384***						-0.3599***	
					(0.008)						(0.006)	
disaster_state	-0.0283***	-0.0278***	-0.0241***		-0.0273***	-0.0378***	-0.0319***	-0.0319***	-0.0318***		-0.0320***	-0.0366***
	(0.005)	(0.004)	(0.008)			(0.000)	(0.001)	(0.001)	(0.000)			(0.000)
disaster_county				-2.0385*						-2.9849**		
				(0.094)	(0.006)					(0.016)	(0.001)	
Constant	3.7532***	3.7569***	3.3812***	3.5658***	3.9786***	3.4884***	3.7016***	3.7003***	3.5324***	3.3681***	3.6941***	2.7086***
	(0.003)	(0.002)	(0.003)	(0.007)	(0.002)	(0.000)	(0.003)	(0.003)	(0.003)	(0.009)	(0.003)	(0.001)
Observations	685	685	685	531	685	685	685	685	685	531	685	685
R-squared	0.030	0.035	0.038	0.045	0.032	0.039	0.022	0.022	0.022	0.024	0.022	0.018
Prob > F	0.0004	0.0003	0.0001	0.0177	0.0003	0.0000	0.0003	0.0003	0.0000	0.0037	0.0003	0.0000
Number of industries	19	19	19	12	19	19	19	19	19	12	19	19

(1): Using an alternative approach to distribute restrictive word counts; (2): adjusting restrictions for MRV; (3): using total word counts; (4): controlling for county-level disaster risk; (5): controlling for other restriction growth; (6): using expert judgment to exclude irrelevant CFR parts.
All specifications include industry fixed effects and time trend; coefficients are omitted.

Appendix D-1 (Continued)

Dependent Variable: yield_growth	Command-and-Control Regulation						Market-based Regulation					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
L.regform_growth	-0.7449***	-0.1414**	-0.4206***	-0.4379***	-0.3726***	-0.3541***	-0.0842	-0.0386	-0.0352	-0.0674**	-0.0573*	-0.0333
	(0.000)	(0.048)	(0.000)	(0.001)	(0.001)	(0.000)	(0.117)	(0.171)	(0.164)	(0.027)	(0.054)	(0.225)
L.total_reg_growth	0.3203**	-0.1236	-0.0936	0.1405		-0.0551	-0.2855**	-0.3287***	-0.3616***	-0.3200**		-0.2949**
	(0.018)	(0.353)	(0.422)	(0.341)		(0.511)	(0.019)	(0.010)	(0.009)	(0.015)		(0.023)
L.other_reg_growth					0.1099						-0.3079**	
					(0.155)						(0.013)	
disaster_state	-0.0288***	-0.0296***	-0.0277***		-0.0278***	-0.0329***	-0.0334***	-0.0323***	-0.0331***		-0.0322***	-0.0364***
	(0.003)	(0.002)	(0.002)			(0.001)	(0.001)	(0.001)	(0.001)			(0.000)
disaster_county				-2.2665*						-3.0338**		
				(0.069)	(0.003)					(0.018)	(0.001)	
Constant	5.5027***	4.4541***	6.2557***	4.8032***	5.0987***	4.0943***	4.6535***	4.4401***	4.2600***	4.7067***	4.6866***	3.3112***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.004)	(0.005)	(0.002)	(0.005)	(0.005)	(0.004)
Observations	685	685	685	531	685	685	685	685	685	531	685	685
R-squared	0.059	0.030	0.039	0.056	0.044	0.029	0.026	0.023	0.021	0.030	0.024	0.019
Prob > F	0.0002	0.0004	0.0001	0.0049	0.0004	0.0000	0.0003	0.0003	0.0001	0.0073	0.0004	0.0000
Number of industries	19	19	19	12	19	19	19	19	19	12	19	19

Dependent Variable: yield_growth	Information-based Regulation						Transfer Regulation					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
L.regform_growth	0.0688*	0.0931**	0.0515	0.1020*	0.0874**	0.1151***	0.3795**	0.4002***	0.4517***	0.6126***	0.1409**	0.3720***
	(0.050)	(0.034)	(0.138)	(0.058)	(0.037)	(0.006)	(0.017)	(0.009)	(0.002)	(0.000)	(0.025)	(0.000)
L.total_reg_growth	-0.3795***	-0.3772***	-0.4333***	-0.3809***		-0.3631***	-0.7303***	-0.7777***	-1.0447***	-1.0922***		-0.7944***
	(0.005)	(0.005)	(0.003)	(0.006)		(0.002)	(0.005)	(0.003)	(0.001)	(0.000)		(0.000)
L.other_reg_growth					-0.3767***						-0.5478***	
					(0.004)						(0.001)	
disaster_state	-0.0303***	-0.0301***	-0.0317***		-0.0300***	-0.0328***	-0.0263***	-0.0251***	-0.0242***		-0.0260***	-0.0288***
	(0.002)	(0.002)	(0.001)			(0.001)	(0.006)	(0.008)	(0.006)			(0.002)
disaster_county				-2.7557**						-1.3097		
				(0.026)	(0.002)					(0.277)	(0.006)	
Constant	4.2070***	4.2384***	3.9508***	3.8884**	4.3296***	3.6727***	4.6123***	4.7624***	6.0735***	4.9745***	5.4392***	3.7314***
	(0.004)	(0.005)	(0.003)	(0.015)	(0.004)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)
Observations	685	685	685	531	685	685	685	685	685	531	685	685
R-squared	0.028	0.032	0.024	0.040	0.033	0.033	0.031	0.036	0.044	0.078	0.050	0.032
Prob > F	0.0002	0.0002	0.0001	0.0019	0.0002	0.0000	0.0004	0.0005	0.0001	0.0027	0.0005	0.0001
Number of industries	19	19	19	12	19	19	19	19	19	12	19	19

(1): Using an alternative approach to distribute restrictive word counts; (2): adjusting restrictions for MRV; (3): using total word counts; (4): controlling for county-level disaster risk; (5): controlling for other restriction growth; (6): using expert judgment to exclude irrelevant CFR parts.
All specifications include industry fixed effects and time trend; coefficients are omitted.

Appendix D-1 (Continued)

Dependent Variable: yield_growth	Administrative Regulation					
	(1)	(2)	(3)	(4)	(5)	(6)
L.regform_growth	-0.1278*	-0.1319**	-0.0606*	-0.2227***	-0.1465**	-0.0727***
	(0.061)	(0.045)	(0.054)	(0.003)	(0.032)	(0.007)
L.total_reg_growth	-0.3286***	-0.3263***	-0.3253**	-0.3078***		-0.3156***
	(0.005)	(0.005)	(0.010)	(0.007)		(0.007)
L.other_reg_growth					-0.3140***	
					(0.006)	
disaster_state	-0.0314***	-0.0314***	-0.0331***		-0.0314***	-0.0325***
	(0.002)	(0.001)	(0.001)			(0.001)
disaster_county				-2.7381**		
				(0.027)	(0.001)	
Constant	3.6459***	3.6541***	3.7429***	3.1240**	3.6969***	2.2146***
	(0.003)	(0.003)	(0.002)	(0.013)	(0.003)	(0.007)
Observations	685	685	685	531	685	685
R-squared	0.029	0.029	0.024	0.050	0.029	0.034
Prob > F	0.0002	0.0002	0.0001	0.0081	0.0002	0.0003
Number of industries	19	19	19	12	19	19

(1): Using an alternative approach to distribute restrictive word counts; (2): adjusting restrictions for MRV; (3): using total word counts; (4): controlling for county-level disaster risk; (5): controlling for other restriction growth; (6): using expert judgment to exclude irrelevant CFR parts.
All specifications include industry fixed effects and time trend; coefficients are omitted.

Appendix D-2: Yield Growth and Restriction Growth for Third-tier Regulatory Forms (Industry FE + Time Trend Model)

Dependent Variable: yield_growth	Licensing						Certification					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
L.regform_growth	-0.0444*	-0.0475	-0.0270	-0.0669	-0.0690	-0.1023*	-0.0991**	-0.1151***	-0.1216***	-0.1839***	-0.1575***	-0.1511***
	(0.090)	(0.190)	(0.469)	(0.110)	(0.118)	(0.053)	(0.012)	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)
L.total_reg_growth	-0.3504***	-0.3549***	-0.3771***	-0.3621***		-0.2963**	-0.3272***	-0.2919**	-0.2701**	-0.2855**		-0.2104**
	(0.006)	(0.006)	(0.007)	(0.006)		(0.015)	(0.008)	(0.011)	(0.018)	(0.014)		(0.038)
L.other_reg_growth					-0.3452***						-0.2872**	
					(0.006)						(0.011)	
disaster_state	-0.0291***	-0.0295***	-0.0305***		-0.0286***	-0.0371***	-0.0340***	-0.0345***	-0.0352***		-0.0349***	-0.0381***
	(0.005)	(0.005)	(0.002)		(0.007)	(0.000)	(0.001)	(0.001)	(0.000)		(0.001)	(0.000)
disaster_county				-2.3860**						-3.4580**		
				(0.048)						(0.014)		
Constant	4.0508***	4.1326***	3.7129***	3.8637***	4.2264***	3.5829***	3.3681***	2.9333**	2.5968**	2.4846**	3.0001**	2.0316**
	(0.003)	(0.003)	(0.002)	(0.004)	(0.003)	(0.000)	(0.006)	(0.015)	(0.023)	(0.047)	(0.013)	(0.017)
Observations	685	685	685	531	685	685	685	685	685	531	685	685
R-squared	0.024	0.023	0.020	0.027	0.024	0.023	0.030	0.036	0.038	0.051	0.036	0.032
Prob > F	0.0003	0.0003	0.0001	0.0176	0.0003	0.0000	0.0001	0.0004	0.0001	0.0201	0.0003	0.0000
Number of industries	19	19	12	19	19	19	19	19	19	12	19	19

Dependent Variable: yield_growth	Monitoring, Reporting & Verification						Performance Standards					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
L.regform_growth	-0.3705***	-0.0416***	-0.2332**	-0.2729***	-0.3607***	-0.3875***	-0.0458	-0.0473	-0.1506**	-0.0698**	-0.0668*	-0.0577
	(0.000)	(0.004)	(0.024)	(0.004)	(0.000)	(0.002)	(0.387)	(0.283)	(0.014)	(0.027)	(0.088)	(0.266)
L.total_reg_growth	-0.1724*	-0.1909	-0.2209*	-0.2162**		-0.0139	-0.2697**	-0.2348*	-0.2780**	-0.1836		-0.2811***
	(0.098)	(0.233)	(0.054)	(0.040)		(0.914)	(0.048)	(0.095)	(0.022)	(0.208)		(0.007)
L.other_reg_growth					-0.1435						-0.1686	
					(0.127)						(0.176)	
disaster_state	-0.0354***	-0.0321***	-0.0338***		-0.0340***	-0.0341***	-0.0324***	-0.0318***	-0.0292***		-0.0315***	-0.0360***
	(0.001)	(0.001)	(0.001)		(0.001)	(0.000)	(0.001)	(0.001)	(0.001)		(0.001)	(0.000)
disaster_county				-2.9832**						-2.8786**		
				(0.023)						(0.023)		
Constant	3.7175***	-0.0025	2.7660**	3.5836***	3.9022***	3.0688***	3.7480***	3.9991***	7.2922***	3.8014***	3.9653***	3.2643***
	(0.003)	(0.999)	(0.013)	(0.007)	(0.002)	(0.001)	(0.003)	(0.002)	(0.000)	(0.003)	(0.002)	(0.000)
Observations	685	559	685	531	685	685	685	685	685	531	685	685
R-squared	0.036	0.027	0.028	0.036	0.036	0.034	0.024	0.025	0.031	0.033	0.024	0.020
Prob > F	0.0000	0.0017	0.0001	0.0205	0.0001	0.0000	0.0003	0.0002	0.0001	0.0118	0.0004	0.0000
Number of industries	19	19	19	12	19	19	19	19	19	12	19	19

(1): Using an alternative approach to distribute restrictive word counts; (2): adjusting restrictions for MRV; (3): using total word counts; (4): controlling for county-level disaster risk; (5): controlling for other restriction growth; (6): using expert judgment to exclude irrelevant CFR parts.
All specifications include industry fixed effects and time trend; coefficients are omitted.

