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Financialization and a New Paradigm for Financial Markets

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INTRODUCTION

The time is ripe to define a new paradigm for the dynamics of the financial markets. The historically prevailing paradigm, the Efficient Market Hypothesis ("EMH"),[1] has suffered many blows since its publication 43 years ago.[2] Many observers, if asked directly, would question its usefulness and this is supported by numerous academic studies spawned by the financial crisis of 2008. Nonetheless, it lives on, embedded in the public's collective psyche. EMH still informs policymaking and research. The Hypothesis endures largely because it fits so well into a constellation of beliefs that are commonplace in our society. We are trained to believe that unfettered commerce serves the common interest and has enhanced wealth creation and economic power for hundreds of years. Price is a function of information[3] and liquid markets that enable competition. EMH describes financial markets that are, by nature, marvelously efficient because of broadly shared information regarding the financial value of the traded securities or derivatives. EMH holds that a trader seeking short-term profit from price moves will not find it absent luck or an external force (such as insider information or a tax rule that results in a specific outcome for a trader). It allows us to believe that markets are inherently fair and efficient.

The appeal of EMH aligns with the economic libertarian ideology that became prevalent with the rise of Ronald Reagan.[4] It reinforces the notion that government intervention into (especially) commercial activity imposes burdens that are often unjustified in terms of the common good. EMH was the intellectual foundation for the deregulation of financial markets. Belief in this elegant and easily understood explanation of the financial markets reinforces a core value, but it also has significant and troubling implications. If EMH is the accepted paradigm, there is no need for inquiry into the dynamics of financial market structure. Inherent efficiency means that anomalies of the market are squeezed out as long as the market forces are free of outside influence or constraint. This is embodied in the corollary to EMH, the Representative Agent Model, in which the marketplace is viewed as monolithic for purposes of analysis. Even learned academics who challenge EMH routinely lapse into the paradigm when describing the markets. Policymakers and opinion leaders are even more susceptible to such lapses.

The epistemological approach that has dominated economics in recent years is one source of the resilience of EMH. EMH, the Representative Agent Model and the related Rational Expectations Hypothesis allow for simplifying assumptions of diversity in modeling data sets so that results can be said to encompass all outcomes. A counter to this approach is Behavioral Finance Economics that focuses on motivations other than price, so-called "irrational behavior," such as herding. This approach also searches for pre-determined behavioral rules that can be modeled for their predictive value. The alternative concept of Imperfect Knowledge Economics is perhaps more useful. It abandons the goal of universal predictive outcomes based on single probability distributions, seeking a set of probability distributions. Markets are seen as moving through the set of probability distributions over time.[5] Imperfect Knowledge Economics seeks to identify boundaries for what contemporary economics can achieve in terms of predicting behavior.

This paper is not directly concerned with predicting behavior in markets or even examining boundaries to predictability. It adopts an ontological approach to identify characteristics of market structures that provide guidance to identify the types of regulatory tools that can be employed to address those characteristics that do not enhance the social value provided by financial markets. To that end, it identifies an alternative paradigm:

- Without constraint, financial markets are inherently and increasingly (a) inefficient, and (b) unstable. Financial *inefficiency* is marked by poor and costly performance of the capital intermediation function, whereby owners of surplus capital are connected with those who need capital. Financial *instability* is marked by persistent and large deviations from fundamentally sound values.[6] Short-term deviations, such as intra-day price volatility or chronic transaction mispricing, create inefficiencies in capital intermediation. Longer and more extreme deviations can be systemically threatening, often taking the form of price bubbles followed by crashes.
- Both inefficiency and instability are functions of (a) increasing asymmetric information and capacity to exploit information advantages, limited to identifiable agents (capital intermediaries), and (b) increasing complexity.

- Capital intermediaries are incented to maximize the value of information by increasing complexity, and they have the power to do so. As a result, the financial markets are characterized by a feedback loop that increases inefficiency and instability to the point of crisis.

Stated more simply, deregulated financial markets allow financial intermediaries to exploit inevitable information asymmetries and complexity in ways that cause capital intermediation to be inefficiently costly and prone to runs on the financial system like the financial crisis of 2008. As a result, regulatory intervention to simplify financial markets is essential to achieve a system of capital allocation that is both fair and stable.

At the core of this paradigm is the concept of "fundamental value." The problem is that the price of a stock, bond or derivative that reflects fundamental value is impossible to calculate precisely because of the number of factors that differ depending on the idiosyncratic views of potential buyers and sellers.[7] For instance, the value of potential future stock dividends may be different for two market participants because one may value near-term returns far more than long-term returns. The best expression of fundamental value is the price generated by the market, but the way to evaluate the performance of a market structure is to test how well it consistently delivers fundamental value. This head spinning circular logic suggests that there is nothing more to be said about fundamental value.

However, it is possible to detect and even measure *non-fundamental* forces that affect prices generated in a given market structure. While we might not be able to calculate the "correct price," we can identify forces that would cause market-derived prices to fail to reflect it and estimate the power of those forces. The identification and analysis of market practices that generate non-fundamental forces can be used to evaluate whether a market structure that permits or encourages such practices effectively generates prices that reflect fundamental value.

THE ROLE OF THE FINANCIAL SECTOR

The substantial and unique public interest in the role of the financial sector was a central concern for the American founders. In the debate over the First Bank of the United States, Alexander Hamilton pointed out that the financial sector must be sufficiently robust to fuel the growth of commercial activity, enhancing the public's welfare and the economic strength of the nation.[8] Thomas Jefferson observed that an overly large and powerful financial sector would risk parasitic redistribution of wealth and power to financiers tasked with handling flows of money.[9] While they were opponents regarding the Bank, they were both right.

