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ARTICLE

Typicality and Minutis Rectis Laws: From Physics to Sociology

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Abstract

This paper contributes to the clarification of the concept of "typicality" discussed in contemporary philosophy of physics by conceiving the nomological status of a typical behaviour such as that expressed in the Second Law of Thermodynamics as a "minutis rectis law". A brief sketch of the discovery of "typicality" shows that there were ideas of typical behaviour not only in physics but also in sociology. On this basis and in analogy to the Second Law of Thermodynamics, it is shown that the nomological status of sociological laws such as Gresham's Law can also be conceived as "minutis rectis laws".

Keywords Ludwig Boltzmann · Ceteris paribus laws · Minutis rectis laws · Physics · Second Law of Thermodynamics · Sociology · Typicality · Max Weber

1 Introduction

In the current literature on philosophy of physics, the term "typicality" refers to behaviour that very often occurs in a certain way, although it could also occur differently. For example, it is typical that gas molecules in a closed container distribute themselves evenly throughout the space, although it would be possible for them to condense in one place. This behaviour is expressed by the Second Law of Thermodynamics.

However, "typicality" is not said to be limited to behaviour of interest only to physics: "Many important phenomena, in physics and beyond, while they cannot be shown to hold without exception, can be shown to hold with very rare exception, suitably understood. Such phenomena are said to hold typically" (Goldstein 2012, 59–60). For example, it also seems typical that in capitalist states and in view of certain fiscal policy measures bad money ousts better money. This behaviour is expressed by Gresham's Law.

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For Max Weber, "Gresham's Law" was the paradigm case of a sociological law (Weber 2002a, 5 and 9; 2004, 318 and 324; 2009, 617 and 626).[1] In his "Basic Sociological Concepts", he defined sociology as a science which seeks "*general* rules in events", i.e. "typical [*chances*]"[2] "that under [certain] circumstances we might *expect* a [...] [course] of social action which can [...] be *understood* in terms of the typical motives and typical intentions of the [actors]" (Weber 2002a, 9; 2004, 324–325). The fact that he associated the terms "law" and "rule" with the word "typical" indicates that he had an idea of "typicality".

Although there is still disagreement in philosophy of physics about the nature of "typicality", it seems worthwhile to transpose the basic idea into sociology in order to gain a better understanding of sociological laws. This transposition is possible only by "analogy" (Bartha 2019), which is justified by the very fact that the concept of "typicality" itself was created by analogical reasoning.

In the following, I will first introduce the basic idea of "typicality" and argue that the nomological status of a typical behaviour such as that expressed in the Second Law of Thermodynamics cannot be adequately understood by conceiving it as a "ceteris paribus law". It must rather be conceived as a "minutis rectis law". I will then provide a brief sketch of the discovery of "typicality" in order to show that Weber placed his sociology in this tradition of analogical reasoning. On this basis, I will finally show in analogy to the Second Law of Thermodynamics that sociological laws such as Gresham's Law can also be conceived as "minutis rectis laws", because this is the definitive property of their nomological status.

2 Physics

In philosophy of physics, the discovery of "typicality" is attributed to Ludwig Boltzmann (Lazarovici and Reichert 2015, 689) and documented with reference to his claim that in a closed container containing gas molecules the "most likely state [...] which we call that of the Maxwellian velocity-distribution [...] is not an outstanding singular state, opposite to which there are infinitely many more non-Maxwellian velocity-distributions, but it is, to the contrary, distinguished by the fact that by far the largest number of all possible states have the characteristic properties of the Maxwellian distribution, and that compared to this number the amount of possible velocity-distributions that deviate significantly from Maxwell's is vanishingly small" (Boltzmann 1898, 252 (translation in Lazarovici and Reichert 2015, 702; Oldofredi et al. 2016, 7)).[3]

Boltzmann wanted to understand the macroscopic laws of a gas, in particular the Second Law of Thermodynamics, by its microconstituents and the laws which determine their

[1] The classic formulation was coined by MacLeod (1858, 476–477), who claimed "that good and bad money cannot circulate together": "A bad and debased currency is the *cause* of the disappearance of the good money." We will concentrate on this law because it is not only Weber's prime example but also a standard reference point in philosophy of science (Oppenheim and Putnam 1958; Fodor 1974; Loewer 2008; 2009; 2012).

[2] Unfortunately, existing English translations of Weber's texts are not always precise enough to allow an adequate understanding of his thought. Here "*Chance*" is translated as "*likelihood*". However, "*Chance*" is an independent concept which dates back to the early days of the theory of probability (de Moivre 1718). For this reason, I have altered inaccurate English translations and marked them as [altered by author].

