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PRESTIGE AND PROFIT:
THE ROYAL SOCIETY OF ARTS AND INCENTIVES FOR INNOVATION, 1750-1850

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ABSTRACT

Debates have long centered around the relative merits of prizes and other incentives for technological innovation. Some economists have cited the experience of the prestigious Royal Society of Arts (RSA), which offered honorary and cash awards, as proof of the efficacy of innovation prizes. The Society initially was averse to patents and prohibited the award of prizes for patented inventions. This study examines data on several thousand of these inducement prizes, matched with patent records and biographical information about the applicants. The empirical analysis shows that inventors of items that were valuable in the marketplace typically chose to obtain patents and to bypass the prize system. Owing to such adverse selection, prizes were negatively related to subsequent areas of important technological discovery. The RSA ultimately became disillusioned with the prize system, which they recognized had done little to promote technological progress and industrialization. The Society acknowledged that its efforts had been "futile" because of its hostility to patents, and switched from offering inducement prizes towards lobbying for reforms to strengthen the patent system. The findings suggest some skepticism is warranted about claims regarding the role that elites and nonmarket-oriented institutions played in generating technological innovation and long-term economic development.

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INTRODUCTION

A central question of economic growth addresses the policies and institutions that would generate ideas, inventive activity and technological innovation (Jones 2005). Recently, interest has revived among economists and policy makers in the use of cash prizes and other sorts of awards that might serve as incentives for promoting such growth-enhancing inputs. Several studies have identified important theoretical features of prize systems, and a number of scholars have further analyzed related institutions (Shavell and van Ypersele 2001; Moser 2005; Brunt et al. 2012; Lerner 1992; MacCormack et al. 2012; Burton and Nicholas 2015; Khan 2015). Specific innovation policies are frequently motivated by reference to unexamined historical case studies, even though the evidence remains largely anecdotal. For instance, the Longitude Prize of 1714 in England (which was never paid out), provides the rationale for a "new longitude prize" of £10m for solutions to the medical problems created by global antimicrobial resistance.[1] As such, there is a need for more systematic empirical evidence about the nature and consequences of technological prizes, and the historical record provides a valuable opportunity for investigating these crucial issues.

This is especially true of the European experience in the early industrial era, which featured a wide array of state-sponsored and private incentives for innovation and economic growth. Despite ongoing debates about the timing and nature of an industrial revolution, a consensus acknowledges that the pattern of technological change and total productivity growth towards the end of the eighteenth century was significantly different from the previous era (Crafts and Harley 1992). Joel Mokyr (2002; 2012) discusses how these advances in Europe were based on an "industrial enlightenment" that melded together a fortuitous and diverse array

[1] See https://longitudeprize.org. The prize board has trademarked the tem "Longitude Prize" and "reinstated the very first Longitude Committee that met 300 years ago for Longitude Prize," apparently unaware or unheeding of the unhappy experience of the first Longitude Board (Sobel 1995).

of factors, most notably the belief that social and economic progress could be attained through methodical approaches to nature, science and technology. Such communities of intellectuals and entrepreneurs as the Birmingham Lunar Society, the Dublin Society, and the Society for the Encouragement of National Industry in France, typified the incentives and institutions that could and would generate cultural and industrial progress in eighteenth-century Europe. Dowey (2014) correlates the location of membership in scientific societies with exhibits at the Crystal Palace Exhibition, and argues that elites were associated with technological innovation during the Industrial Revolution. Similarly, according to Squicciarini and Voigtlander (2015), knowledge elites (proxied by subscribers to the French *Enclyopédie*) or "upper-tail knowledge" generated industrialization and growth in France. For England, Joel Mokyr (2002) and other scholars typically identify the Royal Society of Arts in London as the canonical institution of this era.

The Society Instituted at London for the Encouragement of Arts, Manufactures, and Commerce, most often known as the Royal Society of Arts (RSA), was established in 1754 to "embolden enterprise, enlarge science, refine art, improve our manufacturers and extend our commerce." The imposing façade of the (still-existing) headquarters in London features the slogan "Arts and Commerce Promoted." The RSA published lists of items for which inducement prizes were to be offered, and these awards were administered by individual committees for the Polite Arts, Mechanics, Agriculture, Chemistry, Manufactures, as well as Colonies and Trade. Awards consisted of cash payments or premiums, and honorary prizes comprising gold and silver medals and pallettes.[2] The RSA bestowed many thousands of cash and honorary prizes to

[2] "Profit and Honour are two sharp Spurs, which quicken Invention, and animate Application" (1753 Proposal for the Society, cited in Gray's Inn Journal, 1753, p. 75). The medals had a monetary value that varied according to the price of its metal components, and the size of the medal. For instance, the gold medal was worth about £15 in the 1780s, and a silver medal around £1. In 1840, a large gold medal was valued at £13, a small gold medal a little over £6, and a silver medal was worth £1.

applicants, and is often cited as an institution that should serve as a model for the adoption of prizes.[3]

The RSA initially was convinced that its efforts were central to the process of industrial and cultural development in the eighteenth century.[4] Similarly, the correlation between the operation of the Society and the alleged "take off" of industrialization in Britain led casual observers to make a causal inference between its policy of granting prizes and the pace of technological innovation. However, others became more skeptical about such policies, including many prominent members and administrators of the Society itself. Some chroniclers (including another Secretary) of the RSA alluded to troubling concerns that their activities were redundant, since the profits associated with economic and market expansion soon "made obsolete the whole idea of encouraging industrial progress by the award of prizes."[5] Even those who regarded the institution with a more sanguine perspective nevertheless acknowledged that "the Society of Arts can take no credit for the development of the iron industry in Britain, or that of the steam-engine, and little for the creation of the Lancashire textile industry. It may even be doubted whether the awards of prizes and medals would have had the least effect in strengthening enormous economic forces."[6] Hall (1974, p. 645) similarly concludes that "such awards had negligible effects on major industrial changes." According to Golinski (1999, p. 56) "entrepreneurs

[3] For instance, Joseph Stiglitz (2006, p. 21) proclaimed that "the alternative of awarding prizes would be more efficient and more equitable. It would provide strong incentives for research but without the inefficiencies associated with monopolisation. This is not a new idea – in the UK for instance, the Royal Society of Arts has long advocated the use of prizes. But it is, perhaps, an idea whose time has come."

[4] "Whoever attentively considers the benefits which have arisen to the Publick since the institution of this Society, by the introduction of new manufactures, and the improvements of those formerly established, will readily allow, no money was ever more usefully expended; nor has any nation received more real advantage from any public body whatever than has been derived to this country from the rewards bestowed by this Society," cited in The Gentleman's Magazine (London, England), Volume 83, 1798, p. 333.

[5] D. Hudson and K. W. Luckhurst, The Royal Society of Arts, 1754-1954, London: John Murray, 1954, p. 177.

[6] Rupert Hall, "The Royal Society of Arts: Two Centuries of Progress in Science and Technology," Journal of the Royal Society of Arts, Vol. 122 (5218), 1974: 641-658, p. 644. He adds, "the main pioneers … went without recognition, perhaps because of patent protection. It is my impression that such awards had negligible effects on major industrial changes" p. 645.

preferred to trust themselves to the market economy rather than to a paternalistic reward system."[7]

The relationship between such institutions and technological innovation during industrialization has still not been established or systematically tested. This paper provides an empirical assessment of the experience of the RSA. Current patent rules and standards stipulate that intellectual property rights can only be awarded for ideas that are new and useful, and discoveries that are in the public domain cannot be protected. This implies that a choice must be made between exclusive patents and any applicable prizes. The RSA prohibited the grant of prizes for inventions that had been patented, and therefore provides a valuable opportunity to investigate the nature and consequences of inducement prizes when patents cannot also be obtained. Moreover, the Society offered cash premiums as well as valuable medals, which further allows us to assess the effectiveness in inducing inventive activity of financial incentives relative to honorary prizes and prestige. Finally, and more generally, the analysis sheds light on the extent to which such prizes contributed to the progress of "useful arts" and industrialization in Britain during this critical period.

THE ROYAL SOCIETY OF ARTS

Numerous institutions for the promotion of science and useful knowledge were founded after the middle of the eighteenth century (Wood 1913, Mokyr 2002). Early antecedents included the Royal Society, which coalesced in the 1660s as an "invisible college" for the improvement of "natural knowledge" through observation and experimentation.[8] The RSA emulated these

[7] Kent (2007, p. 214) similarly concurs that "It was ambitious and flexible individuals, not bureaucratic institutions such as the Society of Arts, who helped to initiate the Industrial Revolution."

