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Going for Gold

Industrial Fairs and Innovation in the Nineteenth-Century United States

B. Zorina Khan*

This paper compares the award of prizes to innovation in the patent system. The data set comprises a sample of exhibits and premiums at industrial fairs sponsored by the Massachusetts Charitable Mechanic Association, between 1837 and 1874. The results shed light on the factors that influenced whether specific inventions and inventors attempted to appropriate returns through the protection of intellectual property rights, or through alternative institutions. Prize winners tended to belong to more privileged classes than the general population of patentees, as gauged by the wealth and occupation of inventors at the exhibition. Moreover, the award of prizes was less systematic than that of patents, and unrelated to such proxies for the productivity of the innovation as inventive capital or the commercial success of the invention.

LA COURSE AUX MÉDAILLES. LES EXPOSITIONS UNIVERSELLES ET L'INNOVATION AUX ÉTATS-UNIS AU XIX^{e} SIÈCLE

Dans cet article, on se propose de comparer l'attribution de prix au système des brevets d'invention. Les données comprennent un échantillon de produits exposés et primés aux expositions de l'industrie organisées par la Massachusetts Charitable Mechanic Association, entre 1837 et 1874. Les résultats révèlent les facteurs qui ont conduit des auteurs d'inventions particulières soit à tenter de bénéficier de retours grâce aux droits de propriété intellectuelle, soit à chercher des institutions alternatives. Les lauréats de prix tendent à appartenir aux classes plus privilégiées que l'ensemble des détenteurs de brevets, comme on peut l'évaluer à partir de la fortune et du statut des inventeurs lors des expositions. De plus, l'octroi de prix est moins systématique que celui de brevets, et n'est pas lié à des critères de productivité de l'innovation comme le capital inventif ou le succès commercial de l'invention.

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"Expositions are the timekeepers of progress."

U.S. President William McKinley (1901)

INTRODUCTION

Most empirical studies of the economic history of technological change have relied on patents to gauge progress in the "useful arts." According to such supporters as Abraham Lincoln, the American patent system added "the fuel of interest to the fire of genius," and the nineteenth-century certainly comprised the age of patented invention in the United States. Still, inventive activity undoubtedly occurred outside the patent system, as a plethora of case studies, biographies, and other scattered sources readily demonstrate. Moreover, in other countries patents were much more costly to obtain and difficult to enforce, likely deterring inventors from obtaining patent protection. At the same time, systematic scholarly knowledge about the extent and characteristics of unpatented discoveries is limited. The primary reason for this lacuna lies in the difficulty of obtaining objective and reliable measures of inventive activity and innovation that are comparable across time and region.

As such, one of the most pressing issues in the study of innovation is the analysis of inventions that occur outside the patent system. Research in this area has to address three central questions. The first is a policy question: which incentive mechanisms are the most effective in encouraging and inducing technological change? Of course, this is not a new question, for it was widely debated in the 19th century as individuals, firms and national economies struggled to gain competitive advantage. The United States actively promoted the diffusion of its own patent institution to other countries, but Europeans also employed an extensive array of alternative policy instruments, including public funding of research, subsidies, pensions, prizes and patent buyouts. The coexistence and overlapping of different mechanisms makes it more difficult to detect a causal relationship between any one specific method of promoting inventive activity, and subsequent outcomes. In the case of prizes, a further question arises about the level at which they should be administered, and we know little about how state-controlled prizes differ from more decentralized awards.

The second central question is descriptive: to what extent was invention occurring outside the patent system? This question can never be completely answered. Patent information has many well-known drawbacks as a gauge of inventive activity, but its use is alluring in part because we can account for the entire universe of patented inventions.[1] To attempt a full (or even adequate) census of its complement, "innovation outside the patent system," is clearly an unattainable objective, in both logical and practical terms. Inventions did remain unpatented, but it is not possible to completely catalogue them in any systematic fashion. Even the common statistic regarding the propensity to patent, an

1. Patents have well-known problems as measures of inventive activity (Griliches [1990]). Most significantly, some inventions are not patentable, not all inventors apply for patents, and not all patent applications are granted, the propensity to patent differs across industries and individuals, and patented inventions vary in terms of value.

estimate of the fraction of inventions that is patented, is hardly as straightforward as one would wish. The denominator (unpatented inventions) is typically imprecise and subject to a range of equally plausible definitions that can lead to quite different results. Thus, the research agenda calls for a triangulation methodology, whereby comparable criteria for the selection of the data, and identical questions and methods are applied to well-defined samples. We can then exploit as an advantage, rather than as an obstacle, the institutional variation that occurs outside the patent system.

Differences in rules and regulations, if precisely documented, promise insights into the nature and effects of different incentives on technological discoveries and commercialization. This bears on the third issue we need to consider: that is to say, what were the consequences of patent systems and the award of prizes in terms of the distribution of inventions and inventors, and the rate and direction of technological advance? Again, because these institutions overlap, and many inventors receive both patents and other forms of rewards, the effects are difficult to disentangle. Patent laws and their administration are explicit and transparent, leading to some measure of consistency for users and researchers alike. The most reliable sources of measures of invention and innovation outside the patent system are likely to be associated with institutions that persisted over a significant period, and enforced rules and standards toward technological discoveries that similarly permit some modicum of continuity and at least a minimal degree of uniformity and regularity in the units of observation. Pooled data that combine cross-sections over time offer insights into both spatial and temporal elements of inventive activity. Of course, problems do arise from such analysis, including small-sample biases and the potential for autocorrelation, but panels promise more degrees of freedom, more effective treatment of heterogeneity, and greater efficiency of estimators. Such longitudinal quantitative studies can then be combined with the qualitative details that historians of technology favour, to procure a more comprehensive and accurate perspective on the question of invention and innovation outside the patent system.

Fairs conducted by individuals, guilds, and other institutions, have long been a central feature of market transactions. Early in the nineteenth-century it became evident that global competitiveness in innovative technologies would play an important part in influencing the future of nations, and marketplaces for inventions became more organized. Inventors showcased their discoveries at elaborate international expositions that attracted participants from dozens of countries. Petra Moser's creative 2005 study examined the exhibits at the landmark international Crystal Palace Exhibition, which was held in England in 1851. The success of the Crystal Palace event encouraged other multinational fairs, a number of which convened in the United States. These included the Exhibition of the Industry of All Nations (1853) in New York, the Centennial Exposition (1876) in Philadelphia, The American Exhibition of the Products, Arts and Manufactures of Foreign Nations (1883) in Boston, the World Columbian Exposition (1893) in Chicago, California's Golden Jubilee (1898) in San Francisco, and the Pan-American Exposition (1901) in Buffalo.

The analysis of international exhibitions provides an important perspective on innovation outside the patent system, but these observations incorporate several shortcomings of their own. International exhibitions may not be representative of the inventive capital in individual countries, since the selection of items

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introduces biases that may be uncorrelated with technological capability. The size and content of the exhibition for any country were determined at least in part by distance and political expedience rather than by random draws from the underlying population of inventions in the nation. Each international exposition was a unique event with idiosyncratic rules and differences in period and location that makes comparisons unwieldy. Moreover, without a time-limited test of novelty, entries on display comprise a stock from an unknown and variable period, which increases the difficulty of comparisons. Patent laws differed across countries, influencing the types of inventions that were exhibited: according to American patent law, if the inventors intended to obtain a patent, public display would compromise their ability to claim novelty, hence the newest discoveries were unlikely to be included among exhibits; this would not be an issue among registration systems such as that in Britain where a patent could be obtained many years later. As for the exhibits, it was probable that they often reflected the influence and connections of the inventor and the biases or characteristics of the judges as much as the inherent inventiveness of the discovery.