[3] See also: "One should not forget that the Maxwell distribution is not a state in which each molecule has a definite position and velocity, and which is thereby attained when the position and velocity of each molecule approach these definite values asymptotically. [...] It is in no way a special singular distribution which

behaviour. He maintained that a gas in a closed container consists of moving molecules whose locations and velocities are constantly changing. The movements of the molecules are determined by the fundamental laws of motion formulated in Hamiltonian mechanics. With each configuration of molecules, the gas is in a different microstate which marks a point in the space of all possible microstates called phase space. Measured by the Liouville measure,[4] by far the largest number of all possible microstates realize a Maxwellian velocity distribution, while only a negligibly small number of possible microstates realize other distributions. A Maxwellian distribution is therefore most likely.[5] It follows that the molecules are distributed evenly throughout the entire container whereby the same pressure and temperature prevail, although different distributions and thus different pressure and temperature conditions would be possible. With his insight that the molecules evolve to an "*equilibrium state*", Boltzmann contributed to the foundation of the Second Law of Thermodynamics, "positing the monotonous increase of a macroscopic variable of state called *entropy*, which attains its maximum value in equilibrium" (Lazarovici and Reichert 2015, 690). This macroscopic regularity is determined entirely by its microconstituents and the laws which determine their behaviour. It can be called "typical" because the microstates which realize it are "typical".[6]

Roman Frigg has given a rough definition of "typicality" that is sufficient for our purpose: "Consider an element e of a set $\sum$. Typicality is a relational property of e, which e possesses with respect to $\sum$, a property P, and a measure v, often referred to as a 'typicality measure'. Roughly speaking, e is typical if most members of $\sum$ have property P and e is one of them" (Frigg 2009, 1000). Concerning a gas in a closed container, e corresponds to a microstate x, $\sum$ amounts to all possible microstates, P is the property to evolve to equilibrium, and v is the Liouville measure (cf. Filomeno 2014, 130–131).

The fundamental laws of motion hold strictly and without exceptions (Loewer 2008, 154–155). The Second Law of Thermodynamics, on the other hand, may have exceptions, even though they may be very rare. In philosophy of science, laws that have exceptions are usually called *ceteris paribus* laws (Reutlinger et al. 2019). Such *cp* laws hold only under certain conditions which are fixed more or less explicitly in the *ceteris paribus* clause. Exceptions arise through the violation of this *cp* clause. Accordingly, the assumption is

Footnote 3 (continued)

is to be contrasted to infinitely many more non-Maxwellian distributions; rather it is characterized by the fact that by far the largest number of possible velocity distributions have the characteristic properties of the Maxwell distribution, and compared to these there are only a relatively small number of possible distributions that deviate significantly from Maxwell's. Whereas Zermelo says that the number of states that finally lead to the Maxwellian state is small compared to all possible states, I assert on the contrary that by far the largest number of possible states are 'Maxwellian' and that the number that deviate from the Maxwellian state is vanishingly small" (Boltzmann 1896, 569–570; 2003, 394–395 (cited in Goldstein 2012, 60)).

4 Boltzmann used the Liouville measure (Boltzmann 1898, 252).

5 This only applies if probabilities are associated with phase space volumes, as Boltzmann did.

6 The fact that by far the largest number of all possible microstates really exhibit this particular behaviour can be explained with the "Mentaculus" (Albert 2000; Loewer 2008; 2012). This theory ultimately reduces all higher level probabilities to a uniform probability distribution (PROB) over all possible microstates that can realize the supposed very low entropy macrostate at or right after the Big Bang (Past Hypothesis PH). On the basis of this reasoning, the Mentaculus, consisting of PROB, PH and the fundamental laws of motion, becomes a basis for understanding not only the "thermodynamics laws" but also the "laws of natural selection" and other laws of the special sciences such as the "laws of intentional psychology" and even "Gresham's Law" (Loewer 2008, 160; 2012, 18). For a critical discussion see Wilson (2014).

made that the Second Law of Thermodynamics "is a *ceteris paribus* law since it holds only as long as the system is approximately energetically isolated" (Loewer 2008, 156).

In contrast, Luke Fenton-Glynn argues that "[n]ot all exceptions to scientific generalizations arise due to the non-fulfilment of (explicit or implicit) cp clauses" (Fenton-Glynn 2016, 278). The Second Law of Thermodynamics (SLT) serves him as an example: "*Even assuming an ideal isolated system*, exceptions to SLT may arise just as a consequence of certain unlikely microphysical realizations of the system's initial thermodynamic state" (Fenton-Glynn 2016, 278). In such an isolated system, "the majority of points in the system's phase space (measure ≈ 1) are on non-entropy-decreasing trajectories. However, there are a very few (measure ≈ 0) that are on entropy-decreasing trajectories. SLT only holds if the initial macro-state of the system is realized 'in the right way'—viz. by one of the 'usual' points in phase space that is on a non-entropy-decreasing trajectory" (Fenton-Glynn 2016, 279). Exceptions from SLT may therefore result "just as a consequence of the properties that they concern being realized in the 'wrong' way" (Fenton-Glynn 2016, 279). Fenton-Glynn calls laws that admit such exceptions "*minutis rectis* (*mr*) laws: that is, laws that hold only when the properties that they concern are realized in the right way" (Fenton-Glynn 2016, 278–279).[7]

Fenton-Glynn argues that SLT is not aptly construed as a *cp* law: "Rather than a cp clause, SLT includes a precise specification of its scope of application: it applies to thermodynamically isolated systems (including the universe as a whole)" (Fenton-Glynn 2016, 278). This reference in brackets is important because, with regard to the "universe as a whole", the question of whether there could be an "inference from outside" that would enforce a *cp* clause cannot even arise (Fenton-Glynn 2016, 278). It would be equally "inapt" to impose a *cp* clause on SLT that assumes away the wrong microphysical realizations: "That would be to construe SLT's implicit form as something like 'the total entropy of an isolated system does not decrease over time, except when its initial microstate is such that it does decrease'. But this comes close to rendering SLT empty when clearly it isn't" (Fenton-Glynn 2016, 278).[8]

For the purpose of this paper, it is not necessary to decide whether or not SLT is a *cp* law. Fenton-Glynn points out that "many special science generalizations hold *both* only cp *and* only mr" (Fenton-Glynn 2016, 279). What we must do—beyond Fenton-Glynn who did not refer to the typicality approach—is to establish a connection between typical behaviour and *mr* laws. If SLT is the definitive case of typicality and if *mr* laws can be explicated by means of this case, then we can conceive a typical behaviour as a *mr* law.

