The Essential
RONALD COASE

by L. Lynne Kiesling

FRASER INSTITUTE

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Introduction: Who Was Ronald Coase?

Ronald Coase was one of the most influential economists of the 20th century, and one of the most unusual. His influence spans economics, law, and social science more broadly, and is due largely to two publications, the only two cited in the announcement of his Nobel Prize: "The Nature of the Firm" (1937) and "The Problem of Social Cost" (1960). These two articles are among the most-cited works in economics, and despite their age continue to be cited widely today (Landes and Lahr-Pastor 2011). The ideas Coase developed in these two works led to entirely new fields of inquiry in economics, law, management, and political science, and in conjunction with his article on using markets to allocate radio spectrum (Coase 1959), spawned new market design theory and practice that helped to transform our society and enable innovation and digitization (see, for example, Medema (1998), Ménard and Shirley (2005), Hazlett (2009), and Veljanovski (2015)).

Coase's style of theory, analysis, and persuasion was narrative, fact-driven, and much less formal than is the norm in economics. Coase spent his career asking deceptively simple questions that revealed profound complexities in the arrangement of economic activity. Why do firms exist? Why don't we allocate scarce resources such as radio spectrum by using markets instead of regulation? Can people resolve conflicts over resource use through bargaining and contracts, or is government regulation necessary? Is a lighthouse a public good that requires government provision? How does a durable goods monopolist price its output?

Ronald Harry Coase was born in Willesden, a London suburb, on December 29, 1910. While attending the University of London, from which he graduated with a Bachelor of Commerce degree in 1932, Coase was awarded the Sir Ernest Cassell Travelling Scholarship. This scholarship enabled him

to travel to the United States, study at the University of Chicago from 1931 to 1932 with Frank Knight and Jacob Viner, and visit several factories to learn how they organized production. In particular, his visits to Ford and General Motors factories provided an empirical foundation for his first paper, "The Nature of the Firm" (1937). He initially taught in the UK, and then his academic career saw him migrate to the US. After some years at the University of Virginia, he spent most of his career on the law faculty at the University of Chicago (starting in 1964), where he also served as an editor of the *Journal of Law and Economics*. He was awarded the Nobel Prize in economics in 1991 "for his discovery and clarification of the significance of transaction costs and property rights for the institutional structure and functioning of the economy."

His argument that firms are an organizational structure for economizing on transaction costs, both between the firm and the market and within the firm itself, led to a new field of research in industrial organization. More generally, studying the details about the organization of production set Coase on a path to develop a new approach to economic analysis by focusing on institutions. Institutions are the formal and informal ways that people structure social interactions, including formal law, long-standing customs, and informal social norms. Coase's work has given rise to an emphasis on comparative institutional analysis, in other words, looking at the performance of different arrangements in contexts from production within firms to environmental regulation. His analysis also embedded counterfactual analysis in the examination of alternative institutions, comparing the effects of an institutional arrangement with what the outcome would have been in the next most likely institutional arrangement.

In Coase's view, formal economic theory was mistaken in assuming away institutions in mathematical models, because the institutions that emerge and evolve in society have important economic origins and implications that are worthy of analysis. Coase was consistently critical of what he called a "blackboard economics" approach to economic theory that focuses on optimization models with defined constraints, not on the actual structures of interactions and relationships that underlie economic activity. In many ways Coase found this to be empty theorizing because it overlooked precisely what is economic—the diverse ways people organize production and economic activity for mutual benefit. As Coase stated in his Nobel address:

> This neglect of other aspects of the system has been made easier by another feature of modern economic theory—the growing abstraction of the analysis, which does not seem to call for a detailed knowledge of the actual economic system or, at any rate, has managed to proceed without it.… What is studied is a system which lives in the minds of economists but not on earth. I have called the result "blackboard economics." The firm and the market appear by name but they lack any substance. The firm in mainstream economic theory has often been described as a "black box." And so it is. This is very extraordinary given that most resources in a modern economic system are employed within firms, with how these resources are used dependent on administrative decisions and not directly on the operation of a market. Consequently, the efficiency of the economic system depends to a very considerable extent on how these organizations conduct their affairs, particularly, of course, the modern corporation. Even more surprising, given their interest in the pricing system, is the neglect of the market or more specifically the institutional arrangements which govern the process of exchange. As these institutional arrangements determine to a large extent what is produced, what we have is a very incomplete theory. (1992: 714)

Coase's influence is also evident in the work of his students and colleagues, such as Harold Demsetz and Steven Cheung. They applied and expanded Coase's original ideas, and in the process expanded Coase's own perception of the depth and breadth of the relevance of his work.

Coase wrote and worked until his death on September 2, 2013. Why have the ideas that he developed over an 80-year career stood the test of time? Hoffman and Spitzer summarize his widespread influence:

> We suggest that Coase's work has enduring appeal to, and insight for, social scientists in part because it addresses the most important social problem of all: solving governance and coordination problems when limited information, common resource issues, and

public good issues produce conflicts among several people at once. Social science research for the past half century has focused on examining various aspects of this central issue in particular settings. Any scholar who works on issues of corporate or common-pool governance, pollution, allocation of seats on legislative committees, regulation of systemic risk in financial markets, provision of military forces, patent thickets, creation of optimal communications networks, regulation of decreasing cost industries, or compensation of corporate officers can see his or her work stemming from several of Coase's original insights. (2011: S64)

Chapter 1

Institutions, Property Rights, and Transaction Costs

In fact, a large part of what we think of as economic activity is designed to accomplish what high transaction costs would otherwise prevent or to reduce transaction costs so that individuals can freely negotiate and we can take advantage of that diffused knowledge of which Hayek has told us.

—Coase (1992), p. 716

In all of his work Coase emphasized the importance of incorporating *institutions* into economic theory and empirical economic research. Institutions are the arrangements, the "rules of the game," that structure social interactions. They vary from informal social norms about acceptable conduct to formal law enshrined in precedent or legislation. Institutions structure social interactions in the sense that they shape the incentives that individuals face as they make decisions, decisions that can affect their own outcomes and the outcomes for other people.

One important institution for economic activity is understanding what property rights are, how they are defined, and how they are enforced. Human societies have long developed concepts of what is "mine" and "not mine" (Wilson 2020). That concept of having property in an item specifies what a property owner can do with that item—use it, change or improve it, loan it, lease its use to someone else, let it lie unused, give it, sell it. A property right is a right to take particular actions or make certain decisions about the use of a resource.

A property rights framework reflects the activities that are and are not permissible for property owners to do with their property. That framework

affects their incentives to use the resource productively over time. For example, rent control restricts how someone uses their property, which affects their incentives. Limiting the rent owners can charge limits their revenue and thus their incentive to improve the property, which is why properties often fall into disrepair under rent control. In situations where rent control legislation is very onerous or burdensome, that legislation can even induce owners to stop renting, thereby reducing the supply of rental housing and contradicting the policymaker's original intentions.

In general, a property rights framework in which rights are defined clearly and transparently, and where rights can be enforced at reasonable cost, is an institution that creates incentives for the efficient use of resources and for efficient production, consumption, investment, and innovation. Coase's insights on property rights sparked a new literature that further developed the concept of property rights theory and applying it to a variety of situations (see, for example, Demsetz (1967), Libecap (1989), and Barzel (1989)).

Another important implication arising from the property rights framework concerns transaction costs. Coase defined transaction costs as consisting of all costs of using markets, contracts, and the price system. Allen defines transaction costs as the costs of "establishing and maintaining property rights" (1999: 898). Transaction costs affect the distribution of property rights across all types of governance structures and organizations. Coase never defined transaction costs explicitly, relying instead on examples to illustrate how they affect contracts, incentives, and outcomes.

Much of a society's property rights framework depends on its formal legal institutions because legal definitions and enforcement of property rights are inputs into the specifics of property rights. Some aspects of property rights emerge out of more customary norms and conventions that societies form around property over time, but the bulk of Coase's work focuses on legal institutions, the effect of the law on economic decisions, and the role of the judicial system and legal precedent in defining property rights. Importantly, Coase stressed that various forms of government regulation, including state-owned property, are alternative ways of performing the coordinating tasks of property rights and entail their own transactions costs. Chief among these transactions costs are the barriers that regulation often puts in the way of firms that wish to

reorganize to operate more efficiently or to introduce new innovations. These costs are often unseen and, more dangerously, ignored in traditional economic analyses.

Formal legal institutions and a property rights framework affect market institutions by enabling exchange and supporting the formation of firms that will subsequently produce and offer their wares for sale in markets. Well-defined property rights are often essential precursors to mutually beneficial market exchanges, because a buyer is less likely to purchase from a seller, and an investor is less likely to put resources into perceived opportunities, to the extent that uncertainty exists about whether the seller has the right to sell or develop the item. Indeed, in the abstract, market transactions are really exchanges of rights over the use of items, as anyone who has bought or sold a house or a car realizes.

With respect to firms, one way to think about the management and organization of firms is as markets for corporate control, which uses a property rights approach to describe what firms do. The extent to which markets can emerge, can operate, and can enable participants to create value through mutually beneficial exchange, depends on whether or not the formal, informal, and property rights institutions introduce higher transaction costs or reduce them. For example, well-functioning stock markets enable firms that wish to expand to easily obtain the necessary funds by selling additional shares of ownership. In addition, share prices set on stock markets convey a great deal of information about how well or how poorly firms are currently being managed. Shares of corporations that are poorly managed will be priced lower than they would were these corporations better managed.

This institutional framework is a combination of legal institutions, a property rights framework, and market institutions, within a context of informal social norms and conventions. A society's institutional framework determines the transaction costs that citizens confront. These costs, in turn, are an important part of the incentives that individuals confront when engaging in economic activities. Whether as a producer or consumer, we can think about those outcomes as net value realized from a transaction. In this sense, institutions matter for shaping the transaction costs and incentives that lead to specific outcomes.

