Studies in History and Philosophy of Science 105 (2024) 74–84

Contents lists available at ScienceDirect

Studies in History and Philosophy of Science

journal homepage: www.elsevier.com/locate/shpsa

Tracing the evidence of design: Natural theology through an unpublished manuscript by William Stanley Jevons

Eleonora Buono

Centre Walras-Pareto, IEP, Université de Lausanne, Quartier UNIL-Mouline, Lausanne, CH-1015, Switzerland

ARTICLE INFO

Keywords:
William Stanley Jevons
Natural theology
William Whewell
Charles Babbage
Design

ABSTRACT

This paper takes its cue from an unpublished manuscript by the Victorian polymath William Stanley Jevons (1835–1882). I elucidate how he attempted to integrate science and religion through natural theology. I argue that Jevons's manuscript shows that he took the theory of probability to be the most appropriate tool for finding evidence of divine design in natural phenomena. Jevons thus took part in the nineteenth-century natural theology debate, specifically between William Whewell and Charles Babbage. This debate was about both how to interpret the analogy between natural and human contrivances, and about the tools which should be used in natural theology. After introducing the manuscript, I present Jevons's religious ideas about Unitarianism and the relationship between chance and design in his writings. I show Jevons's commitment to natural theology and his idea that humans, due to their finite intellect, should use the theory of probability to investigate divine providence. I then compare Jevons's position to Whewell's and Babbage's *Bridgewater Treatises*. I show how they had different conceptions of natural theology compared to Jevons, and different ideas about the tools that should be used to investigate natural laws.

1. Introduction

On the 20th September 1864, William Stanley Jevons wrote a letter to Sir John Herschel, complimenting him for his reply to an invitation to subscribe to the Theological Declaration of Scientific Men, a declaration concerning the relationship between science and the Scriptures. According to the Declaration's subscribers, the book of nature could not contradict the Scriptures, and whenever a scientist's position contradicted them it was the scientist's duty to take a step back (VV. AA., 20th September 1864, The Times, 7). Herschel refused to sign the Declaration, and Jevons thus wrote to him:

> Dear Sir,
>
> Permit me to express to you in a few words the extreme satisfaction with which I read your answer concerning the Theological Declaration of Scientific Men. Such an appropriate statement of the position of an inquirer in the present day strikes me as invaluable both to Science and True Religion. And I cannot sufficiently express my concurrence in your protest against a desire for freedom of inquiry being interpreted as a tendency to Irreligion. Is it worthy of Religion to assume that it must be discarded by all who freely seek after the Truth? (Jevons, 1972–1981, Vol. 3, 60)

Throughout his life, Jevons had been a godly man and a Unitarian Dissenter (Jevons, 1972–1981, Vol. 1, 52). He did not hold that religious belief must be separated from scientific investigations. Rather, he was determined to reconcile them. As he wrote in his journal on the 11th March 1866, "I would [...] join science to morals & religion. I would try to show that they are not antagonistic" (Jevons, 1972–1981, Vol. 1, 203). In Jevons's mind, religion was not meant to be confined to the domain of private life or irrational thought. Echoing Joan Richards's account (Richards, 1997, 52), I will highlight how science and religion were not divorced in Jevons's thought.[1]

This article takes its cue from an unpublished manuscript by Jevons, titled "On the evidence of Design" (OEOD), in the Jevons Archive, based in the John Rylands Library, the University of Manchester. This manuscript points to the relationship between science and religion in nineteenth-century England.[2] Jevons used natural theology to integrate science and religion. As a contribution to the tradition of natural theology, the manuscript sheds light on the strategy Jevons used to reconcile science and religion. Jevons planned to write a book on natural theology, the *Tenth Bridgewater Treatise* (see Jevons, 1886, 451–452). His untimely death prevented him from doing so. We do not know whether "On the evidence of Design" was meant to be a part of this

E-mail address: eleonora.buono@unil.ch.

[1] For a rival interpretation of the relationship between science and religion in Jevons's thought, see: White, 1994, 222–223; Cohen, 2007, 162–163.

[2] Concerning Jevons's religious views, also in connection with scientific enquiry, see: Black, 1972a; Chaloner, 1972, 73–74; Mosselmans, 2007, ch. 6.

https://doi.org/10.1016/j.shpsa.2024.05.008
Received 30 May 2022; Received in revised form 13 March 2024
Available online 15 May 2024

unwritten work. What we do know is that Jevons considered writing a work on natural theology, and, according to his wife, had notes prepared for it (see Jevons, 1886, 452-455).

Natural theology investigates God and His attributes using natural faculties, such as reason, not relying on Revelation (Topham, 2010, 59).[3] In nineteenth-century England, natural theology was often meant to reassure the believers that the sciences were not a threat to faith (Topham, 2022, 3-12). On the eve of the Victorian era, the natural theology tradition was renewed by the so-called *Bridgewater Treatises*. Commissioned by the Earl of Bridgewater, eight books, written by renowned scientists and clerks, were published between 1833 and 1836. These works, following the Earl's instructions, aimed to elaborate "*On the Power, Wisdom, and Goodness of God, as manifested in the Creation*" (Whewell, 1833, ix), and addressed a wide audience. A key element was the traditional argument from design: by observing the signs of design in the world — in inanimate as well as in animate creatures — the presence of a divine designer was inferred.[4]

The desire to reconcile science and religion was evident in Whewell's *Bridgewater Treatise*, in which the author explains that his "prescribed object is to lead the friends of religion to look with confidence and pleasure on the progress of the physical sciences, by showing how admirably every advance in our knowledge of the universe harmonises with the belief of a most wise and good God" (Whewell, 1833, vi).[5] In response to the *Treatises*, and especially to Whewell, Charles Babbage, renowned mathematician and Lucasian professor at Cambridge, wrote a further, uncommissioned *Ninth Bridgewater Treatise* (1837).[6] Whewell and Babbage presented two different ways to reconcile science and religion in their works. Their *Treatises* form the background of Jevons's position.

The plan of this article is as follows. First, I provide a brief introduction to Jevons's manuscript, of which I also offer a transcription in the appendix.[7] Second, I will elucidate Jevons's religious ideas, in relation to Unitarianism, as well as to his published writings and private papers. I show that Jevons considered the world to be regulated by God's design. It was because humans were in his eyes finite beings in an infinite universe that it was important to investigate natural laws through the theory of probability. Third, by briefly analysing Whewell's and Babbage's *Treatises*, I situate Jevons's ideas on natural theology in the (then) contemporary debate on the tools and principles of natural theology. The choice of locating Jevons among these *Bridgewater Treatises* is based on the similarity of their topics and methods. Whewell's and Babbage's *Treatises* focused on physical laws *qua* examples of divine design. Babbage also used mathematical methods in his work. Thus, their *Treatises* have a similar outlook to Jevons's writings on the scientific method, such as *The Principles of Science* (1873), and "On the evidence of Design". Moreover, Jevons quoted both Whewell and Babbage. The comparison clarifies Whewell's and Babbage's different conceptions of the analogy between nature and human contrivances. I will then discuss Babbage's machines and a comparison with Jevons's Logical Machine.

2. The argument of "On the evidence of Design"

The manuscript, titled "On the evidence of Design", is composed of six pages and bears no date. Based on the similarity of its content and of the main topic, it would be plausible to suppose that it was written in the same time period (between 1866 and 1873) as the *Principles of Science*, Jevons *magnum opus* on the scientific method.[8] The manuscript's topic is the concept of design. Some phenomena, as Jevons explained, immediately display signs of design (Jevons, OEOD, 1). By this, Jevons meant that these phenomena were made this way because of the intention of an intelligent mind. Determining the cause of these phenomena required different kinds of mathematical tools, such as the study of combinations and permutations, or the theory of probability: Jevons's manuscript elucidated how to identify design as the most probable cause of a given phenomenon.

Jevons illustrated his argument by analysing three main examples. The first (Jevons, OEOD, 1–2) is drawn from Isaac Todhunter's *History of the Mathematical Theory of Probability* (1865). In his *History*, Todhunter informs us that Jean Baptiste D'Alembert discussed the possibility of chance being the cause of certain phenomena. For instance, if the word *Constantinopolitanensibus* was seen written on a table, one would hardly think that the letters were arranged by chance (Todhunter, 1865, 273). Jevons added a mathematical treatment to D'Alembert's example, relying on the calculus of permutations. Given that the word *Constantinopolitanensibus* has twenty-five letters, the number of possible arrangements of the letters, i.e. their permutations, amounts to nearly fifty-trillion, as given by the following formula:

$$\frac{25!}{3!5!3!3!3!2!}$$

Jevons pointed out that *a priori* it is not possible to exclude that such a distribution could be the effect of chance. However, as he showed, the odds of this particular permutation occurring by chance are fifty-trillion to one. As Jevons argued, this ought to be enough to persuade anyone that someone deliberately chose to put the letters in such an order (Jevons, OEOD, 2).[9]

Jevons's second example (Jevons, OEOD, 2–3) is drawn from another source, that is, John Eliot Drinkwater's *Life of Kepler* (1829). This example is based on an episode related by Kepler in *De stella nova* (see Kepler, 1606, 140–141). The passage, as reported by Drinkwater, explained how, as a youth, Kepler enjoyed creating anagrams of his name, and tried to create new anagrams by writing the letters on cards and then arranging them in a random order (Drinkwater, 1829, 13). Jevons commented that Kepler drew a precious lesson from this experiment: every theory attributing the creation of the world to chance is absurd. In Jevons's eyes, the number of permutations of the Latin letters of Kepler's name is so high that the likelihood that chance produced it was incredibly small. As Jevons calculated, the possible permutations are 54,486,432,000 (Jevons, OEOD, 3). This number results from the same formula he used for calculating the permutations of the letters of *Constantipolitanensibus*.

