

NSF Proposal

Title: Foundation for Economics and Social Science: Infinite Spreadsheet, Solution of Value, for Analysis of Current Financial Crisis

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Project Description

I. Objectives for the period of the proposed work and expected significance

A mathematically rigorous solution of value would be a non-violable law of nature in social science, as gravitation is a non-violable law of nature in physical science. Non-violable laws of nature would define the limit of freedom for the Free Market and would replace man-made regulations, which are not based on the laws of nature and, thus, would come into conflict with the non-violable laws of nature.

This research proposal will introduce several possible non-violable laws of nature, in particular, a mathematically rigorous solution of value, where the problem of value is mathematically described in the book *Theory of Value* by Gerard Debreu [Ref. 1]. It will study, from the point of view of the non-violable laws of nature, the recently passed HR 4173: Dodd–Frank Wall Street Reform and Consumer Protection Act [Ref. 2]. The Free Market, advocated by the late Milton Friedman, would be free only within the limit defined by non-violable laws of nature in social science, as material objects are constrained by non-violable laws of nature in physical science. A fundamental question to be studied in this research is: Should social science be dealing exclusively with these non-violable laws of nature in social science, as physical science deals exclusively with laws of nature in physical science? The number of man-made laws in science is exactly zero.

This research on the solution of value will be guided by the fundamental similarity and difference between science and social science. Science depends on empirical verification. Value is defined as the sum total of all the benefits and losses extended to infinity in time. Since infinity never arrives, the correctness of a value or a price cannot be empirically verified. The solution of value, which can be considered the foundation of social science, depends on mathematical rigor, which is more stringent than the rigor of empirical verification. This research speculates on the claim of mathematical economics that economics should satisfy the rigor of mathematics.

On July 21, 2010 President Obama signed into law the most sweeping reforms of Wall Street since the Great Depression. The reforms attempted to reverse the trend of deregulation, which had dominated the world economy for last few decades, under the intellectual leadership of the late Milton Friedman, the Champion of the Free Market. The new Financial Reform Law, HR 4173: Dodd–Frank Wall Street Reform and Consumer Protection Act, is just a shell; what's in the shell will be decided in the coming months or even years. The question to be addressed in this research will be: Should the world economy moving from the Free Market of Milton Friedman into a Post-Friedman economy based on non-violable laws of nature or back to a Pre-Friedman economy based on man-made regulations?

This proposed research is not in agreement the Free Market, for freedom should be exercise only within the limit of freedom, which the reforms proposed by the Act or non-violable laws of nature in social

science are attempting to define. To be free, one must first know the limit of freedom. In social science, the limit of freedom is, according to the PIs of this research, defined by non-violable laws of nature in social science and should not, as argued by the Free Market, be defined by man-made regulations. This proposed research will verify the man-made regulations in the Act against corresponding non-violable laws of nature and will investigate the historical trend that the world economy has been for the past several decades changing from man-made regulations to the Free Market, promoted by the late Milton Friedman, and is again moving back to man-made regulations, after the failure of the Free Market in the recent financial crises.

The Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 (the Act) is, as described by its authors, Dodd and Frank, “a bill to promote the financial stability of the United States by improving accountability and transparency in the financial system, to end ‘too big to fail’, to protect the American taxpayer by ending bailouts, to protect consumers from abusive financial services practices, and for other purposes.”

Even the above summary statement of the Act can have three different interpretations from the perspectives of the Act itself, the Free Market, and non-violable laws of nature. The Act tries to prevent future financial crises by restricting economic freedom through regulations. The Free Market believes financial stability, accountability, transparencies, consumer protection, and restrictions on “too big to fail” are naturally achieved in a free and unregulated market. The non-violable laws of nature agree that there are laws or regulations, but, as in science, these laws of nature should be discovered, not man-made. The Free Market implies that it is better not to regulate than to regulate with the wrong regulations. It is doubtful that the regulations in the Act fully correspond to non-violable laws of nature. This proposal will introduce several logically or mathematically rigorous relationships or laws, which constrain our economic behavior.

In particular, a mathematically derived solution of value can achieve financial stability by detecting over-valuation, give accountability and transparency by the full disclosure of all the relevant factors to infinity in time and space, and protect consumers by disclosure all the future consequences to infinity. It also exposes that “too big to fail” is a political, not economic, problem. Due to the high-risk and high-return, around 40%, of small business based on the survey of the solution of value, only one out of one hundred businesses survives after fifteen years or one out of five in five years. Big businesses have the advantage of political lobbying, which wins them political favors to cover up their weaknesses and to stretch their survival duration. From the point of view of the Free Market, the biggest too big to fail is the government or its agencies. In sum, the solution of value should be incorporated into the Act, or, as suggested by the defenders of the Free Market, the Act or any man-made regulation is not necessary.

One of the most important practical issues to be debated in this research will be the policy on rating agencies in the Act, which contains just little over one page in the Act. The immediate answer to the question on rating and up and down grading of stocks in this research is to replace them with valuation with full disclosure and full accountability. This answer will surely be intensively debated in the coming months.

