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Psychohistory Paradox and Introduction to Quantum Social Science

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Abstract

Why would social science need the help from quantum mechanics? First, there are many unanswerable questions in social science. Are financial markets predictable? How to predict the financial markets? These important questions are not answerable in the existing framework of finance or economics. One important paradox in social science is the psychohistory paradox proposed by Asimov. In his novels, Asimov highlighted a paradox of human society: if the future events of a human society are predictable using psychohistory, people could take the advantage of that prediction to prevent the future events from happening, and the original prediction would be proven wrong. The psychohistory paradox is very real and fundamental in the human society. Second, the existing framework of modern physics can neither explain nor predict the human behavior. It is ridiculous and totally unacceptable that the same modern physics, which often boasts about the accurate descriptions and predictions of the tiniest elementary particles to the largest structures of the universe with amazing accuracies, cannot handle the simple human behavior observed in our everyday life. The flaws of the existing framework of modern physics must be fixed. Third, it is the internal logic of science. If the human free will is a quantum phenomenon as many people believe and social science is all about human choices, social science must be a branch of quantum physics. Fourth and last, quantum social science, or psychohistory, brings powerful tools and new insights to social science. Quantum social science can answer all the previously unanswerable fundamental questions in social science, and re-frame every problem in politics, economics, and other social science to be a physics problem. This paper summarizes the logic flow from the creation of JJW interpretation of quantum mechanics and physics laws of social science (PLSS) to their impacts on economics, finance, politics, and other fields of social science, natural science, and theology. Since many applications of PLSS are still unknown, this paper serves as an introduction to quantum social science and its applications. The central ideas of PLSS are very simple, yet it has profound logic consequences on many corners of human knowledge. The primary goal of this paper is to convey the beauty and simplicity of the framework of quantum social science or psychohistory.

1. Psychohistory Paradox

In his novel “Foundation” first published during 1942-1951, Isaac Asimov described a branch of interesting new science called psychohistory, which combines history, psychology, sociology, and statistical mathematics to predict the future events of a large human population. However, if the future events of a human society are predictable, the population could take the advantage of that prediction to prevent the future events from happening, and the original prediction would be proven wrong. Thus there are inherent contradictions in predicting the human behavior. In order to make psychohistory predictions accurate in his novel, Asimov described that the predictions must be hidden from the general population and assumed no one in the general population would reinvent the psychohistory again.

The psychohistory paradox is very real for today’s forecasters on earth. If forecasters in Federal Reserve predict that AIG have to file for bankruptcy in a month, Federal Reserve could step in to save AIG and the original prediction would be proven wrong. Thus, there are inherent contradictions in predicting human behavior.

How to balance the predictability of a theoretical model and people’s ability to alter the future outcome is the central question in social and natural science.

This paper describes the framework of quantum social science. Quantum social science is a new nonfictional psychohistory that combines quantum physics, statistical mathematics, history, human psychology, and other fields of social science. Quantum social has a unique way to overcome the psychohistory paradox with five physics laws of social science.

2. Brief History of Searching for Physics Laws of Human Society

History, politics, accounting, and military theories are some oldest human knowledge. Ancient historians, philosophers, politicians, and military commanders tried their best to find useful patterns of the human behavior.

Since Issac Newton discovered the laws of motion in 1687, for the next 300 plus years, researchers have been searching for physics laws governing the human society.

In politics, political theories were developed well enough for the founding fathers of the United States to create the first successful constitutional democracy in 1787. The United States Constitution is certainly one of the greatest achievements of the humanity. The framers of the constitution invented many new ideas by themselves and have adopted the best political philosophies at that time including John Locke’s the consent of the governed, Hobbes’s social contract theory, Montesquieu’s divided governments, and Edward Coke’s civil liberties.

In economics, Adam Smith set the foundation of modern economics. When he criticized mercantilism in *The Wealth of Nation* in 1776, Adam Smith was taking an accounting view of economy and he said “the division of labor is the great cause of the increase of public opulence, which is always proportioned to the industry of the people, and not to the quantity of gold and silver as is foolishly imagined”. In other words, Adam Smith correctly pointed out the wealth of a nation was the productive capacity of the

country enhanced by the division of labor, which usually vastly outweighed the value of gold and silver of that nation.

The great success of Newtonian physics has caused many researchers to mimic the framework of physics with mixed successes. Auguste Comte made great efforts to create scientific theories of the human societies. Comte's positivism [1] remains very influential among today's social scientists.

Karl Marx developed a grand and coherent social science theory. Although most ideas of Marxism have been discredited in last 100 years, the framework he created for history, economics, politics, and sociology is more or less the same as the quantum social science. The communism political movements based on Marxism in the 20th century have claimed about 100 million victims around the world [2].

In economics, after the marginal revolution, the use of mathematic tools and the empirical data analysis have transformed economics into a broad and sophisticated field with many subfields. The combination of Marshallian supply demand market equilibrium analysis, the rational choice theory, and Keynesian economics have dominated the mainstream economics today.

In political theory and political philosophy, one dominating topics in the 20th century was how to defeat the dangerous Marxism ideology. In his writings [3-8], Hayek repeatedly warned that natural science and social science are very different and we must shed the illusion like Marxism that we can deliberately create the political future of mankind.

Today despite social science successes, social scientists have constantly debated whether social science could ever become a scientific theory like physics. Theories like democratic theories, Marshallian supply demand market equilibrium analysis, the rational choice theory, and the DSGE models are clearly far away to be scientific. There are many schools of economic thoughts existing today while there is only one school of thought in physics or natural science. Robert Shiller noted that economics is far from a science [9]. Modern political theories are political philosophies, and philosophy is not a science.