The third example (Jevons, OEOD, 3–6) is drawn from a text of William Fishburn Donkin, mathematician and Savillian professor of astronomy at Oxford. In "On Certain Questions Relating to the Theory of Probability" (1851), Donkin described the following situation:

[3] For definitions of natural theology and a historical perspective, see: Topham, 2010; Manning, 2013, 1-5; Peterfreund, 2012, viii. For the development of natural theology in different historical contexts, see: Clark, 2013; Hankey, 2013.

[4] On the history of the argument from design, see Peterfreund, 2012; on how it was interpreted in the nineteenth century, see Eddy, 2013.

[5] See Oslington, 2017, in which this topic is dealt with in relation to Whewell's sermons.

[6] On the publication history, themes and audience of the *Bridgewater Treatises*, see: Topham, 2022, especially 19–42, for an explanation of the appointment and the choice of authors. See also: Topham, 1992; Topham, 1998. On Babbage's *Bridgewater Treatise*, see: Hyman, 1982, ch. 10; Jones, 2016, 234–235; Topham, 2022, 434–441.

[7] The text of the manuscript is reproduced by courtesy of the University of Manchester. I was unable to find the copyright owner for Jevons's manuscript, and I encourage them to contact me.

[8] The journals and letters of Jevons makes plausible that the Principles of Science was written between 1866 and 1873. On 4th December 1866 Jevons wrote in his journal that he had the intention of collecting his thoughts about logic in a comprehensive work (see Jevons, 1972–1981, Vol. 1, 208–209). He much later explained to Alexander Macmillan his plan for the publication of the *Principles*, on 13th September 1872, adding that he had more than three hundred pages ready for press (see Jevons, 1972–1981, Vol. 3, 249). Given this, it is plausible to argue that the composition of the *Principles* took nearly seven years, notwithstanding the uncertainty of its precise starting point.

[9] For an explanation of Jevons's calculus of permutations, see Jevons, 1877, 178–180.

> now suppose I go into a room and see a number of balls laid on a table, and disposed in some regular figure, say a circle. Somebody must have put them there. But was it part of his intention to place them in a circle, or did he merely mean to *lay them on the table*, without intending any particular arrangement? In the latter case the circular disposition would be *accidental*. (Donkin, 1851, 359)

Donkin argued that one would be inclined, by common sense, to consider the arrangement to be intentional. He then noted that this supposition can be studied through the method of inverse probability.

Jevons elucidated this method in the *Principles of Science*.[10] As he explained in the *Principles*, if the theory of probability could be applied to deduce the probability of consequences given a set of conditions, the inverse operation was also possible: "from the known character of certain events", he wrote, "we may argue backwards to the probability of a certain law or condition governing those events" (Jevons, 1877, 240).[11] Through this method, a designing mind could be identified as the most probable cause of certain phenomena. In the passage quoted in Jevons's manuscript, Donkin proceeded by analysing the *a priori* probabilities (in modern language, prior probabilities) of a given event. The *a priori* probabilities, according to Donkin's definition, are the "probabilities derived from information which we possess antecedently to the observation of the phenomenon considered" (Donkin, 1851, 360). Donkin took into consideration four conditions, and their respective prior probabilities, as explained by Jevons in "On the evidence of Design". He explained that it is possible to calculate the probability of an arrangement being caused by design (D) as follows:

$$D = \frac{drp}{drp + (1-d)\,a}$$

The value of D is given by dividing the probability of the circumstances which cause the event and give it its actual arrangement (drp) by the sum of this same element (drp) and the probability that the event is produced by chance, i.e. $(1 - d)\ a$.[12] According to Donkin, we ought to be strongly inclined to think that the arrangement observed is caused by a designing mind.

After reporting the example from Donkin's paper, Jevons concluded his enquiry by explaining why the problem of design is so important (Jevons, OEOD, 6). For Jevons, applying the method of inverse probability enables us to conclude that certain objects are produced by human beings. Thus, in Jevons's mind, the method of inverse probability turns out to be important for archaeological research, because it provides an argument for certain objects being human artefacts.[13]

In all these examples, Jevons always reproduces the same line of reasoning: he considers a phenomenon and asks whether it is reasonable to think that it is the result of chance. Then he applies a deductive procedure or mathematical tool to exclude the possibility that the phenomenon is the result of chance. *Therefore*, he concludes, it is caused by design. Jevons does not take into consideration alternative explanations. He appears to take chance and design to be mutually exclusive and exhaustive explanations. This depends on Jevons's belief that the world is governed by divine providence. Hence, chance does not actually exist; it is rather a delusion of the finite human intellect. I will now elucidate Jevons's religious ideas to highlight his commitment to natural theology and to cast light on the relationship between chance and design.

3. Jevons's religious ideas

None of Jevons's writings are exclusively devoted to religious matters, nor to natural theology. His views on these matters are scattered across his writings. In order to elucidate Jevons's religious ideas, in this section I will focus on his correspondence during his stay in Australia (between 1854 and 1859) and on his private notes as collected by his wife. This will also show how reference to natural theology was common in the tradition of Unitarian Dissent.

Unitarianism is a branch of "rational Dissent", encouraging scientific enquiry and the rational aspects of faith (Hilton, 2006, 460). Unitarians had always favoured a liberal interpretation of the Holy Scriptures. The lack of references to the Trinity in the Bible pushed them to deny its existence; hence the name "Unitarians". His Unitarian background had certainly shown Jevons that science and faith were not opposed. He had further encouragement in this direction from his studies at University College, London. Jevons studied at the new-born College,[14] where many of his teachers were Dissenters as well, for the University did not require a subscription to the Anglican faith. One of these teachers, Augustus De Morgan, is likely to have shaped Jevons's ideas on religious matters. The relation between scientific enquiry and religion was of crucial importance to De Morgan's teaching (see Black, 1972b, 127) and works. De Morgan himself could not complete his degree at Cambridge because of his contempt for the subscription to the Thirty-Nine Articles.[15] He supported the Catholic Emancipation Bill (see Cohen, 2005, 144) and referred to all subscriptions as a "deadly poison".[16] In De Morgan's view, mathematics could be a powerful tool to unify the creeds. This idea was embodied in the *insignia* he drew for the London Mathematical Society. It was a triangle with at each side the Jewish, Christian and Muslim reference to the year of the Society's foundation (1865), according to each calendar. The figure was combined with the motto *'Vis unita fortior'* (a united force is stronger). Mathematics must create a "union of races and nations as well as of individuals".[17]

Given this background, it is not surprising that Jevons was committed to reconciling science and religion. Moreover, the choice of natural theology as a means to reconcile science and religion was consistent with Unitarianism, as this branch of Dissent had a long-standing connection with natural theology.[18] Jevons's correspondence and private notes help to elucidate his commitment to natural theology. In a journal entry dated 28th January 1857, Jevons confessed his rejection of revealed religion, consistent with the way of reasoning

[10] In modern terms, the method of inverse probability would correspond to Bayesian statistics. Bayes's theorem appeared posthumously, in 1763 (see Bayes, 1763). For the history of this method, see: Dale, 1999; Fienberg, 2006.

[11] Jevons relied on Laplace and De Morgan to explain the fundamental principle of the method of inverse probability. For this method in De Morgan's texts, see: De Morgan, 1841, 53–68; De Morgan, 1847, 170–226). For a comparison between Jevons's and De Morgan's use of this method, see: Laudan, 1973; Strong, 1976.

[12] *Drp* stands for the joint probability of the following circumstances: that the given arrangement is not only be produced by design (of which the probability is d), but also in a regular form (the probability of such condition being r) and, specifically, in the observed regular form (the probability of which being p). The mathematics are explained at length in Donkin, 1851, 360.

[13] It is worth mentioning that, since the 1990s, archaeologists started to embrace Bayesian statistics, even though its applications were concerned with issues other than the one Jevons saw; on this, see: Bayliss, 2015.

[14] For more details on Jevons's education at UCL, see: Jevons, 1972–1981, Vol. 1, 13–18; Black, 1993, 163–166.

