Open access • Journal Article • DOI:10.2139/SSRN.2522492

Fundamental Equation of Economics — Source link

James J. Wayne

Institutions: Kean University

Published on: 10 Oct 2013 - Social Science Research Network

Topics: Mainstream economics, Applied economics, Heterodox economics, Complexity economics and Managerial economics

Fundamental Equation of Economics

Wayne, James J.

Lawrence Cedar Housem LLC

10 October 2013

Fundamental Equation of Economics

James J. Wayne
jjwinterpretation@gmail.com

October 10, 2013

Abstract

Recent experience of the great recession of 2008 has renewed one of the oldest debates in economics: whether economics could ever become a scientific discipline like physics. This paper proves that economics is truly a branch of physics by establishing for the first time a **fundamental equation of economics (FEOE)**, which is similar to many fundamental equations governing other subfields of physics, for example, Maxwell's Equations for electromagnetism. From recently established physics laws of social science, this paper derives a fundamental equation of economics, which 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 without any exception. FEOE is a mathematical bridge connecting the current economic reality and all future possibilities. We show that 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 is far more precise and universal mathematical abstraction of economic reality, than the framework of Marshall's laws of supply and demand and market equilibrium, which has been traditionally assumed by most economists as the foundation of economics. With FEOE-based analysis, economics is an exact and precise science just like any other subfields of physics. With restrictive assumptions, FEOE can be reduced to the laws of supply and demand and market equilibrium as special cases of market behavior. FEOE clarifies the widespread confusions among economists regarding the concept of equilibrium and disequilibrium. Because one important conclusion from FEOE is that the conceptual framework of general equilibrium and laws of supply and demand are deeply flawed, those macroeconomic models like DSGE and SL/ML built upon this conceptual framework must be flawed as well, and these macro models are not likely going to work well against the real world economy. A good macroeconomic model should apply FEOE to describe the economic reality and the dynamics of how reality evolves with time. In conclusion, this paper shows that the fundamental equation of economics provides a solid physics foundation for both theoretical and practical economics. Therefore, after establishing the fundamental equation of economics in this paper, there should be no doubt that economics is simply a branch of quantum physics in parallel with chemistry and optics. Over last four hundred years, there are many schools of thought emerged in economics while there is only one school of thought by Newton-Einstein-Bohr survived in physics over the same period. The logic conclusion is that there must be only one school of thought allowed in economics as a subfield of physics.

1. Introduction

Recent great recession of 2008 has pushed many economists *(1, 2, 3)* to re-exam one of the oldest questions in the field: whether economics could ever become a scientific discipline like physics. In most branches of physics, there is a fundamental equation that describes most if not all observed phenomena. In classical mechanics, it's Newton's laws of motion; in electromagnetism, it's Maxwell's Equations. If a fundamental equation of economics could be established for all observed phenomena in economics, it would solve many fundamental and practical issues in the field, and let no doubt that economics is a science or more specifically a subfield of quantum physics.

In this paper, we first introduce the five physics laws of social science as the starting point. Then a **fundamental equation of economics (FEOE)** is derived from physics laws of social science. FEOE is used to clarify many issues regarding the foundation of economics. After pointing out many flaws in the framework of laws of supply and demand and market equilibrium, we use FEOE to establish a more reliable and universal mathematical framework of supply, demand, and market price dynamics. We show that laws of supply and demand and market equilibrium could be valid only as special cases and invalid as generalized market behavior. We pointed out macroeconomic models, which are built on the flawed conceptual framework of general equilibrium and laws of supply and demand, are not going to work well against the real economics. In the end of this paper, since there is only one school of thought existing in physics, if economics is a subfield of physics, we suggest that many current schools of thoughts in economics must be unified into one coherent school of thought.

2. Five Physics Laws of Social Science

The starting point of establishing a fundamental equation of economics is the five physics laws of social science, which have been published elsewhere in a book *(4)* and an academic paper *(5).* 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 Predicting the Future

> 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 constrains, quantum uncertainties in the system will eventually push the system toward equilibrium states.

