Sub-economic impulse and consciousness with quantum chromodynamic modeling

Yang, Yingrui

Rensselaer Polytechnic Institute

25 November 2017

SUB-ECONOMIC IMPULSE AND CONSCIOUSNESS WITH QUANTUM CHROMODYNAMIC MODELING

By Yingrui Yang

Department of Cognitive Science

Rensselaer Polytechnic Institute

110 8th Street, Troy, NY 12180, USA

yangyri@rpi.edu

Abstract

The word "sub-economics" follows the sense of "sub-atomic" (Yang, 2012). The latter is about the smallest in matter while the former is about the deepest in mind. Both are difficult to observe, but science must zoom in to understand them. Sub-economic dynamics studies the underlying human impulse and consciousness that may affect individual behavior in the market. It touches on the elementary mental structure of the sub-economic world. However, coding such an elementary structure or modeling its dynamics is not only a necessity, but also a challenge. Quantum chromodynamics (QCD; Zee, 2010) is about strong interactions of quarks and gluons. It touches on the elementary material structure of the physical world. QCD is applied as a conceptual and instrumental tool in the development of sub-economic modeling. The results show a nearly perfect isomorphism between the two elementary structures. By utilizing gauge field theory, sub-economic dynamics shares the same gauge symmetric group, SU(3), with QCD.

1. Free market and human impulse

The issue of "self-regard vs. others-regard" is sensitive to the attitudes toward the notion of a free market. From this perspective, it would be imperative to mention the heritage relation between the so-called Austrian and Chicago Schools of economic thought. It is well known that the latter sustains a rigid stance on promoting a free market despite of criticisms of different kinds.

One of the representatives of the Austrian school, von Mesis (1966), defends the notion of a free market by arguing that a free market is naturally rooted in individual self-regard, which is the first nature of human impulse. Nevertheless, the origin of human impulse does not necessarily lead only to self-regard. The present paper claims that human impulse is twofold in its very nature and can be motivated by self-regard or others-regard inclusively.

2. Flavors and generations of impulses

In social psychology, there are two basic kinds of motivators: the achieving motivator and the fear-of-failure motivator. On one hand, intuitively, it is easy to see that the achieving motivator will lead to impulses of the self-regard kind. On the other hand, though conceptually it does not seem very straightforward, the fear-of-failure motivator can be viewed as leading the impulses of others-regard kind. Fearing is a kind of human impulse, while others-regard can be viewed as the anti-impulse with respect to fearing. In terms of quantum chromodynamics (QCD), self-regard and others-regard are different flavors of human impulses. For example, consider the food chain in the wild world. An animal wants to kill some weaker animal for food; meanwhile, it must worry about being killed by other animals. On the stock exchange market, one wants to make money from others' pockets, but one also fears others making money from one's pocket. Humans have not only fear of others, but also others-regards as anti-fear. An anti-quark is a quark; both are accelerated by the same field. Similarly, an anti-impulse is an impulse. These are both in the first nature of human impulse. This paper aims to code human impulse matrices by using the quark model in QCD.

Impulses can be relatively weak, intermediately strong, or very strong. The empirical evidence (Yang, Brain, and O'Brien, 1998) shows that when people are asked to rate the relative difficulties of ten parameters, the resulting weights are automatically clustered into three levels without losing any statistical power. Within one's affordability, one may well tell which goods one just bought are cheap, which goods are intermediately expensive, and which goods are very expensive. In general, people are able to solve many problems in everyday life. Within our full capacity, we can tell which problems are easy, which ones are moderately difficult, and which problems are very difficult. These levels are characterized in terms of three generations, similar to how the quarks are leveled in QCD. Each level has two flavors, one achieving motivator based

flavor and one fear-of-failure based flavor. Thus, there are six different flavors of sub-economic impulses. Following the names and notations used in QCD, we have: for the first generation, the up-impulse and the down-impulse, written as *u* and *d*; for the second generation, the charming impulse and strange impulse, written as *c* and *s*; and for the third generation, the top-impulse and the bottom-impulse, written as *t* and *b*.

3. Hesitation, chirality, and anti-impulse

Human impulses often hesitate with varying degrees of frequency before acting. When one wants to go to the restroom during a meeting, one's impulse often hesitates between whether "to-go" or "not-to-go." This tells us that hesitation is an intrinsic property of the impulse, called spin, which has been overlooked in current economic theories. As a quantum theory, QCD takes the internal spin of particles into account, which has no counterpart in Newtonian physics. Human impulses possess handedness, called chirality, which can be left handed or right handed. An impulse and its anti-impulse are distinguished by their handedness. For an achieving motivator based flavor, we reserve the left handed for the impulse described as, "want to have," which hesitates between "to-have" or "not-to-have." The right handed is reserved for its corresponding anti-impulse described as, "want to offer," which hesitates between "to-offer" and "not-to-offer." For a fear-of-failure motivator based flavor, the left handed is reserved for the impulse described as, "fearing," which hesitates between "to-fear" and "not-to-fear." The right handed is reserved for its corresponding anti-impulse described as "others-regard," which hesitates between "to-regard-others" and "not-to-regard-others."