[15] See Cohen, 2005, 139–158 and 143; this information is drawn from De Morgan's autobiographical sketch, London, British Library, MS 28509, f. 421. On this topic see also Cohen, 2007, ch. 4.

[16] For this quotation, see De Morgan to W. R. Hamilton, 27 July 1852, Dublin, Trinity College Library, Hamilton Papers, 1493/541, as quoted in Cohen, 2005, 143.

[17] For this description and references, see Cohen, 2007, 106. The quotation is drawn from Augustus De Morgan, Notebook, Ms Add. 69, De Morgan Papers, Special Collections, University College Library, University College, London.

[18] For the connection between Unitarianism, scientific inquiry, and natural theology, see: Hilton, 1988, 53-54, 76-79; Wood, 2004; Hilton, 2006, 460. For Jevons's connections to Unitarian circles, see: Black, 1972b; Chaloner, 1972, 73–74; Mosselmans, 2007, ch. 6.

typical of natural theology. In his eyes, the very idea of Revelation was almost blasphemous. God had no need to break the order of nature to reveal himself. This would be a sign of imperfection. Jevons considered that "God is seen if anywhere in the wonderful order and simplicity of Nature, in the adaptation of means to ends, and in the creation of man to which everything refers, with power capable of indefinite improvement" (Jevons, 1972–1981, Vol. 1, 155).

His correspondence during the years he spent in Australia is particularly helpful to investigate Jevons's commitment to the framework of natural theology and his conviction of its importance for scientific enquiry (see Jevons, 1972–1981, Vol. 2, the letters between 1856 and 1859). On the 3rd May 1856, Jevons wrote to his sister Henrietta that "God is but the *embodiment* of the first & greatest principle of the world, viz, *universal good*, *order* tending towards good, *design*, all coming under the comprehensive term Providence" (Jevons, 1972–1981, Vol. 2, 226). Jevons's studies on natural sciences led him to develop a rational and critical perspective on religion. This intellectual penchant distinguished him from his sister Henrietta, who in his opinion had a warm and sentimental faith. Jevons illustrated this difference, explaining his doubts in this regard. He then explained his own conception of religion and its relationship with the scientific account:

> Natural science was my chief study and I may say that I have become so impressed with the general character of natural laws of fact and have become so accustomed to habits of severe and exact thought, that I must have a solid foundation for my religion or I shall have none. (Jevons, 1972–1981, Vol. I, 154)

Jevons's view of universe as regulated by divine providence, is also apparent in the notes collected by his wife. While addressing the topic of prayer, Jevons questioned the piety of interpreting prayers as requests to God. "A single ounce of air or water", argued Jevons,

> cannot be diverted from its appointed course without breaking through the framework of nature. The universe might be destroyed and recreated as easily as a leaf be made to fall otherwise than as predetermined causes make it. (Jevons, 1886, 452)

According to Jevons, such prayers were unacceptable and nonsensical because they neglected the inescapable power of divine providence. A prayer "implies an impeachment of His goodness and His wisdom. It is as much as to say that God has ordered things in one way and we think they should be otherwise" (Jevons, 1886, 452). Consequently, prayers could only be pious if understood differently: "cannot we ask that God, instead of bending His course to ours, will bend our course to His?" (Jevons, 1886, 452). The idea that the world is regulated by divine providence runs throughout Jevons's writings and appears to be a conviction he kept throughout his entire life.

An examination of the notions of chance and design as they appear in Jevons's works and private papers and letters, with particular attention to the *Principles of Science*, further clarifies his ideas concerning providence. Jevons believed that chance did not exist and that the universe was regulated by necessary laws, which were the expression of God's design. In the *Principles of Science*, Jevons wrote that "there is really no such thing as chance, regarded as producing and governing events" (Jevons, 1877, 198). In Jevons's view, we may be unable to predict the fall of a die and tend to assume that the outcome is governed by chance. Nonetheless, as Jevons argued, "everyone sees, after a little reflection, that it is in our knowledge the deficiency lies, not in the certainty of nature's laws" (Jevons, 1877, 198).[19] "There is no doubt", continued Jevons,

> in lightning as to the point it shall strike; in the greatest storm there is nothing capricious; not a grain of sand lies upon the beach, but infinite knowledge would account for its lying there; and the course of every falling leaf is guided by the principles of mechanics which rule the motions of the heavenly bodies. (Jevons, 1877, 198)

According to Jevons, chance is therefore a delusion of the finite, human intellect, and it does not exist in nature (see Peart, 1996, 159). Chance only mirrors our deficient knowledge of causes, while, as Jevons noted, "in nature the happening of an event has been pre-determined from the first fashioning of the universe" (Jevons, 1877, 198).

Even if Jevons thought that chance did not exist other than in the human mind, he nonetheless made significant use of the category, as well as of some related categories, such as luck, or fortuitous coincidence. He defined fortuitous coincidence as "an agreement between events, which nevertheless arise from wholly independent and different causes or conditions, and which will not always so agree" (Jevons, 1877, 262). It would be fortuitous for a penny to be thrown several times and always fall on the same side, unless it was always thrown in such a way so as to produce such an outcome. Based on this explanation, fortuitous coincidences could be defined as an unlikely combination of events.

By comparing Jevons's definition of fortuitous coincidence with his account of chance, the question arises: do fortuitous coincidences contradict the idea that chance does not exist in nature? The answer is negative. Indeed Jevons's description of chance in terms of a deficiency of our knowledge sheds light on the notion of fortuitous coincidence. However unlikely a combination of events may seem to us, the conditions producing fortuitous coincidences are no less determined than any other natural event.

If chance and fortuitous coincidences do not exist in nature, the world cannot be governed by chance. As I have noted, Jevons believed that nature was bound by exact laws, and such laws were the expression of *divine design*. Ever since his youth, Jevons was certain that design was the great force governing the world. In a journal entry dated 28th January 1857, he wrote:

> I perfectly comprehend everything that may be deduced from Nature, as to *design*, *order*, unity of conception &c of the universe, and I confess that both the theory of *Chances* and that of *Conditions of existence* are perfectly inadequate as explanations. The world is evidently but one vast organism full of motion and intelligence; it is not mere matter, for the very order & form of it express intention & mind. God is identified and inseparable from his works. (Jevons, 1972–1981, Vol. 1, 155)

Thus, according to Jevons, not only is the world governed by exact laws, but it is also the product of a *designing mind*, namely the infinite mind of the Creator.

It is worth noting that, in Jevons's mind, the laws of nature regulate physical phenomena as well as human social life (see: Jevons, 1877, xxvii–xxviii; Jevons, 1883, 71; Jevons, 1884, xxv).[20] In a journal entry dated 5th April 1857, Jevons discussed Richard Whately's lectures on political economy and observed that the system of cooperation and exchange of modern society results from the social instinct "conferred by God on Man" (Jevons, 1972–1981, Vol. 1, 158). Jevons and Whately agree that such a system is a very remarkable and striking example of God's design and providence.

According to Whately, nothing is more apt to show the signs of God's hand in the world than the regulation and progress of society. To

[19] On the deterministic character of natural laws in Jevons's work, see: Aldrich, 1987, 236; Peart, 1996, 158; Maas, 2005, 145, 235. There are, however, rival interpretations concerning the character of natural laws in Jevons's thought: Michael White has argued that Jevons considered the laws to be mere connections of facts (see White, 1989, 426–431). According to MacLennan, the inessential character of natural laws depended on Jevons's confusion between the notions of correlation and causation (see MacLennan, 1972, 60); for a criticism of MacLennan's statement, see Peart, 1996, 209.

[20] This is the rationale of Jevons's claim according to which all branches of knowledge must share the same methodology. The methodological continuity in Jevons's thought has been noted by several scholars; see: Mays, 1962; Stigler, 1982, for the application of statistics to the social sciences; Aldrich, 1987, 234-235; Schabas, 1990, for the priority of logic in Jevons's system.

the inattentive observer, however, such signs could easily be mistaken for marks of human design, instead of divine. This depends on the fact that, in the case of social regulations, humans are aware of the desirableness of their ends and consciously pursue them (Whately, 1847, 84). Nevertheless, as Whately argues, the task of regulating a large society goes beyond the powers of any board we could possibly imagine (Whately, 1847, 87–88). Even in comparison with the traditional examples of natural theology, such as the human circulatory system or astronomical laws, human society is a far more striking example of divine wisdom (Whately, 1847, 90–91). Thus, Whately implicitly engages with William Paley, who drew on anatomical examples to argue that such complicated and perfect mechanisms implied the existence of a wise contriver, just as the watch was not conceivable without a maker (Paley, 1803, 19–31). While agreeing that these cases are proper signs of divine wisdom, Whately adds that we should ask ourselves

> whether it does not even still more excite our admiration of the beneficent wisdom of Providence, to contemplate, not corporeal particles, but rational free agents, cooperating in systems no less manifestly indicating design, yet no design of theirs; and though acted on, not by gravitation and impulse, like inert matter, but by motives addressed to the will, yet advancing as regularly and as effectually the accomplishment of an object they never contemplated, as if they were merely the passive wheels of a machine. (Whately, 1847, 91)

Consequently, for Whately the study of human society is the highest, most meaningful branch of natural theology (Whately, 1847, 91–92).

