

Scottish Newtonianism in Moral Sciences; Ferguson, Reid, Smith and Scottish Natural Scientists

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Newtonianism has been regarded as one of the driving forces of the Enlightenment in the classical studies of the 18th century history of ideas. Two founding fathers of Scottish moral philosophy, Francis Hutcheson and George Turnbull, followed Newton's claim in his *Opticks* and believed that moral philosophy could be reformed according to the method and the results of this newly founded science. The paper will examine how Scottish moral philosophers in the middle of the century accepted contemporary Newtonian ideas. It will compare moral philosophy of Adam Ferguson, Thomas Reid and Adam Smith. Three components of 18th century Newtonianism, methodology, system and pluralism will be discussed and the paper will conclude that Scottish moral sciences are Newtonian in some senses.

I. Introduction

Newtonianism has been regarded as one of the driving forces of the Enlightenment in the classical studies of the 18th century history of ideas. Two founding fathers of Scottish moral philosophy, Francis Hutcheson and George Turnbull, followed Newton's claim in his *Opticks* and believed that moral philosophy could be reformed according to the method and the results of this newly founded science. This paper will examine how Scottish moral philosophers in the middle of the century accepted contemporary Newtonian ideas. It will compare moral philosophy of Adam Ferguson, Thomas Reid and Adam Smith. Three components of 18th century Newtonianism, methodology, system and pluralism will be discussed. In the final chapter, the paper will refer to the ideas

of natural and moral worlds of William Cullen, Reid and Smith and conclude that Scottish moral sciences are Newtonian in some senses.

II. Methodology and system

Although all these moral philosophers supposed to be engaging in "experimental philosophy", closer examination of their scientific methodology will reveal varieties in Scottish moral philosophy built on the idea that appears to be widely accepted in the first half of the century in Scotland.

In his *Institute of Moral Philosophy*, Ferguson embraced Newtonian "empirical method" in moral science. He claimed that moral philosophy would be established with the methodology that had been applied in natural philosophy.

Both disciplines shared the same notion of "natural law" and empirical methodology. However, compared with Reid's argument on methodology of moral science, Ferguson's notion of experimental philosophy looks too vague and general. Reid's interpretation of Newtonian method was very precise and identical with those of MacLaurin and Henry Pemberton, an empiricist version of Newtonianism based on the methodology of *Opticks* (analysis and synthesis) and of the late versions of *Principia*.¹⁾

"Sir Isaac Newton's method of philosophizing thus laid down in his *Opticks*, by way of analysis ought be proceed the method of composition. This analysis consists in making experiments and observations, and in deriving general conclusions from them by induction and admitting of no objections against the conclusions but such as taken from experiments to synthesis.

In experimental philosophy, propositions collected from the phenomena by induction are to be deemed notwithstanding contrary hypothesis, either accurate or very nearly true, till other phenomena occur by which they may be rendered more accurate or less liable to exceptions."²⁾

While he stated that the method of

natural sciences could be introduced to moral sciences, especially to political philosophy,³⁾ he was very critical to the attempts to apply mathematical or deductive method other than mathematics itself. Empirical sciences like physics were the sciences of probability, because no certain knowledge could be attained by empirical investigations, which was the sole means of studying objective reality.

"The mathematicians, who never taught of applying syllogisms to their science are notable instances of this reasoning.

Mathematics afford the best evidence of the latter kind [demonstrative reasoning], where, from a few axioms long trains of reasoning are carried on, all the links of which are necessarily connected with on another."⁴⁾

To this school of Newtonians, mathematics was the science that was characterized by its ability to attain the certainty of knowledge, because its subjects, line, number, etc., were the products of human imagination, whereas empirical sciences were the sciences of probability.⁵⁾

"It has been disputed whether demonstrative evidence can be applied to any of subject other than

mathematics. For my part I don't think I can, probable evidence arises from a sum of arguments each of which has some weight.