Institutional frameworks don't always generate beneficial outcomes; often people can attempt to improve on realized outcomes by experimenting with different actions or rules. Over time there are feedback effects from the profits and losses realized. If an institutional arrangement embeds high transaction costs that thwart potential gains, people may use that feedback to change the institutional arrangement to be more conducive to welfare creation. In many cases that reform does not happen, and those cases are important to study and understand.

Figure 1 Institutional Frameworks

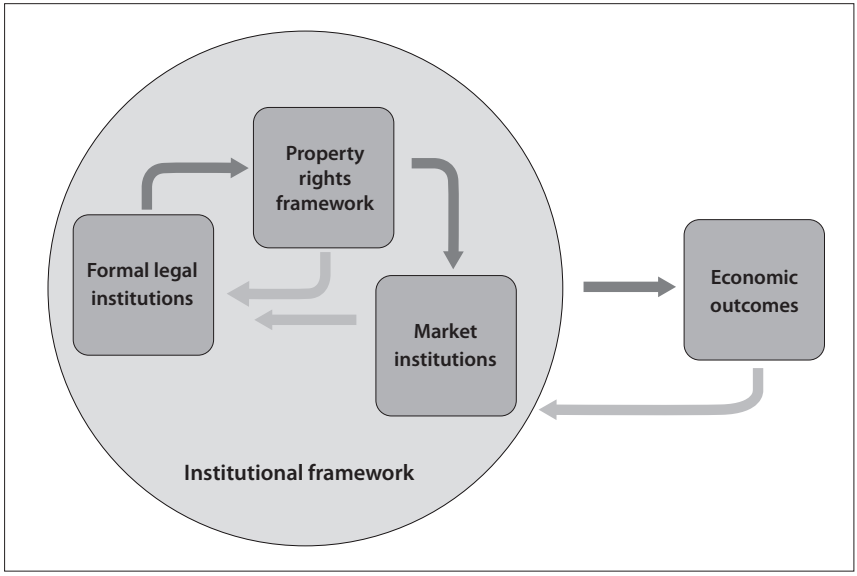


Figure 1 represents institutional relationships and consequences. The dark arrows represent how the legal institutions influence the property rights framework, which shapes market institutions. Together that institutional framework affects market outcomes. The light arrows represent how the experimentation, learning, and feedback effects from market outcomes flow back into the components of the institutional framework.

Chapter 2

Why Do Firms Exist?

[T]he operation of a market costs something and by forming an organization and allowing some authority (an "entrepreneur") to direct the resources, certain marketing costs are saved.

—Coase (1937), p. 392

Consider the operation of an ice cream shop. The owners decide what inputs to use and how to organize them. This set of decisions will have significant implications for what the shop does and how it operates as a firm. The shop requires ice cream, workers, and other inputs (such as cones, cups, and electricity) that vary depending on how much ice cream the shop sells, its operating hours, and so on. It also requires freezers, a place of business, and other pieces of capital to work complementarily with the other inputs to produce ice cream. An economic analysis of the ice cream shop as a firm could examine production costs, and it could investigate the market for ice cream to determine the most profitable prices to charge. It could also explore the firm's operational details to see how it goes about organizing its productive activities. Coase emphasized the latter.

As a 21-year old student at the London School of Economics, Coase won a scholarship to spend a year in the United States learning about and analyzing how firms organize production. This question remains one of the most profound and fundamental in economics—why do firms exist? Coase observed the contrast between markets, where individual actions and decisions are coordinated by the decentralized price system, and firms, where actions and decisions are coordinated by internal hierarchy and central planning. If spot markets using the price system to coordinate production can

maximize economic welfare, why is not all production done through spot market transactions? These two options present alternative institutional structures for the organization of production.

In the neoclassical economic theory Coase was learning in the 1930s, called the cost-based theory of the firm, economists modeled firms based on their input costs, with inputs falling into two categories: labour and capital. Having decided what to produce, firms choose combinations of inputs that maximize their profits. The neoclassical theory of the firm focuses on how firms allocate resources to their highest-valued uses and how they make profit-maximizing investment decisions over time. This theory does not explore what determines the use of hierarchies over markets, or which transactions firms choose to perform internally. It also says little about how firms as organizational structures enable innovation, or how entrepreneurship is expressed in the forms or the actions that firms take.

Coase took the opportunity to explore how firms organize production, which did not negate the cost-based theory of the firm, but rather built upon it to examine how to determine which functions should be performed within firms and which should be performed through contracts with independent suppliers, as well as how internal organizational decisions within firms are made. The article based on this research, "The Nature of the Firm" (1937), was one of the two most influential works cited by the Nobel Committee in awarding the Nobel Prize to Coase in 1991.

In response to the question "why do firms exist?" Coase answered that they exist in order to address—specifically, to keep to a minimum—transaction costs. Coase's answer unleashed a stream of influential research that is still generating new ideas today (although he did not use that phrase in his 1937 article, calling them "marketing costs" instead). Coase defined transaction costs as "the cost of using the price system" (1937: 390). A more general definition is the cost of establishing and maintaining property rights (Allen 1999: 898). As examples of transaction costs, Coase included the task of discovering what market prices are and the cost of negotiating a separate contract for each transaction. Institutions emerge to reduce those costs, but they can never be eliminated entirely. Firms still use contracts, but they are of longer duration and of a different nature:

> It is true that contracts are not eliminated when there is a firm but they are greatly reduced. A factor of production (or the owner thereof) does not have to make a series of contracts with the factors with whom he is co-operating within the firm, as would be necessary, of course, if this co-operation were as a direct result of the working of the price mechanism. For this series of contracts is substituted one. (1937: 391)

Organizing and using managerial hierarchy within the firm has costs, so the decision of what transactions to perform internally involves weighing the tradeoff between transaction costs and organization costs. That was Coase's fundamental insight.

Let's return to the economic analysis of the ice cream shop as a firm employing labour and capital to produce output. So far this model of the ice cream shop fits with the neoclassical view of the firm. Coase's insight gives us deeper understanding, by prompting questions in several dimensions around how the owners organize production. Do the shop owners make the ice cream on-site, or buy in ice cream from a supplier? If they buy ice cream, do they contract for standard flavours, or do they have the supplier make custom flavours that are unique to that shop but (perhaps) might be sold to other shops? Do they have a long-term contract with a single supplier, or do they place orders with any one of a number of multiple suppliers in a spot market when needed? When the shop hires workers, do they contract with them on a day-to-day basis, or do they enter into longer-term employment contracts?

Consider how costly it would be to have to settle on a new contract each day for each worker who comes to the shop, and for that contract to specify the tasks to be performed. Longer-term employment contracts that make the employee part of the firm typically economize on transaction costs, enabling the shop owners to schedule and plan production and the workers to schedule tasks based on more stable expectations and routines. Longer-term employment contracts also encourage firms to invest in worker training, making them more productive. But shop owners may decide not to bring all of the relevant transactions into the firm. It may be cheaper for them to specify the quality of ice cream they want and contract with a private label ice cream manufacturer

(or lease an "industrial kitchen" and hire specialized ice cream "chefs") than to buy all of the equipment and inputs to make the ice cream in their retail shop. The firm, simply responding to profit incentives, tends to discover and implement the lowest transaction costs solution, and thereby deliver quality ice cream to customers at the lowest possible price.

The basic idea is deceptively simple: transaction costs determine what a firm does in house and what inputs it buys, so firms perform functions internally that are cheaper (given a specific level of quality) for them to accomplish than through independent contracts in markets. The firms contract with others for functions that are cheaper to accomplish through markets than by organizing internally. This paradigm may seem basic, but it has sparked a wide range of research and created new fields of inquiry in economics, management, and political science.

If a firm is successful and faces sufficient demand to expand, it can expand by increasing the amount of its production, by expanding into related product lines (product differentiation), or by merging with a competitor (horizontal integration). It can also integrate backward by producing its own inputs, or forward into more finished goods and marketing (vertical integration). Coase argued that the comparison between transaction costs and organization costs determine the size and boundaries of the firm as well as the extent of vertical integration.

> [A] firm will tend to expand until the costs of organising an extra transaction within the firm become equal to the costs of carrying out the same transaction by means of an exchange on the open market or the costs of organising in another firm. (1937: 395)

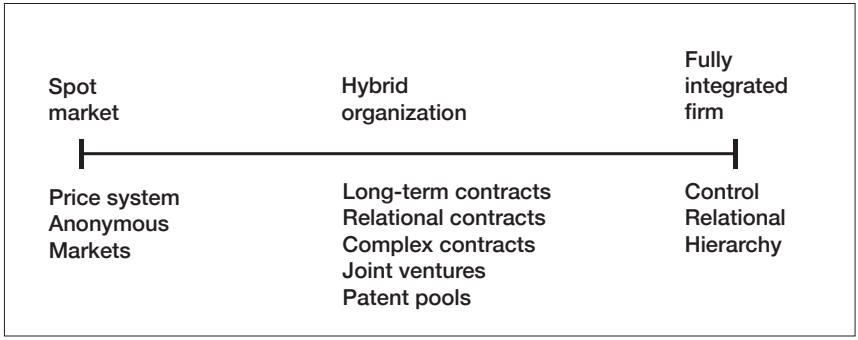
Note how this theory uses the fundamental economic idea of evaluating opportunity costs at the margin, which Coase embeds in all of his work. As an alternative to integration into a firm, Coase pointed out that long-term contracts can avoid some transaction costs and can be attractive to risk-averse parties—but they still have the risks associated with imperfect foresight and forecasting. Thus, contracts are necessarily incomplete and cannot cover every possible circumstance that could arise in a production relationship.