Another issue is on the determination of insurance premiums and uncovered calls or insurance. The existing actuarial analysis, which are suitable for determining the premiums for insuring accidents, must be modified to insure financial instruments, which has a define structure. For example, insurance premiums for market backed securities should be inversely proportional to the equity.

This research will investigate the cause and the cure of the recent financial crisis. It will introduce a Two-Valuation Reform based on a mathematically rigorous solution of value [Ref. 3], which can

determine a price independent of the market price, and an explanation of real estate business cycle as methods of prediction and prevention of future financial crises. The solution of value can determine the rate of return on investment, which is central to setting the interest rate in the logical economic relationship, Rate of Return > Interest Rate. Also to be studied is the Fisher Identity or the Quantity Theory of Money [Ref. 4], namely, $PQ = VM$ (Price x Quantity = Velocity of Circulation of Money x Money Supply), which closely related to the cause and the cure of the current financial crisis.

Federal Reserve Chairman Bernanke stated in the conclusion of his 2009 AEA speech [Ref. 5]“...**interest rate increases in 2003 or 2004 sufficient to constrain the bubble could have seriously weakened the economy...**” If “2003 or 2004” is replaced by “2005 and 2006”, it would become clear that it was the raising of the fed fund rate during 2005 and 2006, not the period of low fed fund rate during 2003 and 2004, that caused the over-valuation. Had the interest rate been lowered in 2006, the Subprime Woe and the entire financial crisis, which was ignited by the Subprime Woe, might be avoided or, at least, delayed.

Bernanke objected to the Taylor Rule [Ref. 6] for setting the fed funds rate in his 2009 Speech. The Taylor Rule should be replaced by the common sense logic relationship:

Rate of Return > Interest Rate > Inflation,

where the Rate of Return can only be surveyed with the availability of a deterministic valuation system applied to sales data to determine the Return.

Also, a Two-Valuation Reform can be introduced as part of the content for the newly passed financial reform law. The Two-Valuation Reform is based on the simply equation

Bubble = Market Price – Intrinsic Value,

where the Market Price is obtained from market comparison to the past sales data, and the Intrinsic Value is calculated based solely on the realistic accounting of future expected cash flows, **Cash Return = Sum of Cash Flows + Cash From Resale**, completely independent of the Market or Resale Price. The introduction of the Intrinsic Value is crucial in consumer protection, which is probably the most important point in the new financial reform law. The mathematically rigorous solution of value strongly suggests the existence of non-violable laws of nature in social science, as the existence of non-violable laws of nature in science, such as gravitation.

The financial reform should also reexamine the Fisher Identity or the Quantity Theory of Money $PQ = VM$, which has been extensively analyzed by Milton Friedman and Ben Bernanke, and where the variable P again involves the fundamental question of determining the correct price, and its role in the current crisis and in the prevention of another Great Depression. The approximately time-invariant nature of the Velocity of Circulation of Money V will be investigated.

From International Valuation Standard 201.01 [Ref. 7], Fair Value under International Financial Reporting Standards is quoted below:

“Valuation Hierarchy

7. The Exposure Draft includes a “Fair Value Hierarchy” that classifies valuations according to the nature of the available inputs. In summary, the three levels of the

hierarchy are:

- Level 1 inputs are “quoted prices (unadjusted) in active markets for identical assets or liabilities that the entity can access on the measurement date”.
- Level 2 inputs are “inputs other than quoted prices included within Level 1 that are observable for the asset or liability, either directly (ie, as prices) or indirectly (ie, derived from prices)”.
- Level 3 inputs are “inputs for the asset or liability that are not based on observable market data (unobservable inputs)”.

Level 1 valuation can be used when the economic condition or future expectation remains constant. However, without a rational method to determine the first price, with which other prices are compared, the market comparison method would just be the “blind following the blind.” In a financial crisis, blind investors follow blind investors until all fall off a cliff, which in the Subprime Woe was create by the rapid raising of the interest rate by the Federal Reserve.

Level 2 valuation corresponds closely to the solution of value, where in the Infinite Spreadsheet [Ref. 8], the “observable” is replaced with the precise description of “market comparable,” and the price is calculated from the inputs, all of which are obtained from market comparison.

Level 3 valuation describes a non-deterministic system, which might correspond to the valuation of innovations or new knowledge discoveries. It suggests that funding or award agencies should neither dictate the fields of research nor select particular researchers to discover new knowledge, for new discoveries are unpredictable; funding should be done for research on applications of knowledge after the knowledge is discovered, and awards should be given after the achievement of the discovery to encourage future knowledge discoveries.

II. Relation to the present state of knowledge in the field, to work in progress by the PI under other support and to work in progress elsewhere

Market Price versus Investment Analysis

Historically, the market price generally oscillates up and down, and when the amplitude of the oscillation becomes intolerably large, the market crashes, and a financial crisis occurs. Generally, as shown in the following picture (Figure 1), a trend line, shown in red, can be drawn through the curve for the market price, shown in black.