Other cases of typicality, such as the results of tossing of a coin,[9] which is usually explained by the Law of Large Numbers, can also be conceived as *mr* laws, because it is always the "right" initial conditions that lead, together with the fundamental laws of motion, to these macroscopic regularities. The payoff of the idea of *mr* laws for the

[7] Fenton-Glynn distances himself from Schurz, who had introduced the distinction between "literal ceteris paribus laws" (other things being equal) and "ceteris rectis laws" (other things being right) (Schurz 2014) in order to refine his former distinction between "comparative ceteris paribus laws" and "exclusive ceteris paribus laws" (Schurz 2002). For Fenton-Glynn, *mr* laws are not a type of *cp* laws (Fenton-Glynn 2016, 275).

[8] Fenton-Glynn refers to Earman and Roberts (1999, 465) who distinguish their position from Carrier's conception of SLT as a *cp* law (Earman and Roberts 1999, 476; Carrier 1998, 221). The conception of SLT which Fenton-Glynn calls "inapt" can also be found in Carrier (2000, 378).

[9] When a coin is tossed repeatedly over a long series, it is typical that it lands almost as often on heads as on tails. Long series in which it lands with great frequency or always on heads or on tails are possible, but atypical (cf. Frigg 2009, 998; Lazarovici and Reichert 2015, 706; Oldofredi et al. 2016, 4, 8–9).

philosophy of science is twofold: It clarifies the nomological status of typical behaviour and thereby relativizes the validity of the concept of *cp* laws.[10]

3 Analogies

The "[a]ncient history (<1950)" (Goldstein 2012, 61) of "typicality" has yet to be written. What is clear, however, is that this is a story of analogies. For our purpose, it is sufficient to sketch one line of reception, which begins with the problem of measurement errors in observing celestial bodies.[11]

Carl Friedrich Gauss formulated an error theory in 1809, based on the assumption that "small errors oftener occur than large ones" (Gauss 1857, 253 (No. 174)). If the "probability" of an error Δ is expressed as a function $\varphi\Delta$, then it is possible to maintain "that its value should be a maximum for $\Delta = 0$, equal, generally, for equal opposite values of Δ, and should vanish, if, for Δ is taken the greatest error, or a value greater than the greatest error" (Gauss 1857, 254 (No. 175)). The "most probable value" can be determined by the "arithmetical mean of the observed values" (Gauss 1857, 258 (No. 177)). On this basis, Gauss derived his function of probability distribution, the graphical representation of which produces the bell-shaped curve of normal distribution (Gauss 1857, 253–255 (No. 175), 257–259 (No. 177)).

Adolphe Quetelet, who was in personal contact with Gauss, explained the error curve in more detail and extended its scope. He did not want the "arithmetical mean" to be misunderstood as "average" but instead, as John F. W. Herschel would formulate it, in the sense of "a natural and recognisable central magnitude, all differences from which ought to be regarded as deviations from a standard" (Herschel 1850, 23). In addition, Quetelet transferred the error curve to other objects by analogy. His best-known example is the 5738 Scottish soldiers, whose different chest circumferences he did not regard as natural differences but as deviations from a "true mean" in which he recognized a "type" (Quetelet 1849, 90–93, 276). He even thought he could observe this regularity in many respects in society, such as in births, marriages, suicides, crimes, etc. (Quetelet 1842).

The extended use of the error curve in Quetelet's "Social Physics" inspired the physicist James Clerk Maxwell, whose attention was drawn to Quetelet through a review published by Herschel in 1850. Herschel not only discussed Quetelet's theory in detail but also improved the error theory (Herschel 1850). Fond of analogies (Maxwell 1856), Maxwell based his derivation of the velocity distribution of gas molecules on the error curve: "the velocities are distributed among the particles according to the same law as the errors are distributed among the observations" (Maxwell 1860, 23). Boltzmann acknowledged the analogy between the "observation errors" and the distribution of the "velocity" of "molecules" proven by "*Maxwell*" (Boltzmann 1886, 37). On this basis, he formulated the citations used to document the discovery of "typicality" (Boltzmann 1896, 569–570; 1898,

[10] Fenton-Glynn introduced the concept of *mr* laws in 2014 (Fenton-Glynn 2014). It was mentioned in Reutlinger et al. (2015, Ch. 10) but not discussed further. This did not change in Reutlinger et al. (2019, Ch. 10). An in-depth debate on the validity of the concepts of *cp* laws, *mr* laws and typicality is still pending.

[11] There are several extensive studies on the history of probability theory. The following sketch is based on Porter (1994) and Stahl (2006) and concentrates on the line starting from Gauss because it is mentioned by Weber. However, there is another line, which begins with Cournot's principle that an event with small or zero probability will not occur (cf. Shafer and Vovk 2006).

252; 2003, 394–395; cf. Goldstein 2012, 60; Lazarovici and Reichert 2015, 702; Oldofredi et al. 2016, 7).