Appendix D-2 (Continued)

Dependent Variable: yield_growth	Permitting						Pre-market Notice & Approval					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
L.regform_growth	-0.1827**	-0.1576**	-0.1322**	-0.1943***	-0.1960***	0.0077	-0.0172	-0.0046	-0.0015	0.0039	-0.0052	-0.0036
	(0.011)	(0.019)	(0.023)	(0.002)	(0.005)	(0.916)	(0.367)	(0.641)	(0.785)	(0.587)	(0.630)	(0.735)
L.total_reg_growth	-0.3093***	-0.2917***	-0.3092**	-0.2450**		-0.3385***	-0.3457**	-0.3424**	-0.3854***	-0.3483***		-0.2921**
	(0.007)	(0.009)	(0.012)	(0.034)		(0.005)	(0.011)	(0.010)	(0.005)	(0.010)		(0.016)
L.other_reg_growth					-0.2296**						-0.3428**	
					(0.016)						(0.010)	
disaster_state	-0.0277***	-0.0303***	-0.0307***		-0.0299***	-0.0367***	-0.0305***	-0.0304***	-0.0311***		-0.0305***	-0.0349***
	(0.003)	(0.002)	(0.001)		(0.002)	(0.000)	(0.002)	(0.002)	(0.001)		(0.002)	(0.000)
disaster_county				-2.7025**						-2.8854**		
				(0.029)						(0.023)		
Constant	4.6359***	4.0949***	3.6955***	3.8786***	4.3465***	2.7242***	4.5474***	4.4718***	4.6001***	4.3772***	4.5143***	2.9637***
	(0.002)	(0.002)	(0.002)	(0.006)	(0.001)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Observations	685	685	685	531	685	685	659	659	659	507	659	659
R-squared	0.033	0.028	0.024	0.040	0.032	0.018	0.020	0.019	0.018	0.020	0.019	0.015
Prob > F	0.0002	0.0004	0.0001	0.0048	0.0004	0.0000	0.0001	0.0001	0.0000	0.0501	0.0001	0.0000
Number of industries	19	19	19	12	19	19	19	19	19	12	19	19

Dependent Variable: yield_growth	Means-based Standards						Prohibitions					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
L.regform_growth	-0.0199**	-0.0107	-0.0022	-0.0080	-0.0115*	-0.0041	-0.0004**	-0.0005**	-0.0018**	-0.0004	-0.0007**	0.4846***
	(0.030)	(0.107)	(0.847)	(0.471)	(0.096)	(0.199)	(0.045)	(0.042)	(0.030)	(0.186)	(0.030)	(0.007)
L.total_reg_growth	-0.3737***	-0.3642***	-0.3946***	-0.3700***		-0.3298***	-0.3690***	-0.3690***	-0.3985***	-0.3759***		-0.2162
	(0.006)	(0.006)	(0.004)	(0.005)		(0.006)	(0.005)	(0.005)	(0.004)	(0.006)		(0.183)
L.other_reg_growth					-0.3666***						-0.3653***	
					(0.006)						(0.005)	
disaster_state	-0.0297***	-0.0309***	-0.0325***		-0.0317***	-0.0367***	-0.0323***	-0.0324***	-0.0333***		-0.0324***	-0.0433***
	(0.002)	(0.002)	(0.001)		(0.001)	(0.000)	(0.001)	(0.001)	(0.001)		(0.001)	(0.002)
disaster_county				-2.8558**						-3.0286**		
				(0.020)						(0.019)		
Constant	4.1306***	3.8169***	3.6402***	3.3986**	3.8624***	3.0164***	3.8741***	3.8832***	3.8141***	3.4591***	3.8696***	2.2428
	(0.003)	(0.003)	(0.002)	(0.011)	(0.003)	(0.001)	(0.002)	(0.002)	(0.001)	(0.009)	(0.002)	(0.519)
Observations	685	685	685	531	685	682	685	685	685	531	685	361
R-squared	0.026	0.023	0.020	0.025	0.023	0.019	0.023	0.023	0.022	0.025	0.023	0.035
Prob > F	0.0003	0.0003	0.0001	0.0162	0.0003	0.0000	0.0000	0.0000	0.0000	0.0256	0.0000	0.0114
Number of industries	19	19	19	12	19	19	19	19	19	12	19	13

(1): Using an alternative approach to distribute restrictive word counts; (2): adjusting restrictions for MRV; (3): using total word counts; (4): controlling for county-level disaster risk; (5): controlling for other restriction growth; (6): using expert judgment to exclude irrelevant CFR parts.
All specifications include industry fixed effects and time trend; coefficients are omitted.

Annex I.
Alternatives to Regression: Partial Dependence Plots

Louis Anthony (Tony) Cox, Jr.

Our main findings show that that growth rates for some specific forms of regulation are negatively associated with land productivity growth (i.e., yield growth). However, our analysis makes heavy use of specific econometric models such as equations (1)-(3). It is natural to wonder how robust our conclusions are to possible errors in model specification and, more generally, to model uncertainty. To find out, we applied a useful innovation from machine learning: an ensemble of several hundred non-parametric (classification and regression tree) models fit to the data, with the frequency distribution of predictions of yield growth over the entire population of models providing a quantitative indicator of the extent of model uncertainty. This appendix briefly explains the method and illustrates specific results. They support the conclusion that growth in some forms of growth is negatively associated with yield growth even when non-parametric methods and large model ensembles are used to avoid possible model specification errors and to assess model uncertainty.

Random Forest

We applied one of the best-known and most widely used machine learning techniques for predictive analytics: the Random Forest algorithm as implemented in the *randomForest* R package and made available for general users via the Causal Analytics Toolkit (CAT) platform.

Links to these resources are as follows:

- General concepts explained for Wikipedia readers: https://en.wikipedia.org/wiki/Random_forest
- *randomForest* R package: https://cran.r-project.org/web/packages/randomForest/randomForest.pdf
- Causal Analytics Toolkit (CAT): http://cox-associates.com:8899/

The CAT software integrates randomForest with other packages to generate partial dependence plots (PDPs), uncertainty bands, and individual conditional expectation (ICE) plots. The key ideas of these techniques are as follows.

- A *partial dependence plot* (PDP) shows how the predicted value of a dependent variable (here, *yield_growth* for NAICS 111110—the Soybean Farming industry) varies as an explanatory variable is changed (here, a measure of regulatory growth. We use

"*l_rel_restrictions_growth21*"—the one-year lagged value of growth rate in regulatory restrictions associated with command-and-control regulations—for purposes of illustration) while holding all other variables fixed at their current values in the data set.[1] (This corresponds to a "natural direct effect" of the predictor on the dependent variable, in the terminology of causal analysis.) The PDP in Figure 1 averages predicted values of *yield growth* from 500 trees in a random forest ensemble of predictive models as the value of the predictor *l_rel_restrictions_growth21* is varied.

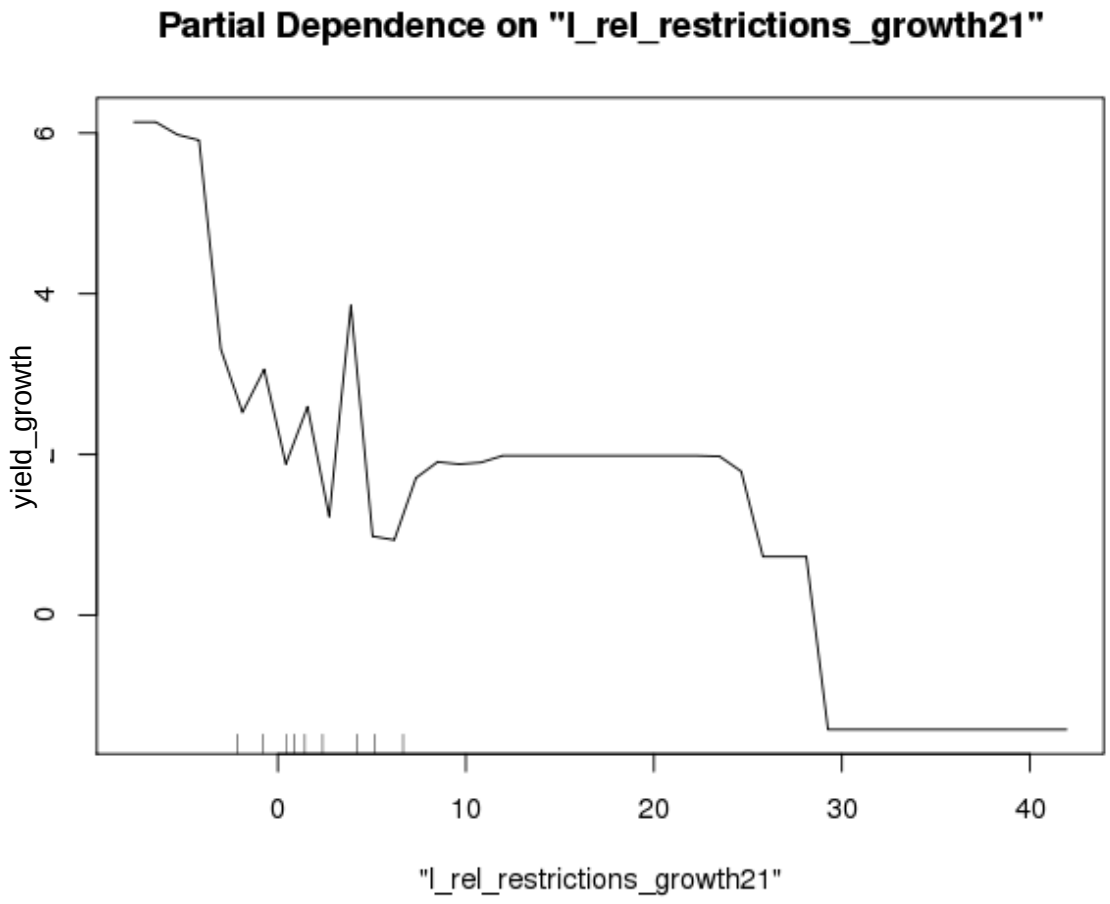
- *Uncertainty bands* for the PDP, illustrated in Figure 2, are derived by discarding the most extreme tails (in Figure 2, the upper 5% and lower 5%) of the frequency distribution of predicted values of the dependent variable for each value of the explanatory variable being varied. The width of the uncertainty band at any point reflects the impact of model uncertainty on predictions: if the correct model were known with certainty, then there would be no spread in these bands, since the correct value could be predicted with certainty by using the correct model.

- *Individual conditional expectation (ICE) cluster plots* search for heterogeneity (e.g., sensitive subpopulations of years in which variations in regulatory growth had exceptionally large or small impacts on yield growth) by clustering predicted responses for each individual case (row) in the data set. Figure 3 shows that, in this application, such clustering did not identify much heterogeneity: the ICE cluster plots are roughly parallel and relatively close to each other, indicating that the approximate size and direction of effects of changes in *l_rel_restrictions_growth21* is on changes in *yield_growth* were relatively uniform throughout the data set.

Overall, these results suggest that our main findings from regression analysis hold up well when more flexible and relatively assumption-free (non-parametric ensemble learning) techniques are used. Although we only explored machine learning methods for a few selected associations, the results illustrated in Figures 1-3 suggest that measures of causal impacts (natural direct effects) that do not depend on the relatively restrictive assumptions of regression modeling still show that measures of growth in some types of regulations are negatively associated with yield growth.

[1] Variables are defined and constructed in the same ways as in Chapter 4.

Figure 1. Example of a PDP generated by CAT software. Yield growth (*yield-growth*) in industry 111110 is significantly negatively associated with growth in regulations (*l_rel_restrictions_growth21*) in non-parametric analysis (Spearman's rack correlation = 0.083, $p < 0.00001$)



The partial dependence plot shows that the association between < l_rel_restrictions_growth21 > and < yield_growth > is: significantly negative (based on Spearman's rank correlation of -0.836 and p-value 0.00000)

Figure 2. Example of 90% uncertainty bands around the PDP showing the range within which 90% of model predictions for *yield_growth* lie for each value of *l_rel_restrictions_growth21*. Even with model uncertainty, it is clear that the association is negative.

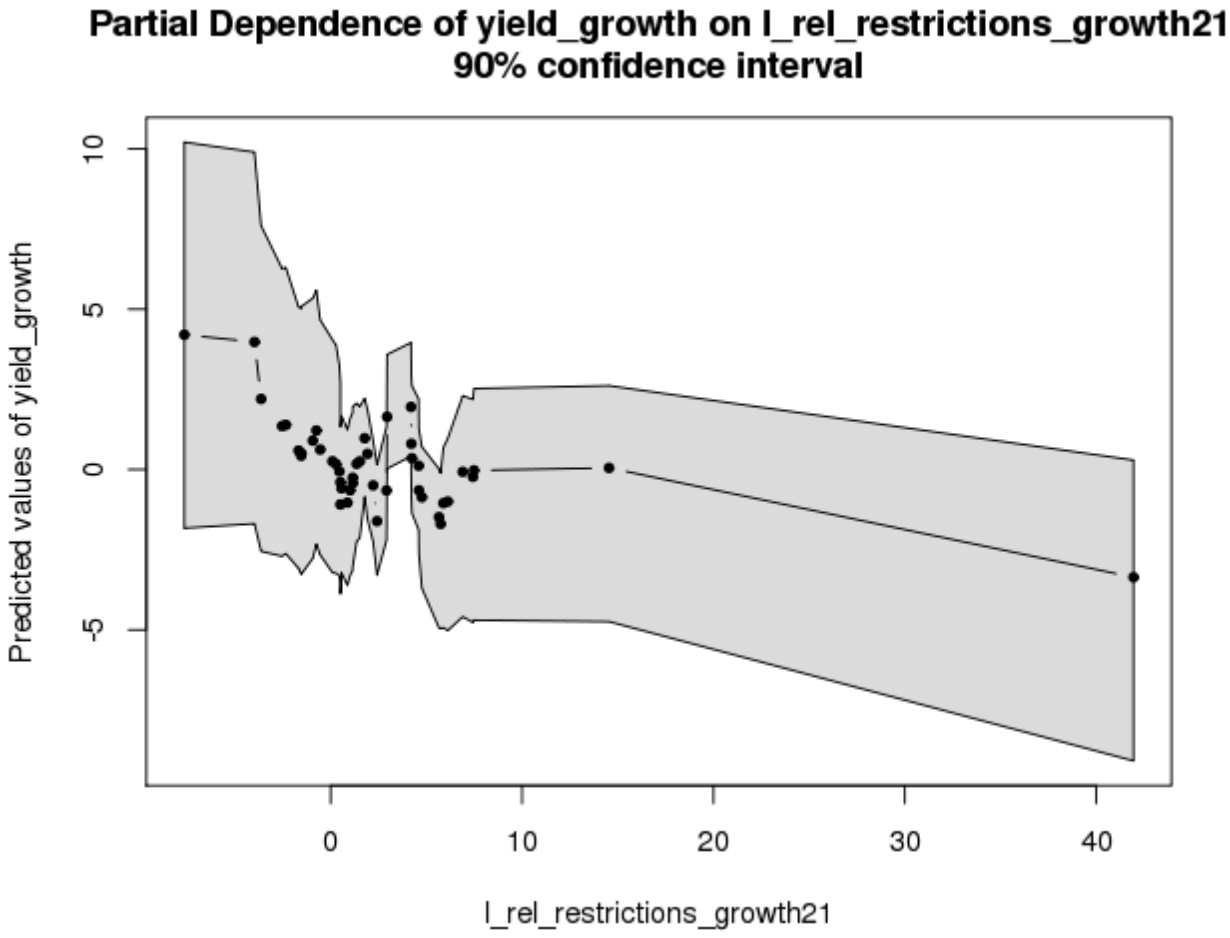
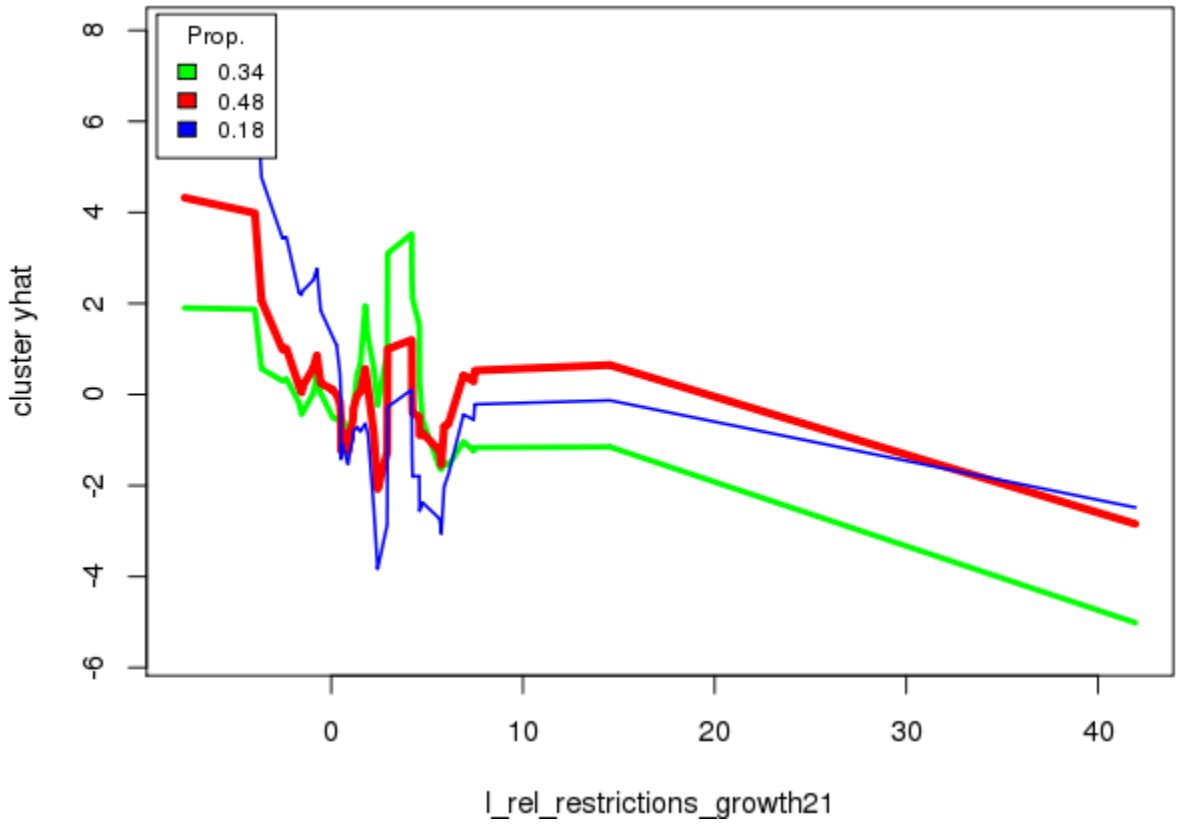