In recent decades, many physicists started to work on financial and other fields of social science under the name social physics or econophysics. The main problem with social physics or econophysics is that although these physicists carry fancy tools, they have not really resolved any outstanding big problems in social science to impress social scientists. Social physics or econophysics has not succeeded because physicists should have focused on those unanswerable fundamental problems in social science. For example, questions like whether financial markets are predictable is far more profound and challenging than marginal questions like what the tails of stock price distributions look like.

3. Why Would Social Science Needs Quantum Mechanics?

Since Issac Newton discovered the laws of motion in 1687, for the next 300 plus years, physics has grown into a highly specialized field covering vast subfields from particle physics, electronics, semi-conductors, chemistry, biophysics, to cosmology. Without formal trainings in modern physics, most social scientists would be are uncomfortable talking about physics. Even some professional physicists are uncomfortable talking about the weirdness of quantum mechanics [10].

The natural question is why would anyone mix social science with the elusive quantum mechanics?

First, there is a long list of fundamental unanswerable questions in social science. How to resolve the psychohistory paradox? Are financial markets predictable? How to predict the financial markets? Are recessions predictable? How to predict the recessions? How should humanity govern itself?

Second, the human behavior paradox says that the existing framework of modern physics cannot handle the human behavior. It is ridiculous and totally unacceptable that the same modern physics, which often boasts about the accurate descriptions and predictions of the tiniest elementary particles to the largest structures of the universe with amazing accuracies, cannot handle the simple human behavior observed in our everyday life. The flaws of the existing framework of modern physics must be fixed. We must develop a new framework of modern physics that could handle the human choices.

Third and most importantly, it is the internal logic of science. If the entire social science is about human choices and the human free will is a quantum phenomenon, then social science must be a branch of quantum physics. The question whether people like quantum social science or not is irrelevant from the scientific research point of view.

Fourth and last, quantum physics brings powerful tools and new insights to social science. Quantum social science can answer all the previously unanswerable fundamental questions in social science, and re-frame every problem in social science to be a physics problem.

4. Unanswerable Questions in Social Science

There are many unanswerable questions in social science. Is social science really a science? American physicist Richard Feynman did not think so because there are no universal laws ever discovered in social science. Feynman famously labeled social science as pseudoscience.

In economics, is economics a science? According to the 2013 economic Nobel Prize winner Robert Shiller [9], economics is far from a science. Then how to make economics a science? Is the recession predicable? If the government could predict a recession is coming, the government could take the fiscal and monetary policy changes to prevent the recession from becoming the realized reality. However, the original prediction would be wrong. If recessions are predictable, why do DSGE models treat recessions as exogenous shocks?

In politics, how should we govern ourselves? For thousands of years, the important question has attracted some greatest thinkers in history including Confucius, Plato, Aristotle, Machiavelli, Locke, Washington, Jefferson, Madison, Kant, Marx, Einstein, Hayek, and many others, yet the problem remains largely unsolved. Is political science really a science? Could a political theory be falsified? The communism movements in the 20th century have claimed more than 100 million victims around the world [2]. One could only wish that a political theory like communism could be first experimented in a small and limited scale before it was fully implemented in some biggest countries in the world.

In history, is history a science? Only few historians think themselves as scientists. However, cosmology, which studies the history of the universe, is now a red hot physical science. Why should the history of the universe not include the human history?

The opposite of history is the future. For most people, knowing the future is far more valuable than knowing the history. Yet despite its importance, there is almost no formal subject devoted to study the future. In the past thousands of years, astrology has been the parallel subject to history, as a field of human knowledge. However, today, while most universities have history departments, virtually no university would have an astrology department. Would it make more sense to teach kids more about the future than history? A new field called futurology is so young that there are few followers. The main difficulty of studying the future is that we do not know whether the future is predictable and how to predict the future.

In finance, are the financial markets predictable? How to predict the financial markets? If financial analysts could predict AIG corporate bonds were going to default and AIG was going to file bankruptcy in the great recession of 2008, could the analysts also predict that the Federal Reserve was going to loan AIG \$85 billions to prevent the company from collapsing? This is the psychohistory paradox.

These are all very fundamental and very difficult questions in social science. However, these questions are unanswerable in the existing framework of social science, because these questions are all related to the physics nature of human behavior, and cannot be solved by the available existing tools in social science. If social physics or econophysics wants to be successful, the focus of researches must be to solve these fundamental and difficult problems in social science.

5. Human Behavior Paradox

Consider to build a forecasting model of the location of a three years old kid in next 5 minutes in a well-defined environment of the physics laboratory using the modern physics. Physicists are clueless about how to predict the future movements of a small kid.

Physics should be extremely good at forecasting the future locations of a planet, a galaxy, a rock, a spaceship, an electron, or a beam of electromagnetic wave. However, physicists cannot predict the future locations of their own three year old kids in next 5 minutes. This is a paradox!

We can critically and systematically examine [11] the question how to predict the human behavior using Newtonian physics, special relativity, general relativity, thermodynamics, and QM with Copenhagen interpretation, this paper reaches a stunning conclusion that the existing physics laws can neither explain nor forecast the human behavior.