Throughout his career Coase viewed Adam Smith's pioneering ideas as important insights. In the idea that transaction costs determine a firm's boundaries, Coase built on Smith's foundations. Smith grounded his economics in the division of labour, and the idea that by specializing in a task and working with others who are specialized in complementary tasks, people can be more productive, be wealthier, and create economic growth. In "The Nature of the Firm" Coase takes this idea of specialization and asks where and how specialization occurs, and how specialization affects which functions are best accomplished within the firm and which are best accomplished through contracts in markets. Specialization and organization are two dimensions of the same question of how best to organize production.

Coase's introduction of transaction costs and organization to the theory of the firm initiated new work in industrial organization, leading to new fields of transaction cost economics (TCE), organizational economics, and new institutional economics, now broadly called institutional and organizational economics (IOE). IOE focuses on governance institutions and their diversity in organizing production relationships, enabling organizations to adapt to unknown and changing conditions, to protect their investments in assets specific to that relationship, and to harmonize the interests of the parties in the relationship.

Figure 2, adapted from Shelanski and Klein (1995), shows the continuum of diverse governance institutions for organizing production, from open spot markets to fully integrated firms. IOE research building on Coase (1937) has expanded the analysis of hybrid methods of organization beyond long-term contracts to include relational contracts that are informal relationships held together by the expectation of future value, as well as other forms of hybrid ownership and control.

Figure 2 The IOE Continuum



Since the 1970s, TCE/IOE research on governance institutions in a variety of settings has grown. One fundamental research topic in this area is the "make or buy" decision. Should a firm make its own inputs, or buy them from a specialized external supplier? This question is relevant in a wide range of industries and applications, from truck manufacturing to information technology to winemaking (and even ice cream shops). The make-or-buy decision is a decision about the degree of vertical integration in a firm's structure. Why do some firms vertically integrate while others do not, even in the same industry? Building on Coase (1937), the tradeoff between transaction costs and organization costs is the starting point for such investigations. Vertical integration provides a means of coordinating production, but substitute institutional choices exist, such as long-term contracts or other hybrid forms of organization. This literature has delved deeply into those alternatives (Klein, 2005).

TCE theories of vertical integration and the make-or-buy decision draw heavily on the work of Oliver Williamson, who was awarded the Nobel Prize in 2009 for his pioneering work in developing TCE in the 1970s and 1980s. Williamson argued that the neoclassical theory of the firm treated the firm as a black box, an observation consistent with Coase's earlier work. Williamson opened that black box and created TCE, introducing governance within the firm as a topic for economic analysis (Tadelis, 2010). This research starts to answer the question of which transactions occur within firms and which within markets. Governance in firms involves hierarchy, increased complexity, and control, so within-firm transactions will be those that, at the margin, benefit

from additional control. Such governance can provide benefits in two general categories—it can enable people in production relationships to adapt better in the face of imperfect foresight, and it can enable them to make longer-term commitments of relationship-specific assets that they might otherwise not make. Analyzing governance institutions takes the idea that incomplete contracts are pervasive and unavoidable and the analysis examines how people manage that incompleteness. Even market contracts can be complex, with short-term and long-term contracts achieving different objectives, so the study of governance institutions applies to market relationships as well.

Relationship-specific assets, also called asset specificity, play a large role in TCE research. Suppose, for example, that our ice cream shop owners want a particular shape of cone to be their signature way of serving ice cream, embossed with their logo. Their make-or-buy decision is whether to make the cones or to contract out cone production to a supplier. If they contract out, do they provide the machinery to make the logo-embossed cones, or does the supplier purchase the asset? If the supplier purchases the machinery, and it is expensive and can only be used to make cones for that single firm, the supplier will want a long-term contract to ensure that it earns what it considers to be a sufficient return on its investment since it cannot use that machinery in any other production relationship. The ice cream shop owners, though, are concerned that the supplier, knowing how essential its work is to the firm, might hold out for a larger share of the economic pie that arises from cone sales (also known as "the holdup problem"). Given that contracts are incomplete, writing a long-term contract that negotiates a mutually beneficial split of those rents might be difficult (in other words, transaction costs exist). Hence, the more profitable arrangement may be for the ice cream shop owners to buy the machinery, hire employees from the supplier, and make the signature cones themselves.

More generally, a cooperative production relationship generates value that the parties did not (or could not) allocate in advance in their contract and which they have to divide between them. The contractual incompleteness gives each one an opportunity to try to get a bigger share of the pie, and they exert effort to do so, so it may be that vertical integration proves to be less costly

because it eliminates the incentive to behave opportunistically (Monteverde and Teece, 1982).

The most commonly cited application of this idea is the analysis of the relationship between General Motors and Fisher Body in the 1920s from Klein, Crawford, and Alchian (1978). General Motors had a 60 percent ownership stake in Fisher Body, which made closed car bodies for GM and other manufacturers and had considerable autonomy in decision-making in its relationship with GM. To accommodate Fisher's production process, GM had to make some very costly investments in production machinery and processes that would have become obsolete had GM switched to another body supplier. Klein, Crawford, and Alchian used this relationship as an example of the potential cost of the holdup problem that GM would bear. The holdup problem arises when party A depends upon party B to perform some action, but party B—knowing that party A has become dependent on B to carry through with the action—threatens not to complete the action unless party A pays more than was originally agreed to by party B.

This specific case ultimately resulted in GM acquiring Fisher Body in 1926 and vertically integrating into auto body production. With the producer of automobile engines and chassis now also owning the maker of automobile bodies—that is, with both operations owned by GM—there was obviously no incentive for one "division" to try to hold up the other. However, the Klein-Crawford-Alchian interpretation of this history as resulting from a holdup problem remains controversial, with a lively debate resurfacing in 2000 that included further research from Coase. As Peter Klein notes,

> Klein, Crawford, and Alchian (1978) and Klein (1988) cite the case as a classic example of vertical integration designed to mitigate holdup in the presence of asset specificity. Fisher refused to locate its plants near G.M. assembly plants and to change its production technology in the face of an unanticipated increase in the demand for car bodies, leading G.M. to terminate its existing ten-year supply contract with Fisher and acquire full ownership. Coase (2000), revisiting the original documents, argues instead that the contract performed well, and was gradually replaced with full ownership

only to get Fisher's top managers (the Fisher brothers) more closely involved in G.M.'s other operation.… In short, G.M. did not acquire the remaining 40 percent of Fisher's stock in response to an inappropriate alignment between transactional attributes and an existing governance structure. Rather, the long-term contract signed in 1919 was adequate for mitigating holdup in the face of asset specificity and uncertainty, and was replaced by vertical integration for secondary reasons. (2005: 446)

Chapter 3

Resolving Disputes: The Problem of Social Cost

The question is commonly thought of as one in which A inflicts harm on B and what has to be decided is: how should we restrain A? But this is wrong. We are dealing with a problem of a reciprocal nature. To avoid the harm to B would inflict harm on A. The real question that has to be decided is: should A be allowed to harm B or should B be allowed to harm A? The problem is to avoid the more serious harm.

—Coase (1960), p. 2

A town has a river running through it, with a running path and park along the river, a boat launch for kayaking and fishing, a water treatment facility, and a paper mill (see Yandle 1998). The paper mill produces products and sells them to consumers who value the products. This transaction defines the mutually-beneficial interaction between parties at the heart of human exchange. The paper firm earns profits from paper sales when its revenues exceed its costs, and paper consumers earn net satisfaction when they derive more benefit from the paper than the cost to them of purchasing it. Both parties weigh benefits and costs in making their choices over resource use.

If we examine the paper mill's production more closely, though, we see some costs that may not be reflected fully in the accounting costs we typically associate with such a calculation. For example, producing paper generates waste by-products. The firm competes for consumers' business, so it has strong incentives to minimize costs. Disposing of waste is costly, so the paper firm has an incentive to discharge its waste into the river if it can do so at no cost. That waste depletes oxygen in the water and is unattractive, so the

company's "free" waste disposal may create costs that other river users have to bear. But because the paper firm does not pay for disposing of its waste in the river, neither the producer nor the consumer of paper, the two parties to the market transaction, bear that cost. Instead, the cost shows up in diminished enjoyment of the riverside park, less pleasant kayaking and reduced fishing, a lower quality ecosystem due to depleted oxygen, and additional costs of treatment for water consumption.

Coase called this problem "the problem of social cost" and wrote an article of the same name on the topic in 1960. How can people resolve conflicts over resource use when that use creates costs for people who are not party to the transaction? Coase used his approach of examining how people resolve such conflicts in reality to look at the history of how disputes were resolved in English common law, from grazing cattle eating a neighbouring farmer's crops to industrial smoke harming nearby residents. One famous case is *Sturges v. Bridgman* (1879). In that case, a London confectioner used heavy machinery to make candy. The confectioner's neighbour, a doctor, built a new room in which to see his patients. But the new room was subject to noise and vibrations from the candy-making machinery, which made it difficult for the doctor to use his own equipment with his patients. This case shares some of the same features as the above case of the paper mill on the river—conflicting uses of a shared resource—in this case, the surrounding air, which is being affected by noise and vibration.

Coase's impetus to explore this question arose from the work of A.C. Pigou (1920), who in the 1920s developed much of the theory of welfare economics, which is still in use today. In the paper mill situation, Pigou's "external cost theory" would start from the point that the paper mill is creating a cost and imposing it on others who are not party to the paper-making transaction. Therefore, the paper mill should pay for the harm associated with that cost. Pigou's analysis implied a specific policy recommendation, specifically, a tax on paper to reflect the per-unit cost of the discharge into the river, or a regulation on the paper mill to induce it to incorporate the cost of its discharge into its accounting. Applying the same logic to *Sturges v. Bridgman* would result in an injunction on the confectioner, such as restricting the times of day he could

operate his machinery. This logic has come to be known as "polluter pays," or that a party that creates a cost should be the one to bear it.

