A PORTFOLIO APPROACH TO POLICYMAKING UNCERTAINTY

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ABSTRACT

This article examines a basic dilemma that appears across nearly all areas of the law: what is the appropriate regulatory response to uncertainty in the policymaking environment, where the costs, benefits, and other consequences of any particular legal intervention are difficult to predict, and often equally difficult to measure after the fact? Although a vast theoretical literature addresses that question, the existing scholarship almost uniformly seeks to identify a single policy rule or procedure that is most robust to uncertainty. This article takes a fundamentally different approach. By drawing on the leading theory of financial investment under uncertainty—Modern Portfolio Theory—it argues that the primary normative implication of an unpredictable legal landscape is that policymakers should apply a portfolio of overlapping rules.

As this article further shows, insights from Modern Portfolio Theory do not only provide normative guidance on how the regulatory structure can account for legal uncertainty; They also explain how the law does in fact address that problem. This second, positive claim helps resolve an empirical puzzle that has long been debated among law-and-economics scholars: why is the joint use of multiple regulations so often found in contexts where a single rule would appear to suffice? The answer, it is argued, is that the widespread use of overlapping regulatory portfolios is an efficient response to the equally widespread problem of policymaking uncertainty.

After laying out these theoretical claims, this article provides supporting evidence from a variety of legal areas, including: safety regulations in accident law; the financial regulation of banking crises; and, environmental law on climate change. The case studies demonstrate the flexibility of Modern Portfolio Theory to questions of regulatory design in general. Although the policy challenges posed by automobile traffic, financial crises, and climate change are essentially unrelated, the legal framework governing each of those areas implicitly reflects a portfolio approach.

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INTRODUCTION

Policymaking uncertainty is endemic to nearly every area of the law and arises from a variety of sources. One source of uncertainty is imperfect scientific knowledge of the natural world. Which chemical compounds pose health risk to employees in the workplace, and at what

levels of concentration does that risk of toxicity appear?[1] Another source of uncertainty stems from our limited understanding of how markets and other social institutions function. When does the merger of large firms help consumers, and when does it create inefficient oligopolies?[2] Does protection of intellectual property rights encourage or stifle innovation?[3] Social science research often fails to converge on a robust consensus to seemingly basic questions of this kind.[4]

Even where such epistemic hurdles can be overcome with enough confidence to suggest that some policy intervention is warranted, policymakers still confront a host of unknowables regarding the adaptive response of both regulators and regulated parties to the particular legal rule which is imposed. Assume a mandatory seatbelt law is passed, based on laboratory tests finding that passive restraints reduce the severity of injuries from traffic accidents. Will highway patrol personnel enforce that requirement with sufficient regularity to ensure

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1. By statute, the Environmental Protection Agency (EPA) and Occupational Safety and Health Administration are required to make such a determination. TOXIC SUBSTANCES CONTROL ACT OF 1976, Pub. L. No. 94-469, 90 Stat. 2003 (1976), codified at 15 U.S.C. § 2601 (2018). With respect to the toxicity of asbestos alone, the EPA's rulemaking took ten years to finalize and 45,000 pages of analysis. *See* 54 FED. REG. 29460 (July 12, 1989); *see also* Daniel Farber, *Rethinking the Role of Cost-Benefit Analysis*, 76 U. CHI. L. REV. 1355, 1380-83 (2009) (reviewing the informational hurdles attendant to workplace hazard calculations such as asbestos).

2. *See* Louis Kaplow, *Market Definition: Impossible and Counterproductive*, 79 ANTITRUST L.J. 361, 361-62 (2013) (arguing standard merger analysis techniques lack theoretical coherence or empirical support); Louis Kaplow, *Market Share Thresholds: On the Conflation of Empirical Assessments and Legal Policy Judgements*, 7 J. COMPETITION L. & ECON. 243, 244 (2011) (same). As a more recent example, antitrust scholars have failed to agree to whether concentration among institutional investors allows firms to raise prices. *Compare* José Azar, Martin C. Schmalz & Isabel Tecu, *Anticompetitive Effects of Common Ownership*, 73 J. FIN. 1513, 1517 (2018) (finding anticompetitive effects), *with* Patrick Dennis, Kristopher Gerardi & Carola Schenone, *Common Ownership Does Not Have Anti-Competitive Effects in the Airline Industry*, Fed. Reserve Bank Atlanta, Working Paper No. 2019-15 (2019) (rebutting the study by Azar et al.).

3. *See* Mark A. Lemley, *Faith-Based Intellectual Property*, 62 UCLA L. REV. 1328, 1334 (2015) (observing that there is no empirical basis for concluding that intellectual property law has a positive effect on innovation); Josh Lerner, *The Empirical Impact of Intellectual Property Rights on Innovation: Puzzles and Clues*, 99 AM. ECON. REV. 343, 343-47 (2009) (same).

4. For example, what is the impact of minimum wage laws on wages and employment? *See* David Card & Alan B. Krueger, *Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania*, 84 AM. ECON. REV. 772, 772 (1994) (sparking the literature, by famously finding no negative effect on employment). *But see* John Kennan, *The Elusive Effects of Minimum Wages*, 33 J. ECON. LIT. 1950, 1950-51 (1995) (questioning the reliability of the Card & Krueger finding); David Neumark, J.M. Ian Salas & William Wascher, *Revisiting the Minimum Wage-Employment Debate: Throwing out the Baby with the Bathwater?*, 67 INDUS. & LAB. REL. REV. 608, 609, 620-21 (2014) (same).

meaningful compliance?[5] And if so, and automobile occupants feel safer as a result, will drivers endanger pedestrians by driving more recklessly?[6] The dynamics of regulatory arbitrage and vagaries of regulatory discretion often overwhelm whatever outcomes policymakers envision at the time a law is passed.[7]

Taken together, these considerations mean that the full consequences of policy interventions are rarely predictable in advance, and it is often difficult to estimate their cost-and-benefits with a high degree of confidence, even after the fact. Given the fundamental nature of that problem, legal scholars have developed a vast body of theoretical literature that explores the optimal response to uncertainty in the policymaking environment. According to advocates of the "precautionary principle," the best response to uncertainty is to impose the most stringent legal restrictions practicable.[8] Law-and-economics scholars, meanwhile, tend to emphasize the merits of simple ex ante rules or open-ended ex post standards.[9] From a federalism perspective, the answer to uncertainty lies in a legal structure that encourages regulatory diversity and competition across jurisdictions.[10] Another influential body of legal scholarship calls for the use of "phased" or "experimental" regulations that are rolled out on a piecemeal basis to allow for maximal flexibility.[11]

This article argues that, despite the array of proposals on offer, all of the leading approaches to policymaking uncertainty are limited by

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5. *See, e.g.*, Dara Lee Luca, *Do Traffic Tickets Reduce Motor Vehicle Accidents? Evidence from a Natural Experiment*, 34 J. POL'Y ANALYSIS & MGMT 85 (2015) (analyzing the impact of state "Click-it-or-Ticket" months); Mohammad Mahdi Rezapour Mashhadi, Promothes Saha & Khaled Ksaibati, *The Impact of Traffic Enforcement on Traffic Safety*, 19 INT'L J. POLICE SCI. & MGMT. 238, 239-40 (2017) (reviewing the empirical literature on the relationship between traffic enforcement and safety outcomes).

6. *See generally* Sam Peltzman, *The Effects of Auto Safety Regulation*, 83 J. POL. ECON. 677 (1975); Steven Peterson, George Hoffer & Edward Millner, *Are Drivers of Air-Bag-Equipped Cars More Aggressive? A Test of the Offsetting Behavior Hypothesis*, 38 J.L. & ECON. 251, 260-62 (1995). The effects of traffic enforcement remain poorly understood, despite being a relatively well-studied area. In financial regulation, for example, similar questions are equally important but rarely explored. *See* Julie Andersen Hill, *Bank Capital Regulation by Enforcement: An Empirical Study*, 87 IND. L.J. 645, 647 (2012) ("[L]ittle academic research has examined regulators' discretionary capital enforcement."); Howell E. Jackson, *Variation in the Intensity of Financial Regulation*: *Preliminary Evidence and Potential Implications*, 24 YALE J. REG. 253, 253, 257 (2007) (observing the no empirical literature exists on finance regulation enforcement).

7. *See* Victor Fleischer, *Regulatory Arbitrage*, 89 TEX. L. REV. 227, 229 (2010) (reviewing the concept of regulatory arbitrage in the tax context); *cf.* Thomas Piketty, Emmanuel Saez & Gabriel Zucman, *Distributional National Accounts: Methods and Estimates for the United States*, 133 Q.J. ECON. 553, fig. 1 (2018) (finding a limited relationship between nominal legal tax rates and the effective income tax rates actually paid for the 1940-2010 period).

8. *See infra* Section I.A. (reviewing the literature on the precautionary principle).

9. *See infra* Section I.B. (reviewing the law-and-economics scholarship on rules versus standards).

10. *See infra* Section I.C. (reviewing the regulatory diversity literature).

11. *See infra* Section I.D. (reviewing the legal scholarship on phased regulations).

a common analytical oversight. That is, each theory proceeds from a working assumption that a particular formal property should inform the design of legal rules in order to make them robust to uncertainty. The motivating research question is then understood as a search to identify the procedural posture or structural feature that works best. As a result of that strategy, the existing scholarship has foreclosed the most promising approach to legal uncertainty at the outset. That is because the primary normative implication of legal uncertainty in a given policy area is to increase the optimal *number* of legal rules that are applied. In other words, policymakers should impose a combination of overlapping regulations. The specific form those legal rules take—whether they be precautionary prohibitions, ex post standards, phased rulemakings, and so on—remains relevant, but is of second-order importance.

This thesis is drawn from the dominant conceptual framework for managing uncertainty in financial investments, known as Modern Portfolio Theory. After first being developed in the 1950s, through the Nobel Prize winning research of economist Harry Markowitz, Modern Portfolio Theory soon revolutionized the existing approaches to financial risk.[12] Today, the simple logic of diversification which underlies Markowitz's work has become household wisdom and a cornerstone of Personal Finance 101. Visit any (reputable) financial advisor and ask how to allocate your savings. There is one reply you will never receive: "I know just the stock for you." The reason is that outcomes in financial markets are uncertain. Once it is recognized that every security carries risk, the investment calculus fundamentally changes along one critical dimension: any attempt to identify a single "best" stock is rendered futile, as a superior risk-return profile can always be achieved through a portfolio of investments consisting of smaller holdings in a broad range of securities.[13]

Importantly, as Markowitz would go on to argue at length, the problem of portfolio selection has little *per se* to do with high finance.[14] Rather, it is a general theory of choice under uncertainty, and can potentially apply to any decision-maker who must choose how to act in the

12. *See generally* Harry Markowitz, *Portfolio Selection*, 7 J. FIN. 77 (1952) (providing the seminal theoretical framework); *see also* Hal Varian, *A Portfolio of Nobel Laureates: Markowitz, Miller and Sharpe*, 7 J. ECON. PERSP. 159, 159-62 (1993) (summarizing the contributions of Markowitz's research which lead to him being awarded the 1990 Nobel Prize in economics).

13. *See infra* Section II.A. (providing an overview of Modern Portfolio Theory).

14. *See* Harry M. Markowitz, *Foundations of Portfolio Theory*, 46 J. FIN. 469, 476 (1991) ("Finally, I would like to add a comment concerning portfolio theory as a part of the microeconomics of action under uncertainty. It has not always been considered so . . . at the time I defended my dissertation, portfolio theory was not part of Economics. But now it is.").

face of risk.[15] As a result, Modern Portfolio Theory has been broadly applied to such as diverse settings as computer science,[16] forestry management, [17] and medical research-and-development. [18] This article shows how the insights of Modern Portfolio Theory can be translated into the policymaking context as well. Legal rules, like securities, are not free. Every policy intervention entails a costly investment by society: public actors must undertake rulemaking and enforcement efforts, while private parties bear the burden of complying with the legal requirements which result from that process. Likewise, the return on that investment—understood in terms of its benefit to social welfare—is at least somewhat uncertain. It follows that, in principle, society can reduce the uncertainty of policy outcomes by imposing a diversified menu of legal rules in conjunction, rather than solely relying on whichever individual policy rule is anticipated to be most effective.[19]

In practice, of course, the legal system differs from financial markets in important ways. It is impossible to "hold the market" of all conceivable regulations, for example, or to compute the optimal regulatory portfolio with the kinds of statistical models used by financial analysts. Accordingly, this article provides some rules of thumb which account for those differences and can inform the design of regulatory portfolios. These include criteria for determining the optimal number of legal rules in a policy portfolio, prioritizing among competing forms of rules, and adjusting regulatory portfolios in response to changes in the legal landscape over time, among others.[20]

As this article further argues, insights from Modern Portfolio Theory do more than simply provide guidance on how the law should be structured to account for legal uncertainty. They also explain how the

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15. *See generally* HARRY M. MARKOWITZ, PORTFOLIO SELECTION: EFFICIENT DIVERSIFICATION OF INVESTMENTS, 205-303 (Basil Blackwell ed., 2d ed. 1991) (expanding on why portfolio theory represents a more general theory of choice under conditions of uncertainty).

16. *See, e.g.*, Jun Wang & Jianhan Zhu, *Portfolio Theory of Information Retrieval*, *in* SIGIR '09: PROC. OF THE 32ND INT'L ACM SIGIR CONFERENCE ON INFO. RETRIEVAL 115, 115 (2009).

17. *See, e.g.*, Thomas Knoke, Katharina Messerer & Carola Paul, *The Role of Economic Diversification in Forest Ecosystem Management*, 3 CURRENT FORESTRY REP. 93, 94 (2017); *see generally* Cynthia A. Montgomery, *Corporate Diversification*, 8 J. ECON. PERSP. 163 (1994) (discussing portfolio theory in the context of corporate governance).

18. *See generally* Mincheol Choi & Chang-Yang Lee, *Technological Diversification and R&D Productivity: The Moderating Effects of Knowledge Spillovers and Core-technology Competence*, KAIST Coll. of Bus., Working Paper Series No. 2019-014 (2019); Darius Lakdawalla & Charles E. Phelps, *Evaluation of Medical Technologies with Uncertain Benefits*, Nat'l Bureau of Econ. Research, Working Paper No. 26058 (2019).

19. *See generally infra* Section II.B. (providing a framework for adapting Modern Portfolio Theory to the public policy context). By analogy, the existing legal literature on policymaking uncertainty inhabits a pre-Markowitzian world in which the challenge for investment decisions is to discover the best stock, class of stocks by industry, or stock-picking procedure. *See id.*

20. *See infra* Section II.C.

law does in fact address that problem. This positive claim helps resolve a long-standing empirical puzzle among law-and-economics scholars: why are so many areas of the law characterized by the joint use of multiple regulations, when a single rule would appear to suffice?[21] The law-and-economics literature has thus far revolved around two opposing answers to that question. Some scholars argue that overlapping regulations are redundant, and a dysfunctional byproduct of the political or legislative process.[22] Others assert that there can often be subtle complementarities between regulations which allow them to work better in combination.[23] Although both of those scenarios certainly describe at least some areas of the law, this article suggests a third explanation which may be even more common. Namely, that the widespread use of overlapping regulations implicitly tracks the diversification principles underlying Modern Portfolio Theory and is therefore an efficient response to the equally widespread presence of policymaking uncertainty.[24]

After laying out these theoretical claims in the abstract, this article provides supporting evidence from three policy areas. First, it sketches the logic of regulatory portfolios in the context of safety regulations in the law of accidents.[25] The article then presents two more extensive case studies, which cover the financial regulation of banking crises environmental law on climate change.[26] The case studies are selected to highlight the flexibility of Modern Portfolio Theory to address questions of regulatory design in general. The policy challenges posed by financial crises, climate change, and automobile accidents are for the most part unrelated. The legal frameworks which govern those issues—such as bank capital requirements, restrictions on fossil fuel emissions, and automobile safety standards—also have little in common, and are subject to radically different sources of uncertainty.[27] Yet the same pair of lessons appear in each case. As a normative matter, a portfolio approach provides the most promising response to policy making uncertainty. And from a positive perspective, the functional

21. *See infra* Section II.D. (reviewing the relevant law-and-economics literature).

22. *See* Charles D. Kolstad, Thomas S. Ulen & Gary V. Johnson, Ex Post *Liability for Harm vs.* Ex Ante *Safety Regulation: Substitutes or Complements?*, 80 AM. ECON. REV. 888, 888 (1990).

23. *See* Patrick W. Schmitz, *On the Joint Use of Liability and Safety Regulation*, 20 INT'L REV. L. & ECON. 371, 371 (2000); *see* Steven Shavell, *Liability for Harm versus Regulation of Safety*, 13 J. LEGAL STUD. 357, 365 (1984).

24. *See infra* Section II.D.

25. *See id.*

26. *See* Section III.

27. *See* Section III.A.1, *infra* (discussing policymaking uncertainty in banking regulation); Section III.B.1, *infra* (discussing sources of policymaking uncertainty in the climate change context); and Section II.D, *infra* (discussing the role of policymaking uncertainty in safety regulations).

logic of actually existing regulation is best understood as reflecting a portfolio approach.

In a broader sense, this article's argument echoes Judge Posner's twin theses that the common law *does* and *should* tend towards economic efficiency.[28] Since the 1970s, there has been extensive debate among law-and-economics scholars over the precise mechanism behind that happy outcome.[29] By comparison, the source of the law's convergence on a portfolio approach is relatively simple. It is the triumph of basic common sense. Although the relationship between risk and diversification was never formalized in mathematical terms until Markowitz, the underlying logic of Modern Portfolio Theory is timeless.[30] The same idea is captured in the proverbial wisdom to not put all of one's eggs in the same basket.[31] It can also be found in passages from Shakespeare,[32] the Bible,[33] and the chronicles of Ancient Rome.[34] Perhaps because the intuition behind portfolio diversification is so intui-

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28. *See* RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW, 30-33 (8th ed. 2011) (summarizing the normative and positive theses about the economic efficiency of common law doctrine).

29. *See* Paul Rubin, *Why is the Common Law Efficient?*, 6 J. LEGAL STUD. 51, 51 (1977) ("Posner, in *Economic Analysis of Law*, argues persuasively that the common law can be best understood as an attempt to achieve economic efficiency. He is less persuasive in his explanation of why this is so[.]"); *see* Todd Zywicki, *The Rise and Fall of Efficiency in the Common Law: A Supply-Side Analysis*, 97 NW. U. L. REV. 1551, 1552 (2003) ("[A]n animating insight of the economic analysis of law has been the observation that the common law process appears to have a strong tendency to produce efficiency-enhancing legal rules . . . requiring an explanation of [] the factors that traditionally drove the common law toward [that outcome].").

30. *See* Harry M. Markowitz, *The Early History of Portfolio Theory: 1600-1960*, 55 FIN. ANALYSTS J. 5, 5 (1999) ("Diversification of investments was a well-established practice long before I published my paper on portfolio selection in 1952 . . . What was lacking prior to 1952 was an adequate *theory* of investment[.]"); *cf.* Mark Rubinstein, *Markowitz's "Portfolio Selection": A Fifty-Year Retrospective*, 57 J. FIN. 1041, 1041 (2002) (noting that the physicist Daniel Bernoulli may have derived the earliest mathematical proof of Modern Portfolio Theory in his 1738 text, "Exposition of a New Theory on the Measurement of Risk").

31. *See* Frank J. Fabozzi, Francis Gupta & Harry M. Markowitz, *The Legacy of Modern Portfolio Theory*, 11 J. INVESTING 7, 8 (2002) ("Conventional wisdom has always dictated not putting all your eggs in one basket. In more technical terms, this adage is addressing the benefits of diversification.").

32. WILLIAM SHAKESPEARE, THE MERCHANT OF VENICE act I, sc. I ("I thank my fortune for it, My ventures are not in one bottom trusted, Nor to one place; nor is my whole estate Upon the fortune of this present year.").

33. *Ecclesiastes* 11:2 (New International Version) ("Invest in seven ventures, yes, in eight; you do not know what disaster may come upon the land.").

34. According to Plutarch, Cato the Elder took a portfolio approach to his investments in the Mediterranean sea trade. PLUTARCH, PARALLEL LIVES: VOL. I 575 (Clough ed. 2001) ("[Cato] desired that those whom he put out his money to, should have many partners; and when the number of them and their ships came to be fifty, he himself took one share . . . so that thus there was no danger of losing his whole stock, but only a little part, and that with a prospect of great profit.").

tively obvious, its full significance has been overlooked by legal scholars.[35] But it has not been overlooked by the law itself. A second irony follows. The leading theories of policymaking uncertainty typically call for departures from the status quo which are often quite dramatic and politically unfeasible.[36] Meanwhile, a portfolio theory suggests that the law tends to arrive at a roughly optimal outcome, due to the deep logic of diversification in an uncertain world.[37]

This article proceeds as follows. Section I surveys the scholarly literature on policymaking uncertainty. Section II outlines a theoretical framework for applying Modern Portfolio Theory to questions of regulatory design. Section III then applies that framework to the three case studies previewed above. A final section briefly concludes.

I. EXISTING THEORIES OF POLICYMAKING UNDER UNCERTAINTY

The discussion below surveys existing legal scholarship on how the law should address policymaking uncertainty. While far from exhaustive, it takes a relatively deep dive for a few reasons. The first is to highlight the novelty of a portfolio approach. Several theories of policymaking uncertainty appear to incorporate a diversification principle reminiscent of Modern Portfolio Theory on a superficial level, but on closer examination do not. Second, the subsequent Section II will show how those theories can be incorporated within a portfolio approach. And third, each of the theoretical frameworks reviewed below reappear in the case studies presented in Section III, where they are contrasted with a portfolio approach.

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35. As with many revolutionary paradigm shifts, the insights of Modern Portfolio Theory feel self-evident in retrospect. *See* Varian, *supra* note 12, at 159 ("From today's perspective it is hard to understand what finance was like before portfolio theory. Risk and return are such fundamental concepts of finance courses that it is hard to realize that these were once a novelty."); *cf.* THOMAS S. KUHN, THE STRUCTURE OF SCIENTIFIC REVOLUTIONS (1962). A parallel case within law-and-economics would be the Coase Theorem. *See* Ronald Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960). *But see* David de Meza, *Coase Theorem*, in THE NEW PALGRAVE DICTIONARY OF ECONOMICS AND THE LAW 270 (Peter Newman ed., 1998) (describing alternative appraisals of the Coase Theorem as "profound, trivial, a tautology, false, [and] revolutionary[.]").