To illustrate, consider an agent who is motivated by an achieving-based impulse toward an option on the financial market. The impulse can be "to long", and hesitates between "to-long" or "not-to-long." Correspondingly, the anti-impulse is "to short," and hesitating between "to-short" and "not-to-short." In case the agent is in the fearing mode, the hesitation may be "to-get-out or not-to-get-out." Here, the anti-impulse for others-regard may well be whether just to follow others' trend, and the hesitation becomes "to-follow or not-to-follow." In psychology of decision making, people are committed to the framing effect (Kahneman and Tversky, 2000.) Human impulses are shaped by how they are framed. This four-way picture is called the basic matrix of sub-economic impulses.

4. Sub-economic charges and fractional market charges

There are many different kinds of human impulses. Sub-economic dynamics is concerned with only those impulses that could affect individual behavior on the market. At the level of market dynamics (Yang, 2015), it studies human intention to buy or to sell, which carries full market charge and is explicitly and fully sensitive to the price. At the sub-economic level, it studies what one wants to have or wants to offer, which only carries implicit market charge and is only partially sensitive to price. Following the terms of QCD, the impulses carry fractional market charges. For three impulses with achieving flavors, each carries +2/3 market charge. For three impulses with fear-of-failure flavors, each carries -1/3 market charge. Consider that the bound state, *uud*, is called proton in particle physics (Veltman, 2003.) Hence, a bound state of impulses such as *uud* is called a sub-economic proton, which carries an integer market charge 1 and becomes fully sensitive to price. It is dominated by achieving flavors but a fear flavor remains. Another bound state, *ddu*, called sub-economic neutron, carries 0 market charge and becomes neutral to price. It is dominated by fear flavors though remaining some hope so that it behaves conservatively. This explains how the underlying sub-economic level is connected with market level.

Sub-economic dynamics is committed to a sourced analysis with charges. Following Freud's (and others') argumentation, the sub-economic impulses are charged by three categories of personality: 1. Identification (ID), which is about people's basic needs for survival; one needs food, somewhere to stay in the wild world, and coupling to produce offspring. 2. Self, which is about people's social needs; one wants to have better education, find a better job, make more money in order to take better care of their family, and have more friends to raise their social positions. And 3. Superego, which is about the people's spirit life concerned with honor, love, belief, faith, or after death life. The three sub-economic charges are modeled by the three color charges in QCD. A sub-economic impulse may be charged by any of the three color charges denoted by: r (red), b (blue), or g (green). A sub-economic anti-impulse may be charged by anti-colors denoted by $\bar{r}$ (anti-red), $\bar{b}$ (anti-blue), or $\bar{g}$ (anti-green).

5. Consciousnesses and gluons

Quarks can only occur in a bound state, called quark confinement. No single quark has been observed. We can reasonably assume, unless experimentally disproven, that sub-economic impulses are confined and can only occur in a bound state. The bound states of impulses are conscious states. Consciousness serves as the medium that is responsible for the interactions of impulses, as if gluing them together. This function of the consciousness can be perfectly characterized by the notion of the gluon in QCD. There are eight different gluons; accordingly, there are eight different sub-economic consciousnesses.

In addition to quarks, gluons also carry color charges; this leads to a fundamentally important phenomenon in strong interaction, called asymptotic freedom. Consciousness also carries personality charges; thus, sub-economic interactions are committed to a similar asymptotic freedom. The harder one tries to separate the impulses in a bound state, the tighter they become entangled.

Sub-economic consciousness is assumed to travel in the mental world with the highest constant speed[2]. Like the gluon in QCD, the sub-economic consciousness will also be treated as a kind of gauge boson; this is required by QCD, as it is not only a quantum theory but also a relativistic theory. In addition, human impulse comes and goes; this is handled by the creation operator and annihilation operator in quantum field theory.

6. Gauge symmetry group and the octet of color isospin

Current economic theories have well-established core modeling methods such as equilibrium and margin analyses, which are mostly adopted from Newtonian physics. In the standard model of modern particle physics, the gauge symmetry is essential. It takes into account both a particle's internal space and its traveling space-time. The impulse internal space has three dimensions, each for a possible color charge. For transforming from one state to another, the gauge transformation matrix has eight degrees of freedom. Each degree of freedom is for a conscious gluon and requires a gauge field. Gauge field theory introduces the covariate derivative and gauge field in order to achieve global and local symmetries. Sub-economic dynamics applies gauge field theory used in QCD, so the two can share the same gauge symmetry group SU(3), which has three basic

representations and eight generators. This shall be explained from phenomenological and mathematical perspectives.