Coase looked at such problems differently, asking instead what the least-cost way of dealing with this problem was, assessing it as a problem of a conflicting use of a resource. This way of thinking about the problem identifies its property rights origins. While Pigou implicitly assumed that the "non-polluter" party has the right to be free from this harm, Coase instead acknowledged that in such cases the property rights definition is not necessarily clear, and that transaction costs limit the ability to define and enforce property rights.

The external cost problem

A related difference in Coase's approach to the problem of social cost is to see the external cost problem as a *reciprocal* problem. In Pigou's analysis, the paper mill creates the waste discharge, the confectioner creates noise, and those actions impose costs on others. Coase argued that this framing of the problem is incomplete, because it misses the fact that the parties impose costs on each other precisely because they have different uses of the shared resource when property rights are not sufficiently well-defined. The paper mill wants to use the river to discharge waste, while the water treatment plant wants clean water to process for consumption, and the kayaker wants an attractive and clean river for recreation. At its core the problem of social cost is a dispute over property rights: "For Coase, natural resource and environmental protection problems typically arise when there is a need to balance these conflicting interests. Whether an actor or group of actors is the 'victim' or 'perpetrator' of an 'externality' is fundamentally a question of who has the rights to engage in the activity concerned and if they wish to trade such rights for compensation" (Pennington 2015: 95). Coordination is difficult, and valuable resources become dissipated, because ownership is undefined. With there being no owner of the river (or the water that flows through it), the pollutant-emitting mill does not pay for the costs it imposes. Hence, bargaining over resource use, where the highest bid for the resource is identified, does not occur. The harmful effects from paper production may destroy clean water—even if clean water has a much greater social value.

Continue to consider the paper mill and the water treatment facility. The two parties can identify each other and the conflicting uses each wants to make of the river, so they can come together and figure out a mutually agreeable way to adjust their uses of the river. In the process of that bargaining, they identify a set of ways to do so, one of which is probably less costly than the others. Suppose they decide that the best way to deal with the waste is for the paper mill to install a new filter. Coase argued that bargaining is a process that enables parties to learn and discover and to create through innovation lower-cost ways of mitigating such costs. In contrast, the Pigouvian approach presumes that the regulator knows the relevant costs and benefits well enough to determine the exact tax to impose to elicit the exactly optimal amount of paper production. That presumption is unrealistic, as Pigou came to acknowledge later in his life.

After figuring out the best way to deal with the harm, the next logical question is, who pays for the filter—the water treatment facility or the paper mill? Where the law establishes property rights, it will be clear. If the mill has the right to pollute, the water treatment plant will pay. If the water treatment plant owns the water, the mill pays. Both parties have incentives to cooperate in enacting this solution if the cost of stopping the pollution is less than the value gained by allowing it to continue. Crucially, this is also the requirement for societal gains–that the benefits exceed the costs.

When property rights are ill-defined or transaction costs are high

Coase noted that such straightforward solutions might not unfold in cases where decision-making is decentralized, i.e., where property rights are not defined or in instances where transaction costs have kept the parties from making efficient bargains. In those instances, Pigouvian policies, such as a regulation mandating that paper mills install filters, might prove superior. But neither the market negotiation nor the regulatory approach is free. The two approaches should be compared and contrasted for their ability to foster social coordination, maximizing the value of the resources involved. We can think of a Coasean bargaining as a knowledge-generating process of negotiating mutually beneficial transfers of rights between parties.

Coase's insight builds on his earlier work by connecting transaction costs to the costs of defining and enforcing property rights—when defining

property rights is prohibitively costly or not feasible (as in, say, air pollution), bargaining to negotiate transfers of rights cannot happen. Property rights definition and enforcement costs are a category of transaction costs. Situations with low transaction costs are more likely to see welfare-enhancing bargaining, while high transaction costs can prevent such conflict resolution. An example of Pigou's that Coase discusses for other reasons illustrates the challenge of transaction costs: the operation of a railroad through rural land in the 19th century. Railroad companies purchased land and built rail networks to run trains pulled by coal-fired steam locomotives, which threw off sparks that could cause fires that destroyed some adjoining crops or woodlands. In a situation such as the transcontinental railroad in the United States, the railroad company operated over thousands of miles and could potentially emit sparks on land owned by thousands of different farmers. This situation and others like it present a considerable transaction cost challenge, one that is common in many situations where there is a conflict in resource uses.

In order for the farmers to bargain with the railroad over the rights to emit sparks and the rights to unharmed crops enough farmers would have to gather together to represent the interests of all affected farmers—in other words, the transaction costs would be high. In situations like these, the courts determine which party has legal liability for harms created, and enforce compensation if necessary. An overarching theme of Coase's work on social cost is that transaction costs are pervasive. Because of that pervasiveness courts are important institutions whose decisions have implications for both the efficiency of outcomes and the distribution of profits across parties. The law is an institution that can act to clarify property rights, as Coase notes in his Nobel address:

> If we move from a regime of zero transaction costs to one of positive transaction costs, what becomes immediately clear is the crucial importance of the legal system in this new world. I explained in "The Problem of Social Cost" that what are traded on the market are not, as is often supposed by economists, physical entities, but the rights to perform certain actions, and the rights which individuals possess are established by the legal system. While we can imagine in the hypothetical world of zero transaction costs that the parties

> to an exchange would negotiate to change any provision of the law which prevents them from taking whatever steps are required to increase the value of production, in the real world of positive transaction costs, such a procedure would be extremely costly and would make unprofitable, even where it was allowed, a great deal of such contracting around the law. (1992: 717)

Courts have an information problem, though: they may not possess all of the knowledge they need to be able to identify which party can avoid the harm at least cost, which is one reason why transaction costs influence outcomes. In a low transaction cost setting, parties can bargain to exchange rights to rearrange them if the court's assignment doesn't reflect the best feasible assignment of rights and liabilities ("contracting around the law" in Coase's words). When courts assign rights and liabilities in the presence of positive (and high enough) transaction costs, though, that assignment could prevent parties from reaching the efficient outcome because transaction costs prevent the parties from bargaining to exchange those rights and liabilities (Pennington, 2015: 97). In the farmer-railroad scenario, if the court assigned the right to emit sparks to the railroad and the cost of sparks to farmers was higher than their benefit to the railroad, then the efficient outcome would be for the farmers to pay the railroad to reduce their sparks. But the high transaction costs of organizing farmers to discover how high their cost is and to bargain with the railroad could prevent the transfer of rights to resolve the conflict.

The Coase Theorem

While Coase focused on the pervasiveness of transaction costs, his colleague George Stigler interpreted Coase's emphasis differently (see Posner's (2017) discussion). Stigler articulated what he called "the Coase Theorem": when transaction costs are zero, the specific assignment of legal liability or the definition of property rights does not change the ability of parties to achieve the most efficient outcome, although it will change the *distribution* of realized costs and benefits. In a situation where there are no transaction costs, the precise definition of property rights does not affect the ability of the parties to find the efficient distribution of rights and efficient use of the resource. In

that setting, the only effect that the specific property rights definition has is on the distribution of costs and benefits, not on the ability to achieve the most efficient outcome. Using the paper mill and water treatment plant example, if the efficient outcome is for the paper mill to install a filter, if they face no transaction costs then discovering that efficient outcome through bargaining is easy and costless. What the court's definition of rights and liabilities does in this case is to determine who pays for the filter that the paper mill installs.

Although Stigler's Coase Theorem has gathered considerable attention over the past four decades, it rather misses Coase's point that courts and legal precedent are important precisely because transaction costs are pervasive and often high enough to prevent mutually-beneficial exchange. "The So-Called Coase Theorem" (McCloskey, 1998) also misses the point to the extent that Coase's emphasis was not on idealized models with transaction costs assumed to be zero, but was entirely on real-world situations where coordination has to create feasible institutional frameworks to manage conflict resolution in the presence of positive transaction costs. Although ~~it~~ the Coase Theorem provides a concrete theoretical benchmark, focusing on the unrealistic zero transaction cost case is a bit too close to the "blackboard economics" that Coase so criticized.

"The Problem of Social Cost" is one of the most influential and widely-cited articles in economics, and its influence extends beyond economics and into law. Coase himself did not see the broader implications of his analysis; he was concentrating solely on the narrow application of his ideas to critiquing Pigou's externality theory:

> I should add that in writing this article I had no such general aim in mind. I thought that I was exposing the weaknesses of Pigou's analysis of the divergence between private and social products, an analysis generally accepted by economists, and that was all. It was only later, and in part as a result of conversations with Steven Cheung in the 1960s that I came to see the general significance for economic theory of what I had written in that article and also to see more clearly what questions needed to be further investigated. (1992: 717)

The ideas Coase developed formed a foundation for the then-new field of law and economics, and created a research agenda for both law and economics and the field of property rights economics that would emerge in the 1970s. Those ideas have also been influential in environmental and natural resource economics by providing a rich theoretical framework for considering policy alternatives to command-and-control regulation or Pigou-style taxation.