The study of annual local industrial fairs provides another way to approach the question of innovation outside the patent system. These data avoid some of the drawbacks that derive from the international element and add a time series component to the cross-section that attenuate the heterogeneity of individual exhibitions. However, such data are not exempt from problems and biases of their own. Ultimately, exhibitions had to attract and stimulate the interest and attendance of members of the ordinary public, who were unlikely to be attracted by extremely complex and abstruse technological innovations. Prizes were determined by decentralized committees, and the criteria for their bestowal were not necessarily identical to the stated rules. Judges may have favoured characteristics besides novelty and inventive quality, including aesthetic appearance, and workmanship. Not all inventions are patented and, similarly, all inventions are not displayed at fairs. Some inventors might avoid fairs completely to maintain secrecy, or because they were able to appropriate returns through superior means. Elite inventors, in particular, who specialized at inventive activity and assigned their discoveries to firms either as independent transactors or as employees, were less likely to participate in such spectacles. In sum, we might conclude that both domestic and international exhibitions provided an effective means of commercializing innovations, and were perhaps less reliable at showcasing truly novel contributions at the frontier of technology.

Despite such caveats, exhibitions data do offer a systematic measure of innovation outside the patent system, and as such they have the potential to yield uniquely valuable insights into the nature of prize systems. Scepticism has increased of late about whether state grants of property rights in patents and in copyright protection comprise the most effective incentives for increasing creativity. A growing number of economists have been persuaded by theoretical models of prizes and subsidies and have begun to lobby for these nonmarket-oriented policies as complements or superior alternatives to intellectual property rights. In a reprise of debates from the nineteenth- century, extremists today refer to patent systems as "an unnecessary evil," creating "costly and dangerous" intellectual monopolies that should be eliminated (Boldrin and Levine [2008]). Such theoretical arguments cannot be fairly evaluated in light of the limited amount of actual evidence that currently exists regarding the functioning and consequences of technological prizes.

The present paper offers an assessment of the inventions and inventors that participated in recurring industrial fairs in the United States. The analysis here focuses on the exhibitions that the Massachusetts Charitable Mechanic Association organized to facilitate and generate interest in "inventive genius." This data set comprises part of an ongoing research project that explores the most prominent institutions that promoted inventions and innovations in the nineteenth century in Britain and the United States. These include the Royal Society of Arts in Britain, the Franklin Institute of Philadelphia, and the American Institute of New York. The samples from the complete data set for the United States comprise approximately 17,000 innovations that were matched in the manuscript censuses to obtain information on characteristics of the inventors, including their wealth and occupations. The inventions and inventors were further traced in patent records, so it is possible to identify key features of innovation in different contexts within and beyond the patent system.

U.S. INDUSTRIAL FAIRS AND THE PROMOTION OF USEFUL ARTS

Long before the advent of large-scale world expositions, hundreds of county and state fairs convened throughout the United States. The Berkshire fair in Massachusetts, possibly the first American county fair, was introduced in 1807; whereas the first formal state fair took place in 1841 in Syracuse, through the sponsorship of the New York Agricultural Society. Local fairs highlighted agricultural products, the output of domestic (in the sense of household) industry, and new machinery or devices that would be of interest to farmers and the fair-going public. In the earliest years, these gatherings were devoted to showcasing livestock, fruit and vegetables, handicrafts, and other farm-related commodities, and technological innovations were initially only a minor part of the show. However, as the manufacturing sector grew in economic importance and captured (indeed, often captivated) popular interest, specialized exhibitions developed to display predominantly mechanical inventions and the output from industry. The reports from such exhibitions allow us to gain further insight into the sources and patterns of inventive activity and innovation in the United States during the nineteenth-century.

The analysis in this paper is based on a sample drawn from the innovations that were displayed at the exhibitions of the Massachusetts Charitable Mechanic Association (MMA). The MMA was founded in 1795 under the auspices of Paul Revere, to "promote the mechanic arts" and "encourage the ingenious" as well as to offer such charitable aid as pensions and death benefits to its members.[2] Early on, in addition to forming a "Committee of patentees and proprietors of patents," the Association received private donations for the dedicated purpose of offering cash premiums (prizes) for specific types of innovations, such as improvements in barrel-making, that were of interest to the donors. Several members of the

2. Membership fees were quite high, ranging from an entrance charge of $25 for members below 30 years of age, through $100 for members who were over 60 years old, plus an annual $5 payment that everyone contributed.

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MMA strongly lobbied to replace these ad hoc efforts with more regular rewards for individual enterprise. They proposed an annual exhibition where deserving inventors would be honoured, information about discoveries would be diffused, and the public would be educated as well as entertained. Encouraged by the examples of the Franklin Institute in Philadelphia and the American Institute of New York, the MMA held its first major exhibition and fair in the fall of 1837.

The 1837 exhibition proved to be enormously popular and, what is more, profitable, encouraging the organizers to hold fairs on a regular –roughly triennial– basis. Table 1 shows the number of exhibits that are included in the sample that was drawn from the entries at each fair. Figure 1 itemizes the total receipts, expenditures and profits for each exhibition through 1890. The early exhibitions were held in Faneuil and Quincy Halls in Boston, but by the end of the century the MMA had its own dedicated hall on Huntington Avenue, conveniently close to major transportation arteries. At the second exhibition in 1839, the two-week event attracted some 70,000 visitors, at a time when the population of Boston was approximately 93,000 residents. This fair included 1196 exhibits, which were awarded 25 gold medals, 133 silver medals, and 254 diplomas. By 1890, the halls displayed the efforts of 1,300 exhibitors, and the medals included 55 of gold, 175 of silver, and 144 of bronze, along with 235 diplomas.[3] The 1890 fair ran for two months, and total attendance was estimated at 500,000, about the same as the population of the town. At the conclusion of each fair, some of the exhibits were sold to the public, but the organizers discouraged itinerant traders who specialized in selling their wares through conventions like these, and attempted to ensure that the exhibition represented the "latest and best in our industrial life, and not a bazaar for the sale of merchandise."[4]

According to its organizers, the exhibits at the MMA industrial fairs promoted "the best specimens of American ingenuity and skill, in every branch of mechanics, rare and valuable productions natural and artificial, labor-saving machines, implements of husbandry, and models of machinery in all their variety, and for superior workmanship in all useful and ornamental branches of the arts, including the beautiful and delicate handiwork of females in every department of industry."[5] Gold medals were granted "only for very valuable and meritorious inventions or improvements" and silver medals for "articles of superior workmanship, new applications of material, and improvements in construction." In addition, bronze medals were awarded for "articles of superior workmanship, but of less importance or utility," while diplomas were bestowed on "all other articles deserving a favorable-mention testimonial."[6] Although the stated objective was to draw attention to domestic enterprise and technological innovation, it was also expected that the Association would recoup its outlays on the

3. "Who has been? or mayhap the question may be more properly put, Who has not been? during the past month, to the Exhibition of the Massachusetts Charitable Mechanic Association. When the number of visitors has grown to near a score of thousand in a day, it may well leave us wondering who of the multitudes have been omitted." *The Repository*, vol. 51, 1874, p. 396.

4. *Annual Report, MMA,* 1892, p. 11.

5. Massachusetts Charitable Mechanic Association, p. 6, *The Exhibition and Fair in the City of Boston, September 18, 1837.* Boston: Dutton and Wentworth, 1837.

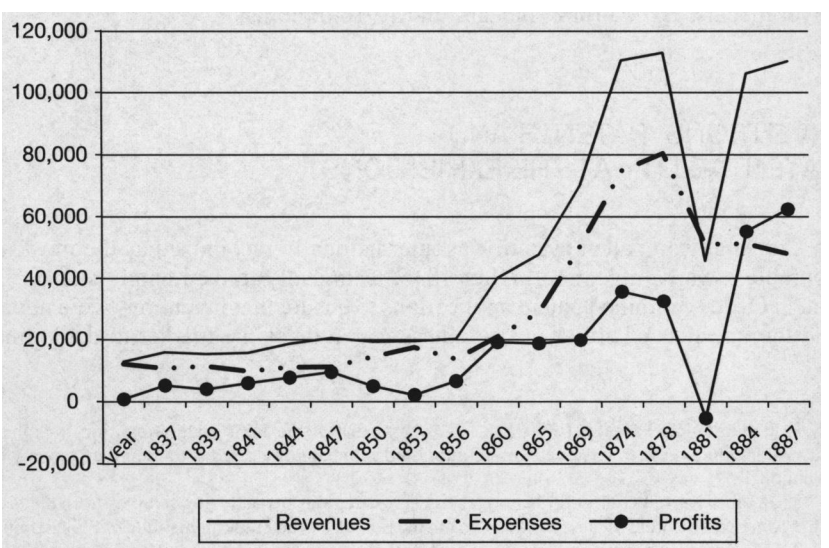
6. Massachusetts Charitable Mechanic Association, p. 6, *The Exhibition and Fair in the City of Boson, September 18, 1837.* Boston: Dutton and Wentworth, 1837. Judges comprised "gentlemen of character and standing, and as far as is practicable of thorough technical knowledge of their respective subjects [...] who will in no case be competitors for premiums."