Figure 3. Example of individual conditional expectation (ICE) cluster plot showing the heterogeneity of model predictions for *yield_growth* from *l_rel_restrictions_growth21*. Clustering the model predictions reveals that there is little heterogeneity: the plots are roughly parallel.



Annex II.
Code of Federal Regulations Parts in the Sample

This annex lists the CFR parts we examined (as described in Chapters 3 and 4). We selected the sample first based on the industry relevance estimates in RegData and then refined it according to expert judgement from USDA. Specifically, we included a CFR part in the sample if it is associated with a relevance value equal to or greater than 0.2 to any of the relevant crop and animal production industries in any year between 1970 and 2017 in RegData 3.1 (see Appendix A in Chapter 3 for the industry list). That resulted in 709 unique CFR parts in the following list. To verify the validity of the sample, subject matter experts in USDA read through these parts and assessed whether a part is likely to affect crop and/or animal production (marked as 1 in the *EJ Rel.* column if it is; 0 otherwise), which resulted in 482 parts. Our analysis of regulatory forms in Chapter 3 is based on the 709 CFR parts. In Chapter 4, the baseline econometric analysis is based on a subset of the 709 parts that are relevant to crop production only (see Appendix A in Chapter 4 for the industry list) according to the industry relevance estimates in RegData 3.1 (marked as 1 in the *Crop Rel.* column if it is; otherwise 0), which resulted in 661 parts. To incorporate the expert judgment into the econometric analysis, we further refined the crop relevant sample in a robustness check. In the check, we only used CFR parts that were identified both as relevant to crop production by RegData and as relevant to crop and/or animal production by USDA experts (marked as 1 in the *Robustness Check* column if it is; otherwise 0), which are 465 parts in total. Therefore, the following list identifies regulations that are likely to affect crop and/or animal production based on different data screens.

Description of the Columns:

Column Name	Description
Title	CFR title number
Part	CFR part number.
Part Heading	Title of the CFR part.
Start Year	The first year between 1970 and 2017 in which the part existed in the CFR.
End Year	The last year between 1970 and 2017 in which the part existed in the CFR.
Agency	The agency that promulgated the regulation codified in the CFR part.
Department	The department of the agency that promulgated the regulation in the CFR part.
EJ Rel.	=1 if USDA experts assessed that the CFR part is likely to affect crop and/or animal production; =0 otherwise.
Crop Rel.	=1 if the CFR part is associated with a relevance value equal to or greater than 0.2 to any of the relevant crop production industries in any year between 1970 and 2017 in RegData 3.1; =0 otherwise.
Robust	=1 if *EJ Rel.*=1 AND *Crop Rel.*=1; =0 otherwise.

Relevant Code of Federal Regulations (CFR) Parts:

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
4	305	Cost Accounting Standards Board Bylaws	1972	1986	General Accounting Office	GAO	0	1	0
5	3	Noncompetitive Acquisition Of Status (Rule Iii)	1970	2017	Office of Personnel Management	OPM	0	1	0
5	8	Appointments To Overseas Positions (Rule Viii)	1970	2017	Office of Personnel Management	OPM	0	1	0
5	12	Standby Regulations For Use In A National Emergency Disaster	1970	1970	Office of Personnel Management	OPM	0	1	0
5	305	Executive Assignment System	1970	1991	Office of Personnel Management	OPM	0	1	0
5	792	Federal Employees' Health, Counseling, And Work/Life Programs	1985	2017	Office of Personnel Management	OPM	0	1	0
5	1200	Board Organization	1979	2017	Merit Systems Protection Board	Other	0	1	0
5	1202	Statutory Review Board	1980	2017	Merit Systems Protection Board	Other	0	1	0
5	1206	Open Meetings	1979	2017	Merit Systems Protection Board	Other	0	0	0
7	2	Delegations Of Authority By The Secretary Of Agriculture And General Officers Of The Department	1970	2017	Office of the Secretary of Agriculture	USDA	0	1	0
7	3	Debt Management	1970	2017	Office of the Secretary of Agriculture	USDA	1	1	1
7	5	Determination Of Parity Prices	1970	2017	Office of the Secretary of Agriculture	USDA	1	1	1
7	7	Selection And Functions Of Farm Service Agency State And County Committees	1970	2017	Office of the Secretary of Agriculture	USDA	1	1	1
7	8	4-H Club Name And Emblem	1970	2017	Office of the Secretary of Agriculture	USDA	0	1	0
7	12	Highly Erodible Land Conservation And Wetland Conservation	1970	2017	Office of the Secretary of Agriculture	USDA	1	1	1
7	13	Setoffs And Withholdings	1970	1990	Office of the Secretary of Agriculture	USDA	1	1	1
7	16	Equal Opportunity For Religious Organizations	1970	2017	Office of the Secretary of Agriculture	USDA	0	1	0
7	24	Board Of Contract Appeals, Department Of Agriculture	1975	2007	Office of the Secretary of Agriculture	USDA	1	1	1
7	26	Determination Of World Market Price For Certain Commodities	1970	1996	Office of the Secretary of Agriculture	USDA	1	1	1
7	28	Cotton Classing, Testing, And Standards	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	31	Purchase Of Wool And Wool Top Samples	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	32	Purchase Of Grease Mohair And Mohair Top Samples	1972	2017	Agricultural Marketing Service	USDA	1	1	1
7	34	Tobacco Seed And Plant Exportation Act	1970	1992	Agricultural Marketing Service	USDA	1	1	1

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
7	48	Regulations Of The Secretary Of Agriculture For The Enforcement Of The Produce Agency Act	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	61	Cottonseed Sold Or Offered For Sale For Crushing Purposes (Inspection, Sampling And Certification)	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	80	Fresh Russet Potato Diversion Program	1982	2017	Agricultural Marketing Service	USDA	1	1	1
7	101	National Laboratory Accreditation Program	1970	1995	Agricultural Marketing Service	USDA	1	1	1
7	105	Broomcorn Warehouses	1970	1977	Agricultural Marketing Service	USDA	1	0	0
7	110	Recordkeeping On Restricted Use Pesticides By Certified Applicators; Surveys And Reports	1994	2017	Agricultural Marketing Service	USDA	1	1	1
7	111	Cottonseed Warehouses	1970	1985	Agricultural Marketing Service	USDA	1	1	1
7	201	Federal Seed Act Regulations	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	205	National Organic Program	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	275	Performance Reporting System	1975	2017	Food and Nutrition Service	USDA	0	1	0
7	300	Incorporation By Reference	1979	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
7	301	Domestic Quarantine Notices	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
7	302	District Of Columbia; Movement Of Plants And Plant Products	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
7	305	Phytosanitary Treatments	2003	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
7	318	State Of Hawaii And Territories Quarantine Notices	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
7	319	Foreign Quarantine Notices	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
7	320	Mexican Border Regulations	1970	1998	Animal and Plant Health Inspection Service	USDA	1	1	1
7	321	Restricted Entry Orders	1970	1997	Animal and Plant Health Inspection Service	USDA	1	1	1
7	322	Bees, Beekeeping Byproducts, And Beekeeping Equipment	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
7	330	Federal Plant Pest Regulations; General; Plant Pests; Soil, Stone, And Quarry Products; Garbage	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
7	331	Possession, Use, And Transfer Of Select Agents And Toxins	1971	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
7	340	Introduction Of Organisms And Products Altered Or Produced Through Genetic Engineering Which Are Plant Pests Or Which There Is Reason To Believe Are Plant Pests	1988	2017	Animal and Plant Health Inspection Service	USDA	1	1	1

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
7	352	Plant Quarantine Safeguard Regulations	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
7	353	Export Certification	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
7	355	Endangered Species Regulations Concerning Terrestrial Plants	1985	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
7	356	Forfeiture Procedures	1985	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
7	360	Noxious Weed Regulations	1977	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
7	363	Certification Of Usefulness Of Pesticide Chemicals	1970	1970	Consumer and Marketing Service	USDA	1	1	1
7	400	General Administrative Regulations	1983	2017	Federal Crop Insurance Corporation	USDA	1	1	1
7	401	General Crop Insurance Regulations; Regulations For The 1988 Through 1998 Contract Years	1970	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	402	Catastrophic Risk Protection Endorsement	1970	2017	Federal Crop Insurance Corporation	USDA	1	1	1
7	403	General Crop Insurance Regulation	1970	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	404	Noninsured Crop Disaster Assistance Program-Regulations For The 1995 And Succeeding Crop Years	1970	1996	Federal Crop Insurance Corporation	USDA	1	1	1
7	405	Apple Crop Insurance Regulations For The 1986 Through The 1998 Crop Years	1970	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	406	Nursery Crop Insurance Regulations	1970	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	407	Area Risk Protection Insurance Regulations	1970	2017	Federal Crop Insurance Corporation	USDA	1	1	1
7	408	Eastern United States Apple Crop Insurance Regulations	1970	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	410	Florida Citrus Crop Insurance	1970	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	411	Grape Crop Insurance Regulations	1970	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	413	Texas Citrus Insurance Regulations	1970	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	414	Forage Seeding Crop Insurance	1979	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	415	Forage Production Crop Insurance Regulations	1979	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	416	Pea Crop Insurance Regulations For The 1986 Through 1997 Crop Years	1980	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	417	Sugarcane Crop Insurance Regulations	1979	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	418	Wheat Crop Insurance Regulations	1980	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	419	Barley Crop Insurance Regulations	1980	1991	Federal Crop Insurance Corporation	USDA	1	1	1

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
7	421	Cotton Crop Insurance Regulations	1980	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	422	Potato Crop Insurance Regulations	1981	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	423	Flax Crop Insurance Regulations	1980	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	424	Rice Crop Insurance Regulations	1980	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	425	Peanut Crop Insurance Regulations For The 1993 Through 1998 Crop Years	1980	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	426	Combined Crop Insurance	1980	1989	Federal Crop Insurance Corporation	USDA	1	1	1
7	427	Oat Crop Insurance Regulations	1980	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	428	Sunflower Crop Insurance Regulations	1980	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	429	Rye Crop Insurance Regulations	1980	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	430	Sugar Beet Crop Insurance Regulations	1980	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	431	Soybean Crop Insurance Regulations	1980	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	432	Corn Crop Insurance Regulations	1980	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	433	Dry Bean Crop Insurance Regulations	1980	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	434	Tobacco (Dollar Plan) Crop Insurance Regulations	1980	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	435	Tobacco (Quota Plan) Crop Insurance Regulations; Regulations For The 1985 Through 1998 Crop Years	1980	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	436	Tobacco (Guaranteed Production Plan) Crop Insurance Regulations	1980	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	437	Sweet Corn Crop Insurance Regulations For The 1985 Through 1997 Crop Years	1981	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	438	Canning And Processing Tomato Crop Insurance Regulations	1981	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	439	Almond Crop Insurance Regulations	1981	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	440	Texas Citrus Tree Insurance Regulations	1985	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	441	Table Grape Crop Insurance Regulations For The 1987 Through 1997 Crop Years	1985	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	442	Prevented Planting Insurance	1983	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	443	Hybrid Seed Crop Insurance Regulations For The 1986 Through 1997 Crop Years	1984	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	444	Fresh Tomato Crop Insurance Regulations	1985	1991	Federal Crop Insurance Corporation	USDA	1	1	1