[8] In Scotland and Ireland, individuals with more specific applied interests in agriculture and industry formed such associations as the Scottish Society of Improvers (1723) and the Dublin Society for Improving Husbandry,

organizations, and initially intended to provide the same opportunities for England alone, but soon expanded its mandate to encompass the entire kingdom, as well as the British colonies. In turn, the Society became a model for other institutions that wished to contribute to social welfare through the promotion of technological progress, in Europe and beyond.

The RSA membership expanded rapidly, drawing on patrons from the prestigious Royal Society, as well as subscriptions from influential political and social groups. In 1755, its total membership amounted to just over a hundred, but exponential growth occurred in both numbers of subscribers and subscriptions. At its peak in the 1760s, over two thousand individuals belonged to the Society of Arts, and annual subscriptions and income exceeded £4000. Noteworthy subscribers were drawn from a wide range of backgrounds and occupations, including eminent figures of the day such as Adam Smith, Edmund Burke, Jeremy Bentham, Josiah Wedgwood, Horace Walpole and Samuel Johnson. The fraction of the roster that belonged to the nobility and landed gentry increased from 10 percent in the 1760s to 20 percent in the 1780s, and included the Duke of Buccleugh, the Duke of Northumberland, and the Earl of Radnor. Merchants comprised only 7 percent of the members in 1764, and artisans, manufacturers and tradesmen a further 11 percent, although even these belonged to the upper ranks of their occupation (Allan 1979). The subscription fee of two guineas per annum (£20 for a lifetime membership) provided the largest source of income for its activities, and was sufficiently high relative to average earnings (approximately £14) that persons of lesser rank were necessarily excluded.[9]

The Society of Arts engaged in many worthwhile activities, including educational lectures, conducting experiments and diffusing information, and maintaining a repository of

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Manufactures and other Useful Arts (1731). The Dublin Society was in part funded by the government, and gave out 42,000 pounds in awards between 1761 and 1767 (Wood 1913, p. 3).

[9] Average earnings for 1750, Table 17, https://www.measuringworth.com/datasets/ukearncpi/earnstudynew.pdf.

mechanic inventions and other items of interest to technology and culture. The Society held regular exhibitions, starting in 1761, and also employed knowledgeable artisans to explain the models and displays for the benefit of visitors. However, in keeping with its founding objectives, it was primarily known for its policies towards inventions. The efforts of the Society were directed towards the provision of ex ante inducements for inventive activities, employing the twin incentives of prestige and profit. The Society published a list each year, comprising inventions or activities that it deemed deserving of rewards, which were intended to encourage potential inventors to turn their attention to meeting these perceived demands. For instance, in 1798 over 240 premiums were offered for a wide array of potential inventions (broadly defined), ranging from methods for preserving cabbages to textile machines.

The applications for prizes were considered by standing Committees which decided whether to make an award.[10] The Society was the target of persistent criticism throughout this period, including scathing assessments by its own members, who attributed outcomes to arbitrary factors such as personal influence, the persistence of one's recommenders, or the self-interest of committees. Even Sir Henry Trueman Wood (1913), long a Secretary of the RSA, was disillusioned with the general and specific operation of prize incentives. Panels of judges applied idiosyncratic criteria to the judging of applications, he noted, and some of the awards may have been motivated by other reasons than the quality of the invention, such as sympathy or friendship. Some of the drawbacks he highlighted were pragmatic, such as the inability of the members of committees to identify or predict the course of economically important new

[10]See the Rules and Order, in the Transactions of the Society Instituted at London for the Encouragement of Arts, Manufactures, and Commerce, various years. The chairman of the Committees of Premiums had to be selected from among the members whose professions were different from the focus of the particular committee. For example, a professional chemist could not chair the committee dealing with chemistry. This avoided conflicts of interest, and the possibility of "capture," but also meant that the Chair was unlikely to have the most up to date specialized knowledge of the proceedings. However, this rule did not pertain to the ordinary membership of the relevant committee.

technologies.[11] Others related to governance, and the Society was continually accused of lack of good judgement and even corruption (Paskins 2014). It was perhaps inevitable that controversies would surround the administration of prizes, but it does seem that for the most part members had good intentions and attempted to establish and revise rules for effective governance. For instance, reforms stipulated that members of the Society were not entitled to apply for or obtain awards, apart from honorary medals. Those who had a stake in a particular issue were not allowed to participate in the vetting of related applications, and were also prohibited from voting on matters that concerned relatives.

The Society of Arts adopted progressive policies towards women, and was the first such institution in Britain to include women among its members.[12] The "ingenious of both sexes" were invited to apply, and over ten percent of the premiums were given for contributions by women.[13] A number of women received notice because of excellence in nonmachine manufactured goods, such as spinning, knitting threads for lace, and the making of starch. In 1824, many awards were given to women from various parts of the United Kingdom who had made bonnets using local materials, including Mary Marshall of Ireland, and the Dyer sisters of Hampshire. More atypical items included a waterwheel, and a lever that could be used for

[11] See H. T. Wood, A history of the Royal Society of Arts, Murray, London, 1913: "A committee which could anticipate the direction in which industry or science would progress would have to be composed of men with prescience beyond their fellows" (p. 241). Instead, one finds that "various prizes were offered, and certain small improvements were duly rewarded. None of them, however, were of any great value, and, as we fully recognize now, the efforts of the Society were quite futile, and its energy was entirely misdirected" (p. 260).

[12] The original 1753 prospectus for the Society noted that "Ladies as well as Gentlemen are invited into this Subscription, as there is no Reason to imagine they will be behind Hand in a generous and sincere Regard for the Good of their Country." Patrons of the Society included the "bluestocking" Elizabeth Montagu who joined in 1758, the Countess of Denbigh, and the Duchess of Northumberland (Wood 1913). Ann Birch Cockings (c. 1766-1844) was employed as a Housekeeper/Registrar of the Society from 1802 to 1844, and wielded a great deal of influence that went well beyond her presumptive job description.

[13] "The ingenious, of both sexes, are invited to submit their works and their inventions to the inspection of the Society, …and thereby secure to themselves not only honour and profit, in the present instance, but have also the pleasing consciousness that their names will stand recorded to posterity, among those who have contributed to the increase of the Arts, the Manufactures, and the Commerce of their Country" (Transactions of the Society of Arts, Volume 16, 1798, p. xvii).

raising earth in building. The Committee for Chemistry in 1773 recognized the invention of Mrs Johanna Khruelle by bestowing £10 10s for her method of cleaning ivory carvings. However, the majority of the female recipients obtained awards from the Committee for Polite Arts, including the fine arts, sculpture and designs such as Hannah Chambers' for a candelabra, in 1757.[14]

PATTERNS OF PRIZE AWARDS

The fortunes of the RSA during the period under review were reflected through the prism of its stated objective of granting prizes to promote enterprise broadly defined. Between 1754 and 1782, the total number of premiums proposed was approximately six thousand (5932), but significantly fewer awards were actually paid out, amounting to just a third of the listed offers. As Figure 1 indicates, in terms of the policy of awarding premiums, the Society's influence peaked quite early in its existence. The first half of the decade of the 1760s was the highpoint in terms of both amounts offered and paid out. In 1763, the various committees offered 375 cash awards, for a total value of more than £18,000, along with 64 gold and silver medals. The following year 147 awards were distributed, with £2,200 in cash payments. The value of proposed payouts quickly fell, and by 1770 the number of offers had fallen to 178, for a total value of less than £3500. The gap between the amounts offered and the actual grants made widened significantly over time, in part because of a lack of claimants. Indeed, the Society likely expected that a large number of its premiums would never be paid out, since the total

[14] Mary Pingo won four prizes between 1758 and 1762, including a cash award of £5 while she was still a teenager. The Pingo family were engravers and medallists who supplied the Society, and collectively they received the greatest number of awards in the history of the Institution.

revenues in its account typically would have been substantially insufficient to cover the full value of the premiums on its list.[15]

The majority of the proposed prizes were never claimed and failed to attract any attention from inventors or even importers of inventions. It would therefore be misleading to gauge the activities of the Society, as some scholars have done, in terms of the length of the list of premiums offered.[16] Robert Dossie (1768), an enthusiastic supporter and promoter of the Society, acknowledged numerous instances in which the call for applicants failed to obtain a response.[17] It was invariably the case that the number and value of awards was disproportionately small relative to the offers, and in some instances were not directly related to the items listed. Some of the proposed projects simply were not economically feasible, such as saltpetre that could not be effectively produced in England because of the prohibitively high costs of inputs and the inappropriate climate. Many were trivial and even nonsensical, such as the 1777 gold medal for establishing a standard for the degree of sweetness in saccharine substances. Some proposed inventions had already been long discovered and were already in use.[18] In other cases, the award was regarded as inadequate relative to the market value of the

[15] For instance, in the period between 1760 and 1764, the average annual receipts of the Society was £4083, compared to a premium list with a value of £12,862 per annum. (Calculated from manuscript accounts ledgers of the RSA, and the sources given in the figure.)