This brief analysis of Whately's text suggests some interesting points related to Jevons's position and involvement with natural theology. First, it confirms that, for Jevons, humans and inanimate matter are akin in that they are regulated by the same power: divine providence. Second, the quoted passage from Whately's *Lectures* shows that there is continuity between human and divine design. An action can be consciously pursued by a human agent, yet this does not exclude that it could serve the purposes of God's design, being thus the expression of providence. Human and divine design are not mutually exclusive. Third, the reference to the mechanism is indeed meaningful for understanding Jevons's point of view. In this lecture Whately compared human society to a mechanical contrivance. Humans are free and conscious agents, and yet they collaborate in a divine plan they cannot fully understand. They act like pieces of a machinery greater than themselves. The continuity between human behaviour, inanimate matter and organic structures is the basis on which Jevons extended the laws of nature to human individuals and society.

The design of the Creator is, in Jevons's view, the order regulating the universe, human beings no less than any other phenomenon.[21] The most striking example of Jevons's position is to be found in the introduction to his *Principles*. Here he highlighted the importance of seeing that the world is not governed by chance: were the world governed by chance, then scientific enquiry would be at a loss to understand it. Hence the crucial importance of denying every causal influence of chance, as Margaret Schabas has stressed (see: Schabas, 1990, 67–68; Schabas, 1984, 137). "Were this indeed a Chaotic Universe", argued Jevons, "the powers of mind employed in science would be useless to us" (Jevons, 1877, 2). Scientific enquiry would be prevented from identifying regularities in natural phenomena, because no such regularities would exist. "In such a world", continued Jevons, "knowledge would be no more than the memory of past coincidences, and the reasoning powers, if they existed at all would give no clue to the nature of the present, and no presage of the future" (Jevons, 1877, 2). As we have seen, Jevons rejected a world of chance. He concluded that "happily the Universe in which we dwell is not the result of chance, and where chance seems to work it is our deficient faculties which prevent us from recognising the operation of Law and Design" (Jevons, 1877, 2).

If the world is the stage on which divine providence and intention is performed, it follows that every investigation of nature, human and non-human alike, is a reconstruction of the effects of God's design. As we read in the *Principles*, induction is the process through which the scientist traces the laws based on the effects. Through induction, "we have to interpret the will by which the conditions of creation were laid down" (Jevons, 1877, 122). There is no doubt regarding whose "will" this is, as Jevons, after a few pages, wrote that "the laws of nature are the invaluable secrets which God has hidden, and it is the kingly prerogative of the philosopher to search them out by industry and sagacity" (Jevons, 1877, 126). Natural theology, using reason to explore the laws through which God governed the universe, showed how absurd it was to consider science and religion to be divorced.

As noted above, even if the world is regulated by exact laws, humans cannot fully grasp God's design. The human mind is limited, and might interpret the effects of divine providence as a fortuitous coincidence. Human knowledge can never be certain, but only probable (see for instance Jevons, 1877, 235). This condition depended on the difference between the human mind and God's intellect and Creation. On the one hand, humans are finite beings; on the other, God has an infinite intellect, which is mirrored by His Creation. Such a difference determined for Jevons, at once, the limits of scientific enquiry and its tools. As he wrote, "all sciences are and will ever remain in their infancy, relatively to the extent and complexity of the universe which they undertake to investigate" (Jevons, 1972–1981, 238). Scientists had to accept the limits of their investigations, but had a powerful instrument to find their way through the labyrinth of this infinite universe, i.e. the study of probabilities. Jevons stressed the importance of the theory of probability: for him it was a guide to life — the noblest product of the intellect, so that "to eulogise the theory ought to be as needless as to eulogise reason itself" (Jevons, 1877, 200).

While "to the view of perfect intelligence nothing is uncertain" (Jevons, 1877, 739), probability is a crucial concept for an imperfect and finite intellect, such as the human intellect. As Jevons wrote,

> It is impossible to expound the methods of induction in a sound manner, without resting them upon the theory of probability. Perfect knowledge alone can give certainty, and in nature perfect knowledge would be infinite knowledge, which is clearly beyond our capacities. (Jevons, 1877, 197)

Induction aimed to identify the laws regulating natural phenomena, and rested on the theory of probability. This was, for Jevons, the tool to be used to trace the evidence of God's design starting from its effects in the world; hence, the importance of the method of inverse probability. "On the evidence of Design", notwithstanding its focus on human design, shows how one should trace a phenomenon back to the designing mind which caused it. This manuscript thus become a remarkable example of how, according to Jevons, an investigation of natural theology should be pursued. I will now consider his position in relation to nineteenth-century works in the field of natural theology, in order to understand how Jevons contributed to this debate.

[21] It is worth noting that Jevons did not always advocate this position. He believed that some characteristics of the human mind were exceptions to this rule. On this, see Jevons, 1869, 232, in which we read that "no physiology of protoplasm, no science that yet has a name, or perhaps ever will have a name, can account for the evolution of the intellect in all its endless developments". For similar statements, see: Jevons, 1877, 576, 733–734; Jevons, 1890, 294. For a rival position, according to which Jevons ruled out the difference between matter and spirit, see: White, 1994; Maas, 2005, 9–10, ch. 5.

4. From human to divine

As noted above, in nineteenth-century England the attempts to reconcile science and religion through natural theology were pursued in particular by the authors of the *Bridgewater Treatises*. I will consider two of these *Treatises*, Whewell's and Babbage's. As I will show, the crucial point in this debate relates to the relationship between the human and the divine. For these thinkers, there is continuity between the human and divine spheres — in particular, the world can be seen as a contrivance similar to human artefacts. The problem is: to what extent is there continuity between human and divine design? As we will see, this also determines the tools to be used in the field of natural theology, and consequently the ways in which natural theology can reconcile science and religion.

William Whewell's *Treatise* aimed to show that natural laws are "remarkably adapted to the office which is assigned them; and thus offer evidence of selection, design, and goodness, in the power by which they were established" (Whewell, 1833, 9). The crucial term here is "selection". The fact that the designer of the natural laws had deliberately *selected* them for fulfilling their purpose proved its *personality*: God had the features of a person.[22] As has been noted, (see Yeo, 1979, 503; Eddy, 2013, 101, 109), Whewell underlined that God had to be thought of in the terms of agency, consistent with the general trend of the *Bridgewater Treatises*. Just as one thinks of oneself as a being endowed with will, purpose, intelligence, consciousness — in other terms, as a person —, based on the primary evidence of one's own nature one assumes that all humans are likewise. In the same way, based on the similarity between human products and the Creation, one should think of God as a person and ascribe the divine designer the very same characteristics, i.e. will, intention, consciousness, purpose (Whewell, 1833, 345–348). God, being a wise and good Legislator, deliberately chose to enforce the laws most adapted to His purpose, that is, the well-being of His creatures, and especially humans (Whewell, 1833, 4–6).[23] The element of selection, or, in other words, of choice, played an important role in Whewell's work. The author of the *Treatise* often remarked that the laws of nature are not necessary. This does not mean that these laws are whimsical or can be infringed at will, but that they cannot be explained based on mechanical necessity. They rather result from a deliberate choice of an intelligent designer regulating the universe, "of a most wise and benevolent Chooser" (Whewell, 1833, 145).

If God is understood as a person, there is no doubt that the analogy between the human and divine holds. Whewell's strategy consisted in analysing human artefacts, making a parallel with a natural phenomenon, and arguing by analogy that we could infer the existence and characteristics of the divine designer.[24] The analogy between natural and human contrivances is for Whewell at the root of the ultimate argument establishing that the world is caused by divine design. Observing both human products and natural phenomena, no-one in their right mind, according to Whewell, would ever think that such beautifully contrived objects could be the result of chance. By excluding that a certain phenomenon is the result of chance, Whewell immediately infers that it must be caused by design, just as Jevons did. One of Whewell's examples is very similar to Jevons's first case of "On the evidence of Design". Just as the latter argued that the letters of the word *Constantinopolitanensibus* are unlikely to be arranged by chance, the former argued that a scientist investigating the natural laws could never take them to be caused by chance: as Whewell continued, "when they [the scientists] had decyphered there a comprehensive and substantial truth, they could not believe that the letters had been thrown together by chance" (Whewell, 1833, 307).