This is the intolerable human behavior paradox facing physicists today: on one hand, the modern physics can explain and forecast the behavior of physical systems ranging from the tiniest elementary particles to the largest structures of the visible universe with amazing accuracy; on the other hand, ironically the existing physics cannot explain nor forecast the human behavior that physicists live and observe in our everyday life.

6. Measurement Problem in Quantum Mechanics

Almost no physicist would lose any sleep because they cannot predict the future locations of their own three year old kids in next 5 minutes. However, one kind of human behavior of the measurement process in quantum physics has caused enormously headaches among profession physicists since the creation of quantum mechanics.

Despite the great success of quantum mechanics, the Copenhagen interpretation, which is the philosophic physics theory interpreting the meaning of quantum mechanics, suffers great difficulties famously known in science as the “measurement problem”. Albert Einstein summarized the measurement problem in a simple question, “Does the Moon exist when we’re not looking?”

When he put quantum mechanics in a rigorous axiomatic framework, John von Neumann [12] formulated the measurement process in the Copenhagen interpretation of a quantum system in two steps: (1) the quantum system evolves according to the initial conditions and the mathematical formulation of quantum mechanics. The evolution of the wave function of the quantum system is deterministic. (2) A measurement of the quantum system takes place. The measurement causes the wave function of the quantum system to make a quantum leap to the observed state. The measurement process, or the wave function collapsing process, is indeterministic.

The measurement problem of the Copenhagen interpretation is that the mathematic formulation of quantum mechanics is unable to describe the process of measurement, even though with today’s computer technology the measurement process could be completely automated to without people’s interference.

There are internal contradictions in the existing framework of quantum mechanics. On one hand, the mathematic formulation of quantum mechanics like Schrödinger equation and quantum field theories appears to describe the dynamics of a quantum system correctly. On the other hand, the experimental observations have been in excellent agreement with the collapsed quantum states. Yet the deterministic mathematic formulation of quantum mechanics and the indeterministic collapse of the wave function by measurement are directly contradictive with each other.

7. JJW interpretation of Quantum Mechanics

The solutions to unanswerable questions in social science, the human behavior paradox, and the famous measurement problem in quantum mechanics is provided by a new interpretation of quantum mechanics called the JJW interpretation of quantum mechanics.

The most important insight provided by quantum social science is to show that to build the coherent physics of human choices is equivalent to build a new interpretation of quantum mechanics. The reason is simply that human free will and human choices are fundamentally quantum phenomena. If all human behavior can be described by quantum mechanics including the experimental quantum measurement processes, the famous measurement problem in quantum mechanics would vanish completely.

Physics Theory of Human Choices = A New Interpretation of Quantum Mechanics

The human choices are so important to our humanity that most books in the Library of Congress are about human choices. History is about choices made in history;

economics is about economic choices; politics is about political choices; sociology is about social choices; law is about legal choices; fictions is the choices of words describing the choices by fictional figures; medicine is about choices of medications; football games is about choices of coaches and players; music is about choices made by composers and performers; and painting is about choices made by painters.

Despite its importance, we do not have a coherent physics theory about the human choices. As a matter of facts, there is no “choice” concept in the modern physics. The human behavior paradox says that the human behavior is incompatible with the existing framework of physics.

Because we concentrate on something as familiar as the human choices, the previously elusive and difficult task of building a new interpretation of quantum mechanics is simple and straight forward. And the new interpretation, which we call the JJW interpretation of quantum mechanics, has profound implications on almost every corner of the human knowledge because the new interpretation essentially provides a fresh new quantum mechanics angles to examine human choices in every book in the Library of Congress.

After the establishment of the JJW interpretation, it becomes clear that the measurement problem in quantum mechanics is related many other unsolved big problems in physics such as the origin of irreversible processes and the arrow of time phenomena.

The importance of JJW interpretation to social science is that quantum social science can answer all the previously unanswerable fundamental questions in social science, and re-frame every problem in politics, economics, and other social science to be a physics problem.

8. Physics Laws of Social Science

The central ideas of JJW interpretation are the five physics laws of social science, which have been published elsewhere in a book [13] and an academic paper [14]. For the benefit of readability of this paper, we list five physics laws of social science in the following.

First Law – Law of Indeterminacy

For a closed system, the outcome of any future event in the system is indeterministic. The quantum uncertainty of the future is the fundamental property of nature and cannot be overcome by any means.

Second Law – Law of Prediction

For a closed system, any future event in the system can be and can only be predicted precisely to the extent of a joint probability distribution among all possible outcomes. The joint probability distribution function exists and is uniquely given by quantum mechanics.

Third Law – Law of Choice

Actions, which are constrained by fundamental laws of physics, can be taken between time 0 and time T to modify the joint probability distribution function of time T of a closed system.

Fourth Law – Law of Information

The complete historic information of any closed system cannot be recreated based on today's complete information. At any time step, new information is created and some historic information is lost permanently.

Fifth Law – Law of Equilibrium

For a system under certain constraints, quantum uncertainties in the system will eventually push the system toward equilibrium states.

The central idea of The JJW interpretation is the Law of Indeterminacy. Starting from the Law of Indeterminacy, many different aspects of quantum physics like reality, wave function, information, time symmetry, equilibrium state, predicting the future, choice, and free will have to be re-examined and formulated.

The explanation and discussion of these five laws can be found in the book [13] and the papers [14-15]. These laws are fundamental laws of physics, which are applicable to any system including any physical and biological systems, and human societies. Fundamental equation of economics is one application of these physics laws in economics.

The correct formulation of physics laws of social science is the most important achievement of quantum social science.