Figure 1 Pictorial Representation of Market Price and Intrinsic Value or Natural Business Cycle

An appraisal determines the market price. An investment analysis determines a price which is independent of the market price and is based on the economic condition. Thus, the price determined by investment analysis does not have to agree with the market price. When correctly determined, the price

determined by investment analysis, which is completely independent of the market price, should resemble the red line, which eliminates partly or all the unnecessary oscillations in price.

Rationally, a complete valuation should contain both prices, namely, the market price and a price determined by investment analysis. And in a rational society the market price will be determined by market participants using a correct solution of value, for example, the Infinite Spreadsheet, which will be explained in a later section, and will, thus, be the same as the price determined by investment analysis.

In conclusion, our solution to prevent future financial crises is to have two valuations, one for the market value and the other for the intrinsic or investment value, where over-valuation is defined by the simple equation

Financial Bubble = Over-Valuation = Market value – Intrinsic value.

Discounted Cash Flow Method (DCF Method) and market comparison will be used to determine the market value. Being a hybrid of income and market approaches, which is still non-deterministic or arbitrary, DCF Method can be used to shed light on the intrinsic value. The Infinite Spreadsheet will be used to calculate a deterministic intrinsic value based on inputs, which are all expressed as approximate time-invariant quantities and, thus, can all be obtained from market comparison.

Practically, there are no need two valuations, one to satisfy the intention, right or wrong, of the buyer and the seller, plus the law, namely, FIRREA (Financial Institutions Reform, Recovery and Enforcement Act of 1989) [Ref. 9] , and the other to satisfy the non-violable law of nature in the form of the mathematically rigorous solution of value. The law of nature constrains our behavior in a way such that if we arbitrarily name the price, the law will calculate the return. Most financial crises are caused by wrong price and intolerably low return. Discounted Cash Flow Method and the Infinite Spreadsheet together can provide the gradual transition from the current “free market” to a free market, which observes non-violable laws of nature in social science, as well as in physical science.

There needs to be a process and standards established for the support of the underlying assumptions of valuation. This is going to be the key to establishing credibility in the concluded value estimate.

The main problem with DCF Method is the resale price, which can make an investment look good or bad by moving it up or down. Worse, in the DCF Model, using a finite spreadsheet, the rate of return and, therefore, the price go up and down with the resale price. Under a stable economic condition, the price and the expected return should go in the opposite directions. The finite spreadsheet is the cause of the Finite Spreadsheet Instability, which drives all the business cycles, causes market crashes, and leads to financial crises.

The following is a brief description of the Infinite Spreadsheet Valuation System from the point of view of Discounted Cash Flow Model, the current standard of real estate software.

Understanding the Infinite Spreadsheet from the point of view of Discounted Cash Flow Model

To determine the price Discounted Cash Flow Method calculates the cash flows during the holding period and the cash received when the investment is resold. All the cash flows are discounted back to the present with one or more discount rates.

To determine the price, the Infinite Spreadsheet accounts the cash flows realistically forward, with the cash flows grow with a reinvestment rate. And when the investment is resold, the cash received from the resale is realistically calculated, based on a yet-unknown resale price. All the cash flows and the cash from resale are accounted forward as would be in an accounting system.

DCF Method assumes a resale cap rate, which gives the resale price needed to determine the cash from resale. Also, terminal value calculation can eliminate the need to assume a resale price.

The Infinite Spreadsheet determines the resale price by going through exactly the same process outlined above for determining the price. And the same process for determining the price is used in all the resale prices to infinity in time.

The equation used in the Infinite Spreadsheet is:

$$\begin{aligned} \text{Cash Return} &= \text{Sum of Cash Flows} + \text{Cash from Resale} \\ &= \text{Initial Investment} \times (1 + \% \text{Rate of Return}) \text{ to the power of holding period} \end{aligned}$$

A similar equation for determining the resale price for a future buyer when it is resold is of the exactly the same form, which introduces an additional resale price for the future buyer. Thus, each time an additional equation is introduced, a new resale price is added. Either this process continues to infinity or the investment is completely used up somewhere along the process, in which case considering to infinity is no longer necessary.

Mathematically, the problem of the Infinite Spreadsheet can be expressed as:

$$P_0 = P_0(P_1(P_2(P_3(P_4(P_5(P_6 \dots (P_n(P_{n+1} \dots (P_{\text{infinity}})) \dots))))))$$

which simply says that the price P_0 depends on P_1 , and P_1 depends on P_2 , so on and so forth to P_{infinity} . Another way to say it is that if P_n is known P_{n-1} can be determined. For example, if P_2 is known, P_1 can be determined, and if P_1 is known, P_0 can be determined.

What the above analysis says is that the calculation should start from a resale price in the distant future and work backward in a time-reversed fashion. The distant future can be as far as one wants, within the computing power. Thus, in principle, the entire infinite spreadsheet can be made mathematically rigorous. In practice, most investors are no longer interested or known sufficiently accurately what happens after a certain time in the future, and an equivalent stable financial condition can be assumed for determining the first resale price in the distant future to be calculated. An approximate valid condition $P_i/P_j = N_i/N_j$ where P_i is the resale price in the year i , and N_j is the net income in the year j . The validity of the condition $P_i/P_j = N_i/N_j$ is still under intensive study by the PIs of this proposal.