Table 1. *Sample size in each exhibition year with percentage of total sample from 1837 through 1874*

Year	No. of Observations	Percent of sample
1837	259	5.02
1839	283	5.49
1841	287	5.56
1844	315	6.11
1847	386	7.48
1850	376	7.29
1853	367	7.11
1856	546	10.58
1860	524	10.16
1865	561	10.87
1869	558	10.82
1874	697	13.50

Notes and Sources: Reports of the Massachusetts Mechanics Charitable Association, various years.
The years refer to the date of each exhibition. The sample was drawn from exhibits that included a minimal degree of technological content. See text.

Figure 1. *Net Income from the Massachusetts Mechanics Association Exhibition, 1837-1890*



Source: Massachusetts Charitable Mechanic Association, *Annals of the Massachusetts Charitable Mechanics Association, 1795-1892*, Boston: Rockwell and Churchill, 1892.

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exhibition from the admission fees that the public paid to attend the fair, since exhibitors were not charged for space. This dual objective of the MMA industrial fairs required some compromises, because extremely complex machinery held little appeal to the tastes of the fair-going public, whereas interest was more sustained among visually attractive specimens. This emphasis on appearance and workmanship rather than novelty was also a feature of international expositions such as the Crystal Palace Exhibition of 1851 and the Paris Exhibition of 1867.[7] Observers noted that the halls of complicated mechanical exhibits were not as crowded as those with more spectacle and colour.

Some of the participants traveled from New York, Philadelphia, and as far away as Michigan and Ohio, but the MMA exhibition remained primarily a display of technologies that originated in Massachusetts and, to a lesser extent, New England. Thus, the population of goods exhibited at these localized fairs is largely unaffected by the bias that results from disparate transportation costs if variable distances were traveled.[8] The sample comprises 5,158 exhibits from the first twelve fairs, and includes exhibits that could be regarded as potentially possessing a minimal degree of technological innovation. That is, the data exclude such entries as fine art paintings, sculpted busts, botanical specimens, displays of published books, artistic designs, confectionery and simple baked goods. Even with such filtering, the catalogued submissions were characterized by enormous variance in subject matter, substance, and technological input. One way of ensuring at least a modicum of uniformity in these dimensions is to limit the universe of items using a minimal criterion of quality. Bronze medals and diplomas were cheap and plentiful, given for exhibits that were relatively undistinguished, and almost never mentioned in subsequent records when itemizing accolades that an inventor or invention had earned. Accordingly, the data set consists of all exhibits for which medals were awarded, and a random sample of the items that were accorded diplomas; amounting to 298 gold medals, 1,739 silver medals, 1,200 bronze medals, and 1,916 diplomas.[9]

INVENTIONS, PATENTS AND PATENTABILITY AT THE EXHIBITIONS

The American patent system was internationally recognized as the most favourable towards inventors. After 1836, technically trained employees of the Patent Office examined patent applications to ensure that inventions were novel, and the question of utility or usefulness was left for the market to determine.

7. For instance, Palmieri ([2003], p. 131) notes that at the Paris Exhibition "jury members and visitors alike seem to have been more interested in the quality of construction than novelty of invention."

8. In other work, I control for heterogeneity across regions by analyzing samples from the fairs of the American Institute of New York, and from the records of the Franklin Institute of Philadelphia.

9. The percent of items awarded any recognition varied from 34 percent to 50 percent, and increased over time. However, the assessment of what this implies is not straightforward, because the organizers became more selective and rejected more items over this period. Such undocumented variation is another reason for being more careful about the conclusions that can be drawn from exhibition data.

Patents were granted only to the first and true inventor, and neither employers nor the government could obtain property rights for the work that their employees created, except by means of contractual assignment. Patentees were required to fully disclose their incremental contribution to the technology, and to distinguish between their own efforts and those of prior inventors. The inventor could be barred from rights of exclusion for undue delay in applying for property rights protection, or if it was ruled that the idea had been ceded to the public domain. Patentees were not only prompt in applying for protection for ideas they had reduced to practical use, they even filed caveats notifying the Patent Office of the progress of their invention before formal application. Consequently, it was unlikely that an intended patentee would display his invention at a public exhibition prior to filing the patent; instead, patent applications certainly would have been submitted beforehand.[10]

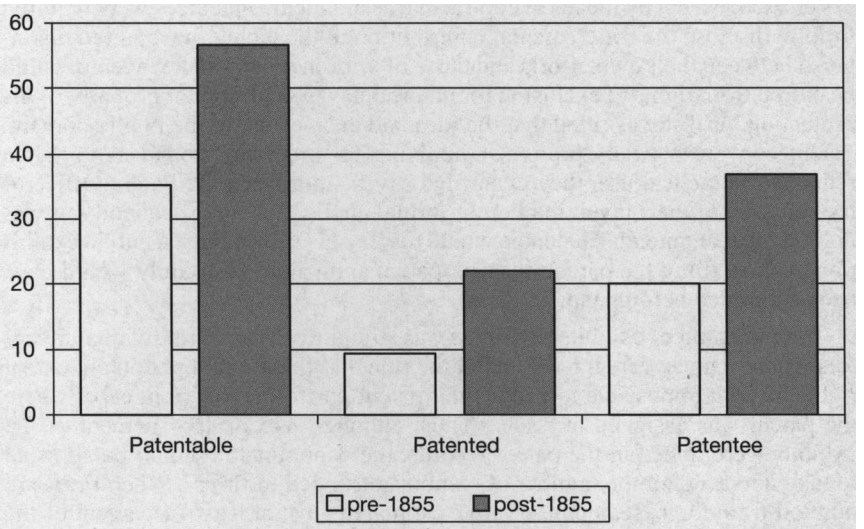
The matching of exhibits to patents was straightforward for individual inventors whose names were traceable, but the rule that firms could not obtain patent rights made it impossible to gauge their patent portfolios except in cases where the patent was assigned at issue. Thus, although 845 or 16.4 percent of the exhibits were traced in the patent records, the denominator should be adjusted to take into account the number of exhibits attributed to firms. When firms are omitted from the base, a conservative estimate is that at least 24 percent of the exhibits were patented, and this figure increased over time. Firms were more likely to own larger amounts of patents than individual exhibitors, so the omission of firms from the calculations of the propensity to patent biases estimates downward. The "exhibitor is patentee" variable in Figure 2 further identifies the number of exhibits whose exhibitors obtained at least one patent at some point in their career, even if the specific item at the fair was not patented. Again, the representation of patentees is higher in the second period, and at least 29.5 percent of the exhibits were credited to patentees (43.4 percent if adjustments are made for firms). These data suggest that prior research significantly underestimated the practice of patenting in the nineteenth-century. At the same time, it is also true that a considerable and diverse amount of creativity at invention was indeed occurring outside the formal patent system, and it is interesting to speculate why such items were not patented.

First, some might argue that such inventors actively rejected the patent option, and instead decided to appropriate returns through other means such as trade secrecy.[11] However, secrecy seems somewhat implausible as a general explanation, for it is unlikely that secrecy would be promoted by participating in a public exhibition. Second, inventors may have compared the costs of getting and enforcing a patent to the benefits of patent protection, and decided that the net present value of patenting was negative. If so, this suggests that many of these unpatented inventions may have been of minimal economic value. Third, a

10. In the matching of patents and exhibits, exact wording of exhibits and patent descriptions were deemed to be for the same invention only if the patent had been awarded in the same 12-month period as the exhibition. As a result of delays between the period of filing and grant, which ranged from a few months to a little over a year, it was possible for an object for which a patent application had already been filed to be exhibited prior to the official date recorded in the patent grant.