Another difference is, the demonstrative evidence admits of no degrees, whereas probable evidence admits of all degrees."⁶⁾

The economic theory of Adam Smith has been often characterized as an adaptation of Newtonianism in social sciences. However, Smith's interpretation of Newtonian method was very peculiar. He taught in *the Lectures in Rhetoric and Belles Lettres* that Newtonian method was to "lay down certain principles known or proved in the beginning, from whence we account for the severall Phenomena, connecting all together by the same Chain." Furthermore, he stated that "Des-Cartes was in reality the first who attempted this method."⁷⁾

Firstly, there are numerous attacks against Cartesian philosophy in the writings of British Newtonians and most of them accused him of employing the false method in empirical sciences, the very method that Smith called Newtonian in the lectures, that is, the method of deductive reasoning. Secondly, the method Smith described should be called Aristotelian method, the method of individual sciences described in *Posterior Analytics*, instead of Newtonian method. Aristotle took geometry as the model of

this method.⁸⁾

"When the premises are certain, and the conclusion drawn from them in due form, this is demonstration, and produces science."⁹⁾

All demonstration must be built upon principles already known; and these upon others of the same kind; until we come at last to first principles, which neither can be demonstrated, nor need to be, being evident of themselves."¹⁰⁾

Apart from the passage analyzed above, he mentioned nothing on Newtonian method that described by Newton in *Opticks*.¹¹⁾ This definition repeatedly appeared in the lectures in Scottish universities.¹²⁾ In fact, the methodological tool to establish the central categories of Smithian economics, such as natural price, was not 'experimental method', which Scottish Newtonians acclaimed as the legitimate method in empirical sciences, but a way of deductive reasoning, as Dugald Stewart reported later;

"The influence of his early taste for the Greek geometry may be remarked in the elementary clearness and fullness, bordering sometimes upon prolixity, which he frequently states his political writings."¹³⁾

The methodology employed in *The Wealth of Nations* has no resemblance to that of Newtonian science, except the fact that, as several authors who tried to describe him as a Newtonian have pointed out, Smith consciously constructed his system deductively from the first and self-evident principle, such as propensity to exchange or the function of sympathy. It looks as if Smith had followed Newton in the first two of the rules of philosophizing of *Principia*, the parsimonious principles that requires the axiomatic principles should be few in number, but not in the second two, the needs for experimental proofs in theoretical reasoning.¹⁴⁾ Whereas Reid reiterated the thesis that the method of analysis, experimental investigation and verification, had to precede the method of synthesis, the construction of system with deduction, Smith only used the method of synthesis.

Smith is, at least methodologically, not particularly Newtonian. The tradition of the history of economics that looked Smith as the example of 'Newtonian revolution' in social sciences stemmed from the preconception of regarding economics as the physics in social sciences. Economics had been heavily influenced by Newtonian physics, not in the 18th century, but in the late 19th century to the early 20th century when the end of the reign of Newtonianism in physics was already in sight. The

ignorance also arose from the negligence of the research tradition of 'social medicine' that will be discussed later.

The reason of the difference among them was probably originated in their understanding of contemporary natural science, which can be judged from existing lecture notes on natural philosophy of both Ferguson¹⁵⁾ and Reid¹⁶⁾, and Smith's philosophical writings especially on the history of astronomy. Ferguson had good but only introductory knowledge of the Newtonian science of the age. Reid was a professional Newtonian natural philosopher and showed, if not creative, but the profound understanding of *Principia* in his lectures. Smith, especially in the "History of Astronomy", revealed his unique and well-documented historiography of natural science, but from the stand point of a moral scientist, and his explanatory tool was his version of the Humean theory of imagination.

Ferguson and Reid tried to introduce Newtonian methodology into their moral sciences in a different degree because their knowledge of natural science was not the same. Reid had the exact understanding of empiricist Newtonian methodology. Smith interpreted "Newtonian method" in his own way. Therefore, Scottish "Newtonian" moral philosophy is methodologically not identical.

However, their idea of their "system" of moral philosophy corresponds to the

development in natural sciences. That is, the method of building individual sciences as derived from certain empirical principles. Newtonians bitterly accused continental philosophers like Descartes and Leibnitz of their ambitions to construct a system that could explain everything in the world from certain first principles by deductive reasoning. Newtonian empiricist systems are plural in number, because, as Newton acclaimed in the method of analysis, they are based upon principles that are the ultimate results of experimental investigations. Thus, when the domains of study are different, principles found by them must be different, too. Following this instruction, great scientists in 18th century Scotland constructed sciences that were to explain natural phenomena from certain empirical principles such as the nerve system of William Cullen, the heat of Joseph Black and James Hutton.