The explanation and discussion of these five laws can be found in the book *(4)* and the paper *(5).* 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.

3. Derivation of the fundamental equation of economics

In this section, we will derive the fundamental equation of economics from physics laws of social science. The central hypothesis of this paper is that human free will is a quantum phenomenon. Then the human behavior and human society are ultimately governed by the famous Schrodinger Equation *(6)* in quantum mechanics.

If ψ is the wave function for a closed social system, then the future evolution of the wave function ψ is given by the Schrodinger Equation

$$i\hbar \frac{\partial \psi}{\partial t} = H \psi$$

where i is the imaginary constant complex number, $\hbar$ is the Plank constant, H is the Hamiltonian operator.

To apply the regular Schrodinger Equation to describe the human behavior and human society is difficult for a few good reasons:

(1) Each term in is Schrodinger Equation is defined by quantum mechanics precisely. The wave function ψ describes the collective behavior of all elementary particles, and it is not clear at all how to describe the Hamiltonian for such a large system.

(2) Even we know how to write down the Schrodinger Equation for human society, how to solve such monster equation is totally out of question based on the existing

technology. Physicists and chemists have difficulties to solve the Schrodinger Equation for small molecules involving only a few atoms.

(3) In theory at least, one could find ways to simplifying the Schrodinger Equation through approximation. It is not clear how to do so for human behavior and human society.

In short, while we know the regular Schrodinger Equation is the fundamental equation of human society, because each item in Schrodinger Equation has precise definition in physics, we don't know how to apply it to describe the human behavior and human society in practice. In order to create the more useful equation for human behavior and human society, we have to apply the second law of physics laws of social science, which is generalized Born's statistical interpretation.

The second law of physics laws of social science states that 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.

Let φ be the joint probability distribution function, the second law of physics laws of social science translate into the **Fundamental Equation of Economics (FEOE).**

$$\frac{\partial \varphi}{\partial t} = \mathrm{H}\,\varphi$$

Here H is an operator. In principal, for a closed system of human behavior and human society, H operator is precisely defined by quantum mechanics. At this stage, we do not know to define H exactly starting the atomic level interactions. However, we do know that H operator does exist and is uniquely defined because the second law of physics laws of social science. For all practical purpose, as long as H exists and is uniquely defined, we could always construct an approximate H operator from empirical data and physics laws, then compare the forecast against the future outcome. The difference between the outcome and expectation provides the needed feedback to further improve the forecasting models. The initial condition φ(t=0) reflects the existing economic reality.

For most applications of FEOE in economics, we can further specify the joint probability distribution function φ. In economics, we mainly concern about monetary matters. Since money always belongs to somebody, in most applications, the joint probability distribution function φ is simply the joint probability of possible values of assets in balance sheets. Therefore, FEOE describes the time evolution of the joint probability distribution of future valuation of assets and liabilities. The initial condition φ(t=0) reflects the economic reality of the existing assets and liabilities.

FEOE is broadly applicable in wide range areas. Besides economics, FEOE is applicable for all human behavior, nature, and social phenomena. Even though we call the equation as the fundamental equation of economics, it is equally applicable in politics, business and military strategy, sociology, and other field of social and nature science.

In physics, FEOE is a very unusual mathematical equation because the future joint probability φ(t) is not the future reality itself, rather it is the probability distribution of all possible future realities. In other subfields of physics except quantum mechanics, most

fundamental equations like Maxwell's Equation, deal with the measurable reality itself. This explains why economic and social phenomena are so different from other phenomena observed in physical world in everyday life.

4. Questions about Foundation of Economics

4.1 Causality in Economics

In all fields of science including economics, the scientific analysis is about analyzing and discovering the causality relationships. FEOE essentially says that all causality relationships in economics are indeterministic and fundamentally quantum mechanics in nature, that is because human beings have free wills, human free wills are quantum phenomena, and human behavior including economic behavior is indeterministic.