8.1 Are Physics Laws of Social Science Really Laws of Physics?

Finding new fundamental laws of physics are so difficult that physicists have found only about a dozen of these laws since Newton formulated first fundamental laws of physics in 1687. Therefore, one obvious question is whether physics laws of social science are truly laws of physics. The reason is the following:

First, law of indeterminacy, law of prediction, and law of equilibrium are already considered as fundamental laws of physics. Since indeterminacy is the most feature of quantum mechanics, law of indeterminacy is universally accepted by all physicists, although few people called the property of nature as law of indeterminacy. Law of prediction is the generalized and modified Born's statistical interpretation. Max Born was awarded a Nobel Prize in physics for his famous statistical interpretation. The law of equilibrium is the generalized second law of thermodynamics. Law of choice and law of information are new to physics, and essential additions to other three laws.

Second, social science needs these new laws. The idea that human free will is quantum phenomenon is not new to science. In his acceptance speech [16] of the Nobel Prize in December 11, 1954, Max Born mentioned the possible connection between quantum theory and the problem of free will. However, the science of free will has not

progress into anything that can solve real problems in social science over last 60 years. Why? It is because physics laws of social science are far beyond the simple notion that human free will is quantum phenomenon.

Third, physics laws of social science are very powerful tools for studying the human behavior and human society. Without physics laws of social science, we must use the JJW interpretation of quantum mechanics as the starting point of solving problems in social science. However, the JJW interpretation is bulky and loaded with quantum terminologies because the JJW interpretation is created as the foundation of quantum mechanics. It would be hard for non-professional physicists and students to understand and apply the JJW interpretation. Physics laws of social science are easy to understand and apply for anybody. Even a five years old kid, who plays the rock paper scissors game, can understand that the world is indeterministic and some other basic aspects of physics laws of social science.

Forth, physics laws of social science are profound statements about the way how the nature and the human society work. Physics laws of social science highlight those shared concepts between natural and social science: indeterminacy, choice, probabilistic causality, information, future uncertainty, equilibrium, and arrow of time. No matter what these statements will be called, these statements will always be the shared foundation of natural and social science.

Fifth, five physics laws of social science are closely related with each other. The law of indeterminacy is the starting point. The law of prediction addresses how to predict the future and the cause and effect relationship of an indeterministic system. The law of choice addresses how to make a choice and how a choice will impact an indeterministic system. The law of information addresses how information is created and destroyed. The law of equilibrium addresses the time symmetry and the equilibrium state. Since these five laws describe the most fundamental behavior of elementary particles and human beings, they are qualified as fundamental laws of physics.

The correct formulation of physics laws of social science is the most important achievement of quantum social science.

9. Applications in Social Science

The quantum physics divides social science into three distinct fields with strong overlapping on forecasting: the value-free positive quantum social science, the not-value-free normative quantum social science, and the value-free normative quantum social science.

The value-free positive quantum social science is to describe and forecast the social reality using law of prediction, and to answer “what is” and “what will be” questions.

The not-value-free normative quantum social science answers “should be” questions using law of prediction, law of choice, and value systems.

The value-free normative quantum social science answers questions “should be” questions using law of equilibrium without value systems. In essence, these solutions will be scientific or permanent equilibrium physics solutions to social problems. Applying law of equilibrium to solve social problems in a scientific way without value systems is a

major contribution of quantum social science. Many important social problems have well-defined scientific answers.

Therefore, quantum social science emphasizes forecasting rather than historic empirical data analysis. Quantum social science sets the very high standards for forecasting in order to be consistent with modeling in other subfields of physics. Quantum social science requires the a scientific forecasting model to be logically self-consistent, making forecast with reasonable accuracy, truthful abstraction of initial reality, capturing key dynamics accurately, and based on a sound theoretical foundation.

PLSS is broadly applicable in all fields of social science. We will discuss quantum economics and quantum politics in details. Other applications in history, business and military strategy can be found in the book [13].

10 Quantum Politics

The framework of quantum politics is centered on the humanity governing problem. In order to solve the humanity governing problem scientifically, we must overcome at least 4 major road blocks: (1) We must put the political science in the modern physics framework; (2) We must reformulate the humanity governing problem into a scientifically answerable format; (3) We must use the hard rod system as the road map to study the structure of political equilibrium state; (4) We must derive the structure of political equilibrium state from the internal logic of quantum politics.

10.1 How Should Humanity Govern Itself

Solving the humanity governing problem [17] is probably the most important contribution of JJW interpretation of quantum mechanics. One problem is standing out above all others in social science: how should humanity govern itself? The problem is so important that all wars of humanity in the past, present, and future, are directly related to this problem. Despite the fact that this problem has attracted interests of some greatest thinkers for thousands of years: Confucius, Plato, Aristotle, Machiavelli, Locke, Washington, Jefferson, Madison, Kant, Marx, Einstein, Hayek, and many others, yet the problem remains unsolved. The latest thinking on this governing problem by mainstream social scientists is represented by views of Friedrich Hayek. In his writings, Hayek repeatedly warned that we must shed the illusion that we can deliberately create the future of mankind. With PLSS, we disagree with Hayek and prove that this problem is a many-body problem in physics solvable scientifically after all applying recently-created physics laws of social science, if the problem is formulated in a correct way: what kind of governing political structure of humanity is most stable? Most-stable structure problems appear routinely in the theoretical and experimental condensed matter physics. We show that the humanity governing problem is equivalent to find an equilibrium political structure of a human society, which is a many-body physics problem 100% solvable using the maximum entropy approach widely-used in the condensed matter physics. PLSS establishes the framework and methodology of quantum politics and replaces traditional political philosophy with quantum physics as the solid foundation of political science, and analyzes the equilibrium political structure of a human society. Quantum politics says that we can create free, fair, just, peaceful, and prosperous human societies.