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
7	445	Pepper Crop Insurance Regulations	1985	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	446	Walnut Crop Insurance Regulations	1985	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	447	Popcorn Crop Insurance Regulations For The 1987 Through The 1998 Crop Years	1985	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	448	Extra Long Staple (Pima) Cotton Crop Insurance Regulations	1986	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	449	Fresh Market Sweet Corn Crop Insurance Regulations	1986	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	450	Prune Crop Insurance Regulations For The 1996 And Succeeding Crop Years	1986	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	451	Canning And Processing Peach Crop Insurance Regulations	1987	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	452	Safflower Crop Insurance Regulations	1988	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	453	Cranberry Crop Insurance Regulations	1988	1991	Federal Crop Insurance Corporation	USDA	1	1	1
7	454	Fresh Market Tomato (Guaranteed Production Plan) Crop Insurance Regulations For The 1987 Through 1997 Crop Years	1988	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	455	Macadamia Nut Crop Insurance Regulations For The 1988 Through The 1997 Crop Years	1989	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	456	Macadamia Tree Crop Insurance Regulations For The 1988 Through 1997 Crop Years	1989	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	457	Common Crop Insurance Regulations	1992	2017	Federal Crop Insurance Corporation	USDA	1	1	1
7	458	Special California Crop Insurance Regulations	1992	2002	Federal Crop Insurance Corporation	USDA	1	1	1
7	600	Organization	1970	2017	Natural Resources Conservation Service	USDA	1	1	1
7	601	Functions	1970	2017	Natural Resources Conservation Service	USDA	1	1	1
7	610	Technical Assistance	1978	2017	Natural Resources Conservation Service	USDA	1	1	1
7	611	Soil Surveys	1975	2017	Natural Resources Conservation Service	USDA	1	1	1
7	612	Snow Surveys And Water Supply Forecasts	1976	2017	Natural Resources Conservation Service	USDA	1	1	1
7	613	Plant Materials Centers	1975	2017	Natural Resources Conservation Service	USDA	1	1	1
7	614	NRCS Appeal Procedures	1987	2017	Natural Resources Conservation Service	USDA	1	1	1
7	620	Purpose And Applicability	1976	1984	Soil Conservation Service	USDA	1	1	1
7	622	Watershed Projects	1976	2017	Natural Resources Conservation Service	USDA	1	1	1
7	623	Emergency Wetlands Reserve Program	1976	2017	Natural Resources Conservation Service	USDA	1	1	1

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
7	630	Long Term Contracting	1974	2017	Natural Resources Conservation Service	USDA	1	1	1
7	631	Great Plains Conservation Program	1974	2017	Natural Resources Conservation Service	USDA	1	1	1
7	633	Water Bank Program	1997	2017	Natural Resources Conservation Service	USDA	1	1	1
7	635	Equitable Relief From Ineligibility	2005	2017	Natural Resources Conservation Service	USDA	1	1	1
7	650	Compliance With NEPA	1975	2017	Natural Resources Conservation Service	USDA	1	1	1
7	653	Technical Standards	1979	2017	Natural Resources Conservation Service	USDA	1	1	1
7	654	Operation And Maintenance	1978	2017	Natural Resources Conservation Service	USDA	1	1	1
7	657	Prime And Unique Farmlands	1979	2017	Natural Resources Conservation Service	USDA	1	1	1
7	658	Farmland Protection Policy Act	1985	2017	Natural Resources Conservation Service	USDA	1	1	1
7	661	Public Information And Right To Privacy	1974	2017	Natural Resources Conservation Service	USDA	1	1	1
7	662	Regional Equity	1975	2014	Natural Resources Conservation Service	USDA	1	1	1
7	704	1986-1990 Conservation Reserve Program	1987	1997	Farm Service Agency	USDA	1	1	1
7	713	Feed Grain, Rice, Upland And Extra Long Staple Cotton, Wheat And Related Programs	1979	1988	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	714	Refunds Of Penalties Erroneously, Illegally, Or Wrongfully Collected	1970	2017	Farm Service Agency	USDA	1	1	1
7	718	Provisions Applicable To Multiple Programs	1970	2017	Farm Service Agency	USDA	1	1	1
7	719	Reconstitution Of Farms, Allotments, Normal Crop Acreage And Preceding Year Planted Acreage	1970	1995	Farm Service Agency	USDA	1	1	1
7	722	Cotton	1970	1984	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	723	Tobacco	1970	2005	Farm Service Agency	USDA	1	1	1
7	724	Fire-Cured, Dark Aircured, Virginia Sun-Cured, Cigar-Binder (Types 51 And 52), Cigar-Filler And Binder (Types 42, 43, 44, 53, 54, And 55) Tobacco	1970	1990	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	725	Flue-Cured Tobacco	1970	1990	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	726	Burley Tobacco	1972	1990	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	728	Wheat	1970	1979	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	729	Peanut Marketing Quotas	1970	2006	Farm Service Agency	USDA	1	1	1
7	730	Rice	1970	1983	Agricultural Stabilization and Conservation Service	USDA	1	1	1

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
7	735	Regulations For The United States Warehouse Act	1986	2017	Farm Service Agency	USDA	1	1	1
7	737	Tobacco Warehouses	1986	2002	Farm Service Agency	USDA	1	1	1
7	738	Wool Warehouses	1986	2002	Farm Service Agency	USDA	1	1	1
7	739	Dry Bean Warehouses	1986	2002	Farm Service Agency	USDA	1	1	1
7	740	Nut Warehouses	1986	2002	Farm Service Agency	USDA	1	1	1
7	742	Cottonseed Warehouses	1986	2002	Farm Service Agency	USDA	1	1	1
7	743	Field Warehouses	1986	1997	Farm Service Agency	USDA	1	0	0
7	752	Water Bank Program	1973	2006	Farm Service Agency	USDA	1	1	1
7	759	Disaster Designations And Notifications	2000	2017	Farm Service Agency	USDA	1	1	1
7	760	Indemnity Payment Programs	1972	2017	Farm Service Agency	USDA	1	1	1
7	761	Farm Loan Programs; General Program Administration	2000	2017	Farm Service Agency	USDA	1	1	1
7	762	Guaranteed Farm Loans	2000	2017	Farm Service Agency	USDA	1	1	1
7	764	Direct Loan Making	2003	2017	Farm Service Agency	USDA	1	1	1
7	765	Direct Loan Servicing-Regular	2008	2017	Farm Service Agency	USDA	1	1	1
7	766	Direct Loan Servicing	2008	2017	Farm Service Agency	USDA	1	1	1
7	769	Highly Fractionated Indian Land Loan Program	2016	2017	Farm Service Agency	USDA	1	1	1
7	770	Indian Tribal Land Acquisition Loans	1984	2017	Farm Service Agency	USDA	1	1	1
7	773	Special Apple Loan Program	2001	2017	Farm Service Agency	USDA	1	1	1
7	775	Feed Grains	1970	1979	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	777	Disaster Payment Program For 1990 Crop Of Sugarcane, Sugar Beets, Soybeans And Peanuts	1970	2003	Farm Service Agency	USDA	1	1	1
7	780	Appeal Regulations	1970	2017	Farm Service Agency	USDA	1	1	1
7	781	Disclosure Of Foreign Investment In Agricultural Land	1980	2017	Farm Service Agency	USDA	1	1	1
7	783	Tree Assistance Program	1998	2010	Farm Service Agency	USDA	1	1	1
7	784	2004 Ewe Lamb Replacement And Retention Payment Program	2001	2017	Farm Service Agency	USDA	1	1	1
7	786	Dairy Disaster Assistance Payment Program (DDAP-Iii)	2009	2017	Farm Service Agency	USDA	1	1	1
7	789	Agriculture Priorities And Allocations System (APAS)	2016	2017	Farm Service Agency	USDA	1	1	1
7	792	Debt Settlement Policies And Procedures	1970	2017	Farm Service Agency	USDA	1	1	1
7	795	Payment Limitation	1971	2017	Farm Service Agency	USDA	1	1	1
7	798	Availability Of Information To The Public	1970	2017	Farm Service Agency	USDA	1	1	1
7	799	Compliance With The National Environmental Policy Act	1975	2017	Farm Service Agency	USDA	1	1	1
7	800	General Regulations	1981	2017	Grain Inspection, Packers and Stockyards Administration	USDA	1	1	1
7	814	Allotment Of Sugar Quotas, Mainland Cane Sugar Area	1970	1975	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	815	Allotment Of The Direct Consumption Portion Of Mainland Sugar Quota For Puerto Rico	1970	1971	Agricultural Stabilization and Conservation Service	USDA	1	1	1

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
7	842	Beet Sugar Area	1970	1973	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	849	Domestic Beet Sugar Producing Area Prevented Acreage Credit; 1972	1970	1973	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	850	Domestic Beet Sugar Producing Area	1970	1975	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	851	Commitment Of National Sugarbeet Acreage Reserve, 1962 And Subsequent Crops	1970	1975	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	857	Sugarcane; Puerto Rico	1970	1975	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	891	General Conditional Payments Provisions - Beet Sugar Area	1970	1975	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	892	General Conditional Payments Provisions - Mainland Cane Sugar Area	1970	1975	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	893	Puerto Rico	1970	1975	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	896	General Conditional Payments Provisions - Texas Cane Sugar Area	1973	1975	Agricultural Stabilization and Conservation Service	USDA	1	1	1
7	904	Grapefruit Grown In A Designated Area In California	1981	1984	Agricultural Marketing Service	USDA	1	1	1
7	907	Navel Oranges Grown In Arizona And Designated Part Of California	1970	1994	Agricultural Marketing Service	USDA	1	1	1
7	908	Valencia Oranges Grown In Arizona And Designated Part Of California	1970	1994	Agricultural Marketing Service	USDA	1	1	1
7	909	Grapefruit Grown In Arizona; In Imperial County, Calif.; And In That Part Of Riverside County, Calif., Situated South And East Of White Water, Calif.	1970	1980	Agricultural Marketing Service	USDA	1	1	1
7	910	Lemons Grown In California And Arizona	1970	1994	Agricultural Marketing Service	USDA	1	1	1
7	919	Peaches Grown In Mesa County, Colo.	1970	1991	Agricultural Marketing Service	USDA	1	1	1
7	921	Fresh Peaches Grown In Designated Counties In Washington	1970	1995	Agricultural Marketing Service	USDA	1	1	1
7	922	Apricots Grown In Designated Counties In Washington	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	923	Sweet Cherries Grown In Designated Counties In Washington	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	924	Fresh Prunes Grown In Designated Counties In Washington And In Umatilla County, Oregon	1970	2011	Agricultural Marketing Service	USDA	1	1	1
7	925	Grapes Grown In A Designated Area Of Southeastern California	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	927	Pears Grown In Oregon And Washington	1970	2017	Agricultural Marketing Service	USDA	1	1	1

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
7	929	Cranberries Grown In States Of Massachusetts, Rhode Island, Connecticut, New Jersey, Wisconsin, Michigan, Minnesota, Oregon, Washington, And Long Island In The State Of New York	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	930	Tart Cherries Grown In The States Of Michigan, New York, Pennsylvania, Oregon, Utah, Washington, And Wisconsin	1972	2017	Agricultural Marketing Service	USDA	1	1	1
7	931	Fresh Bartlett Pears Grown In Oregon And Washington	1970	2006	Agricultural Marketing Service	USDA	1	1	1
7	946	Irish Potatoes Grown In Washington	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	948	Irish Potatoes Grown In Colorado	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	959	Onions Grown In South Texas	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	965	Tomatoes Grown In The Lower Rio Grande Valley In Texas	1970	1995	Agricultural Marketing Service	USDA	1	1	1
7	966	Tomatoes Grown In Florida	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	979	Melons Grown In South Texas	1980	2006	Agricultural Marketing Service	USDA	1	1	1
7	981	Almonds Grown In California	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	982	Hazelnuts Grown In Oregon And Washington	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	984	Walnuts Grown In California	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	985	Marketing Order Regulating The Handling Of Spearmint Oil Produced In The Far West	1981	2017	Agricultural Marketing Service	USDA	1	1	1
7	987	Domestic Dates Produced Or Packed In Riverside County, California	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	991	Hops Of Domestic Production	1970	1985	Agricultural Marketing Service	USDA	1	1	1
7	1150	Dairy Promotion Program	1985	2017	Agricultural Marketing Service	USDA	1	1	1
7	1160	Fluid Milk Promotion Program	1994	2017	Agricultural Marketing Service	USDA	1	1	1
7	1205	Cotton Research And Promotion	1970	2017	Agricultural Marketing Service	USDA	1	1	1
7	1206	Mango Promotion, Research, And Information	2004	2017	Agricultural Marketing Service	USDA	1	1	1
7	1207	Potato Research And Promotion Plan	1972	2017	Agricultural Marketing Service	USDA	1	1	1
7	1208	Processed Raspberry Promotion, Research, And Information Order	1995	2017	Agricultural Marketing Service	USDA	1	1	1
7	1209	Mushroom Promotion, Research, And Consumer Information Order	1993	2017	Agricultural Marketing Service	USDA	1	1	1
7	1210	Watermelon Research And Promotion Plan	1989	2017	Agricultural Marketing Service	USDA	1	1	1