The equation $P_i/P_j = N_i/N_j$ provides the additional equation needed to make the number of equations and the number of unknown prices equal. However, the first calculated resale price generally has to be calculated by iteration. In the iteration, a trial resale price is picked, and using the trial price, the rate of return is calculated. If the calculated rate of return does not equal to the given rate of return within a pre-assigned accuracy, another trial resale price is picked, and the return is again calculated. This process continues until the calculated rate of return falls within the accuracy required, and the trial resale price is the resale price.

THE ABOVE VALUATION BY THE INFINITE SPREADSHEET IS BASED SOLELY ON EXPECTED FUTURE CASH FLOWS AND IS COMPLETELY INDEPENDENT OF THE MARKET

PRICE, WHICH IS NEVER USED OR COMPARED IN THE VALUATION. ALL THE INPUTS OF THE INFINITE SPREADSHEET ARE OBTAINED FROM MARKET COMPARISON.

III. Relation to longer-term goals of the PI's project

New Mathematical Foundation of Economics Based on Value and Time-Invariant Laws of Nature

The current financial crisis provides an opportunity to reexamine the fundamental principles of our economy. The next six months to a year will be the most crucial period in the financial crisis debate. Both principal investigators of this proposal have been heavily involved in financial crisis debates since the Savings and Loan Crisis and have correctly predicted the crisis. Hugh Ching predicted the Subprime Woe in June of 2006 based on his solution of value, which corrects the unrealistic infinite holding period on page 34 of the book *Theory of Value* by Gerard Debreu with a finite holding period, in a comment to Chairman Ben Bernanke of the Federal Reserve with the recommendation to lower the fed funds rate, which, upon further public comments by Ching to the US Treasury in 2007 and 2008, was lowered to below 1% in 2008, indirectly admitting the mistake in raising interest rate in 2004 and 2005.

Fred Foldvary predicted and explained the current real estate and financial crisis in 1998 and again in 2007 based on his analysis of the real estate business cycle, whose period of 18 years is known, but whose explanation is not clearly understood, using Austrian School and Georgist economics. The business cycle is important because it provides and even guarantees a mechanism to initiate the economic fluctuation, which leads to crises. The two principal investigators are in a unique position to examine the claims of predictions by other economists and to offer practical financial reforms. Several of the fundamental topics to be examined, using the financial crisis as an empirical platform, are:

(1) The replacement of the qualitative concept of utility by the quantitative calculation of value based on the solution of value:

The solution of value solves the problem of value described mathematically by Gerard Debreu and Kenneth Arrow and is needed in calculating quantitatively the amount of quantity for a given price in any supply and demand curve. It is potentially applicable across all fields in social science. The broad concept of value is defined as the sum total of all the benefits and losses to infinity in time and can be expressed quantitatively as either the price or the rate of return. The temporal solution of value is applied to infinite spatially, when it is used to determine the quantity of a given price for constructing the supply and the demand curve. The two dimensional supply and demand model for the price and the quantity can be extended to a multi-dimensional supply and demand model, including interest rate, growth rate, psychological effects, etc. for the purpose of the investigation of multiple local equilibriums, which are necessary for financial instabilities and anomalies in game theory, in particular, for treating toxic assets, which are created due to rapid change in interest rate. From a multi-dimensional supply and demand model, this research will study the line of equilibriums for the purpose of understanding financial instabilities.

Toxic Assets Valuation Based on Cash Flows Not Price and Resale Price

Toxic assets, like toxic oil spill, are a national emergency. The valuation of these toxic assets is needed to clear out these assets from banks, insurance companies, and government sponsored enterprises. However, valuation is difficult, if not impossible, without a market, which provides sales data on market prices. This research proposal will introduce a method, which can be used to determine the price in the

absence of a market or any comparable market price. One purpose of this proposal is to use this valuation method to value toxic assets and, in the process, to discover the cause and the cure of the current financial crisis. In terms of the multi-dimensional supply and demand model, one speculative question to be studied in this research is: Can toxic assets be represented by negative Quantity?

Technically, the valuation method should be able to determine the price based purely on cash flows and not on any input of the price or resale prices. Direct tests of this valuation method will be conducted on toxic assets which are not transacted in a market and, thus, do not have comparable sales prices. In the past, the valuation method has been used successfully in detecting and predicting financial crises, such as the US Savings and Loan Crisis and the recent Subprime Woe, but has never used for the valuation of toxic assets.

This research on the valuation of toxic assets is proposed based on the belief that valuation is really at the heart of the financial crisis. The financial crisis occurs because the price is wrong. The valuation of toxic assets is just one entry point to cure the current financial crisis.

Equally urgent to the valuation of the toxic assets is a way to determine research funding priorities. Research projects generally do not have a market to determine their value. The same valuation method, which determines a price without a market, can determine the rate of return of a research project based on the expected future cash flows and social benefits.