In his unofficial *Bridgewater Treatise*, Charles Babbage conceived of the world as a contrivance too. Despite their differences, which will come into question later, Whewell and Babbage agreed on many points. Babbage too considered the world to be the creation of a benevolent and wise good God (Babbage, 1839, 45). He also conceived of God in personalistic and anthropomorphic terms, as Whewell did. In his *Ninth Bridgewater Treatise*, Babbage explicitly ruled out the possibility of the world being the result of chance. As he explained, taking the law of gravity as an example, we can imagine the laws of nature to be different from how they actually are, and the combinations of such alternative laws are infinite (Babbage, 1839, 58–59). Examination of all these different possible configurations, Babbage wrote, "banish for ever the dominion of chance" (Babbage, 1839, 60). "The Being", he continued, "who called into existence this creation, of which we are parts, must have *chosen* the present form, the present laws, in preference to the infinitely infinite variety which he might have willed into existence" (Babbage, 1839, 60). Just like Whewell, Babbage represented God as a being endowed with will and intention, a person who deliberately chose some laws instead of others.

Compared with Whewell's *Treatise*, Babbage takes the analogy between human and divine artefacts to the extreme. An example of this analogy is to be found in his famous Difference Engine (or, as it is called in the *Treatise*, Calculating Engine) and Analytical Engine.[25] Babbage uses these contrivances of his own making to structure the analogy between human mechanisms and nature. Moreover, in Babbage's case the analysis of these machines provided not only a confirmation of what was already known about the laws of nature and its relationship with the Creator; they also engendered new knowledge. As Babbage wrote, his views "respecting the extent of the laws of Nature were greatly enlarged by considering it, and also because it incidentally presents matter for reflection on the subject of inductive reasoning" (Babbage, 1839, 33–34). In Babbage's eyes, the resemblance between his contrivances and nature is so profound that understanding their functioning can shed further light on natural phenomena.[26]

The extent to which the analogy between human and divine contrivances can be understood is also connected to the tools the scientist could and should use in the field of natural theology. Their disagreement concerning this analogy is mirrored by the famous dispute between Whewell and Babbage concerning the role of deduction in natural theology (see: Hyman, 1982, 137, 139–140; Yeo, 1993, 123–134; Schaffer, 2003, 285–286; Maas, 2005, 105–107; Ashworth, 2021, 44–46; Topham, 2022, 434–438).

From the very beginning of his *Bridgewater Treatise*, Whewell expressed doubts concerning the use of deduction in natural theology, because of the state of mind which these instruments might engender in the scientist. In Whewell's opinion, the impression of the wisdom, power and goodness of God could never be conveyed by "a few steps of reasoning, like the conclusion of a geometrical proposition, or the result of an arithmetical calculation" (Whewell, 1833, 13). It is not a matter

[22] Even though Whewell's *Treatise* is not primarily a theological work, it is arguable that his focus on the personality of God depended on the influence of the patristic theological tradition, according to which God is interpreted through the Latin term '*persona*'. On this, see: Gamberini, 2022, 411–413. I am indebted to Francesco Emmolo for this remark.

[23] On the function of the analogy between God and the human legislator, and how the analogy differs from Paley's, see: Topham, 2010, 73; Topham, 2022, 14. For this concept in Whewell's work and its significance in the context of nineteenth-century natural theology, see: Whewell, 1833, 3, 300–301, 356-357; Topham, 2010, 73; Eddy, 2013, 108.

[24] There are various examples of this argument in Whewell's text, see for instance: Whewell, 1833, 29–30; 31–32; 42–43; 126; 139; 146; 156–157; 345.

[25] Concerning Babbage's machines, see in particular: Maas, 2005, 98–111; Bruce Collier, 1998; Swade, 2000; Jones, 2016, also for further references.

[26] Babbage's machines can be properly called, as Harro Maas has suggested, engines of discovery, as, by looking at human-made machines, we can make new discoveries about the order of nature (see Maas, 2005, 108). See also Hyman, 1982, 138–139, and Swade, 1996, concerning how Babbage used these contrivances in his investigations of natural phenomena.

of mathematical demonstration, but of the effect which contemplating nature has "on a sober and reflecting frame of mind" (Whewell, 1833, 13). Whewell claimed that the erroneous belief in the mechanical and necessary character of natural laws is far more likely to arise in people who make use of deductions, like mathematicians (Whewell, 1833, 329–330).[27] Were these scientists to believe that they could know everything that there is through deduction, they would be delusional. Mathematics and logic are mere methods, drawing conclusions from known premises, and from which no new truths can be generated (see Whewell, 1833, 335–336). The sources bearing all primary knowledge of nature, which can then be interpreted through deductive procedures, "is obviously the general course of human experience, and the natural exercise of the understanding" (Whewell, 1833, 336).

Although the comprehension of the divine order was disclosed through induction, it ultimately depended on the scientist's intuition (see Maas, 2005, 106–107; see also Yeo, 1993, 168). Whewell's appeal to intuition, or rather to Fundamental Ideas,[28] complementing knowledge which could be drawn inductively from experience, was crucial to underline the spiritual character of humans. Whewell stressed that the most important aspect of the relationship between humans and God rested in His moral character (see Whewell, 1833, 251–253). Therefore, Whewell argued that, however deep the analogy was between human contrivances and God's creation — most of all, the creation of humans themselves —, it was true only to a limited extent (Whewell, 1833, 359–361). Humans, who for Whewell were God's masterpiece, were also spiritual creatures, while human contrivances were not. This was also why deductive and mechanical reasoning could disclose God's hand in the universe only to a limited extent, as they were unable to seize the moral character of the Creator.

On this point, Babbage and Whewell were irremediably at odds. As Babbage explained in its preface, his *Ninth Bridgewater Treatise* was triggered by his disagreement with Whewell's attack on the use of deduction in natural theology. This gave the impression that "*the pursuits of science are unfavourable to religion*" (Babbage, 1839, x), despite Whewell's intention of reconciling them through his own *Treatise*. Babbage chose a different strategy to reconcile science and religion. According to Babbage, Whewell's perspective could be detrimental to this end, as it lessened the importance of the deductive sciences in the field of natural theology. Thus, Whewell disposed of the most appropriate tool for understanding God's design. After criticising Whewell in the advertisement for the second edition of his *Treatise*, Babbage argued that the natural laws, while deriving some confirmation by the "testimony of our sense, [...] derive their highest confirmation from the aid of pure mathematics, by which innumerable consequences, previously unobserved, are proved to result from them" (Babbage, 1839, vi). There is no incompatibility between the truths of mathematics and of natural theology, quite the contrary. As Babbage claimed,

> many of the facts on which the conclusions of natural religion are founded, derive their chief importance from the aid supplied by the united power of the two former classes [mathematical and physical truths], and the amount and value of this support will be enlarged with the advance of those sciences. (Babbage, 1839, vi)

This view of the deductive instruments was crucial to found Babbage's appeal to his machines. While Whewell stressed how mechanical necessity could not explain the laws of the divine Legislator, Babbage suggested that it could. For him, the natural laws were mechanical. Nature was not *similar to* a mechanical contrivance; it *was* such, only its maker was not human, but divine.[29] Hence the heuristic role of Babbage's machine: if the world is a contrivance, what could be more profitable than analysing another machine to understand it? As Babbage claimed, speculating on his machine elucidated God's agency. Therefore, "the study of the most abstract branch of practical mechanics, combined with that of the most abstruse portions of mathematical science, has no tendency to incapacitate the human mind from the perception of the evidences of natural religion" (Babbage, 1839, 98). On the contrary, it provided more evidence of the greatness of God than physical sciences had done yet (Babbage, 1839, 98–99). The world and Babbage's Calculating Engine followed the same rules. Thus, what was observed in one could be extended to the other. The disagreement with Whewell depended on this: Babbage turned Whewell's analogy into an identity.[30]

5. The tools of natural theology

Where do Jevons and his manuscript stand with respect to this controversy? With respect to the role of deduction and induction in scientific enquiry, Jevons inclined towards deduction. As he explained in the *Principles of Science*, experience provided the materials for knowledge. Those primary empirical inputs were then "digested" through induction. Thus, the foundation of knowledge was induction, as all knowledge was "derived by a certain inductive reasoning from the facts of experience" (Jevons, 1972–1981, 12). However, this did not imply a primacy of induction, because no reasoning could dispense with deduction. According to Jevons, "there is no mode of ascertaining the laws which are obeyed in certain phenomena, unless we have the power of determining what results would follow from a given law" (Jevons, 1972–1981, 12). He thus claimed that induction was the inverse process of deduction: just as one who enters a maze would have to retrace their steps to get out, so "the facts furnished to us by experience are a maze of particular results; we might by chance observe in them the fulfilment of a law, but this is scarcely possible, unless we thoroughly learn the effects which would attach to any particular law" (Jevons, 1972–1981, 12). Deduction was necessary to trace the laws of nature and understand how to apply the data known inductively. Moreover, as human knowledge always stays in the domain of probability rather than certainty, it was crucial for Jevons to apply the theory of probability to the study of natural laws.