Just like in quantum mechanics, indeterministic causality relationship means that the same cause could produce different effects, and the no cause is needed to have effects. For identical decaying radioactive atoms, while the laboratory environment and initial conditions are the same, the decay time of individual atoms are very different. Radioactive decay is spontaneous and no external causes are needed to have the atom decay. For example, similar things happen in everyday life. Under the same condition, a person could get out of the bed at very different times. Also no external cause is required to have the person get out of bed. Thus human behavior in a fundamental way is the same as the behavior of radioactive decaying atoms.

To summarize, the quantum nature of human behavior demands the description of economic phenomena using the mathematics of probability. FEOE is simply the bridge connecting the current economic reality and all future possibilities.

4.2 One and Only Equation Governs All Observed Economic Phenomena

FEOE reflects most critical and most fundamental features about human economic behavior: human free will is a quantum phenomenon; the causality in social science is indeterministic and probabilistic in nature; human individual and society obey the same set of physics laws of quantum mechanics; the importance of property ownership; the owner of balance sheets generally tend to manage the assets and liabilities to maximize the owner's total wealth and minimize the risks of bankruptcy; the existing economic reality; and the various constrains imposed on the free wills to limit their choices.

FEOE is the mathematical bridge connecting the current economic reality and all future possibilities. One side of the bridge is the current economic reality, which is mathematically organized in terms of balance sheets. FEOE emphasizes the central role of balance sheets in economics. In many fields of science, the complexities of observed phenomena are often reduced to the interactions of basic units. For example, in biology, those basic units are individual cells; in chemistry, the basic units are individual atoms and molecules. In economics, FEOE asserts that those basic units are individual balance

sheets. Because all economic phenomena can be viewed as the interactions of balance sheets, FEOE becomes the one and only one equation needed to describe all observed economic phenomena.

FEOE is equally applicable in both microeconomics and macroeconomics. In microeconomics, the focus is how the individual balance sheet evolves from the current existing state into all future possibilities. Balance sheets analysis is already widely used to study the consumer finance. The central role of balance sheet analysis in corporate finance is unquestionable. In the public sector, the government balance analysis is widely used but often less emphasized. Thus all economic analysis in microeconomics can be easily repackaged in terms of the language of FEOE.

Because both current and future balance sheets have nice properties that can be mathematically combined and divided, the macroeconomics can be viewed as applying FEOE to study the time-evolution of the aggregated balance sheets of key sectors. The usual macroeconomic measures like GDP, unemployment rates, inflation and interest rates can be viewed as key secondary parameters. The FEOE's approach to macroeconomics puts equal emphasis on the stock and flow while traditional macro-analysis puts more emphasis on flow.

It's important to note that FEOE can be different from traditional balance sheet analysis because FEOE emphasis the existing economic reality, indeterministic nature of causality relationships, the central roles of free wills in the decision making, future uncertainties, and the use of joint probability distribution function to describe the future possibilities. For example, tradition balance sheet accounting analysis uses largely arithmetic while FEOE employs probability distribution function as its main mathematical language.

4.3 Economic Forecasting

Historically, economic forecasting has been a major source of embarrassment for professional economists. The famous quote "the only function of economic forecasting is to make astrology look respectable." is very accurate description of the state of arts of the profession.

One contribution of FEOE and physics laws of social science is to clarify the most important question in economic forecasting: what can be forecasted and what cannot be forecasted in economics. The precise which event will happen cannot be forecasted while the probability of the future events can be precisely forecasted at any moment. That is exactly what happens in quantum mechanics. In quantum physics, the precise timing when a radioactive atom will decay cannot be forecasted while the probability of the decay time can be precisely forecasted and checked with experiments.