The recent financial crisis has exposed two major defects of our society. First, economics does not have a solution for the chronicle financial crises. Secondly, our world has run out of significant innovations. Both of these problems require a solution of value, which can determine the price other than the wrong market price and can calculate the rate of return of innovations for public funding.

Furthermore, the effect of the rapid change in the interest rate in igniting the financial crisis should be addressed before undertaking further research based on the broad issue of value theory. And this topic of interest rate is best addresses while the memory of the financial crisis is still fresh and the debate on the crisis is most intense in the next several months.

- (2) The replacement of the Taylor Rule for setting the fed funds rate with the common sense logic relationship: **Rate of Return > Interest Rate > Inflation**, where the Rate of Return can only be surveyed with the availability of a deterministic valuation system applied to sales data to determine the Return,
- (3) The proposal of a Two-Valuation Reform based on the equation **Bubble = Market Price – Intrinsic Value**, where the Market Price is obtained from market comparison to the past sales data, and the Intrinsic Value is calculated based solely on the realistic accounting of future expected cash flows, **Cash Return = Sum of Cash Flows + Cash From Resale**, completely independent of the Market or Resale Price,
- (4) The reexamination of the Fisher Identity or the Quantity Theory of Money **PQ = VM**, which has been extensively analyzed by Friedman and Bernanke, and where P again involves the fundamental question of determining the correct price, and its role in the current crisis and in preventing a Great Depression,
- (5) The reexamination of the business cycle, whose amplitude is driven by the Finite Spreadsheet Instability, where finite, not infinite, consideration of future price and earning appreciation leads, with

regular frequency, to over-expectation, resulting in a vicious cycle or instability. Foldvary claims that the real estate business cycle is an approximately time-invariant with a period of eighteen years and analyzes the distortions caused by subsidized credit and real estate prices, which results in malinvestment and malspeculation, based on the Austrian School and Georgist economics. One question to ask is: How does instability show up in the multi-dimensional supply and demand model?

In the United States there has been a real estate cycle with a typical duration of about 18 years. This is shown on the table on the next page. This cycle was discovered by real estate economist Homer Hoyt (1960 [1970], p. 538), who explained, “While there were variations in timing between different cities and different types of property, the urban real estate cycle was approximately 18 years in length.” Hoyt adds, “The urban real estate cycle has been closely associated with the general business cycle.”

Hoyt, however, did not fully understand the economics of the real estate cycle, at least the way it is analyzed here. He thus thought that the real estate cycle had been eliminated by 1960, whereas in fact it had already resumed. In real prices, after adjusting for inflation, real estate prices fell in 1973 and in 1990, and then again in 2006 and 2007. Fred Harrison (2005) divides this 18-year length by adding two years from the peak to the trough, two years for the economy to recover from the depression, and 14 years for developers to buy land and construct new housing.

As shown in the table below, there has been a cycle in real estate prices, which is really the rise and fall of land values. Peaks in construction have come at about the same time as peaks in land value. Depressions have followed these peaks within a couple of years. There were two exceptions to the 18-year period. The next real estate boom after the 1920s would have been during the 1940s, but World War II interfered, as millions of Americans were overseas and much of the economy was devoted to war-time production. With no real estate boom, there was no post-war depression. The real estate cycle resumed started up again during the 1950s.

The other exception was during the 1970s, when there was high inflation yet unemployment stayed high. Tangible goods such as gold, silver, gems, collectibles, and land values all rise substantially, until the Federal reserved stopped the rapid increase in the money supply, resulting in a sharp recession in 1980.

Peaks in land value interval	Peaks in Construction interval	Start of Depressions interval
1818 --	-- --	1819 --
1836 18	1836 --	1837 18
1854 18	1856 20	1857 20
1872 18	1871 15	1873 16
1890 18	1892 21	1893 20
1907 17	1909 17	1918 25
1925 18	1925 16	1929 11
1973 48	1972 47	1973 44
1979 6	1978 6	1980 7
1989 10	1986 8	1990 10
2006 17	2006 20	2008? 18?

The land-value data from 1818 to 1929 are from Harrison (1983, p. 65) and Hoyt (1960, p. 7). Building data for the 1909-1929 period, which are from Harrison (1983, p. 65), Hansen (1964, p. 41), and Shirk (1981). Data for 1972-1989 are from Statistical Abstract, 1990, housing prices and "Value of New

Construction Put in Place" reports of the U.S. Department of Commerce, Bureau of the Census. Data for 1990 - 2006 are from several news sources.

(6) The basic concept of freedom on scientific, social, economic, and creative behavior: Are We Free? The fundamental question of freedom is exemplified by the three conflicting economic philosophies of the Pre-Friedman economics of man-made regulations, the Milton Friedman's Free Market, and the Post-Friedman economics of regulations based on non-violable laws of nature that we are free within the limit of freedom.