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
7	1211	Pecan Promotion And Research Plan	1993	1995	Agricultural Marketing Service	USDA	1	1	1
7	1212	Honey Packers And Importers Research, Promotion, Consumer Education And Industry Information Order	1993	2017	Agricultural Marketing Service	USDA	1	1	1
7	1214	Christmas Tree Promotion, Research, And Information Order	1998	2017	Agricultural Marketing Service	USDA	1	1	1
7	1215	Popcorn Promotion, Research, And Consumer Information	1998	2017	Agricultural Marketing Service	USDA	1	1	1
7	1216	Peanut Promotion, Research, And Information Order	2000	2017	Agricultural Marketing Service	USDA	1	1	1
7	1218	Blueberry Promotion, Research, And Information Order	2001	2017	Agricultural Marketing Service	USDA	1	1	1
7	1219	Hass Avocado Promotion, Research, And Information	2003	2017	Agricultural Marketing Service	USDA	1	1	1
7	1220	Soybean Promotion, Research, And Consumer Information	1992	2017	Agricultural Marketing Service	USDA	1	1	1
7	1221	Sorghum Promotion, Research, And Information Order	2009	2017	Agricultural Marketing Service	USDA	1	1	1
7	1230	Pork Promotion, Research, And Consumer Information	1987	2017	Agricultural Marketing Service	USDA	1	1	1
7	1240	Honey Research, Promotion, And Consumer Information	1987	2009	Agricultural Marketing Service	USDA	1	1	1
7	1250	Egg Research And Promotion	1976	2017	Agricultural Marketing Service	USDA	1	1	1
7	1260	Beef Promotion And Research	1977	2017	Agricultural Marketing Service	USDA	1	1	1
7	1270	Wool And Mohair Advertising And Promotion	1979	1995	Agricultural Marketing Service	USDA	1	1	1
7	1280	Lamb Promotion, Research, And Information Order	1979	2017	Agricultural Marketing Service	USDA	1	1	1
7	1290	Specialty Crop Block Grant Program	1984	2016	Agricultural Marketing Service	USDA	1	1	1
7	1291	Specialty Crop Block Grant Program—Farm Bill	2009	2017	Agricultural Marketing Service	USDA	1	1	1
7	1301	Definitions	1998	2002	Northeast Dairy Compact Commission	Other	1	1	1
7	1304	Classification Of Milk	1998	2002	Northeast Dairy Compact Commission	Other	1	1	1
7	1308	Administrative Assessment	1998	2002	Northeast Dairy Compact Commission	Other	1	1	1
7	1400	Payment Limitation And Payment Eligibility	1997	2017	Commodity Credit Corporation	USDA	1	1	1
7	1401	Commodity Certificates, In Kind Payments, And Other Forms Of Payment	1997	2017	Commodity Credit Corporation	USDA	1	1	1
7	1402	Policy For Certain Commodities Available For Sale	1970	2017	Commodity Credit Corporation	USDA	1	1	1
7	1407	Debarment And Suspension	1970	2017	Commodity Credit Corporation	USDA	1	1	1
7	1410	Conservation Reserve Program	1992	2017	Commodity Credit Corporation	USDA	1	1	1
7	1411	Oilseeds Program	2001	2003	Commodity Credit Corporation	USDA	1	1	1

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
7	1412	Agriculture Risk Coverage, Price Loss Coverage, And Cotton Transition Assistance Programs	1997	2017	Commodity Credit Corporation	USDA	1	1	1
7	1413	Hard White Wheat Incentive Program	1989	2017	Commodity Credit Corporation	USDA	1	1	1
7	1415	Grasslands Reserve Program	1995	2017	Commodity Credit Corporation	USDA	1	1	1
7	1416	Voluntary Production Limitation Program	1995	2017	Commodity Credit Corporation	USDA	1	1	1
7	1421	Grains And Similarly Handled Commodities	1970	2017	Commodity Credit Corporation	USDA	1	1	1
7	1422	Peanuts	1970	1997	Commodity Credit Corporation	USDA	1	1	1
7	1423	Commodity Credit Corporation Approved Warehouses	1970	2017	Commodity Credit Corporation	USDA	1	1	1
7	1424	Bioenergy Program	1970	2017	Commodity Credit Corporation	USDA	1	1	1
7	1427	Cotton	1970	2017	Commodity Credit Corporation	USDA	1	1	1
7	1429	Asparagus Revenue Market Loss Assistance Payment Program	2012	2017	Commodity Credit Corporation	USDA	1	1	1
7	1430	Dairy Products	1970	2017	Commodity Credit Corporation	USDA	1	1	1
7	1434	Nonrecourse Marketing Assistance Loans And Loan Deficiency Payments For Honey	1970	2017	Commodity Credit Corporation	USDA	1	1	1
7	1435	Sugar Program	1978	2017	Commodity Credit Corporation	USDA	1	1	1
7	1436	Farm Storage Facility Loan Program Regulations	2001	2017	Commodity Credit Corporation	USDA	1	1	1
7	1437	Noninsured Crop Disaster Assistance Program	1997	2017	Commodity Credit Corporation	USDA	1	1	1
7	1438	Naval Stores	1970	1987	Commodity Credit Corporation	USDA	1	1	1
7	1439	Emergency Livestock Assistance	1997	2009	Commodity Credit Corporation	USDA	1	1	1
7	1443	Oilseeds	1970	1995	Commodity Credit Corporation	USDA	1	1	1
7	1446	Peanuts	1970	2006	Commodity Credit Corporation	USDA	1	1	1
7	1447	2000 Peanut Marketing Assistance Program	2001	2003	Commodity Credit Corporation	USDA	1	1	1
7	1450	Biomass Crop Assistance Program (BCAP)	2011	2017	Commodity Credit Corporation	USDA	1	1	1
7	1463	2005-2014 Tobacco Transition Program	2006	2017	Commodity Credit Corporation	USDA	1	0	0
7	1464	Tobacco (Subchapter B - Loans, Purchases, And Other Operations)	1970	2005	Commodity Credit Corporation	USDA	1	1	1
7	1465	Agricultural Management Assistance	2004	2017	Commodity Credit Corporation	USDA	1	1	1
7	1466	Environmental Quality Incentives Program	1998	2017	Commodity Credit Corporation	USDA	1	1	1
7	1468	Agricultural Conservation Easement Program	1970	2017	Commodity Credit Corporation	USDA	1	1	1

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
7	1469	Conservation Security Program	2000	2017	Commodity Credit Corporation	USDA	1	1	1
7	1470	Conservation Stewardship Program	1989	2017	Commodity Credit Corporation	USDA	1	1	1
7	1474	Farm Storage Facilities	1970	1993	Commodity Credit Corporation	USDA	1	1	1
7	1475	Emergency Livestock Assistance	1970	1995	Commodity Credit Corporation	USDA	1	1	1
7	1476	Cranberry Market Loss Assistance Payment Program	1985	2003	Commodity Credit Corporation	USDA	1	1	1
7	1477	1998 Single-Year And Multi-Year Crop Loss Disaster Assistance Program	1987	2003	Commodity Credit Corporation	USDA	1	1	1
7	1478	1999 Crop Disaster Program	1989	2003	Commodity Credit Corporation	USDA	1	1	1
7	1479	Harney County Flood Assistance	1970	2003	Commodity Credit Corporation	USDA	1	1	1
7	1480	2001 And 2002-Crop Disaster Program	1979	2006	Commodity Credit Corporation	USDA	1	1	1
7	1481	Sugar Beet Disaster Program	1970	2006	Commodity Credit Corporation	USDA	1	1	1
7	1490	Payments On Exports Of Certain Kinds Of Tobacco	1970	1980	Commodity Credit Corporation	USDA	1	1	1
7	1491	Farm And Ranch Lands Protection Program	1980	2017	Commodity Credit Corporation	USDA	1	1	1
7	1495	Disposition Of Agricultural Commodities Under The CCC Barter Program	1970	1996	Commodity Credit Corporation	USDA	1	1	1
7	1497	Payment Limitation	1983	1995	Commodity Credit Corporation	USDA	1	1	1
7	1498	Foreign Persons Ineligible For Program Benefits	1989	1995	Commodity Credit Corporation	USDA	1	1	1
7	1520	Availability Of Information To The Public	1970	2017	Foreign Agricultural Service	USDA	1	1	1
7	1702	Organization And Functions	1983	1990	Rural Electrification Administration	USDA	1	1	1
7	1794	Environmental Policies And Procedures	1985	2016	Rural Utilities Service	USDA	1	1	1
7	1806	Insurance	1970	2017	Rural Housing Service, Rural Business-Cooperative Service, Rural Utilities Service, and Farm Service Agency	USDA	1	1	1
7	1809	Appraisals	1970	1993	Rural Housing Service, Rural Business-Cooperative Service, Rural Utilities Service, and Farm Service Agency	USDA	1	1	1
7	1821	Farm Purchase and Development Loans to Individuals	1970	1978	Farmers Home Administration	USDA	1	1	1
7	1843	Farm Loan	1974	1995	Farmers Home Administration	USDA	1	1	1
7	1872	Real Estate Security	1970	1986	Rural Housing Service, Rural Business-Cooperative Service,	USDA	1	1	1

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
					Rural Utilities Service, and Farm Service Agency				
7	1886	Disposal Of Reserved Mineral Interests	1970	1974	Farmers Home Administration	USDA	1	0	0
7	1888	Special Assistance To Drought Stricken Areas	1978	1982	Farmers Home Administration	USDA	1	1	1
7	1904	Loan And Grant Programs (Individual)	1977	1982	Rural Housing Service, Rural Business-Cooperative Service, Rural Utilities Service, and Farm Service Agency	USDA	1	1	1
7	1922	Appraisal	1981	1999	Rural Housing Service, Rural Business-Cooperative Service, Rural Utilities Service, and Farm Service Agency	USDA	1	1	1
7	1941	Operating Loans	1979	2007	Rural Housing Service, Rural Business-Cooperative Service, Rural Utilities Service, and Farm Service Agency	USDA	1	1	1
7	1943	Farm Ownership, Soil And Water And Recreation	1979	2007	Rural Housing Service, Rural Business-Cooperative Service, Rural Utilities Service, and Farm Service Agency	USDA	1	1	1
7	1945	Emergency	1979	2012	Rural Housing Service, Rural Business-Cooperative Service, Rural Utilities Service, and Farm Service Agency	USDA	1	1	1
7	1951	Servicing And Collections	1980	2017	Rural Housing Service, Rural Business-Cooperative Service, Rural Utilities Service, and Farm Service Agency	USDA	1	1	1
7	2003	Organization	1979	2017	Rural Housing Service, Rural Business-Cooperative Service, Rural Utilities Service, and Farm Service Agency	USDA	1	1	1
7	2842	Standards For Condition Of Food Containers	1978	1981	Food Safety and Quality Service	USDA	1	1	1
7	2880	Fresh Irish Potatoes	1979	1981	Food Safety and Quality Service	USDA	1	1	1
7	3017	Government-wide Debarment And Suspension (Non-procurement)	1990	2010	Office of the Chief Financial Officer	USDA	1	1	1
7	3021	Government-wide Requirements For Drug-Free Workplace (Financial Assistance)	2004	2012	Office of the Chief Financial Officer	USDA	1	1	1
7	3434	Hispanic-Serving Agricultural Colleges And Universities Certification Process	2013	2017	National Institute of Food and Agriculture	USDA	1	1	1
7	3550	Direct Single Family Housing Loans And Grants	1997	2017	Rural Housing Service	USDA	0	0	0

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
7	3600	Organization And Functions	1988	2017	National Agricultural Statistics Service	USDA	1	1	1
7	3601	Public Information	1988	2017	National Agricultural Statistics Service	USDA	1	1	1
8	241	Apprehension And Detention Of Aliens Ordered Removed	1970	2017	Department of Homeland Security	DHS	1	1	1
9	1	Definition Of Terms	1970	2017	Animal and Plant Health Inspection Service	USDA	1	0	0
9	11	Horse Protection Regulations	1973	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	50	Animals Destroyed Because Of Tuberculosis	1976	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	51	Animals Destroyed Because Of Brucellosis	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	52	Swine Destroyed Because Of Pseudorabies	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	53	Foot-And-Mouth Disease, Pleuropneumonia, Rinderpest, And Certain Other Communicable Diseases Of Livestock Or Poultry	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	54	Control Of Scrapie	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	55	Control Of Chronic Wasting Disease	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	71	General Provisions	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	73	Scabies In Cattle	1970	2017	Animal and Plant Health Inspection Service	USDA	1	0	0
9	77	Tuberculosis	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	79	Scrapie In Sheep And Goats	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	80	Johne'S Disease In Domestic Animals	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	81	Chronic Wasting Disease In Deer, Elk, And Moose	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	86	Animal Disease Traceability	2014	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	94	Rinderpest, Foot-And-Mouth Disease, Newcastle Disease, Highly Pathogenic Avian Influenza, African Swine Fever, Classical Swine Fever, Swine Vesicular Disease, And Bovine Spongiform Encephalopathy: Prohibited And Restricted Importations	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	102	Licenses For Biological Products	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	106	Exemption For Biological Products Used In Department Programs Or Under Department Control Or Supervision	1981	2017	Animal and Plant Health Inspection Service	USDA	1	1	1

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
9	108	Facility Requirements For Licensed Establishments	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	113	Standard Requirements	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	116	Records And Reports	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	122	Organisms And Vectors	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	151	Recognition Of Breeds And Books Of Record Of Purebred Animals	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	160	Definition Of Terms	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	161	Requirements And Standards For Accredited Veterinarians And Suspension Or Revocation Of Such Accreditation	1970	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	166	Swine Health Protection	1983	2017	Animal and Plant Health Inspection Service	USDA	1	1	1
9	201	Regulations Under The Packers And Stockyards Act	1970	2017	Grain Inspection, Packers and Stockyards Administration	USDA	1	1	1
9	204	Organization And Functions	1970	2017	Grain Inspection, Packers and Stockyards Administration	USDA	1	1	1
9	205	Clear Title	1987	2017	Grain Inspection, Packers and Stockyards Administration	USDA	1	1	1
9	301	Terminology; Adulteration And Misbranding Standards	1970	2017	Food Safety and Inspection Service	USDA	1	1	1
9	302	Application Of Inspection And Other Requirements	1970	2017	Food Safety and Inspection Service	USDA	1	0	0
9	310	Post-Mortem Inspection	1970	2017	Food Safety and Inspection Service	USDA	1	1	1
9	317	Labeling, Marking Devices, And Containers	1970	2017	Food Safety and Inspection Service	USDA	1	1	1
9	318	Entry Into Official Establishments; Re-inspection And Preparation Of Products	1970	2017	Food Safety and Inspection Service	USDA	1	1	1
9	320	Records, Registration, And Reports	1970	2017	Food Safety and Inspection Service	USDA	1	1	1
9	322	Exports	1970	2017	Food Safety and Inspection Service	USDA	1	1	1
9	327	Imported Products (Subchapter A-Agency Organization And Terminology; Mandatory Meat And Poultry Products Inspection And Voluntary Inspection And Certification)	1970	2017	Food Safety and Inspection Service	USDA	1	1	1
9	381	Poultry Products Inspection Regulations	1970	2017	Food Safety and Inspection Service	USDA	1	1	1
9	412	Label Approval	2014	2017	Food Safety and Inspection Service	USDA	1	1	1
10	11	Criteria And Procedures For Determining Eligibility For	1973	2017	Nuclear Regulatory Commission	Other	0	1	0

