



# Coase and transaction costs reconsidered: the case of the English lighthouse system

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## Abstract

What is Coase's understanding of transaction costs in economic theory and history? Our argument in this paper is twofold, one theoretical and the other empirical. First, Coase regarded positive transaction costs as the beginning, not the end, of any analysis of market processes. From a Coasean perspective, positive transaction costs represent a profit opportunity for entrepreneurs to erode such transaction costs, namely by creating gains from trade through institutional innovation. We demonstrate the practical relevance of entrepreneurship for reducing transaction costs by revisiting the case of the lightship at the Nore, an entrepreneurial venture which had arisen to erode the transaction costs associated with regulation by Trinity House, the main lighthouse authority of England and Wales. By intervening into the entrepreneurial market process, Trinity House would pave the way for the nationalization of the entire English and Welsh lighthouse system. By connecting our theoretical contribution with an empirical application, we wish to illustrate that Coase's theoretical understanding of transaction costs is inherently linked to an empirical analysis of market processes.

**Keywords** Ronald Coase · Transaction costs · Lighthouses · Lightships

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*The provision of markets is an entrepreneurial activity and has a long history.*  
 Ronald H. Coase, *The Firm, the Market and the Law* (1988, 8).

## 1 Introduction

The lighthouse has long been taken as a classic example of a public good because of the difficulties associated with the exclusion of free-riders from the service it provides (Mill [1848] 2004; Sidgwick 1887; Pigou 1932; Arrow 1969; Samuelson 1964; Samuelson and Nordhaus 2009). This was ultimately challenged by Ronald Coase (1974) who argued, using the case of England and Wales between the sixteenth and nineteenth centuries, that there were ways for private providers to produce lighthouses, notably by excluding free-riders through collection of light dues at ports (Coase 1974, 364; Meade 1949, 114). This reconsideration by Coase of the lighthouse as a public good only began to be reexamined from the 1990s onwards by several economists and legal historians (Van Zandt 1993; Taylor 2001; Bertrand 2006, 2009, 2016a, b; Barnett II and Block 2007; Block and Barnett II 2009; Lai et al. 2008a, b; Carnis 2013, 2014; Lindberg 2013).<sup>1</sup>

The purpose of this paper is to approach this empirical controversy regarding the private provision of lighthouses by addressing a more fundamental theoretical question: what is Coase's understanding of transaction costs in economic theory and history? Answering this question has broader implications that go well beyond the private or public provision of lighthouses. Our inquiry illustrates a broader point that historical facts are theory-laden, and that alternative conceptualizations of transaction costs in law and economics yield alternative policy conclusions regarding the government's role in the amelioration of market failures.

Our argument in this paper is twofold, one theoretical and the other empirical, respectively. First, we argue in Sect. 2 that Coase regarded positive transaction costs as the beginning, not the end, of any analysis of market processes. Following Coase, we define transaction costs as the “cost of using the price mechanism” (1937, 390; see also Coase 1992, 715). The costs of pricing a good are based, fundamentally, on the costs of establishing and enforcing property rights<sup>2</sup> in order to create the institutional conditions necessary for establishing exchange ratios, hence prices, in the first place<sup>3</sup> (Demsetz 1968, 35; Wallis and North 1986, 102, North 1990, 28; Allen 1991, 2000). From a Coasean

<sup>1</sup> There is also a growing literature that examines the financing and operation of lighthouse markets and other seamounts beyond that had been examined by Coase. See for example Krause (2015), Lindberg (2015), Mixon and Bridges (2018), Saito (2019), and Candela and Geloso (2019).

<sup>2</sup> This does not imply that the transaction costs associated with calculating, or measuring, the valuable attributes of goods and services are unimportant (see Barzel 1982, 2005; North 1992). Rather, the ability to measure and calculate the value of goods and services is a *by-product* of having established exchangeable and enforceable private property rights (see Candela 2019).

<sup>3</sup> The point that private property is a necessary precondition for pricing a good had been first made by Mises ([1920] 1975) in the context of the socialist calculation debate (see also Lavoie 1985 and Boettke 1998). As Edmund Phelps has argued, “Mises is regarded as the originator of *property rights theory*” (emphasis original, 2013, 123). Moreover, it suggests, as argued by Baird (2000) and Piano and Rouanet (2018), a neglected link between the Austrian tradition in economics and the transaction-cost tradition in economics.

perspective, positive transaction costs represent a profit opportunity for entrepreneurs to erode such transaction costs, namely by creating gains from trade through institutional innovation<sup>4</sup> (Boettke and Candela 2014, 2015). Though this theoretical point has been the basis for an empirical literature in law and economics, property-rights economics, and transaction-costs economics that can be traced either directly or indirectly from Coase (see Cheung 1973; Benson 1989; Kiser and Barzel 1991; Barzel 1997; Pejovich 2003; Anderson and Hill 2004; Leeson 2007, 2011; Anderson and Libecap 2014; Leeson, Boettke, and Lemke 2014; Hudik and Chovanuliak 2018; Munger 2018), its application has been underemphasized in the economic analysis of lighthouses.