The question is "Are We Free?" The last debate between the economist Milton Friedman and PI Hugh Ching was about whether the Free Market is free. Ching believes that the market is regulated by NON-VIOLABLE laws of nature, as all motions of material objects are regulated by non-violable laws of nature in science. For example, after investors have determined the market price, a rigorous mathematical relationship can calculate the rate of return. When the rate of return drops below zero, a financial crisis occurs.

(7) Replacement of the peer review process

The peer review process is similar in concept to the market comparison method, the main cause of the US Savings and Loan Crisis. It should be replaced with valuation, where only the time-invariant inputs, not the price, are obtained from market comparison and are to be debated between the research proposer and the proposal reviewer.

[As an example, this proposal is valued at about \$200 million (far exceed the maximum \$200,000 for this funding) by the Time-Varying Infinite Spreadsheet, which is a valuation software based on the solution of value, using the most conservative estimates of the inputs: \$1million from year 1 -15 (based on the 18-years real estate business cycle and interval for crises; the next crisis occurring in 16 years), \$1,200,000 million (\$50,000,000,000,000 world GNP x 4 years x 10%-4%=6% unemployment x 1/10 of contribution to preventing next crisis) from year 16-19, \$120 million with 3% growth to infinity; 100% rate of return for the first 8 years and 40% rate of return for investment period for all the resale to infinity; 0 finance, tax 35% and 15% resale; 100% land for no depreciation, etc. All future research projects should have valuations which can justify their funding and should provide full disclosure now and full accountability in the future, which will be one of the key elements of consumer protection.]

(8) The Qualitative Supply and Demand Model Is Wrong

The broad reexamination of the foresight of mathematical economists, such as Gerard Debreu and Kenneth Arrow, in establishing a new purely mathematically rigorous foundation for economics that our economy is constrained by mathematically rigorous relationships, which satisfy the fundamental requirements of 1. All-inclusive, 2. Realistic, and 3. Deterministic, and 4. Quantitative, with the goal of being requirement 5. Predictive.

However, the qualitative supply and demand model of Arrow and Debreu, even with extension to a multi-dimensional model, is wrong and could be a contributing factor to financial crisis because the fundamental calculation of the Quantity of demand or supply at a given Price. The solution of value, in particular, the Infinite Spreadsheet, determines $Q(P)$, the Quantity as a function of Price.

Five Fundamental Requirements of Mathematical Systems for Social Science

The five fundamental requirements are:

1. Realistic (r: R)
2. All-inclusive (r: A)
3. Deterministic (r: D)
4. Quantitative (r: Q)
5. Predictive (r: P)

The requirement of realistic, symbolically represented by r: R, means that the mathematical description of a system corresponds sufficiently to reality. The requirement of all-inclusiveness describes the condition that all the factors are included in the system. For example, a rational decision system should take into consideration of all the future expectations to infinity in time.

Deterministic means simply that the number of equations equal the number of unknowns. Predictive means that the mathematical description of the social system can be used to make predictions. These four requirements are satisfied in a mathematically rigorous solution of value, which is described in the patent “Quantitative Supply and Demand Model Based on Infinite Spreadsheet” (Pat. No. 6,078,901). However, these requirements can be illustrated in the simple mathematical system of paying money M for a good of price P with a change C and any error in the change E .

Usually, the simple equation of $M - P = C + E$ is described by just $M - P = C$ or Money – Price = Change. The mathematical system of purchasing is certainly realistic, for it represents the common daily activity of buying something. But, $M - P = C$ is not all-inclusive, while $M - P = C + E$ is all-inclusive. To be deterministic, the system also needs three more equations, for example, $M = M_0$, $C = C_0$, and $E = E_0$ are easily determined, if P is given. When the requirements of realistic, all-inclusive, and deterministic being satisfied, the mathematical system is predictive, for example, $E_0 = M_0 - P_0 - C_0$.

The fact that the price P appears in almost all the mathematical systems implies that value is the foundation of social science. For example, the solution of value should be used to determine the unknown P in the mathematical system of purchasing. The solution of value generally involves infinity in time and space. The problem of value is mathematically described in the book “Theory of Value” by Gerard Debreu. Unfortunately, the treatment of the temporal dependence of price on page 34 of the book is not realistic. The solution of value satisfies all the four requirements of a mathematical system for describing value, in particular, the requirement of being predictive, for example, it has successfully predicted both the US Savings and Loan Crisis of the 1980s and early 1990s and the recent Subprime Woe.

The current crisis was caused by not knowing and, thus, not observing the non-violable mathematical relationship between the price and the rate of return, whereby after the market has incorrectly determined the price, the over-valued price causes the Rate of Return to fall below the Interest Rate, which has precipitated the Subprime Woe as the result of the violation of the logical economic order, **Rate of Return > Interest Rate**.

Additionally, the theory of value by Debreu and Arrow will be expanded to include multi-dimensional supply and demand model with multiple equilibriums, which might be useful in studying the business

cycle whose amplitude is driven by economic instabilities, which cause local upward demand curve or downward supply curve, such as caused by negative externalities. Instabilities are central to the current financial crisis and might lead to some original findings in this proposal. For example, the drop in the interest rate in 2000 and 2001 and the rapid rise of the interest rate from 2004 to 2006 must have drastically altered the demand curve, which would best be detected in a multi-dimensional supply and demand model, with or without the time dimension, but definitely including the interest dimension. As there are around 50 variables in the temporal solution of the price, the number of dimensions in the spatial solution can be expected to be about 50, most of which, unlike in the temporal case, will never be considered.