Weber was familiar with this tradition. In his lectures on *General* ("*Theoretical*") *Political Economy* held from 1894 to 1898, he determined "*typical* processes and sizes" with reference to the "*probability* calculation" since the time of "Quetelet and Gauss" (Weber 2009, 348–349). He knew that this "calculation" was based on the "error probability theory of astronomers" and he even added sketches of "normal or Gaussian distribution" to his lecture manuscripts (Weber 2009, 347–348). He knew Quetelet's work at first hand (Weber 2009, 94, 347–348, 350, 358–359) and became familiar with Maxwell's and Boltzmann's approach from his reading of Johannes von Kries's *Principles of Probability Calculation* (Weber 1982a, 269; 2012a, 171; cf. 2018, 666), in which Boltzmann had recognized a "logical reasoning" of his own "calculations" (Boltzmann 1886, 38).

Indeed, Kries had grasped the basic idea of typicality.[12] He conceived the phase space as a "range" of behaviour ("Spielraum") (Kries 1886, 24–47). A "whole range" can be divided into "two parts", namely in "configurations" of "conditions" that would "effect" the "outcome" of a "success" and in "configurations" of "conditions" that would "effect" its "absence" (Kries 1888, 183).[13] The "probability" with which a success is to be expected is determined by the "size ratio" of these two "effecting and non-effecting" parts (Kries 1888, 189), which Kries also referred to as "partial ranges" (1886, 24) or as "ranges" themselves: "A success is all the more probable the greater the [partial] range is which brings it about" (1888, 189). In a closed container with gas molecules, the "predominantly greatest [partial] range" of the "initial states" allows an equilibrium to occur, while "only very special initial states" could bring about a different distribution (Kries 1886, 197–198). Thus Kries conceived equilibrium as the "*normal state*" (1886, 201).[14]

After the turn of the century, Weber made Kries's probability theory the basis of his model of causal explanation in the social sciences (Weber 1982a; 2012a; cf. Wagner 2020a, b). He returned to this model a decade later in his "Basic Sociological Concepts" (Weber 2002a, 5–6; 2004, 318–319). He also seems to have made Kries's theory the basis of his idea of sociological laws, which he conceived as "typical [*chances*]"[15] "that under [certain] circumstances we might *expect* a […] [course] of social action which can […] be *understood* in terms of the typical motives and typical intentions of the [actors]" (Weber 2002a, 9; 2004, 324–325). As a paradigm case of such a "*general* rule", he quoted "Gresham's law" with its roots in political economy (Weber 2002a, 5, 9; 2004, 318, 324).

[12] Rosenthal (2016, 167) has already associated Kries with the "typicality approach".

[13] We also use Kries's supplementary study "On the Concept of Objective Possibility and Some Applications", in which his theory is formulated more systematically (Kries 1888). Weber was also familiar with this study (Weber 1982a, 269; 2012a, 171).

[14] Another example confirms that Kries had grasped the basic idea of typicality. According to Kries, "temperature equality can be understood as the normal state of two touching bodies" (Kries 1886, 201). In philosophy of physics, this is discussed with reference to "*typicality*": "If we have two metal rods at different temperatures and then bring them into thermal contact, typical behavior […] will be for the motions of the atoms in the rods to evolve so that the temperatures in the rods equalize" (Maudlin 2007, 287).

[15] Weber used the term "[chance]" synonymously with the term "probability" (Weber 2002a, 14; 2004, 332).

4 Sociology

Boltzmann had no reservations about claiming that "each molecule goes its own way independently like an individual who acts independently" (1886, 34). In the following, we will use this analogy in order to achieve a better understanding of sociological laws.[16] The physical system of gas molecules in a closed container has its analogous counterpart in the social system of human individuals in a politically regulated capitalist market. Both systems are "ranges" of possible behaviour. The social system certainly cannot be defined so sharply. However, there are in any case legal laws that limit the space of possibility.

Like Boltzmann, Weber distinguished between micro and macro and took a reductionist position: "'Law' merely = Reduction of economic processes to *normal* consequences of human behaviour which we *understand* and consider to be *normal*" (Weber 2009, 362).[17] Just as the macroscopic regularity known as the Second Law of Thermodynamics is reduced to the behaviour of molecules, the macroscopic regularity known as Gresham's Law is reduced to the behaviour of individuals which Weber conceived as action. He defined "action" as "human behaviour" with which individuals associate a "subjective *meaning*"; if they refer "to the behaviour of *others*", "such behaviour is 'social' action" (Weber 2002a, 1; 2004, 312). Actions are the movements of the individuals. In fact, they ultimately consist of physical movements.

Regarding the initial conditions, in the physical system we are dealing with the locations and velocities of molecules, whereas in the social system we are dealing with the "motives" and "intentions" of individuals (Weber 2002a, 9; 2004, 324). As concerns the laws, the movements of the molecules are determined by the fundamental laws of motion, whereas the movements of the individuals are determined by laws that Weber was hesitant to term "psychological". However, he assumed that individuals are goal-oriented actors: "The more '*freely*' the acting person 'decides'—that is to say: the more [the 'decision'] is based on [that person's] 'own' '*deliberations*', which have not been blurred by 'external' constraint[s] or irresistible 'affects', the more completely […] will the motivation [ceteris paribus] fit into the categories of 'end' and 'means'" (Weber 1982b, 132; 2012b, 85).[18]

It is not surprising that Weber understood this law as a *cp* law. The term "ceteris paribus" emerged in nineteenth century political economy, where it was associated with the concept of law (Reutlinger et al. 2019, Ch. 2.1).[19] In contemporary philosophy of science, this law is really classified as a law of "psychology" and discussed as a prime example of

[16] Current econophysics applies models from physics to economics, also with regard to money and Gresham's Law; cf. Yakovenko and Rosser (2009) and Smith (2012). We will elaborate the analogy along sociological lines.