This brings us to our empirical contribution of the paper. By applying our theoretical understanding of transaction costs, we argue in Sect. 3 that high transaction costs associated with the provision and financing of lighthouses were not a cause or justification for a government-enforced collusion by Trinity House—the main lighthouse authority responsible for the establishment and operation of lighthouses and other seamarks throughout England and Wales. On the contrary, it was the enforcement of collusion and rent-seeking by Trinity House that caused high transaction costs to persist, specifically by crowding out entrepreneurs from eroding such transaction costs. We demonstrate the practical relevance of entrepreneurship for reducing transaction costs by revisiting the case of the lightship at the Nore, an entrepreneurial venture which had arisen to erode the transaction costs associated with regulation by Trinity House (Candela and Geloso 2018a, b). Two entrepreneurs, David Avery and Robert Hamblin, constructed this lightship and funded it by subscription and light dues collected without government monopoly or subsidy, demonstrating that entrepreneurs can successfully discover ways to exclude non-payers from what appears to be a public good. By intervening into the entrepreneurial market process, however, Trinity House would pave the way for the nationalization of the entire English and Welsh lighthouse system, namely by crowding out the possibility for institutional innovation among entrepreneurs. Connecting our theoretical contribution with an empirical application, we wish to illustrate that Coase's theoretical understanding of transaction costs is inherently linked to an empirical analysis of market processes. Section 4 concludes.

## 2 Transaction costs and the Coasean analysis of markets

Coase's analysis of lighthouses fits into his larger theoretical project of turning economists away from 'blackboard economics,' which 'does not study the real world economy. Instead, its efforts are on an imaginary world that exists only in the mind of economists, for example, the zero-transaction cost world' (quoted in Wang 2014, 101). However, Coase's analysis of the lighthouse system of England and Wales, as it operated prior to its complete nationalization in 1836, has encountered criticism for being mischaracterized as an example of the private provision and financing of lighthouses (Van Zandt 1993; Bertrand 2006, 2009; Lindberg 2013). For example,

<sup>4</sup> This theoretical understanding of Coase has elsewhere been recognized by Medema (1994, 165), Cheung (1998, 516), Frischmann and Marciano (2015, 331), and Marciano (2018).

Élodie Bertrand has argued that, ‘when examining the same historical experience, we are led to doubt Coase’s conclusions: the system was not as private, and above all not as *efficient*, as he suggests, in the sense that it was not well adapted to needs’ (emphasis added 2006, 390).

We have emphasized the word ‘efficient’ in order to examine and assess the welfare conclusions that critics of Coase have made regarding his analysis of lighthouses. There are two analytic benchmarks from which an economist can assess the ‘efficiency’ of any market—in this particular case, the market for lighting services—from which alternative public policy conclusions are made. The first benchmark utilizes equilibrium analysis, or the end point of a market process, in which all transaction costs have been eliminated. From a Coasean perspective, the problem with this understanding of ‘efficiency’, so often used in neoclassical economic theory, is that ‘the absence of transaction costs in the theory *makes the effect of a reduction in them* difficult to incorporate in the analysis’ (emphasis added, Coase 1988, 10), the consequence of which, ‘not usually noticed, is that, when there are no cost of making transactions, it costs nothing to speed them up, so that eternity can be experienced in a split second’ (Coase 1988, 15).

This brings us to a second benchmark of welfare analysis, which assesses the *process* by which existing inefficiencies are eliminated in the marketplace, namely through the reduction of transaction costs *through time*. Such an understanding of efficiency does not neglect the importance of equilibrium analysis. Rather, consistent with Coase’s analysis, it begins in a world in which markets are imperfect, exhibiting positive transaction costs, and studies the alternative contractual arrangements that emerge to reduce transaction costs and, as a by-product of this contractual process, create a *tendency* towards equilibrium *through time*. As Coase best states this point in the case of commodity and stock exchanges:

It is not without significance that these exchanges, often used by economists as examples of a perfect market and perfect competition, are markets in which transactions are highly regulated (and this quite apart from any government regulation that there may be). It suggests, I think correctly, that for anything approaching perfect competition to exist, an intricate set of rules and regulations would normally be needed. Economists observing the regulations of the exchanges often assume that they represent an attempt to exercise monopoly power and aim to restrain competition. They ignore, or at any rate, fail to emphasize, an alternative explanation for these regulations: *that they exist in order to reduce transaction costs and therefore to increase the volume of trade*<sup>5</sup> (emphasis added, 1988, 9).

For Coase, it is the very existence of frictions manifested as transaction costs that give rise to markets in the first place, as well as institutional change and adaption to cope with the reduction of transaction costs in particular circumstances of time and

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<sup>5</sup> For an empirical illustration of this point, specific to commodity and stock exchanges, see Stringham (2002, 2003, 2015) for a historical and institutional analysis of the emergence and enforcement of rules governing stock exchanges in England and Holland.

place. This is evidenced throughout Coase's career, not only in his analysis of the firm (1937) but also in his analysis of the emergence of private property rights in China in his last book (co-authored with Ning Wang), *How China Became Capitalist* (2012).