Many economists devoted their lifetime forecasting precisely the next unemployment rates or the upcoming year end stock price. Their work is no longer scientific and no better than astrology because physics laws of social science states that only the probability distribution of the next unemployment rate or the year end stock price can be precisely forecasted.

Another contribution of FEOE is that FEOE provides the universal starting point and the framework for all forecasting in social science. In traditional economic forecasting, various forecasting methods are used by practitioners. Different methods

often produce different answers. For example, to forecast the year end stock price, one could use linearly extrapolate, different moving averages, fundamental valuation, technical analysis, supply and demand analysis, surveying experts, or even trying astrology. FEOE sets a much higher standard for choosing the forecasting methods. The acceptable model in social science must to be a physics model based on the mathematic abstraction of reality and laws of physics. In astrophysics, to forecast the future motions of planets in the solar system, the acceptable physics models must apply the Newtonian laws of motion and law of gravity or other closely related theories like general relativity. Even though astrology might make the correct forecasting of the star movement, it still does not make astrology as an acceptable scientific model.

4.4 Role of Empirical Data in Economics

Economics is often advertised as an empirical science, and what economists really mean is that only economic models built upon historic empirical data are acceptable. FEOE rejects the fundamental role of empirical data. At the top level, only the initial condition and FEOE are needed for forecasting. Therefore, at the top level, the empirical data are actually irrelevant.

In most sub-fields of physics, the historic data are usually irrelevant. To forecast the future motions of planets around the sun, only the initial condition of planets and laws of physics are needed. The historic data are not required. Although historic empirical data could be useful to back-test the forecasting model, that importance is secondary. At the top level, the historic data has no use and not required in all fields of physics, which must include economics.

The emphasis on the initial condition and laws of physics instead of empirical data is very important because it brings economics up to the same playing level as other fields of physics, and force economists to focus on the future instead of interpreting what happened in the past. There is a widely shared believe among economists that their main job is to interpret the history instead of forecasting the future. In contrast, the main tasks of scientists in most other subfields of physics are to forecast the future instead of interpreting the past.

In practice, empirical data are critical for calibrating and back-testing the forecasting models. When empirical data are used, we are assuming the history will repeat itself in some fashions. In social science, because people have free wills, there is no guarantee that history will repeat itself. Figuring out what will repeat in the future is the heart and soul of the FEOE-based economic analysis.

4.5 Money as Socialized Free Energy

Money plays the central role in FEOE. It brings up the most important question in economics: what is the money? Traditional economics textbook *(7)* often simply defines money as the exchange medium. From the physics and FEOE point of view, money is more properly viewed as the “socialized” form of free energy. There are several reasons why money plays the role of “socialized free energy” in the human society.

(1) The second law of thermodynamics dictates that the continuous inflow of free energy is essential for sustaining all human activities. There are many different forms of free energy are used in human societies: manual labor, food, oil, electricity, heat, natural gas, solar energy, nuclear, and other forms of energy. While money itself is not a form of free energy, money can be used to buy real free energy in order to sustain human activities. Because there are many forms of free energy in the human society, money is created to play the role of universal and "socialized" free energy. Without money to buy free energy, almost no social activity can be sustained.

(2) Looking beyond human societies, free energy flow is usually the defining factor of many biological, ecological, and physical systems. More interestingly, many systems employ their own unique universal free energy units. For example, ATP molecules are the official providers of free energy for biochemical reactions in cells insider human body. Edible food is the official carrier of free energy for the ecosystems like Everglades National Park in Florida. Animals could flourish with ample amount of food and also could perish for lack of foods. In human societies, money is created to play the role of universal and "socialized" free energy. Each balance sheet grows or shrinks because of the flow of money. Cities, factories, and families could flourish with available large amount of money and also could perish for lack of money.

(3) In traditional economics, natural resource, labor, and capital are key factors of production. Free energy is the ultimate limiting factor of economic activity because the law of energy conservation dictates that the available free energy cannot be created or destroyed arbitrarily. In the FEOE framework, real free energy and capital plays more fundamental role in human activities.