[16] "The annual list of premiums proposed, form a most amusing contrast to the subjects claiming them, and the rewards actually bestowed. Judge the Society by the one, and we shall place it high in the number of the useful institutions of Europe; by the other, and it will sink to a level with the most insignificant" (The London journal of arts and sciences, 1825, p. 362). The author of the commentary attributes this pattern in part to "the trouble and expence of dancing attendance upon their long and protracted deliberations."

[17] As with other contemporary members of the Society, Dossie (1768) repeatedly documented the failure of the premiums to induce useful results, but then proceeded to disregard them in favour of optimistic conclusions about the overall effectiveness of the policies.

[18] Wood (1912, p. 264) notes that in 1782, a gold medal was offered for a cheap and portable transit instrument, but was never claimed until it was dropped from the list in 1819. "The transit instrument was invented in 1690 by Olaus Römer, the great Danish astronomer, who was the first to measure the velocity of light by observing the eclipses of Jupiter's satellites. The first transit instrument was set up at Greenwich in 1721. It is not very obvious why this prize should have been offered."

innovation.[19] For instance, the Society offered £10 for the production of a sufficient quantity of marbled paper in 1760, but increased the sum to £100 after potential applicants complained that the amount of the reward was negligible compared to the commercial value.[20] Moreover, in the absence of spillovers, the possessor of an important trade secret would be unlikely to reveal his methods to his competitors unless the present value of the award exceeded expected future revenues from his specialized knowledge, but that price was unlikely to be accurately determined by a committee.[21] Others who did not have influential connections were deterred by the bureaucratic procedures, time and expense involved in making an application.

Table 1 shows the total value of sums offered and disbursed to prize winners by the major committees of the Society between 1754 and 1782.[22] Perhaps surprisingly, during this key period of the British industrialization, the largest sums of prizes on offer were proposed for colonial projects. The primary inducements for domestic enterprise were in agriculture, in terms of the gross amount as well as the percentage of cash awards and medals. Manufacturing and mechanics together accounted for a minor fraction (10.8) percent) of proposed awards. The second part of the table displays the actual amounts that were paid out as cash prizes and medals, comprising gold and silver medals and palettes. Over this entire period, £26,704 was distributed for financial incentives, and £1510 in medals, for a total of £28,214, and the amount spent on awards accumulated to some £40,000 by 1801. Less than a half of the expenditures on prizes

[19] (Dossie 1768, p. 220) noted that a premium for ironmaking was unsuccessful because "none but the proprietors of considerable works could possibly perform what was required to be done; and they have infinitely greater inducements than the sum offered, to possess themselves of the means, if they were within their reach."

[20] Several payments were made, including one in 1763 to Henry Houseman, who had already obtained a patent for this method. Attempts to produce marbled paper predated the premium, and patents had been granted as early as 1724. Nevertheless, the Society claimed that its efforts had succeeded in encouraging the diffusion of marbling and the development of the paper industry.

[21] A 1760 premium to catch rats attracted several applicants but no premium was awarded because the information that they provided was too inadequate, since "the sum offered is not a sufficient consideration for a man to lay open the secret of a business, by which he gets his livelihood" (Dossie 1768, p. 215).

[22] Premiums that had not been distributed were often repeated in the lists for subsequent years, so the aggregate offers include some double-counting of specific items.

were allocated to inventions and discoveries in agriculture, chemistry, manufacturing and mechanics, areas that might be expected to have a direct impact on the course of industrialization. Medals were more prevalent in agriculture, comprising 15.4 percent of the value of awards, relative to less than one percent in manufacturing. Funding for manufacturing and mechanics amounted to just £4602 or 16.3 percent of the total awarded, whereas agriculture received 13.7 percent.

The overall conclusion from the table on aggregate offers is that, during the era of the industrial revolution, the attention of the RSA was largely focused on the concerns of landowners and other elites, who formed a significant fraction of the Society's membership.[23] Many of the prizes in agriculture were given to members of the nobility, and the awards in the pure arts also catered to the upper classes. At the same time, the difference between the prizes offered and those that were allocated might feasibly have occurred because of a selection effect. Inventors or creators of items that were valued in the marketplace would have an incentive to seek to appropriate returns through other channels than the grant of prizes, whereas those with innovations of low market value would have a greater incentive to obtain RSA awards. This is consistent with the greater percentage of grants (54.7 percent) relative to offers (12 percent) that occurs in the category of the arts.

In order to investigate these patterns at a more disaggregated level, a random sample of approximately 2500 prize awards was taken from 1754-1850. Table 2 shows the mean and standard deviation for cash awards in the eighteenth and nineteenth centuries. Table 3 presents

[23] The data on premiums bestowed in the different sectors, when compared with the proposed offers, reveals that in the polite arts 52 percent of proposed payments were actually made, relative to 45.9 percent in mechanics and 19.5 percent in manufacturing. By way of contrast, the fractions for agriculture, chemistry and the colonies are significantly lower (8.6, 8.8 and 5.2 percent respectively.) It is not possible to determine whether this discrepancy was due to variation in the demand for premiums, the quality of proposals, or to differential screening of applicants by the committees.

the proportion of prizes awarded by sector in each decade, and shows how their relative importance changed over time. The patterns indicate further inconsistencies with the claim that the award of prizes by the Society succeeded in generating technological innovation during the British industrial revolution. These inconsistencies are evident in the allocation of awards across and within sectors, and also in terms of the timing of the prizes in relation to that of industrial and productivity growth.

Initially, the pragmatic objective of the prize-granting committees was to aid British industry, and this was especially true of the awards to the colonies and to the polite arts. The grants to the arts was intended to facilitate improvements in the design of manufactured goods such as pottery and textiles, and to make the country competitive with the elegant and higher-quality products on the Continent. The 1758 premium list included several invitations for submissions regarding improved applied designs, including "the best drawings fit for cabinetmakers, coach makers, manufacturers of iron, brass, china, or earthen ware, or any other mechanic trade that requires taste."[24] Very few responses were received; industrial design was regarded as a "lower branch" of the tree of knowledge; and the membership of the Society was more inclined towards the "purer" arts such as paintings and sculpture. As a result, the policies rapidly shifted away from applied or industrial design, and the premiums were overwhelmingly awarded to painters, sculptors, and drawings "to encourage a love of the polite arts, and excite an emulation among persons of rank and condition," without any further rhetoric about the relationship to industry.[25]

[24] In addition, the premiums for improving the arts were justified by the fact that taste and drawing skills were "absolutely necessary to all persons concerned in building, furniture, dress, toys, or any other matters where elegance and ornament are required." See premium list of 1758.

[25] The phrase occurs in the premium list of 1758. This emphasis on fine art persisted until Prince Albert became President of the Society in 1843 and reminded the Society of its original objectives, recommending that public

A second deviation away from the original aims of the Society for the Encouragement of Arts, Manufactures, and Commerce is evident in the patterns of offers and awards for agriculture, a pursuit which also dominated the awards to the colonies. In the eighteenth century the major subscribers were gentlemen and landowners, so it is not surprising that during that period almost a half of the number of proposed premiums were in agriculture, and a significant fraction of the actual awards were for planting trees and similar agricultural improvements of interest to landed estates. Successes included the many tests and experiments that the Society sponsored, and the RSA also enhanced the diffusion of small agricultural implements. Many of these policies in agriculture undoubtedly had beneficial spillover effects that were hard to measure. At the same time, economic historians have remarked that in the second half of the eighteenth century agriculture was "remarkable for its stagnation" (Allen 1999, p. 209). The timing is also off in terms of the nineteenth century, since agricultural output and productivity increased significantly through 1850, while RSA awards in agriculture markedly dwindled in number and total value over the same period.[26]

The movement for the encouragement of British industry was essentially mercantilist in nature, and import substitution was promoted in many forms (Hall 1974, Fouster 2014).[27] The mercantilist doctrines that informed the RSA premium choices meant that a great deal of time and funds were allocated towards attempts to replicate items and inputs that already existed and

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welfare would be served more efficiently through applied arts that enhanced the nation's manufacturing sector (Wood 1913).