Our point in clarifying Coase's theoretical understanding of market processes is to highlight an important question left unanswered by the literature that has followed Coase's analysis: if transaction costs represent existing inefficiencies in the market, what is preventing entrepreneurs from eliminating them? It is indeed the case that positive transaction costs existed in establishing and enforcing property rights, which is a necessary precondition for pricing and financing lighthouse services. Such transaction costs came in various forms, which we discuss in detail in Sect. 3. Though the literature on the economic analysis of lighthouses takes positive transaction costs as an analytical point of departure, economists and legal historians have concluded that the historical facts of the case study analyzed by Coase illustrates an inherent failure of lighthouse markets to adapt to consumer demands, thereby requiring nationalization by the English government.

However, such a conclusion can only follow from a *static* theoretical understanding of transaction costs as the *endpoint* of analysis. Based on this theoretical interpretation of transaction costs, Bertrand and Van Zandt conclude that the existence of high transaction costs to exclude non-payers of lighthouse services precludes the possibility of private lighthouse markets, requiring government intervention and the inevitable nationalization of the lighthouse system. This seems to be inconsistent with Coase's theoretical understanding of markets as *dynamic processes* of adaptation and adjustment, in which the existence of transaction costs are the *starting point* of an empirical analysis of how they come to be reduced.

Therefore, if Coase underestimated the role of government in the provision of lighthouses, as Bertrand and Van Zandt have claimed, it was not because Coase downplayed the government's role in reducing the transaction costs associated with defining and enforcing property rights (see Coase 1974, 375). Rather, on the contrary, it was because Coase underestimated the extent to which government intervention *caused* transaction costs to remain high, rather than fall. By intervening into the process of establishing and enforcing property rights, Trinity House would redirect entrepreneurial incentives in the lighthouse market towards unproductive entrepreneurial initiatives, such as rent-seeking, to exclude entrants into the lighthouse market. This intervention, in turn, precluded the possibility of private lighthouse financing by preventing the possibility of institutional innovations that would reduce the transaction costs associated with free riding among non-payers of lighthouse services.

### 3 Innovating around pilotage and patents: the case of the Nore lightship

First incorporated in 1514 by King Henry VIII, Trinity House was a seaman's guild chartered with the responsibility for establishing and regulating lighthouses in England and Wales. At first, it was charged with the dual mandate of providing charity

to aged and wounded mariners (or their widows) and regulating pilotage through licensure (i.e. the service provided by an experienced local who acted as a guide to incoming and outgoing ships). Moreover, as Bertrand states, ‘Trinity House also tried to prevent private individuals from building lighthouses by attempting to have the exclusive nature of its building right recognised’ (2006, 394). In doing so, Trinity House increased the transaction costs of entry into the lighthouse market. G. Harris, a historian of Trinity House, explains the tenuous grounds on which Trinity House justified its restriction of the construction of lighthouses:

The line which the Brethren [of Trinity House] took has been defended on the grounds that the lights in those days were so dim that they were more likely to do harm than good. The view has also been expressed that lights would be a guide to enemies. There is an element of truth in the first argument: yet it is unlikely that the seventeenth-century mariner would be so gullible as to relax his vigilance as he neared a dangerous coast because he felt sure that a light would give him ample warning: lights were few and far between, and navigation was not so precise that a shipmaster could be sure that his landfall would be in an area where a light would be visible. As for the second argument, it is doubtful whether enemies, pirates and privateers between them took a greater toll of ships and lives than shipwreck; moreover, it is not really consistent with the first argument (Harris 1969, 214).

Trinity House’s reluctance to take the initiative in constructing lighthouse makes sense for two (interrelated) reasons. First, it was trying to control entry over the whole market for maritime safety—not just the market for lighthouses. As historian Alwyn Ruddock writes, Thomas Spert, the first master of Trinity House, and his fellow pilots, ‘were determined to bring all pilotage on the Thames under the control of the master and brethren of the Trinity House’ (Ruddock 1950, 464). The quasi-monopoly on pilotage, provided by its incorporation in 1514, meant that it could restrict entry, thus generating greater earnings for pilots from whom they would ask a contributory fee that would serve to finance the guild’s charitable activities. In 1566, Trinity House was granted a privileged position regarding the provision of all seamarks, which included lighthouses, buoys and beacons ‘for the guidance of pilots and mariners’ (Ruddock 1950, 468). In 1594, it was granted the exclusive right to ballastage (i.e. the act of adding sands or gravel to the bottom of an empty ship to stabilize it). In 1604, after some years of legal uncertainties, King James I made pilotage compulsory on the Thames River and gave Trinity House the exclusive power of licensing pilots. Gradually, through acts like the 1732 Ballast Act, the 1732 Pilotage Act and the 1808 Act for Maritime Pilotage,<sup>6</sup> Trinity House fortified its

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<sup>6</sup> To illustrate the importance that Trinity House attributed to these acts, it is interesting to note that Joseph Cotton (1818, 50) called the Act for Maritime Pilotage of 1808, the ‘Trinity House Pilot Act’. Cotton became an elder brethren of Trinity House in 1788 and later, in 1803, became the deputy master of the Society. See also Tran (2003) for more on the Act for Maritime Pilotage of 1808 and Hignett (1978) for the Pilotage Act passed in 1732.

ability to erect barriers into the market for maritime safety broadly speaking.<sup>7</sup> Any relaxation of these efforts would threaten the revenues that Trinity House collected.