(4) In both quantum mechanics and Newtonian physics, Hamiltonian is defined as some forms of free energy. If money is "socialized" free energy, FEOE brings the economics analysis in line with other branches physics. FEOE is an equation governing about how "socialized" free energy evolves with time.

(5) In physics, minimizing or maximizing the free energy is often the key organizing feature of an equilibrium state. In economics, the maximizing the wealth of balance sheet is the key to optimize the economic structure.

4.7 Invisible Hand and Maximization of Wealth

The nature of the "invisible hand", which efficiently organizes the worldwide economic system, has been in great interests to economists. 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 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.

In economics, 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 for 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 aggregated balance sheet of entire economy is also maximized. Therefore, the aggregated net wealth of the aggregated balance sheet of an economy becomes a fundamental measure of the efficiency of the economy as whole.

4.8 Value-Free Economic Analysis

Historically one of the dreams of economic professionals has been to have value-free economic analysis. In practice, however, opinions from economists often divergent widely even with the same set of identical publically available data. The reason is that different people uses different methods of analysis.

It is not controversial to separate the normative economics from the value-free analysis of positive economics. How to conduct the value-free analysis is an open question. For the same public data set, the opinions vary is because economists are using different starting points, methodologies, and assumptions. For example, at this point of writing this paper, what the future of Chinese economy will be in the next few years is very controversial even though the public data available about Chinese economy is more or less the same.

FEOE provides a reliable and universal approach to economic forecasting. FEOE analysis is inherently value-free because it starts with economic reality and applies laws of physics and causality relationships for economic forecasting. Economic reality and laws of physics are independent on passive observers. Causality relationships are based on logics and empirical data. The variation of economic forecasting depends on the approximations and assumptions. Law of Predicting the Future demands the forecasted joint probability distribution to be unique. Therefore, there must be some correct ways to make the assumptions and approximations. FEOE puts tight constrains on approximations and assumptions.

4.9 Reality-Based Economics

Central criticism of existing economic theories are that many existing theories requires unrealistic assumptions: people with perfect rationality, perfect competitive market, market equilibrium, perfect information, maximizing of profits, efficient financial market, no transaction costs, and many others. FEOE uses none of these assumptions. FEOE only works when dealing with reality because physics laws only applicable to physical reality. In imaginative worlds like video games or fairy tales economic theories, physics laws cease to work. In practice, reality is often complicated.

Simplification and approximation are essential and often made through insights gained through research. For example, the super-conducting phenomena in physics are too complicated to be understood by applying first principles of quantum mechanics. Through a brilliant insight, BCS theory was proposed for traditional superconductors. BCS theory is an example of good theory that balances between laws of physics and simplification of reality. In the end, whether simplification and assumption are good or not is judged by the accuracy of forecasts, accuracy of estimating uncertainty, and the correct capture of dynamics.

5. Flaws in Framework of Laws of Supply and Demand and Market Equilibrium

5.1 Flaws in Laws of Supply and Demand

Although it is has been widely recognized as the foundation of economics, the framework of laws of supply and demand and market equilibrium is deeply flawed. Laws of supply and demand are not fundamental laws of physics for several reasons:

(1) Because physics is a precise science, all variables referred in laws of physics must be precisely defined. The quantity of supply and quantity of demand are hard to define precisely. Potential demands are not directly observable by definition in the market places because potential demand implies the psychological states of minds of potential buyers, which could change at any moment at consumers' free will. There could be many measures to gauge the potential buyers' interests. However, law of supply and demand does not state precisely how to quantify the amount of demand. Take the US housing market as an example, the amount demand can mean many things: the number of households showing interests in purchasing houses in consumer survey, the number of households showing interests and financially prepared to purchase a house, the amount foot traffic to open houses and local sell offices, the legally-binding bids received for houses listed for sell, the mortgage applications for purchasing houses, and the number of houses sold in a given period. While all these measures are good indicators of the amount of demand in the US housing market, none of them can measure precisely the amount of potential demands at various price levels.