We prove that there is certainly no better alternative than the equilibrium political structure, which is defined by a set of 16 democratic principles. Quantum physics clearly says that there is a global political equilibrium state, which corresponds to the permanent world peace. This paper provides a theoretically-sound and practical solution to eliminate the nuclear, biological, chemical, robotic, and other forms of weapons of massive destruction. In the long run, humanity can finally grow up and will put an end to deaths, miseries, and economic destruction caused by wars, which have been plagued us since the dawn of humanity.

10.2 Drivers of Long-Term Social Changes

Treating the human society as many-body problems in physics naturally leads to extend the hydrodynamic mode methods in the condensed matter physics [18] to analyze the human society to answer an important question of social science [19]: what drives the economic, political, and social changes in the human society? In a simple fluid like water, the macroscopic changes are characterized by 5 hydrodynamic modes in connection with the conservation laws of energy, mass, and the 3-dimensional momentum vector. The conservation of momentum and the Newton's second law of motion lead to the well-known Navier-Stokes hydrodynamic equation. In human society, there are millions and billions of changes every day. The hydrodynamic mode approach says that most of these changes in human society are transient and short-term changes. In the long run, only changes characterized by the hydrodynamic modes are relevant. In the human society, there are 16 hydrodynamic modes in connection with the equilibrium political structure of the permanent world peace. It is a very surprising conclusion that despite the complexity of human society, the only important drivers of the long-term political, economic, and social changes in the history, present, and the future are these 16 classes of global mega-trends associated with hydrodynamic modes.

10.3 Fundamental Design Flaws of American Constitution

Studying the political equilibrium structure leads to a conclusion that the US constitution has many fundamental design flaws [20]. American civil wars, slavery, epidemic gun violence, and run away government debts are some direct results of design flaws of the US constitution. The constitution is certainly one of the most important documents in the world history. It was designed wisely and beautifully by US founding fathers. However, the constitution was written by a group of farmers with limited knowledge of political theories one and a half centuries before quantum mechanics was created. We now know the foundation of political science is quantum physics. Also the constitution was a practical legal contract out of compromises. Even though many founding fathers knew the slavery was wrong, they did not grant the equal rights to slaves. They declared all mans are created equal. Yet they gave more representation to states with less population in the senator seats.

Today many social and economic problems in US can be traced to the fundamental design flaws of the constitution [20]. The principle of fiduciary duty requires the congress to treat the future generation fairly. However, the running away federal fiscal deficit is a clear sign that the congress has failed their fiduciary duty. The

US constitution fails to constrain the congress with their fiduciary duty to the future generations. The epidemic gun violence in US is the direct result of the right to bear arms in the second amendment of the constitution. The principle of nonviolence says that conflicts should be resolved peacefully with compromises. Historically, American civil wars and slavery are some other examples of the design flaws of the US constitution. Because the 16 democratic principles are universally applicable to any countries, the comparison can be made between the political structure of any country and the equilibrium political structure. These results will have important practical implications.

10.4 Permanent Equilibrium Solution to Government Budget Deficits

Studying the political equilibrium structure also leads to solve one of most intractable and contentious problem in modern political economics [21] in a value-free way. The debates about how to deal with government budget deficits are raging all over the world. In US, the federal government forced to shut down for 16 days in 2013 because of the failure to pass a budget through congresses, and barely averted a default of federal government obligations due to failure to raise the federal debt ceiling limit. The city of Detroit filed the largest municipal bankruptcy in the US history on July 18, 2013, despite Michigan State constitution's balanced budget requirement. In Europe, the sovereign debt crisis has dragged down the entire EU economy since late 2009 with no end in sight. In Japan, the government debt to GDP ratio is well over 200%, which is one of the highest in the world. In the world of academics, the debates of government deficits have become the key battlegrounds of different schools of thoughts of economics. Economists and political scientists could not even agree to a framework to solve these issues, let alone settle these debates. Quantum politics provides a permanent solution to government budget deficits. Surprisingly the solution comes from the first principles of quantum physics. The political equilibrium structure has the time translational symmetry in treating different generations equally. One result of applying physics laws of social science to study the most stable political structure is that the most stable political structure is not only to require the majority voters must deal with minority voters fairly to avoid the tyranny of the majority, but also to require the voting generation must exercise their fiduciary duty to their children and future generations. In terms of government budget deficits, the fiduciary duty means that the current voting generation must take the full responsible of the current government budget deficits or surplus. The permanent solution of government budget deficits is legally and personally held the voting generation accountable for the current fiscal surplus and deficit at all level of governments. In contrast to the balanced budget approaches, the permanent solution in this paper allows deficit spending and government debt as long as the government debt must be paid off by the responsible borrowers and voters. The method to solve the government budget deficit problem is an excellent example of applications of law of equilibrium, which can be used to solve economic, political, and other social problems in a value-free way. The permanent solution to government budget deficits presented in this paper is consistent with a different line of reasoning in economics, which is known as the tragedy of the commons. In cases of government budget deficits, the tragedy of fiscal abuse happens because the exact ownership of government budget deficits by which generation is unclear in the US constitution, and current voting generation financially

takes unfair advantage of their children and the future generations, who virtually have no political power.