Concerning the relationship between induction and deduction, Jevons was thus closer to Babbage than to Whewell. Even though induction was the mandatory starting point of knowledge, deduction was always its necessary complement in the investigation of natural phenomena. Thus, how could deduction lead the scientists astray in their study of nature? Moreover, "On the evidence of Design" provides a useful suggestion concerning the role of deduction in Jevons's conception of natural theology. In the manuscript it is implied that design, no less than any other feature of nature, could and should be investigated through deductive instruments, in particular through the study of probabilities. Jevons applied here the study of combinations and permutations, as well as the method of inverse probability to phenomena bearing the signs of design. Whether it is human or divine design, the method of enquiry is equally deductive, as long as there is analogy between these two levels. Jevons's position is thus consistent with Babbage's rebuttal of Whewell's attack against mathematical and deductive sciences as tools of natural theology. In Jevons's opinion, no branch of science could dispense with deduction, and the study of the divine mind's design was no exception. However, it is worth noting that

[27] Whewell was obviously thinking of Laplace, one of his major targets of criticism (see Whewell, 1833, 181–191, 338).

[28] According to Whewell's definition, Fundamental Ideas are "those inevitable general relations which are imposed upon our perceptions by acts of the mind, and which are different from anything which our senses directly offer to use this notion" (Whewell, 1840, Vol. 1, 26–27); on Fundamental Ideas and intuition in Whewell's thought see, in particular: Yeo, 1979, 503; Snyder, 2006, 57–62, 92; Ashworth, 2021, especially 57–58.

[29] According to Neal C. Gillespie, this was also the case for Paley; see Gillespie, 1990, 214.

[30] On this point, see Maas, 2005, 112.

Jevons, similarly to Whewell, stressed the limits of the analogy between human and divine. Its limit was the finiteness of the human mind, on which depended the crucial role played by the theory of probability.

Moreover, for both Jevons and Babbage, machines played a very important role in natural theology. As noted above, this was the case for Babbage's Calculating Engine in his *Treatise*. Jevons was enthusiastic about Babbage's Difference Engine, as is apparent from his "On the Mechanical Performance of Logical Inference" (1870) (see Jevons, 1890, 140–141). In this paper, Jevons showed how he followed Babbage's footsteps, creating for himself a Logical Machine.[31] Babbage's contrivances were calculating machines, while Jevons's showed their utility in relation to his system of logic. Jevons's Machine had a keyboard which enabled one to express the logical sentences, according to his system of logical notation. Some keys permitted one to fill in the terms of a proposition. Each term obviously included its negative as well. There were also some operational keys, namely introducing the copula, the full-stop and the disjunctive conjunction. The premises of a stretch of reasoning could be inserted into the machine. Once all premises had been inserted, another operational key, the Finis key, could be pressed to calculate the result. Eventually the Machine would eliminate every conclusion which would be inconsistent with the premises.

The Logical Machine was able to provide all the possible combinations resulting from the proposition inserted, in accordance with the laws of thought, which were, in their turn, the laws regulating the universe. Thus, Jevons agreed with Babbage in holding that the reasoning process could successfully be translated into a mechanism; moreover, as Jevons wrote, "it would afford a conspicuous proof of the generality and power of the method if I could reduce it to a purely mechanical form" (Jevons, 1877, 107). For Jevons, the smoothness of this mechanism would *per se* provide evidence of the smoothness of laws governing it.

It was no coincidence that both Jevons and Babbage contrived these machines, as they both believed that the laws of nature were mechanical.[32] As I have shown, Jevons took natural laws to be necessary and flawless, perfect mechanical processes contrived by the infinite mind of the divine contriver, showing signs of design. Furthermore, the laws regulating the universe were the same as the laws regulating the human reasoning process, or what Jevons, following Boole, called the Laws of Thought.[33] Such laws, which ultimately were the principles of Aristotelian logic (law of identity, non-contradiction and of the excluded middle), were laws of "both thought and things" (see Jevons, 1890, 12, 16, 21, 25, 28, 31, 34). We could understand the structure of the world because of this uniformity between our mind and the world.

Therefore, Jevons's Logical Machine was a dynamic embodiment of both the mind and the world, which were both regulated by the same mechanical laws, even if the mind could never be entirely reduced to a mechanism, as I noted above (see fn. 21). As I have written elsewhere, Jevons's Logical Machine was thus a "theatre of the world", as it staged the effects of the natural laws and the ceaseless combining of its phenomena (see Buono, 2022, 306). Indeed the analogy between the world and machines was suggested by Jevons in his *Principles*:

> doubtless there is in nature some invariably acting mechanism, such that from certain fixed conditions an invariable result always emerges. But we, with our finite minds and short experience, can never penetrate the mystery of those existences which embody the Will of the Creator, and evolve it throughout time. We are in the position of spectators who witness the productions of a complicated machine, but are not allowed to examine its intimate structure. (Jevons, 1877, 222)

Because the laws of nature were the expression of divine design, Jevons's machine can also be seen as an embodiment of God's providential design.

Even though Babbage and Jevons both relied on their machines to understand God's design, the role played by their machines in their thought was nonetheless different. As I have argued above, Babbage's machine could provide new insights into God's plan and agency: what could not be understood by inductive analysis of the world, could be inferred by studying the machine's functioning. Jevons's machine played a different part in the investigation of nature. First, as I noted, it was a representation of the laws of nature, and thus of God's design, but Jevons never suggested that it could provide new knowledge of the world. Its function was illustrative, not heuristic. Thus, Jevons attached a didactic function to his machine. Second, it was a useful instrument to show the evidence and correctness of his logical principles (see: Jevons, 1890, 151; Jevons, 1877, 112–113). Third, Jevons specified that the machine was meant to mechanise the task of reasoning, thus preventing logical blunders (Jevons, 1877, 95–96); however, its practical utility should not be overestimated, for — as Jevons noted — "we do not require in common life to be constantly solving complex logical questions" (Jevons, 1877, 112; see also Jevons, 1890, 170–171). Thus, compared to Babbage's use of his Calculating Engine in the *Treatise*, the role played by Jevons's Logical Machine in his investigation of nature was limited.

Despite their different conceptions of the role played by their machines in natural theology, there is no doubt that Jevons's ideas were rather closer to Babbage than to Whewell. Even though he did not deny induction its role in scientific pursuits, Jevons's view of the universe came closer to Babbage's deductive and mechanistic interpretation of God's work to than Whewell's account. In addition, it is not surprising that Jevons supported Babbage's view, in which the mechanical laws of God's creation were the basis for mechanising society and the economy (see: Schaffer, 2003, especially 267–268, 278–284; Prendergast, 2021; Topham, 2022, 434), which Whewell opposed. Nor is it a coincidence that, in Whewell's *Treatise*, God was compared to a legislator: the natural order displayed by Whewell's natural theology was mirrored by the order of society.[34]

6. Conclusion

As I have shown in the present study, Jevons's manuscript offers an important contribution both to Jevons scholarship and to nineteenth-century studies on science and religious thought. In "On the evidence of Design", Jevons used the method of inverse probability to trace the evidence of design. The limited nature of the human mind, compared with the infinite Creation of God, explained the crucial role played by the theory of probability. If natural theology strives to grasp God's work through reason, for Jevons, the quintessence of human reason was the understanding of probabilities. This was Jevons's answer to the question concerning what the most appropriate tool for natural theology was.

As we have seen, there were rival positions. Whewell was loath to emphasise the importance of these instruments within the field of natural theology, as he believed that they might lead the scientist's mind astray from religion and to exaggerate the analogy between human and divine design. While, to the contrary, Babbage was positive that the deductive sciences were more than apt to investigate God's

[31] For Jevons's description of this machine, see: Jevons, 1890, 156–170; Jevons, 1877, 107–114. On this topic, see also: Mays & Henry, 1953, 493–499; Maas, 2005, especially 124–150.

[32] For this position in relation to Babbage, see Hyman, 1982, 137.

[33] On Jevons and Boole, see: Mays, 1962, 236; Strong, 1976, on probability; Schabas, 1990, 60–65 especially; Maas, 2005, 112–117 and 137, concerning the laws of thought.

[34] On the relationship between Whewell's political and scientific views, see: Schaffer, 1991; Williams, 1991; Yeo, 1993; Snyder, 2006; Snyder, 2011; Carlton, 2022.

work, and that their potential should be fully exploited. Each of their positions is consistent with their account of the world, as well as of the relationship between God and humans. On the one hand, for Whewell, the rebuttal of deductive instruments ensured our understanding of the similarity between the human and divine mind, which formed the foundation of morality. On the other hand, for Babbage and Jevons, God's laws were mechanical at their core; the world, mechanical itself, was indeed made in His image. However, for Jevons, the finite human intellect cannot fully grasp His image. Humans have thus to use the theory of probability to trace the evidence of God's design. These were different strategies to reconcile science and religion. Nonetheless, all these authors believed that natural theology could be a powerful tool in order to do so.

CRediT authorship contribution statement

Eleonora Buono: Conceptualization, Funding acquisition, Investigation, Methodology, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This research was supported by the Swiss National Science Foundation (grant no. TMPFP1_217268). I would like to thank Elia Steve, Jean Claverie, Lukas Verburgt, and especially Harro Maas, for their comments on earlier versions of this paper. I am also grateful to Laura Buono, who helped decipher some complicated words in Jevons's manuscript, and to Coralie Amiot and Yuri Gallo, for their help while I was trying to identify the copyright holder. In addition, I would like to thank Jonathan Nassim, for his work as proofreader, as well as for his precious comments on the paper's content.