36. *See, e.g.*, Jonathan S. Masur & Eric A. Posner, *Toward A Pigouvian State*, 164 U. PA. L. REV. 93, 96 (2015) ("Pigouvian taxes are constantly advocated by economists who seek to influence public policy . . . Yet, turning from the scholarly literature to government practice, one discovers that Pigouvian taxes are used rarely by Congress and almost never by regulators[.]").

37. Emphasis on roughly. *See* POSNER, *supra* note 28, at 32 ("What we may call the efficiency theory of the common law is not that *every* common law doctrine and decision is efficient. That would be highly unlikely . . . The theory is that the common law is best (not perfectly) explained as a system for maximizing the wealth of society.").

A. The Precautionary Principle

Perhaps the most prominent approach to policymaking uncertainty is the "precautionary principle."[38] The precautionary principle's exact meaning is subject to some debate and, as a consequence, often functions more as a rule-of-thumb than a precise criterion.[39] Roughly stated, however, the principle stands for a better-safe-than-sorry proposition: when there is at least some reason to suspect that a certain activity could pose a significant risk of harm, the proper policy response is to mandate maximal legal precautions against that risk.[40]

The precautionary principle tends to inform the design of legal rules in a variety of ways, two of which are most common.[41] In its simplest and most extreme form, the principle cautions that the risk-creating activity at issue should be prohibited outright. One example is the European Union's ban on the sale of genetically modified foods.[42] Because the long-term health effects of genetically modified foods remain to be seen, the argument goes, the ultimate precaution must be taken by eliminating the sale of those products altogether.[43] In the United States, a similar strategy can be found in the Food and Drug Administration's ban on carcinogenic food additives.[44] This version of the precautionary principle is embodied in several international agreements as well.[45]

A less demanding variation of the precautionary principle is reflected in regulations that apply a "feasibility" standard. Rather than labeling activities illegal *per se*, feasibility standards provide that regulated parties must undertake every practicable measure necessary to

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38. For overviews, *see generally* Cass R. Sunstein, *Beyond the Precautionary Principle*, 151 U. PA. L. REV. 1003 (2003); *see generally* Frank B. Cross, *Paradoxical Perils of the Precautionary Principle*, 55 WASH. & LEE. L. REV. 851 (1990).

39. *See generally* TIM O'RIORDAN, INTERPRETING THE PRECAUTIONARY PRINCIPLE (O'Riordan & Cameron eds. 1994).

40. *See* Sunstein, *supra* note 38 at 1004; *see* Cross, *supra* note 38, at 851.

41. *See* Richard B. Stewart, *Environmental Regulatory Decision Making Under Uncertainty,* 20 RES. L. & ECON. 71, 75-76 (2002).

42. *See* John Davison, *GM Plants: Science, Politics and EC Regulations*, 178 PLANT SCI. 94, 94-96 (2010).

43. *See* David Vogel & Diahanna Lynch, *The Regulation of GMOs in Europe and the United States: A Case-Study of Contemporary European Regulatory Politics*, COUNCIL ON FOREIGN REL. (2001); Sunstein, *supra* note 38, at 1015 n.50 (characterizing the EU's GMO regulations as an application of the precautionary principle).

44. *See* Richard Merrill, *FDA's Implementation of the Delaney Clause: Repudiation of Congressional Choice or Reasoned Adaptation to Scientific Progress?*, 5 YALE J. ON REG. 1, 9-12 (1988).

45. *See* Owen McIntyre & Thomas Mosedale, *The Precautionary Principle as a Norm of Customary International Law*, 9 J. ENV'T L. 221 (1997).

prevent the risks their activities create from arising.[46] Feasibility standards of this kind can be found in the Clean Air Act, which places limits on the emission of ambient air pollution by industrial facilities.[47] They also appear in provisions of the Resource Conservation and Recovery Act, which directs entities that dispose hazardous waste to "minimize" the risks attendant to that process.[48]

On its face, the precautionary principle is not incompatible with the imposition of multiple legal rules to prevent a common risk. The core focus of the principle, however, is on the intensity, rather than the numerosity, of policy interventions. Uncertainty should trigger legal rules that place a heightened burden on regulated parties and be implemented without delay.[49] This can be seen in both of the implementation scenarios identified above. With the strong-form version of the precautionary principle, such as the EU's ban on genetically modified foods, there is by definition only one policy rule: a prohibition on the risk-creating activity. Similarly, for feasibility standards, the sole legal requirement is to undertake the highest level of precaution reasonably available.[50] Thus, unlike Modern Portfolio Theory, the precautionary principle is at best agnostic on the optimal number of legal rules in a common-policy space.[51]

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46. On the relationship between feasibility standards and the precautionary principle, *see* Mark Geistfeld, *Implementing the Precautionary Principle*, 31 ENV'T. L. REP. 11326 (2001); David M. Driesen, *Distributing the Costs of Environmental, Health, and Safety Protection: The Feasibility Principle, Cost-Benefit Analysis, and Regulatory Reform*, 32 B.C. ENV'T. AFF. L. REV. 1, 9-16 (2005).

47. *See* Clean Air Act, 42 U.S.C. § 7401 et seq. (1977); Am. Trucking Ass'n v. Env't Prot. Agency, 283 F.3d 355, 378 (D.C. Cir. 2002) (holding that, in promulgating air quality standards under the CAA, the "EPA must err on the side of caution . . . to protect the [] health with an adequate margin of safety"); *see also* Ethyl Corp v. Env't Prot. Agency, 541 F.2d 1, 6-7 (D.C. Cir. 1976) (en banc) (interpreting the CAA to apply a similar standard for the use of lead additives in gasoline).

48. *See* Resource Conservation and Recovery Act, 42 U.S.C. § 6924(m)(1)(2000); Hazardous Waste Treatment Council v. Env't Prot. Agency, 886 F.2d 355, 361 (D.C. Cir. 1989) (holding that "minimize" refers to an even lower risk level than the "acceptable" level); *see also* John S. Applegate, *The Taming of the Precautionary Principle*, 27 WM. & MARY ENV'T L. & POL'Y REV. 13, 29-30 (2002) (reviewing feasibility standards in the RCRA).

49. *See* David M. Driesen, *Cost-Benefit Analysis and the Precautionary Principle: Can They Be Reconciled*?, 2013 MICH. ST. L. REV. 771, 788-89 (arguing that the precautionary principle could also mean lowering the burden of proof for triggering a regulatory intervention, or accelerating the timing of its implementation).

50. If firms can identify a single safeguard which meets that goal, compliance with the feasibility standard has been achieved. For example, under the Clean Air Act, industrial plants may be able to minimize their emissions of pollutants by installing the most technologically advanced smokestack scrubbers that are economically feasible. *See generally* Samuel A. Bleicher, *Economic and Technical Feasibility in Clean Air Act Enforcement Against Stationary Sources*, 89 HARV. L. REV. 316 (1975).

51. *See* discussion *infra* Section II.B.ii. (drawing further distinctions between the precautionary principle and portfolio theory).

B. The Law & Economics of Legal Rules

Another approach to policymaking uncertainty comes from law-and-economics scholarship on the formal structure of legal rules. This literature makes two conceptual distinctions. First, it draws a contrast between legal "rules" and "standards."[52] Second, it differentiates laws that are "simple" from those that are "complex."[53] Both distinctions are frequently invoked in arguments regarding the optimal form of regulation under uncertainty.

The rules versus standards dichotomy turns on the timing of when the substance of a given legal requirement is formulated.[54] A regulation is said to function as a "rule" when the policymaker invests in specifying its content ex ante, before the conduct it seeks to address has taken place.[55] A regulation functions as a "standard" when the bulk of its content is determined ex post.[56] For example, a speed limit of seventy-five miles per hour is a rule; requirements that drivers must yield to ongoing traffic or refrain from reckless driving are standards.[57]

The dichotomy between simple and complex rules turns on the number of factors policymakers take into account in order to determine how a legal rule applies to a particular course of conduct.[58] Unlike the rules versus standards tradeoff, complexity is about the information costs associated with sorting states of the world into relatively fine or coarse categories, rather than the timing of *when* that sorting process is undertaken.[59] The federal tax code exemplifies a highly complex set of rules due to the endless distinctions it makes regarding the tax

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52. *See generally* Louis Kaplow, *Rules Versus Standards: An Economic Analysis*, 42 DUKE L.J. 557 (1992).

53. *See* Colin S. Diver, *The Optimal Precision of Administrative Rules*, 93 YALE L.J. 65, 67-68 (1983); Isaac Ehrlich & Richard A. Posner, *An Economic Analysis of Legal Rulemaking*, 3 J. LEGAL STUD. 257, 261 (1974); *see generally* Louis Kaplow, *A Model of the Optimal Complexity of Legal Rules*, 11 J.L. ECON. & ORG. 150 (1995).

54. *See* Kaplow, *supra* note 52, at 560.

55. *See id*.

56. *See id*.

57. Securities law provides another set of examples: ex ante registration requirements for broker-dealers are rules, while the Rule 10b-5 prohibition against securities fraud is a classic standard. *Compare* 15 U.S.C. § 780-4,5 (registration rules), *with* 15 U.S.C. § 78j (Exchange Act Section 10(b) *and* 17 C.F.R. § 240.10b-5 (2020) (SEC Rule 10b-5). *See* Kaplow, *supra* note 51, at 618 (associating prohibitions on fraud with standards).

58. *See* Kaplow, *supra* note 52, at 586-90; Kaplow, *supra* note 52, at 151-55; *see generally* Vincy Fon & Franceseo Parisi, *On the Optimal Specificity of Legal Rules*, 3 J. INT'L. ECON. 147 (2007).

59. *See* Kaplow, *supra* note 52, at 564-66 ("[B]oth rules and standards can in fact be quite simple or highly detailed in their operation.") (providing some examples of complex rules and simple standards); Prasad Krishnamurthy, *Rules, Standards, and Complexity in Capital Regulation*, 43 J. LEGAL STUD. S273, S274-75 (2014).

treatment of different sources of income.[60] By comparison, the requirement that driver's licenses may only be issued to people over the age of sixteen is a simple rule.

Law-and-economics scholars have developed a number of competing rationales for which form of legal rules is the most effective backstop against uncertainty—depending on the context, the recommendation varies from ex ante rules, to ex post standards, to rules that are simple rather than complex.[61] For present purposes, the various answers proposed in this literature are less important than how it frames the question.[62] A governing assumption in each case is that a particular design feature of legal rules offers the optimal response to regulatory uncertainty, and the policy challenge is to then discover which kind of legal rule works best under those conditions. The possibility that a portfolio of regulations combining multiple simple rules or complex standards may provide a superior approach is put aside at the outset.[63]

C. Regulatory Diversity & Jurisdictional Competition

A third important approach to policymaking uncertainty involves a family of arguments that focus on the benefits of regulatory diversity across jurisdictions. This view is familiar to discussions of the role of states in constitutional federalism. It also appears at the international level with respect to cross-border regulation, where the question is whether or not to harmonize legal rules across different countries.[64] Although many values have been ascribed to federalism and regulatory diversity, two justifications in particular are closely tied to the

60. *See* Kaplow, *supra* note 52, at 622. Another illustration of complexity is provided by disclosure rules in the securities laws. *See* Frank H. Easterbrook & Daniel Fischel, *Mandatory Disclosure and the Protection of Investors*, 70 VA. L. REV. 669, 669 (1984) (reviewing the complex distinctions that SEC regulations make among firms and categories of information).

61. For example, standards are often considered a natural solution to the problem of uncertainty because they allow regulators discretion to tailor the substance of legal requirements with hindsight, in light of unforeseen circumstances. *See* Maciej Kotowski, David Weisbach & Richard Zeckhauser, *Rules and Standards When Compliance Costs Are Private Information*, 43 J. LEGAL STUD. S297, S300 (2014); Fon & Parisi, *supra* note 58 at 149.

62. *See infra* Section II.B.ii.

63. *See* Krishnamurthy, *supra* note 59, at S293-94 ("Finally, the question remains whether a [complex rule] should be used in addition to a [simple rule.]").

64. *See generally* Stephen J. Choi & Andrew T. Guzman, *Portable Reciprocity: Rethinking the International Reach of Securities Regulation*, 71 S. CAL. L. REV. 903 (1997); Roberta Romano, *For Diversity in the International Regulation of Financial Institutions: Critiquing and Recalibrating the Basel Architecture*, 31 YALE J. ON REG. 1, 1 (2014); Roberta Romano, *The Need for Competition in International Securities Regulation*, 2 THEORETICAL INQUIRIES L. 388, 390 (2001); *see generally* Charles K. Whitehead, *Destructive Coordination*, 96 CORNELL L. REV. 323 (2011).

issue of policy uncertainty—both of which appear to mimic a portfolio approach.[65]

The first is a theory of federalism, famously articulated by Justices Holmes and Brandeis, which conceives of states as "laboratories" of policy experimentation.[66] As the science metaphor and its roots in the 1920s progressive era suggest, rapid social and technological change was seen as the source of novel policy problems that the contemporary legal framework was ill-equipped to address.[67] Accordingly, Holmes and Brandies argued that a system of federalism that encouraged regulatory diversity would empower states to develop innovative policy solutions. Beginning in the 1950s, law-and-economics scholars put forth a separate rationale for the same conclusion by incorporating the states-as-laboratories trope into a broader theory of regulatory competition.[68] Under this view, policy uncertainty is mitigated through a race-to-the-top dynamic: when states are able to offer competing policy options, individuals and firms can then vote with their feet by shifting into jurisdictions that have selected relatively well-performing rules.[69]

Regulatory diversity sounds synonymous with the diversification approach found in Modern Portfolio Theory. Yet the parallels are mostly semantic. Critically, theories of regulatory diversity tend to be silent as to the optimal number of within-jurisdiction rules. In the simplest model of regulatory competition, each jurisdiction selects one legal rule for a given policy problem and each individual selects one jurisdiction.[70] For example, while the legal treatment of non-compete agreements in employment contracts varies widely across all fifty

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65. One classic defense of regulatory diversity unrelated to policy uncertainty concerns heterogeneous preferences. Speed limits in rural Kansas may be higher than in those in Los Angeles, without there being any uncertainty over what is the best rule for each jurisdiction. *See* Edward A. Purcell, Jr., *Evolving Understandings of American Federalism: Some Shifting Parameters*, 50 N.Y. L. SCH. L. REV. 635, 675-87 (2005); *see generally* Richard B. Stewart, *Federalism and Rights*, 19 GA. L. REV. 917 (1985) (arguing that federalism can serve as a safeguard for individual rights); *see generally* Erwin Chemerinsky, *The Values of Federalism*, 47 FLA. L. REV. 499 (1995).

66. *See* New State Ice Co. v. Liebman, 285 U.S. 262, 311 (1932) (Brandeis, J., dissenting) ("It is one of the happy incidents of the federal system that a single courageous State may . . . serve as a laboratory[] and try novel social and economics experiments without risk to the rest of the country."); Truax v. Corrigan, 257 U.S. 312, 342, 344 (1921) (Holmes, J., dissenting) (praising the ability of states to conduct "social experiments").

67. *See* Purcell, *supra* note 65, at 664-75 (providing an intellectual history of the laboratory conception of federalism).

68. *See id.* at 678-91; *see generally* Daniel C. Esty, *Regulatory Competition in Focus*, 3 J. INT'L ECON. L. 215 (2000).

69. *See* Purcell, *supra* note 65, at 686-90. *See generally* Charles Tiebout, *A Pure Theory of Local Expenditures*, 64 J. POL. ECON. 416 (1956) (providing the seminal economic model of regulatory competition).

70. Lack of overlapping rules across jurisdictions is necessary to make regulatory experimentation work well. *See Truax*, 257 U.S. at 344 (Holmes, J., dissenting) (referring to states as "insulated chambers" of policy experimentation); Choi & Guzman, *supra* note 64, at 935-37 (explaining how "portable reciprocity" in international securities laws can encourage regulatory competition by avoiding the problem of overlapping regulations).

states, any particular employee is subject to a single policy on the enforceability of those provisions, depending on the state where they live.[71] A paradoxical part-to-whole problem follows. Although regulatory diversity appears to imply that *society* in the abstract is hedged against policy uncertainty, no actual person receives the benefits of that hedge. Instead, each individual remains exposed to the risk that *their* jurisdiction has failed to select the optimal legal rule.[72]

Both the state laboratory and jurisdictional competition perspectives are premised on a system of *dual federalism*, in which each state has exclusive jurisdiction over the policy issue at hand.[73] A second set of arguments which connects regulatory diversity to the problem of policy uncertainty has been raised by scholars of *dynamic* or *cooperative* federalism, which refers to instances where states and the federal government have concurrent jurisdiction to intervene in the same policy space.[74] In contrast to the state laboratory theories premised on dual federalism, proponents of cooperative federalism suggest that the best response to policy uncertainty turns on the number of rule-makers, rather than the number of alternative rules on offer from competing jurisdictions.[75] In doing so, legal scholars have explicitly tied the merits of cooperative federalism to diversification principles associated with Modern Portfolio Theory. Professor Buzbee, for example, has argued that uncertainty cautions in favor of "federalism hedging," which involves the "retain[ing] overlapping, interacting, and often in-

71. *See generally* Orly Lobel, *Non-Competes, Human Capital Policy & Regional Competition*, 45 J. CORP. L. 931 (2020).

72. By analogy, federalism resembles a hypothetical hedge fund which manages a portfolio of up to fifty stocks. Investors are not entitled to a share of the total return on the fund, only the return on one of the fifty stocks. States as laboratories implies that the fund can experiment with which fifty stocks are included in the fund. Regulatory competition implies that investors can select whichever stock in the fund they find most promising, and switch between stocks over time. In this scenario, the hedge fund itself is diversified while none of its actual investors are.

73. *See generally* Edward S. Corwin, *The Passing of Dual Federalism*, 36 VA. L. REV. 1 (1950).

74. *See* Purcell, *supra* note 65, at 684-91.

75. *See generally* David E. Adelman & Kirsten H. Engle, *Adaptive Federalism: The Case Against Reallocating Environmental Regulatory Authority*, 92 MINN. L. REV. 1796 (2008); Ann E. Carlson, *Iterative Federalism and Climate Change*, 103 NW. U. L. REV. 1097 (2009); Kirsten H. Engel, *Harnessing the Benefits of Dynamic Federalism in Environmental Law*, 56 EMORY L.J. 159 (2006); Robert A. Schapiro, *Toward a Theory of Interactive Federalism*, 91 IOWA L. REV. 243 (2005).

tertwined federal and state roles, even in a setting where the apparently ideal regulatory regime would rely on exclusive federal regulation that would preempt state rules."[76]

Here again, however, the theoretical labels can be deceptive.[77] In practice, cooperative federalism functions as a one-way ratchet to increase the overall degree of regulatory intensity across jurisdictions: whichever jurisdiction is the first mover sets the regulatory floor, the second mover can only raise that floor.[78] Although this ratchet effect may increase the total number of policy rules being applied, that is not necessarily the case. Often, the result is that the second-mover raises the substantive legal standard of the initial policy instrument,[79] or makes it subject to a heightened level of enforcement.[80] Thus, despite evocations of overlapping federalism as a hedge against the risks of policy error, the underlying logic is a second-order theory of policymaking certainty. The theory only works if regulatory regimes are predictably lax; the policy error it helps avoid is under regulation.[81] Due to

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76. *See* William W. Buzbee, *Federalism Hedging, Entrenchment, and the Climate Challenge*, WIS. L. REV. 1037, 1039 (2017) ("Effective regulatory design, like effective investment strategies, must be designed for success yet anticipate unfavorable developments and error risks."); *see also* Sarah E. Light, *Precautionary Federalism and the Sharing Economy*, 66 EMORY L.J. 333, 361 (2017) ("Just as we do not know under conditions of uncertainty what the best regulatory policy is, we also do not necessarily know who will be the best regulator or whether a 'best' regulator exists at all[.]").

77. The value of concurrent jurisdiction by multiple rule makers does not necessarily have anything to do with federalism. The same outcome could be achieved by multiple federal agencies operating in a common policy space. *See generally* Jacob E. Gersen, *Overlapping and Underlapping Jurisdiction in Administrative Law*, 2006 SUP. CT. REV. 201 (2006); Jody Freeman & Jim Rossi, *Agency Coordination in a Shared Regulatory Space*, 125 HARV. L. REV. 1131 (2012); Daphna Renan, *Pooling Powers*, 115 COLUMB. L. REV. 211 (2015).

78. *See generally* William Buzbee, *Asymmetrical Regulation: Risk, Preemption, and the Floor/Ceiling Distinction*, 82 N.Y.U. L. REV. 1547 (2007); Buzbee, *supra* note 76, at 1044, 1049.

79. The Clean Air Act requires the EPA to promulgate automobile fuel efficiency requirements (known as CAFÉ standards) on a federal basis, but does not preempt states from issuing their own standards as well. This allowed California to impose a state-level CAFÉ standard of 36 miles per gallon, thereby raising the federal floor which had set a requirement of 27.5 miles per gallon. The result of overlapping federalism was therefore not more emissions regulations, but a stricter version of existing federal regulations. *See* Carlson, *supra* note 75, at 1109-28 (discussing California's impact on federal CAFE standards); *see generally* Jonathan Klick & Francesco Parisi, *Intra-Jurisdictional Tax Competition*, 16 CONST. POL. ECON. 387 (2005) (modelling concurrent jurisdiction as a one-way ratchet in the tax context).

80. *See* Buzbee, *supra* note 76, at 1049 (noting that overlapping federalism "can include not just more stringent regulation, but also states filling in regulatory gaps"). Hence, the familiar "piling on" dynamic that appears when multiple states or federal agencies have enforcement authority over a single policy rule. *See generally* Amanda Rose, *The Multienforcer Approach to Securities Fraud Deterrence: A Critical Analysis*, 158 U. PA. L. REV. 2173 (2009); Brian D. Feinstein, Cheng Meng & Manisha Padi, *State Politics and Mortgage Markets* (Univ. of Chi. Coase-Sandor Inst. for Law & Econ., Research Paper No. 882, 2020).