[26] Lim (1998, abstract) examines the premium system in English agriculture between 1754 and 1870, and concludes that "although it did lead to some new techniques and technologies, the overall impact of these on agricultural progress was not as great as contemporary literature would lead us to believe. Nonetheless, the agricultural societies and the premium system were significant channels for the communication of information during the Agricultural Revolution."

[27] The RSA often referred to the Customs list of items imported, to identify areas in which premiums should be offered. Institutions with such aims ranged from the Anti-Gallican Society that denounced French imports and offered minor prizes for domestic substitutes, to the Sublime Society of Beef Steaks that was founded to counter the pernicious effect of French cuisine.

were produced more efficiently in foreign countries. The highest average payouts in the entire period were for premiums in the Colonies. For instance, early awards were offered for the domestic production of verdigris, Turkey red dyes, madder, and marbled paper that was of similar quality to the items imported from Europe. The Society offered "Premiums for the Advantage of the British Colonies" as a means of enhancing output and trade in the colonies, but with the ultimate aim of benefiting the mother country.[28] In 1755 a premium was offered for the making of silk, and in 1771 the Society sent James Stewart to Maryland, to help with the American potash industry. The Society offered premiums of several hundred pounds for the cultivation of hemp in the American colonies, between 1760 and 1766, which failed to elicit any applications, despite changes that made the terms more favourable. The premiums offered to the colonies were typically for raw materials and natural resources, rather than for manufactured goods which would compete with the home country.

After the "present and unhappy disputes" resulted in independence for the American colonies, the Society shifted its attention to less rebellious regions, such as Australia and the West Indies, although the taste for colonial improvements had suffered a permanent setback. John M'Arthur received two gold medals in 1822, for the largest quantity and the best quality of wool imported into England from New South Wales.[29] In the same session, John Raine was

[28] Benjamin Franklin was appointed a Corresponding Member of the RSA in 1755, and when he was in London actively participated in their deliberations and Committees. In accepting the nomination, Franklin also contributed twenty guineas towards the RSA premium fund. Despite this close alignment with the overall goals of fostering technological change and economic progress, he came to disapprove of the Society's policies towards the colonies. When he was elected a Corresponding Member, the RSA indicated that "Their desire is to make Great Britain and her Colonies mutually dear and serviceable to each other: They know their Interests are the same" (cited in Goodwin 2016, p. 4). Franklin, however, ultimately concluded that the goal of the Society's premiums and awards was to benefit Britain rather than its overseas constituents, and their efforts had a net negative impact on the American economy (Burns 2005). He noted in 1770, "What you call Bounties given by Parliament and the Society are nothing more than inducements offered us… to quit a Business profitable to ourselves and engage in one that shall be profitable to you; this is the true Spirit of all your Bounties."(Goodwin 2016, p. 205).

[29] M'Arthur was a sheep farmer in New South Wales, and he exported over 15,000 pounds of fine wool that the Society judged to be of the same quality as Saxon or Spanish wool. M'Arthur had made a trip to London in 1804,

given a large silver Ceres medal for his business transactions in selling merino rams and importing wool from Tasmania, and a second medal for his imports of several tons of elephant seal oil. RSA medals were neither necessary nor sufficient inducements for the completion of such transactions. Wool was fetching high prices in the market, and the RSA Transactions of 1823 explicitly recognized that such prices served as the most effective incentive for exports from New South Wales to England.

Awards for chemistry absorbed a low but fairly steady proportion of the funding over time, and this sector offers a number of general insights into the operations of the prize system. This included difficulties in verifying quality, and in the commercialization of prize-winning methods which often were not scalable. Europeans expended a great deal of effort in replicating "Turkey red" dyes, which the French, Swiss and Indians succeeded in reverse engineering. The RSA offered a premium in 1760 and made an award, but on finding that the submitted method was ineffective, renewed the premium, making another award in 1764 which still did not achieve the desired effect. The cost of inputs, and high price of the dye, as well as the quality, limited the usage and commercial success of the prize-winning methods (Dossie 1768, p. 184).[30] The Society achieved some success in calling attention to scarcity in such areas as the production of soda made from salt, but it is likely that the market for such a solution was so profitable that no additional incentive was needed.

Over time the numbers of RSA awards in manufactures and mechanics increased, together accounting for 20.7 percent of all prizes. Total factor productivity growth during British

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and testified before the Privy Council. As a result, he received land grants in the colony to encourage his sheep farming, and was also allowed to buy stock from the King's estates.

[30] The English attempts failed until artisans from France decided to share their own trade secret. In 1781, Louis and Abraham Borell, dyers from Rouen, approached interested parties in England about their willingness to reveal the secret and received £2,500 from Parliament in 1786 for their contributions in diffusing the information about 'Turkey red' dyes.

industrialization was most evident in capital-intensive industries such as textiles and iron manufactures, and in improvements to motive power and transportation (Crafts and Harley 1992). However, Table 2 shows that the average value of prizes in this area was relatively low in the earlier period, and fell further in the nineteenth century. Closer examination of the individual awards reduces one's confidence in the economic and technological significance of the inventions associated with the prizes. For instance, premiums were offered in 1795 for spinning wheels, decades after this process had been mechanized. Less than three percent of the total awards were in transportation, and these were offered for esoteric or minor improvements in ways of examining the bottom of ships, anchors, revolving lights for boats, braces for coaches, and adjustments to carriage wheels. An assessment of the biographical details of the prize winners and the absence of the majority of recognized inventors and their canonical inventions on the list of prize winners support the argument that, for the most part, these prize-oriented applicants and their contributions to economic advances were relatively minor.[31]

PROFIT OR PRESTIGE: PATENTS AND PRIZES BY INDUSTRY

The majority of empirical studies of prizes tend to use data based on honorary awards such as medals at exhibitions. However, current policy discussions center around financial cash awards. The experience of the RSA offers a uniquely valuable opportunity to assess incentives for both profit and prestige. The rationale for the founding of the Society was the belief that creative individuals of all sorts responded positively to incentives, but RSA members were somewhat

[31] The Society itself was initially self-congratulatory and complacent about its contributions, but others dismissed its "highly coloured view of its own usefulness" and rejected the claim that the awards had an effect on such key technologies as textile machinery (Wadsworth and de Lacy Mann 1965, p. 476).[31] Wood (1913, p. 241) acknowledges that few of the canonical inventors or inventions of the industrial revolution appear on the Society's list of prize winners. For details about the British great inventors, see Khan (2015). For debates among economic historians about the Society's awards in the textile industry, see Griffiths (1991) and Sullivan (1995).

divided on whether the most effective motivation was provided by financial awards, or through appeals to honour and prestige. The consensus was that elites, whether knowledge or otherwise, would disdain financial inducements. Henry Baker, for instance, contrasted the effectiveness of "the Desire of Gain" and "the Desire of Esteem," and felt that cash prizes would serve to encourage ordinary artisans, whereas the approbation of one's peers was the most effective incentive among ingenious minds, scholars and gentlemen of high estate (Wood 1913, p. 315).[32]

Economists who support prize systems contend that patents provide socially inefficient incentives for innovation, whereas prizes offer more effective and less distorted incentives (Stiglitz 2008). Sokoloff (1988) showed that inventive activity in the form of patents significantly increased when markets and profit opportunities expanded. Similarly, other research indicates that patent incentives were evident at very disaggregated levels, especially among relatively disadvantaged groups. For instance, women's commercial activity jumped when they could financially benefit from their patenting (Khan 1996, 2016). By way of contrast, Griffiths et al. (p. 881) disagree with "economic historians [who] continue to insist that the rational pursuit of profit was the principal spur to innovative effort during the Industrial Revolution." According to Fehr and Falk (2002), economic approaches will necessarily be limited to a very narrow range of behaviour unless attempts are made to understand nonmonetary incentives based on prestige and social norms. This section therefore examines the factors that were associated with honorary awards as well as financial cash incentives.