11. For a survey of alternative methods of appropriation see Levin *et al.* [1987]. Teece [1986] highlights the control of complementary assets. An anonymous referee suggests that inventors might have been participating in industrial fairs in order to enhance their reputation and exploit a lead-time strategy, which is likely to apply primarily in the case of commercializers such as factory owners.

Figure 2. *Patenting and Patentability of Inventions in the* MMA *Exhibitions* (percentages)



Notes and Sources: The MMA sample was matched with the patent records to determine whether the invention at the exhibition was patentable ["patentable"], whether the inventor had obtained a patent for the exhibited Invention ["patented"], and whether the exhibitor had ever obtained a patent over the course of his entire life ["patentee"]. See text for details.

straightforward explanation is that many exhibits were simply not eligible to be considered for a patent, either because the degree of novelty or improvement was minimal or because the innovation fell outside the subject matter that could be patented. Although such innovations could have been commercially valuable, and did indeed garner medals, it is useful to distinguish between exhibits that were eligible for patents and those that were not.

It is not feasible to determine the amount of novel inventive capital vested in unpatented exhibits, but we can categorize the patentability of each item in terms of subject matter. For instance, items that just featured higher quality workmanship, and mere changes in appearance or form (decorative flourishes, or silver plating used in place of wood) were not patentable, and neither were better ways of raising silkworms, artificial gardens, jewelry, ivory combs, hand-cut crystal, glass door knobs, perfumed soaps, decorative improvements in rugs and the patina of pianos. Application of this minimal filter of subject matter suggests that less than half, or a total of 47.2 percent of the sample, was patentable. This in turn indicates that at least 34.7 percent (845 patents out of 2,436 patentable exhibits) of eligible items were covered by patent protection. A closer assessment of the unpatentable items reveals that a large fraction comprised final or consumer goods, a finding that supports the conventional view that patents may be a better measure of inputs than of output. Patentability statistics thus indicate that much of the creativity that we observe in exhibitions was quite different from the creativity that resulted in patents or in enhanced capacity for economic growth.

I allocated the exhibits to a sector and industry according to the final use of the innovation. In the period between 1790 and 1850, 22.3 percent of national patents in the United States were in agriculture, 16.7 percent in construction, 40.1 percent in manufacturing, 12.8 percent in transportation, and 8 percent in the miscellaneous category.[12] In contrast to the relatively more even sectoral dispersion of patents, the majority of the entries at the MMA fairs fell into the manufacturing category. Thus, although the exhibition data reveal higher rates of innovation in manufacturing than the patent records show, patent protection extended to a wider range of creative activities than those at the MMA. However, previous studies of patenting have found that the propensity to patent and other dimensions of inventive activity varied in terms of narrower classifications, so the exhibits were also allocated to twelve more detailed industrial categories.

Table 2 presents the industrial distribution of the exhibits, their patentability, and those that were actually patented. The table also includes the distribution by industry of the medals and diplomas awarded. Heat and power-related innovations (ranges, furnaces, lamps, electrical goods and the like) accounted for 9.7 percent of the entire sample, but 19.1 percent of the patentable and 18.6 percent of patented entries. In comparison, apparel comprised 6.2 percent of all innovations, but only 1.4 percent of those that were patentable, and still less of those that were patented. Chi-square tests confirm that the patentable exhibits, as well as those that were patented, varied significantly across industrial category. However, the shares of the total number of awards comprised 5.8 percent gold medals, 33.8 percent silver, and 23.3 percent bronze medals, and there is little variation in these allocations across industries. Transportation accounted for 6 percent of all exhibits, and garnered an equivalent proportion of each category of award. In other words, the medals in each industry were proportional across the different industrial lines, a conclusion that is supported by the finding that statistical tests of independence are not significant. This lack of variation across such disparate technologies raises the possibility that the award of medals was largely unrelated to the quality of inventive input, and may simply have been apportioned on a quota basis to each technology class on display.

WHO WENT TO THE FAIR?

The MMA's stated objective was to showcase the newest products and mechanisms, and exhibitors were required to highlight improvements that they had made to former goods, but it was still possible to be credited for inventions that had been created several years before. In many respects, although the explicit entry costs were close to zero, the MMA exhibitions were more analogous to European patent systems based on registration, rather than the American examination system. First, in the absence of an examination for novelty, it is difficult to ascertain whether an item comprises an invention (a new creation) or an innovation (early commercial application). Second, it should be noted that exhibitors were not necessarily the inventors, but according to the rules of the organization were still eligible to receive the credit for the innovation. Third, it is unclear

12. Khan [2005], p. 63.

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Table 2. *Industrial Distribution of Exhibits at Massachusetts Mechanics Association Fair, 1837-1874*

INDUSTRY	Total	Patentable	Patents	Gold Medal	Silver Medal	Bronze Medal
Agriculture (n)	358	200	73	20	129	81
Col %	6.9	8.2	8.6	6.7	7.4	6.8
Row %		55.6	20.4	5.6	36.1	22.7
Apparel (n)	319	33	6	18	95	66
Col %	6.2	1.4	0.7	6.0	5.5	7.3
Row %		10.3	1.9	5.7	29.9	20.8
Arts (n)	609	167	40	39	95	66
Col %	11.8	6.9	4.7	13.1	12.4	11.3
Row %		27.4	6.7	6.4	35.5	22.2
Construction (n)	329	185	79	19	113	79
Col %	6.4	7.6	9.4	6.4	6.5	6.6
Row %		56.2	23.9	5.8	34.2	23.9
Furniture (n)	305	75	38	11	95	73
Col %	5.9	3.1	4.5	3.7	5.5	6.1
Row %		24.6	12.5	3.6	31.2	23.9
Heat & Power (n)	499	464	157	33	150	143
Col %	9.7	19.1	18.6	11.1	8.6	11.9
Row %		93.0	31.5	6.6	30.1	28.7
Manf. Machines (n)	493	441	125	36	161	133
Col %	9.6	18.1	14.8	12.1	9.3	11.1
Row %		89.5	25.4	7.3	32.8	27.1
Manf. Goods (n)	898	350	144	52	307	179
Col %	17.4	14.4	17.0	17.5	17.7	14.9
Row %		39.0	16.0	5.8	34.2	19.9
Printing & Publish. (n)	295	71	22	12	100	69
Col %	5.7	2.9	2.6	4.0	5.8	5.8
Row %		24.1	7.5	4.1	33.9	23.4
Scientific (n)	132	51	17	9	41	26
Col %	2.6	2.1	2.0	3.0	2.4	2.2
Row %		38.6	12.9	6.9	31.3	19.9
Textiles (n)	620	185	71	31	226	140
Col %	12.0	7.6	8.4	10.4	13.0	11.7
Row %		29.8	11.5	5.0	36.5	22.6
Transportation (n)	300	214	73	18	106	76
Col %	5.8	8.8	8.6	6.0	6.1	6.3
Row %		71.3	24.3	6.0	35.3	25.3
Total (n)	5,157	2,436	1521	298	1,739	1,200
%	100	47.2	29.5	5.8	33.8	23.3

Notes and Sources: See text. The percentages in the table include the undisplayed calculations for a total of 1,915 diplomas that were awarded to 37 percent of the exhibits in the dataset.

whether annual records consist of stocks drawn from former inventions created several years prior to the date, or flows of the latest discoveries. The way in which patent registration systems and exhibitions blur the line between invention and innovation is illustrated by the prevalence of business enterprises at the fairs. As shown before, approximately one third of the sample consisted of firms, whose primary objectives clearly included commercialization and advertisement of merchandise that might have had little to do with original or novel inventive activity. If firms had the intention of showcasing their best new inventions, it might be expected that they would tend to win a disproportionate amount of the better prizes awarded. However, their share of each category of medal was roughly proportionate to their share of all items exhibited.