81. *See* Buzbee, *supra* note 76, at 1088-93 (arguing that overlapping federalism can encourage "coalitional entrenchment" that protects against the "derailment" of existing regulations); Light, *supra* note 75, at 354-55.

this posture, cooperative federalism tends to collapse into a jurisdictional twist on the precautionary principle. Indeed, advocates of overlapping federalism have referred to it as a form of "precautionary federalism."[82]

D. Phased Regulations & Real Options

A final approach to policymaking uncertainty comes from a growing body of scholarship that identifies creative mechanisms for the use of "staged," "phased," or "experimental" regulations.[83] The case for phased regulations is often spelled out as an application of "real options" theory from the strategic management literature.[84] Real options theory is itself an extension of the logic of financial options (such as an option to buy or sell stock) applied to a firm's decision to invest in a particular business project.[85] The starting point of real options theory is that most investments share three features: (a) they involve irreversible sunk costs; (b) their future value is uncertain; and (c) there is some leeway in the timing of when the investment can be made.[86] Taken together, the insight is that there are gains from either delaying a decision to invest or, if delay is impracticable, making a small upfront investment that preserves the option to invest fully later.[87] As

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82. *See* Light, *supra* note 76, at 346-50 (explaining overlapping federalism in terms of the precautionary principle); Buzbee, *supra* note 76, at 1040 ("Retaining latitude for both federal and state roles also can serve in a valuable precautionary role . . . in regulatory settings characterized by rapid change."). To be sure, this is not necessarily true of all forms of concurrent jurisdiction. When concurrent jurisdiction involves a reciprocal veto-power, it begins to resemble a portfolio approach. Structural features of the U.S. Constitution, such as bicameralism, the presidential veto, and separations of powers, arguably play this function. *See generally* Saul Levmore, *Bicameralism: When are Two Decisions Better than One?*, 12 INT'L REV. L. & ECON. 145 (1992).

83. *See generally* Zachary Gubler, *Experimental Rules*, 55 B.C. L. REV. 129 (2014); Yoon-Ho Alex Lee, *An Options Approach to Agency Rulemaking*, 65 ADMIN. L. REV. 881 (2013); Matthew Spitzer & Eric Talley, *On Experimentation and Real Options in Financial Regulation*, 43 J. LEGAL STUD. S121 (2014); Charles K. Whitehead, *The Goldilocks Approach: Financial Risk and Staged Regulation*, 97 CORNELL L. REV. 1267 (2012).

84. *See* Spitzer & Talley, *supra* note 83, at S123 (proposing a model of experimental regulations that contain an "embedded real option"); Whitehead, *supra* note 83, at 1273 (discussing relationship between phased regulations and real options theory); Lee, *supra* note 83, at 887.

85. *See* RICHARD FRIBERG, MANAGING RISK AND UNCERTAINTY: A STRATEGIC APPROACH 258 (2015) ("By analogy to a financial option we may see a firm's position as giving it a right but not an obligation to invest[.]"); Avinash K. Dixit, *Entry and Exit Decision Under Uncertainty*, 97 J. POL. ECON. 620, 621 (1989) ("An opportunity to make a real investment is a call option on a stock that consists of the capital in place. Making the investment is like exercising the option, and the cost of the investment is the strike price of the option."). For real options theory, see generally AVINASH K. DIXIT & ROBERT S. PINDYCK, INVESTMENT UNDER UNCERTAINTY (1994).

86. *See* DIXIT & PINDYCK, *supra* note 85, at 3. *See* FRIBERG, *supra* note 85, at 258.

87. The decision to either make an upfront investment or delay an investment altogether are analytically identical, because there is always a sunk opportunity cost to delay. *See* DIXIT & PINDYCK, *supra* note 86, at 3. Real options theory also has implications for how to time the abandonment of ongoing investments. *Id.* at 14-15.

adapted by the legal scholarship on phased regulations, policy uncertainty cautions against a permanent decision to impose a legal rule with unknown consequences, because preserving regulatory flexibility is paramount.

Law-and-economics scholars who draw upon real options theory usually focus on its implications for administrative rulemaking. For example, Professor Whitehead has proposed rules that are phased-in—in terms of the breadth or burdensomeness of their requirements—on a piecemeal basis over time.[88] Another set of proposals addresses the back-end question of how regulations can be phased out after being implemented. Professors Spitzer, Talley, and Gubler propose a procedure for the use of "experimental regulations" that are rolled out on a temporary trial basis, after which they must either expire or be renewed via a sunset provision.[89] A third alternative, suggested by Professor Lee, is for regulated parties to be granted an option, after the initial implementation period of rule, to either petition agencies for an exemption from the rule or request its repeal as a whole.[90]

By relying on optional value concepts from asset pricing theory, the solution to policy uncertainty offered in the literature on phased regulations may appear aligned with Modern Portfolio Theory. But the two frameworks are fundamentally different. Most importantly, real options theory is concerned with the sequencing of a single investment over time, rather than the total number of investments a firm should make in an uncertain business environment.[91] It has been noted in the management literature that the optimal portfolio of real options is rarely if ever considered.[92] The same blindspot reappears in the legal scholarship. As a result, the literature on phased or experimental regulations has a posture that is closer to the law-and-economics of rules versus standards than to Modern Portfolio Theory. Where there is policy uncertainty, legal rules should be designed a certain way. Namely, the decision to implement a regulation should be restructured from a

88. *See* Whitehead, *supra* note 83, at 1299–1306 (describing a phased approached to the Dodd-Frank Act's Volcker Rule).

89. *See* Spitzer & Talley, *supra* note 83, at S126–27, S130; Gubler, *supra* note 83, at 130-31; *see also* Jacob Gersen, *Temporary Regulation*, 74 U. CHI. L. REV. 247 (2007) (providing a similar proposal with respect to legislation, rather than administrative rulemaking).

90. *See* Lee, *supra* note 83, at 887; *see also* Gubler, *supra* note 83, at 131-32 (arguing that experimental rules should be encouraged by courts).

91. *See* Roberto Vassolo et. al, *Non-Additivity in Portfolios of Exploration Activities: A Real Options-Based Analysis of Equity Alliances in Biotechnology*, 25 STRATEGIC MGMT. J. 1045, 1045 (2004) ("The real options as well as other literatures to date have tended to focus on individual investment.").

92. *Id.* at 1045 ("When firms have multiple real options . . . [t]he implication is that the timing or likelihood of exercise of a single option may be influenced by the presence of correlated options in the firm's option portfolio.").

one-time, yes-or-no question to a phased approach that follows a "some now, maybe more later" timeline.

This section has reviewed the leading approaches to policymaking uncertainty in the legal scholarship. The main point is not that they lack merit. As will be shown, many of these mechanisms could be incorporated into this Article's proposed portfolio theory. Rather, it is that they proceed from a common premise. The solution to uncertainty turns on the particular formal structure that will make legal rules perform well in an unpredictable world. Thus, given uncertainty, regulation should take the form of precautionary feasibility requirements, or they should be promulgated at the state level, or they should be simple rather than complex, or they should be experimental rather than permanent. In all of the above cases, one set of questions is not asked: how many feasibility standards?; how many simple rules?; how many experimental rules with sunset provisions?; and so on. The diversification principle at the heart of Modern Portfolio Theory has yet to be directly confronted in legal scholarship of policymaking uncertainty.

II. A PORTFOLIO THEORY OF POLICYMAKING UNCERTAINTY

This Section presents this Article's portfolio approach to policymaking uncertainty. In contrast to the theories surveyed above, the defining feature of a portfolio approach is to relax the assumption that policymakers should address uncertainty by adopting the single policy rule or legal procedure that will perform best in light of unpredictable circumstances. By addressing a policy problem with a portfolio of overlapping legal rules, the risk of any particular regulatory intervention performing poorly is thereby mitigated.

Part A below begins with an overview of Modern Portfolio Theory as it was originally developed in finance. Part B shows how insights from the finance context can be translated into a parallel framework for the optimal design of regulations. After laying out that framework at a high level, Part C then provides some practical guidance on how a portfolio approach to legal rules can be effectively implemented. Finally, Part D shifts from normative to positive theory. It argues that the frequent use of overlapping regulations found across many areas of the law suggests that, as a descriptive matter, a portfolio approach to policy uncertainty is already commonplace.

A. Modern Portfolio Theory in Finance

Modern Portfolio Theory proceeds from the observation that outcomes in financial markets are uncertain.[93] The expected return on any given stock depends on the future profitability of the firm issuing

93. *See* Markowitz, *supra* note 14, at 469.

the stock, which is unknowable to investors in advance.[94] The implications of uncertainty for investment decisions become clear after imagining the opposite case—where the future path of stock price movements can be forecast without error.[95] In a hypothetical world where such perfect foresight is possible, expected returns are identical to actual future returns. The result, in such a scenario, is that every investor should opt for zero diversification and allocate their entire portfolio to a single stock: the stock with the highest expected return.[96]

Even when actual returns are uncertain, the investment calculus does not change unless investors are risk-averse.[97] An investor who is indifferent to risk should also only hold the security which, on average, has the highest expected return.[98] It is widely recognized, however, that in real life almost all people prefer to avoid unanticipated losses and therefore care about the overall risk-return profile of an investment.[99] Critically, Markowitz recognized that this does not mean investors should care about the risk-return profile of each particular security they own.[100] Instead, when investors are able to hold shares of multiple different stocks, all that matters is their entire investment portfolio considered as a whole.[101]

As Markowitz further demonstrated, the risk-return profile of an investment portfolio is a function of three features of the underlying securities, their: (a) expected return, (b) variance, and (c) covariance.[102] The expected return of a security is a forward-looking estimate of its actual return in future periods.[103] Variance measures the range in which a security's actual return may differ from its expected return.[104] Variance is therefore a proxy for investment risk, and synonymous

94. *See* Markowitz, *supra* note 12, at 77. Moreover, the *relative* return on any particular stock cannot be known, unless the future profitability of every public company is also known. *See id.* at 78.

95. *See id.* at 78.

96. *See id.* Or, if there is an exact tie among multiple stocks with the highest expected return, any combination of those stocks. *See id.*; *see also* Markowitz, *supra* note 14, at 469.

97. *See* MARKOWITZ, *supra* note 15, at 6-7 (explaining the role of investor risk aversion).

98. An investor who is risk-seeking, like a gambler, would chase the security with the highest possible return, regardless of its average expected return. *See* Markowitz, *supra* note 12, at 90.

99. *See id.* at 91 (observing that portfolio theory applies to the "great variety of investing institutions which consider . . . risk a bad thing; gambling, to be avoided"); Varian, *supra* note 12, at 160.

100. *See* Markowitz, *supra* note 14, at 470; Rubenstein, *supra* note 30, at 1042.

101. *See* Markowitz, *supra* note 14, at 470; Rubenstein, *supra* note 29, at 1042.

102. Expected return is typically represented as the weighted average from a probability distribution of possible returns. *See* Markowitz, *supra* note 12, at 79-81.

103. *See id.*

104. *See id.* at 89 (explaining that variance is the variable which captures investment risk).

with the level of ex ante uncertainty associated with the financial performance of a security.[105] Covariance refers to the correlation in variance between individual securities.[106] When two securities are subject to a common set of risks, with the result that their prices tend to move up and down in the same direction, their covariance is high (and vice versa).[107]

The great discovery of Modern Portfolio Theory is that covariance is the linchpin between risk and return where the benefits of portfolio diversification are realized.[108] So long as the variance in the expected return of two securities is not perfectly correlated, a portfolio that combines both is less risky than an individual investment in either one.[109] This is an extremely wide-reaching result, as it is nearly impossible for the variance in any pair of stocks to be perfectly correlated. Even the stocks of Pepsi and Coca-Cola have an imperfect covariance because the profitability of those companies will vary depending on the performance of different managers, different supply chains, different branding strategies, and so on. Moreover, in the ideal case, where the variance between securities has a perfect *negative* correlation, diversification completely eliminates risk: the expected and actual return of the investment portfolio are guaranteed to be the same.[110] Hence, the powerful benefits of diversification. A portfolio approach will almost always decrease the investment uncertainty to some degree, and, under ideal conditions, removes it altogether.[111]

Since its publication in 1952, Markowitz' *Portfolio Selection* paper spawned a massive scholarly literature in theoretical finance. Much of this work—including the influential Capital Asset Pricing Model developed by Markowitz's co-Nobel Prize laureates William Sharpe and Merton Miller[112]—is concerned with refining elaborate mathematical

105. *See id.* at 89.

106. *See id.* at 89 (discussing covariance).

107. A common example of securities with high covariance is stocks in the same industry, such as a pair airline companies—the value of stocks is likely to move in the same direction. *See* Markowitz, *supra* note 12, at 89 n.12 (citing railroad stocks as another example).

108. *See* MARKOWITZ, *supra* note 15, at 5; Varian, *supra* note 12, at 161 (stating that the significance of covariance is "perhaps, the central insight of Markowitz's contribution to finance").

109. Markowitz, *supra* note 12, at 89.

110. For the stocks of an umbrella producer and sunscreen producer, if it is rainier than forecasted in the coming year, the umbrella company stock will have an unexpectedly high return, while the sunscreen company's profits will be lower than expected.

111. In practice, the ideal case is considered unlikely to hold. A well-diversified portfolio is still subject to a baseline level "market risk," such as the risk of a war or recession, which will affect most firms the same way. *See* MALKIEL: WALK DOWN WALL STREET, 194-95; Markowitz, *Portfolio Selection*, *supra* note 12 at 79 ("[Because] the returns from securities are too intercorrelated [] diversification cannot eliminate all variance.").

112. *See generally* Varian, *supra* note 12 (summarizing the relevant contributions made to Modern Portfolio Theory by Markowitz, Sharpe, and Miller).

tools for calculating the optimal portfolio.[113] But the essence of the Modern Portfolio Theory is simple. All investments involve uncertainty. Uncertainty implies that diversification is the rare free lunch whenever investments are not subject to identical sources of risk.

B. Applying Portfolio Theory to Policymaking

Modern Portfolio Theory is more than a guide to investing in the stock market. As the proverb about carrying eggs in multiple baskets suggests, its theoretical significance is much broader, and can potentially be extended to any set of two or more random variables.[114] Properly understood, Modern Portfolio Theory comes close to a theory of everything.[115] The discussion in this Part B shows how Modern Portfolio Theory can be transported from finance to the legal system as well. First, it maps out a basic conceptual framework for doing so. It then illustrates how those concepts can be applied, using a hypothetical case of littering regulations at a state park.

1. Regulation as Investment Under Uncertainty: Basic Concepts

The first step toward a portfolio theory of regulatory policymaking is to view legal rules as investments by society, with an expected return, variance, and covariance. Secondly, it is necessary to clarify what it means to "diversify" legal rules in a common policy space. Once these concepts are adapted to the legal system, it becomes easy to see that the benefits of diversification may apply to a portfolio of regulations just as they do to a portfolio of financial investments.

The expected return to any legal rule can be interpreted through the lens of a conventional cost-benefit analysis that is already a widespread practice at most administrative agencies.[116] The social cost of investing in a particular legal rule has both public and private components. Public costs are incurred upfront as part of the legislative and rulemaking process, and on the backend with the resources used to

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113. For a general survey of the Capital Asset Pricing Model, *see generally* Eugene F. Fama & Kenneth R. French, *The Capital Asset Pricing Model: Theory and Evidence*, 18 J. ECON. PERSP. 25 (2004). For the seminal early papers of Sharpe, Miller, and their contemporaries, *see generally* Fischer Black, *Capital Market Equilibrium with Restricted Borrowing*, 45 J. BUS. 444 (1972); John Lintner, *The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets*, 47 REV. ECON. & STAT. 13 (1965); William F. Sharpe, *Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk*, 19 J. FIN. 425 (1964); James Tobin, *Liquidity Preference as Behavior Towards Risk*, 25 REV. ECON. STUD. 65 (1958).

114. *See* Fabozzi, Gupta & Markowitz, *supra* note 31; MARKOWITZ, *supra* note 15, at 38-70.

115. *See supra* notes 16, 17, & 18 and accompanying text.

116. *See* MATTHEW D. ADLER & ERIC A. POSNER, NEW FOUNDATIONS OF COST-BENEFIT ANALYSIS 3-6 (2006).

enforce the rule.[117] The private costs, which are borne by regulated parties, include: the time spent learning what a regulation requires; the financial burden associated with retaining accountants, lawyers, and other compliance professionals; and, the opportunity cost to regulated parties of foregoing otherwise valuable activities to comply with the rule.[118] The benefits of a legal rule consist of the increase to social welfare it yields. That is, how much better off are people with the rule compared to the status quo of privately ordered activity in its absence.[119] Thus, a regulation has a positive expected return whenever a cost-benefit analysis suggests that imposing the rule will result in a net benefit to society.

The variance of a legal rule describes the potential for its expected return to vary from its actual return, meaning its future net benefit to society. Just as variance is the measure of investment risk, it is also a proxy for the degree of policymaking uncertainty. In a world of perfect certainty, regulations perform exactly as expected and have no variance. But as with securities, all regulations have at least some variance. Consider a legal rule aimed at reducing obesity, such as a soda tax.[120] The benefits of that regulation depend on a number of factors that cannot be known with certainty, such as the propensity of consumers to switch to other, less sugary beverages.[121] For a soda tax, or any other legal rule, the exact "point-estimate" of a cost-benefit analysis is always a convenient fiction, bounded by a range of reasonable estimates.[122] The wider that range of estimates must be extended to cover the possible consequences of a rule, the greater is its variance.

The covariance between a pair of legal rules captures the degree to which uncertainties about their expected benefits turn on a similar set of factors. Consider the soda tax alongside a related public health regulation requiring fast-food restaurants to disclose the calories of menu items.[123] The success of that disclosure rule will depend, among other

117. *See id.* at 12-19.

118. *See* Kotowski et al., *supra* note 61; John C. Coates IV, *Cost-Benefit Analysis of Financial Regulation: Case Studies and Implications*, 124 YALE L. J. 882, 891-98 (2015).

119. In law-and-economics jargon, regulatory benefits consist of the allocative efficiencies realized by the correction of negative externalities or other market failures. *See* John H. Cochrane, *Challenges for Cost-Benefit Analysis of Financial Regulation*, 43 J. LEGAL STUD. S63, S68 (2014).

120. *See generally* Katherine Pratt, *A Constructive Critique of Public Health Arguments for Antiobesity Soda Taxes and Food Taxes*, 87 TUL. L. REV. 73 (2012).

121. *See, e.g.*, Zarko Kalamov, *A Sales Tax is Better at Promoting Healthy Diets than the Fat Tax and the Thin Subsidy*, 29 HEALTH ECON. 353 (2020); Markus Gehrsitz, Henry Saffer & Michael Grossman, *The Effect of Changes in Alcohol Tax Differentials on Alcohol Consumption* (Nat'l Bureau of Econ. Rsch., Working Paper No. 27117, 2020).

122. *See* Cass R. Sunstein, *The Limits of Quantification*, 102 CALIF. L. REV. 1369, 1393 (2014).

123 *See generally* Devon E. Winkles, *Weighing the Value of Information: Why the Federal Government Should Require Nutrition Labeling for Food Served in Restaurants*, 59 EMORY L.J. 549 (2009).

things, on whether the information it provides consumers causes them to prefer a lower-calorie meal.[124] That impact is not only difficult to determine, but also largely independent of whether consumers are unwilling to pay a higher price for their preferred menu item under a soda tax. As with stocks, the covariance between regulations will rarely if ever be perfectly correlated.[125]

Lastly, the diversification analogy. With financial portfolios, diversification implies the division of an investment into parts, rather than an increase in its overall size. As a practical matter, the size or "intensity" of society's investment in a legal rule can be adjusted up or down along a number of dimensions. Take a traffic rule that prohibits driving under the influence. The intensity of that rule could be ratcheted up by increasing the resources used to enforce it, for example by deploying police checkpoints on New Year's Eve. Similarly, the minimum blood alcohol level required for a violation could be lowered, or the penalties for violations increased in terms of fines or jail time. Conversely, and more generally, a regulation can be made relatively light touch by lowering the substantive standard of care, reducing enforcement efforts, or imposing lesser penalties for non-compliance.[126] The regulatory framework governing any particular policy problem can therefore be diversified by increasing the number of rules that are imposed, while also reducing the intensity of each rule so that the total social cost of the policy intervention remains constant.

2. Illustration: Littering in State Parks

Applying the conceptual framework outlined above, the benefits from regulatory diversification can be illustrated through the following stylized example. Assume that littering has become a problem at state parks. In response, the state legislature is considering two regulations: (1) a rule that imposes a fine for park visitors who are caught littering, and (2) a rule that requires the park to install trash cans near campsites and hiking trails. Further, assume that the state has run a cost-benefit analysis, which concludes that either rule would cost $2 million to implement. By reducing littering, and thereby enhancing the use and enjoyment of the parks, the same analysis estimates that either rule would increase social welfare by $10 million. Thus, the expected return for either rule is the net of those costs and benefits, $8 million.[127]

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124. *See id.* at 557-58; *see also* Brian Elbel et al., *Calorie Labeling and Food Choices: A First Look at the Effects on Low-Income People in New York City*, HEALTH AFF. w1110 (2009).

125. *See supra* note 108 and accompanying text.

126. *See generally* Jackson, *supra* note 6.