The way in which Smith presented his systems on ethics, Jurisprudence and political economy was similar to those of Scottish scientists. He began his systems with some given 'principles' that were justified as self-evidently true by the daily experience of human race, without going back to, or deducing them from, certain general philosophical notions seen as universal truths. Then he constructed the whole of his systems deductively from them, adding necessarily modifications with the help of empirical data

collected from many examples. Along with his fellow scientists, Smith had no intention to design the complete explanatory body of the world, as Descartes and Leibnitz did. He only created several individual theories belonged to different disciplines and all of them supposed to be founded on 'experience' rather than on 'speculation'. There were no abstract principles in his systems like 'cogito' or 'the principle of sufficient reason', and his 'principles' differed according to the phenomena to which they had to explain.

Ferguson attempted to build his moral philosophy upon some empirical observations of human nature, such as the sociability of animals. Reid's presentation of many principles in human nature that were thought to be the products of his experimental investigations irritated Joseph Priestley as pedantry. All three moral philosophers were Newtonians in the usage of following method; the way of constructing an 'imaginative machine' to explain phenomena of nature upon the foundation of 'observations and experiments'. In other words, the method of building individual sciences as derived from certain empirical principles.

III. Pluralism

The idea of "the plurality of worlds" has not often been discussed as an element of Newtonianism like methodology

and system although it was thought to be one of the essential parts of Newtonian credo in the middle of the 18th century.

Smith's attitude toward plurality is not clear. William P.D. Wightman wrote in his Introduction to *The Essays on Philosophical Subject*.

"but his omission of any reference to the ill-supported but widely publicized 'plurality of worlds' affirmed by Giordano Bruno is less easy to excuse."¹⁷⁾

Ferguson was one of the many supporters of astronomical pluralism in the century. He integrated his belief with Stoic virtues and his favour on active life. Astronomy, plurality, political economy and Stoic virtues are consciously mixed together in one of his late memoir in order to demonstrate the idea of human moral progress. Based upon Semitic religious tradition of omnipotent God, Ferguson was able to put together the image of infinite universe and the superiority of mind above the material world.

"Is the universe of body then formed for the sake of mind alone? To us there appears no other end or purpose for which it is made. If so great the corporeal departments of nature, what are we to think of the mental for whose sake

those departments are so formed and dispersed throughout the immensity of space?..."

Then he calculated the population of intellectual beings in the universe as hundred thousands of millions of millions.

"That we may perceive the vanity to number in this instances be it remembered that the human species of any one generation has been reckoned at one thousand millions: if but one hundred generations are supposed to have assed, one hundred thousand millions of souls have already flown from terrestrial source; and if every planet in he solar system has been equally productive, the sum will amount to seven hundred thousand millions; and if every fixed star supposed to be two thousand is but the sign post if a system similar to ours, let imagination try to accompany in thought two thousands millions of millions which figures may in vain be used to express and let the vanquished conception acknowledge that the material world, however great, is still subordinate, and even upon such data as the material world itself can supply must shrink in magnitude as well as in estimation before the world of living and conscious existence whose essence is power and distinction,

felicity...

When the aspiring mind recalls the millions of millions and hundred thousands of millions of millions with whom he may now have to contend for distinction, he may possibly shrink in despair. But if he judge aright, the object of a just ambition is not comparative but of an absolute value. That in which the value of existence itself consists is the capacity of happiness, and the happy mind is of the highest value whatever be the number that partakes in the same distinction.

If you perform what in the present moment what you are called upon to do with benignity, diligence and resolution, you are happy.

To this it may be subjoined that the multitude of competitors in the same pursuit will not impede but promote the success."¹⁸⁾

Thomas Reid was more cautious than Ferguson. He wrote in his *Inquiry* that although the existence of other worlds had not yet proved, its probability was not little.

"Besides the pleasure we receive from analogies, they are of very considerable use, both in helping us to think about things that we can't easily get hold of without that

handle, and in leading us to probable conjectures about the nature and qualities of things that we haven't the means to investigate more directly. When I consider that the planet Jupiter is like the earth in this: it rotates around its own axis, revolves around the sun, and is lit up by several secondary planets as the earth is lit up by the moon, I am inclined to conjecture from analogy that, as these features of the earth fit it to be the habitation of various orders of animals, they also make the planet Jupiter fit to contain animals; and having no more direct and conclusive argument to settle the matter, I accept the conclusion of this analogical reasoning, with a degree of assent proportioned to its strength."¹⁹⁾

As expected from his strict empirical Newtonianism, Reid's position towards plurality is the same as French Newtonian scientist Laplace: that is, the existence of other worlds is not yet demonstrated or cannot be demonstrated, but very plausible. It is foreseeable from his Newtonian tendency that, as a scientist, Reid was a pluralist as his fellow Newtonian scientists with cautious empiricist reservations.