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
		Access To Or Control Over Special Nuclear Material							
10	300	Voluntary Greenhouse Gas Reporting Program: General Guidelines	1979	2017	Department of Energy	DOE	1	0	0
10	307	New Powerplants And New Major Fuel Burning Installations	1976	1980	Department of Energy	DOE	1	1	1
10	390	Accounting Procedures For Determining Net Profit Share Payment For Outer Continental Shelf Oil And Gas Leases	1981	1983	Department of Energy	DOE	0	1	0
10	452	Production Incentives For Cellulosic Biofuels	2010	2017	Department of Energy	DOE	1	1	1
10	770	Transfer Of Real Property At Defense Nuclear Facilities For Economic Development	2001	2017	Department of Energy	DOE	0	1	0
10	1046	Medical, Physical Readiness, Training, And Access Authorization Standards For Protective Force Personnel	1985	2017	Department of Energy	DOE	0	1	0
12	1701	Assessments (OFHEO Organization And Functions)	2002	2008	Office of Federal Housing Enterprise Oversight	HUD	0	1	0
13	116	Policies Of General Application	1975	1995	Small Business Administration	Other	1	1	1
14	47	Aircraft Registration	1970	2017	Federal Aviation Administration	DOT	0	1	0
14	150	Airport Noise Compatibility Planning	1982	2017	Federal Aviation Administration	DOT	0	1	0
14	198	Aviation Insurance	1970	2017	Federal Aviation Administration	DOT	0	1	0
14	300	Rules Of Conduct In Dot Proceedings Under This Chapter	1970	2017	Office of the Secretary	DOT	0	1	0
15	80	Furnishing Personal Census Data From Census Of Population Schedules	1976	2017	Bureau of the Census	DOC	1	0	0
15	946	Modernization Of The National Weather Service	1994	2017	National Oceanic and Atmospheric Administration	DOC	1	1	1
16	300	Rules And Regulations Under The Wool Products Labeling Act Of 1939	1970	2017	Federal Trade Commission	FTC	1	1	1
16	301	Rules And Regulations Under Fur Products Labeling Act	1970	2017	Federal Trade Commission	FTC	1	1	1
16	303	Rules And Regulations Under The Textile Fiber Products Identification Act	1970	2017	Federal Trade Commission	FTC	1	1	1
16	801	Coverage Rules	1979	2017	Federal Trade Commission	FTC	1	1	1
16	802	Exemption Rules	1979	2017	Federal Trade Commission	FTC	1	1	1
16	1603	Statements Of Policy Or Interpretation	1974	1975	Consumer Product Safety Commission	CPSC	1	1	1

Annex II. Code of Federal Regulations Parts in the Sample

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
18	16	Procedures Relating To Takeover And Relicensing Of Licensed Projects	1970	2017	Federal Energy Regulatory Commission	DOE	1	1	1
18	270	Determination Procedures	1979	2017	Federal Energy Regulatory Commission	DOE	1	1	1
18	415	Basin Regulations	1977	2017	Delaware River Basin Commission	Other	1	0	0
18	420	Basin Regulations	1977	2017	Delaware River Basin Commission	Other	1	1	1
18	803	Review And Approval Of Projects	1975	2006	Susquehanna River Basin Commission	Other	1	1	1
18	806	Review And Approval Of Projects	2007	2017	Susquehanna River Basin Commission	Other	1	1	1
18	807	Water Withdrawal Registration	2007	2017	Susquehanna River Basin Commission	Other	1	1	1
19	177	Administrative Rulings	1976	2017	US Customs and Border Protection	DHS	1	1	1
19	181	North American Free Trade Agreement	1994	2017	US Customs and Border Protection	DHS	1	1	1
19	206	Investigations Relating To Global And Bilateral Safeguard Actions, Market Disruption, Trade Diversion, And Review Of Relief Actions	1970	2017	United States International Trade Commission	Other	1	1	1
19	353	Antidumping Duties	1980	1997	International Trade Administration	DOC	1	1	1
20	209	Railroad Employers' Reports And Responsibilities	1970	2017	Railroad Retirement Board	Other	0	1	0
20	323	Nongovernmental Plans For Unemployment Or Sickness Insurance	1992	2017	Railroad Retirement Board	Other	0	1	0
20	364	Use Of Penalty Mail To Assist In The Location And Recovery Of Missing Children	1987	2017	Railroad Retirement Board	Other	0	1	0
20	679	Statewide And Local Governance Of The Workforce Development System Under Title I Of The Workforce Innovation And Opportunity Act	1979	2017	Employment and Training Administration	DOL	0	0	0
20	681	Youth Activities Under Title I Of The Workforce Innovation And Opportunity Act	2017	2017	Employment and Training Administration	DOL	0	0	0
20	683	Administrative Provisions Under Title I Of The Workforce Innovation And Opportunity Act	2017	2017	Employment and Training Administration	DOL	0	0	0
20	801	Establishment And Operation Of The Board	1973	2017	Benefits Review Board	DOL	1	1	1
21	1	General Enforcement Regulations	1970	2017	Food and Drug Administration	HHS	1	1	1
21	45	Margarine, Oleomargarine	1970	1976	Food and Drug Administration	HHS	1	1	1
21	51	Canned Vegetables	1970	1976	Food and Drug Administration	HHS	1	1	1

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
21	109	Unavoidable Contaminants In Food For Human Consumption And Food-Packaging Material	1977	2017	Food and Drug Administration	HHS	1	1	1
21	112	Standards For The Growing, Harvesting, Packing, And Holding Of Produce For Human Consumption	2016	2017	Food and Drug Administration	HHS	1	1	1
21	120	Hazard Analysis And Critical Control Point (HACCP) Systems	1970	2017	Food and Drug Administration	HHS	1	1	1
21	122	Smoked And Smoke-Flavored Fish	1974	1984	Food and Drug Administration	HHS	0	1	0
21	123	Fish And Fishery Products	1975	2017	Food and Drug Administration	HHS	0	1	0
21	132	Registration Of Producers Of Drugs And Listing Of Drugs And Listing Of Drugs In Commercial Distribution	1970	1974	Food and Drug Administration	HHS	0	1	0
21	138	Drugs; Official Names	1970	1971	Food and Drug Administration	HHS	0	1	0
21	172	Food Additives Permitted For Direct Addition To Food For Human Consumption	1977	2017	Food and Drug Administration	HHS	1	1	1
21	173	Secondary Direct Food Additives Permitted In Food For Human Consumption	1977	2017	Food and Drug Administration	HHS	1	1	1
21	175	Indirect Food Additives: Adhesives And Components Of Coatings	1977	2017	Food and Drug Administration	HHS	1	1	1
21	176	Indirect Food Additives: Paper And Paperboard Components	1977	2017	Food and Drug Administration	HHS	1	1	1
21	178	Indirect Food Additives: Adjuvants, Production Aids, And Sanitizers	1977	2017	Food and Drug Administration	HHS	1	1	1
21	184	Direct Food Substances Affirmed As Generally Recognized As Safe	1977	2017	Food and Drug Administration	HHS	1	1	1
21	186	Indirect Food Substances Affirmed As Generally Recognized As Safe	1977	2017	Food and Drug Administration	HHS	1	1	1
21	193	Tolerances For Pesticides In Food Administered By The Environmental Protection Agency	1977	1988	Food and Drug Administration	HHS	1	1	1
21	207	Requirements For Foreign And Domestic Establishment Registration And Listing For Human Drugs, Including Drugs That Are Regulated Under A Biologics License Application, And Animal Drugs, And The National Drug Code	1975	2017	Food and Drug Administration	HHS	0	1	0
21	299	Drugs; Official Names And Established Names	1975	2017	Food and Drug Administration	HHS	0	1	0
21	306	Prescriptions	1970	1973	Food and Drug Administration	HHS	0	1	0

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
21	500	General	1975	2017	Food and Drug Administration	HHS	1	1	1
21	507	Current Good Manufacturing Practice, Hazard Analysis, And Risk-Based Preventive Controls For Food For Animals	1977	2017	Food and Drug Administration	HHS	1	0	0
21	509	Unavoidable Contaminants In Animal Food And Food-Packaging Material	1977	2017	Food and Drug Administration	HHS	1	1	1
21	510	New Animal Drugs	1975	2017	Food and Drug Administration	HHS	1	1	1
21	511	New Animal Drugs For Investigational Use	1975	2017	Food and Drug Administration	HHS	1	0	0
21	514	New Animal Drug Applications	1975	2017	Food and Drug Administration	HHS	1	0	0
21	530	Extra-label Drug Use In Animals	1997	2017	Food and Drug Administration	HHS	1	1	1
21	556	Tolerances For Residues Of New Animal Drugs In Food	1975	2017	Food and Drug Administration	HHS	1	1	1
21	561	Tolerances For Pesticides In Animal Feeds Administered By The Environmental Protection Agency	1975	1988	Food and Drug Administration	HHS	1	1	1
21	570	Food Additives	1977	2017	Food and Drug Administration	HHS	1	1	1
21	573	Food Additives Permitted In Feed And Drinking Water Of Animals	1977	2017	Food and Drug Administration	HHS	1	1	1
21	584	Food Substances Affirmed As Generally Recognized As Safe In Feed And Drinking Water Of Animals	1994	2017	Food and Drug Administration	HHS	1	1	1
21	710	Voluntary Registration Of Cosmetic Product Establishments	1974	2017	Food and Drug Administration	HHS	1	1	1
21	807	Establishment Registration And Device Listing For Manufacturers And Initial Importers Of Devices	1978	2017	Food and Drug Administration	HHS	0	1	0
21	1306	Prescriptions	1974	2017	Drug Enforcement Administration	DOJ	1	1	1
21	1312	Importation And Exportation Of Controlled Substances	1974	2017	Drug Enforcement Administration	DOJ	1	1	1
22	4	Notification Of Foreign Official Status	1970	2017	Department of State	State	0	1	0
23	20	National Standards For Regulation By States Of Outdoor Advertising Signs, Displays And Devices Adjacent To The National System Of Interstate And Defense Highways	1970	1972	Federal Highway Administration	DOT	0	1	0
23	661	Indian Reservation Road Bridge Program	1977	2017	Federal Highway Administration	DOT	0	1	0
23	772	Procedures For Abatement Of Highway Traffic Noise And Construction Noise	1973	2017	Federal Highway Administration	DOT	0	1	0

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
23	795	Process Guidelines (For The Development Of Environmental Action Plans)	1973	1982	Federal Highway Administration	DOT	0	1	0
24	203	Single Family Mortgage Insurance	1970	2017	Office of Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	207	Multifamily Housing Mortgage Insurance	1970	2017	Office of Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	220	Mortgage Insurance And Insured Improvement Loans For Urban Renewal And Concentrated Development Areas	1970	2017	Office of Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	224	Armed Services Housing--Military Personnel (Sec. 803)	1972	1995	Office of Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	225	Military Housing Insurance	1972	1995	Office of Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	231	Housing Mortgage Insurance For The Elderly	1970	2017	Office of Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	234	Condominium Ownership Mortgage Insurance	1970	2017	Office of Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	241	Supplementary Financing For Insured Project Mortgages	1970	2017	Office of Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	244	Mortgage Insurance For Group Practice Facilities [Title Xi]	1972	2017	Office of Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	266	Housing Finance Agency Risk-Sharing Program For Insured Affordable Multifamily Project Loans	1994	2017	Office of Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	279	College Housing	1972	1980	Office of Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	290	Disposition Of Multifamily Projects And Sale Of Hud-Held Multifamily Mortgages	1977	2017	Office of Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	291	Disposition Of HUD-Acquired And -Owned Single Family Property	1990	2017	Office of Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
24	571	Community Development Block Grants For Indian Tribes And Alaskan Native Villages	1978	1994	Office of Assistant Secretary For Community Planning and Development	HUD	0	1	0
24	590	Urban Homesteading	1979	2014	Office of Assistant Secretary For Community Planning and Development	HUD	0	1	0
24	791	Allocations Of Housing Assistance Funds	1984	2017	Office of the Secretary	HUD	0	1	0
24	803	Section 23 Housing Assistance Payments Program	1970	1981	Low-Income Housing	HUD	0	1	0
24	811	Tax Exemption Of Obligations Of Public Housing Agencies And Related Amendments	1976	2017	Office of the Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	812	Definition Of Family And Other Related Terms; Occupancy By Single Persons	1978	1995	Office of the Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	841	Public Housing Development	1977	1983	Low-Income Housing	HUD	0	1	0
24	880	Section 8 Housing Assistance Payments Program For New Construction	1976	2017	Office of the Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	881	Section 8 Housing Assistance Payments Program For Substantial Rehabilitation	1976	2017	Office of the Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	885	Loans For Housing For The Elderly Or Handicapped	1976	1995	Office of the Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	889	Supportive Housing For The Elderly	1976	1995	Office of the Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	890	Supportive Housing For Persons With Disabilities	1976	1995	Office of the Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	891	Supportive Housing For The Elderly And Persons With Disabilities	1977	2017	Office of the Assistant Secretary For Housing-Federal Housing Commissioner	HUD	0	1	0
24	912	Definition Of Family And Other Related Terms; Occupancy By Single Persons	1984	1995	Office of Assistant Secretary For Public and Indian Housing	HUD	0	1	0
24	941	Public Housing Development	1984	2013	Office of Assistant Secretary For Public and Indian Housing	HUD	0	1	0
24	983	Section 8 Project-Based Certificate Program	1997	2017	Office of Assistant Secretary For Public and Indian Housing	HUD	0	1	0
24	1910	Criteria For Land Management And Use	1970	1979	Federal Insurance Administration	HUD	0	1	0