Secondly (and most importantly), between 1610 and 1675, Trinity House built no lighthouses (Stevenson 1959, 259; Coase 1974, 364; Bertrand 2006, 394). However, this can be explained by the fact that, at the onset of the eighteenth century, Trinity House earned the bulk of its revenues from ballastage and pilotage fees. Such revenues served, in large part, to finance the charitable missions of the Society which were aimed at decayed pilots and their widows. As of 1805, more than 64% of the Society's expenditures was dedicated to 'Pensions to Alms People and Monthly Pensioners, Prisoners of War, &c' (Cotton 1818, 186–187). As a guild, this was one of the benefits (other than restraining entry into the pilotage and ballastage business) that the Society could offer to its members (see notably Wallis 2018). However, its ability to make those expenditures depended on the cost of its other operations. If lighthouses were costly to operate and volumes were not high to earn large sums, it was better, in that context, to delegate the management to someone in exchange for a lump sum rent. Trinity House's initial reluctance to construct can be explained by the fact the positive external benefits provided by lighthouses were not worth the cost of their internalization. Delegation of the construction of lighthouses constituted a more efficient way of extracting rents from the ability to regulate who entered the lighthouse market without incurring any management risks. In fact, as the official historians of Trinity House note, several of the private leases to lighthouses were granted to members of Trinity House itself (Adams and Woodman 2013, 120–122). In effect, Trinity House agents were incentivized to redirect their initiatives towards rent-seeking in the form of protecting (and extending) their monopoly privilege over pilotage and ballastage rather than constructing lighthouses. Given that lighthouse construction fell under the discretion of Trinity House through the 1566 Seemarks Act, Trinity House would exercise its authority by erecting both indirect and direct barriers to entry, raising the transaction costs for private entrepreneurs, not only to enter the lighting market, but also to create private mechanisms to prevent free-riding of lighting services.

### 3.1 Indirect barriers

The indirect channel of erecting barriers to entry is best illustrated by the example of pilotage. Pilotage was one of the important services that could be provided for bringing ships to port and can be argued to have been more vital to maritime safety than lighthouses (Clancy 1984). Local pilots would board foreign ships and guide

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<sup>7</sup> There are other examples provided by Trinity House members. One such example is Joseph Cotton in his retelling of a conflict between Trinity House and Liverpool and Irish merchants (1818, 113–114). Lights in Ireland, at the time a British possession, were under a different authority than Trinity House. The Irish agency managed to get a bill introduced in parliament for the construction of a lighthouse on the Isle of Man in the middle of the Irish sea. There appears to have been a conflict over the issue of under whose purview the Isle of Man fell and the rates to be charged. 'Rather than suffer an encroachment on the authority' that it had received earlier, Trinity House 'was disposed to undertake the light at the inferior toll' (Cotton 1818, 114).

them in otherwise unfamiliar waters. However, pilots and lighthouses were complementary goods as the efficiency of the services provided by pilots was enhanced by the presence of a lighthouse. And unlike lighthouses, pilotage is an excludable service. Under the theory of public goods, a positive price in the presence of a marginal cost of zero will discourage some use of the public good leading to foregone gains from trade. If one bundles the public good with a private good, one can ‘price in’ potential users (Bakos and Brynjolfsson 1999; Liebowitz and Margolis 2011), allowing the provision of a greater quantity of this particular good. In fact, this is an easier task if the different goods and services are complements to the same end such as pilotage and lighthouses. A pilot could be a lighthouse operator and could refuse to board a ship if a fee was not paid that included the lighthouse’s costs. By monopolizing pilotage, Trinity House precluded the private use of such an exclusionary mechanism.

We know that this bundling occurred in colonial America where lighthouses were often operated by pilots who saw the good as a natural complement to their own services (McKenzie 2003, 98; Clancy 1984, 47–48).<sup>8</sup> Other examples exist for Australia (Hydrographic Office of the Admiralty 1879, 73), colonial Canada (Leclerc 2003, 102) and nineteenth century Northern Ireland (Anonymous 1853, 52). In England, Trinity House vigorously fought to protect its privilege over the pilotage market and, as such, it blocked a channel through which exclusionary mechanisms could have emerged, specifically by bundling the consumption of lighthouses with another good.<sup>9</sup>

### 3.2 Direct barriers

After 1679, Trinity House adopted a policy of directly controlling the conditions of entry and exit into the lighting market (Van Zandt 1993, 65; Bertrand 2006, 394, 2009, 2016; see also Taylor 2001; Lindberg 2013). It did so by becoming the exclusive provider of leases for the right to construct lighthouses, for which a private entrepreneur financed the cost of construction and paid a rent to Trinity House for a specific duration. Moreover, the fees paid to lighthouse owners, known as light dues, were not set through voluntary exchange, but were fixed by the patent provided by King. Moreover, such light dues were not privately collected, but could only occur through government coercion. Bertrand and Van Zandt illustrate historical examples in which patents were obtained for lighthouses, in which voluntary payments were not forthcoming, therefore concluding that private collection of light dues was

<sup>8</sup> When lobbying for special treatments, pilots who operated lighthouses complained that while they worked on the lighthouses, other pilots were stealing their services (Clancy 1984, 47–48).