127. On the use of dollar figures to quantify the costs and benefits of legal rules, *see infra* Section II.C.iv.

In a world of perfect certainty—where the expected return on legal rules never varies from their actual return—the two state park regulations are interchangeable: whichever option the policymaker chooses will make society exactly $8 million better off. When it comes to the world of parks and recreation, however, nothing is certain. Purchasing, installing, and maintaining trash cans around the state park might prove more expensive than expected. Possibly, food discarded in the trash cans will attract hungry animals who attack and scare the campers. Or, the trash cans might be placed at an awkward distance from campsites and go unused (or, they could be perfectly well-placed, until camping patterns change). Likewise, for the littering fine, it might be difficult for park personnel to catch and cite campers who have littered before they leave the park. Campers may be undeterred by the fine if it is set too low, or refrain from visiting the park if it is set too high. The park rangers, upset at their onerous new enforcement duties, could go on strike. As a result, the state's cost-benefit analysis determines that the anticipated $8 million net benefit of each rule could actually fall anywhere in the range of $2 to $14 million. The expected return of each rule will therefore vary with a standard deviation of $6 million.[128]

Finally, assume, as is plausible, that the uncertainties affecting each rule are not closely related. The chance that animals are drawn to the trash cans does not depend on whether camp rangers will be able to consistently detect campers who litter, or whether campers cited for violations will be deterred by the fines. The possibility that campers will visit the park less to avoid being fined is independent of whether the trash cans are sufficiently well-positioned to encourage their use. The covariance between the two rules therefore has a correlation coefficient of zero.[129]

In light of these uncertainties, the state legislature decides to take a portfolio approach and apply both rules in conjunction. To diversify across both rules, the intensity of each rule is halved relative to a single-rule scenario. For the trash can regulation, this could mean fifty percent fewer units are installed. For the littering fine, some combination of less enforcement staff and lower monetary penalties. As a consequence, the social cost of each rule is now $1 million, and their benefits are $5 million, making an expected return on net of $4 million. Since the rules are being jointly applied, the expected return on the regulatory portfolio as a whole remains the same as under the single-rule scenario: $8 million. Yet, at the same time, the lack of covariance

128. Or $36 million, when variance is expressed as a squared deviation from the mean. One could also describe the expected return as a mean of $8 million with a ninety-five percent confidence interval of [$2 million, $14 million].

129. In other words, the probability that the trash can rule will yield a net benefit of $14 million is just as likely as the probability that the littering fine will yield a benefit of $2 million, and vice versa.

between the rules means that the standard deviation in outcomes from the state legislature's overall policy intervention has gone down from $6 million to about $4 million.[130]

Because the variance of legal rules is the relevant metric for policy-making uncertainty, the magnitude of that problem has been reduced by a third. Moreover, the reduction in uncertainty has come at no cost. Society should still expect to benefit the same amount from the state park regulations. What has changed is that, with a portfolio of two rules, there is a lower probability that expectation will prove incorrect. Thus, so long as it is assumed that "society" as a whole is at least somewhat risk-averse, the portfolio approach, which includes both state park rules, strictly dominates the use of either rule in isolation. That assumption should be uncontroversial, and is common to most normative theories of social welfare.[131] Indeed, if society was indifferent to highly unpredictable regulatory outcomes, policy uncertainty would not be a matter of concern.

Note that, despite the use of several simplifying assumptions for the sake of illustration, the application of these principles is extremely general. Nothing in this state park hypothetical turns on the number of regulations considered, nor on the stipulation that the trash can rule and littering fine have symmetrical costs, benefits, and variance. Assume, for example, that the state legislature considers a third rule. The third regulation requires state parks to undertake an advertising campaign with the goal of raising awareness of the litter problem, in order to deter campers from littering through moral suasion. This might include placing notices on park maps, signs posted at campsites, public service announcements on local radio or television, and so on. The ad campaign is perceived as a longshot. On one hand, it could very well be disregarded by park-goers and prove totally ineffectual. On the other hand, there is a chance that the ad campaign may influence social norms in a way that has a large impact on littering behavior.[132] Without belaboring the math, it can be shown that diversifying the

130. The variance of the portfolio (a combination of the two investments) can be expressed as $\sigma^2 = w_a^2\sigma^2 + w_b^2\sigma^2 + 2w_a w_b Cov_{1,2}$. Taking the square root of the above expression is the standard deviation of the portfolio. In this case, assuming the city spends fifty percent of its budget on each investment and that the covariance of the investments is zero, the portfolio standard deviation is equal to sqrt [(.25)(36)+(.25)(36)+2(.5)(.5)(0)] =4.2. Therefore, the net benefit from a joint rule will range from $3.8 million to $12.2 million, rather than $2 to $14 million.

131. *See* MATTHEW D. ADLER, WELL-BEING AND FAIR DISTRIBUTION: BEYOND COST-BENEFIT ANALYSIS 104-08 (2012); JOHN RAWLS, A THEORY OF JUSTICE 146 (1971) (presenting the famous argument that individuals in a hypothetical "original position" would be risk-averse when negotiating the social contract).

132. *See* Cass R. Sunstein, *On the Expressive Function of Law*, 144 U. PA. L. REV. 2021, 2032-33 (1996). *See generally* ERIC A. POSNER, LAW AND SOCIAL NORMS (2002).

regulatory regime for state parks among all three rules further improves the risk-return profile of the state park's anti-littering policy.[133]

Moreover, there is no unique feature of state parks, nor of littering as a policy problem, that makes them especially amenable to a portfolio approach. The particular source of uncertainty underlying each rule in the regulatory portfolio is irrelevant, except for the extent that those uncertainties are correlated across rules. Nor does the specific procedural form those rules take matter. The same logic applies regardless of whether a regulatory portfolio combines ex ante rules, ex post standards, phased regulations with sunset provisions that function as real options, or feasibility requirements following the precautionary principle.[134] Nor does the result turn on the number or diversity of rulemakers: the three littering rules could have been variously promulgated by the state legislature, state park agency, or park management itself. With each variation, the basic intuition behind diversification of risk remains the same. Financial market uncertainty increases the optimal number of investments; policy uncertainty increases the optimal number of legal rules.

C. The Design & Implementation of Regulatory Portfolios

The preceding Part B emphasizes how Modern Portfolio Theory can be adapted to the legal system. But the analogy laid out above is not perfect, and financial markets have special features that do not translate to the regulatory context in every respect. As an initial matter, a standard normative implication of Modern Portfolio Theory is that an efficient portfolio may be achieved by spreading an investment across

133. To see this, assume the state park will add a new third investment to the previous two investment portfolio. *Supra* note 130. The standard deviation of a three investment portfolio is the square root of $\sigma^2 = w_a^2\sigma^2 + w_b^2\sigma^2 + w_c^2\sigma^2 + 2w_aw_bCov_{1,2} + 2w_aw_cCov_{1,3} + 2w_bw_cCov_{2,3}$. This third investment will have an expected net return of $8 million but will have a standard deviation of $8 million (i.e. the investment will pay out net either $0 or $16 million). Therefore, the investment is more risky than both of the two previous investments. Assume further that the covariance among all three investments is zero. Assuming further that the state park invests evenly in each of the three projects, the portfolio expected return will be (8/3) + (8/3) + (8/3) = $8 million. The standard deviation of the portfolio will be equal to sqrt[(64)(.11) + (36)(.11) + (36)(.11) + 2(.33)(.33)(0) + 2(.33)(.33)(0) + 2(.33)(.33)(0) = sqrt [7.04 + 3.96 + 3.96 + 0 + 0 + 0] = $3.8 million. Therefore the portfolio of all three investments will have a net benefit that will range from about $4.2 million to $11.8 million. By adding the third investment to the portfolio, the city will have kept the expected return of the investment portfolio the same but has decreased the overall variability of the portfolio in comparison to both the two project portfolio and the third project alone.

134. The state park's littering fine is a simple ex ante rule. The trash can installation requirement and advertising campaign would likely be considered ex post standards, depending on how they are formulated. All three regulations could be structured as experimental rules if they are phased-in gradually or phased-out with sunset provisions. The littering fine could be designed to track the precautionary principle: for example, if it excluded a de minimis exception for small amounts of litter, or included an outright ban on the use of certain products in the park (such as six-pack beverages with plastic rings that hurt animals).

the entire stock market.[135] Yet it is intuitively obvious that the optimal regulatory portfolio will not include every possible legal rule. Accordingly, the discussion below highlights some salient differences between financial markets and regulatory policymaking that complicate the application of a portfolio approach to legal rules. It then develops some rules of thumb to inform the design and implementation of regulatory portfolios which account for those differences.

1. Size of Regulatory Portfolio

Financial investments differ from legal rules in two basic ways which have implications for the optimal size and structure of regulatory portfolios. For one, there is no inherent ceiling to the return on investment in a particular security or portfolio of securities.[136] As a result, the optimal size of a financial portfolio is, in theory, only limited by an investor's willingness or ability to raise further capital to invest.[137] In addition, the expected return on a publicly-traded stock is almost by definition always positive—otherwise, its price falls to zero.[138] Neither of these features characterize society's investment in legal rules.

First, the expected return from any policy intervention is, in principle, capped. That is because the increase in social welfare that a regulation provides cannot exceed the magnitude of the market failure it seeks to correct.[139] Put simply, the benefit of solving a problem is limited by the seriousness of the problem. Returning to the state park hypothetical, the expected benefit from any anti-littering policy cannot be greater than the value which visitors place on a litter-free park.[140]

Second, legal rules can have a negative expected return. All this means is that some policies can be expected to do more harm than good. In the state park scenario, for example, it is plausible that a rule requiring park management to equip a fleet of airborne drones to collect litter would not be worth the cost. A long list of real-world examples would be easy to compile, although the items on that list may vary depending on whom is asked. Whenever objection is made to a public

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135. *See* Varian, *supra* note 12, at 164.

136. *See* Gregory Zuckerman, *Trader Made Billions on Subprime*, WALL STREET J. (Jan. 15, 2008), https://www.wsj.com/articles/SB120036645057290423 [https://perma.cc/D5PE-BFAU].

137. *See* Sharpe, *supra* note , at 431-35.

138. A financial asset that is expected to be worth less tomorrow than it is today is worthless today. *See* Varian, *supra* note 12, at 164; Fama & French, *supra* note 113, at 30.

139. *See* Cochrane, *supra* note 119, at S68.

140. In conventional cost-benefit analysis jargon, this benefit would be expressed in terms of a state resident's willingness to pay for a park without litter. That willingness to pay cannot exceed the deadweight loss caused by the littering externality which the park regulations attempted to correct. *See* Eric A. Posner & Cass R. Sunstein, *Moral Commitments in Cost-Benefit Analysis*, 103 VA. L. Rev. 1809, at 1818-24, 1823 (2017) (discussing the role of the "willingness to pay" criterion in cost-benefit analysis).

policy decision (on disinterested grounds), the objector's claim is that, by their estimation, society's investment in that policy has a negative expected return. [141]

This pair of distinctions suggests two rules of thumb for the composition of efficient regulatory portfolios. First, there is no sense in holding the entire "market" of all conceivable regulations—only the subset of legal rules which have a positive expected return. An efficient regulatory portfolio should exclude rules that fail a cost-benefit analysis. Second, regardless of how many legal rules are included in a policy portfolio, the total aggregate cost of those regulations should not exceed the benefits associated with correcting the market failure at issue. A corollary to this second point is that, as mentioned above, the quantity and intensity of rules in the optimal regulatory portfolio are inversely related.[142] Thus, as a policy portfolio is diversified among a greater number of rules, the intensity of each rule should be ratcheted downwards.

2. Diversification of Legal Rules is Costly

Modern Portfolio Theory generally assumes that diversification is costless to the investor.[143] This assumption works well for modern financial markets, especially with the rise of mutual funds and brokerage services which have made the transaction costs of buying and selling securities negligible.[144] The same does not hold true when it comes to the legal system, however. There are a variety of social costs that accompany the addition of new legal rules. Understanding the specific sources of those transaction costs provides further clarity on the optimal design of regulatory portfolios.

First, unlike stocks, regulations cannot be acquired over the phone or with the swipe of an E-Trade app. There are fixed costs to the development of any new legal rule. The burdensome procedural hurdles attendant to congressional legislation and the regulatory rulemaking process are well known.[145] Public administrative costs also grow with

141. *See* Robert Han, *The Economic Analysis of Regulation: A Response to the Critics*, 71 U. CHI. L. REV. 1021, 1037 (2004).

142. *See generally* Jackson, *supra* note 6.

143. *See* Erzo Luttmer, *Asset Pricing in Economies with Frictions*, 64 ECONOMETRICA 1439, 1439 (1996).

144. *See* Richard Booth, *Index Funds and Securities Fraud Litigation*, 64 S.C. L. REV. 265, 271 n.26 (2012); Matt Levine, *The Trades Will be Free Now*, BLOOMBERG (Oct. 2, 2019), https://www.bloomberg.com/opinion/articles/2019-10-02/the-trades-will-be-free-now [https://perma.cc/3Y73-5QXV].

145. *See, e.g.*, Thomas O. McGarity, *Some Thoughts on "Deossifying" the Rulemaking Process*, 41 DUKE L. J. 1385, 1385-86 (1992).

the number of regulations, as agencies must invest more time and resources to learn and enforce each new rule.[146] Additional learning costs are also incurred by private parties, who must navigate compliance in an increasingly complex regulatory environment.[147]

Second, the expected return on a security is typically assumed to be a constant linear function of the original investment.[148] When the price of Apple stock rises five percent, the rate of return to its stockholders is the same five percent, whether they hold one share or a thousand.[149] By contrast, the expected return for regulations may be "lumpy" or non-linear, due to increasing or decreasing returns to scale.[150] For example, a law that subsidizes vaccinations for contagious diseases may become increasingly effective the more broadly it expands access to vaccinations.[151] Similarly, a half-built bridge does not increase social welfare fifty percent as much as a full bridge would. It is therefore often the case that policy interventions must reach a critical threshold of intensity in order for their benefits to be realized.

Third, the returns to securities in an investment portfolio are usually assumed to be "separable," or independent of one another.[152] It is not possible for my purchase of Apple stock to reduce the expected return on shares in Microsoft that I already own. By contrast, the cost-and-benefits of regulations which overlap in a common policy space are often interdependent and non-separable.[153] Imagine a zoning regulation intended to liberalize restrictions on real estate development, combined with a rule that imposes a fine for excessively noisy activity in the same neighborhood. The expected benefit from an increased housing supply under the zoning rule may not be forthcoming if the nuisance fine is set so high that developers find it prohibitively expensive to proceed with construction projects.

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146. *See* Peter Schuck, *Legal Complexity*: *Some Causes, Consequences, and Cures*, 42 DUKE L. J. 1, 3-7 (1992).

147. *See id.* at 7.

148. *See* Michael Klein, *The Economics of Security Divisibility and Financial Intermediation*, 28 J. FIN. 923, 924-25 (1973).

149. *See id.* at 927-28 (noting the assumption that investments are infinitely divisible at no cost).

150. *See* Lee Anne Fennel, *Lumpy Property*, 160 U. PA. L. REV. 1955, 1958-59 (2011).

151. For studies that discuss increasing returns to scale in vaccines, *see generally* Greg Attenweiler & Angie Thomure, *Best Practices: A Network Approach of the Mandatory Influence Vaccination Among Health Care Workers* (Wright State Univ. Master of Pub. Health Student Publ'ns, 2014); Douglas Luke & Katherine Stamatakis, *Systems Science Methods in Public Health: Dynamics, Networks*, *and Agents*, 33 ANN. REV. PUB. HEALTH 357 (2012).

152. *See* David Cass & Joseph E. Stiglitz, *The Structure of Investor Preference and Asset Returns, and Separability in Portfolio Allocation*, 2 J. ECON. THEORY 122 (1970).

153. *See* Matthew C. Turk, *Overlapping Legal Rules in Financial Regulation & the Administrative State*, 54 GA. L. REV. 791, 811-14 (2020).

Taken together, the foregoing distinctions between securities and legal rules have one common takeaway. At some point, further diversification of a regulatory portfolio comes at a net loss, once the transaction costs of adding more rules begin to outweigh the gains from reduced policy uncertainty. It follows that an efficient policy portfolio will not only exclude legal rules with negative expected value, but also omit some rules that are anticipated to provide a net benefit as well. There is therefore a need to prioritize among the set of regulations with a positive expected return which may potentially be included in a policy portfolio. The costs to regulatory diversification identified above suggest three criteria for doing so.

The first criterion is straightforward: prioritize regulations with a relatively high expected return. For instance, dividing a regulatory framework among several rules—each of which is expected to have only slightly greater benefits than costs—may be less beneficial than focusing resources on an intensive application of a single, "lumpy" rule that is more promising. A second commonsensical principle is to avoid the joint use of two rules that have a positive expected value when viewed in isolation but work poorly together. In the zoning example given above, it is plausible that diversifying across a rule that facilitates new home building and a noise prohibition that discourages construction carries costs that outweigh the benefits of reduced policy uncertainty.

A third criterion, which is less obvious but perhaps most important of all, is that priority should be given to rules with low (or ideally negative) covariance.[154] Returning once again to the state park hypothetical, a combination of the advertising campaign and littering fine arguably presents a case where rules have negative covariance. If parkgoers are not moved to voluntary action by public service announcements that discourage littering, they may be deterred by the bottom-line cost of monetary penalties. Conversely, a more public-spirited group might be heavily influenced by official exhortations to avoid littering, relative to the threat of a fine. Ex ante, it may be difficult to tell which scenario is more likely. But by combining the two regulations, policymaking uncertainty is minimized, as the risk of an unexpected downside from one rule is offset by the unexpected upside from another.

3. Policymaking Uncertainty Fluctuates over Time

With financial assets, uncertainty is largely a constant. According to the Efficient Market Hypothesis, stock prices in well-functioning capital markets follow a "random walk" around their present value,

154. *See supra* note 108-11 and accompanying text.

and are therefore inherently unpredictable.[155] This is why buying—and holding—a broadly diversified index of stocks is generally advised.[156] Any effort to better anticipate how stock prices will move is almost always a fool's errand, even for sophisticated financial professionals.[157]

By contrast, policymaking uncertainty can rise or fall over time. Uncertainty tends to increase when an exogenous policy shock—such as a financial crisis, environmental catastrophe, or global pandemic—reveals that less is known about the prevalence of market failures and efficacy of the existing regulatory framework than was previously thought. Uncertainty can also decrease. Policymakers may gain better information about the functioning of particular legal rules; social science research may converge on more reliable findings regarding the underlying policy problems those rules address; technological advances, market innovations, or scientific discoveries may render existing policy interventions obsolete.

This feature of the policy world has a few implications for how regulatory portfolios should be adjusted over time. On one hand, an unexpected policy shock that increases uncertainty calls for expanding the number of rules in the regulatory framework. On the other hand, a decline in policymaking uncertainty allows for the number of rules in a regulatory portfolio to shrink. This is simply a corollary to diversification as a response to risk: the greater the uncertainty, the greater the benefits of diversification. The potential for policymaking uncertainty to fluctuate is also relevant to the kinds of rules that are incorporated in the optimal regulatory portfolio, including those advocated in three of the theories of policymaking uncertainty surveyed above in Section I of this article.

The use of phased or experimental regulations which follow the logic of real options provides a straightforward example.[158] Real options, like financial options to buy or sell a security, are premised on a *temporary* period of *predictably* decreasing uncertainty.[159] The value of optionality is that waiting might allow the underlying source of uncertainty to be resolved.[160] Thus, when it is plausible that a high level of

155. *See* BURTON MALKIEL, A RANDOM WALK DOWN WALL STREET 26-27 (1973).

156. *See generally id.* at 15-17; JEREMY SIEGEL, STOCKS FOR THE LONG RUN 283 (5th ed. 2014).

157. *See* MALKIEL, *supra* note 155, at 26-27; Kenneth French, *Presidential Address: The Cost of Active Investing*, 63 J. FIN. 1537, 1539-41 (2008).

158. *See supra* Section I.D.

159. *See* Edward H. Bowman & Gary T. Moskowitz, *Real Options Analysis and Strategic Decision-Making*, 12 ORG. SCI. 772, 772 (2001) ("Real options models are based on the assumption that there is an underlying source of uncertainty, such as the price of a commodity or the outcome of a research project. Over time, the outcome of the underlying uncertainty is revealed, and managers can adjust their strategy accordingly.").

160. *See* DIXIT & PINDYCK, *supra* note 85, at 30-31; FRIBERG, *supra* note 85, at 259.

policy uncertainty could dissipate in the near term, phased regulations provide a natural mechanism for expanding the regulatory portfolio.[161] Likewise, incorporating sunset provisions in rules can serve as a valuable flexibility device for policymakers to correct the regulatory portfolio once better information about a regulation's performance is acquired.[162]

That said, there is one serious limitation to relying on regulations structured as real options in lieu of, rather than as a component of, a broader portfolio approach. Most public policy problems resemble capital markets, in that there is a substantial level of baseline uncertainty that lingers indefinitely and cannot be foreclosed in the short-term.[163] The scholarship on phased regulations, at times, is ready to concede this point.[164] Yet its substantive focus on the securities laws as an application of real options theory is nonetheless telling.[165] Despite over eighty years of hindsight, there remains no robust empirical consensus on whether the Securities Exchange Act of 1934[166] or Securities Act of 1933[167] have had a measurable impact on the efficiency of American capital markets.[168] The same can be said of the federal prohibition on insider trading, first announced by the SEC in 1961.[169] Modern Portfo-

161. *See* Gubler, *supra* note 83, at 129; Whitehead, *supra* note 83, at 1273.

162. *See* Lee, *supra* note 83, at 887; Spitzer & Talley, *supra* note 83, at S121.

163. The genius of pure financial options is to artificially structure an environment in which investment uncertainty automatically falls to zero during the exercise period of the option. *See* Ron Adner & Daniel Levinthal, *What is* Not *a Real Option: Considering Boundaries for the Application of Real Options to Business Strategy*, 28 ACAD. MGMT. REV. 74, 76-77 (2004) ("In the context of financial options, one can clearly state a priori when a given option will be 'in the money' and worth exercising."); *see also id.* at 76 ("[T]he market signal of option value [for financial options] is readily observable and is independent of the investors behavior . . . . The greater the extent to which these properties are violated [for real options], the more problematic the applications of an options framework is.").

164. *See* Lee, *supra* note , at 909 ("The inconvenient truth is, for many critical issues, both the agency and the public lack sufficient insight to determine the effects of regulation with any certainty."); Spitzer & Talley, *supra* note 83, at S123 ("[A]n issue that continually plagues empirical corporate governance research is the challenge of using observational studies to demonstrate much of anything[.]").

165. *See* Gubler, *supra* note 83, at 131; Lee, *supra* note 83, at 881-82; Spitzer & Talley, *supra* note, at S123; Whitehead, *supra* note 83, at 1273-74.

166. Securities Exchange Act of 1934, 15 U.S.C. § 78 (2012).

167. Securities Act of 1933, 15 U.S.C. § 77 (2012).

168. *See* FRANK H. EASTERBROOK & DANIEL R. FISCHEL, THE ECONOMIC STRUCTURE OF CORPORATE LAW 276-314 (2d ed. 1991).