In conclusion, JJW interpretation of quantum mechanics provides a solid physics foundation for political science. There should be no doubt that political science is simply a branch of quantum physics in parallel with economics, chemistry and optics. Establishing quantum politics is a giant step forward for the humanity because for the first time we can solve contentious political problems in a scientific manner.

11 Quantum Economics

The framework of quantum economics is centered on fundamental equations of economics (FEOE), which is one equation governing all economic phenomena.

11.1 Fundamental Equation of Economics

In economics, a fundamental equation of economics [22], which is similar to many fundamental equations governing other subfields of physics, for example, Maxwell's Equations for electromagnetism, can be derived from physics laws of social science (PLSS). FEOE is the one mathematic equation that governs all observed economic phenomena. The fundamental equation of economics establishes a common entry point to solve all economic problems. FEOE is a mathematical bridge connecting the current economic reality and all future possibilities. Establishing FEOE clarifies many open questions regarding the foundation of economics, for example, what can be forecasted and what cannot be forecasted in economics. FEOE comes with its own version of microeconomics and macroeconomics.

We must emphasize that FEOE and quantum economics is far more than just applying probability theory for the economic analysis. In physics, quantum mechanics is far more than just applying probability theory for the physics analysis. In the FEOE framework, the future joint probability distribution function is unique and objective, and can be forecasted precisely only at one moment. FEOE is the generalized Born's statistical interpretation in the human society.

One application of FEOE is to examine existing economic theories. After reviewing existing economic theories, FEOE is not compatible with many existing theories like rational choice theory, DSGE models, modern portfolio theory, and general equilibrium theory. These theories incompatible with FEOE will be thrown into historic dustbins. One great strength of FEOE is that not only FEOE attacks the existing economic theories but also one can derive relevant theories from FEOE to replace these abandoned theories. Although many economic theories incompatible with FEOE are very popular among mainstream economists and standard economic textbooks, we must abandon these theories because these are theories that prevent economics from becoming a true science.

11.2 Rejecting Marshallian Market Equilibrium Framework

Most economists regard Marshall's laws of supply and demand and market equilibrium framework as the foundation of all fields of economics. However, Marshall's framework is not compatible with FEOE and must be rejected.

Laws of supply and demand are not laws of physics. In reality, there are no simple deterministic relationships among supply, demand, and price these variables. In order to make economics a real science, the laws of supply and demand must be abandoned as the foundation of economics and downgraded into statistical relationships, which work sometimes and do not work in other times. It is ridiculous to use such shaky relationships as the foundation of economics.

The concept of market equilibrium is incompatible with law of equilibrium [23]. The concept of market equilibrium is built on the observation that the amount sold equals the amount bought. In the market places, the observation that the amount sold equals the amount bought is always true simply by definition. Therefore, it has been a sad and simple mistake for many generations of economists to apply incorrectly the concept of equilibrium in the market place over last one hundred years. And what even worse is that entire economic framework like general equilibrium theory and DSGE models are built upon this misconception.

In the FEOE framework, the markets in general are dynamic and not in equilibrium. Markets in equilibrium are special cases where the supply, inventory, demand, and price are range-bound and stable. Under very special conditions, the flow of products from producers, wholesale and retail inventory, to the end consumers is stable. We can claim that the market is in equilibrium and the nature of this market equilibrium is a flowing equilibrium not market equilibrium. The flow equilibria in economics is similar to many flow equilibria in hydrodynamics.

Strangely, most standard economy textbooks rarely talk about inventories. Why? It is simply because the existence of inventory almost invalidates the entire framework of laws of supply and demand and market equilibrium. Unfortunately, in a market economy, most products do carry inventories.

Take the US automobile market as an example. Except very few red-hot models which need the waiting lists to manage the demand, most auto models carry inventories by dealers. When one walks into any auto dealer in the neighborhood, one would find out immediately that the supply of new and used cars for sell is often far more than potential customers on any day, because auto dealers typically carry inventories of 45 to 60 day's sell volume. Therefore, with the existing of inventories, the supply of autos is always much greater than the demand on any given day.

Because the existing inventory in a market simply means that supply always greater than demand, and therefore in reality, there is no such thing as the market equilibrium defined as supply equals demand. One might attempt to fix the problem by re-defining the market equilibrium as production equals demand. However, the fact that production equals to demand would only mean the stable inventory not the market equilibrium defined as supply equals demand. With the existence of inventory, the pricing changes in a far more complicated fashion than laws of supply and demand would conclude. For example, when the potential supply is greater than the potential demand, the market price could rise, stable, or fall. When inventories run low, suppliers may or may not choose to raise prices even though supply is always greater than demand. Inventory would damp the pricing impacts due to small changes in production and

consumer demand. The central tenet of Marshall's cross diagrams is the intersection of supply and demand curves. Because inventory means supply is always greater than demand, the existing of inventory means that the supply and demand curves will never cross.

To summarize, the classic concepts such as laws of supply and demand, market equilibrium, and Marshall's cross diagrams are incompatible with the framework of FEOE. In order to make economics to be truly a science, we must reject the Marshallian framework.

11.3 Indeterministic Supply Demand Pricing Model

Creating marketplaces for voluntary exchanges is one of most important inventions of humanity. Yet it has been very challenging to create scientific descriptions of the market phenomena. If the economics is a branch of physics, FEOE should provide truly scientific descriptions of these simple and fundamentally important economic phenomena. In this section, we will derive a new model called indeterministic supply demand pricing model (ISDP) to replace the framework of laws of supply and demand and market equilibrium.