(2) Laws of physics must be always true. Even when the potential supply and demand could be approximately measured, the laws of supply and demand are not always true. During the housing booming years of 2004 and 2005, when the housing prices were soaring, the demand interests measured by various indicators are also soaring. Yet when the housing prices plunged in 2008 and 2009, the demand indicators also plunged. In other words, the observed housing prices were positively correlated with the consumer demand. This empirical observation contradicted the laws of demand. In everyday life, most prices of goods for sell in supermarkets, retail stores, and restaurants are often fixed regardless the amount of short-term supply and

demand. For example, the prices of hamburgers in McDonald Restaurant do not automatically change, simply because there are more peoples are standing in the line and waiting. Therefore, unlike universal applicable laws of physics, laws of supply and demand are not always true.

(3) Laws of supply and demand incorrectly specify causality among supply, demand, and price three variables. In reality, these three variables inter-depend on each other without any simple, clear, and universal-applicable dependence. Future supply is a function of production feasibility constrained by reality, and past, present, and future expectations of demand and price; future demand depends on recent demand history, and past, present, and future expectations of supply and price; future prices are determined by the pricing mechanism, pricing history, and past, present, and future expectations of supply and demand. Because buying and selling houses are one of the biggest financial decisions for US consumers, potential sellers and buyers of courses will use all information available to them in order to make sound decisions.

(4) Laws of supply and demand deny that people have free wills. Law of demand states that with everything else fixed, when price rises, the demand falls. However, if buyers have free wills, they don't always have to react passively, rationally or mechanically according to any price change. Therefore, laws of supply and demand directly contradict with physics laws of social science and are fundamentally wrong.

To summarize, the laws of supply and demand are not laws of physics. In order to make economics a real science, the laws of supply and demand must be abandoned as the foundation of economics.

5.2 Inconsistency in the Concept of Market Equilibrium

While equilibrium is one of most important concepts in economic, there are many definitions of equilibrium depending on different branches of economics: perfect competition, general equilibrium theory, macroeconomics, game theory, and financial market theory. There are many controversies surrounding how to apply the equilibrium concept in the real market places. For example, during the 2003 and 2013, the WTI crude oil spot price changed significantly from $20's in 2003 to peak $140's in 2008, then back to $30's in early 2009 during the great recessions, and to $100's in late 2013. What is the market equilibrium of WTI oil price during that ten-year period? Are all daily closing prices market equilibrium prices because they were results of balancing the daily supply and demand? In macroeconomics, was the overall market in general equilibrium before, during, or after the great recession of 2008? In financial markets, is the financial market always in equilibrium all the time?

Statistical physics has its own definition of equilibrium, which has been applied so successful that the concept of equilibrium has become a corner stone of modern physics. However, to many physicists, since market places and human society in general

are phenomena of far from equilibrium, they believe that it is a mistake to apply the concept of equilibrium to study the market dynamics and human societies.

In short, from statistical physics to different branches of economics, there is no consistency about the concept of equilibrium. This paper asserts that economics is a subfield of physics. There must be a single universal definition of equilibrium applicable to all branches of economics and physics.

5.3 FEOE Analysis on Supply, Demand, Price, and Market Dynamics

In this section, we apply FEOE to construct a new universal framework of supply, demand and market price without laws of supply and demand and market equilibrium. We use the US housing market as an example. The framework presented here is applicable to all other markets.

In the FEOE framework, since the future supply (S), demand (D), and prices (P) are indeterministic, only the joint probability density function J(S, D, P, t) at time t is predictable.