169. In re Cady, Roberts & Co., 40 S.E.C. 907, 907 (1961). *See* Binay Adhikari, Anup Agrawal & Bina Sharma, *Does Litigation Risk Deter Insider Trading?: Evidence from Universal Demand Laws* 1, 1 (Nov. 27, 2019) ("[E]mpirical evidence on the effectiveness of regulations in deterring insider trading has been mixed. One set of studies finds that insider trading regulations have been effective in reducing the frequency and profitability of opportunistic trades. But several other studies cast doubt on the efficacy of insider trading regulations.").

lio Theory is about managing precisely this kind of residual uncertainty, which can be minimized through a diversification strategy but never really goes away.[170]

Like legal scholarship on real options, the theoretical literature regarding jurisdictional diversity and federalism is also underpinned by strong assumptions about the potential for policy uncertainty to fall over time.[171] Justice Brandeis and other early Twentieth Century legal progressives who championed states as laboratories of federalism took their science metaphor literally. A premise was that, once the state laboratories ran their policy experiments, the superior policy rule would be conclusively discovered.[172] Immediately thereafter, harmonization was to proceed on a national scale through federal legislation.[173] Federalist theories of regulatory competition have a similar posture, only they contemplate convergence occurring through a more decentralized process at the state level. Implicit in a race-to-the-top dynamic is the notion that the regulatory competition to identify the best policy rule can be "won" by a particular jurisdiction, with other jurisdictions adopting the winning rule.[174] Thus, after a regulatory race is over, policy uncertainty has been eliminated, and any remaining legal diversity across jurisdictions reflects a response to the heterogeneous preferences of their residents.[175]

Re-examining a leading example from within the jurisdictional-diversity literature is instructive here too. Ever since the "internal affairs" doctrine was first articulated by common law courts in the 1860s,

170. The theoretical finance literature on optimal portfolio adjustments over time is surprisingly small, and mainly emphasizes the difficulty of the problem. *See, e.g.*, Andrew Chen, Frank Jen & Stanley Zionts, *The Optimal Portfolio Revision Policy*, 44 J. BUS. 51 (1971).

171. *See supra* Section I.C.

172. *See* Purcell, *supra* note 65, at 673 ("When Brandeis spoke of the states as laboratories for resolving social problems, he also spoke of identifying the 'ultimate right solution of the problem.' ").

173. *See id*.

174. *See id.* at 686-91; Daniel Esty, *Revitalizing Environmental Federalism*, 95 MICH. L. REV. 570, 615-16 (1996).

175. *See* Richard L. Revesz, *Rehabilitant Interstate Competition: Rethinking the 'Race to the Bottom' Rationale for Federal Environmental Regulation*, 67 N.Y.U. L. REV. 1210, 1221-24 (1992) (exploring the relationship between regulatory competition and geographic diversity); Ofer Eldar & Lorenzo Magnolfi, *Regulatory Competition and the Market for Corporate Law*, 12 AM. ECON. J.: MICROECONOMICS 60, 60-65 (2020) (explaining the rise of innovative corporate chartering rules in states like Nevada in terms of the unique preferences of certain small firms).

the federalist structure of corporate law has been considered the paradigm case of jurisdictional competition.[176] Yet, to date, there is no consensus among legal scholars about the dominant position of Delaware corporate law over the past century: some say it has won a race-to-the-top,[177] others a race-to-the-bottom,[178] still others a race-to-the middle.[179] The persistence of extreme policy uncertainty explains why the optimal number of rules in a regulatory framework is largely unrelated to the jurisdictional level at which they are formulated.[180] Instead, the jurisdictional question is primarily about determining what allocation of policymaking authority is best suited for identifying an efficient package of overlapping regulations.[181]

The law-and-economics of rules versus standards can be understood in terms of its assumptions about the dynamics of policy uncertainty as well.[182] Simple rules are thought to be preferable when policymakers do not have access to information that would allow more complex legal requirements to sort the behavior of regulated parties in a meaningful way.[183] Law-and-economics scholars often argue in favor of one particular kind of simple rule—known as a Pigovian tax—which sets an additional cost on activities that produce negative externalities.[184] By raising the price of socially undesirable conduct, a Pigovian tax shifts the task of resolving policy uncertainty from public to private

176. *See* Howell v. Chi. & N.W. Ry. Co., 51 Barb. 378, 383 (N.Y. Gen. Term 1868). *See generally* Frederic Tung, *Before Competition: Origins of the Internal Affairs* Doctrine, 32 J. Copr. L. 33 (2006) (summarizing the conventional view that "Respecting the firm's choice of corporate law, the doctrine forces state legislatures into competition to attract incorporations," while casting doubt on its historical pedigree); Vincent Buccola, *Opportunism and Internal Affairs*, 93 TULANE L. REV. 339, 342, N.11 (2018) (providing further historical context on the jurisdictional competition interpretation of the internal affairs doctrine).

177. *See* Ralph K. Winter, Jr., *State Law, Shareholder Protection, and the Theory of the Corporation*, 6 J. LEGAL STUD. 251, 254-55 (1977).

178. *See* Lucian Arye Bebchuk, *Federalism and the Corporation: The Desirable Limits on State Competition in Corporate Law*, 105 HARV. L. REV. 1435, 1444 (1992).

179. *See* William Magnuson, *The Race to the Middle*, 95 NOTRE DAME L. REV. 1183, 1200-01 (2020).

180. As shown in the state park hypothetical, diversifying among multiple littering rules is optimal, regardless whether those rules are made by the state legislature, state administrative agency, or the park's management. *See supra* Section II.B.ii. Nor does the optimal diversification of regulations turn on the number of rule-makers. The existence of overlapping jurisdictional authority has little or no connection to the optimal size of a regulatory portfolio. *See* sources cited *supra* note 77; Turk, *supra* note 153, at 866-68.

181. *See* George A. Berman, *Taking Subsidiarity Seriously: Federalism in the European Community and the United States*, 94 COLUMB. L. REV. 331, 336 (1994); Gordon Tullock, *Federalism: Problems of Scale*, 6 PUB. CHOICE 19, 19-20 (1969).

182. *See supra* Section I.B.

183. *See* Kaplow, *supra* note 53, at 151; Fon & Parisi, *supra* note 58, at 154.

184. *See generally* ARTHUR C. PIGOU, THE ECONOMICS OF WELFARE (1932).

actors, who are presumed to have better information about the relevant market failure.[185] Lastly, a premise of ex post standards is that the legislative or agency rule-maker is operating under relatively high levels of uncertainty, which can be reduced by empowering enforcement officials or courts to exercise discretion on an ad hoc case-by-case basis.[186]

Of the three theoretical frameworks reviewed above, the literature on rules versus standards makes the most conservative assumptions about the epistemic limits of regulatory policymaking. In that, it is closely aligned with Modern Portfolio Theory, and also provides a useful analytical toolkit to inform the selection of rules and standards within a policy portfolio. At the same time, the portfolio selection problem cannot be reduced to a yes-no question of whether to use simple rules or ex post standards. That is because doing so remains an all-or-nothing bet that one particular actor—whether it be legislators, courts, enforcement authorities, or markets—is best positioned to navigate the market failure at issue. As the foregoing examples from securities and corporate law indicate, making such a bet tends to require an unrealistic degree of second-order certainty about the informational environment in which a policy problem unfolds.[187]

4. Risk versus Uncertainty, and the Limits of Quantification

The analogy between securities and legal rules breaks down in one final respect. Securities are, to a large extent, artificial mathematical constructs. It is therefore theoretically possible to calculate the complete set of efficient investment portfolios on a computer program.[188] That will never be the case when it comes to public policy. Although the state park illustration stipulated figures for the expected return, variance, and covariance of various hypothetical policy interventions, those estimates cannot be directly observed in real life or measured with scientific precision. This raises the question of how a portfolio approach to regulation can be realistically implemented, given the limits to quantification in cost-benefit analyses of legal rules. The discussion below addresses two main grounds for skepticism on this point and

185. Jonathan S. Masur & Eric A. Posner, *Toward a Pigovian State,* 164 U. Pa. L. Rev. 93, 105-06 (2015); Louis Kaplow & Steven Shavell, *On the Superiority of Corrective Taxes to Quantity Regulation*, 4 AM. L. & ECON. REV. 1 (2002).

186. *See supra* note 184. On the other hand, simple rules are thought to outperform standards in situations where it is uncertain whether enforcement officials can commit to exercising their discretion in a disinterested or reliable manner. *See* Krishnamurthy, *supra* note 59, at 278 ("Rules are likely to prove superior to standards when there are substantial agency costs associated with delegated enforcement.").

187. As a result, the state park hypothetical is typical of most areas of the law, which tend to apply an overlapping patchwork of ex ante rules and ex post standards. *See infra* Part III.

188. *See* MARKOWITZ, *supra* note 15, at 37.

explains why the difficulty of quantifying policy outcomes is not a liability for a portfolio approach. Rather, it is the reason why a diversified regulatory framework is essential in the first place.

The first objection is a common philosophical argument against the quantification of regulatory costs-and-benefits in general. How is it appropriate to assign a numerical dollar amount to the value of a human life or the natural beauty of a pristine state park, when the objects of those comparisons are so fundamentally unalike?[189] The usual response to this incommensurability argument is lack of a better option. The damages awarded in a wrongful death case cannot be infinite, and also should not be zero, so the courts must arrive at some number; state parks must have some budget.[190] The argument on incommensurability grounds can therefore be put aside as an objection to a portfolio approach to regulation, for the same reason it is set aside elsewhere. While the philosophical issues it raises are real, they do not provide practical guidance on public-policy questions that require answers.[191]

The second line of critique is more complicated, but more relevant. It starts from Frank Knight's famous distinction between "risk" and "uncertainty."[192] A decision is said to be subject to risk when the distribution of all possible outcomes is known in advance.[193] Betting on a roll of dice or draw from a deck of cards entails risk. The outcome of any particular draw is unpredictable, yet an exact "objective probability" can be placed on the odds of drawing an ace.[194] By contrast, a decision involves what is called "Knightian uncertainty" if the decision-maker must act without knowing every possible state of the world on which an outcome depends.[195] As a business proposition, the voyage of Christopher Columbus to the New World was a decision made under Knightian uncertainty for some obvious reasons.[196] When dealing with uncertainty, it is not possible to identify objective probabilities. Outcomes can only be predicted according to "subjective probabilities"—

189. *See* FRANK ACKERMAN & LISA HEINZERLING, PRICELESS: ON KNOWING THE PRICE OF EVERYTHING AND THE VALUE OF NOTHING (2004).

190. *See* Sunstein, *supra* note 38, at 1372.

191. *See* Sunstein, *supra* note 38, at 1379 ("We might say that the objection from incommensurability is deeply right but nonetheless unhelpful. The argument for quantification is intensely pragmatic."). This problem with the incommensurability argument is also a limitation of the precautionary principle, to the extent those two rationales are combined (and they often are). *See* Cross, *supra* note 38, at 859 ("The appealing underpinning of the precaution principles is the belief that economic gain should not justify taking risks with public health and safety or general environmental welfare.").

192. *See generally* FRANK H. KNIGHT, RISK, UNCERTAINTY, & PROFIT (1921).

193. *See* FRIBERG, *supra* note 84, at 23-27.

194. *See id.*

195. *See id.*

196. *See id.* at 25-26, 144-45.

meaning a best guess based on whatever limited information is available.[197]

Legal scholars have laid great emphasis on the significance of Knight's distinction.[198] Usually, it animates claims that regulation should follow the precautionary principle where the policymaking environment is characterized by uncertainty.[199] The argument is that a fine-tuned quantification of cost-and-benefits is only feasible in situations involving risk; for policy questions that carry many "unknown unknowns," maximal legal precautions are necessary in order to avoid the downside of a worst-case scenario.[200] In this sense, the precautionary principle is in direct tension with Modern Portfolio Theory, as the latter calls for a cost-benefit optimization of risk at the margin.[201] Under most interpretations of the precautionary principle, the decision to diversify a single strict legal prohibition into several relatively light-touch regulations would be considered anathema.[202]

The critique sketched above appears to present a challenge to this Article's portfolio theory of regulation because it suggests that Modern Portfolio Theory is inapplicable to the problem of policymaking uncertainty, the domain to which it is being applied. There are a number of reasons, however, why invocations of risk versus uncertainty do less work than may first appear. A basic issue is that, outside of casinos and card games, real-world decisions almost always involve uncertainty rather than risk.[203] As was shown, a question as simple as whether a state park should be legally required to install trash cans is plagued with unknowables that do not resemble actuarial risk.[204] In

197. *See id.* at 23-27, 146-47.

198. *See generally* Daniel A. Farber, *Uncertainty*, 99 GEO. L. J. 901 (2011).

199. *See id.* at 905, 914-20; Light, *supra* note 76, at 337-38.

200. *See* Farber, *supra* note 198, at 903; Sunstein, *supra* note 38, at 1033.

201. On the incompatibility of the precautionary principle and cost-benefit analysis, see CASS R. SUNSTEIN, LAWS OF FEAR; BEYOND THE PRECAUTIONARY PRINCIPLE 4-6 (2005); RICHARD A. POSNER, CATASTROPHE: RISK AND RESPONSE 140 (2004); David A. Weisbach, *Should Environmental Taxes Be Precautionary?*, 65 NAT'L TAX. J. 453, 462 (2012). For a dissenting view on this point, see Dreisen, *supra* note, at 792 (questioning the consensus that "almost everybody seems to assume that CBA and precaution conflict"). To the extent the precautionary principle does have a rigorous formal interpretation, it is arguably synonymous with a Rawlsian maximin criterion. *See* RAWLS, *supra* note 131, at 152-53 ("The maximin rule tells us to rank alternatives by their worst possible outcomes: we are to adopt the alternative the worst outcome of which is superior to the worst outcomes of the others.").

202. By analogy to the finance context, a precautionary principle of investment in the form of a feasibility standard would be to hold only the safest financial asset available, such as U.S. treasury bonds. The stronger, prohibitionary form of the precautionary principle would take a Keynesian turn and advise storing all one's savings as cash under the mattress. *See* JOHN MAYNARD KEYNES, A GENERAL THEORY OF EMPLOYMENT, INTEREST, AND MONEY (1936).

203. *See* FRIBERG, *supra* note 85, at 137; Mark Machina & Marciano Siniscalchi, *Ambiguity and Ambiguity Aversion*, *in* HANDBOOK OF THE ECONOMICS OF RISK AND UNCERTAINTY: VOL I 729, 740 (2014).

204. *See supra* Section II.B.ii.; *see also* FRIBERG, *supra* note 85 at 24.

the policy context, things are always a matter of degree between low and high uncertainty.

Pervasive policymaking uncertainty presents both theoretical and practical problems for the precautionary principle. The theoretical issue is that—if policymakers always operate under uncertainty rather than risk—then the justification for a precautionary approach must be unrelated to the original conceptual distinction that Knight made between objective and subjective probabilities. That theoretical oversight gives rise to a pragmatic dilemma. Presumably, moving past a certain threshold from low to high uncertainty is what shifts the regulatory calculus from a cost-benefit analysis to a precautionary approach. Yet the amount of uncertainty that counts is rarely articulated, mainly because it impossible to say.[205] Like the objection to quantification on incommensurability grounds, the objection based on Knightian uncertainty does not provide a workable guide to important questions of regulatory structure.[206]

While the distinction between risk versus uncertainty leads the precautionary principle to an analytical dead-end, it is not so problematic for a portfolio approach to regulation. Modern Portfolio Theory does not assume that the future price of securities can be estimated based on the kind of reliable, objective probabilities found in a poker game.[207] At least as originally conceived by Markowitz, the subjective judgment of the financial analyst—who must provide a best guess about expected return and variance of different stocks—was the first step in the portfolio selection process.[208] In the legal context, the same role is

205. *See* Sunstein, *supra* note 38, at 1004; Cross, *supra* note 38 at 859-61.

206. Knight himself admitted as much. *See* KNIGHT, *supra* note 192 at 226 ("[I]t is true, and the fact can hardly be over-emphasized, that a judgment of probability is actually made in such cases [involving uncertainty rather than risk.]"). Keynes also took a similar stance of the practical irrelevance of Knightian uncertainty. *See* John Maynard Keynes, *The General Theory of Employment*, Q.J. ECON. 209, 212-13 (1937). The distinction between risk and uncertainty has fueled many interesting and paradoxical findings in probability and decision theory, yet there remains no consensus on how or when that distinction should drive real-world choices. Arguably, every decision theory that puts independent weight on Knightian uncertainty will eventually run into self-contradictions that violate the fundamental axioms of rational choice. *See* Machina & Siniscalchi, *supra* note 203, at 796-800; MARKOWITZ, *supra* note 15, at xi.

207. Markowitz explicitly follows a long line of expected-utility models in rational choice, first developed by Leonard Savage and Frank Ramsey, which treat decisions under uncertainty the same as those involving risk. *See* Markowitz, *supra* note 14, at 470; *see also* MARKOWITZ, *supra* note 15, at 48, 76, 106, 257-58.

208. *See* Markowitz, *Portfolio Selection*, *supra* note 12, at 77; *id.* at 91; MARKOWITZ, *supra* note 15, at 4, 23, 33, 114-15, 206.

played by policymakers who must evaluate the merits of different regulations.[209] Thus, this article has referred to regulatory "risk" and "uncertainty" interchangeably, because the value of diversification holds with equal force to policymaking decisions in either context. Indeed, a high level of policy uncertainty is the premise of a portfolio approach, not a constraint on its range of applicability.[210]

Lastly, to the extent that the problem of quantification presents some practical challenges to the implementation of a portfolio approach, those challenges are not unique. The policymaker, like the financial analyst, must often fall back on simplifying heuristics.[211] The legal literature on rules versus standards, or regulatory diversity versus harmonization, rarely, if ever, offers an empirical basis for its claims, yet the tradeoffs identified in that scholarship are real and important. Similarly, the design of regulatory portfolios does not necessarily require a strictly quantitative cost-benefit analysis of legal rules at all. The expected return, variance, and covariance of a given regulation remain critical to questions of regulatory structure, even if they can only be expressed in relatively crude categories—such as a range from "high" to "medium" to "low."[212] For that reason, the preceding Part C sketched various rules of thumb for determining the optimal policy portfolio at a relatively high level of generality, as a way to highlight the factors which a policy analyst must consider when evaluating the design of a diversified regulatory framework.

D. Positive Theory: Explaining Regulatory Portfolios in Practice

Modern Portfolio Theory was first conceived as a positive, rather than normative, account of investment behavior. The question Markowitz asked was not *how* securities investments should be structured. Instead, he sought to explain *why* it was so often observed that investors take positions in multiple financial assets at the same time.[213] Only after Markowitz derived the mathematical relationship between

209. *See* Coates, *supra* note 118, at 998 (explaining that CBA inevitably turns on the "guesstimates" of policy analysts); Masur & Posner, *supra* note 36, at 120-25 (proposing that agencies undertaking CBA "should be allowed to rely on pure guesswork or intuition" to the extent their analysis cannot be verified empirically).

210. *See* Machina & Siniscalchi, *supra* note 203, at 754, 782.

211. *See* Markowitz, *supra* note 14, at 471 ("Thus we prefer an approximate method which is computationally feasible to a precise one which cannot be computed."); MARKOWITZ, *supra* note 15, at 5 ("It is impossible to derive all possible conclusions concerning portfolios. A portfolio analysis must be based on criteria which serve as a guide to the important and unimportant, the relevant and irrelevant.").

212. Similarly, Markowitz suggests a portfolio selection protocol in which the financial analyst describes securities as "less than normally correlated," "normally correlated," "highly correlated," or "very highly coordinated." *See* MARKOWITZ, *supra* note 15, at 32.

213. *See* Markowitz, *supra* note 30, at 5; *see also* Markowitz, *supra* note 12, at 77.

diversification and covariance was a full prescriptive theory of investment worked out in the form of the Capital Asset Pricing Model.[214] As will be shown in the discussion below, a similar procedure can be applied to a portfolio theory of policymaking from a positive perspective.

A quick review of the daily Federal Register presents a parallel question to the one which prompted Markowitz's inquiry into securities investments: why, exactly, are there so many legal rules?[215] Further, any visit to the DMV for a driver's license renewal test raises a follow-up question which is even more directly on point: why is it so common for many legal rules to be concurrently applied to the single policy problem (in this case, traffic safety)?[216] The law literature is surprisingly short on explanations for this basic feature of the legal system.[217] Perhaps the lone exception is a modest body of law-and-economics scholarship from the 1980s and 1990s, which examines the joint use of legal rules in the context of safety regulations for accidents.[218] The logic of a portfolio approach can be clarified by comparison to the arguments aired in that scholarship.

The specific issue the law-and-economics literature addressed was the frequent incidence of overlapping policy interventions in the law of accidents, usually in the form of an ex ante safety regulation paired alongside an ex post liability standard.[219] For example, a local zoning ordinance may require business owners to install precautions on their premises—such as a protective fence around the property or floodlights in the parking lot—in order to reduce the chance that customers and workers will suffer personal accidents (or be exposed to criminal activity from the surrounding neighborhood). Meanwhile, those same business owners are also subject to tort liability under a negligence or strict liability standard for injuries that occur on their property.

For law-and-economics scholars, that pattern was thought to present an empirical puzzle because "[e]conomists have generally viewed

214. *See* Rubinstein, *supra* note 30, at 1044.

215. The length of the Federal Register reached its high mark in 2016, totaling nearly 100,000 pages for the year. For the final installment, see Federal Register: The Daily Journal of the United States Government, 81 Fed. Reg. 96, 992, 97, 044 (Dec. 30, 2016).

216. The State of Indiana's study guide for driver's license applicants is 84-pages long. *See* IND. BUREAU OF MOTOR VEHICLES, INDIANA DRIVER'S MANUAL (2020), https://www.in.gov/bmv/licenses-permits-ids/files/drivers-manual.pdf [https://perma.cc/A3N8-Y5DF].

217. For recent research that explores this question in the financial regulation area, see generally Turk, *supra* note 153. *See also* Vartan Shadarevian & Robert Delaney, *Multiple-Rule Cost Benefit Analysis*, 15 CHARLESTON L. REV. 373 (2021).

218. *See* Kolstad et al., *supra* note 22; Schmitz, *supra* note 23; Shavell, *supra* note 23; Steven Shavell, *A Model of the Optimal Use of Liability and Safety Regulation*, 15 RAND J. ECON. 217 (1984).