From the phenomenological perspective, following the logic of QCD, we can only observe the bound states of impulses. Impulses are bounded in certain ways through consciousness as a medium. In other words, the consciousness is responsible for strong interactions of sub-economic impulses. The interactions of impulses involve color changes, and color exchanges through consciousnesses. Thus, according to the possible ways of impulses to be bounded, the consciousness carries multiplet charges, called conservation charges. There are eight (and only eight) possible color combinations of impulses with anti-impulses. Accordingly, there are eight color conservation charges that a consciousness may carry (Watson, 2004). These are:

$$(r\bar{g}), (r\bar{b}), (b\bar{r}), (b\bar{g}), (g\bar{r}), (g\bar{b}), (r\bar{r}, g\bar{g}), (r\bar{r}, b\bar{b}, g\bar{g}).$$

This is the complete set of the eight consciousness color configurations, called the octet of color isospin.

7. Color space and gauge transformation

From the mathematical perspective, every sub-economic impulse has an internal space of three-dimensions, with respect to three possible color states.

$$\varphi = \begin{pmatrix} \varphi_1 \\ \varphi_2 \\ \varphi_3 \end{pmatrix}$$

This color space is a complex space, in which each component φ_i is a Dirac spinor. The special unitary transformation from one state φ to another φ' requires the special unitary matrix U. U is a 3×3 complex matrix containing 9 complex parameters, or 18 real parameters. The unitary condition for U requires to fix 9 real parameters. In addition, the unitary mode condition requires one more real parameter to be fixed. Thus, the number of independent real parameters is 8. Hence, the transformation matrix U can be represented by the linear superposition of 8 independent hermit matrices, called Gell-Mann matrices (Peskin & Schroeder, 1995), given below.

$$\lambda^1 = \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \quad \lambda^2 = \begin{pmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \quad \lambda^3 = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \\ 1 & 0 & 0 \end{pmatrix},$$

$$\lambda^4 = \begin{pmatrix} 0 & 0 & -i \\ 0 & 0 & 0 \\ i & 0 & 0 \end{pmatrix}, \quad \lambda^5 = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}, \quad \lambda^6 = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & -i \\ 0 & i & 0 \end{pmatrix},$$

$$\lambda^7 = \begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \quad \lambda^8 = \frac{1}{\sqrt{3}} \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -2 \end{pmatrix}.$$

Gell-Mann matrices satisfy:

$$Tr(\lambda^a) = 0, \quad Tr(\lambda^a \lambda^b) = 2\lambda^{ab},$$

where $a, b = 1, \dots, 8$. The structure constant can be defined as:

$$T^a = \frac{\lambda^a}{2}$$

Thus, the transformation matrix can be represented by:

$$U = e^{i\theta_a T^a}$$

The notation $\theta_a T^a$ follows the Einstein summation convention. Since $a = 1, \dots, 8$, to hold gauge symmetry group SU(3) for the local symmetry by taking into account individual differences, it requires 8 gauge fields, one for each independent parameter.

8. Conclusion

Current behavioral economics is strong in finding empirical evidence and in making critical arguments. But it needs to be strengthened in principled theorizing and advanced modeling technologies. QCD is a quantum field theory, which is an integration of quantum theory and special theory of relativity. Sub-economic dynamics is a part of the economic mechanics (Yang, 2012, 2015), which is an integration of economics and cognitive science; the further integration with modern theoretical physics is not for the purpose of doing physics, but rather for using it as a logic to advance modeling methods in developing social sciences. By utilizing the modeling advantages of modern

theoretical physics, we have gotten a better idea about how to look into deeper cognitive structure of the mental world.

Acknowledgement

My thanks go to the students who participated in my courses over years at Rensselear Polytechnic Institute, and at Peking University, Tsinghua University, and Zhongshan University of China. They served as the first round proof readers.

References

Kahneman, D. and Tversky, A. (2000). Choices, Values, and Frames. Cambridge University Press.

Peskin, D. and Schroeder, M. (1995). An Introduction to Quantum Field Theory. Westview Press, USA.

Veltman, M. (2003). Facts and Mysteries in Elementary Particle Physics. World Scientific Publishing, Singapore.

Von. Mises, L. (1966). Human Action: A Treatise on Economics. Henery Regnery Company, 3rd revised edition.

Watson, A. (2004). The Quantum Quark. Cambridge University Press. Cambridge, UK.

Yang, Y. (2015). Gauge field theory of market dynamics. June, Munich Personal RePEc Archive (MPRA) paper, No. 65274. Preprint at http//mpra.ub.uni-muenchen.de/6527.

Yang, Y. (2012). Modern Principles of Economic Mechanics: A qualitative integration of economics, cognitive science, and theoretical physics. Xlibris, USA.

Yang, Y., Braine, M.D.S., and O'Brien, D. (1998). Some empirical justifications of a mental predicate logic. In Brain, M.D.S. and O'Brien, D. (Eds.), Lawrence Erlbaum Associates, NJ.

Zee, A. (2010). Quantum Field Theory in a Nutshell. Princeton University Press.

Author Information Correspondence and requests for materials should be addressed to Yingrui Yang (yangyri@rpi.edu).