The future supply S(t) has its own supply dynamics. The exact future supply is not predictable and only the probability distribution of supply is predictable. It depends on all factors related to future production including past, present, and future expectations of demand and price. In the US housing market, the housing supply comes from the new and existing home sells as well through the banks' and mortgage servicers' foreclosure, short-sells, and REO process. The housing supply dynamics changed dramatically before and after the 2008 great recession. It confirms the notion that it is impossible to forecast the future housing supply exactly.

The future demand D(t) has its own market demand dynamics. The exact future demand is not predictable and only the probability distribution of potential demand is predictable. It depends on all factors influencing consumer demand. In the US housing market, the housing demand depends the strength of overall economy, consumer confidence, mortgage financing, and recent housing price history whether it's bull or bear market. Consumer demand is very sensitive to consumer psychology.

The future price P(t) also has its own pricing dynamics. The exact future price at time t is not predictable and only the probability distribution of price is predictable. It depends on the pricing all factors related to future pricing including past, present, and future expectations of supply and demand. In the recent US housing, the housing prices went through a bull market between 1999 and 2006, a bear market from 2006 to 2012, and a recovery in 2012 and 2013. The experience by most housing market analysts during the great recession is that the housing market is largely unpredictable exactly. Despite it great importance of the US housing market, there were virtually no analyst in 2006 would foresee the US housing prices would drop 30% or more in the next three years.

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.

5.4 Concept of Market Equilibrium in FEOE

In the FEOE framework, market equilibrium is defined as the future joint probability density distribution function is independent of time, i.e., J(S, D, P) valid for all time t instead of time-dependent J(S, D, P, t). This definition is an application of law of equilibrium of physics laws of social science. It is one universal definition applicable to all fields of physics including all fields of economics.

In the FEOE framework, the markets in general are not in equilibrium. Markets in equilibrium are special cases where the supply, demand, and price are range-bound and stable. The equilibrium analysis is useful as a tool for the long-term forecasts. Equilibrium analysis should be only used when the real market is in equilibrium in the first place.

5.5 Derivation of Laws of Supply and Demand from FEOE

The tradition framework of laws of supply and demand and market equilibrium is a special case of FEOE and can be derived from the framework of FEOE.

There is a relationship between the average supply <S> and price P. For given price P and time t,

$$< S > = \iint S\, J(S, D, P, t)\, dSdD \;/\; \iint J(S, D, P, t)\, dSdD$$

The average supply and price relation is similar to law of supply except that here supply curve could take any shape depending on the market condition. For example, in the US housing market, at the December of 2006, if the housing market was forecasted for the end of 2008, if the housing price continued to rise relative to 2006, the supply curve would be positively sloped; however, if the housing price dropped, the supply curve would be negatively sloped because the rise of housing supply due to the foreclosure and short sells.

Similarly, there is a relationship between the average demand <D> and price P. For given price P and time t,

$$< D > = \iint D\, J(S, D, P, t)\, dSdD \;/\; \iint J(S, D, P, t)\, dSdD$$

The average demand and price relation is similar to law of demand except that here demand curve could take any shape depending on the market condition. For example, in the US housing market, at the December of 2006, if the housing market was forecasted for the end of 2008, if the housing price continued to rise mildly relative to 2006, the demand curve would be negatively sloped; however, if the housing price dropped, the demand curve would be also positively sloped because the unusual severe recession and the bearish housing market could easily scare buyers away.

To summarize, 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.

6. Flaws in Macroeconomic Models Based on General Equilibrium

From FEOE analysis of the market price, supply and demand dynamics, we have concluded that markets in general are not in equilibrium, and laws of supply and demand are poor description of the general market behavior. Unfortunately many macroeconomic models are built on the central idea of general equilibrium, aggregated supply and aggregated demand, and laws of supply and demand. These models are deeply flawed for several reasons:

(1) The main objective of macroeconomic modeling is to forecast the short-term economic fluctuations and long-term growth potentials. If the main tool is based on the concept equilibrium where everything variables is static or close to static, it's not a coherent picture of economic reality. It should be obvious to any observers that a growing economy is not in equilibrium in the long run, and economics suffering boom or bust cycles is not in equilibrium in the short run. If the real economic are not in equilibrium, the equilibrium based models are not likely to work well.