There is a paper By Mario Arturo Ruiz Estrada, Su Fei Yap, and Shyamala Nagaraj “**Beyond the *Ceteris Paribus* Assumption: Modeling Demand and Supply Assuming *Omnia Mobilis***” which supports the need to extend the spatial consideration, at a given time, of general equilibrium analysis of Debreu and Arrow to accommodate multi-dimensions, such as interested rate (causing the Subprime Woe), income growth rate (causing the Savings and Loan Crisis), even psychological effects, which might cause logical inconsistencies in the whole system of general equilibrium analysis or decision making. For the convenience of the reader, the **Abstract** of the paper, which has clearly expressed the insufficiency of the two-dimensional supply and the demand model, is enclosed below:

“This research is concerned with the application of multi-dimensional graphs in visualizing and modeling total change in a dependent variable in response to changes in any or all of the (many) independent variables affecting it. Previous literature has used the *ceteris paribus* assumption to obtain total change as a cumulative effect of the effect of the individual parts. The multi-dimensional graph applied to demand and supply shows that under the *Omnia Mobilis* (everything is moving) assumption, the quantity sold in the market is a joint function of all the independent variables that affect supply and demand.”

(9) An additional highly speculative point is the historical issue of good and evil or ethics. In the investigation of ethics based on the solution of value, the equation of evil

Evil = Ambition - Ability

Also, evil can be considered a survival mechanism created for the weak to compete against the strong.

Good and evil should be replaced by non-violable laws of nature in social science. One of the most important laws of nature related to good and evil or morality is the solution of value. The solution of value, being mathematically rigorous, is non-violable, but can be maximized. In the process of maximizing value, good and evil naturally take their place.

Non-violable laws of nature, and the requirement of permanent creation by nature, which are far more restrictive than all the man-made laws put together, and the requirement of permanence, NOT GOOD AND EVIL, punishes us with pain and suffering when we get them wrong or reward us with pleasure and happiness when we get them right.

Pain and suffering, and happiness and pleasure, are created to help us understand these laws of nature. For example, it had taken two world wars, namely, WWI and WWII, to force us to accept laws of nature in science. Similarly, it might take two global financial Great Depressions to force us to believe in the existence of laws of nature in social science.

The laws of nature are far more restrictive than all the current man-made laws put together. They affect every decision we make, and, thus, demand us to consider its consequences before we act. For example, any rational decision, plan or valuation requires that we take into consideration infinity in time, for every action produces consequences to the infinite future.

The first Great Depression occurred around 1930s, and from that experience, Milton Friedman suggested the Quantity Theory of Money, such that $\text{Price} \times \text{Quantity} = \text{Velocity of Circulation Of Money} \times \text{Money Supply}$ ($PQ=VM$), can be used to avoid future Great Depressions. The second financial Great Depression could either be going on right now in 2009 or will come later. In any case, the current financial crisis seems to have the financial authorities believing in the Quantity Theory Of Money, which, at least, have rescued us from the initial stage of potentially another Great Depression, through the faithful execution of the suggestion of Milton Friedman by the Chairman of Federal Reserve Board, Ben Bernanke.

Good and evil take a lower priority than non-violable laws of nature in social science. In any action, laws of nature must be obeyed. We will be punished through pain and suffering, when we are ignorant of the laws of nature. Punishment is how nature teaches us laws of nature. Thus, ethics, which, Benedict Spinoza proposed, should depend on punishment, not any timely notion of good and evil, should be defined by the non-violable laws of nature rather than by good and evil.

However, the Equation Of Evil is practical. Basically, it says that one uses evil to achieve one's overly ambitious goals when one lacks the ability. Evil exists as a survival mechanism for low-ability creatures to compete against high-ability creatures for survival. It is a survival mechanism, a minimal ambition, for the weak to compete against the strong; it compensates the lack of ability.

If good is considered the opposite of evil, the equation for good is $\text{Good} = \text{Ability} - \text{Ambition}$. People with high ability and low ambition generally "have to" spend their time doing good. Throughout history there are people with high ability being defeated by evil people of low ability. Historically greatest ambitions for good were achieved with great ability, often accompanied by some "necessary" evil.

The Equation is useful for judging people. It helps explain the prevalent evil in politics and business, which are characterized by unquenchable ambition for power and money. In particular, it helps to explain religion, which exists mainly to promote good and to eradicate evil. The greatest sin for Buddhism, the earliest of the main traditional religions, is ambition.

There should be a proper balance for good and evil. When evil becomes excessive, religions are invented to promote good. Idealistic practices of good in socialism or communism, which equalizes ambition, are the main causes of their downfall; they require too much good or ability for support.

