

Link Relative method was similarly used to connect the pre-1898 data, which lacked the Technical Schooling that had nevertheless been a real factor. Lastly we combine our three weighted subtotals into one Index of Inventive Effort or Input, by taking their geometric mean.⁶⁴

[77] Our system of weighting has been explained at length more to answer suspicion than because it is important. If the various indices to be combined into an average had all the same, parallel slopes and fluctuations, it would make no difference at all what system of weighting were used. Our constituent indices have strikingly parallel long-run slopes, as is evident from a glance at the charts, wherefore what weighting system we use matters little. The extent of error it might introduce doubtless falls well within the percent of general uncertainty in our whole program for measuring inventions, which we discuss further, and in ¶ 9-12.

[78] The values which can be read from the margins of chart 4 have no simple significance, save for the Abstracts⁶⁰ and the Organized Research Professional Staff.⁶² All are for comparing a graph with itself and with other rates of growth, but the two named are also simple measures, with the decimal point supplied by the cited Notes.

[78.5] The indices of Inventive Effort and Output form very straight, regular, reliable looking graphs, particularly the former one, which is based on more numerous, varied, and better kinds of evidence. The Abstracts suffered a sudden and permanent setback in 1940-5, which would seem due to secrecy entering as a major factor from then on. Accordingly, we have continued by a dotted line the straight course of the abstracts after 1920, and shall use this assumption in our further calculations.

[79] Our graphs are steep, increasing to 105-fold for the corrected Abstracts Output and to 345-fold for the Inputs. Those are rises of 79% per decade and 6% per year for the Output, and 107.7% in each decade for the Inputs, more than doubling, which means 7.5% per year. In the same period patents to Americans have increased only to 3-fold (chart 1). If inventive output be truly measured by the Abstracts, that would entail that the proportion of inventions patented, or more accurately, the ratio of patents to invention, has gone down to 2.9% of what it was only 75 years before, in 1885.⁶⁵ These conclusions are so surprising, and would entail such a changed view of the present and future of the patent system, that we should next ask whether such a statistical conclusion can be believed, and

⁶⁴ The geometric mean was chosen as the most suitable kind of average for this case, because it is affected equally by the proportional fluctuations in each of its constituents, regardless of their absolute magnitude. Thus, if one constituent index fell from 4 to 2, while another was rising from 500 to 1,000, the two movements would just cancel out by the geometric mean, whereas by the ordinary, arithmetic average, the result would have reflected almost exclusively the latter index— $\frac{1}{2}(504 \rightarrow 1002)$. The geometric mean is obtained by multiplying all the items together, and then extracting the corresponding root—if 3 items, then the cube root of their product. Weighting is introduced by multiplying an item by itself. Thus, from 1895 to 1925 we had two items with equal weighting to multiply together and extract the square root. Thereafter we multiply that product of the two, by the cube of Professional Staff, and extract the 5th root, all easily done on a slide rule. The geometric mean is a standard average in Statistics for suitable cases, used, e.g., in computing the Government's index of prices.

While our graph of Inputs embodies the same cited weights throughout the period of each subtotal constituent (each constituent one type of evidence, in all the three sciences), these had already included weighting, greatly altering, according to the respective rises of Chemistry and Physics and the relative decline of Engineering.

⁶⁵ During 1880-85 patents approximately kept pace with Abstracts.