It seems plausible that individual exhibitors had more mixed objectives than those of firms, that likely ranged from the pursuit of financial gain to personal gratification. However, the average age of the exhibitors (40.5) were a close match to the average age of patentees (38.5) and seem to suggest the pursuit of more systematic goals than glory. Although the typical number of appearances in the roster of medals and diplomas was two, for most attendees recognition at the fair was a unique event, since two thirds of these exhibits were entered by owners who only won a single award. The average number of patents that were granted to patentees nationwide (sampled in 1860 and 1870) over the course of their career was 6.3. This suggests at least in part that patentees possessed a greater degree of commitment to technological discovery than inventors who participated in exhibitions. This is consistent with the finding that only a few of the exhibitors (such as Jordan Mott, Moses Farmer, Jonas Chickering, Timothy and Lemuel Gilbert, and sewing machine entrepreneurs Wheeler and Wilson, among others) possessed technological "brand name recognition," in comparison to the much longer list of relative unknowns.[13]

The organizers of the exhibition actively encouraged women to submit entries, expecting that their "taste and delicacy" would conduce to more visually appealing displays. Towards the end of the century special gallery space was set aside for a "Woman's Department," with the intention of encouraging "only those lines of woman's industries of intrinsic value and practicable as a means of obtaining a livelihood. The manufacture of certain classes of fancy articles –notably crazy quilts and elaborate trifles– was not encouraged."[14] Still, for the most part, women tended to exhibit unique works of craft, clothing, household and domestic enterprise. The category of "needle work, millinery goods, artificial flowers" was dominated by women participants (including a "young squaw of Arkansas" and the precocious 11-year old Miss Caroline Harris of Boston). Women accounted for approximately 10 percent of the sample, a significantly higher proportion than the 1 percent of patentees that were female. The fraction that earned medals, however, was closer to the patenting rates: only 25 (0.5 percent of the full sample) obtained a gold medal, 157 (3.1 percent) silver medals,

13. This is an unsystematic claim, based on Google searches for biographical information about the exhibitors, ancestry.com research, and on my personal knowledge of technological history.

14. *MMA Exhibition Report* [1887], p. 16. "Another notable feature of the Exposition were the inventions of women. It has been so often reiterated that women are not inventors, that many have fallen into the trap of believing the statement. To all such, the eye evidence which they received at the Fair, that the inventive genius of women is rapidly developing, will be a beneficial correction of their misapprehension." (*The Repository*, vol. 51, 1874, p. 396.) Such ebullient declarations seem to derive from generous or chivalrous instincts rather than the actual records of the exhibits.

and 86 (1.7 percent) received bronze medals. The gold medals to women exhibitors were awarded for such creations as wax flowers, decorative furniture, bonnet trimmings, and shellwork.[15] None of the women participants in the sample ever obtained a patent, and few created items that were patentable. For instance, Mr. and Mrs. A. Brooks of South Scituate, Massachusetts presented samples of silk from cocoons that she raised (not patentable), spun into thread using a machine that he invented (patentable subject matter). These records, taken in tandem with the patterns of patenting, suggest that for much of the nineteenth century women's creativity was not market-oriented, and the majority of their innovations tended to be limited to the household sector.

OCCUPATIONS AND WEALTH OF EXHIBITORS

Prior research has suggested that patent institutions in the United States promoted a process of market-oriented democratization (Khan [2005]). In some instances, new technological discoveries are difficult to finance because of asymmetries in information and other capital market imperfections, giving an advantage to wealthier or more well-connected inventors, who might be better able to fund marketing and production of their discoveries and innovations themselves. In Europe, the high cost of patent rights and obstacles in their enforcement comprised additional barriers to inventors with only modest financial resources. However, talented but impecunious nineteenth-century American inventors could readily specialize in their area of expertise, and appropriate the benefits from their endeavours through an extensive market for patent rights (Lamoreaux and Sokoloff [2001]). A system that offers greater accolades to elites has different implications for economic prospects than one that promises rewards will accrue to the most productive, so it is worth investigating the extent to which such patterns characterized technological advances throughout the United States, irrespective of institutional context.

An examination of the occupations and status of U.S. patentees supported the notion of open access to the benefits of patent institutions (Khan and Sokoloff [2004]; Khan [2005]). The majority of early patentees were quite unspecialized, and the increase in inventive activity that Sokoloff [1988] identified was generated by an influx of individuals with little prior experience at technological innovation in the form of patents. During the antebellum period, the majority of patentees comprised artisans (approximately one third) and manufacturers (21 percent), whereas the elite social class of merchants, professionals and white collar workers decreased over time. The importance of more technically-qualified machinists and engineers grew substantially over this period, but such skills were hardly necessary even for significant discoveries, as studies of the "great inventors" reveals. Great inventors who made significant contributions to productivity growth and economic progress came from a diverse range of occupations and socioeconomic backgrounds. The most valuable inventions of

15. The Maryland Institute for the Promotion of Mechanic Arts organized an exhibition in 1850 which rewarded creativity by gender: they presented men with gold and silver medals, whereas women received butter knives, ladles, tea spoons, pencils and thimbles.

the time, such as Thomas Blanchard's lathe or Cyrus McCormick's reaper, were typically based on commonly available information applied to a bottleneck or specific practical problem that the inventor encountered on the job.

As discussed before, a key mandate of the Massachusetts Charitable Mechanic Association was to advance the standing of innovative workers and artisans. Nevertheless, Figure 3 shows that participants in the fairs were drawn from more prominent occupations than the general population of patentees.[16] Indeed, exhibitors were less likely to be artisans and ordinary labourers (in the 'other' category) than were patentees, even though these estimates for the MMA data exclude the category of firms from the analysis. The representation of artisans at the exhibitions also declined over time: among those who participated at the fairs before 1855, 156 or 24.1 percent were artisans, compared to 18.5 percent after this period. It was, of course, possible that the innovations firms displayed were created by artisans in their employment. However, the point is that, when appropriating returns on their own account, inventors without social backing were more likely to turn to the patent system. At the same time, it is true that occupational class does not directly translate into economic or social status or influence, as witnessed by the MMA's founder, Paul Revere. For this, despite the flaws in the census surveys, we turn to the records on wealth-holding in the federal population censuses of 1850, 1860 and 1870.

The information on wealth allows us to more directly assess the economic status of exhibitors relative to patentees in general.[17] Lee Soltow estimated that the white male population owned an average of $2,231 and $2,141 in real estate in 1860 and 1870 respectively, and an average of $1,549 and $966 in personal property over the same period. He found it to be "rather shocking" that 57 percent of white men in 1860 possessed no real estate wealth, and 43 percent owned no personal estate, a pattern that was maintained in 1870.[18] My own estimates indicate that, on the eve of the outbreak of war, poor patentees were on average rather like the general population. Over a half of all such inventors held no real estate, and over a third recorded no personal wealth. Poor inventors were somewhat more likely to assign their inventions so it is not surprising that, unlike those with lower human capital in the general population, many of these inventors had acquired assets within the following decade. Thus, patentees in general experienced greater economic mobility than the American population between 1860 and 1870. The gains over this period in terms of both personal and real wealth were especially evident for patentees at the higher end of the wealth distribution.

The data for the three decades in which the federal population census provides information for wealth reveal that the participants in the Massachusetts

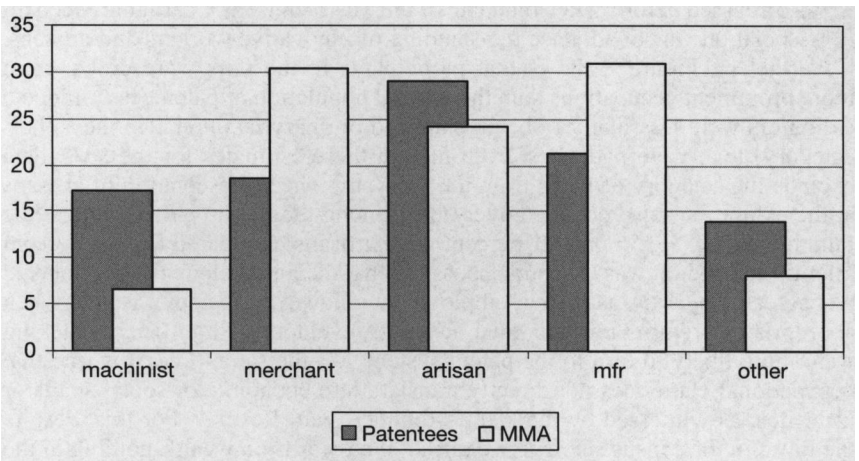
16. The diplomas of the exhibition included "a procession of artisans" who were presenting their inventions as candidates for prizes (see appendix).