219. *See*, *e.g.*, Shavell, *supra* note 23, at 357; Kolstad et al., *supra* note 23, at 888.

ex ante and ex post polices as substitutes for correcting externalities,"[220] and only "[r]arely is the joint use of ex ante and ex post policies recommended for a given externality."[221] One possibility was that the textbook economic intuition was right. Overlapping ex ante and ex post safety rules are in fact perfect substitutes and, as a result, "major mistakes have been made in the use of liability and regulation."[222] Another possibility was that the conventional law-and-economics analysis had overlooked some feature of either safety regulation or liability standards that makes the combination of those two policy instruments efficient. With the research question thus framed, the literature proceeded to debate a series of explanations and counter-explanations as to why the latter thesis might hold true.[223]

None of the justifications for overlapping safety rules that emerged from that debate prove entirely compelling. For one, each of the theoretical models that were developed yield results that are highly context-specific. Professor Shavell argues that overlapping safety rules may be efficient, depending on a mix of four factors—regarding the severity of harm at issue, the possibility that defendants are judgment proof, and so on.[224] Professor Kolstag and co-authors, on the other hand, produce a model in which overlapping rules are only efficient if one of three preconditions satisfied, all of which are different from those identified by Professor Shavell.[225] In a third model, presented by Professor Schmitz, the factors emphasized by Shavell and Kolstag are irrelevant to the choice of safety regulations; instead, all that matters is the degree of heterogeneity in defendants' wealth.[226]

The context-specific predictions of these models are problematic when viewed as a positive theory of regulation because the empirical pattern is not that overlapping rules are occasionally observed in some subset of accident laws. Rather, the motivating puzzle was why the joint use of legal rules is so widespread that it appears in nearly every

220. Kolstad et al., *supra* note 23, at 888.

221. *Id.*

222. Shavell, *supra* note 23, at 372.

223. For the three alternative theoretical models that were proposed, see Schmitz, *supra* note 23; Kolstad et al., *supra* note 22; Shavell, *supra* note 23 (presenting an informal discussion); Shavell, *supra* note 218 (providing a formal mathematical model).

224. *See* Shavell, *supra* note 218, at 271. The other two factors are the relative access to information between regulators and regulated parties, and the relative administrative costs of ex ante regulation versus tort liability. *See*, *e.g.*, Shavell, *supra* note 23, at 360-64.

225 . The specific preconditions are: (a) if potential injurer's are uncertain over the applicable legal standard; (b) if injurers hold a mistaken perception of the applicable legal standard that "is highly biased to the left of the socially optimal level of care"; or (c) "the injurer's marginal cost of precaution is large at the social optimum." Kolstad et al., *supra* note 22, at 900. "Otherwise, ex ante and ex post regulation should be used separately." *Id.* at 900.

226. *See* Schmitz, *supra* note 23, at 372.

conceivable case: food contamination, premises liability, the transportation of toxic waste, and the approval of medical devices.[227] That descriptive inconsistency is further compounded by the fact that the theoretical models tend not to hold, even in the handful of anecdotal examples offered to illustrate their results. Kolstag and co-authors note that automobile accidents are a paradigm case where the preconditions for combining ex ante regulation with a liability rule are not met.[228] Yet the regulation of traffic safety relies on both a liability standard and a panoply of ex ante rules, such as speed limits, a minimum driving age, and so on.[229]

A second problem with the leading positive theories of overlapping safety regulations is that they turn on technical modeling assumptions which are either mutually inconsistent or unrealistic. Specifically, all three models reviewed above artificially cabin the issue of policymaking uncertainty in various ways.[230] The failure to incorporate policy uncertainty as a relevant variable is significant because, as with other areas of the law, it is likely that the costs and benefits of safety regulations are difficult to ascertain.[231]

Consider ex post liability. In theory, either negligence or a strict liability standard can induce an efficient level of care.[232] As a practical matter, however, "[w]e know very little about the number of incidents that give rise to [actionable] torts,"[233] since that figure is largely unobservable except in cases that result in litigation. Furthermore, "[i]nferences from trial data must be drawn with caution,"[234] as only a small unrepresentative sample of cases are adjudicated to the merits at trial.[235] The benefits of a liability standard, therefore, turn on an unknowable distribution of judgment-proof defendants, cash-strapped plaintiffs, and meritorious but hard to prove cases.[236] They also depend on the ability of juries to ascertain the correct level of damages, the

227. *See* Kolstad et al., *supra* note 22, at 889.

228. *See id.* at 900.

229. Schmitz, *supra* note 23, at 377; *see* Shavell, *supra* note 23, at 357-58, 366-67.

230. Kolstad and coauthors assume in their model that ex ante regulations can perfectly target the optimal level of care. Kolstad et al., *supra* note 23, at 900. Shavell's model assumes that courts can always impose the optimal level of liability in litigated cases. Shavell, *supra* note 218, at 373. Schmitz demonstrates that neither the Kolstad nor the Shavell models imply the joint efficiency of overlapping accident rules under those assumptions. Schmitz, *supra* note 23, at 371-72. He then produces an alternative model, which assumes perfect enforcement of both ex ante regulation and ex post liability. *See id.*

231. *See* Shavell, *supra* note 23, at 372.

232. *See* John Prather Brown, *Toward an Economic Theory of Liability*, 2 J. LEGAL STUD. 323, 323 (1973).

233. Eric Helland, Jonathan Klick & Alexander Taborrak, *Tort-uring the Data*, 19 J. ECON. PERSP. 207, 207-08 (2005).

234. *Id.* at 208.

235. *Id.* at 208-12.

236. *See* Steven Shavell, *Liability for Accidents* 31-33 (Nat'l Bureau of Econ. Research, Paper No. 11781, 2005).

availability of liability insurance, and the ease of aggregating claims into class actions.[237] Meanwhile, the social costs of administering the tort system are substantial, multifaceted, and equally difficult to measure. [238]

The effects of ex ante safety requirements are, if anything, more uncertain. For instance, although it is reasonable to expect that security fences or floodlights may make a business owner's property safer to some degree, the magnitude of that benefit is necessarily speculative. The success of command-and-control precautions usually depends on whether policymakers have accounted for local conditions and technical minutia—such as construction specifications for the height of the fence, the type of locks used on gates, or spatial arrangement of floodlights.[239] It will also depend on the ability of enforcement authorities to monitor regulated parties, detect instances of noncompliance, and impose penalties that are calibrated to neither over nor under deter the risk-creating activity at issue.[240]

Most importantly, the failure of these law-and-economics models to fully account for policymaking uncertainty obscures a simple functional explanation for the use of overlapping legal rules across all areas of safety regulation. Modern Portfolio Theory implies that the consequence of investment uncertainty is to transform financial assets, which would otherwise be perfect substitutes in a world of complete information, into partial substitutes that are best held in combination under a portfolio approach. The same logic also applies to the optimal number of baskets used to carry eggs. And, as was shown above, it can be extended to society's investment in legal rules as well.[241]

Given the substantial variance in the expected return of both ex ante safety regulation or ex post liability, a diversification strategy that combines the two will yield benefits so long as: (a) there is low or

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237. *See* Alexander Tabarrok & Eric Helland, *Court Politics: The Political Economy of Tort Awards*, 42 J. L. & ECON. 157 (1999) (exploring some of the factors that may lead to arbitrary or biased damages awards by judges and juries); *see* J. David Cummins, Richard D. Phillips & Mary A. Weiss, *The Incentive Effects of No-Fault Automobile Insurance*, 44 J. L. & ECON. 427, 427 (2001); *see generally* Eric Helland & Jonathan Klick, *The Tradeoffs between Litigation and Regulation: Evidence from Insurance Class Actions*, 1 J. TORT L. 1 (2006).

238. "Expenditures on the tort system are substantial, about $250 billion a year, and some estimates suggest that indirect costs through 'defensive medicine' and other response to the threat of lawsuits are even more costly." Helland et al., *supra* note 233, at 207; *see also* Shavell, *supra* note 236, at 9-10 (surveying various direct and indirect costs of the litigation system); TILLINGHAST-TOWERS PERRIN, U.S. TORT COSTS: TRENDS AND FINDINGS ON THE COSTS OF THE U.S. TORT SYSTEM (2003) (attempting to estimate and disaggregate the annual direct costs of tort litigation).

239. *See* Shavell, *supra* note 23, at 359-60 (on the high informational demands that tend to accompany the design of command-and-control regulations).

240. *See* Donald Whittman, *Prior Regulation versus Post Liability: The Choice Between Input and Output Monitoring*, 6 J. LEGAL STUD. 193, 196 (1977) (analyzing the issues raised by probabilistic enforcement of regulatory requirements).

241. *See infra* Section II.B.1.

negative covariance between the uncertainties affecting each rule, and (b) the intensity of each rule is reduced when they are jointly applied.[242] Both features describe overlapping rules in the law of accidents. With premises liability, for example, the propensity of tort defendants' to be judgment-proof is independent of whether ex ante fencing requirements are well-specified. Likewise, the extent that potential plaintiffs will fail to bring meritorious suits due to lack of verifiable evidence will not be closely related to the efficacy of mandatory parking lot floodlights.

The joint use of safety rules also tends to be relatively light touch. Due to the administrative and related procedural hurdles of the tort system, only a fraction of viable claims are brought to court or reach final adjudication on the merits.[243] Similarly, ex ante safety regulations are typically less demanding than the substantive level of care required under a negligence standard.[244] Motor vehicle traffic regulation is representative in that sense. Drivers must be over the age of sixteen, wear a seatbelt, and may drink before driving up to (but not past) the point of intoxication. These rules are not onerous, and, in most jurisdictions, the enforcement of non-compliance is sporadic at best.

To summarize, the joint use of overlapping safety regulations is sufficiently general that it calls for an equally general explanation. The notion that regulatory excess is endemic to the legal system is one possibility.[245] Alternatively, the combination of ex ante and ex post safety rules may instead reflect some efficiency in their joint use. However, the existing theories as to what those efficiencies might be all turn on situational factors and simplifying assumptions that do not describe the joint use of accident rules that occurs in practice. By contrast, Modern Portfolio Theory supplies a more consistent and parsimonious explanation for overlapping safety rules: policymakers, acting under conditions of uncertainty, implicitly resort to a portfolio approach by diversifying the number of legal interventions applied.

This section has laid out the theoretical basis for this article's application of Modern Portfolio Theory to the issue of policymaking uncertainty. From a normative perspective, it has shown that policymaking uncertainty increases the optimal number of legal rules, and that portfolio theory can inform the selection and design of rules which will work best within a diversified regulatory framework. It has also sketched the theoretical intuition behind this article's positive thesis.

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242. *See* Schmitz, *supra* note 23, at 372; Shavell, *supra* note 23, at 372; Kolstad et al., *supra* note 23, at 889 ("emphasizing" the "unconventional" nature of this conclusion).

243. *See* Shavell, *supra* note 236, at 32-33.

244. *See* Kolstad et al., *supra* note 23, at 897; Shavell, *supra* note 23, at 371.

245. *See generally* DENNIS C. MUELLER, PUBLIC CHOICE III, 343-47, 362-63, (Cambridge Univ. Press, 2003).

That is, that the use of overlapping rules across many areas of the law is best explained as a diversification strategy in response to uncertainty about the consequences of individual rules.

III. TWO CASE STUDIES: THE REGULATION OF FINANCIAL CRISES AND CLIMATE CHANGE

This section presents two studies which provide more detailed empirical evidence in support of the theoretical claims set forth above and previewed in the safety regulation context. The first covers banking regulation and financial crises, the second analyzes environmental law on climate change. The discussion for each case study follows the same structure. First, they begin by identifying the underlying policy problem at issue, and the sources of uncertainty which make those problems difficult to address. Second, the case studies explain how both areas of the law are best described as implementing a portfolio approach. And lastly, this section compares how competing theories of policymaking uncertainty—the precautionary principle, federalism, and so on—measure up on those counts. As will be shown, those theories do not closely map onto the existing regulatory structures that address financial crises and climate change, and there are compelling normative reasons why the preference shown for a portfolio approach is sound.

A. Financial Regulation & Banking Crises

Financial regulation is notoriously prone to policymaking uncertainty.[246] The financial system is overwhelmingly complex, and subject to vulnerabilities which are difficult to predict or constrain with legal rules.[247] With the financial crisis of 2008, those dynamics were put in stark relief and did so on a global scale. Accordingly, the post-crisis reform to financial regulation provides a valuable example of policymaking uncertainty at its most extreme.

1. The Policy Problem & Uncertainty

The underlying policy problem posed by financial crises is easy to summarize in the abstract. Banks benefit from taking financial risks, but do not internalize the full cost of those risks when their bets go bad.[248] The cost to society of a failing bank is, in part, borne by other financial institutions, which can be destabilized by the ripple effects

246. *See, e.g.*, Jeffrey N. Gordon, *The Empty Call for Benefit-Cost Analysis in Financial Regulation*, 43 J. LEGAL STUD. S351, S352-53 (2014) ("We simply do not have the foresight to forecast how that [financial] system will evolve.").

247. *See* Dan Awrey & Katherine Judge, *Why Financial Regulation Keeps Falling Short* 5 (Eur. Corp. Governance Inst. L. Working Paper No. 494/2020, 2020).

248. *See* Eric A. Posner, *How Do Bank Regulators Determine Capital Adequacy Requirements?*, 82 U. CHI. L. REV. 1853, 1858-60 (2015).

from that collapse.[249] In addition, if bank failures become sufficiently widespread, they begin to impose costs on the real economy as a whole by reducing access to credit for consumers and businesses. Both of these externalities were on display in 2008 when a cascade of failures at large financial institutions, such as AIG and Lehman Brothers, ultimately plunged the U.S. economy into the so-called Great Recession.[250] Thus, the challenge for policymakers on financial regulation is to find legal mechanisms that will prevent financial institutions from taking excessive risk (or minimize the costs of failure when those risks materialize), while also ensuring that banks can continue to function as an efficient source of financial intermediation.[251]

The task of identifying exactly which regulatory interventions will meet that goal, however, is hindered by numerous sources of uncertainty. Almost by definition, the bursting of asset price bubbles and sudden runs on the banking system come as a surprise.[252] The fact that the 2008 financial crisis shocked most experts is therefore unexceptional, as is the inability of scholars to agree on what triggered those events in the decade since they took place.[253] To this day, economic historians continue to debate what really "caused" the Great Depression of the 1930s.[254]

The inscrutable dynamics of the financial system are not the only problem when designing financial regulation. Policymakers must also account for the strategic response of various actors to those rules after they are put in place. As Professor Merrill has noted, the problem of regulatory arbitrage is particularly severe in the context of banking regulation, because "financial instruments are like quicksilver that can wiggle out of your grasp at a moment's notice."[255] In addition to the prospect of regulatory arbitrage by industry participants, the incentives of bank regulators matter as well. The agency cost problems which accompany all forms of delegated enforcement apply with special force to banking regulation, particularly in the emergency environment of a financial crisis where regulators enjoy broad discretion

249. *See* Steven L. Schwarcz, *Systemic Risk*, 97 GEO. L.J. 193, 198-200 (2008).

250. *See generally* William K. Sjostrom Jr., *The AIG Bailout*, 66 WASH. & LEE L. REV. 943 (2009).

251. *See generally* Posner, *supra* note 248.

252. *See* Markus K. Brunnermeier & Martin Oehmke, *Bubbles, Financial Crises, and Systemic Risk* 35-39, 48-49 (Nat'l Bureau of Econ. Rsch., Working Paper No. 18398, 2012).

253. *See generally* Governor Ben S. Bernanke, Member, Bd. of Governors Fed. Rsrv. Sys., Remarks at the Meetings of the Eastern Economic Association: The Great Moderation (Feb. 20, 2004).

254. *See generally* PETER TEMIN, LESSONS FROM THE GREAT DEPRESSION (1989).

255. Thomas W. Merrill, *A Comment on Metzger and Zaring: The Quicksilver Problem*, 78 LAW & CONTEMP. PROBS. 189, 189 (2015).

over the timing and scope of regulatory interventions.[256] Taken together, the unique features of the financial system reviewed above result in a high level of policymaking uncertainty that substantially "undermine[s] the ability of science to precisely and reliably estimate the effects of financial regulations, even retrospectively."[257]

2. Post-Crisis Financial Regulation

How has the law responded to the policymaking uncertainty associated with financial crises? The discussion below reviews the evolution of financial regulation since the 2008 crisis and argues that it reflects a portfolio approach. First, post-crisis reforms increased the number of legal rules by installing a multiplicity of overlapping regulations. Second, the cost of diversifying the regulatory portfolio has been contained by making each individual rule relatively light touch. And third, the benefits of diversification have been maximized by assembling rules that have low or negative covariance.

(a) Overlapping Rules as a Response to Uncertainty

Prior to the financial crisis, U.S. banking regulation was already characterized by numerous overlapping rules. With some simplification, the main policy instruments used in pre-crisis financial regulation fall into three categories. First, banks are subject to prudential supervision, a form of oversight that involves on-site audits by bank examiners who are responsible for evaluating banks' overall safety-and-soundness.[258] Second, banks must meet certain minimum capital requirements, which place quantitative limits on the mix of debt and equity in bank balance sheets.[259] And third, there are rules for the "resolution" of failing banks, which set forth a bankruptcy-like process that is administered by financial regulators.[260]

The Dodd-Frank Act of 2010 introduced sweeping changes after deficiencies in the regulatory framework outlined above were exposed in the financial crisis.[261] Perhaps the most salient feature of Dodd-Frank is the sheer number of new policy instruments it creates. All told, the statute directs the federal banking agencies to promulgate nearly four

256. Regulators have incentives to both underreact and overreact to information that a bank is experiencing financial distress. *See* Ansgar Walther & Lucy White, *Rules Versus Discretion in Bank Resolution*, 33 THE REV. OF FIN. STUD. 5594 (2020).

257. Coates, *supra* note 118, at 888.

258. *See* MICHAEL BARR, HOWELL JACKSON & MARGARET TAHYAR, FINANCIAL REGULATION: LAW & POLICY 75-78 (2016).

259. *See id.* at 259-84.

260. *See id.* at 893-915.

261. Dodd-Frank Wall Street Reform and Consumer Protection Act, Pub. L. No. 111-203, 124 Stat. 1376 (2010) [hereinafter Dodd-Frank Act].

hundred regulatory rules.[262] The reforms to capital requirements are illustrative. Dodd-Frank went far beyond an overhaul of the two main pre-crisis capital rules—known as the "simple leverage ratio" and "risk-weighted asset ratio."[263] It also adds a novel pair of liquidity requirements, the "net stable funding ratio" and "liquidity funding ratio."[264] Another rule, the "countercyclical capital buffer," grants bank regulators authority to increase the aforementioned capital ratios in response to rising asset prices.[265] Lastly, Dodd-Frank provides for periodic stress tests, which ask banks to project whether they could meet their capital requirements during a recession.[266]

Dodd-Frank likewise increased the number of rules governing the bank resolution process, especially for larger financial institutions. Big banks must now submit living wills for regulatory approval, thereby disclosing how they plan to navigate a potential emergency resolution.[267] Banks must also hold certain assets in reserve to ensure they maintain a sufficient total loss-absorbing capacity once the resolution process is underway.[268] Pursuant to the "single point of entry" rule, banks are further required to adopt a corporate legal structure that enables regulators to administer the resolution process exclusively at the holding company level.[269]

Besides these new capital and resolution regulations, Dodd-Frank makes countless other additions to the financial regulatory framework that seek to safeguard banks from more specific risk factors. Among them are: new restrictions on mortgage lending;[270] restrictions for the

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262. DODD-FRANK PROGRESS REPORT, DAVIS POLK LLP (July 19, 2016), https://www.davispolk.com/sites/default/files/2016-dodd-frank-six-year-anniversary-report.pdf [https://perma.cc/97TL-9VPK].

263. *See* Regulatory Capital Rules, 78 Fed. Reg. 62,018 (Oct. 11, 2013) (to be codified 12 C.F.R. pts. 3, 5-6, 165, 167, 208, 217, 225).

264. *See* Liquidity Coverage Ratio, 78 Fed. Reg. 71,818 (proposed Nov. 29, 2013) (to be codified at 12 C.F.R. pts. 50, 248, 329; *see* Net Stable Funding Ratio, 81 Fed. Reg. 35,124 (proposed June 1, 2016) (to be codified at 12 C.F.R. pts. 50, 249, 329).

265. *See* FED. RSRV. BD. GOVERNORS, REGULATORY CAPITAL RULES: THE FEDERAL RESERVE BOARD'S FRAMEWORK FOR IMPLEMENTING THE U.S. BASEL III COUNTERCYCLICAL CAPITAL BUFFER (Sept. 8, 2016).

266. *See* Supervisory and Company-Run Stress Test Requirements for Covered Companies, 77 Fed. Reg. 62,378 (Oct. 12, 2012) (to be codified at 12 C.F.R. pt. 252).

267. *See* Dodd-Frank Act, *supra* note 261, at § 165(d); *see* Federal Reserve, Resolution Plans Required, 26 Fed. Reg. 67,323 (Nov. 1, 2011) (to be codified at 12 C.F.R. pts. 243, 381) (providing the final administrative rule for bank resolution plans, colloquially known as Living Wills).

268. *See* External Total Loss-Absorbing Capacity Requirement and Buffer, 12 C.F.R. § 252.63 (2020).

269. *See* Resolution of Systemically Important Financial Institutions: The Single Point of Entry Strategy, 78 Fed. Reg. 76,614 (proposed Dec. 18, 2013).

270. *See* Dodd-Frank Act, *supra* note 261, at § 1411(a)(2); *see* Ability-to-Repay and Qualified Mortgage Standards Under the Truth-in-Lending Act (Regulation Z),78 Fed. Reg. 6408 (Jan. 30, 2013) (to be codified at 12 C.F.R. 1026).

securitization of mortgages into mortgage-backed securities;[271] the Volcker Rule, which limits the ability of deposit-taking banks to engage in propriety trading;[272] and an elaborate set of trading protocols for banks that participate in over-the-counter derivatives markets.[273]

Measured against most normative theories of policymaking uncertainty, the post-crisis reforms to financial regulation lack coherence and "threw the proverbial kitchen sink at the financial system."[274] Law-and-economics scholars have emphasized the need for simple rules, with a particular focus on the simple leverage ratio.[275] Yet, whether it is in the area of capital requirements or elsewhere, Dodd-Frank relies on complex rules and ex post standards just as often. Proponents of regulatory diversity have urged a retreat from pre-crisis efforts to harmonize financial regulations on an international basis.[276] The response of international financial regulators, however, was to double-down on global coordination by replacing the existing cross-border accords, known as Basel II, with a new set of rules, Basel III.[277] Nor was post-crisis financial regulation consistent with the incrementalist, information-gathering orientation of real options theory.[278] Instead, policymakers opted to "regulat[e] in the dark"[279] by enacting Dodd-Frank (and the transformative reforms it entailed) right on the heels of the crisis.