The pervasiveness of transaction costs includes difficulty defining property rights, so there are resources and contexts in which groups of people use resources communally and have to figure out how to make the best use of them. Elinor Ostrom pioneered the comparative institutional analysis of situations with common pool resources, for which she was awarded the Nobel Prize in Economics in 2009. Consider the example of an agricultural village with an irrigation network, a situation that Ostrom analyzed in her 1990 book, *Governing the Commons*. If digging private wells and self-irrigating is either too costly or not feasible for individuals, then the people in the village will benefit from the alternative arrangement of a shared irrigation network. But in a shared network the villagers run into the problem that each of them has an incentive to draw as much water as possible, which can lead to scarcity and waste because the irrigation network is a common-pool resource. Ostrom identified the fundamental cause of the incentive problem as a lack of well-enough defined (imperfectly defined) property rights. In combining extensive field work and data with game theory (the irrigation situation is an example of a Prisoner's Dilemma, i.e., individuals in a group choose to act in their own self-interest—at the expense of the others—which does not produce the best outcome for everyone), Ostrom's insight was that the villagers evolved an institutional framework that enabled them generally to avoid the "tragedy of the commons,"—to avoid scarcity and waste—by developing a system of use rights to the common pool. To do so, they use governance to make the best possible use of the resource. This field of comparative institutional analysis builds on the institutional and transaction cost foundations in Coase's work, and applies Coase's approach of examining how people actually arrange their transactions, find approaches to reducing conflict, and develop welfare-enhancing governance institutions as a result.

Chapter 4

Applied Transaction Cost Economics: Spectrum Allocation

Certainly, it is not clear why we should have to rely on the Federal Communications Commission rather than the ordinary pricing mechanism to decide whether a particular frequency should be used by the police, or for a radiotelephone, or for a taxi service, or for an oil company for geophysical exploration, or by a motion-picture company to keep in touch with its film stars or for a broadcasting station. Indeed, the multiplicity of these varied uses would suggest that the advantages to be derived from relying on the pricing mechanism would be especially great in this case.

—Coase (1959), p. 16

We use the electromagnetic radio spectrum constantly, for radio, television, wireless internet, navigation, and many other applications. Innovative uses of that spectrum since the 1990s, which have greatly improved our lives, arose in part from policy changes with deep roots in Coase's work. An important policy application of Coase's ideas on institutions, property rights, and transaction costs is the allocation of radio spectrum using spectrum license auctions. More specifically, Coase's work has led to market-based allocation of radio spectrum rather than administrative allocation, and to the liberalization of the property rights that are conveyed in those licenses. This liberalization has enabled extensive innovation and market complexity.

Radio waves are electromagnetic waves with a range of frequencies (measured in megahertz, or millions of cycles per second). The radio "spectrum" is the set of these frequencies. Different parts of the spectrum, with different wavelengths, are suitable for different uses, and have been divided

accordingly — broadcast radio, short wave radio, television, mobile phones, wireless internet, the Global Positioning System, and so on. If multiple users are too close to each other and try to use the same frequency (for example, two FM radio operators broadcasting at 93.1 megahertz), the interference between them would disrupt both broadcasts, and that frequency would not be put to its best use. Users of the radio spectrum must leave enough space between frequencies to avoid interference. Since the origins of broadcast radio in the early 20th century, new technologies have radically altered the interference problem, continually creating new opportunities for communication, but simultaneously, generating new demands that drive conflicts.

Commercial uses of spectrum started around the turn of the 20th century for ship-to-ship and ship-to-shore communications. In 1912, concerns about maritime safety led to legislation requiring radio stations to have federal Department of Commerce-issued licenses. With the introduction of broadcasting in the 1920s, spectrum scarcity became a problem (Hazlett, 1990). Political conflicts arose over how to govern the use of the spectrum. (Most strikingly, the Navy argued for a government monopoly under their control.) Congress passed legislation in February 1927, establishing the Federal Radio Commission (FRC). The FRC created and granted licenses according to "public interest, necessity, or convenience" (Coase, 1959: 14).

Spectrum license lotteries

In 1934 the FRC's regulatory jurisdiction was transferred to the new Federal Communications Commission (FCC), which to this day regulates radio, television, wire, satellite, and cable communications in the United States. Between 1927 and 1981, the FRC/FCC awarded licenses using comparative public interest hearings, a process that according to the US Congressional Budget Office "weighs the relative merits of the contending applicants"—and a process that telecommunications economist Thomas Hazlett called "socially wasteful and politically charged" (1998: 530). In 1981 the FCC switched from the hearings to using lotteries to allocate spectrum licenses, which de-politicized the process but did not ensure efficient license allocation and continued the process of wasteful rent seeking (as lottery applicants had to fill out voluminous documents to establish their "public interest" credentials).

Up until the switch to the lottery system, and worried about interference, the FCC did not issue "spectrum licenses" granting permission to use a given bandwidth, but very specific authorizations that mandated the service, technology, and business model to be used. This decision greatly restricted competition among licensees; in addition, many potential competitors were denied licenses. The result was a cartelization of wireless markets via government regulation. Substantial profits accrued to those who succeeded in the comparative public interest hearing process, while the radio spectrum was underused compared to its capacity. Innovations were thwarted as no market in spectrum existed: new applicants or networks had to apply for permission to use part of the spectrum from the FCC—and they were dependably opposed by incumbent operators and the regulators rarely granted permission. In the face of technological progress in electronics, the social burdens of these restrictions grew substantially over time. Had entrepreneurs been able to buy spectrum rights, wireless innovations bringing new products and services to market could have competed for consumers. Instead, these new value-creating opportunities were all too rarely realized.

In 1959 Coase published "The Federal Communications Commission," an article that explained the institutional and historical background of the development and use of radio spectrum in the United States since the 1910s. After describing this background (summarized above), Coase asked if there was a feasible way to allocate the use of radio spectrum to create the most possible value out of it, which the then-current public interest hearings method did not accomplish. The policy objective should be not to minimize interference along the spectrum, but to maximize output from the spectrum, treating interference as a constraint to be managed (or something that innovation would reduce). Why not define a property right in a specific part of the spectrum for each user, and make those rights tradable? Coase here followed the suggestion of Leo Herzel (1951), who proposed defining spectrum ownership rights and allocating them through auctions.

Coase claimed that despite arguments to the contrary, the scarcity of spectrum does not necessitate its administrative allocation, ongoing regulation, or government ownership. Coase identified the core of the spectrum allocation

problem as ill-defined property rights, and drew analogies between spectrum and land:

> We know from our ordinary experience that land can be allocated to land users without the need for government regulation by using the price mechanism.… If one person could use a piece of land for growing a crop, and then another person could come along and build a house on the land used for the crop, and then another could come along, tear down the house, and use the space as a parking lot, it would no doubt be accurate to describe the resulting situation as chaos. But it would be wrong to blame this on private enterprise and the competitive system. A private-enterprise system cannot function properly unless property rights are created in resources, and, when this is done, someone wishing to use a resource has to pay the owner to obtain it. Chaos disappears; and so does the government except that a legal system to define property rights and to arbitrate disputes is, of course, necessary. (1959: 14)

Why use markets? Markets reveal the opportunity cost of the license and factor that opportunity cost into the decision-making of incumbent and entrant license holders. A right to use a frequency would have to be defined precisely in order to be transacted (Coase, 1959: 25).

Section V of his "Federal Communications Commission," article foreshadows arguments Coase would make the following year in "The Problem of Social Cost." In the spectrum allocation situation as well as the more general argument made a year later, Coase shows that clearer property rights definitions can reduce conflicting uses of resources.

Coase's recommendation fell on deaf ears for decades, in part because spectrum licenses are complex, those holding scarce licenses did not want competition, and designing and testing the auction rules is an important precursor to success. Auctions were bitterly opposed by television broadcasters and by the leaders of the committees in Congress who supervised the FCC.

The move to spectrum license auctions

Thirty-four years after Coase proposed using markets to allocate spectrum, Congress passed legislation allowing non-broadcast spectrum licenses to be allocated using auctions. Licenses for the most valuable bandwidth are "flexible use" licenses, where the specific use is not stipulated in the license. The FCC moved away from the lottery system and began spectrum license auctions in 1994. Each license was defined by a particular frequency and geographic location. As a result of the liberalization of property rights in the licenses and their allocation by auctions, market participants now determine how airwaves are used and how interference conflicts are managed.

Early auctions covered mobile phone frequencies, and mobile operators interested in building a network would bid on several licenses. Depending on which licenses they got, the subjective value of other licenses could change, and efficient allocation entailed changing their bids to reflect that changing value. Moreover, as a new market, price discovery was important yet there were few comparable markets, so an information-rich auction design helped facilitate price discovery (it could also facilitate collusion, but Cramton (1996) found little evidence of meaningful collusion). Several auction theorists collaborated to design a new auction for these early spectrum auctions, called a "simultaneous multiple round auction" (SMRA) (McMillan, 1994). In an SMRA, participants bid simultaneously on the set of available licenses, and bids are observable to all participants. Each round is timed, and licenses with multiple offers have their prices increased in the next round. Bidding continues until all licenses have no further bidding activity. Simultaneous bids combined with multiple rounds enable participants to move among licenses to create the license combinations to build their networks.

The SMRAs were successful at efficiently allocating licenses, getting licenses in the hands of operators who could build out the cellular networks that helped transform our economy into a digital one. Since 1994, spectrum auctions have created new, valued products and services, enhancing economic welfare and enabling communications firms to profit from creating innovative uses of the radio spectrum. They have also created considerable revenue for the federal government (see Hazlett, Porter, and Smith, 2011, and Hazlett, 1990 for overviews of Coase's influence on spectrum license property rights).

The SMRA is prone to a problem called the exposure problem. Many licenses are complements to each other in creating a viable network, and at the end of the auction an operator might lack some essential licenses to enable business viability. That complementarity means that the licenses have interdependent values. In 2006 Ausubel, Cramton, and Milgrom (2006) introduced a combinatorial clock auction that enabled participants to incorporate these complementarities and reduce the exposure problem while retaining the beneficial features of the SMRA. Revised combinatorial clock auction designs are now used widely worldwide (Milgrom, 2019: 392).