[32] Baker (1698-1774), a fellow of the elite Royal Society, had made a fortune in teaching the deaf and dumb; he also dabbled in chemistry, for which the Royal Society awarded him a Copley Medal in 1744. Adam Smith, briefly a member of the Society, felt that pecuniary rewards were ineffective because they could not be calibrated to reflect the value of the invention, but he acknowledged that premiums given to artists might serve to increase the quality of their output at a modest cost. Dossie (1768) supposed that medals were appropriate to benefit wealthy individuals, for whom financial inducements were unlikely to be effective. Neil J. Smelser (2005, p. 83) notes that "the assets which accrue to the inventor and producer of ideas are prestige, honour and publicity… if we examine the rewards granted to inventors … the bifurcation between profit and prestige appears."

The aggregate descriptive statistics of premiums proposed and disbursed showed that the nature of the awards of the Society of Arts varied significantly in terms of number and value. Figures 2 and 3 illustrate the different types of prizes, including cash payments, gold medals and other nonmonetary awards, over the period when the RSA focused its attentions on such policies. The number of cheaper gold and silver medals increased to 117 in 1770, and to over 250 a decade later. At the same time, the cash value of both honorary medals and financial premiums exhibited a longitudinal decline, but with significant variation around the falling trend. These "prestige and profit" incentives were also unevenly distributed across different industries in the same time period. Table 4 shows that the awards for the arts shifted markedly from cash payments in the 18th century, towards honorary medals of lesser value (silver) in the nineteenth century. Gold medals were given disproportionately to individuals in the area of agriculture and the colonies. Thus, this heterogeneity provides a useful means of distinguishing the factors that were associated with these mechanisms.

Another dimension of the prize data is revealed through an examination of the extent to which the subject matter of the awards was patentable. Patentability was determined by conformity to the patent laws, and by searches in the patent records to establish whether a patent had ever been granted for that type of invention. It is noticeable that the percent of patentable prizes increased somewhat over time, but that only 14.8 percent of the awards over the entire period were patentable. As might be expected, very few of the contributions to the arts were patentable. Mechanics exhibited a high degree of patentability, but these inventions accounted for a small fraction of all the prizes. Very low patentability characterizes innovations in agriculture (5.4 percent), and chemistry (12.5 percent). Patentability was atypical even in manufacturing (37.3 percent), and the proportion fell over time from 40.2 percent to 30.6

percent. As such, these patterns are consistent with the notion that inventors with patentable discoveries largely bypassed the prize system.

The logistic regressions in Table 6 examine the variables that influenced the log odds of a specific type of inducement. The first regression shows the determinants of cash payouts relative to medals, and the second and third equations present the results for gold medals and silver medals respectively. Women were significantly less likely to receive financial awards and gold medals, and were more likely to earn minor recognition in the form of silver medals. The dummy variables for industry relative to the "polite arts" indicate that the odds of financial payments for textile inventions were significantly higher, and this was also true of prizes in chemistry. The overall explanatory power of regressions that assess variation in gold and silver medals is quite low, which is consistent with empirical studies of other prize-granting institutions (Khan 2013, 2014). Gold medals tended to be given to prize winners in agriculture and mechanics. The residents of the capital did not have a particular advantage in any of the awards, and an assessment of the composition of prizewinners outside London shows that the Society was indeed national in scope.

The regressions in Table 6 illustrate two further aspects of patents and prizes. The first is the impact of patentability on the award of prizes. Patentable inventions, or those that were characterized by the same subject-matter that was eligible for a patent award, were more likely to get a financial prize rather than an honorary award, but only marginally so. Unpatentable inventions were more likely to get the highest honorary prizes; but there was no difference in the probability of a lesser medal in terms of patentability. Similarly, one might associate greater value with an invention that was in an area that was so significant that it garnered large numbers of patents through 1890 (Cumulative patents), but such entries did not increase the probability of

gold and silver medals. These findings are again consistent with the operation of a process of adverse selection, whereby primarily low-valued patentable items were part of the prize competition.

Table 7 confirms that these patterns also hold for variation in the size of payments. The monetary value of medals was computed from the archival accounts manuscripts of the RSA, and the first regression examines the factors that were associated with variation in the value of both medals and cash awards. Frequent prize-winners ("total awards") tended to receive higher-valued prizes, either because of a reputation effect or perhaps because they were encouraged by positive outcomes to either create or submit more important discoveries. Patentability was positively and significantly associated with cash payments, suggesting that the awards were greater for the inventions with higher technical value. Despite this positive variation of awards with patentability, inventors with greater numbers of patents before application for the prize ("prior patents"), and with large stocks of career patents ("total patents") received significantly lower cash payments. These findings are consistent with the idea that patentees participated in the RSA prize competitions in order to obtain payouts for inventions that were not as valuable in the marketplace, or were not eligible for patent protection.

TECHNOLOGICAL INDUCEMENTS

A large body of research has been directed towards such incentives for innovation as property rights in patented inventions. Empirical economists who have begun to assess such alternatives as prize systems have failed to reach definitive conclusions. For instance, the Longitude prize is the most well-known of all historical awards, but a recent empirical investigation discovers little relationship between payouts to inventors and industrial advances in terms of market entry or

patenting (Burton and Nicholas 2015). This study also finds that that the probability of using the patent system increased with the quality of invention. Brunt et al. (2012) investigated the exhibitions of the Royal Agricultural Society, and contended that such non-pecuniary awards as silver medals were especially effective as inducements to inventive activity. However, the applicants were able to obtain prizes as well as patents for the same invention, implying that the type of incentive was not a choice variable.

Inventors today who wish to obtain patents are required to avoid prior use of their discovery, and would lose eligibility if their ideas were dedicated to the public domain in the form of a prize. As such, inventors need to choose between exercising the rights associated with a patent, and the benefits from an award given by a prize-granting body. The Rules and Orders of the Royal Society of Arts similarly stipulated that patented items were not eligible for prizes, prize winners were not permitted to obtain patents for their inventions, and patented inventions were not even included in the displays in the RSA repositories.[33] Their data therefore provides a unique opportunity to examine the experience of an institution whose rules implied that patents and prizes were substitutes and not complements.

A number of the members of the RSA were themselves patentees (Harrison 2006). Bryan Donkin (1768-1855), a Vice President of the Society and Chairman of the Committee on Mechanics, received two gold medals for minor machines (a tachometer and counting machine) that he submitted to the Society for awards. However, his major discoveries in printing and textiles were patented, and he not only obtained numerous patents, but also purchased the rights

[33] See the Rules and Orders of the Society, in Transactions of the Society Instituted at London for the Encouragement of Arts, Manufactures, and Commerce, Volumes 29-30, Royal Society of Arts (Great Britain) 1812: "Every person who shall receive any premium or bounty from the Society, shall relinquish all pretensions to a patent for any matter for which he has obtained such premium or bounty. No model or machine, for which a patent has been obtained, or is proposed to be obtained, shall be admitted into the repository of the Society. XV. No member who has obtained a patent for any article similar to such as may be produced to the Society, shall be allowed to vote either in the committee or Society on that subject."

to others. Jacob Perkins, a famous American inventor, accumulated a large portfolio of valuable patents from many countries. After moving to England to set up a printing enterprise that used his own patented method of engraving that was less susceptible to counterfeiting, he became a member of the RSA, probably as a way of becoming integrated in the British circle of innovators. Perkins received three medals from the Society in 1820, for inventions for which he had already obtained U.S. patents and profits.[34]

John Morris, a carpenter from Greenwich, submitted an invention for improvements in window shutters, for which the Committee voted to award him twenty guineas; however, he preferred to take out a patent and forfeit the prize (Transactions 1783, p. 239). The Society issued a public warning in 1798 when it found that one of its prize winners, Adam Scott of Guildford, Surrey was selling his award-winning plough under a patent filed under another person's name. The Committee made several experiments and Scott was given a bounty of thirty guineas in exchange for a model and information about the invention. The award had stipulated that the plough would be sold for a competitive price of two and a half guineas, but the market price he set for the patented plough was four times that amount. Scott was blacklisted from receiving any future awards, and interested parties were invited to freely inspect the specification of the invention and make their own copies at the RSA offices.[35] The matter was widely reported in the press, and he was denounced for his immoral behaviour.[36]

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[34] Perkins noted that "the principles on which they are constructed is a modification of one of the objects of a patent granted to me; yet, should the Society approve of it, I am willing to wave any advantage from it, in favour of the British public" (Transactions, 1820).