17. The 1850 census measures real estate wealth, whereas the 1860 and 1870 censuses included information on real estate wealth, exclusive of "liens or encumbrances," as well as personal estates comprising all personal property "consist of what it may." These entries are not entirely accurate, because of missing values, left-censoring of observations around values of $100, and "clumping" around popular figures such as round hundreds. However, they do suffice to give a general sense of the material standing of the two groups.

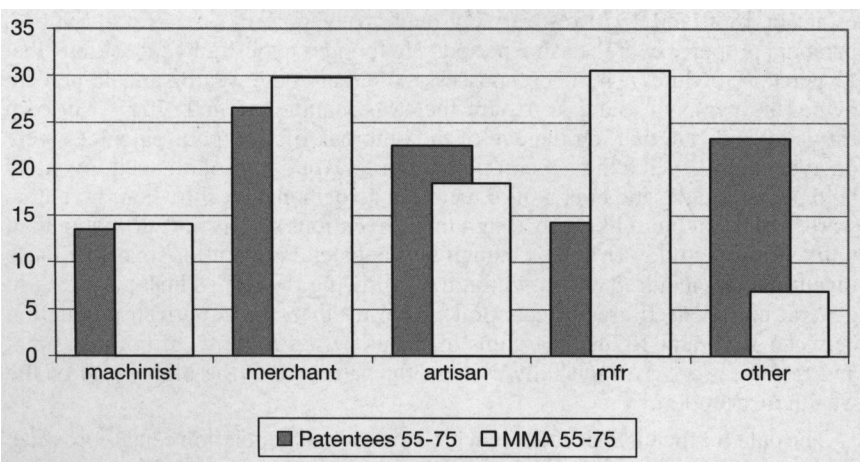
18. See Soltow ([1975], p. 60)."Patterns [between 1860 and 1870]... were remarkably stable. The most striking finding was that this country harbored vast proportions of populations with no wealth" (p. 61).

Figure 3. *Occupational Distributions of Patentees and MMA Participants, 1835-1875*

3a. *Occupations for Patentees and Exhibitors at MMA*
(Percent, 1835-1850)



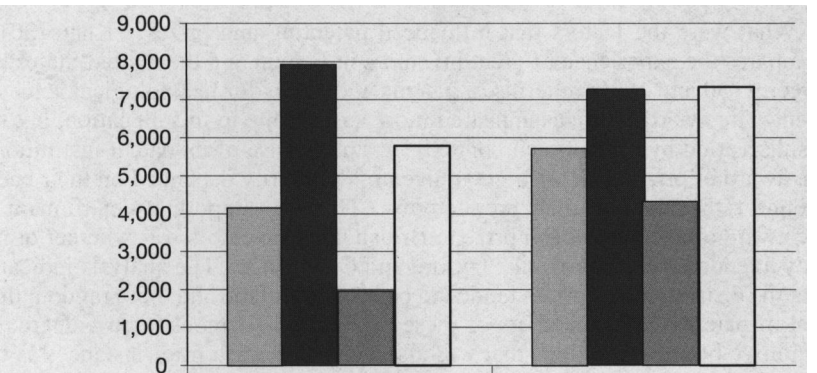
3b. *Occupations for Patentees and Exhibitors at MMA*
(Percent, 1855-1875)



Notes and Sources: The MMA sample was matched with the manuscript population census that was closest to the date of the exhibition to obtain occupations. Patenting was determined by matching the exhibitors to patent records. See text.

exhibitions were substantially wealthier than the general population. Recall that these data do not include information on corporations and companies whose owners could not be identified, which is likely to bias the estimates of property-holding downward for the MMA sample. Forty six percent of the exhibitors owned no real estate, and 32 percent had no personal property. Nevertheless, Figure 4 illustrates how the assets of the exhibitors significantly exceeded that

Figure 4. *Real and Personal Wealth of Patentees and MMA Exhibitors, 1860 and 1870*



	1860	1870
Real-Pat	4,158	5,710
Real-MMA	7,926	7,190
Personal-Pat	1,948	4,316
Personal-MMA	5,787	7,335

Notes and Sources: The MMA sample was matched with the manuscript census that was closest to the date of the exhibition. This resulted in 404 matches for 1860 and 329 matches for 1870, over which these averages for real estate and personal wealth were estimated. Missing values are treated as zero. Wealth is expressed in terms of real 1,860 dollars. For the sample of ordinary patentees in 1860 and 1870, see Khan, "Creative Destruction" [2007].

of the sample of general patentees. In 1860 the MMA sample owned average personal property of almost twice that of patentees in general, and more than double their average real estate holdings. A number of these individuals were exceptionally wealthy for this era. Edward H. Ashcroft, who possessed $150,000 in real estate and $20,000 in personal property in 1870, was the inventor of 12 technically and commercially notable steam engine patents, which are still cited in patents today.[19] The 1860 portfolio of iron-founder Amos Chafee Barstow (1813-1894) included $288, 500 in real estate and $151, 500 in personal goods, and he employed four servants in his home.

Barstow was a stove manufacturer and proprietor of the Barstow Stove Company on Point Street in Providence, Rhode Island, and he was appointed as mayor of the city in 1852 and Speaker of the House in 1870. A capable inventor who specialized in cooking appliances, Barstow devised and patented some eight successful inventions. The improvement in stoves that he patented in 1873 was awarded the Grand Medal of Merit at the 1873 Vienna World's fair, but at the MMA of 1874 this innovation only received a bronze medal. Such discrepancies in the allocation of prizes leads to speculation about the determinants of technological awards.

19. For further details, see David [2003].

JUDGES AND JUDGING

What were the factors that influenced patenting and prizes? Khan [2011] compares the experience of great inventors in Britain and the United States between 1750 and 1930, in terms of patents and prizes for technological achievement. The award of prizes appeared more susceptible to misallocation, but the results varied by institutional context. As in the case of its patent institutions, the award of prizes to British great inventors primarily depended on their background rather than on their productivity. The most important determinant of the award of a technological prize to British great inventors was whether or not they attended elite schools like Oxford and Cambridge. The analysis indicated that the distribution of prizes tended to be less systematic and more random than that of patents. The members of these prize panels demonstrated a degree of cognitive bias toward elites that was also evident in such prior instances as the experience of the unfortunate artisanal clockmaker John Harrison in his dealings with the Longitude Board (Sobel [1995]).

A significant fraction of the variation in patenting activity in the general population owed to economic factors including access to markets and expected profit opportunities (Sokoloff [1988]). Similarly, a number of systematic factors influenced the patentability and patenting of exhibits. Women's entries were significantly less likely to be patentable or patented. Multiple exhibitors were responsible for more patentable exhibits, but there is no difference in their propensity to patent, relative to other innovators. However, multiple patentees (those with more patents in total over the course of their career) were more likely to obtain patent protection for their exhibits at the MMA fair. As the simple statistics suggested, wealthier individuals did not possess any particular advantages in the realm of patenting. Machinists, who tended to be more technically qualified than other inventors, were associated with higher levels of patentability and patenting of their exhibits, but other classes of inventors were relatively similar in terms of their patenting behaviour. Significant differences existed across industries in terms of the probability that exhibits were patentable or patented, especially for the heat, power and communications inventions and for manufacturing machines. The overall conclusion from these results is that the profiles of patentee-exhibitors at the MMA were not identical to those of patentees in general, but they differed even further from the findings for the population of exhibitors.