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
24	2700	Emergency Homeowners' Loan Program	1976	2014	Emergency Mortgage Insurance and Loan Programs	HUD	0	1	0
25	101	Loans To Indians From The Revolving Loan Fund	1970	2017	Bureau of Indian Affairs	DOI	0	1	0
25	114	Special Deposits	1978	2000	Bureau of Indian Affairs	DOI	0	1	0
25	120	Reimbursement Of The Ute Tribe Of The Uintah And Ouray Reservation, Utah	1972	1987	Bureau of Indian Affairs	DOI	0	1	0
25	128	Sale Of Irrigable Lands, Special Water Contract Requirements	1970	1981	Bureau of Indian Affairs	DOI	1	1	1
25	137	Reimbursement Of Construction Costs, San Carlos Indian Irrigation Project, Arizona	1982	2017	Bureau of Indian Affairs	DOI	1	1	1
25	161	Navajo Partitioned Lands Grazing Permits	1970	2017	Bureau of Indian Affairs	DOI	1	1	1
25	162	Leases And Permits	1970	2017	Bureau of Indian Affairs	DOI	1	1	1
25	166	Grazing Permits	1982	2017	Bureau of Indian Affairs	DOI	1	1	1
25	171	Irrigation Operation And Maintenance	1970	2017	Bureau of Indian Affairs	DOI	1	1	1
25	172	Pueblo Indian Lands Benefited By Irrigation And Drainage Works Of Middle Rio Grande Conservancy District, New Mexico	1970	2017	Bureau of Indian Affairs	DOI	1	1	1
25	174	Operation And Maintenance Charges	1970	1982	Bureau of Indian Affairs	DOI	1	1	1
25	177	San Carlos Indian Irrigation Project, Arizona	1970	1991	Bureau of Indian Affairs	DOI	1	1	1
25	191	Peration And Maintenance	1970	1981	Bureau of Indian Affairs	DOI	1	1	1
25	193	Crow Irrigation Project, Montana	1970	1977	Bureau of Indian Affairs	DOI	1	1	1
25	194	Flathead Irrigation Project, Montana	1970	1977	Bureau of Indian Affairs	DOI	1	1	1
25	196	Fort Belknap Irrigation Project, Montana	1970	1977	Bureau of Indian Affairs	DOI	1	1	1
25	201	Wind River Irrigation Project, Wyoming	1970	1977	Bureau of Indian Affairs	DOI	1	1	1
25	202	Pueblo Indian Lands Benefitted By Irrigation And Drainage Works Of Middle Rio Grande Conservancy District, New Mexico	1970	1981	Bureau of Indian Affairs	DOI	1	1	1
25	215	Lead And Zinc Mining Operations And Leases, Quapaw Agency	1970	2017	Bureau of Indian Affairs	DOI	0	1	0
25	216	Surface Exploration, Mining, And Reclamation Of Lands	1970	2017	Bureau of Indian Affairs	DOI	0	1	0
25	221	Operation And Maintenance Charges	1970	1981	Bureau of Indian Affairs	DOI	0	1	0
25	243	Reindeer In Alaska	1982	2017	Bureau of Indian Affairs	DOI	1	1	1
25	503	Commission Information Collection Requirements Under The Paperwork Reduction Act: OMB Control Numbers And Expiration Dates	1970	2017	National Indian Gaming Commission	DOI	0	0	0

Annex II. Code of Federal Regulations Parts in the Sample

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
25	542	Minimum Internal Control Standards	1999	2017	National Indian Gaming Commission	DOI	0	0	0
26	14	Temporary Income Tax Regulations Relating To Incentive Stock Options	1970	2004	Internal Revenue Service	Treasury	1	1	1
26	35	Employment Tax And Collection Of Income Tax At Source Regulations Under The Tax Equity And Fiscal Responsibility Act Of 1982	1983	2017	Internal Revenue Service	Treasury	0	0	0
27	9	American Viticultural Areas	1980	2017	Alcohol and Tobacco Tax and Trade Bureau	Treasury	1	1	1
27	18	Production Of Volatile Fruit-Flavor Concentrate	1976	2017	Alcohol and Tobacco Tax and Trade Bureau	Treasury	1	1	1
28	550	Drug Programs	1979	2017	Bureau of Prisons	DOJ	0	1	0
29	11	Department Of Labor National Environmental Policy Act (NEPA) Compliance Procedures	1970	2017	Office of the Secretary of Labor	DOL	0	1	0
29	500	Migrant And Seasonal Agricultural Worker Protection	1983	2017	Wage and Hour Division	DOL	1	1	1
29	502	Enforcement Of Contractual Obligations For Temporary Alien Agricultural Workers Admitted Under Section 218 Of The Immigration And Nationality Act (Suspended 6-29-2009)	1989	2017	Wage and Hour Division	DOL	1	1	1
29	503	Enforcement Of Obligations For Temporary Nonimmigrant Non-Agricultural Workers Described In The Immigration And Nationality Act	1990	2017	Wage and Hour Division	DOL	1	1	1
29	1206	Handling Representation Disputes Under The Railway Labor Act	1970	2017	National Mediation Board	Other	0	0	0
29	1913	Rules Of Agency Practice And Procedure Concerning Osha Access To Employee Medical Records	1973	2017	Occupational Safety and Health Administration	DOL	1	0	0
29	2550	Rules And Regulations For Fiduciary Responsibility	1975	2017	Employee Benefits Security Administration	DOL	1	1	1
29	2611	Annual Report	1976	1995	Pension Benefit Guaranty Corporation	DOL	1	1	1
29	2620	Valuation Of Plan Assets	1980	1995	Pension Benefit Guaranty Corporation	DOL	1	1	1
29	4002	Bylaws Of The Pension Benefit Guaranty Corporation	1997	2017	Federal Mine Safety and Health Review Commission	Other	0	0	0
29	4065	Annual Report	1997	2017	Federal Mine Safety and Health Review Commission	Other	0	1	0
30	220	Accounting Procedures For Determining Net Profit Share Payment For Outer Continental Shelf Oil And Gas Leases	1983	2010	Minerals Management Service	DOI	0	1	0

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
30	254	Oil-Spill Response Requirements For Facilities Located Seaward Of The Coast Line	1993	2017	Bureau of Safety and Environmental Enforcement	DOI	0	1	0
30	701	Permanent Regulatory Program	1979	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	702	Exemption For Coal Extraction Incidental To The Extraction Of Other Minerals	1990	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	705	Restriction On Financial Interests Of State Employees	1978	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	0	0
30	715	General Performance Standards	1978	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	716	Special Performance Standards	1978	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	717	Underground Mining General Performance Standards	1978	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	764	State Processes For Designating Areas Unsuitable For Surface Coal Mining Operations	1979	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	772	Requirements For Coal Exploration	1983	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	773	Requirements For Permits And Permit Processing	1983	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	774	Revision; Renewal; Transfer, Assignment, Or Sale Of Permit Rights; Post-Permit Issuance Requirements; And Other Actions Based On Ownership, Control, And Violation Information	1983	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	776	General Requirements For Coal Exploration	1979	1983	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	779	Surface Mining Permit Applications—Minimum Requirements For Information On Environmental Resources	1979	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	780	Surface Mining Permit Applications—Minimum Requirement For Reclamation And Operation Plan	1979	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	783	Underground Mining Permit Applications-Minimum Requirements For Information On Environmental Resources	1979	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	784	Underground Mining Permit Applications-Minimum Requirements For Reclamation And Operation Plan	1979	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
30	785	Requirements For Permits For Special Categories Of Mining	1979	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	786	Review, Public Participation, And Approval Or Disapproval Of Permit Applications And Permit Terms And Conditions	1979	1983	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	800	Bond And Insurance Requirements For Surface Coal Mining And Reclamation Operations Under Regulatory Programs	1979	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	805	Amount And Duration Of Performance Bond	1979	1982	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	806	Form, Conditions, And Terms Of Performance Bonds And Liability Insurance	1979	1982	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	807	Procedures, Criteria And Schedule For Release Of Performance Bond	1979	1982	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	808	Performance Bond Forfeiture Criteria And Procedures	1979	1982	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	815	Permanent Program Performance Standards—Coal Exploration	1979	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	816	Permanent Program Performance Standards-Surface Mining Activities	1979	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	817	Permanent Program Performance Standards-Underground Mining Activities	1979	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	819	Special Permanent Program Performance Standards-Auger Mining	1979	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	823	Special Permanent Program Performance Standards	1979	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	824	Special Permanent Program Performance Standards-Mountaintop Removal	1979	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	840	State Regulatory Authority: Inspection And Enforcement	1979	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	902	Alaska	1983	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	915	Iowa	1981	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	916	Kansas	1981	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
30	918	Louisiana	1981	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	944	Utah	1981	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	955	Certification Of Blasters In Federal Program States And On Indian Lands	1986	2017	Office of Surface Mining Reclamation and Enforcement	DOI	0	1	0
30	1220	Accounting Procedures For Determining Net Profit Share Payment For Outer Continental Shelf Oil And Gas Leases	2011	2017	Office of Natural Resources Revenue	DOI	0	1	0
31	332	Offering Of United States Savings Bonds, Series H	1970	2017	Fiscal Service	Treasury	0	1	0
31	341	Regulations Governing United States Retirement Plan Bonds	1970	2017	Fiscal Service	Treasury	0	1	0
31	346	Regulations Governing United States Individual Retirement Bonds	1975	2017	Fiscal Service	Treasury	0	1	0
32	62	Drunk And Drugged Driving By DOD Personnel	1970	2005	Office of the Secretary of Defense	DOD	0	1	0
32	66	Qualification Standards For Enlistment, Appointment, And Induction	1970	2017	Office of the Secretary of Defense	DOD	0	1	0
32	190	Natural Resources Management Program	1970	2005	Office of the Secretary of Defense	DOD	1	1	1
32	193	Highways For National Defense	1970	2017	Office of the Secretary of Defense	DOD	0	1	0
32	233	Federal Voting Assistance Program (FVAP)	1970	2017	Office of the Secretary of Defense	DOD	0	1	0
32	234	Conduct On The Pentagon Reservation	1970	2017	Office of the Secretary of Defense	DOD	0	1	0
32	256	Air Installations Compatible Use Zones	1977	2011	Office of the Secretary of Defense	DOD	0	1	0
32	263	Traffic And Vehicle Control On Certain Defense Mapping Agency Sites	1970	2017	Office of the Secretary of Defense	DOD	0	1	0
32	265	Natural Resources Management Program	1970	1991	Office of the Secretary of Defense	DOD	0	1	0
32	518	The Freedom Of Information Act Program	1970	2017	Department of the Army	DOD	0	0	0
32	631	Armed Forces Disciplinary Control Boards And Off-Installation Liaison And Operations	1970	2017	Department of the Army	DOD	0	0	0
32	642	Facilities Engineering, Natural Resources--Land, Forest And Wildlife Management	1977	1985	Department of the Army	DOD	0	1	0
32	651	Environmental Analysis Of Army Actions (Ar 200-2)	1981	2017	Department of the Army	DOD	0	1	0
32	657	Facilities Engineering, Pest Management Program	1978	1985	Department of the Army	DOD	0	1	0
32	757	Affirmative Claims Regulations	1970	2017	Department of the Navy	DOD	0	1	0

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
32	1210	Bonds, Insurance, And Indemnification	1970	1983	Defense Logistics Agency	DOD	0	1	0
32	1453	Mandatory Exemptions From Renegotiation	1970	1978	Defense Logistics Agency	DOD	0	0	0
32	1661	Classification Of Conscientious Objectors	1973	1981	Selective Service System	Other	0	1	0
33	27	Adjustment Of Civil Monetary Penalties For Inflation	1997	2017	Coast Guard	DHS	0	1	0
33	105	Maritime Security: Facilities	1970	2017	Coast Guard	DHS	0	1	0
33	106	Marine Security: Outer Continental Shelf (OCS) Facilities	2003	2017	Coast Guard	DHS	0	1	0
33	126	Handling Of Dangerous Cargo At Waterfront Facilities	1970	2017	Coast Guard	DHS	0	1	0
33	133	Oil Spill Liability Trust Fund; State Access	1993	2017	Coast Guard	DHS	0	0	0
33	154	Facilities Transferring Oil Or Hazardous Material In Bulk	1973	2017	Coast Guard	DHS	0	1	0
33	274	Pest Control Program For Civil Works Projects	1978	2017	Corps of Engineers	DOD	0	1	0
33	290	Planning Process: Multiobjective Planning Framework	1976	1981	Corps of Engineers	DOD	0	0	0
33	292	Problem Identification	1976	1981	Corps of Engineers	DOD	0	0	0
33	323	Permits For Discharges Of Dredged Or Fill Material Into Waters Of The United States	1978	2017	Corps of Engineers	DOD	1	1	1
33	328	Definition Of Waters Of The United States	1978	2017	Corps of Engineers	DOD	1	1	1
33	341	Evaluation Of Beneficial Contributions To National Economic Development For Flood Plain Management Plans	1975	1980	Corps of Engineers	DOD	1	1	1
34	235	Drug-Free Schools And Communities Federal Activities Grants Program	1976	1994	Office of the Secretary	DOE	0	1	0
34	236	Drug-Free Schools And Communities-Regional Centers Program	1991	1994	Office of the Secretary	DOE	0	1	0
34	788	National Diffusion Network: State Facilitator Projects	1988	1995	Office of Educational Research and Improvement	DOE	0	0	0
34	789	National Diffusion Network: Private School Facilitator Project	1988	1995	Office of Educational Research and Improvement	DOE	0	1	0
36	322	Public Use Of Salt Plains National Wildlife Refuge And Great Salt Plains Dam And Reservoir Area, Salt Fork Of Arkansas River, Oklahoma	1970	1978	Corps of Engineers	DOD	0	0	0
36	327	Rules And Regulations Governing Public Use Of Water Resource Development Projects Administered By The Chief Of Engineers	1973	2017	Corps of Engineers	DOD	0	0	0