Coase's 1959 analysis did not delve into the particular details of auction theory or market design. Rather, he provided a detailed institutional description and analysis of the existing license allocation method, identified the loss of economic welfare arising from that institutional arrangement, and asked the deceptively simple question: why not use markets to allocate use rights to different frequency bands in the spectrum? He argued that government planning of spectrum allocation was unnecessary, and that flexible rights issued to competitive market participants would be a better approach. The digital world we inhabit today has been built in part on the innovation unleashed by competitive spectrum license auctions.

Chapter 5

Applied Transaction Cost Economics: Emission Permit Trading

If factors of production are thought of as rights, it becomes easier to understand that the right to do something which has a harmful effect (such as the creation of smoke, noise, smells, etc.) is also a factor of production.… The cost of exercising a right (of using a factor of production) is always the loss which is suffered elsewhere in consequence of the exercise of that right—the inability to cross land, to park a car, to build a house, to enjoy a view, to have peace and quiet or to breathe clean air.

—Coase (1960), p. 44

Together, three of Coase's most influential works, "The Nature of the Firm," "The Federal Communications Commission," and "The Problem of Social Cost," create a coherent theory about the relationship between property rights and transaction costs and the institutional implications of those relationships. Transaction costs, that is, the costs of defining property rights, shape incentives and how we organize the use of resources. As the example in the previous chapter of spectrum license auctions shows, these ideas have significant policy implications, even if their implementation takes decades. The use of emission permit trading in the United States to reduce air pollution is another example; it too, has long-lasting and great beneficial effects. The design of the emission permit trading program has several Coasean features, particularly the emphasis on institutional design to reduce transaction costs.

In 1970 the US Congress passed the Clean Air Act (CAA), enacting regulatory standards for a specific set of emissions. Geographic areas were required to meet specific National Ambient Air Quality Standards (NAAQS), and companies that were the sources of emissions faced limits on their emission rates and regulation of the particular technologies that could be used in production processes. One of the "criteria pollutants" regulated under the CAA was sulphur dioxide (SO_2), produced primarily from burning coal to generate electricity. When airborne SO_2 combines with water, sulfuric acid is the result; it falls as acid rain and harms aquatic life, trees, and the carved faces of sculptures on buildings. Airborne SO_2 also causes respiratory illness and consequent health costs. The CAA regulations led power plant owners to build tall smokestacks to reduce local SO_2 emissions, but that SO_2 entered the jet stream and was transported to other regions where the resulting acid rain caused harm. The CAA regulations had not reduced the harms associated with SO_2 emissions, but had relocated them, and many areas were still not meeting the CAA's air quality standards. Economists working on environmental policy suggested a different approach.

Emission permit trading

This different approach was emission permit trading. Emission permit trading built on a "netting" program that the Environmental Protection Agency (EPA) had established in the mid-1970s to allow new sources of SO_2 in a region if they purchased emission credits from an existing source in the region. However, that program had substantial bureaucratic requirements that created high transaction costs (Tietenberg, 2010: 362). The EPA worked with economists to design a market for SO_2 emission permits, or allowances. The design of this new market was also part of the process of negotiating the Clean Air Act Amendments (CAAA), which Congress passed in 1990 and authorized the EPA to design and administer. Title IV of the CAAA aimed to reduce SO_2 levels by 10 million tons from their 1980 levels in a decade, implemented in two five-year phases. (In 1985 electricity generation accounted for around 70 percent of SO_2 emissions in the US and coal-fired power plants accounted for 96 percent of that amount.)

The design of this program, called the EPA Acid Rain Program, involved considerable bargaining and its implementation was extremely detailed.

Focusing on the most essential design details indicates how important Coase's ideas were for the design and the ultimate success of the program. The Acid Rain Program included several innovative features (see Stavins, 1998; Ellerman et. al., 2000; and Sandor, 2012). The CAAA targeted a total national quantity of SO_2 emissions rather than individual source emission rates or technologies. It laid out an emissions reduction timeframe to meet the target in 2000. The total quantity, or cap, declined over time to deliver more emissions reductions. In Phase I (1990-1995), the 263 largest SO_2-emitting coal-fired power plants were required to reduce their annual emissions every year. In Phase II almost all fossil fuel-fired power plants were subject to the national emissions cap. The EPA used a formula to determine each plant's allowable emissions, and each plant received emission allowances based on its historic emission rates (so that it could not manipulate its current emissions to affect its allowance allocation).

The mechanism for meeting the Phase I and II requirements was trading emission allowances. Utilities would be required to have emission allowances, each of which permitted the owner of the allowance to emit one ton of SO_2 in the year it was issued or in any subsequent year. If annual emissions exceeded allowable emissions, the utility had three choices: use an allowance it already owned, abate (i.e., reduce emissions), or purchase an allowance. If emissions were below allowable emissions, the utility could sell the difference. The number of annual allowances decreased over time, tightening the cap and ensuring emission reductions. This "cap-and-trade" system created incentives for utilities to find the least-cost ways to reduce SO_2 emissions.

Parties could trade the allowances through the annual auction market the EPA established at the Chicago Board of Trade, as well as through private market transactions. Electricity generators were not the only parties allowed to participate in the allowance market; brokers speculating on a future price increase could purchase allowances and sell them later, and environmental groups could purchase them and retain them, which would ensure that that ton of SO_2 was never emitted. The program also had a voluntary participation option. In addition, some allowances were auctioned to utilities in every year in a "revenue-neutral" auction.

One aspect of better-defined property rights and lower transaction costs is using technology to do so. The EPA developed a continuous emission

monitoring system and implemented it in the Acid Rain Program, enabling it to verify the amounts utilities entered into the allowance tracking system. Using technology to reduce monitoring costs (and backed up by a $2,000/ton penalty on any emissions that exceed allowances) facilitated exchange in ways consistent with the examples Coase used in "The Problem of Social Cost."

Seeing the emission allowance as an asset

The predominance of the market in the program design is the feature that reflects Coase's ideas, particularly his argument for spectrum license auctions. Making property rights clear and transferable in markets makes it possible to discover what the allowances are really worth, rather than having a bureaucratic process establish some estimate of the value. It created a decentralized process by which the allowances find their highest-valued uses and users.

> There were two policy options to reduce acid rain: command and control (CAC) or flexible mechanisms.… Flexible mechanisms consisted of taxes and/or subsidies, or something more dynamic like emissions trading, that is, cap-and-trade. The concept of emissions trading… had its roots in Ronald Coase's theory of social cost (fully articulated by J. H. Dales). (Sandor, 2012: 206)

In this case, as with the spectrum license, the emission permit is more of a use right than a property right, but the essential feature for value discovery and creation is that the right is transferable, which turned the regulation from a requirement into an asset.

Thinking of the emission allowance as an asset highlights another important feature of the Acid Rain Program. Allowances could be banked for use in future years, which had a considerable effect on the incentives of allowance holders. In any given year a utility had three choices for an allowance: use it, sell it, or bank it. Facing this explicit choice made the utility confront the opportunity cost of the allowance because it had to evaluate what it thought the allowance was worth in each of those three options, and then choose what it saw as the most valuable option. Different utilities viewed those options differently; in other words, their opportunity costs were subjective, and that

diversity combined with good market institutions enabled a mutually beneficial exchange of emission allowances. In the SO_2 emission reduction context, this evaluation amounted to each utility figuring out if it could abate the pollution more cheaply than the market price of the allowance, which would mean it could make money from selling the allowance and instead abating the pollution. An emission permit market created incentives for firms to figure out cheaper and more effective abatement technologies. Similarly, if they could abate more cheaply than they expected the future price of the allowance to be, they could bank the allowance to sell later, or to use later if necessary. The emission permit market made the opportunity cost of emitting a ton of SO_2 economically salient in a way that prior command-and-control regulations had never been able to do.

What are some ways to abate SO_2 pollution? It turned out that buying lower-sulphur coal from the Powder River Basin in Wyoming was a relatively low-cost way to reduce emissions and sell allowances to others, and utilities profited from doing exactly that. Coal substitution was cheaper than new generation technology (made even cheaper by railroad rate deregulation in the late 1970s) and delivered emission reductions without having to use allowances. Creating more cost-effective smokestack scrubbers also abated emissions without using allowances. As Coase had argued for spectrum licenses and in "The Problem of Social Cost," property rights and markets created incentives to innovate that economized on resource use.

The Acid Rain Program succeeded beyond the expectations of its designers. Utilities achieved emissions reduction targets ahead of schedule, and most of the areas that had SO_2 concentrations above the NAAQS saw reductions that brought them into compliance with the regulation. Some regional pollution "hotspots" occurred occasionally, but overall, between 1990 and 2004, SO_2 emissions fell by 36 percent—despite an increase in coal-fired electricity generation of 25 percent during the same period (Schmalensee and Stavins, 2013: 106).

As SO_2 concentrations fell—and even fell below increasingly tight standards—the market value of the allowances dropped and trading volume dwindled. Early banking of so many allowances provided a cushion for future technological and commercial changes and the tightening of the cap that brought

down SO_2 emissions. Most recently, the shift from coal to natural gas generation since the mid-2000s has reduced emissions further, a result of hydraulic fracturing innovations that have increased natural gas supplies. More significant, though, has been the subsequent government regulation of individual sources at the federal and state levels that has essentially closed down the SO_2 allowance market.

> Through a series of new Clean Air Act regulations, court rulings, and regulatory responses, the courts affirmed that EPA could not set up a new interstate trading system or modify the Title IV system in the absence of new legislation from Congress. In response, state-level and source-level constraints were put in place that ultimately rendered the SO_2 cap-and-trade system itself nonbinding and effectively closed down the allowance market. (Schmalenseee and Stavins, 2013: 113)

Despite the Congressional demise of the Acid Rain Program, it remains the most successful market-based pollution control initiative ever developed. Its most valuable features are Coasean: defining use rights in a shared resource, reducing transaction costs, and using markets to enable parties to discover value, create value, and innovate.