Moreover, Pluralism seems to

contribute to his design of moral philosophy. As with Ferguson, James Beattie and Immanuel Kant, Pluralism is one of the bases of his moral philosophy. Reid taught in the lectures on moral philosophy at Glasgow University that the human nature is only one empirical subject available to us from which we understood how mind worked. In this context, the mind means universal intelligence whose owners include God, angels and the probable inhabitants of other planets and other systems. His *Treatise* expressed the notion in its introduction.

Reid points out that although the existence of extra terrestrial intelligence is very probable, there is no means to know them. The knowledge of them remains in the domain of conjecture.

"What variety there may be of minds or thinking beings throughout this vast Universe, we cannot pretend to say. We dwell in a little corner of God's dominion, disjoined from the rest of it. The Globe which we inhabit is but one of seven planets that encircle our sun. What various orders of beings may inhabit the other six, their secondaries, and the comets belonging to our system, are things altogether hid from us. Although human reason and industry have discovered with great accuracy the order and distances of the planets, and the laws of their

motion, we have no means to corresponding with them. That may be the habitation of animated beings is very probable; but of the nature, or powers of their inhabitants, we are perfectly ignorant."²⁰⁾

Therefore, according to the methodology of experimental philosophy, the subject of the study of mind is limited to human mind.

"Every man is conscious of a thinking principle or mind in himself, and we have sufficient evidence of a like principle in other men. The actions of brute animals show that they have some thinking principle, through of a nature far inferior to the human mind. And everything about us may convince us of the existence of a supreme mind, the Maker and Governor of the Universe. There are all the minds of which reason can give us any certain knowledge."²¹⁾

His pneumatology was the study of universal mind, the mind of God and of other intelligent beings supposed to exist somewhere in the Newtonian infinite universe. His professionalism as a Newtonian scientist brought him further to the contemplation of the existence of higher dimensional space in his "geometry of visible". Pluralism was at least

the two of them a fundamental credo upon which their system of moral philosophy should have been established.

IV. Concept of nature and moral order: Cullen

1. Smith: body natural and body politick

If Newtonian cosmology based on modern astronomy gave moral philosophers the idea of the superiority of mind over the infinite world of body, 18th century physiology provided them with the prospect of natural and moral order. Smith's view of self-regulating market has something in common with contemporary physiology. When he criticised Francois Quesnay and defended his idea of 'the system of natural liberty', Smith did not employ the astronomical metaphor of mechanical universe that he used in the *Theory of Moral Sentiment*, but the physiological image of political body.

"In the political body, however, the wisdom of nature has fortunately made ample provision for remedying many of the bad effects of the folly and injustice of man; in the same manner as it has done in the natural body, for remedying those of his sloth and intemperance."²²⁾

Smith followed the tradition of social medicine²³⁾. Before the Newtonian

revolution, medicine has been the leading sector in scientific revolution. To compare society to human body was long tradition and Hobbes did the same in his *Leviathan*. There were many medical doctors in the early stage of the development of political economy. The same metaphor that Smith used had been appeared many occasions²⁴⁾. The research tradition of 'social medicine' was one of the contexts within which the Classical School of economics has been established.

The following paragraph of William Cullen disclosed the same idea that Smith embraced in *The Wealth of Nations*:

"The animal economy has powers in itself, and, in consequence of its own peculiar constitution, resists and obviates various injuries, and not only so as to prevent their effects, but that when these are produced, the constitution remedies these very evils, and restores health."²⁵⁾

"we, for the most part, perceive, that the connexions established are suited to the purpose of animal economy, and particularly to the supporting the system in a certain condition for a certain time, and of averting what might hurt or destroy it. This constitution of the animal economy, we call NATURE; and every where in the economy we perceive the vires conservatrices and

medicatrices naturae, so justly celebrated in the schools of physic."²⁶⁾

The natural order of body natural that was elaborated by Newtonian methodology and the way of mechanical explanation contributed to the development of the idea of equilibrium in society. As human body has its own self-healing power indifferent of human will, social body has a general tendency to achieve equilibrium when public authority does not arbitrary intervene. The natural order of these bodies can be seen as natural laws both in the sense of scientifically found regularity and the optimum state of beings.

