CHAPTER 1:

Regulation & Economic Growth

Theoretical Foundations & Empirical Findings in Agriculture

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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*.

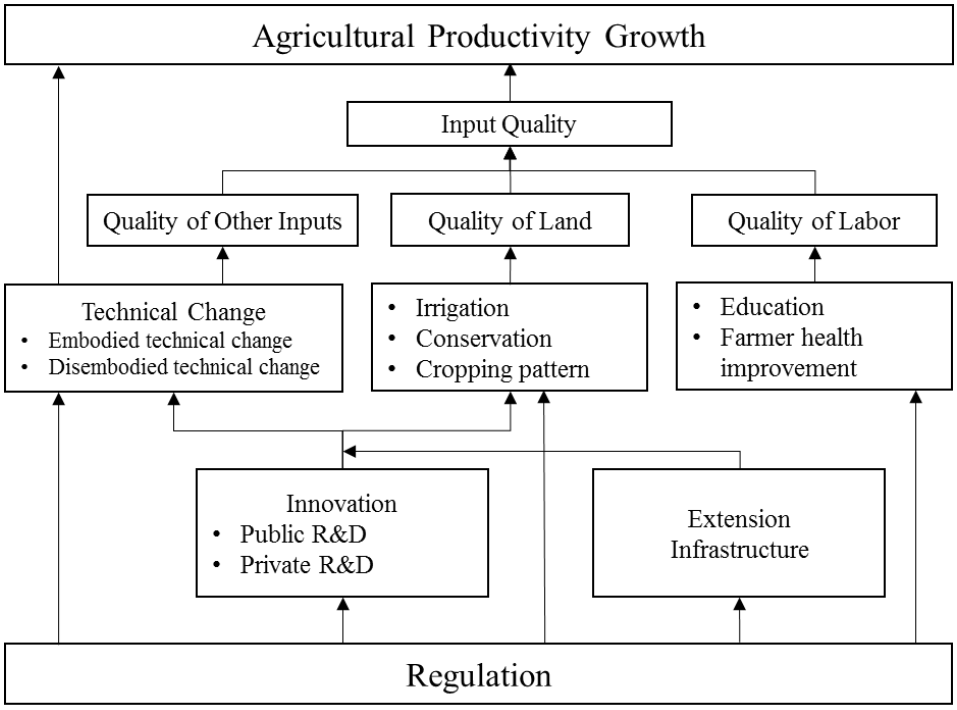
[61] Munisamy Gopinath and Terry L. Roe, "Sources of Sectoral Growth in an Economy Wide Context: The Case of U.S. Agriculture," *Journal of Productivity Analysis* 8, no. 3 (1997): 293-310.

[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.