Khan [2009] examined the factors that influenced whether an exhibit received a gold or silver medal at the exhibitions of the Massachusetts Mechanic Association. Regressions of gold medals alone had zero explanatory power, and most of the variation in the silver or gold awards also remains unexplained. Amidst this welter of null results, two findings stand out. The first is that women were less likely to receive the highest accolades at the exhibitions. The second is striking: regardless of the specification, exhibitors with greater personal wealth experienced a greater probability of winning gold and silver medals. The magnitude of the effect was rather small, but there was also a lot of noise in the wealth measure which made it difficult to gauge the size with any degree of precision. The regressions were consistent with the simple statistics, and with the biographical information of the participants in the fairs. However, the mechanism through which wealthier exhibitors gained an edge over their competition is unclear. The finding could be due to greater expenditures on their presentation at the fairs, or

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to a noncausal correlation whereby more innovative and deserving entrepreneurs also tended to be richer.

The patterns of prizes for the most part consisted of what statisticians term noise, or random variance. Such variables as occupation and industrial classification had little influence on the award of the MMA medals. We might expect that machinists would be responsible for more technologically advanced discoveries, but in fact they did not evince any advantage over technically unqualified exhibitors. Patent assignments are a proxy for commercially successful inventions, but they were similarly unrelated to the likelihood of a medal. Urbanization is associated with higher productivity at invention, but adding cities yields no additional explanatory power. As the summary statistics showed, medals were awarded uniformly across technology and industry classes, and similarly, industry effects added virtually nothing to the explanatory power of the estimated regression equation. Since it is quite unlikely that the apparel and furniture industries were as technologically creative as heat, power and communications or transportation, the results support the notion that medals reflected factors other than inventiveness, productivity or technological innovation.

Isaac W. Lamb, who obtained his first patent at age 19, contributed several important patented improvements which are still incorporated in modern knitting machines. At the Paris World's Fair of 1867 his invention was awarded the silver medal, and he later established knitting factories in Europe that employed his internationally patented technology. However, at the 1869 exhibition of the MMA, his knitting machine only received a bronze medal. On the other hand, John O' Neil of Xenia Ohio applied for patented protection for a churn in 1852, but the application was rejected.[20] Nevertheless, a diploma was given for the churn he exhibited at the MMA in 1853. The judges' report on the New York Safety Steam Power Co.'s vertical engines states "we know of no distinctive feature in this engine that calls for particular mention," but they nevertheless awarded the engine a diploma in the 1874 exhibition.[21] The lack of systematic patterns in the regressions, in tandem with numerous such examples, raises questions about why, and by whom, prizes were awarded.

Judges of the exhibits included "gentlemen of character and standing, and as far as is practicable of thorough technical knowledge of their respective subjects [...] who will in no case be competitors for premiums."[22] Although they did not compete in the particular exhibition for which they were appointed as judges, many of the judges and trustees of the MMA did participate in exhibitions in other years, so there was a repeated-game element that had the potential for unconscious or explicit bias in the awards. But quite apart from such concerns, there is reason to doubt that medals were an effective proxy for technological creativity, because of the heterogeneity in the criteria for their award. The judges stated

20. See the disclaimer in John K. Mickey's patent grant of February 1861: "I am aware that the paddles in the case have been arranged obliquely in combination with vertical paddles on the shaft and also that in the case of John O'Neil's rejection of June 24, 1852 the stationary and rotating paddles are both made tapering in two directions, and are solid, or without any perforations and I disclaim any such mode of construction."

21. Diplomas also went to Charles Wardwell's Wood Planing Machines and Blind Slat Planer, although "there is nothing new or novel in their construction," and to George Cavanagh's machines which were "neatly made" but "we think it would be very liable to get out of order."

22. Massachusetts Charitable Mechanic Association, p. 6, *The Exhibition and Fair in the City of Boson, September 18, 1837*, Boston: Dutton and Wentworth, 1837.

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their objective was to reward novelty and inventive ingenuity. In practice, they bestowed medals for an array of other reasons besides inventiveness, including overcoming adversity (such as age or physical handicaps), cheapness of the item, neatness, and aesthethic factors.[23] In addition, a mercantilist orientation was evident in awards for American products that rivaled innovations that originated in foreign countries. The decentralization of judging committees, the lack of transparency and private nature of their decision making process, and the absence of appeal from their rulings, all encouraged idiosyncratic and inconsistent decisions. It is therefore not surprising that observers continually criticized the lack of "a methodical, systematic, and intelligent basis" for the awards that were given out, at domestic and international fairs alike.

The managers of the 1874 exhibition pointed to "the necessity of an uniform standard of merit for rewards should prizes continue to be given... In the past, each set of Judges has fixed its own standard of awards, and as a consequence some have been rigidly exacting in the qualities of usefulness and originality, while others have been profuse and generous, touched by sympathy or good-fellowship; others, again, have asked the question whether their Department was receiving its full share of the higher awards, as though the bestowal, not the merit, was the consideration influencing them."[24] The results presented here are likewise consistent with the notion that "the bestowal, not the merit," was indeed the consideration. The committee members also pointed out that, despite the longstanding practice of offering premiums, it was becoming more common elsewhere for exhibitions to incorporate "mechanical and inventive results without awards."[25] Such criticisms were still being offered later on, but the organizers ultimately concluded that "further consideration of whether prizes are wisely given or not is one we prefer to leave to our successors."

According to the 1874 Report of the Massachusetts Charitable Mechanic Association: "there is no doubt that they [awards at the exhibitions] are an incentive and stimulus to the best effort, and that they are of incalculable advertising advantage to those who receive them." Inventors such as Cyrus McCormick and Obed Hussey participated in numerous agricultural fairs, organizing tractor races and harvesting competitions, largely as a way to commercialize their inventions. The bestowal of a prize, whether monetary or nonmonetary awards of certificates, medals and ribbons, had the effect of boosting the inventor's reputation and of publicizing his products. Exhibitions undoubtedly facilitated efforts to advertise and commercialize innovations. Many manufacturers accumulated medals at numerous fairs, and highlighted their awards in magazines, journals and other advertisements. Medals may have proven useful in competitive

23. Thus, prizes were allocated to blind craftsmen, and for a baby quilt that was "made by a lady one hundred and two years old, without glasses." In the latter case, the committee noted that "Crazy quilts and patchwork, when made by elderly women or invalids, should receive just commendation; in all other cases, the occupation is an entire waste of time, and should be discouraged."

24. Report of the MMA Exhibition, 1874, p. vii.

25. "If any radical change is needed in connection with our exhibitions, I think it should be in the method of bestowing the medals. Each committee is now almost the sole judges of awards. They establish their own standard of excellence for goods, and bestow medals accordingly. Some are conservative in their estimate of merit, while others are found to be generous. The result is a great disparity in the significance of the award." (Massachusetts Charitable Mechanic Association, *Annals of the Massachusetts Charitable Mechanic Association*, 1795-1892, Boston: Rockwell and Churchill, 1892, p. 327.)

markets as a means of product differentiation, and as a way of signaling higher quality or brand-name capital.

Some observers go further and contend that prize systems performed as effective incentives to stimulate new inventions. Wile [1928] argues that "at these fairs were displayed the finest products of agriculture and manufacturing, the newest types of machinery, the most recent contributions of inventive genius... [the fairs] served a two-fold purpose: that of playing the part of demonstrator to the public and that of furnishing an incentive to the exhibitors, both through competition and through the desire to win the very liberal awards and premiums." Brunt et al. [2008] conducted an empirical analysis of prizes at the Royal Agricultural Society of England, and concluded that these mechanisms proved to be effective in inducing competitive entry into targeted areas, and in encouraging inventive activity.

The MMA executives likewise argued that their endeavours provided incentives for ingenious individuals to turn their attention to invention. However, whether the prizes that such private institutions proposed were indeed effective in encouraging creativity and inventive activity is difficult to determine. Many of the displayed items were entered into competition at multiple exhibitions, both here and abroad, so the effect of any one event is debatable. More important, as shown before, procedures through which the prizes were determined were idiosyncratic and difficult to predict. The random nature of judging is a theme that recurs in numerous contexts both within and beyond the MMA expositions.[26] Competitors who were financially better off may have had an advantage in gaining the attention of the judges, regardless of the technological merits of their contributions. Decentralized judging encouraged a lack of uniformity in standards, and also led to the award of premiums that did not necessarily reflect the same degree of inventive capital across technology classes. By contrast, the centralization and consistency of patent grants in the United States were derived from their administration at the federal level, from an examination system that was based on predetermined standards that were applied by technically trained professional examiners, and from the right to appeal decisions up to the highest court in the land. If potential inventors responded rationally to net expected benefits, then prize systems such as the MMA's were arguably less successful in achieving the Constitution's mandate to "promote the progress of science and useful arts."