Appendix. On the evidence of Design[35]

[1] When we say that a certain arrangement of things is due to Design, we mean that the uniform and harmonious intention of some intellect were the conditions or cause of their arrangement. Accordingly we can investigate the probability that certain phenomena indicate a designing mind in the same manner as in the case of conditions generally. The human mind feels truly to be a cause of the arrangements which it makes and if phenomena anywhere present themselves in an arrangement like that to which a mind might have given rise there is an irresistible tendency to believe in its mental origin. And this belief is doubtless well founded. If we meet for instance with the letters of the word *Constantinopolitanensibus*, arranged in this order, two hypotheses are possible: they were arranged because they would have meaning or they [2] come together by chance. Now the probabilities of the 25 letters are in numbers[36] $\frac{\lfloor 25}{\lfloor 3 \lfloor 5 \lfloor 3 \lfloor 3 \lfloor 3 \lfloor 3 \lfloor 2}$ or nearly fifty trillions and though each permutation is capable of happening by chance and as likely to happen as any other the probability of design is immensely greater, because this is perhaps the one arrangement of the letters which would be chosen by design. The above is an example chosen by D'Alembert[37] and Condorcet has also discussed the probability of design as indicated in the arrangement of numbers.[38]

Kepler tells us that when a youth he occupied himself in making anagrams of his name and being dissatisfied with the only two arrangements he could make by trial, cramming words meaning "The tapster of the Sirens" and "The serpent in his sting", he resolved to try the effect of chance, and writing each letter as [3] a separate card shuffled them time after time in hope of some interesting arrangement presenting itself. But no such arrangement turned up and much time was wasted except that he deemed from the employment an impressive lesson on the futility of all theories which ascribe the world to chance. We would not wonder at Kepler's failure when we observe that the fifteen letters in his Latin name, Joannes Keplerus, admit of 54,486,432,000 arrangements[39], so that his whole life might have been spent on the employment without in the least degree exhausting the permutations.

This subject has been carefully investigated by the late Professor Donkin of Oxford. He supposes a person to enter a room and observe the books upon the table to be arranged in a symmetrical form; required the probability that the arrangement was intentional. Several quantities enter into the question. Thus let d be the [4] Antecedent probability that the person who placed the books on the table designed to place them in some particular form; let r be the probability that he would choose a regular one, if he chose any; let p be the probability that if he chose a regular arrangement it would be the one observed; and finally let a be the antecedent probability that such an arrangement would occur by chance. Now there are five possible suppositions before the event has been observed, two of which are 1st that it is produced by design, the probability of which is drp, or 2nd that it is produced but not by design, the probability of which is $(1 - d)\, a$. The other three become impossible after the event has happened so that we must alter each of the above probabilities in such a rate that their sum will be equal to unity, which is effected by dividing each of them by the sum of the two. We then detain for the probability of design the formula

[5]

$$\frac{drp}{drp + (1-d)\,a}$$

We may simplify the result by supposing that we have no antecedent knowledge as to the intentions of the person, and learn only from observation of the event. This we do by making $d = \frac{1}{2}$ when we obtain $\frac{1}{1+\frac{a}{rp}}$. Now r is nearly equal to unity because if a person selected any arrangement it would in all probability have some method or symmetry in it. The value of the expression turns then upon the comparative values of a and p; but of these p is immensely greater, because it is the probability that a person would select this particular regular form out of all regular forms, whereas a is the probability that the regular form would occur by chance out of all forms regular or irregular. Now the irregular forms may be considered almost infinitely more numerous that the regular ones — [6] so that the occurrence of any symmetrical or peculiar form which might be the result of human choice is approximatively certain evidence that it was the result of human choice.[40]

This problem is of great importance because it is concerned in all the judgements we make concerning the origin of worked stones, plinths, and all kinds of antiquarian questions. The position of six stones or even fewer in an approximate circle is sufficient proof of their being placed there by human hands. Six of the Pyramids at Gizah have straight passages exactly pointing to the position which the star γ Draconis must have occupied about 3970 years ago when it served as the Pole

[35] A manuscript by William Stanley Jevons (Jevons Family Papers, John Rylands Library, University of Manchester, JA6/05/101 [6pp.]). *Editor's note*: references are transcribed as Jevons wrote them in the manuscript, except that numbers are used instead of Jevons's original signs for references. Pages breaks and numbers are marked by a number in squared brackets.

[36] *Editor's note*: the old signs for factorials were used, as they were written by Jevons in the manuscript.

[37] Todhunter's *History*, p. 273.

[38] *Ibid.*, pp. 393–394.

[39] Drinkwater's *Life of Galileo*, L.O.K, p. 13.

[40] Chambers *Astronomy*, 1st ed., p. 270.

Star.[41] These coincidences are sufficient to prove that the builders of the pyramids designed the direction of the passages from astronomical motives and that the age assigned to the pyramids is not far wrong.

References

Aldrich, J. (1987). Jevons as statistician: The role of probability. *Manchester School*, *60*(3), 233–253. http://dx.doi.org/10.1111/j.1467-9957.1987.tb01300.x.

Ashworth, W. (2021). *The Trinity circle: Anxiety, intelligence, and knowledge creation in nineteenth-century England*. Pittsburgh: University of Pittsburgh Press.

Babbage, C. (1839). *The ninth Bridgewater treatise: A fragment*. London: Murray.

Bayes, T. (1763). An essay towards solving a problem in the doctrine of chances. *Philosophical Transactions of the Royal Society*, *53*, 370–418.

Bayliss, A. (2015). Quality in Bayesian chronological models in archaeology. *World Archaeology*, *47*(4), 677–700. http://dx.doi.org/10.1080/00438243.2015.1067640.

Black, R. D. C. (1972a). W. S. Jevons and the foundation of modern economics. *History of Political Economy*, *4*(2), 362–378, reprinted in John C. Wood (Ed.), *William Stanley Jevons: Critical assessments*. London and New York: Routledge, Vols. 3, Vol. 1, 298–310.

Black, R. D. C. (1972b). Jevons, Bentham and De Morgan. *Economica*, *39*(2), 119–134. http://dx.doi.org/10.2307/2552637, Reprinted in John C. Wood (Ed.), *William Stanley Jevons: Critical assessments*. Routledge, London and New York, Vols. 3, Vol. 1, 280–297.

Black, R. D. C. (1993). Jevons' contribution to the teaching of political economy in Manchester. In A. Kadish, & K. Tribe (Eds.), *The market for political economy* (pp. 162–183). London and New York: Routledge.

Bruce Collier, J. M. (1998). *Charles Babbage and the engines of perfection*. Oxford: Oxford University Press.

Buono, E. (2022). A syntax of phenomena: William Stanley Jevons's logic and philosophy of Science as an *ars combinatoria*. *Intellectual History Review*, *32*(2), 299–323. http://dx.doi.org/10.1080/17496977.2021.1911575.

Carlton, H. (2022). *Cosmology and the scientific self in the nineteenth century*. New York: Palgrave Macmillan.

Chaloner, W. H. (1972). Jevons in Manchester. *Manchester School*, *40*(1), 73–82, reprinted in John C. Wood (Ed.), *William Stanley Jevons: Critical assessments*. London and New York: Routledge, Vols. 3, Vol. 1, 268–279.

Clark, S. R. L. (2013). The classical origins of natural theology. In R. R. Manning (Ed.), *The Oxford Handbook of natural theology* (pp. 9–22). Oxford: Oxford University Press.

Cohen, D. J. (2005). Reasoning and belief in Victorian mathematics. In M. Daunton (Ed.), *The organisation of knowledge in Victorian Britain* (pp. 139–158). Oxford: Oxford University Press.

Cohen, D. J. (2007). *Equations from God: Pure mathematics and Victorian faith*. Baltimore: John Hopkins University Press.

Dale, A. I. (1999). *A history of inverse probability: From Thomas Bayes to Karl Pearson* (2nd ed.). Springer: New York.

De Morgan, A. (1841). *An essay on probability, and on their application on life contingencies and insurance offices* (2nd ed.). London: Longman.

De Morgan, A. (1847). *Formal logic: Or, the calculus of inference, necessary and probable*. London: Taylor and Walton.

Donkin, W. F. (1851). On certain questions relating to the theory of probability. *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, *1*(Fourth Series), 353–368.

Drinkwater, J. E. (1829). Life of Kepler. In *The life of Galileo Galilei, with illustrations of the advancement of experimental philosophy*. London: Baldwin and Craddock.

Eddy, M. D. (2013). Nineteenth-century natural theology. In R. R. Manning (Ed.), *The Oxford Handbook of natural theology* (pp. 100–117). Oxford: Oxford University Press.