<sup>9</sup> In fact, bundling may even occur between seemingly unrelated services. In this case, the aforementioned monopoly of Trinity House over ballastage is crucially important. As the weight added at the bottom of an empty ship was crucial in assuring stability, the service was an essential component of reducing the risks of being shipwrecked. Like pilotage, ballastage is an excludable service (i.e. no payment, no ballastage) and just like pilotage, it could be bundled with lighthouses. A ballast provider could produce a lighthouse and bundle the fee within his excludable service.

impossible. Their conclusion is that government intervention was required because private financing of lighthouses was not possible.

If indeed property rights in lighthouses are not well defined and enforced, with respect to excluding non-payers, then private production is indeed not possible. But to then conclude that nationalization was necessary from this interpretation can only follow if the understanding of Coase's theoretical message is one in which positive transaction costs of excluding non-payers precludes the possibility of the private production of lighting services. Indeed, there were private attempts of collecting payments that failed, as Bertrand (2006, 397) and Van Zandt (1993, 68) illustrate. However, business failure is inherent to any market process. Without failure and entrepreneurial losses, there would exist no future profit opportunities for entrepreneurs to discover either. What neither Bertrand nor Van Zandt do not include in their narrative is how such failures to overcome the transaction costs of defining property rights in lighting services provided entrepreneurial opportunities to discover alternative contractual arrangements for excluding non-payers. The existence of positive transaction costs, from a Coasean perspective, represents not an endpoint of economic analysis, but the theoretical starting point of economic analysis, one in which *previous market failures represent future profit opportunities to adapt and correct such market failures through the reduction of transaction costs*.

Based on this interpretation, we further develop two points, which follow from a Coasean theoretical interpretation of the facts. First, the policy adopted by Trinity House in 1679 was *because* of the efficiency of the market process in adapting to consumer demands, namely to reduce the transaction costs of entering the lighthouse market, created by Trinity House in the first place. Candela and Geloso (2018b) illustrate how the patent system adopted after 1679 can be traced to the entrepreneurial efforts of Sir William Erskine to circumvent Trinity House, which had refused to respond to a petition to establish a light on the steeple of Winterton Church. Erskine petitioned for a patent directly from King James I himself (Harris 1969, 196). Therefore, contrary to Bertrand's claim, the lighthouse market was in fact efficient and adaptive to consumer demands *once we take into account the transaction costs imposed by Trinity House to enter the lighting market*. Moreover, this example runs contrary to the suggestion that the patent system arose because private attempts to collect light dues were not possible.

Second, another historical observation made by Bertrand, which seems to undercut her central claim that private financing of light dues was not possible, is that 'the lighthouse 'owner' did not have the right to enforce the payment of dues without the Crown's authorisation' (Bertrand 2006, 397).<sup>10</sup> If indeed this is true, as we illustrate below, then nationalization was not required because private efforts to finance the

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<sup>10</sup> Nevertheless, private leasers were inventive in finding ways to circumvent this issue. For example, in 1775, Charles Hawker was trying to obtain subscriptions for a lighthouse at the Ayr (also known as the Chester) near Liverpool. The subscriptions were solicited before the opening of the lighthouse which technically circumvented the prohibition (*Chester Chronicle*, December 11th, Anonymous 1775). From the work of Joseph Cotton (1818, 114, 146), we know that Trinity House owned the lease for the lighthouse.

lighthouse system ended in failure.<sup>11</sup> Rather, nationalization was required because of efforts by Trinity House to thwart the actual existence of private methods of financing.

The case of floating lighthouses, also known as lightships, best illustrates this point, particularly that of the lightship at the Nore in 1731 (Candela and Geloso 2018a, b). The Nore was the entry point of the Thames River leading to the port of London which was known for its treacherous sandbanks on which ships would often be wrecked. Because of these sandbanks, it was largely impossible to build a lighthouse that was efficient given the technologies of the time. The problem was amplified by the fact that sandbanks change position making navigation charts unreliable to sailors (Fautley and Garon 2005, 208). In 1679 and 1724, private entrepreneurs had proposed the mooring of a small ship which would act as ‘a floating light’—a proposition which Trinity House strenuously opposed (Clarke 2016, 39; Stevenson 1959, 138). In 1731, David Avery and Robert Hamblin decided to pursue the idea by circumventing Trinity House. They petitioned the Crown for a patent to an innovation meant to distinguish different lights from one another, effectively circumventing the existing patent system. In secret, they launched an experimental lightship of 19 tons at the Nore in August 1731 and upon the apparent success of the experiment they launched a 100 tons ship. Relying largely on subscriptions prior to construction,<sup>12</sup> price discrimination in order to cater to marginal consumers,<sup>13</sup> and voluntary contributions collected in the different exchanges and coffeehouses of London (notably those frequented by insurers and merchants involved in the crucially important coal trade), they managed to make their activities profitable enough to announce the construction of two additional lightships off the coasts of Cornwall (southwestern England) and East Anglia (off the central eastern coast of England). In effect, they adapted to consumer demand by avoiding the transaction costs imposed by the existing patent system and innovating around it.