[17] Weber used the term "normal" synonymously with the term "typical" (Weber 2002a, 15; 2004, 334).

[18] There is no consensus in philosophy of science that psychological laws determine human behaviour. However, a reductionist position in analogy to Boltzmann makes this premise necessary. Although he does not distinguish between micro and macro, we can follow Schurz here, who, in his explication of the Law of Demand, refers to the law of "psychology" that "people's actions are goal-oriented" (Schurz 2002, 352–353). Accordingly he writes: "The truth of the law of demand requires not only a cp clause, but also a cr [ceteris rectis] clause: the cp-demand-price relation holds only under the conditions of an 'ideal market', which requires that the sellers and buyers are fully informed and free utility-maximizers; irrational behaviour and government price regulations (etc.) have to be excluded" (Schurz 2014, 1803 and cf. 1806). We concentrate on this psychological law, assuming that other microlaws are also involved in the production of the macrostate. For a critical view of the emphasis on rationality see Thaler (2015).

[19] See Cairnes (1875) and Marshall (1891). Weber was familiar with their works (Weber 2009, 89–90) and made use of the term "ceteris paribus" in several other places (Weber 1995, 205, 306; 2002b, 45, 109, 128, 165, 669; 2009, 214–215, 314, 349, 654).

cp laws: "*Ceteris paribus*, people's actions are goal-oriented, in the sense that if person *x* wants *A* and believes *B* to be an optimal means for achieving *A*, then *x* will attempt to do *B*" (Reutlinger et al. 2019, Ch. 3.1). Therefore, a negative analogy in our scenario is that the fundamental laws of motion are strict laws, whereas this law is a *cp* law. It holds only under the condition that constraints and affects are excluded. Nevertheless, it is assumed to determine behaviour in a way that leads to macrophenomena.

With each configuration of the molecules, the physical system is in a different microstate. Something similar applies to the social system. The molecules collide with each other and the walls of the container, whereas the individuals orient their actions to each other as well as to economic and political institutions and the legal framework (Weber 2002a, 16–20; 2004, 335–341).[20] The motives and intentions of individuals may not change as quickly as the locations and velocities of molecules, but they do change or at least they increase or decrease in intensity and immediacy, which also results in different microstates.

The measurement of the "range" of all possible microstates of the physical system is performed with the Liouville measure. However, in philosophy of physics less mathematical methods are also favoured with regard to "typicality": "only sets of very large (≈ 1) or very small (≈ 0) measure are meaningful" (Oldofredi et al. 2016, 8). Even the thesis that "typicality is not a *quantitative* concept" is supported on the grounds that it is sufficient to speak of the "overwhelming majority" of microstates which lead to typical behaviour (Lazarovici and Reichert 2015, 706; cf. Volchan 2007, 809). Regarding the social system, measurement seems more difficult. Kries had carried out physiological studies, in which he concluded that mental states cannot be measured at all (Kries 1882). Thus he assumed that "only a very general use of the principle of ranges" without any "numerical designation of any particular probability" comes into question for human behaviour (Kries 1886, 239, cf. 263–264). Although Weber shared these reservations (1982a, 285; 2012a, 181), he conducted quantitative psychophysical studies himself (1995). However, contemporary neuroscience, psychology and sociology should have solved this problem to the extent that the "overwhelming majority" of all possible microstates of the social system can be determined.[21]

In the physical system, by far the largest number of all possible microstates have the property to evolve to an equilibrium state. Because these microstates are "typical" (Frigg 2009, 1000), they lead, together with the fundamental laws of motion, to the macroscopic regularity known as the Second Law of Thermodynamics. In the social system, the overwhelming majority of all possible microstates must have the property to evolve to a state in which there is only bad money. These microstates must be just as typical so that they lead, together with psychological laws, to the macroscopic regularity known as Gresham's Law.

[20] Weber also understood these constructs in a reductionist manner as "[*conceptions* of something partly existing, partly supposed to be valid in the heads of real people, on which their actions are *oriented*] […] A modern 'state' is to a great extent of this sort—as a complex [of a specific acting together] of people—*because* [certain people] orient their action on their *conception that* [it] exists […] or *should* exist in this form" (Weber 2002a, 7; 2004, 321). However, he did not address the material dimension, including bad and better money. An elaborated conception of the microstates of the social system would have to take this dimension into account. Latour's Actor-Network-Theory, which conceives objects as actors, could be used for this purpose (Johnson 1988; Latour 1994; 2005). Since this additional dimension probably does not change the fact that the majority of microstates realize the same macrostate, it is sufficient for our purpose to focus on the psychophysical dimension of social action. For a critical discussion of "ontological individualism", as Weber also represents it, see Currie (1984) and Epstein (2009).

[21] There are corresponding positions in logic; cf. Adams (1974) and Strößner (2018).

In fact, Weber described the initial conditions that produce the microstates of the social system as "typical motives and typical intentions", which make the microstates typical as well (Weber 2002a, 9; 2004, 324).