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
36	1155	Statement Of Organization And Procedures	1985	1997	Architectural and Transportation Barriers Compliance Board	Other	0	0	0
39	53	State Department Regulations 9Arms And Technical Data)	1972	1975	United States Postal Service	Other	0	1	0
39	125	Second Class Bulk Mailings	1970	1974	United States Postal Service	Other	0	1	0
39	136	Air And Priority Mail	1970	1974	United States Postal Service	Other	0	1	0
39	253	Contract Compliance Program	1970	1983	United States Postal Service	Other	0	1	0
40	62	Approval And Promulgation Of State Plans For Designated Facilities And Pollutants	1979	2017	Environmental Protection Agency	EPA	1	1	1
40	66	Assessment And Collection Of Noncompliance Penalties By EPA	1981	2017	Environmental Protection Agency	EPA	1	1	1
40	68	Chemical Accident Prevention Provisions	1994	2017	Environmental Protection Agency	EPA	1	1	1
40	70	State Operating Permit Programs	1993	2017	Environmental Protection Agency	EPA	1	1	1
40	75	Continuous Emission Monitoring	1993	2017	Environmental Protection Agency	EPA	1	1	1
40	112	Oil Pollution Prevention	1974	2017	Environmental Protection Agency	EPA	0	1	0
40	113	Liability Limits For Small Onshore Storage Facilities	1974	2017	Environmental Protection Agency	EPA	0	1	0
40	116	Designation Of Hazardous Substances	1978	2017	Environmental Protection Agency	EPA	1	1	1
40	122	EPA Administered Permit Programs: The National Pollutant Discharge Elimination System	1972	2017	Environmental Protection Agency	EPA	1	1	1
40	124	Procedures For Decisionmaking (Subchapter D - Water Programs)	1973	2017	Environmental Protection Agency	EPA	1	1	1
40	127	NPDES Electronic Reporting	2016	2017	Environmental Protection Agency	EPA	1	1	1
40	129	Toxic Pollutant Effluent Standards	1977	2017	Environmental Protection Agency	EPA	1	0	0
40	150	General	2006	2017	Environmental Protection Agency	EPA	1	1	1
40	152	Pesticide Registration And Classification Procedures	1985	2017	Environmental Protection Agency	EPA	1	1	1
40	156	Labeling Requirements For Pesticides And Devices	1988	2017	Environmental Protection Agency	EPA	1	1	1
40	158	Data Requirements For Pesticides	1985	2017	Environmental Protection Agency	EPA	1	1	1
40	159	Statements Of Policies And Interpretations	1998	2017	Environmental Protection Agency	EPA	1	1	1
40	161	Data Requirements For Registration Of Antimicrobial Pesticides	2008	2013	Environmental Protection Agency	EPA	1	1	1
40	162	State Registration Of Pesticide Products	1972	2017	Environmental Protection Agency	EPA	1	1	1
40	163	Certification Of Usefulness Of Pesticide Chemicals	1972	2005	Environmental Protection Agency	EPA	1	1	1

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
40	166	Exemption Of Federal And State Agencies For Use Of Pesticides Under Emergency Conditions	1974	2017	Environmental Protection Agency	EPA	1	1	1
40	167	Registration Of Pesticide And Active Ingredient Producing Establishments, Submission Of Pesticide Reports	1974	2017	Environmental Protection Agency	EPA	1	1	1
40	170	Worker Protection Standard	1974	2017	Environmental Protection Agency	EPA	1	1	1
40	171	Certification Of Pesticide Applicators	1975	2017	Environmental Protection Agency	EPA	1	1	1
40	172	Experimental Use Permits	1975	2017	Environmental Protection Agency	EPA	1	1	1
40	174	Procedures And Requirements For Plant-Incorporated Protectants	2002	2017	Environmental Protection Agency	EPA	1	1	1
40	176	Time-Limited Tolerances For Emergency Exemptions	2001	2017	Environmental Protection Agency	EPA	1	1	1
40	177	Issuance Of Food Additive Regulations	1991	2005	Environmental Protection Agency	EPA	1	1	1
40	180	Tolerances And Exemptions For Pesticide Chemical Residues In Food	1972	2017	Environmental Protection Agency	EPA	1	1	1
40	185	Tolerances For Pesticides In Food	1988	1999	Environmental Protection Agency	EPA	1	1	1
40	186	Pesticides In Animal Feed	1988	1999	Environmental Protection Agency	EPA	1	1	1
40	232	404 Program Definitions; Exempt Activities Not Requiring 404 Permits	1988	2017	Environmental Protection Agency	EPA	1	1	1
40	267	Standards For Owners And Operators Of Hazardous Waste Facilities Operating Under A Standardized Permit	1981	2017	Environmental Protection Agency	EPA	1	1	1
40	300	National Oil And Hazardous Substances Pollution Contingency Plan	1983	2017	Environmental Protection Agency	EPA	1	1	1
40	302	Designation, Reportable Quantities, And Notification	1985	2017	Environmental Protection Agency	EPA	1	1	1
40	355	Emergency Planning And Notification	1987	2017	Environmental Protection Agency	EPA	1	1	1
40	370	Hazardous Chemical Reporting: Community Right-To-Know	1988	2017	Environmental Protection Agency	EPA	1	1	1
40	372	Toxic Chemical Release Reporting: Community Right-To-Know	1988	2017	Environmental Protection Agency	EPA	1	1	1
40	412	Concentrated Animal Feeding Operations (CAFO) Point Source Category	1974	2017	Environmental Protection Agency	EPA	1	1	1
40	423	Steam Electric Power Generating Point Source Category	1975	2017	Environmental Protection Agency	EPA	0	1	0
40	434	Coal Mining Point Source Category Bpt, Bat, Bct Limitations And New Source Performance Standards	1976	2017	Environmental Protection Agency	EPA	0	1	0

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
40	451	Concentrated Aquatic Animal Production Point Source Category	2005	2017	Environmental Protection Agency	EPA	1	1	1
40	455	Pesticide Chemicals	1977	2017	Environmental Protection Agency	EPA	1	0	0
40	503	Standards For The Use Or Disposal Of Sewage Sludge	1993	2017	Environmental Protection Agency	EPA	1	1	1
42	2	Confidentiality Of Alcohol And Drug Abuse Patient Records	1970	2017	Public Health Service	HHS	0	1	0
42	34	Medical Examination Of Aliens	1970	2017	Public Health Service	HHS	0	0	0
42	60	Health Education Assistance Loan Program	1981	2017	Public Health Service	HHS	0	1	0
42	72	Interstate Shipment Of Etiologic Agents	1970	2007	Public Health Service	HHS	0	1	0
42	102	Smallpox Compensation Program	2003	2016	Public Health Service	HHS	0	1	0
43	11	Natural Resource Damage Assessments	1986	2017	Office of the Secretary of the Interior	DOI	1	1	1
43	418	Operating Criteria And Procedures For The Newlands Reclamation Project, Nevada	1970	2017	Bureau of Reclamation	DOI	1	1	1
43	426	Acreage Limitation Rules And Regulations	1984	2017	Bureau of Reclamation	DOI	1	1	1
43	1600	Planning, Programming, Budgeting	1996	2017	Bureau of Land Management	DOI	1	1	1
43	1601	Planning	1979	1995	Bureau of Land Management	DOI	1	1	1
43	1610	Resource Management Planning	1983	1995	Bureau of Land Management	DOI	1	1	1
43	1871	Ajudication Principles And Procedures (Principles)	1971	1995	Bureau of Land Management	DOI	0	0	0
43	2071	Type And Effect Of Designations	1971	1993	Bureau of Land Management	DOI	0	1	0
43	2236	Permits	1970	1970	Bureau of Land Management	DOI	1	1	1
43	2530	Indian Allotments	1971	2017	Bureau of Land Management	DOI	0	1	0
43	2641	Procedures	1971	1995	Bureau of Land Management	DOI	0	0	0
43	2653	Miscellaneous Selections	1973	1995	Bureau of Land Management	DOI	0	1	0
43	2920	Leases, Permits And Easements	1971	2017	Bureau of Land Management	DOI	1	1	1
43	2924	Sports, Events, Races, And Rallies	1971	1977	Bureau of Land Management	DOI	0	1	0
43	3100	Oil And Gas Leasing	1970	2017	Bureau of Land Management	DOI	0	0	0
43	3101	Issuance Of Leases	1970	1995	Bureau of Land Management	DOI	0	1	0
43	3103	Fees Rentals And Royalty	1970	1995	Bureau of Land Management	DOI	0	1	0
43	3109	Leasing Under Special Acts	1971	1995	Bureau of Land Management	DOI	0	1	0
43	3130	Oil And Gas Leasing: National Petroleum Reserve, Alaska	1970	2017	Bureau of Land Management	DOI	0	0	0

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
43	3420	Competitive Leasing	1970	2017	Bureau of Land Management	DOI	0	1	0
43	3832	Locating Mining Claims Or Sites	1971	2017	Bureau of Land Management	DOI	0	1	0
43	3851	Assessment Work: General	1971	1993	Bureau of Land Management	DOI	0	1	0
43	3872	Protests, Contests And Conflicts	1971	1994	Bureau of Land Management	DOI	0	1	0
43	5401	Advertised Sales; General	1970	1994	Bureau of Land Management	DOI	0	1	0
43	8000	Recreation Programs	1978	1995	Bureau of Land Management	DOI	0	0	0
44	61	Insurance Coverage And Rates	1979	2017	Federal Emergency Management Agency	DHS	1	1	1
44	81	Purchase Of Insurance And Adjustment Of Claims	1979	1998	Federal Emergency Management Agency	Other	0	1	0
44	401	Shipping Restrictions (T-1)	1970	2017	Department of Commerce and Department of Transportation	DOC & DOT	0	1	0
45	12	Disposal And Utilization Of Surplus Real Property For Public Health Purposes	1970	2017	Department of Health and Human Services	HHS	0	1	0
45	101	Describing Agency Needs	1970	2017	Department of Health and Human Services	HHS	1	1	1
45	116	Financial Assistance To Local Educational Agencies And State Agencies To Meet The Special Educational Needs Of Educationally Deprived, Handicapped, Migrant, And Neglected And Delinquent Children-General Provisions	1970	1980	Department of Health and Human Services	HHS	1	1	1
45	126	Health Education Assistance Loan Program	1975	1980	Department of Health and Human Services	HHS	0	1	0
45	144	Requirements Relating To Health Insurance Coverage	1970	2017	Department of Health and Human Services	HHS	1	1	1
45	177	Guranteed Student Loan Program	1970	1980	Department of Health and Human Services	HHS	0	1	0
45	182	Cooperative Education Programs	1975	1980	Department of Health and Human Services	HHS	0	1	0
45	403	Special Projects In Vocational Rehabilitation	1970	1974	Social and Rehabilitation Service	HHS	0	1	0
45	540	Filing Of Claims And Procedures Threfor	1970	1986	Foreign Claims Settlement Commission of the United States	DOJ	0	1	0
45	641	Environmental Assessment Procedures For Proposed National Science Foundation Actions In Antarctica	1992	2017	National Science Foundation	Other	0	1	0
45	684	Rules For Consultants, Board Members, And Other “Special Employers'	1982	1996	National Science Foundation	Other	0	1	0
46	150	Compatibility Of Cargoes	1981	2017	Coast Guard	DHS	1	1	1
46	287	Establishment Of Construction Reserve Funds	1970	2017	Maritime Administration	DOT	0	0	0

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
46	289	Insurance Of Construction-Differential Subsidy Vessels, Operating-Differential Subsidy Vessels And Of Vessels Sold Or Adjusted Under The Merchant Ship Sales Act 1946	1970	2017	Maritime Administration	DOT	0	1	0
48	211	Describing Agency Needs	1984	2017	Department of Defense	DOD	0	1	0
48	1304	Administrative Matters	1996	2017	Department of Commerce	DOC	0	1	0
48	2132	Contract Financing	1993	2017	Office of Personnel Management, Federal Employees Group Life Insurance	OPM	0	1	0
48	2414	Sealed Bidding	1984	2017	Department of Housing and Urban Development	HUD	0	1	0
48	2436	Construction And Architect-Engineer Contracts	1988	2017	Department of Housing and Urban Development	HUD	0	1	0
48	6102	Crop Insurance Cases	1997	2017	Civilian Board of Contract Appeals, General Services Administration	GSA	1	1	1
49	33	Transportation Priorities And Allocation System	2012	2017	Office of the Secretary of Transportation	DOT	1	1	1
49	172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, And Security Plans	1970	2017	Pipeline and Hazardous Materials Safety Administration	DOT	1	1	1
49	194	Response Plans For Onshore Oil Pipelines	1993	2017	Pipeline and Hazardous Materials Safety Administration	DOT	1	1	1
49	1085	Reight Forwarders Of Household Goods	1974	1989	Interstate Commerce Commission	Other	0	1	0
49	1223	Express Companies	1970	1975	Interstate Commerce Commission	Other	0	1	0
49	1226	Motor Carriers And Brokers	1970	1975	Interstate Commerce Commission	Other	0	1	0
49	1227	Water Carriers	1970	1975	Interstate Commerce Commission	Other	1	1	1
49	1330	Filing Quotations For Government Shipments At Reduced Rates	1970	1995	Interstate Commerce Commission	Other	0	1	0
50	1	Definitions	1970	2017	Fish and Wildlife Service	DOI	0	0	0
50	2	Agency Organization And Locations	1970	2017	Fish and Wildlife Service	DOI	0	1	0
50	12	Seizure And Forfeiture Procedures	1970	2017	Fish and Wildlife Service	DOI	1	1	1
50	13	General Permit Procedures	1970	2017	Fish and Wildlife Service	DOI	1	1	1
50	15	Wild Bird Conservation Act	1970	2017	Fish and Wildlife Service	DOI	1	0	0
50	20	Migratory Bird Hunting	1973	2017	Fish and Wildlife Service	DOI	1	1	1
50	25	Administrative Provisions	1970	2017	Fish and Wildlife Service	DOI	0	1	0
50	26	Public Entry And Use	1970	2017	Fish and Wildlife Service	DOI	0	1	0
50	27	Prohibited Acts	1970	2017	Fish and Wildlife Service	DOI	0	1	0

Annex II. Code of Federal Regulations Parts in the Sample

Title	Part	Part Heading	Start Year	End Year	Agency	Department	EJ Rel.	Crop Rel.	Robust
50	28	Enforcement, Penalty, And Procedural Requirements For Violations Of Subchapter C	1970	2017	Fish and Wildlife Service	DOI	0	1	0
50	29	Land Use Management	1970	2017	Fish and Wildlife Service	DOI	0	1	0
50	31	Wildlife Species Management	1970	2017	Fish and Wildlife Service	DOI	0	0	0
50	32	Hunting And Fishing	1970	2017	Fish and Wildlife Service	DOI	0	1	0
50	33	Sport Fishing	1970	1992	Fish and Wildlife Service	DOI	0	1	0
50	34	Refuge Revenue Sharing With Counties	1970	2017	Fish and Wildlife Service	DOI	0	1	0
50	35	Wilderness Preservation And Management	1972	2017	Fish and Wildlife Service	DOI	0	1	0
50	36	Alaska National Wildlife Refuges	1981	2017	Fish and Wildlife Service	DOI	0	1	0
50	38	Midway Atoll National Wildlife Refuge	1998	2017	Fish and Wildlife Service	DOI	0	1	0
50	96	Alaska National Wildlife Monuments	1979	1986	Fish and Wildlife Service	DOI	0	0	0
50	226	Designated Critical Habitat	1977	2017	National Marine Fisheries Service, National Oceanic and Atmospheric Administration	DOC	1	1	1