Over the past 15 years as environmental policy attention has turned to greenhouse gas emissions, the cap-and-trade design has been applied in several places (e.g., the European Emissions Trading Scheme, California's Cap and Trade program, and the Regional Greenhouse Gas Initiative in the US northeast), with mixed results. One economist involved in the Acid Rain Program, Richard Sandor, created the Chicago Climate Exchange (CCX) in 2003. Inspired by Coase, Sandor designed the CCX as a voluntary, legally binding, greenhouse gas emission reduction and trading exchange (Sandor, 2012: chps. 11 and 18). The CCX ceased trading in 2010 due to inactivity in US carbon trading.

Applying the successful Acid Rain Program emission permit market design to greenhouse gases faces significant physical, economic, and political challenges. Greenhouse gases behave differently from SO_2, and the effects are not felt locally or on a short timeframe. They are also embedded in widespread

economic activity, unlike the concentration of SO_2 emissions, which was centred in fossil fuel electricity generation. The challenges of designing and implementing carbon markets reinforce the lesson from Coase that institutions matter and are highly context-specific.

Chapter 6

Coase and the Lighthouse in Economics

I think we should try to develop generalisations which would give us guidance as to how various activities should best be organised and financed. But such generalisations are not likely to be helpful unless they are derived from studies of how such activities are actually carried out within different institutional frameworks… by showing us the richness of the social alternatives between which we can choose.

—Coase (1974), p. 375

Since the 19th century economists have routinely posed the lighthouse as an example of a *public good*. Ships coming in to port benefit from lighthouse services. Ships cannot individually be excluded from using the lighthouse if they have not paid for it, so the public good argument suggests that ships will free-ride on the payments of others for the provision of the lighthouse. If the free-rider problem is extreme, then there won't be enough lighthouses, or any at all. For that reason, economists starting with John Stuart Mill in 1848 and most notably Paul Samuelson, who formalized public good theory in 1954, concluded that public goods should be supplied by governments and paid for through taxation. Coase was dissatisfied with this treatment of public goods, and in "The Lighthouse in Economics" (1974) he laid out his critique and an alternative analysis.

In economics, "public goods" has a precise technical definition—a public good is both non-excludable and non-rival. Non-excludable means that a person cannot be prevented from consuming the good if they don't pay, and non-rival means that adding more consumers does not reduce the

amount of the good available for others. National defence is the closest thing to a pure public good because national defence protects everyone in a country, not just taxpayers, and adding more people to the country does not diminish the amount of defence available to others to consume (the marginal cost of serving an additional consumer is zero). National defence is clearly provided by the state and paid for through taxation, and public good theory suggests that doing so avoids the free-rider problem that arises with a decentralized pricing system.

Another economic good that interested Coase—the use of radio spectrum for broadcasting—also has the public good features of non-excludabiilty (anyone can listen to radio broadcasts) and non-rivalry (the signal does not degrade even when more people listen). Yet broadcast radio is a private industry (even public radio in the US is supported almost entirely by individual memberships and corporate sponsorships), paid for by advertising, with little evidence of a free-rider problem. How is this private provision of a public good possible?

The private provision of a public good

In his analysis Coase does two things that are common in his work: he points out relevant aspects of the question that other scholars are overlooking, and he emphasizes the essential role of institutional detail and knowing that detail to be able to produce sound economic theory. Coase uses Mill and Samuelson as analytical foils. He notes that Mill's argument supports government taxation to pay (private or public) lighthouse owners for their services while Samuelson makes a different argument, that zero marginal cost for an additional ship means that the lighthouses should be provided to everyone, and therefore through government ownership. Both Mill and Samuelson engage in a casual observation of reality, pointing out that in their day the provision of lighthouses was a government function and then deducing that private lighthouses were not sustainable due to the free-rider problem.

Coase challenges that claim, and through it the theory they developed, with his empirical investigation of the history of the British lighthouse system. England was the dominant maritime power in Europe in the 18th and 19th centuries, and its shipping industry was expanding quickly. Lighthouses initially emerged as private commercial entities, but in 1836 were nationalized and operated by governments (Candela and Geloso, 2019). Using the centuries-old

piloting organization Trinity House, the British government first nationalized the lighthouses-and then supervised the collection of light dues to create a General Lighthouse Fund. Different types of vessels paid different dues, some by journey and some as an annual fee, so price discrimination was reflected in their monopoly grants (foreign ships always paid more than domestic ones). Between the 16th and early 19th centuries, though, Britain had private lighthouses, the owners of which overcame free riding by collecting port fees and bundling lighting services with other maritime safety services such as pilotage and ballastage. There were also other substitute means of providing light and guidance along the coast, particularly in the 16th and 17th centuries. For instance, as Rosolino Candela and Vincent Geloso have analyzed, entrepreneurs provided floating lighthouses or lightships along the English coast, with construction funded by voluntary contributions, subscriptions, and user fees that differed for different types of vessels (price discrimination) (Candela and Geloso, 2018).

Coase's examination of this rich history was detailed and showed the diversity of institutional arrangements that existed in maritime safety. For example, in a shallow port with shifting sands, having a local pilot bring the ship into port had substantial value as a private good to the ship's captain, and the lighthouse service was a complement to such pilotage. A lighthouse owner could charge a fee for pilotage that bundled the light service with it (Candela and Geloso, 2019). Such arrangements were common in Britain and elsewhere. The more important way of thinking about the situation was to characterize it as a market for maritime safety services, which involved a variety of services that could be provided in a variety of ways by different private parties. Lighthouses were but one part of that broader market.

Public good theory that focused only on one service often overlooked alternative institutional arrangements and, from Coase's perspective, missed the important economic theory that would help us understand why and how such institutional arrangements emerged and were beneficial to both producer and consumer (in constrast, see Bertrand (2006) for a critique of Coase's argument). If we theorize without understanding the actual markets and institutional frameworks about which we theorize, our theories have little meaning and are no more than "blackboard economics" likely to be derided as irrelevant when economics can and does provide valuable insights.

Chapter 7

Problems of Monopoly

No Government could distinguish in any detail between the varying tastes of individual consumers… without a pricing system, a most useful guide to what consumers' preferences really are would be lacking; furthermore, although a pricing system puts additional marketing costs on to consumers and firms, these may in fact be less than the organising costs which would otherwise have to be incurred by the Government.

—Coase (1946), p. 172

An interesting and thorny question in the economic organization of production is monopoly, that is, when a single firm produces all output sold in a market. Coase analyzed two different monopoly questions: how should public utilities price their output, and how should a monopolist that produces a durable good price it?

The marginal cost controversy and public utility pricing

Industries, like railways, electricity, and telecommunications, have characteristics that lead to difficult economic questions and challenging analyses. In such industries, production costs are skewed heavily toward capital, or fixed costs, with variable costs being a small share of total costs. In these high fixed-cost industries, the average production cost per unit of output declines as a firm's output increases, at least over the quantity or amount of product that consumers want to buy ("over the relevant range of demand"). That cost structure means that the marginal cost of a unit of that company's product is lower than its average cost over this significant range of output. Companies structured this way are called "decreasing-cost." If firms in a decreasing-cost industry compete in a typical market process, their rivalry would drive the

price of their product down to its marginal cost, because if the market price is the same as a firm's marginal cost it can still pay its variable costs like wages. But if the price they receive is equal to marginal cost and this is a decreasing-cost industry, the market price will be lower than average cost, which will lead to losses. If marginal cost is not the right way to price goods in a decreasing-cost industry, how should prices be determined?

Early in his career Coase entered a lively debate over prices in decreasing-cost industries. In 1938 Harold Hotelling published an argument in favour of marginal cost pricing on efficiency grounds, based on the general argument that social welfare is maximized where marginal benefit equals marginal cost. For that reason, Hotelling argued, these firms should charge consumers a price equal to marginal cost and receive taxpayer-funded subsidies to cover their fixed costs (which, again, are considerable). Hotelling relied on taxation theories to suggest lump-sum taxes on consumers that, in aggregate, would pay for fixed costs.

In 1946 Coase's analysis of Hotelling's proposal, "The Marginal Cost Controversy," clarified the question and gave the debate its name. (Frischmann and Hogendorn (2015) provide an excellent summary of the marginal cost controversy debate and the lasting relevance of Coase's argument today.) While acknowledging the efficiencies inherent in marginal cost pricing, Coase argued that imposing lump-sum taxes to pay for firms' fixed costs would not actually result in the most efficient outcome. Coase distilled the problem down to three essential parts:

1) The divergence between marginal cost and average cost, with marginal cost lower than average cost;
2) The allocation of common costs across consumers;
3) That many fixed costs are pre-payments on long-term contracts for inputs that could be considered variable costs.

While the divergence between marginal and average cost is the predominant analytical issue, the other two are tricky. When there is a common fixed cost that must be shared across consumers, economic theory does not suggest a single, clear, definitive method of doing so. In electricity, for example, much

of the capital in the distribution system creates a shared network that different consumers use to different degrees (and at different times of day). How should the costs be apportioned among these different consumers, particularly at the time Coase was writing, when digital technologies did not exist to enable precise measurement of use of the distribution grid? This question of the apportioning of common costs remains relevant in regulated electric utility rate design.

To examine Hotelling's question Coase set up a simplified conceptual model, using a style of analysis common to all of his major works. He argued that while price would equal marginal cost, resource misallocation would still arise because neither producers nor consumers would take fixed costs into account in making production and consumption decisions. In other words, if fixed costs were paid for through taxes or subsidies, neither producers nor consumers would have any incentive to consider the opportunity cost of those resources.