Using the example of economic actions Weber has best illustrated the interplay of typical initial conditions and the psychological law known to us in producing a macroscopic regularity. In a market, individuals "[orient their behaviour, as a 'means', on their own *typical* subjective economic interests as an 'end' and on the equally typical expectations which they have of the prospective behaviour of others as 'conditions' for achieving that end. By acting in this way, *the more strictly* rational their manner of acting is, the more similarly they react to given situations, similarities, regularities and continuities of attitude and action are created]" (Weber 2002a, 15; 2004, 334). There is no doubt that a typical interest of market participants is to increase their profits. Given a certain fiscal policy measure, they can achieve this end by means of hoarding higher quality coins. By taking these coins out of the payment system and paying only with bad money, the macroscopic regularity known as Gresham's Law occurs: "Actual regularities can be observed within social action, i.e. regularities whose *intended meaning* is typically similar in actions repeated by the same actor, in actions replicated by many actors, or in both of these at the same time" (Weber 2002a, 14; 2004, 333).

Like the Second Law of Thermodynamics, Gresham's Law, therefore, can be conceived as a *mr* law (Fenton-Glynn 2016, 278–279). It holds only when the property to evolve to a state in which there is only bad money is realized in the right way, i.e. in the overwhelming majority of all possible microstates. In the case of SLT, we had left it open whether it is also a *cp* law. However, Gresham's Law is one of those special scientific generalizations which "hold *both* only cp *and* only mr" (Fenton-Glynn 2016, 279). Weber conceived sociological laws as typical chances that "under [certain] circumstances" we might expect a certain course of social action (Weber 2002a, 9; 2004, 324). This suggests that he had *cp* laws in mind. It is not clear whether he was thinking of the *cp* clause that should apply to the psychological law that people's actions are goal-oriented or whether he was thinking of other conditions. However, it is easy to see that certain macro conditions must also be met in order for the social system to function. Inferences from outside, such as wars or ecological disasters, must be excluded.[22]

5 Conclusion

In summary, it can be documented that behaviour referred to by the term "typicality" can be conceived as a "minutis rectis law". Furthermore, it has been shown that "typicality" not only exists in behaviour of interest to physics but also to sociology. In analogy to the Second Law of Thermodynamics, typical behaviour expressed in sociological laws such as Gresham's Law or the Law of Demand can also be understood as "minutis rectis laws". This, however, presupposes an understanding of sociology, according to which macrophenomena are reduced to social actions of individuals. Such an understanding was proposed by Max Weber, who placed his sociology in the tradition of the pioneers of "typicality".

[22] Weber tried to formulate his understanding of *cp* laws in terms of the "ideal type" (Weber 1982b, 130; 1982c, 190; 2012b, 84; 2012c, 124). For the history of this term and the use Weber made of it, see Wagner (2014) and Wagner and Härpfer (2014).

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References

Adams, E. W. (1974). The logic of "almost all". *Journal of Philosophical Logic, 3,* 3–17.

Albert, D. Z. (2000). *Time and chance*. Cambridge, MA: Harvard University Press.

Bartha, P. (2019). Analogy and analogical reasoning. Retrieved February 20, 2020 from https://plato.stanford.edu/entries/reasoning-analogy/.

Boltzmann, L. (1886). Der zweite Hauptsatz der mechanischen Wärmetheorie. In L. Boltzmann, *Populäre Schriften*, ed. by E. Broda (pp. 26–46). Braunschweig: Friedrich Vieweg & Sohn 1979.

Boltzmann, L. (1896). Entgegnung auf die wärmetheoretischen Betrachtungen des Hrn. E Zermelo. In L. Boltzmann, *Wissenschaftliche Abhandlungen* (Vol. 3, pp. 567–578). New York: Chelsea Publishing 1968.

Boltzmann, L. (1898). Vorlesungen über Gastheorie. II. Theil. In *Vorlesungen über Gastheorie*. I. und II. Theil. Graz, Braunschweig: Akademische Druck- und Verlagsanstalt, Friedrich Vieweg & Sohn 1981.

Boltzmann, L. (2003). Reply to Zermelo's remarks on the theory of heat. In S. G. Brush & N. S. Hall (Eds.), *The kinetic theory of gases: an anthology of classic papers with historical commentary* (pp. 392–402). London: Imperial College Press.

Cairnes, J. E. (1875). *The character and logical method of political economy*. London: Macmillan.

Carrier, M. (1998). In defense of psychological laws. *International Studies in the Philosophy of Science, 12,* 217–232.

Carrier, M. (2000). Menschliches Verhalten und psychologische Gesetze. *Philosophia Naturalis, 37,* 375–384.

Currie, G. (1984). Individualism and global supervenience. *British Journal for the Philosophy of Science, 35,* 345–358.

de Moivre, A. (1718). *The doctrine of chances: or, a method of calculating the probability of events in play*. London: W. Pearson.

Earman, J., & Roberts, J. (1999). Ceteris paribus, there is no problem of provisos. *Synthese, 118,* 439–478.

Epstein, B. (2009). Ontological individualism reconsidered. *Synthese, 166,* 187–213.

Fenton-Glynn, L. (2014). Ceteris paribus laws and minutis rectis laws. Retrieved February 20, 2020 from http://philsci-archive.pitt.edu/10941/1/Ceteris_Paribus_Laws_and_Minutis_Rectis_Laws.pdf.

Fenton-Glynn, L. (2016). Ceteris paribus laws and minutis rectis laws. *Philosophy and Phenomenological Research, 93*(2), 274–305.