The new service was cheaper to operate than a lighthouse and, as such, the proposed rates were less than half as high as those charged by lighthouses operating within the traditional system. They also relied on a system of price discrimination which allowed them ‘price in’ marginal customers.<sup>14</sup> This ability to price discriminate through market prices, rather than fixed prices, was predicated on their ability to reduce the transaction cost of establishing, and hence exchanging, property rights

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<sup>11</sup> This conclusion that ‘private’ lighthouses ended in failure and required centralisation’ is put forth by Bertrand (2006, 401).

<sup>12</sup> See Brubaker (1975) and Tabarrok (1998) on how pre-contract excludability facilitates the private provision and financing of public goods.

<sup>13</sup> See Demsetz (1970) for how price discrimination facilitates the private provision of public goods. Lighthouses with licenses had fixed schedules of prices that they could not change and they generally had a flat rate (Anonymous 1768, 17–18, 22–24).

<sup>14</sup> In discussing another public good in England at the same time, prosecution and policing, Mark Koyama (2012) highlights that private ‘prosecution associations’ were able to produce a highly efficient and productive system notably through the practice of price discrimination which allowed these association to ‘price in’ marginal customers.

over lighthouse services. More importantly, their aim was explicitly to compete with *existing* lighthouses.

By late 1731, Trinity House had become wise to the actions of Avery and Hamblin and initiated legal procedures against them arguing not only that their invention patent had been obtained by fraud, but also because Trinity House regarded such private methods of financing to violate their authority (National Archives PC 1/5/3). Trinity House also viewed the lightships as direct competitors to lighthouses as Avery and Hamblin had announced that this was their plan (with two other lightships being announced soon after the launch of the Nore lightship). In effect, Trinity House outlawed any institutional innovation that would have reduced the transaction costs associating with free-riding. In early 1732, the Attorney General recommended that the invention patent be rescinded, to which the King acquiesced in May 1732. Nevertheless, the lightship continued operating outside the traditional system until November 1733. At that point, Avery (who had bought out Hamblin) ceded to the pressures of Trinity House. He was granted a sixty-one-year lease on the lightship he had built for the price of £100 per year. One of the other lightships he had announced (the one off the coast of East Anglia) also fell under the traditional English lighthouse system with a lease of 21 years at an annual rent of £200 for two years and £300 thereafter (Adams and Woodman 2013, 87). The upside of this arrangement was that Avery gained monopoly (i.e. he was lured into the traditional lighthouse patent system) which allowed him to increase his rates.<sup>15</sup> In effect, Trinity House had co-opted a new technology for private financing that had threatened its monopoly, while the legal precedent also erected a barrier to future entry on that particular front, precluding the existence of a private lighting market in any form.

### 3.3 Nationalization

In the process of protecting its privileges, Trinity House paved the way for nationalization—which it supported. Here, two features of the English lighthouse system are crucial. The first is that, as mentioned above, the patents came with fixed rates which could not be easily altered. The second is that Trinity House was not only an agent of the Crown acting to provide public goods; it was also a guild which regulated entry into the pilotage business and provided its members with a social safety net.

While the marginal costs of constructing lighthouses are more or less steady (Lai et al. 2008a, b) as demand increased over the course of the nineteenth century, net revenues increased rapidly. With improvements in lighting technologies (Adams and Woodman 2013, 96), which may have caused marginal costs to actually fall, the growth of England's trading volume over the course of the eighteenth century meant that more revenues could be earned from concentrating on lighthouses. With the

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<sup>15</sup> In 1731, the rates announced varied between from 0.045 to 0.12 pences per ton regardless of origins (*Daily Courant*, Sept. 15, Anonymous 1731). The terms of the 61 years patents must have included an increase in rates as they varied from 0.15 to 0.24 pences per ton for domestic ships and twice those for foreign ships (Anonymous 1768, 23).

**Table 1** Changes in operator and light dues

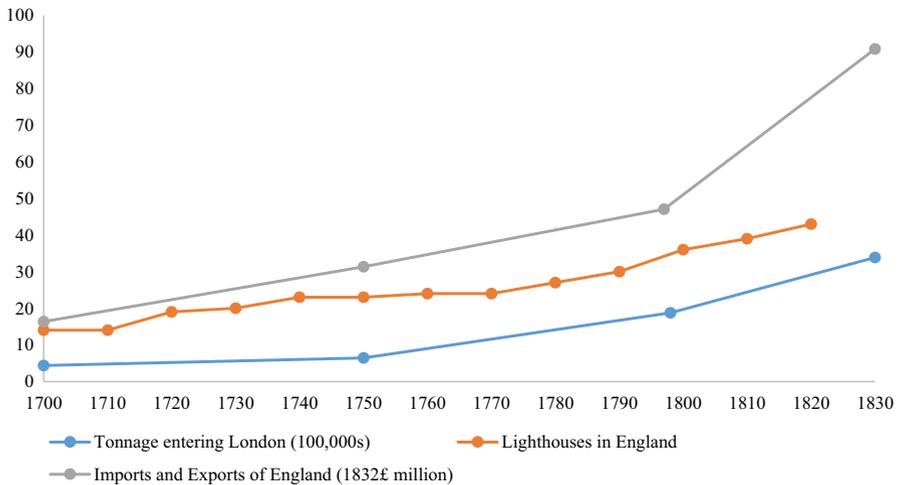
Private from 1768 to 1832		Changed to Trinity House between 1768 and 1832		Trinity House from 1768 to 1832	
Name	Rate change	Name	Rate change	Name	Rate change
Spurn	No change	Castor and Lowestoff	Increase	Well light	No change
Orford	No change	Forelands	No change	Foulness lights	No change
Winterton	No change	Flatholm	Reduction	Nore lightship	No change
Harwich	No change	Eddystone	No change	Portland	No change
Skerries	No change			Casketts	No change
Dungeness	No change			Lizard	No change
				Scilly	No change
				Milford	No change
				Beeshead	No change
				Gatt	No change