Fienberg, S. E. (2006). When did Bayesian inference become 'Bayesian'? *Bayesian Analysis*, *1*, 1–40. http://dx.doi.org/10.1214/06-BA101.

Gamberini, P. (2022). *Deus duepuntozero: Ripensare la fede nel post-teismo*. Verona: Gabrielli.

Gillespie, N. C. (1990). Divine design and the industrial revolution: William Paley's abortive reform of natural theology. *Isis*, *81*, 214–229. http://dx.doi.org/10.1086/355335.

Hankey, W. (2013). Natural theology in the patristic period. In R. R. Manning (Ed.), *The Oxford Handbook of natural theology* (pp. 38–56). Oxford: Oxford University Press.

Hilton, B. (1988). *The age of atonement. The influence of evangelicalism on social and economic thought, 1795-1865*. Oxford: Clarendon Press.

Hilton, B. (2006). *A mad, bad and dangerous people? England 1783-1846*. Oxford: Oxford University Press.

Hyman, A. (1982). *Charles Babbage, pioneer of the computer*. Princeton: Princeton University Press.

Jevons, W. S. (1869). A deduction from Darwin's theory. *Nature*, *1*, 232–233.

Jevons, W. S. (1877). *The principles of science: A treatise on logic and scientific method* (2nd ed.). London: Macmillan.

Jevons, W. S. (1883). *Methods of social reform and other papers*. London: Macmillan.

Jevons, W. S. (1884). *Investigations in currency and finance*. London: Macmillan.

Jevons, W. S. (1886). *Letters and journal of William Stanley Jevons*. London: Macmillan.

Jevons, W. S. (1890). *Pure logic and other minor works*. London: Macmillan.

Jevons, W. S. (1972–1981). In R. D. C. Black, & M. Könekamp (Eds.), *Papers and correspondences of William Stanley Jevons*, London: Macmillan.

Jones, M. L. (2016). *Reckoning with matter: Calculating machines, innovation, and thinking about thinking from Pascal to Babbage*. Chicago: The University of Chicago Press.

Kepler, J. (1606). *De stella nova in pede serpentari*. Praha: Paul Sessius.

Laudan, L. (1973). Induction and probability in the nineteenth century. In P. Suppes, & et al. (Eds.), *Vol. 74, Logic, methodology and philosophy of science IV* (pp. 429–438). Amsterdam: North-holland Publishing Company.

Maas, H. (2005). *William Stanley Jevons and the making of modern economy*. Cambridge: Cambridge University Press.

MacLennan, B. (1972). Jevons's philosophy of science. *Manchester School*, *60*(1), 53–71. http://dx.doi.org/10.1111/j.1467-9957.1972.tb00673.x, reprinted in John C. Wood (Ed.), *William Stanley Jevons: Critical assessments*. London and New York: Routledge, Vols. 3, Vol. 1, 251–267.

Manning, R. R. (2013). Introduction. In R. R. Manning (Ed.), *The Oxford Handbook of natural theology* (pp. 1–5). Oxford: Oxford University Press.

Mays, W. P. (1962). Jevons' conception of scientific method. *Manchester School*, *40*(3), 223–249. http://dx.doi.org/10.1111/j.1467-9957.1962.tb00330.x, reprinted in John C. Wood (Ed.), *William Stanley Jevons: Critical assessments*. London and New York: Routledge, Vols. 3, Vol. 1, 212–232.

Mays, W. P., & Henry, D. P. (1953). Jevons and logic. *Mind*, *62*, 484–505.

Mosselmans, B. (2007). *William Stanley Jevons and the cutting edge of economics*. London and New York: Routledge.

Oslington, P. (2017). Natural theology, theodicy, and political economy in nineteenth-century Britain: William Whewell's struggle. *History of Political Economy*, *49*(4), 575–606. http://dx.doi.org/10.1215/00182702-4296317.

Paley, W. (1803). *Natural theology, or, evidences of the existence and attributes of the deity, collected from the appearances of nature*. London: Wilks and Taylor.

Peart, S. (1996). *The economics of W. S. Jevons*. London and New York: Routledge.

Peterfreund, S. (2012). *Turning points in natural theology from Bacon to Darwin: The way of the argument from design*. New York: Palgrave Macmillan.

Prendergast, R. (2021). Charles Babbage's economy of knowledge. In C. Meyns (Ed.), *Information and the history of philosophy* (pp. 241–293). London and New York: Routledge.

Richards, J. L. (1997). The probable and the possible in early Victorian England. In B. Lightman (Ed.), *Victorian science in context* (pp. 51–71). Chicago and London: University of Chicago Press.

Schabas, M. (1984). The 'Worldly Philosophy' of William Stanley Jevons. *Victorian Studies*, *28*(1), 129–147, reprinted in John C. Wood (Ed.), *William Stanley Jevons: Critical assessments*. London and New York: Routledge, Vols. 3, Vol. 1, 401–418.

Schabas, M. (1990). *A world ruled by number: William Stanley Jevons and the rise of mathematical economy*. Princeton: Princeton University Press.

Schaffer, S. (1991). The history and geography of the intellectual world: Whewell's politics of language. In S. S. Menachem Fisch (Ed.), *William Whewell: A composite portrait* (pp. 201–231). Oxford: Oxford University Press.

Schaffer, S. (2003). Paper and brass: The Lucasian professorship, 1820–39. In R. N. Kevin C. Knox (Ed.), *From Newton to Hawking: A history of Cambridge University's Lucasian professors of mathematics* (pp. 241–293). Cambridge: Cambridge University Press.

Snyder, L. J. (2006). *Reforming philosophy: A Victorian debate on science and society*. Chicago: University of Chicago Press.

Snyder, L. J. (2011). *The philosophical Breakfast Club: Four remarkable friends who transformed science and changed the world*. New York: Broadway Books.

Stigler, S. (1982). Jevons as statistician. *Manchester School*, *50*(4), 354–365. http://dx.doi.org/10.1111/j.1467-9957.1982.tb00186.x.

Strong, J. V. (1976). The infinite ballot box: De Morgan, Boole, and Jevons on probability and the logic of induction. *Proceedings of the Philosophy of Science Association*, *1*, 197–211.

Swade, D. (1996). It will not slice a pinapple: Babbage, miracles and machines. In J. S. F. Spufford (Ed.), *Cultural Babbage, technology, time and invention* (pp. 34–51). London: Faber & Faber.

Swade, D. (2000). *The cogwheel brain: Charles Babbage and the quest to build the first computer*. London: Little, Brown and Company.

Todhunter, I. (1865). *A history of the mathematical theory of probability from the time of Pascal to that of Laplace*. Cambridge and London: Macmillan and CO..

Topham, J. R. (1992). Science and popular education in the 1830s: the role of the *Bridgewater Treatises*. *British Journal of the History of Science*, *25*(4), 397–430. http://dx.doi.org/10.1017/S0007087400029587.

Topham, J. R. (1998). Beyond the 'common context': the production and reading of the Bridgewater Treatises. *Isis*, *89*(4), 233–262. http://dx.doi.org/10.1086/384000.

Topham, J. R. (2010). Natural theology and the sciences. In P. Harrison (Ed.), *The Cambridge companion to science and religion* (pp. 59–79). Cambridge: Cambridge University Press.

[41] Chambers *Astronomy*, 1st ed., p. 270. *Editor's note*: Jevons made the same reference twice, attaching the same passage of Chambers's book to both occurrences.

Topham, J. R. (2022). *Reading the book of nature: How eight best sellers reconnected christianity*. Chicago: Chicago University Press.
Whately, R. (1847). *Introductory lectures on political economy*. London: B. Fellowes.
Whewell, W. (1833). *Astronomy and general physics considered with reference to natural theology*. London: William Pickering.
Whewell, W. (1840). *The philosophy of the inductive sciences founded upon their history*: *Vol. 2*, London: John W. Parker.
White, M. V. (1989). Why are there no supply and demand curves in Jevons? *History of Political Economy*, *21*(3), 425–456. http://dx.doi.org/10.1215/00182702-21-3-425.
White, M. V. (1994). The moment of Richard Jennings: The production of Jevons's marginalist economic agent. In P. Mirowski (Ed.), *Natural images in economic thought, "Market Read in Tooth and Claw"* (pp. 197–230). Cambridge: Cambridge University Press.
Williams, P. (1991). Passing on the torch: Whewell's philosophy and principles of English education. In S. S. Menachem Fisch (Ed.), *William Whewell: A composite portrait* (pp. 119–146). Oxford: Oxford University Press.
Wood, P. (Ed.), (2004). *Science and dissent in England, 1688-1945*. Farnham: Ashgate.
Yeo, R. (1979). William Whewell, natural theology and the philosophy of science in mid nineteenth century Britain. *Annals of Science*, *36*(5), 493–516. http://dx.doi.org/10.1080/00033797900200341.
Yeo, R. (1993). *Defining science: William Whewell, natural knowledge, and public debate in early Victorian Britain*. Cambridge: Cambridge University Press.