Filomeno, A. (2014). On the possibility of stable regularities without fundamental laws. Ph.D. thesis, University of Barcelona.

Fodor, J. A. (1974). Special sciences or the disunity of science as a working hypothesis. *Synthese, 28,* 97–115.

Frigg, R. (2009). Typicality and the approach to equilibrium in Boltzmannian statistical mechanics. *Philosophy of Science, 76,* 997–1008.

Gauss, C. F. (1857). *Theory of the motion of the heavenly bodies moving about the sun in conic sections*. Boston: Little, Brown and Company.

Goldstein, S. (2012). Typicality and notions of probability in physics. In Y. Ben-Menahem & M. Hemmo (Eds.), *Probability in physics* (pp. 59–71). Berlin: Springer.

Herschel, J. F. W. (1850). Quetelet on probabilities. *Edinburgh Review, 92*(185), 1–57.

Johnson, J. [Latour, B.]. (1988). Mixing humans and nonhumans together: the sociology of a door-closer. *Social Problems*, *35*(3), 298–310.

Kries, J. V. (1882). Ueber die Messung intensiver Grössen und über das sogenannte psychophysische Gesetz. *Vierteljahrsschrift für wissenschaftliche Philosophie, 6,* 257–294.

Kries, J. V. (1886). *Die Principien der Wahrscheinlichkeitsrechnung*: *Eine logische Untersuchung*. Freiburg: J. C. B. Mohr (Paul Siebeck).

Kries, J. V. (1888). Ueber den Begriff der objectiven Möglichkeit und einige Anwendungen desselben. *Vierteljahrsschrift für wissenschaftliche Philosophie und Soziologie*, *12*, 179–240, 287–323, 393–428.

Latour, B. (1994). Pragmatogonies: a mythical account of how humans and nonhumans swap properties. *American Behavioral Scientist, 37*(6), 791–808.

Latour, B. (2005). *Reassembling the social: an introduction to Actor-Network-Theory*. Oxford: Oxford University Press.

Lazarovici, D., & Reichert, P. (2015). Typicality, irreversibility and the status of macroscopic laws. *Erkenntnis, 80,* 689–716.

Loewer, B. (2008). Why there *is* anything except physics. In J. Hohwy & J. Kallestrup (Eds.), *Being reduced: new essays on reduction, explanation, and causation* (pp. 149–163). New York: Oxford University Press.

Loewer, B. (2009). Why is there anything except physics? *Synthese, 170,* 217–233.

Loewer, B. (2012). The emergence of time's arrows and special science laws from physics. *Interface Focus, 2,* 13–19.

MacLeod, H. D. (1858). *The elements of political economy*. London: Longman, Brown, Green, Longmans, and Roberts.

Marshall, A. (1891). *Principles of economics* (Vol. 1). London: Macmillan.

Maudlin, T. (2007). What could be objective about probabilities? *Studies in History and Philosophy of Modern Physics, 38,* 275–291.

Maxwell, J. C. (1856). On Faraday's lines of force. *Transactions of the Cambridge Philosophical Society, 10*(Part 1), 27–83.

Maxwell, J. C. (1860). Illustrations of the dynamical theory of gases—Part I. On the motions and collisions of perfectly elastic spheres. *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, 19*(124), 19–32.

Oldofredi, A., Lazarovici, D., Deckert, D.-A., & Esfeld, M. (2016). From the universe to subsystems: why quantum mechanics appears more stochastic than classical mechanics. *Fluctuation and Noise Letters*, *15*(3), 1640002 (16 pages).

Oppenheim, P., & Putnam, H. (1958). Unity of science as a working hypothesis. In H. Feigl, M. Scriven, & G. Maxwell (Eds.), *Minnesota studies in the philosophy of science* (Vol. II, pp. 3–36): *concepts, theories, and the mind-body problem*. Minneapolis: University of Minnesota Press.

Porter, T. M. (1994). From Quetelet to Maxwell: social statistics and the origins of statistical physics. In I. B. Cohen (Ed.), *The natural sciences and the social sciences: some critical and historical perspectives* (pp. 345–362). Dordrecht: Kluwer.

Quetelet, A. (1842). *A treatise on man and the development of his faculties*. Edinburgh: William and Robert Chambers.

Quetelet, A. (1849). *Letters addressed to H. R. H. the Grand Duke of Saxe Coburg and Gotha, on the theory of probabilities, as applied to the moral and political sciences*. London: Charles and Edwin Layton.

Reutlinger, A., Schurz, G., & Hüttemann, A. (2015). Ceteris paribus laws. Retrieved July 03, 2019 from https://plato.stanford.edu/entries/ceteris-paribus/.

Reutlinger, A., Schurz, G., Hüttemann, A. & Jaag, S. (2019). Ceteris paribus laws. Retrieved February 20, 2020 from https://plato.stanford.edu/entries/ceteris-paribus/.

Rosenthal, J. (2016). Johannes von Kries's range conception, the method of arbitrary functions, and related modern approaches to probability. *Journal for General Philosophy of Science, 47,* 151–170.

Schurz, G. (2002). Ceteris paribus laws: classification and deconstruction. *Erkenntnis, 57,* 351–372.

Schurz, G. (2014). Ceteris paribus and ceteris rectis laws: content and causal role. *Erkenntnis, 79,* 1801–1817.

Shafer, G., & Vovk, V. (2006). The sources of Kolmogorov's Grundbegriffe. *Statistical Science, 21*(1), 70–98.