To gain a intuitive understanding of why there should be a proper balance, good and evil can be thought, respectively, as credit and debt. At a first glance, credit seems to be better than debt, but debt can provide leverage in investments, tie over emergency needs of cash, even enhance the chances of survival either in business or in life. Too much debt, as too much evil, can be a bad thing. Thus, good is useful in balancing evil, or credit, debt.

IV. Outline of the general plan of work

Brief Description of Its Application

The main purpose of this research proposal is to formalize a vital part of the current financial reform, involving a Two-Valuation Reform based on a rigorous solution of value, which is demonstrated commercially by the Infinite Spreadsheet.

The Two-Valuation Reform will require real estate appraisers to perform two valuations, one for the market price and the other for an investment value based purely on investment or cash flow analysis, independent of the market price.

The market value appraisal is needed to satisfy the buyer and the seller, who have agreed on the price and to satisfy FIRREA, which endorses the market comparison approach. The investment value should be able to detect and prevent market overvaluation.

The proposed Two-Valuation Real Estate Appraisal Reform is designed to predict and prevent future financial crises caused by real estates. The first step in introducing the Reform is the writing of a formal proposal by the collaboration of some of authoritative people and their students in real estate appraisal. Hopefully, the whole project will involve government financial authorities, represented chiefly by the Federal Reserve and FDIC, whose members will be invited to our conferences and meetings.

Members of the International Valuation Standard Committee, Federal Reserve, FDIC, and other government agencies will be invited to give presentations. Inputs from the government agencies will form a major part of the Two-Valuation Reform.

The first draft of the Two-Valuation Reform is schedule to be finished by the middle of 2011. Final publication depends on further funding and feedback from the real estate community and the financial authorities.

Outline of the Proposed Research Methodology and Anticipated Results

The Two-Valuation Reform formal proposal will be examined and debated by academics, practitioners, financial authorities, and law makers during the second half of 2010 and the first half of 2011, before the end of the Financial Reform Commission end in December 31, 2010. We expect noticeable discrepancies between the two values, indicating either under-valuation, due to fire sales, or over-valuation, due to inflexibility in real estate price, even in 2010 and 2011.

The proposal can be summarized roughly by listing the decision-making processes, which might be replaced by valuation, after having been verified by this research. The solution of value might be able to replace the following processes:

1. Partially, the **Dodd–Frank Wall Street Reform and Consumer Protection Act**,
2. The qualitative concept of utility by the quantitative calculation of value based on the solution of value,
3. One valuation process by a Two-Valuation Reform, **Bubble = Market Price – Intrinsic Value**,
4. The Taylor Rule by the logical relationship: **Rate of Return > Interest Rate > Inflation**,
5. The Free Market by a market constrained by non-violable laws of nature,
6. The peer review method by valuation, where only the inputs, not the final decision, will be debated,
7. Economics by mathematical economics,
8. Two-dimensional supply and demand model by multi-dimensional supply and demand model,

9. Ethics or good and evil by the maximization of value, and
10. Area-specified and person-specified award and funding processes by funding and award processes, which are non-area-or-person-specific and are given after the discovery, for discoveries are unexpected and should not be dictated by money.

Timeline and Budget

There will be plans for holding meetings and attending conferences. The funding will also be used for fees related to the publication of papers on the subject. Total Budget is \$202,400 lasting for one year. Hugh Ching will devote 40% time at \$60 per hour for a total of \$50,000.00 and Fred Foldvary will devote 20% for a total of \$25,000.00. The salaries of two half-time research assistants/programmers at \$30 per hour add a total of \$62,400. Additional \$65,000 will be used for travel(\$20,000), administration cost(\$30,000), publications(\$5,000), communication fees(\$2,000), consulting fees(\$5,000), and other expenses(\$3,000).

A final remark and possibly one of the most important practical points is that, in this research involving the limit of human ability, the bottleneck is thinking ability. This research will spend a large share of its effort in search for good thinkers world-wide.

V. Broader impacts resulting from the proposed activities to enhance scientific and technological understanding and its potential benefits of the proposed activity to society at large.

The financial crisis creates an historical opportunity to transform our society from the current Age of Science into the coming Age of Social Science. Science deals with the behavior of material objects. Social science deals with human behavior. Material objects are governed solely by laws of nature in science. The fundamental question to be addressed in this research proposal is: Is or should human behavior constrained solely by non-violable laws of nature in social science? The recently passed financial reform law introduces a sense of urgency and supplies a realistic arena for debate on this question.

In conclusion, this research will try to clearly distinguish the root causes of the financial crisis from its symptoms. General, the research will attempt to establish a new quantitative foundation for economics, which will be able to explain past financial crises and predict and prevent future crises. Particularly, the research will start with a mathematically rigorous solution of value and an explanation of the real estate business cycle. At the peak and the concluding period of the financial crisis debate in the next six month, the viewpoints of the principal investigators with those of Arrow and Bernanke will challenge and be challenged by other finalized views on the crisis. In sum, this research intends to do a thorough study into the cause and the cure of the financial crisis based on new fundamental discoveries in economics.

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