In the FEOE framework, since the future supply $S(t)$, demand $D(t)$, and prices $P(t)$ are indeterministic, only the joint probability density function $J(S, D, P, t)$ at time t is predictable. With the three margin probability distribution functions for the future supply, demand, and prices, the joint probability density distribution function of $J(S, D, P, t)$ at time t can be constructed as the final forecast by considering all relevant information available.

FEOE offers a straight forward and realistic description of the market price, supply and demand dynamics. The FEOE approach is universally applicable for all markets while the framework of laws of supply and demand and market equilibrium is reserved for some special markets. Laws of supply and demand are valid only in special cases as statistical relationships.

11.4 Rejecting General Equilibrium Theory

While the general equilibrium theory is widely recognized as a landmark achievement by the traditional economic textbooks, the general equilibrium theory requires many strict and unrealistic assumptions like perfectly competitive markets. Despite its historic importance, general equilibrium theory is not compatible with FEOE.

The general equilibrium theory is built upon the concept of market equilibrium. If we reject the concept of the market equilibrium, we must reject the general equilibrium theory.

Inventory, spare capacity, and unemployed labor forces are fundamental features of any market economy. The existence of inventory means supply is always greater than demand. Therefore, in reality, there is no such thing as a general equilibrium characterized as aggregate supply equals aggregate demand.

In the FEOE framework, the general equilibrium theory is replaced by the wealth maximizing principle. At the consumer and corporate level, the primary responsibility of the person who is in charge of a balance sheet is to maximize the net worth of the balance

sheet while keeping potential risks of bankruptcy in check. In the process of pursuing the maximization of wealth, the economy becomes more efficient because the people earning potential is maximized and the costs and wastes are minimized. If the net wealth is maximized for all individual balance sheets in an economy, then the net wealth of the aggregate balance sheet of entire economy is also maximized. Therefore, the aggregate net wealth of the aggregate balance sheet of an economy becomes a fundamental measure of the efficiency of the economy as whole.

The nature of the “invisible hand”, which efficiently organizes the worldwide economic system, has been in great interests to economists since Adam Smith. In physics, there are similar invisible hands in many physical systems. For example, snowflakes are spontaneously self-organized into beautiful symmetric patterns. If money is viewed as the socialized free energy, then two invisible hand phenomena in economics and physics are the same phenomena with similar dynamics. In physics, the “invisible hand” is characterized by the maximization of entropy or minimization of the free energy depending on the boundary conditions. In economics, the “invisible hand” is driven by the maximization of wealth, which is money or socialized free energy.

11.5 Rejecting Rational Choice Theory

The rational choice theory is replaced by a new universal choice theory to be published elsewhere. The rational choice theory works when assuming people are rational. However, the precise scientific definition of rationality does not exist. Taking the travel salesman problem with large number of cities as an example, the extremely rational people could choose the unique optimal solution; average persons could be happy with sub-optimal solutions using approximation methods; less rational people could simply choose a solution randomly. The new universal choice theory based on physics laws of social science is equally applicable to well-educated and extremely rational scholars, average persons, mad people, monkeys, or rocks. After all, studying the behavior of people with mental illness is a well-established medical science.

11.6 Personal Finance

In personal finance, FEOE implies a realistic and scientific sound way to manage financial wealth. Take playing lottery as an example. While many intelligent people refuse to play the lottery, yet nearly all of them are dreaming to be millionaires one day. With FEOE, it is very easy to see why one should play lottery with a limited amount of money because it increases your probability to become a millionaire in your lifetime. However, it does not mean you should spend a lot of money on lottery. As long as the amount is not a significant sum over your lifetime, the financial impact on ones' other activities will be minimum. More importantly, the same logic applies to ones' other economic activities like pursuing a career as a physician, lawyer, trader, investment banker, or CEO, saving, investing, or starting a new business. What FEOE teaches is that the probabilities can be estimated scientifically and that future probabilities can be

manipulated by ones' actions. Therefore, with FEOE, you actually can have a realistic and scientific sound way to become a millionaire or billionaire. It is all in probabilities. Even better this is all physics!

11.7 Consumer Finance

In consumer finance, one of central questions facing banks and other financing institutions is how to predict which customers will voluntarily prepay their debts like mortgages, voluntarily or involuntarily stop paying debt obligations. Analyzing problems with empirical data and FEOE, we reach a surprising conclusion that there is a fundamental limit how well a model can forecast consumers' voluntary and involuntary behavior. This fundamental limit can be traced back all the way to Heisenberg uncertainty principle in quantum mechanics. Therefore, this fundamental limit is important in both physics and economics. The existing this fundamental limit greatly constrains the choice of the forecasting models because any deterministic models like multiple variable linear regression models must be avoided. Details of this research will be published elsewhere.