It is true that Smith represented another tendency in social sciences, as a predecessor of modern economics, methodological individualism based on self-interest axiom. It is not clear though that whether Smith believed in 'the system of natural liberty' because individuals in the market made rational and optimum decisions. Smith said that individuals knew their businesses better than a statesman. But it does not necessary mean that he regarded them as rational actors who have the complete knowledge of markets and could reason like perfect computers. It seems that Smith, as his countryman James Steuart, thought that, in political economy or the science of domestic policy, statesman should have never supposed the good will of his

subjects and should have tried hard to stimulate their energy regardless of its moral origin. Therefore, individuals must have looked as amoral, self-interest propelled animals who had, when educated, the good understanding of their environment.

When introduced the science of human nature into political economy as a moral philosopher, Smith began the tendency of methodological individualism. But he never completed this attempt. He rather employed the wholist framework of political economy that had been developed by Petty, Cantillon and Quesnay, and handed it to David Ricardo, James and J.S. Mill of the Classical School of political economy. For this school, individuals were not subjects but the objects of the policy of liberal statesmen. This imperfection of methodological individualism had ground in 18th century physiology.

2. Reid: mind and body

For Reid, the mind is not a natural entity. He described human actions as originated in vegetable and animal natures in many levels. But he acclaimed that human mind had active power that transcended the natural order of beings and could arrived at the moral kingdom of the god. For Reid and most of moral philosophers of the age, human is moral being.

This created difficulty that Descartes

had contemplated; how philosophy can explain the relation between mind and body, moral entity and natural entity. Cullen and Reid shared the same idea on the matter. Cullen regarded, just as Reid did²⁷⁾, the body-mind relation was, in the Newtonian manner, one of the ultimate facts that could not be reduced to any superior principle. The mind is indispensable to the functions of the body, though how the former affects the latter is not comprehensible for a human.

"this immaterial and thinking part of man is so connected with material and corporeal part of him, and particularly with the nervous system, that motions excited in this give occasion to thought; and thought, however occasioned, gives occasion to new motions in the nerve system. This mutual communication or influence we assume with confidence as a fact."²⁸⁾

"Philosophers have considered it as a proof of the existence of an intelligent and all-powerful Being governing the Universe, that they find a connexion of the several parts in it nicely adapted to their several ends, and this is adduced a posteriori in proof of the existence of a Deity, by Ray, Derham, and Nieuwentyt... But whilst the philosophers have taken their illustrations from the external functions, physicians can go

further, and show the nice adjustment and capacity of the heat, with its valves, for directing the motion of blood;...

In short, upon the most minute consideration of the smallest internal functions, they will be found an illustration of this equal to that taken from external functions, and from the various operations of moral causes."²⁹⁾

"As mechanism of the brain, suited to its several functions, is not at all perceived, and, at the same time, as very few of these functions are carried on without sensation and volition, it must appear from this and many other considerations, that The mechanism of the brain, would not be sufficient for the purpose, without being united with a sentient principle or mind that is constantly present in the living system."³⁰⁾

Employing Newtonian empiricist methodology, Cullen's physiology defended the active power of the mind that existed independently from the body and affect human psychology and behaviours. This description of mind is in harmony with Reid's notion of active power. 18th century non-materialistic physiology did not allow the naturalist notion of human mind, and thus prohibited the understanding of human intelligence as a

rational calculator of pleasure and pain.

IV. Conclusion

Ferguson's attitude toward Newtonianism is innocent and naive. He accepted Newtonian methodology as an empirical research that is identical with Baconianism in the 17th century. Ferguson whole – heartedly embraced Newtonian natural theology. Pluralism and Stoicism is obvious in his late writings.

Smith's acceptance of contemporary Newtonianism was very selective. It was probably because he studied in Oxford by himself, read contemporary French literature, perhaps of French Newtonians', such as Condillac's works, And his intellectual closeness to David Hume who performed destructive argument, the fallacy of cause and effect, against the demonstration of Samuel Clarke's natural theology. For Reid, Smith presented another naturalist theory of mind that was in the end identical with Thomas Hobbes. But Smith himself did not construct his theory of political economy and jurisprudence from the stand point of methodological individualism. His system of social sciences was rather historical and institutional. As Hegel said, classical political economy demonstrated natural and rational order arose from the simple and careless decisions of many actors in the market.