[35] "The Public are requested to guard against imposition, from persons advertising or pretending to have patents, for articles rewarded by the Society. It is a stipulated condition, that all persons who receive premiums, or bounties, from the Society, shall relinquish all pretensions to a patent for articles so rewarded, and shall allow them to be made by any person whatever." (Transactions 1798, p. xiv).

[36] In January 1780, John Mitchell sent an application to the Society, but was not considered because he disclosed his intention of applying for a patent. Mitchell instead chose to obtain Patent no. 1250, 3/30/1780, for an invention to rectify "spent lees from which soap has been made, rendering it again fit for use."

As a result of its policies, it was widely recognized that the annals of the RSA prizes were largely devoted to undistinguished contributions, and the truly significant innovations were to be found in the roster of patentees, rather than in their records. The inventor Samuel Clegg patented a highly profitable gas-meter in 1815, and the RSA gold medal was instead given for an incremental improvement on Clegg's patent. The successes of the RSA were typically in subject areas that were unpatentable, such as the 1802 medal and cash award to Henry Greathead, who also received numerous other awards from Parliament, and other institutions.[37] As one contemporary observer pointed out: "Of the importance of these discoveries the Society is by no means ignorant; but as, in connection with the majority of the industries which grew out of these discoveries, patents were obtained, the Society refused to take cognizance of them, having effectually closed its doors against all patented inventions; the necessary result, as coal, iron, and the steam engine extended their influence, was that the Society lost power and position till at length it practically died out."[38] The Journal of the Royal Society of Arts notes prizes which never received worthy applications over the course of decades, and other prizes that had been listed for problems that had already been patented.[39] The empirical results support the claim that such policies towards patents led to an adverse selection effect, because the owners of important inventions obtained patents and bypassed the RSA, whereas the owners of minor discoveries had an incentive to try to get a prize award that was likely to be in excess of the market value of their invention.

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[37] Wood censures some of the decisions that were motivated by "lamentable ignorance" (p. 210), but looks on the bright side, musing that "while a great many undeserving inventions were rewarded, there are not a great many which were rejected and which afterwards proved themselves of any value" p. 209. Henry Trueman Wood, "The Royal Society of Arts," VI.—The Premiums, Journal of the Royal Society of Arts, Vol. 60 (3086) 1912: 208-216.

[38] The quote is from an address of the Financial Officer of the Society, Samuel Thomas Davenport, "A Glance of the Past and Present of the Society of Arts, with some suggestions as to the Future," Journal of the Royal Society of Arts, vol 17, 1868: 10-27, p. 22.

[39] Sir Henry Trueman Wood, "The Royal Society of Arts VI.—The Premiums. (1754-1851) ," Journal of the Royal Society of Arts, vol. LX January 26 1912: 263-274. The other examples in this paragraph are drawn from this article. The quoted phrase appears on p. 268.

The binomial regression in Table 8 consider the consequences of such policies in terms of the impact on the future stock of inventions. The dependent variable comprises the cumulative stock of patented inventions that had been filed in the specific technology field of the prize award, through 1890. Thus, a positive coefficient would be expected if the prize were given for an influential area of technological discovery. Instead, one finds that both gold and silver medals are negatively and significantly related to the cumulative stock of future innovations. Although one can imagine other reasons for this finding, the qualitative evidence supports the interpretation that adverse selection in part accounts for the relationship. Frequent winners of awards similarly are less likely to contribute to these technologically fruitful areas of future endeavour, whereas a positive relationship existed for prize-winners who had acquired patent-specific human capital in the form of prior patents. This finding holds up even after controlling for the fact that these individuals were more likely to create patentable inventions.

Many observers and key personnel in the RSA recognized that "the exclusion of patented inventions had been extremely detrimental to the interests of the Society" (Wood 1913, 347).[40] The influential elite members of the Society were initially able to block reforms that the more pragmatic advocated, including the abandonment of the premium-granting system. However, by the turn of the nineteenth century the Society faced bankruptcy and irrelevance, and was forced to change or become extinct. In response, its policies were ultimately significantly reformed. By the time of the Crystal Palace Exhibition in 1851, the RSA had fully recognized the value of the patent system, and became active in lobbying for improvements in the problematic British patent

[40] "When the second period was entered upon, the barriers to progress were thrown down; the restrictions which had kept patented inventions and their inventors from its doors were removed… [the Society] set free invention (p. 23)."

laws along the lines of the U.S. model.[41] Contemporaries, both insiders and outsiders, noted that the drastic shift in its attitude towards patents was primarily responsible for a rapid positive turnaround in the fortunes and influence of the Society (Wood 1913; Harrison 2006).

CONCLUSION

Current policy debates that center around the relative merits of prizes and other incentives for technological innovation suffer from a lack of reliable empirical evidence. The economic history of Britain during the era of the "industrial revolution" offers valuable data regarding the sources of long term economic development. An influential cadre of economists contends that elites and their privileged institutions were responsible for the advance of useful knowledge during this period. The RSA model, it is further claimed, provides support for the efficacy of technological prizes as incentives for generating economic and technological change.

The RSA offered both financial incentives and honorary medals as inducements in areas that its elite members thought were most appropriate, such as fine arts rather than the less-valued realm of industrial design, and benefits to the estates of landowners. Prizes that were proposed and bestowed bore little relationship to the actual development of new technologies or to productive areas of industry. The RSA committees proved to be largely incapable of predicting the future course of innovation and value in the marketplace. Despite the admirable objectives of the Society, the measures it employed to induce technological innovation and industrialization proved to be rather ineffective, if not irrelevant, to the course of British economic advance.

The Society initially was averse to patents and prohibited the award of prizes for patented inventions. As a result, inventors of items that were valuable in the marketplace chose to obtain

[41] "Another reason which prevented the Society from taking cognizance of many important inventions was the regulation which excluded patented articles (Wood 1913, p. 244)."

patents and to bypass the prize system. Investigations of other prize-granting institutions in the United States find results that are consistent with such adverse selection, and it is noticeable that the vast majority of "great inventors" did not participate in prize competitions unless they wished to garner benefits owing to advertising and commercialization. Prizes were negatively related to subsequent areas of important technological discovery, likely as a result of such adverse selection. The RSA itself became disillusioned with the prize system, which they ultimately recognized had done little to promote technological progress and industrialization. The Society openly acknowledged that its efforts had been "futile" because of its hostility to patents, and switched from offering prizes towards supporting patents and lobbying for reforms in the patent system. In general, these results suggest some scepticism is warranted about claims regarding the central role that elites and nonmarket-oriented institutions played in generating technological innovation and long-term economic development.

Figure 1
Annual Premiums Offered and Bestowed by the Royal Society of Arts, 1754-1784
(£, logarithmic scale)

Source: Summary Abstracts of the Rewards Bestowed by the Society, 1754-1782, London: Royal Society of Arts, 1806; Annual Transactions of the Royal Society of Arts, London, various years; Manuscript Accounts Ledgers of the Royal Society of Arts. Notes: The cash value of gold and silver medals offered was inferred from the average values for the eighteenth century.