11.8 Put Game Theory under a New Framework

In game theory, FEOE agrees with many game theory analyses with probability theory. The equilibrium concept in game theory is largely consistent with law of equilibrium. However, FEOE is fundamentally different from traditional game theory. One key assumption of the game theory is the rational choice theory, which is not compatible with FEOE. In the framework of FEOE, the future probability of a game in the real world is precisely defined while it is somewhat arbitrary given in game theories. Therefore, in real life, human and society behavior could be far away from Nash equilibrium solutions proposed by traditional game theory. Take rock paper scissors game. FEOE gives you scientific guidance: 1) People have free wills. Don't be so sure you can guess how others will move. That is laws of physics; 2) On average, you cannot lose if you could use or mimic a quantum random number generator; 3) FEOE assures you that the probability how others moves is precisely predictable. Therefore, the key is to think in terms of probabilities. The same logic applies to other games. Essentially FEOE uses the special version of probability theory to study game theory and equilibrium. Although many economists regards game theory as the theoretical foundation of economics, the difference between FEOE and game theory regarding the future probability shows that FEOE is the true foundation of economics and game theory is an useful analytical tool only when the assumptions are consistent with FEOE. Therefore, the new game theory becomes useful analytics under the framework of FEOE.

11.9 Option Pricing Theory

In financial economics, FEOE is compatible with option pricing theory. However, FEOE is a more general approach than the Black-Sholes formulation. FEOE invalidates the popular Modern Portfolio Theory and Capital Asset Pricing Model. Details will be published elsewhere.

11.10 CDO Pricing Theory

In financial markets, one most difficult problem in recent years is how to price a CDO with mortgage, corporate, or muni bonds. The Gaussian copula pricing models of CDOs were widely blamed as one of the major causes of the great recession. Despite the poor reputation of copula models, FEOE confirms that the copula functions are the correct approaches to the CDO pricing because copula functions are closely related with general JPFDs. However, FEOE advises not to use Gaussian copula in general. There are hundreds other copula and there are many ways to build your own copula functions. This more general approach works well before, during, and after the great recession of 2008. FEOE are useful for other financial market theories like risk management. Details will be published elsewhere.

11.11 Corporate Finance

In corporate finance, FEOE works naturally with balance sheets analysis. The only difference between FEOE and traditional balance sheet analysis is that FEOE emphasizes more on the indeterministic nature of future evolutions of corporate balance sheets.

11.12 Government Finance

In government financing, FEOE sees no difference between public financing and private corporate financing. Strict accounting standards required for most corporations should be required more all government institutions. In terms of fiscal policies, the government budget deficits have been key controversial issues among economists. FEOE and PLSS offer a surprising value-free physics permanent solution to government budget deficit problem. The new solution greatly limits the usefulness of Keynesian active fiscal policies. Details will be published elsewhere.

11.13 Political Economy

In political economics, the public choice theory is generalized into a broad framework of quantum politics, which will be published elsewhere. While quantum politics shares many concerns of conflicting interests of elected public officials with the public choice theory, quantum politics has a more broad scope of replacing the entire traditional political science. In other words, politics is also a branch of quantum physics

like economics and chemistry. Quantum politics largely rejects the constitutional economics as a valid approach. Detailed analysis shows that many key constitutional principles are deeply rooted in laws of physics. The traditional economic approach of the rational choice, incentive, and utility are generally too narrowly focused to be useful for studying the constitutions. For example, the principle of separation of church and state is a reflection of the important relationships between science and religion, which is well beyond the scope of the traditional economics but well within the scope of PLSS.

11.14 Macroeconomics

In macroeconomics, FEOE translates into the Indeterministic Balance-sheet Plus (IBSS+) model [24] and rejects popular DSGE models and Agent-based Computational Economic (ACE) models. FEOE is fully compatible with national account system. IBS+ models can be viewed as a natural extension of current and historic data captured in national account system. Like many models in physics, the IBS+ model is universally applicable in any kind of economy, empirically falsifiable, making forecasts with reasonable accuracy, truthful abstraction of reality, capturing macroeconomic dynamics accurately, and most importantly based on a sound theoretical foundation. Recent experience during the great recessions of 2008 has shown that the accounting models have worked significantly better than DSGE and ACE models.

11.15 Summary

To summarize, FEOE is compatible with many existing economic theories like option pricing theory and national accounting system. FEOE elevates these compatible theories to be permanent features of quantum economics. In other words, these compatible theories will be parts of economic theories forever in the same way the Maxwell equations will be permanent parts of physics. Those questions addressed by these compatible theories should be regarded as settled once for all. One of most important applications of FEOE is to decide whether an economic problem is settled or remains open. After reviewing existing economic theories, FEOE is not compatible with many existing theories like rational choice theory, DSGE models, modern portfolio theory, and general equilibrium theory. These theories incompatible with FEOE will be thrown into historic dustbins. One great strength of FEOE is that not only FEOE attacks the existing economic theories but also one can derive relevant theories from FEOE to replace these abandoned theories. Although many economic theories incompatible with FEOE are very popular among mainstream economists and standard economic textbooks, we must abandon these theories because these are theories that prevent economics from becoming a true science.

12. Concluding Remarks

Since Issac Newton discovered the laws of motion in 1687, for the next 300 plus years, physics has achieved great successes in describing the microscopic world of elementary particles to the large scale structures of the universe. It has become dreams of many generations of social scientists to replicate the success of physics in describing human society. Establishing the JJW interpretation and physics laws of social science are firm steps towards realizing those dreams.

This paper has summarized the logic flow from the creation of JJW interpretation of quantum mechanics and physics laws of social science to their impacts on economics, finance, politics, and other fields of social science, natural science, and theology. Since many applications of PLSS are still unknown, this paper serves as an introduction to quantum social science and its applications. The central ideas of PLSS are very simple, yet it has profound logic consequences on many corners of human knowledge. The main message of this paper is to convey the beauty and simplicity of the framework of quantum social science or psychohistory.

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