*Source:* Anonymous (1768, 22–24) and House of Commons (1834, 341, 512, 513). The ownership was clearly specified for 1832 in the House of Commons report. However, for the status in 1768, we had to consult different sources such as Stevenson (1831, 1959), Cotton (1818) and Adams and Woodman (2013). It is worth pointing out that this concern only England. According to Stevenson (1831, VI), all the lighthouses of Scotland were operated privately

growth of merchant traffic, Trinity House became increasingly interested in rescinding leases or reacquiring them once they had lapsed. It also became increasingly interested in building additional lighthouses which now constituted a larger source of revenues—more so than the previously important source of revenues from ballastage (Adams and Woodman 2013). The deputy master of Trinity House, Joseph Cotton, expressed this desire best in 1818 when he complained that many lighthouses were ‘in the hands of private persons’ over which Trinity House had ‘no superintending control to constrain the exhibition of them in the most effectual style for the safety of navigation’ (1818, 70–71). By that point, he argued, the Society had determined ‘never again, under any circumstances, to grant a lease’ (1818, 71). The goal for Trinity House was to increase its hold over the lighthouse market in order to capture a greater level of revenues caused by the increase in shipping activity (and a mild reduction in the cost of operating lighthouses).

During the century preceding nationalization, the rates proposed by lighthouses tended to remain steady in nominal terms because of the nature of the patents for operating lighthouses. Of 19 lighthouses whose rates could be tracked from 1768 (Anonymous 1768, 22–24) to 1832 (House of Commons 1834, 341), none of the private lights changed their dues, one of the three lighthouses that went from being privately operated to being operated by Trinity House increased its rate, while another reduced its own. None of the nine lighthouses operated continuously by Trinity House increased their rates (see Table 1).

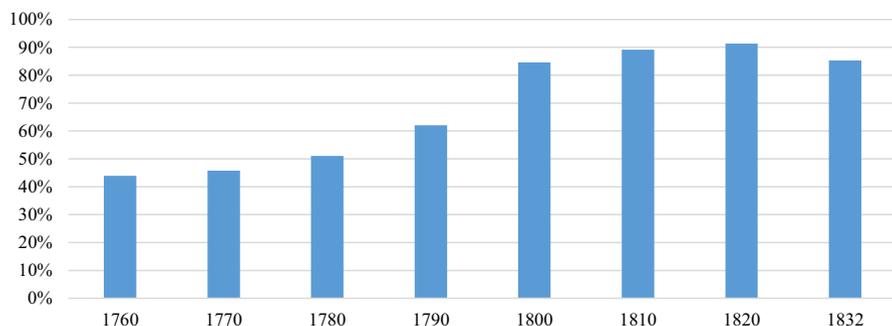
However, the various price indices that exist for England over the period (Feinstein 1998; Allen 2001; Clark 2005, 2018; Broadberry et al. 2015) suggest that the general price level doubled in the hundred years to 1832, which entails that the real rates for lighthouses fell by half. When eighteenth century private operators rented



**Fig. 1** Lighthouses in England and Tonnage Entering Port of London. *Source for tonnage:* Usher (1928, 471); *Source for lighthouses:* Stevenson (1959, 251); *Source for imports and exports:* Mitchell and Deane (1962, 274–282)

a patent from Trinity House, they did so with the expectation of a certain real price for their services. The main attraction for private operators was the acquisition of a monopoly right reinforced by state agents, which came with the ability to charge high prices. However, with the fixed rates falling in real terms, private operators could only increase their profits in two ways. The first was to cut down on quality. This is what numerous scholars who investigated lighthouses in the early nineteenth century, including Bertrand (2006) and Taylor (2001), point to in unison. The second was to hope for an increase in demand which, given marginal costs of lighthouses, would increase the volume served at little extra cost. This latter channel was quite important: between 1700 and 1798 the port of London saw its entering shipping volume increase from 435,135 to 1,877,736 tons an increase that continued to 1830 when this figure reached 3,388,430 tons in 1830 (Usher 1928, 471). This growth fueled increases in the demand for lighthouses and it is during this period that their numbers grew from 14 to 43 (see Fig. 1).