Smith, R. D. (2012). A drift formulation of Gresham's law. *Hyperion. International Journal of Econophysics and New Economy, 5*(1), 71–84.

Stahl, S. (2006). The evolution of the normal distribution. *Mathematics Magazine, 79*(2), 96–113.

Strößner, C. (2018). The logic of "most" and "mostly". *Axiomathes, 28,* 107–124.

Thaler, R. H. (2015). *Misbehaving: the masking of behavioral economics*. New York: W. W. Norton.

Volchan, S. (2007). Probability as typicality. *Studies in History and Philosophy of Modern Physics, 38,* 801–814.

Wagner, G. (2014). Der lange Schatten des Syllogismus: Zur Einheit der Wissenschaftslehre Max Webers. *Sociologia Internationalis, 52*(2), 219–249.

Wagner, G. (2020a). The emergence of sociology out of the quest for causality: the case of Max Weber. In E. Podoksik (Ed.), *Doing humanities in nineteenth-century Europe* (pp. 264–279). Leiden: Brill.

Wagner, G. (2020b). Was heißt „kausaler Regressus“? Max Weber in der Schule von Padua. In A. Albrecht, F. Bomski, & L. Danneberg (Eds.), *Ordo inversus: Formen und Funktionen einer Denkfigur um 1800* (pp. 313–334). Berlin: de Gruyter.

Wagner, G., & Härpfer, C. (2014). On the very idea of an ideal type. *SocietàMutamentoPolitica, 5,* 215–234.

Weber, M. (1982a). Kritische Studien auf dem Gebiet der kulturwissenschaftlichen Logik: II. Objektive Möglichkeit und adäquate Verursachung in der historischen Kausalbetrachtung. In M. Weber, *Gesammelte Aufsätze zur Wissenschaftslehre*, ed. by J. Winckelmann (pp. 266–290). Tübingen: J. C. B. Mohr (Paul Siebeck).

Weber, M. (1982b). Roscher und Knies und die logischen Probleme der historischen Nationalökonomie: III. Knies und das Irrationalitätsproblem. In M. Weber, *Gesammelte Aufsätze zur Wissenschaftslehre*, ed. by J. Winckelmann (pp. 105–145). Tübingen: J. C. B. Mohr (Paul Siebeck).

Weber, M. (1982c). Die “Objektivität” sozialwissenschaftlicher und sozialpolitischer Erkenntnis. In M. Weber, *Gesammelte Aufsätze zur Wissenschaftslehre*, ed. by J. Winckelmann (pp. 146–214). Tübingen: J. C. B. Mohr (Paul Siebeck).

Weber, M. (1995). Zur Psychophysik der industriellen Arbeit. In M. Weber, *Zur Psychophysik der industriellen Arbeit: Schriften und Reden 1908–1912*. Max Weber-Gesamtausgabe. Vol. I/11, ed. by W. Schluchter (pp. 162–380). Tübingen: J. C. B. Mohr (Paul Siebeck).

Weber, M. (2002a). Soziologische Grundbegriffe. In M. Weber, *Wirtschaft und Gesellschaft: Grundriss der verstehenden Soziologie*, ed. by J. Winckelmann (pp. 1–30). Tübingen: J. C. B. Mohr (Paul Siebeck).

Weber, M. (2002b). *Wirtschaft und Gesellschaft*: *Grundriss der verstehenden Soziologie*, ed. by J. Winckelmann. Tübingen: J. C. B. Mohr (Paul Siebeck).

Weber, M. (2004). Basic sociological concepts. In M. Weber, *The essential Weber: a reader*, ed. by S. Whimster, trans. by K. Tribe (pp. 311–358). London: Routledge.

Weber, M. (2009). *Allgemeine* (“*theoretische*”) *Nationalökonomie*: *Vorlesungen 1894–1898*. Max Weber-Gesamtausgabe. Vol. III/1, ed. by W. J. Mommsen. Tübingen: J. C. B. Mohr (Paul Siebeck).

Weber, M. (2012a). Critical studies in the logic of the cultural sciences: II. Objective possibility and adequate causation in the historical causal approach. In M. Weber, *Collected methodological writings*, ed. by H. H. Bruun & S. Whimster, trans. by H. H. Bruun (pp. 169–184). London: Routledge.

Weber, M. (2012b). Roscher and Knies and the logical problems of historical economics: III. Knies and the problem of irrationality (continued). In M. Weber, *Collected methodological writings*, ed. by H. H. Bruun & S. Whimster, trans. by H. H. Bruun (pp. 68–94). London: Routledge.

Weber, M. (2012c). The “objectivity” of knowledge in social science and social policy. In M. Weber, *Collected methodological writings*, ed. by H. H. Bruun & S. Whimster, trans. by H. H. Bruun (pp. 100–138). London: Routledge.

Weber, M. (2018). Die “Nervi”-Notizen. In: M. Weber, *Zur Logik und Methodik der Sozialwissenschaften: Schriften und Reden 1900-1907.* Max Weber-Gesamtausgabe. Vol. I/7, ed. by G. Wagner (pp. 623–668). Tübingen: J. C. B. Mohr (Paul Siebeck).

Wilson, A. (Ed.). (2014). *Chance and temporaral asymmetry*. Oxford: Oxford University Press.

Yakovenko, V. M., & Rosser, J. B., Jr. (2009). Colloquium: statistical mechanics of money, wealth, and income. *Review of Modern Physics, 81,* 1703–1725.