(2) The general equilibrium theory generally ignores the economic reality by assuming perfectly competitive markets. In reality, few markets can be described as perfectly competitive or in equilibrium. For example, US housing market, a key consumer market, does not remotely fit with the idealized competitive market or in equilibrium.

(3) A good macroeconomic model should be built on economic reality and how economic reality evolves in the future. In FEOE framework, the economic reality is the balance sheets of the existing economics. General equilibrium macroeconomic models generally ignore the balance sheets of the existing economics. For example, how many macroeconomic models built in toxic CDOs and the high leverage of Wall Street banks before the great recession of 2008? Without examining the balance sheets of high tech firms and telecom industries at 1999, how could macro models built in the over investments during the dotcom boom. Without looking at the subprime mortgage quality at 2006, macro models are unlikely to forecast the massive defaults in the following years.

(4) A good macroeconomic model should describe correctly the key economic dynamics. General equilibrium macroeconomic models built upon the flawed idea of laws of supply and demand. It is important to realize that laws of supply and demand sometimes work and sometimes do not work. For example, many economists have warned the runaway inflation after the great recession of 2008 because the excessive money supply by the Federal Reserve. It did not happen that way. The excessive money supply produced below average inflation. In this case, the law of supply did not work. A reliable macroeconomic model cannot start with sometimes very shaky.

In conclusion, a good macroeconomic model should be built on rock solid foundation of FEOE, and it deals with the economic reality instead of the unreliable framework of law of supply and demand and general equilibrium. Law of supply and demand and general equilibrium are not necessary to macro models, and do not add anything new insights to understand how macroeconomic works. The applications of FEOE to build macroeconomic models for the Chinese economy and US economy will be published in other papers.

7. Unifying Different Schools of Economic Thoughts

In last four hundred years, different approaches to economic problems have created many different schools of economic thoughts. In comparison, over the same time period, there is only one school of thought survived the endless experimental tests in physics, which is the Newton-Einstein-Bohr physics.

One key assertion in this paper is that economics is a branch of quantum physics like chemistry and optics. The logic conclusion is that different schools of economic thoughts must be unified into one single framework of Newton-Einstein-Bohr economics. Nobody is entitled to their own physics or economics.

Many economic problems are about "what ought to be done". Normative economics is often involves the value-based arguments. It is important to realize that the value-based arguments will be never totally replaced by science. In physics, engineering problems cannot be solved completely by value-free science. In that sense, the different schools of economics could still exist as different philosophical schools of values in the future.

8. 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 physics laws of social science and fundamental equations of economics are firm steps towards realizing those dreams. These papers are just the very beginning. There are many questions remaining to be answered. For example, the mathematics of joint probability distribution functions is exceedingly complicated and challenging when many assets are involved. The science and art of making approximations and simplifications remains largely unexplored.

9. Reference and Notes

1. Paul Krugman, 2009. "How did Economists Get it So Wrong?", New York Times Sunday Magazine September 6, 2009
2. Mark Buchanan, 2013. "Is Economics a Science or a Religion?", Bloomberg View July 17, 2013
3. Alex Rosenberg and Tyler Curtain, 2013, "What Is Economics Good For?", New York Times August 25, 2013

4. James J. Wayne, 2005. “Physics Laws of Social Science”, Lawrence Cedar House
5. James J. Wayne, 2013. “Physics Laws of Social Science”, Working paper, Munich Personal RePEc Archive, 47811
6. Leonard I. Schiff, 1968. “Quantum Mechanics”, McGraw-Hill Companies
7. Robert H. Frank & Ben S. Bernanke, 2003. “Principles of Economics”, Irwin/McGraw