From the perspective of Modern Portfolio Theory, on the other hand, the posture of post-crisis policymaking makes much more sense. Given the inherent unpredictability of financial markets, where investors are always investing in the dark, the solution is to diversify risk

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271. *See generally* Steven L. Schwarcz, *Securitization and Post-Crisis Financial Regulation*, 101 CORNELL L. REV. ONLINE 115 (2016).

272. *See* Dodd-Frank Act, *supra* note 261, at § 619; *see also* 12 C.F.R. § 248.20 (2020).

273. *See* Dodd-Frank Act, *supra* note 257, at §§ 701-774.

274. NYU STERN AND NYU LAW SCHOOL FACULTY, REGULATING WALL STREET: CHOICE ACT VS. DODD-FRANK 4 (2017); *see also* Cochrane, *supra* note 119, at S70 (describing Dodd-Frank's guiding philosophy as "all of the above and more").

275. *See* Krishnamurthy, *supra* note 59, at S285-87; *see also* David Aikman et al., *Taking Uncertainty Seriously: Simplicity versus Complexity in Financial Regulation*, (Bank of Eng., Financial Stability Paper No. 28, 2014) https://www.bankofengland.co.uk/-/media/boe/files/financial-stability-paper/2014/taking-uncertainty-seriously-simplicity-versus-complexity-in-financial-regulation.pdf?la=en&hash=2DE92C65BBF37630EE568ED475A4B2B2D996EE90 [https://perma.cc/3K8T-ZPM97 [https://perma.cc/3K8T-ZPM9].

276. *See* Whitehead, *supra* note 64; Romano, *supra* note 64.

277. *See* BASEL COMM. ON BANKING SUPERVISION, BASEL II: INTERNATIONAL CONVERGENCE OF CAPITAL MEASUREMENT AND CAPITAL STANDARDS: A REVISED FRAMEWORK (2006) [hereinafter BASEL II]; BASEL COMM., BASEL III: A GLOBAL REGULATORY FRAMEWORK FOR MORE RESILIENT BANKS AND BANKING SYSTEMS (2010).

278. *See* Whitehead, *supra* note 82, at 1295.

279. *See* Roberta Romano, *Regulating in the Dark and a Postscript Assessment of the Iron Law of Financial Regulation*, 43 HOFSTRA L. REV. 25, 25 (2014); *see also* William Dudley, President and Chief Executive Officer, Fed. Reserve Bank of N.Y., Remarks at the Princeton Club of New York, New York City: Principles for Financial Regulatory Reform (Apr. 7, 2017) (stating that only as of 2017 "we can begin to evaluate" the Dodd-Frank Act).

by holding the proverbial kitchen sink of available securities. Similarly, the 2008 crisis represented a massive exogenous shock that upended prior understandings of how banking regulation works. In such an environment, a decision to anchor the regulatory framework around any particular rule, such as a simple leverage ratio, is highly speculative fraught with unknowable downsides. By contrast, a portfolio approach suggests that the optimal response to that uncertainty is to diversify the number of policy instruments that are applied to the financial system, which is precisely what Dodd-Frank did.

(b) Individual Rules Light Touch

Recall that a diversification strategy does not necessarily mean investing *more* money, but, instead, splitting a given amount of capital across more investments. In addition to dramatically increasing the number of financial regulations, a second notable feature of Dodd-Frank that reflects a portfolio approach is that none of the new rules it creates are particularly onerous.

The reform of capital requirements makes this clear. Although the simple leverage ratio and risk-weighted asset ratio underwent comprehensive changes, those modifications largely focus on technical, financial accounting issues, and did not materially heighten the substantive regulatory standards that were imposed before the crisis.[280] Of the two new liquidity rules, the liquidity coverage ratio is considered relatively undemanding, while the net stable funding ratio was never finalized.[281] The countercyclical capital buffer has also never been used to raise those baseline capital and liquidity ratios above the existing regulatory floor.[282]

Other post-crisis rules repeat the same pattern. The cornerstone of Dodd-Frank's new "qualify[ing] mortgage" rules—that banks consider a borrower's "ability to repay" their loan—is an issue that most lenders will care about in the absence of regulation.[283] Likewise, the manda-

280. *See* Anat Admati & Marin Hellwig, The Bankers New Clothes, 95-98, 188-91 (2013); Admati, *supra* note 275, at 95-98, 188-91; *see also* Thomas M. Hoenig, Vice Chairman, Fed. Deposit Ins. Corp.FDIC, Remarks to the International Association of Deposit Insurers 2013 Research Conference in Basel, Switzerland, Basel III Capital: A Well-Intended Illusion The Basel III Illusion, Int'l Assoc. Deposit Insurance Research Conference (Apr. 9, 2013).

281. On the liquidity coverage ratio, *See Ryan N. Banerjee & Hitoshi Mio,* The Impact of Liquidity regulation on Banks, 35 J. FIN. INTERMEDIATION 30 (2018) . The Net Sable Funding Ratio rule was abandoned during the proposed rulemaking process. *See* Net Stable Funding Ratio, 81 Fed. Reg. 35,124 (proposed June 1, 2016) (to be codified at 12 C.F.R. pt. 329).

282. *See generally* Brett H. McDonnell, *Designing Countercyclical Capital Buffers*, 18 N.C. BANKING INST. 123 (2013).

283. *See* Neil Bhutta & Daniel Ringo, *Effects of the Ability to Repay and Qualified Mortgage Rules on the Mortgage Market*, FEDS NOTES: BD. OF GOVERNORS FED. RES. SYS. 1, 7 (Dec. 29, 2015) (presenting an empirical study of the ability-to-repay rule which finds that it "did not materially affect the mortgage market").

tory disclosure and risk-retention rules found in Dodd-Frank's securitization reforms effectively codify what was already standard industry practice prior to the crisis.[284] Living wills are often criticized as a toothless paperwork requirement.[285]

The light touch nature of these reforms has been controversial.[286] Particularly in light of Dodd-Frank's preamble, which promises "to end [T]oo [B]ig to [F]ail, [and] to protect the American taxpayer by ending bailouts,"[287] a number of proposals have been forwarded which reflect a more precautionary approach. One example that arose in the wake of the financial crisis was bipartisan calls for legislation that would "break[] up" big banks.[288] If the problem is that banks are too big to fail, the precautionary principle would suggest a legal rule that prohibits banks from becoming too big. Another family of proposals, developed in the recent work of several financial regulation scholars, aims to restructure the regulatory framework in a way that allows for "safe banking."[289] The common thread among safe banking proposals is that they allow banks to be big, while making it legally impossible for banks to "fail" in a meaningful sense—for instance, by prohibiting financial institutions from issuing any debt instruments that could be subject to default.[290]

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284. *See* Matthew C. Turk, *Securitization Reform after the Crisis: Regulation by Rulemaking, or Regulation by Settlement*, 37 REV. BANKING & FIN. L. 861, 885-88; *see* Schwarcz, *supra* note 271, at 125 ("Prior to the financial crisis, the risks associated with complex securitization transactions and their underlying financial assets, including subprime mortgage loans, were fully disclosed[.]").

285. *See, e.g.*, David K. Suska, *Reappraising Dodd-Frank's Living Will Regime*, 37 REV. BANKING & FIN. L. 779, 782 n.15 (2017) (observing that the academic commentary on Living Wills has been mostly critical); Nizan Geslevich Pakin, *The Case Against Dodd-Frank Act's Living Wills: Contingency Planning Following the Financial Crisis*, 9 BERKELEY BUS. L.J. 29 (2012).

286. *See, e.g.*, Arthur E. Wilmarth, Jr., *The Dodd-Frank Act: A Flawed and Inadequate Response to the Too-Big-to-Fail Problem*, 89 OR. L. REV. 951 (2010).

287. *See* Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010, Pub. L. No. 111-203, 124 Stat. 1376, preamble, § 1.

288. *See* Donna Borak, *Warren, McCain Push for Return of Glass-Steagall*, AM. BANKER (July 11, 2013, 12:40 PM) https://www.americanbanker.com/opinion/warren-mccain-want-to-bring-back-glass-steagall [https://perma.cc/8Y37-XKNA]; Akane Otani & Ryan Tracy, *President Trump Says He's Looking into Breaking Up Wall Street Banks*, WALL ST. J. (May 1, 2017, 3:09 PM) https://www.wsj.com/articles/president-trump-says-hes-looking-into-breaking-up-wall-street-banks-1493660319 [https://perma.cc/7RQX-W8C5].

289 . Under one version of this arrangement, banks are only allowed to finance their lending by raising equity. *See* Adam J. Levitin, *Safe Banking: Finance and Democracy*, 83 U. CHI. L. REV. 357, 357 (2016); John H. Cochrane, *Toward a Run-Free Financial System*, *in* ACROSS THE GREAT DIVIDE: NEW PERSPECTIVE ON THE FINANCIAL CRISIS 197 (Martin Neil Baily & John B. Taylor eds., 2014). Under a second version of safe banking, banks are allowed to take deposits and issue short-term debt, but only on the condition that those liabilities are fully guaranteed by the federal government. *See* MORGAN RICKS, THE MONEY PROBLEM: RETHINKING FINANCIAL REGULATION 3 (2016) (arguing that such an arrangement would "panic proof[]" the financial system).

290. *See* Levitin, *supra* note 289.

None of these proposals have made traction or stand much of a chance of being implemented in the near future.[291] As a descriptive matter, post-crisis financial regulation does not embody the precautionary principle.[292] There are also strong normative arguments why that outcome was rightly avoided. For one, the push to break up "Too Big to Fail" banks overlooks the potential for regulatory arbitrage.[293] Once large banks are prohibited, financial risk-taking will shift to smaller financial institutions, which would then collectively become "Too Many to Fail."[294]

Similarly, Professor Judge has persuasively argued that safe banking proposals fall prey to an overly optimistic "view[] on the capacity of any single government intervention to bring about lasting [financial] stability."[295] The reason, she goes on to explain, is policymaking uncertainty: "[T]he exceptional dynami[cs] of financial markets ensures that policymakers will never succeed in identifying and addressing all sources of systemic instability in advance."[296] More generally, an exclusive focus on the goal of perfect financial stability is misguided, assuming it can even be achieved. An aggressively precautionary regulatory structure will introduce new costs if it indirectly cripples the financial intermediation services that make having a banking system worthwhile in the first place.[297]

(c) Emphasis on Covariance and High PEV

Finally, recall that for a diversification strategy to be effective, it must combine risks that are not highly correlated.[298] Post-crisis financial regulation follows a portfolio approach in this respect as well. The risk factors affecting many of Dodd-Frank's novel policy instruments are uncorrelated: whether an ability-to-repay rule for mortgages improves home lending does not turn on the success of Dodd-Frank's new

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291. *See* Jeremy Kress, *Solving Banking's "Too Big to Manage" Problem*, 104 MINN. L. REV. 171, 175 (2019).

292. That said, some sub-components of post-crisis financial regulation do resemble the precautionary principle. The Volcker Rule's prohibition on proprietary trading arguably falls in this category, as do provisions in Dodd-Frank that strip away most of the previous functions played by credit ratings agencies. *See* Dodd-Frank Act, *supra* note 257, at § 943 (imposing new restrictions on the use of third-party credit ratings).

293. *See generally* Matthew C. Turk, *The Convergence of Insurance with Banking and Securities Industries, and the Limits of Regulatory Arbitrage in Finance*, 2015 COLUMB. BUS. L. REV. 967, *supra* note 7.

294. *See* Jeremy C. Kress & Matthew C. Turk, *Too Many to Fail: Against Community Bank Deregulation*, 115 NW. U. L. Rev. 647, 647 (2020) (examining the indirect costs of banking crises on the real economy).

295. *See* Kathryn Judge, *The Importance of "Money"*, 130 HARV. L. REV. 1148, 1152 (2017).

296. *See id.*

297. *See* Anjan V. Thakor, *Bank Capital and Financial Stability: An Economic Tradeoff or Faustian Bargain?*, 6 ANN. REV. FIN. ECON. 285, 185 (2014).

298. *See* Markiwitz, *supra* 109, and accompanying text.

derivatives clearing rules.[299] Moreover, the most important areas of banking regulation—capital requirements and resolution procedures—were reformed with rules that have a negative covariance.

Specifically, the two core capital rules—the simple leverage ratio and risk-weighted asset ratio—share this feature. The risk-weighted asset ratio requires policymakers to make fine-grained distinctions about which particular asset classes pose the greatest risk to bank balance sheets.[300] To the extent those calculations prove misguided or difficult to enforce, the cruder risk-assessment categories used in the simple leverage ratio provide a valuable backstop.[301] A similar form of negative covariance applies to Dodd-Frank's combination of these two capital requirements with liquidity rules such as the liquidity coverage ratio as well.[302]

The same interaction also characterizes the joint use of capital requirements and resolution rules, considered as a whole. Capital regulations are designed to work ex ante, by preventing banks from taking risks that may destabilize their financial stability.[303] Bank resolution procedures work ex post, by allowing regulators to restructure distressed banks in a manner that minimizes the collateral costs of their failure on the broader financial system.[304] If either intervention is effective—banks are made failsafe or safe to fail—the negative externality that arises from bank failures has been corrected. Thus, to the extent that capital regulations have a lower than expected return (meaning that many banks fail), the return on society's investment in a resolution process for failing banks should be relatively higher than expected.

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299. Dodd-Frank's mortgage lending standards and derivative clearing rules apply to distinct categories of financial institutions engaged in unrelated financial activities. *See* Dodd-Frank Act, *supra* note 261, at § 1411(a)(2); Ability-to-Repay and Qualified Mortgage Standards Under the Truth-in-Lending Act, 78 Fed. Reg. 6408 (Jan. 30, 2013) (cited supra); Dodd-Frank Act, *supra* note 259, at §§ 701–774 (derivative rules).

300. *See* Turk, *supra* note 153, at 834–39 (analyzing the mechanics of Dodd-Frank's capital requirements and how they interact).

301. *Cf.* Xavier Vives, *Strategic Complementarity, Fragility, and Regulation*, 27 REV. FIN. STUD. 3547, 3457 (2014); Anil K. Kashyap, Dimitrios P. Tsomocos & Alexandros P. Vardoulakis, *Optimal Bank Regulation in the Presence of Credit and Run Risk* (Nat. Bureau of Econ. Rsch. Working Paper No. 26689, 2020).

302. *See* Ansgar Walther, *Jointly Optimal Regulation of Bank Capital and Liquidity*, 48 J. MONEY CREDIT & BANKING 415, 417 (2016); Andreas Ita, *How do Banks Adapt Their Asset Holdings to Binding Leverage Ratio and Liquidity Requirements Under Basel III?*, (Univ. Zurich, Dep't Banking & Finance, July 31, 2017).

303. *See* Steven Schwarcz, *Ex Ante Versus Ex Post Approaches to Financial Regulation*, Keynote Address Before 2011 Chapman Law Review Symposium "From Wall Street to Main Street: The Future of Financial Regulation" (Jan. 28, 2011) *in* 15 CHAP. L. REV. 257, 258 (2011).

304. *See id.*; *see also* Kenneth Ayotte & David A. Skeel, Jr., *Bankruptcy or Bailouts?*, 35 J. CORP. L. 469, 471 (2009).

To be sure, the argument presented in this section is not that post-crisis financial reforms are perfectly consistent with a portfolio approach or otherwise optimal in every respect. For instance, the covariance between legal rules only matters if their expected return is positive, and if the joint use of those rules does not cause them to function at cross-purposes.[305] At least some of the hundreds of regulatory rulemakings triggered by Dodd-Frank certainly fail those tests. Some of these regulatory rulemakings that fail said tests may have been unidentifiable at the time of Dodd-Frank's passage in 2010. The solution implied by a portfolio approach is to reduce the diversification of financial regulations over time as the dysfunctional aspects of post-crisis policymaking become more clear.[306]

In fact, that process has already begun. Pursuant to the Economic Growth, Regulatory Relief, and Consumer Protection Act of 2018, and related reforms within the Trump administration, recent action has been taken to prune away certain portions of the post-crisis financial architecture perceived as unduly expansive.[307] With this latest deregulatory push, the decade of policymaking since the 2008 financial crisis has come full circle. In doing so, it demonstrates two things about the practical feasibility of a portfolio approach: it is possible to both dramatically expand and to contract the diversification of legal rules within a relatively short period of time.[308]

B. Environmental Regulation & Climate Change

Environmental law has long been recognized as a policy area that involves substantial uncertainty about the costs and benefits of regulatory interventions.[309] That issue reaches another level of complexity with the regulation of climate change, a global problem with an extremely long time horizon, where policymaking must confront "enormous scientific and economic uncertainties about the future."[310] Given that climate change regulation represents the "[u]ltimate [c]hallenge

305. *See supra* Section II.B.2.

306. *See supra* Section II.B.3.

307. *See generally* Economic Growth, Regulatory Relief, and Consumer Protection Act, Pub. L. No. 155-174, 132 Stat 1296; *But cf.* John Crawford, *Lesson Unlearned?: Regulatory Reform and Financial Stability in the Trump Administration*, 117 COLUM. L. REV. ONLINE 127, 127-29 (2017).

308. This, despite the absence of sunset clauses in Dodd-Frank as would be recommended by real options theory. *Cf.* Kristen Underhill, &, Ian Ayres & Pranav Bhandarker, *Sunsets are for Suckers: An Experimental Test of Sunset Clauses* 20-21 (Colum. L. & Econs., Working Paper No. 651, 2020) (providing more general empirical evidence that sunset clauses have a limited impact on their intended goal of increasing regulatory flexibility).

309. *See* Richard L. Revesz, *Quantifying Regulatory Benefits*, 102 CALIF. L. REV. 1423, 1436-44 (2014).

310. ERIC A. POSNER & DAVID WEISBACH, CLIMATE CHANGE JUSTICE 3 (2010); *see also id.* at 11 ("Uncertainty affects every choice with respect to climate change.").

for [e]conomics"[311]—as well as for the law—it provides another useful test case for this article's portfolio theory of policymaking uncertainty.

1. The Policy Problem & Uncertainty

The underlying market failure associated with climate change is straightforward. Firms and individuals that engage in activities that emit carbon dioxide and other greenhouse gases (GHGs) into the atmosphere impose a negative externality on third parties.[312] While the economic benefits of those activities are fully captured by the emitting party, the adverse environmental effects of climate change are experienced by other people across the globe.[313] Climate change regulation therefore turns a classic collective action or tragedy of the commons problem: a sustainable climate is a global public good, but no individual consumer of that good has a sufficient incentive to maximize its value for the group.[314]

There are also some near-scientific certainties when it comes to climate change. At a minimum, three findings are well-established.[315] First, the release of GHGs has a positive relationship with global temperatures as a consequence of the greenhouse effect.[316] Second, atmospheric concentrations of GHGs have been increasing at a rapid rate due to human activity, starting with the industrial revolution.[317] And third, observable temperatures in the earth's atmosphere and oceans have been rising in recent decades as a result.[318] When moving beyond these baseline facts to more concrete issues of regulatory design, however, there are many more questions than answers.

Environmental scientists must not only project the global rate of GHG emissions several decades in advance, but also its impact on a further variable known as "climate sensitivity"—the magnitude of

311. William Nordhaus, *Climate Change: The Ultimate Challenge for Economics*, 109 AM. ECON. REV. 1991, 1991 (2019).

312. *See id.* at 1992.

313. *See id.*

314. *See id.* at 1992-94; POSNER & WEISBACH, *supra* note 310, at 17; *cf.* Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243, 1243 (1968).

315. *See* POSNER & WEISBACH, *supra* note 310, at 13.

316. *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, 2014 SYNTHESIS REPORT: SUMMARY FOR POLICYMAKERS 2 (2014) [*hereinafter* IPCC 2014 Report]; *see also* DAVID ARCHER, GLOBAL WARMING: UNDERSTANDING THE FORECAST, PART I: THE GREENHOUSE EFFECT 29-40 (2007).

317. *See* IPCC 2014 Report, *supra* note 316, at 2; POSNER & WEISBACH, *supra* note 310, at 13.

318. *See* IPCC 2014 Report, *supra* note 316, at 2; POSNER & WEISBACH, *supra* note 310, at 13.

temperature increases that those emissions will eventually produce.[319] And, estimating the trajectory of global temperatures is still just one preliminary step. A warming atmosphere is mainly relevant to the extent it affects other global patterns relating to weather, ecosystem sustainability, and disease.[320] From a policy perspective, understanding the scope of those environmental disruptions is yet another input for a further variable, "carbon intensity"—which refers to the ultimate economic impact that climate change will have on human populations.[321] The mathematical models used to calculate these variables, while impressively sophisticated, are necessarily limited to conclusions that do not go much beyond a best guess.[322] Moreover, the estimates in those models leave considerable room for the presence of "tail risks," the likelihood or possible impact of an unexpectedly catastrophic climate outcome.[323]

Even if the modeling issues identified above can be resolved to an acceptable degree of confidence, there are several practical hurdles facing the implementation of any policy response. One of those hurdles is the ability to negotiate an effective cross-border agreement,[324] which may be frustrated by substantial regional variation in the impact that climate change is expected to have across countries.[325] In addition, however sound the terms of such an agreement may appear to be on

319. *See* Robert S. Pindyck, *The Use and Misuse of Models for Climate Policy*, 11 REV. ENV'T ECON. & POL'Y 100, 101 (2017). The consensus estimate is that the earth's atmosphere will warm by approximately three degrees Celsius by the year 2100. *See* IPCC 2014 Report, *supra* note 307, at 62-63.

320. *See* IPCC 2014 Report, *supra* note 316, at 6–7.

321. *See* POSNER & WEISBACH, *supra* note 310, at 17; Pindyck, *supra* note 319, at 101.