For Trinity House, nationalization—publicly presented as a manner to improve upon the poor provision made by private operators—meant that it could act fully as an agent of the crown but that it would collect the revenues. The tacit support for the nationalization of 1836 was foreshadowed in an enabling act passed in 1822. The act permitted Trinity House to buy out three important leases before they lapsed while, prior to that point, it could not legally enter into negotiations with private operators with the aim of purchasing their leases using the funds of the Corporation (Taylor 2001; 757). While Trinity House reduced light dues after the passage of the 1822 enabling act and promised to further reduce them after nationalization



**Fig. 2** Share of Trinity House revenues from lighthouses and buoys. *Source from 1760 to 1800:* Convertito-Farrar and Cozens (2009, 14); *Source for 1810:* Cotton (1818, 186–187); *Source for 1820:* House of Commons (1822, 344–347); *Source for 1832:* House of Commons (1834, 413–415). Revenues were deflated by the Clark (2005) measures made available by MeasuringWorth.com. *Note:* The figure of 4.44 times is *conservative*. The data by Convertito-Farrar and Cozens for the pre-1800 appear to use gross receipts. The other sources took the net revenues—the gross receipts from lights and buoys minus the expenses related to their operation—which served to finance the charitable activities of Trinity House. As such, the increase is probably larger

(House of Commons 1834, XXVII),<sup>16</sup> it was able to collect increasingly important revenues from lights and buoys. In Fig. 2 below, it can be seen that 44% of its revenues stemmed from lights and buoys in 1760. However, by 1832, this proportion had reached 85% and real revenues were 4.44 times greater than in 1760. These greater revenues served to service a greater number of pensioners: whereas their numbers in 1732 equaled 2000 (Trinity House 1732, 1), they had grown to 7012 by 1815 (Taylor 2001, 756) and 8431 in 1834 (House of Commons 1834, 366) and the sums disbursed increased accordingly.<sup>17</sup> During the debates over the passage of the act that finalized nationalization, Trinity House managed to resist encroachments to its system of pensions to mariners—it was only in 1853 that the government announced its intention to phase out the pensions system in order to reduce expenditures and, eventually, light dues (Taylor 2001, 770).

In short, Trinity House prevented the formation of private alternatives to financing lighthouses and lightships in order to preserve the mechanism by which is extracted its rents, namely the monopoly rights leased to private operators with contractually fixed light dues. This intervention by Trinity House eventually sowed the

<sup>16</sup> It is worth noting that the reductions in rates promised and those accomplished since 1822 occur during an era of overall price deflation. The price level fell by 20% from 1815 to 1832 (the year most discussed in the 1834 report to the House of Commons) and fell an additional 6% from 1832 to 1845 (Clark 2005; Measuring Worth 2018). As such, the reductions promised by Trinity House appear to keep the real price steady at 1815 levels and did not constitute real reductions in dues. In any case, the dues did not start to fall immediately after nationalization in 1836—merchants had to wait to 1849 for this to occur (Taylor 2001, 769). The stability in nominal rates after from 1836 to 1849 suggest that, as the general price level kept falling, real light dues actually increased by 10%.

<sup>17</sup> The reference for 1732 placed their expenditures at 450£ per month on pensions and almshouses which implies an annual total of 5400£ per year. In real monetary terms (£ of 1832), this amounted to 9976£ per year. The House of Commons report of 1834 placed the figure at 32,861£ in 1832 (1834, XII).

seeds of discontent once increases in the general price level forced private operators to cut on quality as it constituted the only channel for profitability. Moreover, the final push for nationalization was beneficial to Trinity House as it occurred when the profitability of operating a lighthouse increased.

## 4 Conclusion

There is no question that the lighthouse market that Coase analyzed was imperfect, as is the case for any market for that matter. However, from a Coasean perspective, the very presence of such market imperfections are why markets are required to allocate resources to their most valued uses. The presence of market imperfections due to transaction costs represent profit opportunities for entrepreneurs to establish, enforce, and exchange property rights. In doing so, entrepreneurs create gains from trade from which they themselves and consumers expect to benefit.

We have argued that the persistence of high transaction costs in privately establishing property rights over the lighthouse system, which is necessary for financing and pricing lighthouse services, resulted from Trinity House's efforts to preserve its rent-extraction. Such efforts eliminated, both directly and indirectly, any possibility of entrepreneurial solutions with regard to the definition and enforcement of property rights (i.e. private financing) in lighthouses. We further argue that it is for the same reasons that Trinity House supported the nationalization of the lighthouse system under its purview, which suggests that nationalization constituted neither evidence of market failure nor an improvement upon the previous state of affairs.

From Coase's analysis of lighthouses, we can draw three broader implications related to transactions costs. First, our theoretical understanding of transaction costs shapes our understanding of their empirical manifestation. Second, our empirical analysis of transaction costs yields alternative public policy conclusions about how transaction costs become eroded over time. Third, to the extent we neglect the role of the entrepreneur in market processes, what policymakers may regard as a cause of a market failure associated with asymmetric information, externalities, monopoly power, or public goods, may in fact be a consequence of public policies that created them in the first place. In effect, regulation may unintentionally stifle the innovative capacity for entrepreneurs to reduce transaction costs that would have otherwise ameliorated such market failures.

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