Table 1
Royal Society of Arts Premiums Offered and Bestowed, by Sector (1754-1782)

a) Premiums Offered (£)

Sector	Cash Prizes	Medals	Total	% Medals	% Total
Agriculture	32739	12122.0	44861	27.0	29.8
Chemistry	15125	1045.0	16170	6.5	10.8
Colonies	53480	1668.0	55148	3.0	36.7
Manufacturing	10045	585.0	10630	5.5	7.1
Mechanics	5191	333.0	5524	6.0	3.7
Polite Arts	16863	1133	17996	11.3	**12.0**
TOTAL	133443	16886	150329	11.2	100.0

b) Premiums Paid Out (£)

Sector	Cash Prizes	Medals	TOTAL	% Medals	% Total
Agriculture	3281	598	3879	15.4	13.7
Chemistry	1391	25	1416	1.8	5.0
Colonies	2786	102	2888	3.5	10.2
Manufacturing	2058	11	2069	0.5	7.3
Mechanics	2453	80	2533	3.2	9.0
Polite Arts	14735	694	15429	8.2	**54.7**
TOTAL	26704	1510	28214	5.4	100.0

Source: Summary Abstracts of the Rewards Bestowed by the Society, 1754-1782, London: Royal Society of Arts, 1806; Annual Transactions of the Royal Society of Arts, London, various years; Manuscript Accounts Ledgers of the Royal Society of Arts. Notes: The sectoral categories correspond to the titles of the Committees that administered the awards. Polite Arts includes a miscellaneous category. The cash value of the gold and silver medals offered was inferred from the average values for the eighteenth century. The column "% Medals" indicates the value of gold and silver medals as a fraction of prizes in the sector.

Table 2
Value of Cash Premiums Bestowed, 1754-1840
By industry, patentability and gender

(£)

	18th Century		19th Century	
	Mean	Std	Mean	Std
INDUSTRY				
Agriculture	23.7	35.3	27	28.8
Chemistry	36.1	27.9	16.3	13.1
Colonies	77.4	78.5	38.5	23
Manufactures	20.1	16.9	8.3	5.6
Mechanics	21.6	16.9	15.1	12.2
Polite Arts	11.5	17.2	27.5	14.1
PATENTABILITY				
Patentable	25.7	30.4	14.7	11.6
Not Patentable	15.3	24.2	17.7	18
GENDER				
Men	17.7	26.1	16.7	14.8
Women	5.2	4	4.4	3.3
TOTAL	16.8	25.4	16	14.7

Source: See Table 2. Notes: The industrial categories were assigned by the names of the Committees that adjudicated the applications and bestowed the awards. Patentability was determined by whether the item fell under the subject matter that could be eligible for a patent.

Table 3
Distribution of the Number of Awards by Industry, 1754-1840
Percentage (N=2466)

	1750s	1760s	1770s	1780s	1790s	1800s	1810s	1820s	1830s	Total
Agriculture										
Row %	3.4	52.8	11.1	2.7	12.3	7.9	5.9	3.2	0.7	100%
Col %	6.7	22.5	17.8	22.0	40.3	26.7	11.5	3.6	1.6	16.5%
Chemistry										
Row %	12.5	30.6	11.1	0.0	4.2	2.8	13.9	19.4	5.6	100%
Col %	4.3	2.3	3.2	0.0	2.4	1.7	4.8	3.9	2.2	2.9%
Colonies										
Row %	9.2	52.3	12.3	0.0	4.6	7.7	4.6	9.2	0.0	100%
Col %	2.9	3.6	3.2	0.0	2.4	4.2	1.4	1.7	0.0	2.6%
Manufactures										
Row %	9.9	44.7	10.6	1.2	3.1	2.5	3.1	17.4	7.5	100%
Col %	7.7	7.5	6.7	4.0	4.0	3.3	2.4	7.7	6.6	6.5%
Mechanics										
Row %	3.2	16.3	9.2	3.2	9.7	6.6	15.8	24.6	11.5	100%
Col %	5.3	6.0	12.7	22.0	27.4	19.2	26.4	23.7	21.9	14.2%
Polite Arts										
Row %	10.7	39.5	9.8	1.9	2.1	3.9	7.9	15.4	8.8	100%
Col %	71.8	58.0	54.6	52.0	23.4	45.0	53.4	59.5	67.8	56.9%
Total (N)	209	956	253	50	124	120	208	363	183	2466
Row %	8.5	38.8	10.3	2.0	5.0	4.9	8.4	14.7	7.4	100.0%

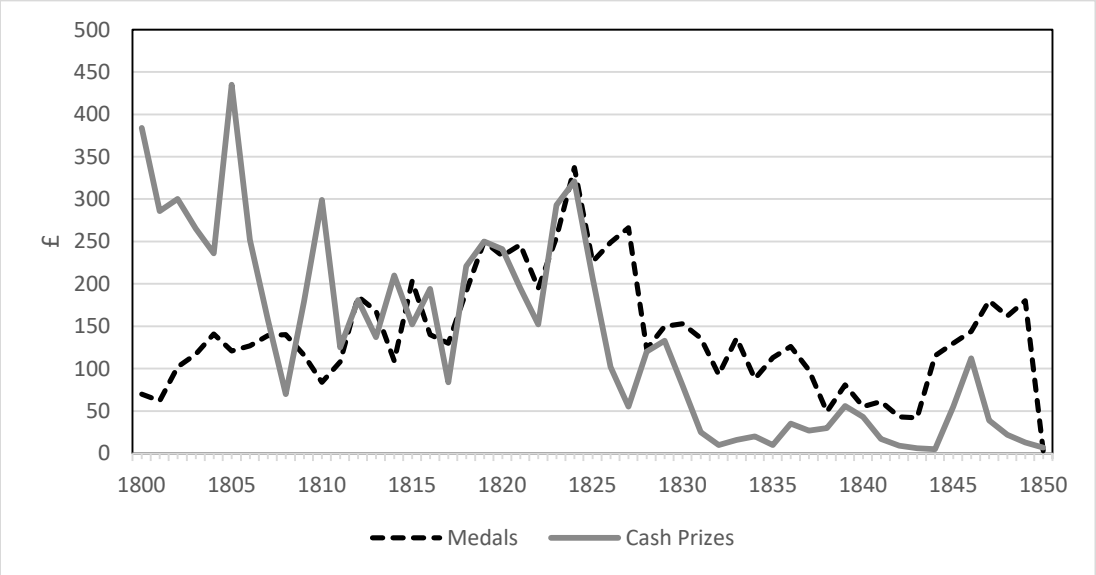
Source: Annual Transactions of the Royal Society of Arts, London, various years. Notes: The data comprise a random sample of the awards bestowed between 1754 and 1840.

Figure 2
Types of Awards: Cash, Gold Medals, Other Medals, 1754-1840
Percentage (N) by decade

Source: Annual Transactions of the Royal Society of Arts, London, various years Notes: The graph is based on a random sample of 2466 awards bestowed between 1754 and 1840. The percentages indicate the number of awards in each category, as a fraction of the total number in that decade.

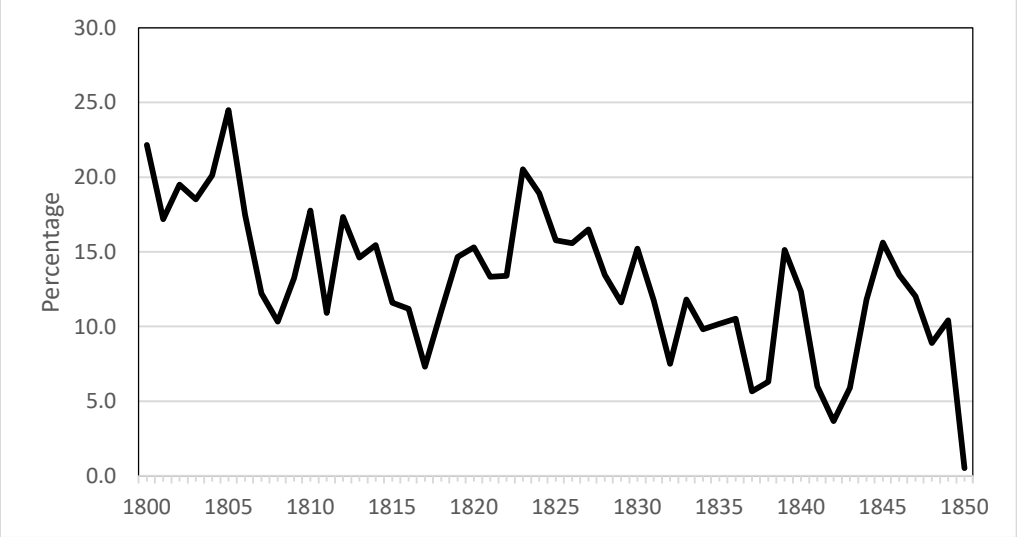
Figure 3
The Value of Financial and Honorary Incentives, 1800-1850

(a): Value of Medals and Cash Prizes Awarded (£)



Notes: RSA Accounts Ledgers (Manuscript). The figure indicates the nominal cash value of awards made in each fiscal year.