322. *See* Pindyck, *supra* note 319, at 100 (concluding that the complex "Integrated Assessment Models" used by climate economists "create a perception of knowledge and precision that is illusory and can fool policymakers into thinking that the forecasts the models generate have some kind of scientific legitimacy.").

323. *See id.* at 101 (noting that these tail risks may materialize if the amount of global warming exceeds 5°C). *See generally* Martin L. Weitzman, *Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change*, 5 REV. ENV'T. ECON. & POL'Y 275 (2011) (analyzing the conceptual problems raised by the tail risks embedded in climate change models). *See generally* Weitzman, *supra* note 310 (analyzing the conceptual problems raised by the tail risks embedded in climate change models).

324. *See* Jonathan M. Gilligan & Michael P. Vandenbergh, *Accounting for Political Feasibility in Climate Instrument Choice*, 23 VA. L.J. 1, 2 (2014); Gary D. Libecap, *Addressing Global Environmental Externalities: Transaction Cost Considerations*, 52 J. ECON. LIT. 424, 425-26 (2014).

325. *See* IPCC 2014 Report, *supra* note 316, at 6-7, 10-16; POSNER & WEISBACH, *supra* note 310, at 25.

paper, enforcement issues are sure to follow.[326] Lastly, given the long time horizon in which climate change must be addressed, the value of regulatory interventions are highly dependent on the "discount rate" that society assigns to those investments.[327] In sum, these considerations mean that "[t]he issue of global climate change and what to do about it has put [law and] economics to a severe test," [328] and in doing so forces policymakers "to think afresh about how to model (or at least how to conceptualize) such fundamental notions as risk, uncertainty, and discounting." [329]

2. Overview of Climate Change Regulation

A concerted legal response to climate change has only emerged within the past two decades and the regulatory landscape remains in flux.[330] To date, however, the evolving structure of climate change regulation has tended to follow a portfolio approach. As with the case of financial regulation, one of the more notable features of climate change law is that it combines a broad menu of policy instruments while limiting the regulatory intensity of each particular intervention that is used.

The current global accord on climate change is the Paris Agreement of 2015,[331] an international treaty which supplanted the prior Kyoto Protocol of 1997.[332] The Paris Agreement operates by setting forth

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326. It is difficult to monitor and sanction non-compliance with international treaties of all sorts, but those problems are especially severe when it comes to climate change. *See* POSNER & WEISBACH, *supra* note 310, at 33-39. The problem of regulatory arbitrage looms large here as well. Any effort to reduce carbon emissions in one country may indirectly trigger a dynamic known as "carbon leakage," in which emissions-producing economic activity shifts to other, less-regulated jurisdictions. *See* Joshua Elliott et al., *Unilateral Carbon Taxes, Border Tax Adjustments, and Carbon Leakage*, 14 THEORETICAL INQUIRIES L. 207, 208 (2013).

327. The discount rate is an accounting concept that is used in all investments to "match cash flows that occur in different periods." Cass R. Sunstein & David A. Weisbach, *Climate Change and Discounting the Future: A Guide for the Perplexed* 2 (Harvard Law Sch., Research Paper No. 08-20, 2008); *see also id.* at 3.

328. Martin L. Weitzman, *A Review of the Stern Review on Economics of Climate Change*, 65 J. ECON. LIT. 703, 703 (2007).

329. *Id.*

330. *See generally* Cinnamon P. Carlarne, *U.S. Climate Change Law: A Decade of Flux and an Uncertain Future*, 69 AM. U. L. REV. 387 (2019).

331. Paris Agreement (Dec. 13, 2015), *in* UNFCCC, Report of the Conference of the Parties on its Twenty-First Session, Addendum, at 21-36, UN Doc. FCCC/CP/2015/10/Add.1 (Jan. 29, 2016). Although the Trump Administration has formally withdrawn from the Paris Agreement, Article 28 of the treaty limits the ability to exit, so that the United States will remain bound by the agreement until the next presidential term beginning in 2021. *Id.* at art. 28; *see also* Philip Wallach, *Where Does US Climate Change Policy Standing in 2019?*, BROOKINGS INST. (Mar. 22, 2019).

332. Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 11, 1997, 2303 U.N.T.S. 162. The Kyoto Protocol was dissolved in 2010, pursuant to an international agreement called the Copenhagen Accord. Copenhagen Accord (Dec 18, 2009), *in* COPReport No. 15, Decision 2/CP.15, UN Doc. FCCC/CP/2009/11/Add.1 (Mar. 30, 2010).

emissions goals for each state signatory, among a variety of other terms, such as reporting requirements that obligate member states to disclose their progress toward meeting those targets.[333] In doing so, the Paris Agreement takes a "comparatively modest approach . . . [relative to] its more ambitious predecessor, the Kyoto Protocol,"[334] which was abandoned in 2010, largely because its requirements were perceived as too heavy-handed.[335] As Professor Carlarne notes, "at the time of adoption of the Paris Agreement, the aggregate mitigation contributions to which the parties had committed—even if fully implemented—would fail to keep warming below the 2°C target the Agreement establishes."[336]

The Paris Agreement leaves it to each signatory state to adopt their own strategy for meeting its emissions targets.[337] In the United States, a leading strategy to that end has been to use command-and-control requirements which place limits on the emissions of particular industries or technologies. For mobile sources—such as automobiles, heavy-duty trucks, and aircraft—the governing rules have been implemented via the Energy Independence and Security Act of 2007.[338] Emissions from industrial plants and other stationary sources are capped according to administrative rules promulgated pursuant to Section 111(d) of the Clean Air Act.[339]

A separate category of interventions departs from a command-and-control approach by changing the price of activities that produce carbon emissions. At the federal level, the primary policy instrument that adopts this method are subsidies for alternative energy—wind, solar power, and so on—that encourage the development and consumption

333. *See* Daniel Bodansky, *The Paris Climate Change Agreement: A New Hope?*, 110 AM. J. INT'L L. 288 (2016); *id.* at 289-91.

334. *Id.* at 289.

335. *See id.* ("The Paris Agreement seeks a Goldilocks solution that is neither too strong (and hence unacceptable to key state) nor too weak (and hence ineffective).").

336. Carlarne, *supra* note 330, at 394-95.

337. *See* Bodansky, *supra* note 333, at 289.

338. Energy Independence and Security Act of 2007, 74 Fed. Reg. 4907 (Jan. 28, 2009).

339. *See* Carbon Pollution Emissions Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 80 Fed. Reg. 64,662 (Oct. 23, 2015) (to be codified at 40 C.F.R. pt. 60); Massachusetts v. EPA, 549 U.S. 497 (2007) (interpreting the Clean Air Act to allow for the regulation of GHG emissions). *See* Wallach, *supra* note 331 (noting how the stationary source rules set forth in the Obama administration's Clean Power Plan have been tied up in litigation and its long-term future is unknown).

of energy sources that do not rely on carbon-based fossil fuels.[340] In addition, California and several states in the Northeast have established cap-and-trade systems, which allow industrial firms to buy and sell regulatory permits for their carbon emissions.[341] Lastly, at least twenty jurisdictions around the globe have adopted some form of economy-wide carbon tax.[342] While no such tax exists in the United States, the federal gas tax performs an analogous function on a more limited basis.[343]

The foregoing rules all represent an "abatement" strategy—the goal is to mitigate climate change by reducing carbon emissions. Two other categories of climate change regulations take a different posture. The first is a set of rules that focus on climate "adaption." Instead of preventing climate change from taking place, adaption policies attempt to limit the damage of global warming as it happens. The development of drought-resistant crop varieties and infrastructure projects relating to flood zones or the construction of sea walls are some examples.[344] A second set of policies focuses on what is known as carbon capture or "sequestration"—a process that also takes place after emissions have occurred, by leveraging technologies that remove carbon from the atmosphere or oceans.[345] As of now, policies that encourage investment

340. *See, e.g.*, 26 U.S.C. § 30B (offering a $7500 tax credit for plug-in electric vehicles); 26 U.S.C. §48 (providing tax credits for investments in solar, wind, and geothermal energy production); *see* David M. Schizer, *Energy Subsidies: Worthy Goals, Competing Priorities, and Flawed Institutional Design*, 70 TAX. L. REV. 243, 247 (2017) ("Climate change is perhaps the most common justification for subsidizing renewable energy."); *See also* U.S. ENERGY INFO. ADMIN., DIRECT FEDERAL FINANCIAL INTERVENTIONS AND SUBSIDIES IN ENERGY IN FISCAL YEAR 2013 (2015) (reporting that approximately $30 billion of green energy subsidies provided by the federal government per year).

341. *See generally* Robert N. Stavins, *Carbon Taxes vs. Cap and Trade: Theory and Practice* (Harvard Project on Climate Agreements, Disc. Paper ES 19-9, 2019). For a review of the California system, see Jonathan Kintzele, *Easy Come, Easy Go: A Guide to California Cap-and-Trade Spending*, 90 S. CAL. L. REV. 719 (2017). Nine states also participate in a cap-and-trade market known as the Regional Greenhouse Gas Initiative (RGGI): Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. *See* Richard Schmalensee & Robert N. Stavins, *The Design of Environmental Markets: What Have We Learned from Experience with Cap and Trade?*, 33 OXFORD REV. ECON. POL'Y 572 (2017).

342. *See* Schmalensee & Stavins, *supra* note 341.

343. The federal gasoline tax has been held at 18.4 cents per gallon in recent years. *See* U.S. DEPT. TRANSP., OFFICE OF HIGHWAY POL'Y INFO., FEDERAL TAX RATES ON MOTOR FUELS 1 (2015); *see also* Schizer, *supra* note 340.

344. *See* IPCC 2014 Report, *supra* note 316316; Bodansky, *supra* note 328, at 309-10.

345. *See* Moonsook Park, *The Government's Multi-Faceted Role in Resolving the Main Legal Issues Regarding Carbon Capture and Sequestration*, 94 N.D. L. REV. 481 (2019).

in adaptation or carbon sequestration measures have remained marginal in the United States and are modest in scope in other jurisdictions as well.[346]

While the structure of climate change regulation tracks a portfolio approach in certain important respects, it does not follow the two most prominent theories of policymaking uncertainty that have been proposed in the context of climate law. The first of these is the precautionary principle. Numerous academic commentators have argued that climate change regulation should take a precautionary approach, citing the large and uncertain downside risks raised by global warming.[347] The precautionary principle also appears as the guiding philosophy in recent legislative proposals that call for a Green New Deal.[348] Yet, the Green New Deal failed to progress through congress and, at least of now, the prospect of enacting legislation along similar lines remains unlikely. [349]

Second, the consensus view in law-and-economics scholarship on climate change is that the optimal regulatory response is a simple rule in the form of a global carbon tax.[350] The recommendation to address climate change through the price mechanism—with either a carbon tax or, alternatively, a cap-and-trade permitting system—is typically justified on information costs and policymaking uncertainty grounds: "the chance that the government could correctly choose the right sources for reduction and the right technologies is low."[351] Here again,

346. *See id.* at 485 (reviewing the emerging regulatory regime for carbon sequestration in the United States); EXEC. OFFICE OF THE PRESIDENT, THE PRESIDENT'S CLIMATE ACTION PLAN, 6-20 (2013) (outlining climate adaption measures proposed under the Obama administration's Climate Action Plan); *cf.* Zachary Liscow & Quentin Karpilow, *Innovation Snowballing and Climate Law*, 95 WASH. U. L. REV. 387, 392 (2017) (arguing that government subsidies for innovative carbon reducing technologies can play a useful role in climate policy, regardless whether a carbon tax is also in place).

347. *See, e.g.*, Farber, *supra* note 196 (arguing that climate change law should follow the precautionary principle); Park, *supra* note 337, at 483 (arguing that the precautionary principle "should be realized as firmly established . . . in the area of international environmental law").

348. *See* H.R. Res. 109, RECOGNIZING THE DUTY OF THE FEDERAL GOVERNMENT TO CREATE A GREEN NEW DEAL, 116th Cong. (2019-2020); *id.* at § 4(b).

349. *See* Robinson Meyer, *Seven Reasons Democrats Won't Pass a Green New Deal*, THE ATLANTIC (Jan. 29, 2019), https://www.theatlantic.com/science/archive/2019/01/green-new-deal-why-democrats-will-struggle/581245/ [https://perma.cc/8PV3-MKEJ] ("The task [of passing a Green New Deal] is enormous, and the path is narrow.").

350. *See* POSNER & WEISBACH, *supra* note 301, at 41; Stavins, *supra* note 341, at 2 ("There is widespread agreement among economists—and a diverse set of other policy analysts—that, at least in the long term, economy-wide carbon pricing will be an essential element.").

351. *See* POSNER & WEISBACH, *supra* note 301, at 44; *cf.* Stavins, *supra* note 341, at 3 ("These two approaches to carbon pricing [carbon tax and cap-and-trade] are perfectly or nearly equivalent in regard to some issues and attributes.").

there has been widespread resistance to the (robust) use of a carbon tax or cap-and-trade system in both the United States and at the international level.[352]

3. Evaluation

By most accounts, the law of climate change reflects a crazy-quilt of half measures that lack any coherent normative justification. For advocates of the precautionary principle, a better-safe-than-sorry approach that aims for maximal regulatory intensity is necessary, and the current legal framework is too lax. For law-and-economics scholars, the problem is the choice of policy instrument rather than insufficient regulatory intensity.[353] Economic theory suggests that the most efficient intervention is a Pigouvian tax which sets a price on carbon emissions equal to the "social cost of carbon."[354] Yet, as noted above, command-and-control requirements tend to predominate compared to the use of a carbon tax or cap-and-trade system in most jurisdictions, including the United States.

As a consequence, the present state of climate law is usually understood as the product of voter myopia, poor political leadership, or related dysfunctions in the policymaking process.[355] When climate change policy is assessed from the perspective of Modern Portfolio Theory, however, a much different and more balanced picture emerges. The fact that policymakers have relied on an overlapping array of regulatory half-measures is not necessarily a sign of confusion. Rather, it reflects a rational response to the deep uncertainties associated with any particular policy instrument. A closer look at the argument for why climate change policy should be exclusively, or at least predominantly, centered around a uniform carbon tax illustrates this point.

Although the superiority of a carbon tax over alternative policy instruments is well-grounded as a matter of textbook economics, economic principles are not empirical facts: they are tools for making predictions about the world. The prediction is essentially that carbon taxes have a higher expected return than other regulatory interventions. But the actual return to society from the imposition of a carbon tax in any concrete form will depend on a variety of factors. For example, it depends on whether the price set on the negative externality caused by GHG emissions accurately reflects the true social costs of

352. *See* Schizer, *supra* note 340, at 271; POSNER & WEISBACH, *supra* note 331.

353. *See* Nathaniel O. Keohane, Richard L. Revesz, & Robert N. Stavins, *The Choice of Regulatory Instruments in Environmental Policy*, 22 HARV. ENVT'L L REV. 313, 313 (1998).

354. On the social cost of carbon, *see* Schizer, *supra* note 340, at 245; Stavins, *supra* note 341, at 4.

355. *See* Stavins, *supra* note 341, at 28; Schizer, *supra* note 340, at 270-73.

those emissions. That introduces a problem, because "there is no consensus about the climate cost of carbon,"[356] and leading estimates of the social cost of carbon vary wildly.[357] It also means that a carbon tax will be less effective than anticipated if the particular estimate it relies on to set the price of GHG emissions proves to be too high or too low.

Moreover, even under the heroic assumption that the social cost of carbon can be measured with perfect accuracy, the benefits of carbon tax remain indeterminate. Most climate models indicate that the United States could eliminate all GHG emissions by the year 2030 without having a material impact on the rate of global temperature trends.[358] Thus, the geographic scope of a carbon tax is critical; only a broad-based international agreement that covers most of the world's major polluters is sufficient, and there are no guarantees that such an agreement will be formed.[359] Still, then—on the further heroic assumption that a carbon tax treaty can be negotiated with universal global membership—the administration of a global carbon tax involves many logistical hurdles, and the devil will be in the implementation details.[360] This is all to say that variance in the expected return of a carbon tax is extremely high; under many plausible scenarios, the actual benefits may approach zero.[361]

Three implications follow. First, the use of a carbon tax in isolation is dominated by a portfolio approach that includes additional interventions (so long as those additional policy instruments have low or negative covariance with a carbon tax).[362] Adaption measures have this feature. The value of localized investments in more sustainable coastlines and water consumption will be relatively higher to the extent that global coordination on emissions reductions does not succeed.[363]

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356. *See* Schizer, *supra* note 340, at 249.

357. *See id.* ("While the IMIF values it at $25 per metric ton of C02 ,23 the Obama administration uses $38.24, and others have offered much lower or higher numbers."); *see also* Elisabeth Moyer et al., *Climate Impacts on Economic Growth as Drivers of Uncertainty in the Social Cost of Carbon*, 43 J. LEGAL STUD. 401, 402-03 (2014).

358. *See* POSNER & WEISBACH, *supra* note 301, at 31.

359. *See id.* at 40.

360. *See* David A. Weisbach & Gilbert E. Metcalf, *The Design of a Carbon Tax*, 33 HARV. ENVTL. L. REV. 499, 503 (2009); Severin Borenstein et al., *Expecting the Unexpected: Emissions Uncertainty and Environmental Market Design*, 109 AM. ECON. REV. 3953, 3955 (2019).

361. Professor Stavins notes that "British Columbia has had in place since 2008 a carbon tax that comes closest to the version of an ideal carbon tax typically recommended by economists." *See* Stavins, *supra* note 341 at 24. And yet "[i]n terms of its performance, the empirical evidence is unclear." *Id.* at 25. At least one study finds that British Columbia's carbon tax has had no impact on its emissions. *See* Felix Pretis, *Does a Carbon Tax Reduce CO2 Emissions? Evidence from British Columbia* 1-2 (2021).

362. *Cf.* Oskar Lecuyer & Philippe Quirion, *Can Uncertainty Justify Overlapping Policy Instruments to Mitigate Emission*?, 93 ECOLOGICAL ECON. 177, 177 (2013); Rebeca Runting et al., *Reducing Risk in Reserve Selection using Modern Portfolio Theory: Coastal Planning Under Sea-Level Rise*, 55 J. APPLIED ECOLOGY 2193, 2193-94 (2018).

363. *See* IPCC 2014 Report, *supra* note 316, at 19-20.

Another example is public funding of infrastructure for carbon capture projects and other forms of geo-engineering.[364] Certain command-and-control requirements, such as emissions caps for industrial plants, arguably fall into this category as well.[365]

Second, although the estimated social cost of carbon is often considered a direct input for setting the level of a carbon tax, that changes when carbon pricing regulations are used in combination with other policy instruments. Instead, the social cost of carbon sets an upper bound for the total cost of the entire regulatory portfolio as a whole. Thus, under a portfolio approach, the optimal carbon tax is by definition lower than the social cost of carbon. This conclusion reflects the logic of diversification as the division of an investment into multiple smaller parts which function as partial substitutes.[366]

Third, the optimal mix of policy interventions will fluctuate as uncertainty about climate change decreases over time. This is clearly the case with respect to scientific uncertainty over the rate of global temperature increases and the associated environmental and economic costs. But it also applies to uncertainty over the relative efficacy of different policy instruments as well. If an international agreement on carbon taxes is ultimately unworkable, for instance, the intensity of alternative policy instruments should be ratcheted up accordingly. Here, the potential for addressing policymaking uncertainty by combining phased regulations within a broader portfolio approach is particularly compelling. As of now, the feasibility of many adaptation measures or geo-engineering strategies remains to be seen, and will turn on the pace of technological innovation in coming decades.[367] Real options theory suggests that the best response to that uncertainty is an initial upfront investment in research on ambitious projects, like the construction of sea walls, which can then be scaled in later periods to the extent they prove viable.[368]

As in the previous case study on financial crises, the claim that climate change regulation resembles a portfolio approach is meant as a rough approximation, and does not imply that the legal status quo is perfectly efficient in all respects. For one, there is substantial room for improving the allocation across regulatory instruments in U.S. climate

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364. *See* David Victor, *On the Regulation of Geo-Engineering*, 23 OXFORD REV. ECON. POL'Y 322, 332 (2008).

365. *See* Joseph E. Stiglitz, *Addressing Climate Change through Price and Non-Price Interventions* 22-23 (Nat'l Bureau of Econ. Rsch. Whitepaper No. 25939, 2019).

366. *See supra* note 146 and accompanying text.

367. *Cf.* Jay Michaelson, *Geoengineering: A Climate Change Manhattan Project*, 17 STAN. ENVT' L. J. 73 (1998).

368. *See* Peter Linquiti & Nicholas Vonortas, *The Value of Flexibility in Adapting to Climate Change: A Real Options Analysis of Investments in Coastal Defense*, 3 CLIMATE CHANGE ECON. 1250008, 10, 20-21 (2012).

policy. At present, the legal framework is characterized by under-investment in relatively efficient interventions; namely, carbon pricing in the form of a tax or cap-and-trade system. It also includes over-investment in certain interventions, such as subsidies to wind energy, which almost certainly have a negative expected return.[369] As this section has argued, portfolio theory provides a valuable lens for understanding the structure of climate change regulation in its current form, as well as a conceptual framework for refining that legal structure going forward.

CONCLUSION

This article has applied Modern Portfolio Theory to the problem of policymaking uncertainty. It argues that the same principles of diversification that are used to mitigate the riskiness of financial investments can also inform the design of regulations which have uncertain costs and benefits. As the article further argues, the legal system already reflects the logic of diversification in many policy areas. Whether it comes to safety requirements for automobiles, the structure of banking regulation, or policies aimed at climate change, the common thread is a portfolio approach that combines the joint use of several light touch legal rules.

While the fact that the law often takes a portfolio approach has not been widely recognized among legal scholars, it is not necessarily surprising either. The underlying logic behind diversification of risk has been a piece of folk wisdom for thousands of years, and is familiar from the proverbial rule to never carry all of one's eggs in the same basket. For policymakers who must intervene in a complex and unpredictable world, the decision over which regulatory instrument will work best is almost always subject to numerous uncertainties. As this article has shown, the merits of a portfolio approach prove valuable with respect to questions of regulatory design, just as they do for the question of how to carry eggs or how to invest in the stock market.

369. *See* Schizer, *supra* note 340, at 246 ("Congress pays 2.3 cents for each kWh of electricity generated with wind. To claim this subsidy, producers sometimes generate electricity that no one needs, and then *pay* customers to take it.").