CONCLUSIONS

The question of the appropriate institutions to promote technological change and economic progress has always generated a great deal of controversy. In the nineteenth century, calls for the repeal of patent systems intensified, and its

26. For a contemporary assessment, see "Awards at Exhibitions" in the *Electrical Review* of August 22, 1885, p. 172: "The cynic will say that medals, like kissing, go pretty much by favour [...] Gold medals are limited in number; and while two hundred firms may deserve them, two hundred cannot receive them [...] while a gold medal indicates the reputation of a firm, the lack of a gold medal does not necessarily indicate an inferior reputation [...] The majority of gold medals call for no comment, but when we come to the silver medals the process of selection seems more invidious. It is very difficult to see why certain names should be selected as being more worthy than some of those in the "bronze" class."

proponents influenced the Netherlands to abolish patents in 1869. The leading European countries such as Britain and France employed prizes and alternative policies to induce and reward inventive activity, but such mechanisms were never popular in the United States at the national level. The United States was the global leader in setting rules and standards that favoured patentees. Patent rights were affordable, their scope of protection extended over the entire country, procedures for the application and grant of patents were so straight-forward that few inventors used professional attorneys to navigate the process, and such property rights were moreover well-enforced. The American patent system was market-oriented, and offered all classes of inventors the opportunity to benefit from their technological creativity. The evidence on the nineteenth-century patent system in the United States suggested that the specific design of this institution played a substantial role in influencing the rate and direction of inventive activity. The ability to protect their ideas through strongly-enforced property rights was arguably successful in inducing relatively ordinary individuals to reorient their efforts to exploiting market opportunities. Still, it is quite possible that such findings owe to the generally more open economic and social institutions of the United States rather than to the nature of patent institutions per se.

Theoretical models suggest that prizes, public funding or payment on delivery might be preferable to the temporary monopoly associated with intellectual property rights (Maurer and Scotchmer [2004]). Shavell and Van Ypersele [2001] argued that subsidies were likely the most effective means of calibrating rewards for innovations according to social value. Kremer [1998] proposed an ingenious hybrid whereby the patent is tranformed into a prize that is auctioned to the highest bidder in a process that reveals the underlying value of the invention; the government could then engage in patent buyouts of high-valued discoveries and turn them over to the public domain. The theoretical and practical problems with prizes are well recognized, however, and they include challenges in assessing the value of the invention (such as those that arise from asymmetric information, delays in the determination of value, and the difficulty of aggregating benefits which might accrue from sequential innovations). Even if these potentially intractable issues were resolved, the credibility or efficiency of bureaucrats in holding to contracted promises might be questioned, leading to a diminution in the expected return from a prize.

This paper examined technological innovation through a comparison of the patterns in patenting and innovations at industrial fairs. Patent rights were administered at the national level. By contrast, the regular award of prizes occurred at the local level, as private associations mobilized inventors and innovators in industrial fairs in different cities. The major annual exhibitions were those organized by the American Institute of New York City, the Franklin Institute of Philadelphia, and the Massachusetts Charitable Mechanic Association of Boston. It should be noted that the organizers and participants at these conventions would have been appalled at the notion that the patent system should be abolished, and they proudly advertised and showcased patented items. In any event, the MMA exhibits illustrate that invention was indeed occurring outside the patent system, and the industrial fairs played a key role in the commercialization of technologies, both patented and unpatented.

However, the results reported here indicate that further research is needed before implementing a system of national prizes for technological discoveries. The benefits of patent rights are offered to inventors on the basis of their

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productivity and success in satisfying participants in the marketplace. The results for Britain and the United States seem to indicate that prizes risk being allocated on the basis of social status or personal characteristics rather than on the quality of technological contributions. Inefficiencies in the grant of prizes may have had minimal impact on social welfare when awards were made by local private institutions; the potential for harm is much greater if such premiums were offered at the national level. Open access and equality of opportunity seem to be at risk in nonmarket-oriented prize systems. Since these factors comprise key elements of both economic and political democracy, it is worth investigating more closely whether the features highlighted here are inherent to administered awards for inventive activity. Insights into such issues are critical for devising and implementing effective policies to expand the technological frontier at the national and global levels.

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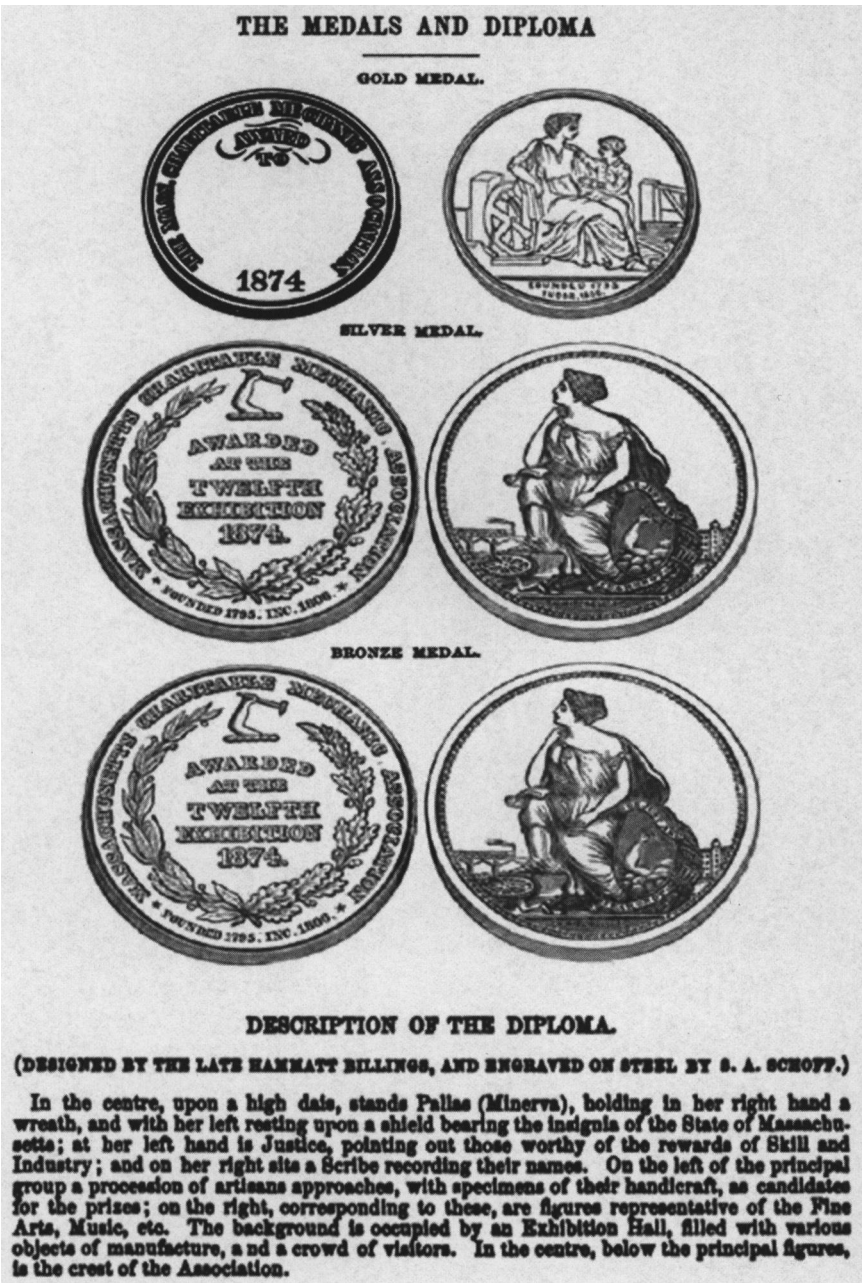
APPENDIX

AWARDS OF THE MMA EXHIBITION



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