(b): Medals and Cash Prizes Awarded Relative to Total Revenues (%)



Notes: RSA Accounts Ledgers (Manuscript). The figure indicates the value of awards made, as a percentage of total receipts of the RSA in that fiscal year.

Table 4
Types of Awards by Industry, 1754-1840
Percentage (N)

		18th Century		19th Century		Total		
		Cash	Gold	Cash	Gold	Cash	Gold	Other medal
Agriculture	row %	62.7	25.7	11.1	40.3	53.6	28.6	18.2
	% all	13.2	5.4	0.9	3.3	8.8	4.7	3
Chemistry	row %	85.7	7.1	26.7	30	61.1	16.7	22.2
	% all	2.3	0.2	0.9	1	1.8	0.5	0.7
Colonies	row %	70.6	27.5	35.7	21.4	63.1	26.2	10.8
	% all	2.3	0.9	0.6	0.3	1.7	0.7	0.3
Manufactures	row %	93.8	1.8	49	4.1	80.1	2.5	17.4
	% all	6.6	0.1	2.8	0.2	5.2	0.2	1.1
Mechanics	row %	85.5	4.1	27	18.1	51.3	12.3	36.4
	% all	7.8	0.4	6.3	4.2	7.3	1.7	5.2
Polite Arts	row %	81.1	4.2	1.4	9.5	52.4	6.1	41.5
	% all	45.7	2.4	0.8	5.5	29.8	3.5	23.6
TOTAL	%	77.8	10	12.2	14.7	54.5	11.6	33.8
	N	N=1592			N=874		N=2466	

Source: See Table 2. Notes: The data comprise a random sample of the number of awards bestowed between 1754 and 1840. The types of awards include cash, gold medals, and other medals (which is the excluded category for the row percentages in the first two periods). The industrial categories were assigned by the names of the Committees that adjudicated the applications and bestowed the awards.

Table 5
Patentability of Prize-Winning Submissions by Industry, 1754-1840
Percentage (N)

		18th Century Pct Patentable	19th Century Pct Patentable	Total Pct Patentable
Agriculture	row %	4.5	9.7	5.4
	% all	0.9	0.8	0.9
Chemistry	row %	14.3	10	12.5
	% all	0.4	0.3	0.4
Colonies	row %	21.6	0	16.9
	% all	0.7	0	0.4
Manufactures	row %	40.2	30.6	37.3
	% all	2.8	1.7	2.4
Mechanics	row %	78.6	72.6	75.1
	% all	7.2	16.9	10.6
Polite Arts	row %	0.1	0.2	0.1
	% all	0.1	0.1	0.1
TOTAL				
	%	12.1	19.9	14.8
	N	1592	874	2466

Source: See Table 2. Notes: The industrial categories were assigned by the names of the Committees that adjudicated the applications and bestowed the awards. Patentability was determined by whether the item fell under the subject matter that could be eligible for a patent, and by searches of patent records during the entire period. The row percentage indicates the proportion of all awards in that sector that was patentable. The "% all" figure indicates the percentage of all awards in that period that was patentable.

Table 6
Logistic Regressions of "Profit and Prestige Awards"

Dependent Variable:	Financial Award		Gold Award		Silver Award	
	Coefficient	Chi-Sq	Coefficient	Chi-Sq	Coefficient	Chi-Sq
Intercept	159.60	448.5***	-38.55	44.4***	-123.3	485.7***
Female	-0.57	6.7***	-0.17	0.4	0.66	11.0***
London	-0.21	0.82	0.01	0.0	0.10	0.3
Cumul. inventions	0.001	3.7*	-0.0	0.7	-0.00	0.2
Patentability	1.26	16.6***	-1.24	17.1***	0.10	0.6
Textiles	4.0	84.5***	-1.50	5.8**	-3.0	50.7***
Agriculture	-0.68	20.2***	2.14	141.2***	-0.82	20.4***
Chemistry	1.36	9.3***	1.20	11.7***	-1.99	27.6***
Mechanics	0.66	4.2*	2.84	91.1***	-1.41	29.6***
Colonies	-1.42	19.4***	1.35	26.4***	-1.89	15.0***
Year	-0.09	441.0***	0.02	38.3***	0.07	477.1***
-2 Log L=	1754.3***		1488.5***		1804.9***	

Notes and Sources:
The regressions estimate the log of the odds of a specific prize being awarded, and are estimated over 2467 observations. For a description of the sample of RSA awards, see the text. The dependent variable in the first regression is a dummy variable for a financial (cash) award relative to an honorary award (medal); the second regression indicates a gold medal relative to any other award; and the second a silver medal relative to any other award. London is a dummy variable for the residence of winners. Significant technical area is measured by the cumulative number of inventions patented in the same area as the award, from the date of the award through 1890. Patentability is a dummy variable that indicates whether the RSA award comprised patentable subject matter. The industry dummies are defined relative to the excluded variable of the Polite Arts.

Table 7
OLS Regressions of Determinants of Variation in Value of Prizes

Dependent Variable:	Log of value of awards				Log of cash awards	
	Coefficient	T-stat	Coefficient	T-stat	Coefficient	T-stat
Intercept	41.83	20.7***	42.92	21.9***	93.04	28.5***
Female	-0.50	-6.9***	-0.40	-5.6***	-0.56	-4.7***
London	-0.20	-2.8***	-0.03	-0.5	-0.02	-0.1
Total patents	0.01	0.5	0.00	-0.1	-0.09	-2.6***
Total awards	0.02	1.5	0.03	3.2***	0.09	5.4***
Patentability	0.62	8.5***	0.27	2.9***	1.00	6.4***
Prior patents	-0.02	-0.4	-0.06	-1.3	0.12	1.7
Year	-0.02	-19.9***	-0.02	-21.3***	-0.05	-28.5***
Textiles			1.03	10.0***	1.80	10.5***
Agriculture			0.45	7.3***	-0.22	-2.1*
Chemistry			1.02	8.0***	1.53	7.2***
Mechanics			0.94	7.5***	0.60	3.9***
Colonies			0.53	5.7***	-0.17	-0.8
R-sq	0.31		0.37		0.46	
F-stat	155.3		119.3		176.6	

Notes and Sources:
For a description of the sample of RSA awards, see the text. The value of awards includes cash awards as well as the cash value of medals. Total patents and total awards comprise career patents and career prizes. Prior patents represents patents that the winner received before the date of the award. Patentable invention is a dummy variable that indicates patentable subject matter of the RSA award. The industry dummies are defined relative to the excluded variable of the Polite Arts.

Table 8
Binomial Regressions of Relationship between Awards and Future Stock of Innovations

Dependent Variable: Cumulative stock of future inventions

	Coefficient	Chi-Sq.	Coefficient	Chi-Sq.	Coefficient	Chi-Sq.
Intercept	-11.55	9.1***	-14.82	17.8***	-0.35	0.02
Gold medal	-1.15	109.0***	---	---	---	---
Silver Medal	-0.90	76.4***	---	---	---	---
Patentability	---	---	---	---	4.59	2430.1***
Honorary awards	---	---	-1.01	130.1***	-0.08	1.1
Frequent winner	-0.15	82.8***	-0.15	82.2***	0.00	0
Female	-0.25	5.0*	-0.24	4.5*	0.04	0.2
London	-0.02	0.1	-0.05	0.3	0.20	7.0***
Prior patents	0.10	148.2***	0.11	156.9***	0.04	95.1***
Textiles	1.69	142.3***	1.68	140.6***	0.04	0.1
Agriculture	0.77	63.7***	0.73	59.6***	0.05	0.5
Chemistry	2.87	288.9***	2.87	287.2***	0.49	13.0***
Mechanics	3.07	989.1***	3.03	1011.7***	0.07	0.5
Colonies	3.08	345.8***	3.05	341.9***	0.48	12.8***
Year	0.01	10.9***	0.01	20.5***	0.00	0.01
Log Likelihood	-6237.5		-6239.6		-4973.9	

Notes and Sources:

For a description of the sample of RSA awards, see the text. Frequent winner indicates the total number of awards received by each person over the entire period. Patentable invention is a dummy variable that indicates whether the RSA award comprised patentable subject matter. Honorary awards is a dummy variable with a value of one for medals and honorary prizes, relative to financial awards. The industry dummies are defined relative to the excluded variable of the Polite Arts.

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