Coase also argued that in the absence of a market price that reflected opportunity costs, there would be no institutional framework, no market process, for learning whether or not consumers were willing to pay the full cost of the output they consumed; this observation overlaps with the challenge of allocating common costs across consumers. Finally, Coase observed that in Hotelling's system the redistribution of wealth from people who used only a little of the product in question to those who used a lot of it would be almost unavoidable. Wealth redistribution would also arise from the mismatch between consumers and taxpayers—not all consumers of the firm's output would necessarily be taxpayers, and vice versa.

Rather than accepting Hotelling's static analysis of an already-existing decreasing-cost firm, Coase performed a dynamic analysis of the broader incentives of Hotelling's proposal and the realistic institutional framework that would be required to implement it. How would the government determine consumer demand to learn consumer preferences, to make sure that the right amount and type of fixed costs were incurred? In his emphasis on government ability to acquire knowledge, government performance, and the assumption of government as neutral public servants, Coase makes points that presage the later developments of public choice economics in the 1950s and 1960s.

Coase made an alternative proposal to Hotelling's: multi-part pricing. While he did not provide specifics in his 1946 article, his idea was to have the price include a component that reflected the marginal cost and a component that allocated the fixed cost, subject to the constraint that the firm does not earn losses; this example is called a two-part tariff. Such pricing incorporates all costs into the prices to which producers and consumers respond, and does not involve either the funding problems or institutional incentive problems that Coase identified with the tax/subsidy proposal. Multi-part pricing does not avoid the problem of allocating common costs across consumers, and such allocation will also be the province of estimates and be prone to bureaucratic manipulation, but it may be the best we can do given realistic assumptions about our constraints and the limitations of our knowledge.

Coase's analytical framework for decreasing-cost industries persists to this day in the form of regulated rate setting in the electricity and natural gas distribution industries. If you look at your electric bill you will see a variable "energy charge," reflecting marginal cost, and a "wires charge" or "carrying charge," that allocates a share of the fixed costs of constructing, maintaining, and operating the distribution network. At least in theory, regulated rate setting is grounded in Coase's logic.

Coase and his interlocutor William Vickrey remained interested in the marginal cost controversy questions through 1970, and the ideas in that debate informed Coase's work on the related question of public utility pricing. Utilities such as telephone, electricity, and natural gas have traditionally had the high fixed costs that had been the focus of the marginal cost controversy analyses. Coase (1970) revisited his earlier analysis and applied his approach to the Federal Communications Commission ruling that allowed competitive entry in the microwave band of the radio spectrum. This decision created a new option for businesses: they could invest in their own microwave communications system or use AT&T's new Telpak microwave band service.

In this articulation of his argument Coase made the economic logic even clearer:

> A consumer does not only have to decide whether to consume additional units of the product. He also has to decide whether it is worth

> his while to consume the product at all rather than spend his money in some other direction. This can be discovered if the consumer is asked to pay an amount equal to the total costs of supplying him....
>
> Apparently what the advocates of marginal cost pricing had in mind was that the Government should estimate for each consumer whether he would be willing to pay a sum of money which would cover the total cost. However, if it is decided that the consumer would have been willing to pay a sum of money equal to the total cost, then—and this strikes me as a very paradoxical feature of this argument—he will not be asked to do so. So the Government would estimate whether a consumer would be willing to pay, and if he is willing to pay, it does not charge him.
>
> I found this a very odd feature. But I do not see how it would be possible for any government, or anyone else for that matter, to make accurate estimates at low cost and without knowledge of what would have happened if consumers had been required to pay the cost. The way we discover whether people are willing to pay something is to ask them to pay it, and if we do not have such a system, it becomes extremely difficult to make estimates of whether they would be willing to pay.…
>
> But, of course, such estimates, if made, would in practice be very expensive, and they would be inaccurate, and much waste of resources would result from the kind of procedure envisaged by the advocates of marginal cost pricing. (1970: 118)

In addition to reiterating that efficiency entails consideration of both marginal cost and total cost, Coase makes a transaction cost argument—that attempting a government survey to elicit consumer preferences is costly. Designing and implementing such a survey would be an expensive venture, and those transaction costs have to be considered when choosing a utility pricing scheme. Earlier work from Hotelling and others assumed that those transaction

costs would be zero. This point bolsters Coase's epistemic argument that governments cannot aggregate the knowledge required to estimate fixed costs in the absence of a decentralized price system (an insight similar to Hayek's (1945) argument about the role of the price system).

Durable goods monopoly

One of Coase's most theoretical and abstract works, "Durability and Monopoly" (1972), starts by posing yet another deceptively simple question: "Assume that a supplier owns the total stock of a completely durable good. At what price will he sell it?" (1972: 143) If the good is completely durable (i.e., does not depreciate) and no other supplies and suppliers exist, the profit-maximizing monopolist will charge the competitive price (price = marginal cost), a provocative claim that is known as the Coase Conjecture. The logic of Coase's argument is

1) Having sold the quantity where marginal revenue equals marginal cost, the monopolist can earn additional profit by selling additional units at a lower price. They can charge a lower price on later units sold and still profit because they do not have to lower the price on the earlier units that were already sold.
2) Consumers have the rational expectation that this price decrease will occur in the future, and will hold off purchasing at the earlier, higher price.
3) If the monopolist can change prices quickly, the initial price will be marginal cost.

In essence, the monopolist supplier is competing with its future selves. That intertemporal competition prevents the monopolist from exercising market power to raise prices today. A profit-maximizing monopolist today sells the "monopoly quantity"—that is, a quantity less than would be sold if the seller had no monopoly power—but then has strong incentives to sell more in the future, which requires lowering the price.

How could the monopolist avoid this outcome and maintain a higher price? Coase suggested leasing the good rather than selling it. A consumer can cancel a lease and then sign a new one if the price is lower, which imposes

pricing discipline on the monopolist. He also suggested making the good less durable, or in other words, planned obsolescence. Another option is a money-back guarantee, which creates a disincentive to lower the price. Credible pre-commitment to a future production schedule could also attenuate the incentive to reduce the price.

The Coase Conjecture has generated a large literature that formalizes the theory and applies it to durable goods markets. Much of this work is game-theoretic in nature, which makes sense — the core of Coase's logic is backward induction, or reasoning backward to determine a sequence of optimal actions. The intertemporal strategic interaction among the monopolist and its future selves is a good example of how the monopoly maximizes its profits at each separate decision stage, working backward from the end to today, to determine the sequence of optimal pricing decisions over time. Deneckere and Liang (2008) and the research they cite provide good examples of this literature expanding on the Coase Conjecture.

In both the decreasing-cost industry question and the durable goods question, Coase's analysis of the implications of monopoly deepened our understanding of those implications. The static monopoly model, with its naïve presumption that a monopolist would charge a high price, did not explain the actual experience of pricing observed in these markets. Coase's work helps us understand why, and has led to further research to deepen and extend that understanding.

Chapter 8

Conclusion

Coase's pioneering work brought institutions, property rights, and transaction costs into economic analysis, catalyzing new research in diverse fields in economics, management, law, political science, and other social sciences. The fields of law and economics, property rights economics, transaction cost economics, and institutional and organizational economics built upon Coase's original contributions to our understanding of the organizational structure of production and the effect of law on economic activity. Founded in 2000, the Ronald Coase Institute works to promote institutional and transaction cost scholarship, particularly by connecting young international scholars and providing them with valuable research opportunities. Similarly, the annual Institutional and Organizational Economics Academy brings together European graduate students working in the Coasean tradition. Through such efforts, research and application in institutional, organizational, and transaction cost economics continues to expand and thrive.

Coase worked continuously until his death in 2003 at age 102. In the last decade of his life he became increasingly interested in China's increasing economic activity and worked with Chinese scholars to build networks of researchers in institutional and organizational economics. In his last work, "How China Became Capitalist," (Coase and Wang, 2002) Coase and Ning Wang examined the incremental institutional changes that had taken place in China over the previous four decades and that enabled sustained economic growth and widespread increases in living standards. One of the institutional bulwarks of economic growth is the development and spread of new ideas, and they argue that markets for ideas are essential for increased flourishing in China, building on China's long-standing cultural reverence for ideas.

Coase's enduring influence extends beyond academic scholarship to actual, meaningful institutional changes that have transformed society,

increased economic growth, and expanded the dimensions of our flourishing. Institutional innovations in emissions permit trading, in spectrum license markets, and in many other applications derive inspiration from Coase's ideas. In my own work on transactive energy, Coase's ideas form a foundation for designing market institutions based on the extent to which digital technologies reduce transaction costs (Kiesling, 2016). Transactive energy uses digital automation to enable a house's thermostat to submit bids to pay for power in a given time period; along with other houses they form a demand curve, while suppliers submit offers that create a supply curve. The market-clearing price is communicated back to each device along with an instruction of what action it has to take depending on whether its bid or offer was accepted. As energy technologies become more diverse and smaller in scale, the reductions in transaction costs from digital technologies will increase the potential welfare creation from such markets. In a complex network such as the power grid, the prices emerging from these markets can serve as control signals to keep the grid in balance.

Coase's ideas live in our institutional frameworks. In both scholarly work and applied institutional design, Ronald Coase has been one of the most influential economists of our time. Economic ideas and the world we inhabit and create are better due to his insights.

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About the author

Lynne Kiesling is a Research Professor and Co-Director of the Institute for Regulatory Law & Economics in the College of Engineering, Design and Computing at the University of Colorado-Denver. She also provides advisory and analytical services as the President of Knowledge Problem LLC. Her research in grid modernization and transactive energy uses institutional and transaction cost economics to examine regulation, market design, and technology in the development of retail markets, products, and services, and the economics of smart grid technologies in the electricity industry. She served as a member of the National Institute of Standards and Technology's Smart Grid Advisory Committee, and is an emerita member of the GridWise Architecture Council. Her academic background includes a BS in Economics from Miami University (Ohio) and a PhD in Economics from Northwestern University.

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