Reid as a professional natural scientist showed elaborate Newtonianism in methodology, ideas of the system of knowledge and pluralism. He shared the concept of mind with Newtonian philosophers. Mind was for them qualitatively different from the nature in its inner core. Reid preserved 18th century Newtonian's concept of humanity. As Kant described in the *Critic of Practical Reason*, humanity shared with other intelligent beings in the universe that prevailed over nature. This was, as Cullen stated, thought to be established by contemporary physiology:

"In all or any of these cases in which the actions of the brain takes place, we cannot perceive the manner, that is, the mechanical means, by which the several causes produce their effects; and we perceive only an institution of our Maker, establishing a connexion between the several causes and the motions that ensue."³¹⁾

Scottish moral philosophy was not identical with, but parallel to, the Newtonian science of the age. The mindset it created was unique to the century and not the same as 19th and 20th century Newtonianism.

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- 1) Empiricist tendency are strongly seen in these representative textbooks written after John Keil's introductory works had published. Colin MacLaurin, *An Account of Sir Isaac Newton's Philosophical Discoveries*, Johnson Reprint Corporation, New York and London, 1968. Henry Pemberton, *A View of Sir Isaac Newton's Philosophy*, New York and London, 1728.
- 2) Thomas Reid, *Lectures of Thomas Reid on Natural Philosophy* 1757-8, Aberdeen University Library K.106, pp.7-8.
- 3) In his lectures on logic taught at Aberdeen University, Reid admitted that the experimental method of natural sciences was applicable to psychology and politics, too. Thomas Reid, *The System of Logic, taught at Aberdeen 1763, by Dr. Thomas Reid, now professor of moral philosophy of Glasgow*, Edinburgh University Library DK 3.2, 1775, p. 90. In his *Inquiry*, he made a bold statement claiming that the method was the only legitimate way of philosophizing. Thomas Reid, *An Inquiry into the Human Mind, on the Principles of Common Sense*, Thoemmes Antiquarian Books, Bristol, 1990, pp. 2-3. Later, facing the fierce criticism of Joseph Priestley, he became cautious to the application of Newtonian method to moral philosophy, maintaining still that this was justifiable in psychology and political philosophy. Thomas Reid, Paul Wood (ed.), *Thomas Reid on the Animate Creation*, Edinburgh University Press, Edinburgh, 1995, p.183.
- 4) Thomas Reid, *The System of Logic, taught at Aberdeen 1763, by Dr. Thomas Reid, now professor of moral philosophy of Glasgow*, Edinburgh University Library DK 3.2, 1775, p.90.
- 5) For certainty and probability in British Scientists' thought, see Barbara J. Shapiro, *Probability and Certainty in Seventeenth-Century England* (Princeton: Princeton University Press, 1983).
- 6) Reid, Edinburgh University Library DK 3.2, p.90.
- 7) Adam Smith, *Lectures in Rhetoric and Belles Lettres*, Oxford University Press, Oxford, 1983, pp.145-6.
- 8) See G.E.R. Lloyd, Aristotle, Cambridge University Press, London, 1968, Chapter 6.
- 9) Thomas Reid, "A brief account of Aristotle's logic, with remarks," Henry Home, *Sketches of the History of Man*, Edinburgh, 1778, p.391.
- 10) *Ibid.*, pp. 392-3.
- 11) Queries 31 of the second edition of *Opticks*, 1717/18.
- 12) See, for example, Thomas Gordon, *A Manuscript of Moral Philosophy, by Mr. Thomas Gordon, Professor of Philosophy, Kings College, 1773-4, written by Alexander Thomson*, Aberdeen University Library MKS 166. James Clow, *A System of Logic to which prefixed a history of philosophy and a history of logic, by James Clow, professor of logic, Glasgow University, taken by John Campbell, 1773*, Edinburgh University Library Dc. 8.13).
- 13) William Hamilton (ed.), *The Collected Works of Dugald Stewart* Vol. X, Thoemmes Press, Bristol, 1994, p.8.
- 14) To interpret the first two as the assertions of 'Ockam's razor' is controversial, because the expressions of the rules are different according to the versions of *Principia*. Moreover, they appeared only from the second version (1713) as such. It seems that Newton became more conscious to present himself as an empiricist in the later versions of *Principia*. Reid's interpretation of the first

- ones based on the third version was rigorously empiricist. See Wood's introduction of Reid, 1995.
- 15) Adam Ferguson, *Of Natural Philosophy*, c.1760.
 - 16) Thomas Reid, *Lectures of Thomas Reid on Natural Philosophy* 1757-8, Aberdeen University Library K.106.
 - 17) W.P.D. Wightman and J.C. Bryce (eds.), *Adam Smith: Essays on Philosophical Subjects*, Clarendon Press, Oxford, 1980, p.20.
 - 18) *Papers of Adam Ferguson*, owned by Edinburgh University Library, first published by Yasuo Amoh in 1996. Yasuo Amoh, *The Papers of Adam Ferguson*, Rinsen Shoin, 1996.
 - 19) Thomas Reid, *Inquiry into the Human Mind*, Chapter 7: Conclusion.
 - 20) Derek Brooks (ed.), Thomas Reid, *Essays on the Intellectual Powers of Man*, Edinburgh University Press, 2002, p.12.
 - 21) *Ibid.*, p.12.
 - 22) Adam Smith, *The Wealth of Nations, volume 2*, Clarendon Press, Oxford, 1976, p.674.
 - 23) Richard Olson, *The Emergence of the Social Sciences, 1642-1792*, Twayne Publishers, New York, 1993.
 - 24) "We must consider in general, that as wiser physicians tamper not excessively with their patients, rather observing and complying with the motions of nature, than contradicting it with vehement administrations of their own, so in politics and economics the same care must be used", *The Economic Writings of Sir William Petty*, Cambridge U.P., Cambridge, 1899, p.60.
- "And indeed these Consequences will necessarily follow, if all Obstacles are removed out of the way; but if Things are diverted from their natural Course by the Mistakes or sinister Arts of Mankind, the good

Consequences will always be lessened in Proportion to the Number, and Nature of such Obstructions. This being the case, it is obvious to remark, That the Business and Aim of the infusing Sections, must be to remove those Obstructions of Self-Love, and to set Mankind and Nature FREE:- Free, I mean, in that Sense in which consists our true Liberty. For if Self-Love is restrained from doing Good to Society, it will do Mischief; and if prevented from doing Mischief, it will do good. Hence therefore the physician to the politic may learn to imitate the conduct of the physician to the body natural, in removing those disorders which a bad habit, or a wrong turn of treatment hath brought upon the constitution; and then leave the rest to nature, who best can do her own work. For after the constitution is restored to the use and exercise of its proper faculties and natural powers, it would be wrong to multiply laws relating to commerce, as it would be for ever prescribing physic", Josiah Tucker, *The Elements on Commerce and the Theory of Taxes*, Chapter II, Certain Policies for the Increase and Improvement of Manufacture, 1755, pp.78-9. Physiological analogy could co-exist with the mechanical representation of universe because Newtonian physiology employed mechanical explanations. "So that the Circulation of Commerce may be conceived to proceed from the Impulse of two distinct Principles of Action in Society, analogous to the centrifugal and centripetal Powers in the Planetary System. But unerring Wisdom being the Guide and Director of these Powers in the heavenly Bodies, causes that Costancy and Regularity in their Motions, which is never observable in the Affairs of Commerce. And why is that? - It is because the Circulation of Commerce being

Scottish Newtonianism in Moral Sciences

only directed by the Reason or Wisdom of Man, is therefore subject to all those Impediments, Obstructions and Irregularities, which result from the Vices and Extravagancies, the partial Interests, the false Conceptions, and mistaken Policy of Mankind.", *Ibid.*, p.8. "the one is like a beautiful Machine, which regulates and adjusts its own Motions; and the other a clumsy imperfect Work, which is always out of Order, unless the Maker stands by to correct and amend it." *Ibid.*, p.10.

25) John Thomson (ed.), *The Works of William Cullen, M.D. in Two Volumes, Vol. I*, London, MDCCXXVII, p.114.

26) *Ibid.*, p.111

27) Paul Wood (ed.), *Thomas Reid on the Animate Creation: Papers Relating to the Life Sciences*, Edinburgh University Press, 1995.

28) John Thomson (ed.), *The Works of William Cullen, M.D. in Two Volumes, Vol. I*, London, MDCCXXVII, p.18.

29) John Thomson (ed.), *The Works of William Cullen, M.D. in Two Volumes, Vol. I*, London, MDCCXXVII, p.112.

30) John Thomson (ed.), *The Works of William Cullen, M.D. in Two Volumes, Vol. I*, London, MDCCXXVII, p.114.

31) John Thomson (ed.), *The Works of William Cullen, M.D. in Two Volumes, Vol. I*, London, MDCCXXVII, p.111.

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