The public's interest in the financial sector has historically been different from its interests in other commercial activity. Hamilton recognized that the value to society of the financial sector is defined in terms of the value it adds to other activities, namely commerce and government. Jefferson pointed out that bankers are incented to extract more value than needed to secure the social value that Hamilton identified and, because of their powerful

role as intermediaries, have the ability to do so. The U.S. government has repeatedly sought to balance these public interests by constraining the financial sector in a variety of ways throughout the nation's history. The debate has swung back and forth, characterized by episodic movement toward greater constraint in response to financial disasters (*e.g.,* the Pujo Committee hearings leading to creation of the Federal Reserve following the Panic of 1907; New Deal financial regulations; the 2010 Dodd-Frank Act) followed by periods of diminished regulation during periods of exuberance.

The most recent financial crisis has led us to revisit the balance between the two strains of thought in the context of today's financial system. This has posed unprecedented challenges. The dynamics of the financial system are tremendously more complex than ever before, including global interconnections that bring into question the ability of individual jurisdictions to effectively regulate.

As the founders observed, it is essential that the balance be based on the core purpose of the financial markets. Aside from insurance (risk transfer) and payment systems, the core service of the financial sector is capital intermediation.[10] Sources of capital (funds that need to be "put to work," such as savings and pension funds) must be matched up with users of capital who are financing productive activities. Intermediaries operate a "pipeline" that transmits and allocates investment capital to users—businesses, institutions, governments and households.

One element of this process is mechanically matching current investment supply with capital demand. But the needs of investors and consumers of capital are often not the same. For instance, investors may want to lend at floating rates of interest while a borrower may want to have a fixed rate. An important feature of the service provided by capital intermediaries is to reconcile these differences.

Traditional commercial banking provides capital intermediation. In that model, a bank deploys customer deposits and capital to fund capital needs of the economy. The mismatches between the two, such as term, interest rate, currency denomination and credit, are absorbed by the bank's capital base. If the sources of capital and its uses become unbalanced (*e.g.,* if customers withdraw deposits or the bank suffers loan defaults) the banks' own capital is available as a cushion. If the demands are large and/or uncertain, a bank run may ensue in which bank funding sources, particularly deposits and short-term lending by other banks, are withdrawn. To secure integrity of the system, the U.S. government provides FDIC deposit insurance to the customers to discourage panicked withdrawals, and the Federal Reserve allows banks to borrow at the discount window to provide liquidity.

A second model of capital intermediation is the trading market. This has become the predominant form of capital intermediation over the last 35 years.[11] The trading market, like the commercial bank model, can be thought of as an intermediation pipeline. In the "primary market," a business or company issues new securities into the pipeline to raise capital. At the same time investors supply new capital funds by putting money into the pipeline to

acquire the newly issued securities. In a trading market, however, investors can put their investment back in the pipeline whenever they wish to, in exchange for cash or replacement investments. The investments are said to be liquid. Liquidity is thought of as a major advantage for investors, one that can make capital less expensive for productive users of funds raised in the primary market. Intermediaries facilitate liquidity by buying and selling investments that are in the pipeline (*i.e.*, market making), intermediating this "secondary market." This secondary market trading is absolutely vital to capital intermediation through the trading market model. Without it, investors cannot easily trade out of their positions and they cannot anticipate prices if they are considering doing so. Many of the numerous "innovations" developed by Wall Street in recent decades, such as derivatives, algorithmically driven high speed trading, securitization, exchange traded funds and hedge funds, to name a few, are focused on trading markets, not commercial bank intermediation.

Secondary market trading is essential to capital intermediation through trading markets, but this does not mean that all trading activity, in terms of the volume of trading or the quality of the trading activity, provides liquidity that is useful in terms of the efficiency of capital intermediation. If the financial sector is performing its core function well, the matching systems will be efficient in terms of intermediation. The price paid for intermediation (*i.e.*, its net cost to the economy) will be rationally related to the quality of the service provided. In terms used by economists, the economic rent extracted for capital intermediation will be optimally small.

If EMH is the paradigm for the financial markets, this analysis is relatively simple and relies on the Representative Agent Model for assumptions needed to evaluate how capital intermediaries operate in the economy. Assuming that the markets offer no potential for riskless gain to traders from price moves, efficiency is determined by transaction cost. Since prices are determined by broadly available information, there is no way to achieve superior capital intermediation other than prohibition of factors such as insider trading and distortions such as those generated by factors like tax incentives.[12] Further, technological advances are certain to increase capital intermediation efficiency. Under the paradigm proposed herein, the analysis requires examination of many other factors.

FINANCIALIZATION

The term "financialization" has been widely used to describe changes to the financial markets over the period of deregulation that began in the 1970s.[13] It refers to the process by which the volume and significance of financial instruments and contracts has grown relative to the economy as a whole. This term has been defined in several ways, including the following:

- "[T]he transformation of one dollar of lending to the real economy into many dollars of financial transactions."
- "[T]he increasing importance of financial markets, financial motives, financial institutions, and

financial elites in the operation of the economy and its governing institutions, both at the national and international level."

- "[T]he growing importance of financial activities as a source of profits in the economy."

As we shall see below, each of these descriptions accurately reflects characteristics of the modern trading market. However, as definitions, they are not sufficiently connected to the fundamental social function of the financial markets. A better definition of financialization may be:

> The increase in financial market activity that does not improve, and may impair, the efficiency (i.e., net cost to the economy) of capital intermediation by the financial sector.

This definition ties the activity to the core social value of financial markets. It focuses attention on the question whether the activity provides value to the "real" economy. As used herein, financialization will have that meaning.

MEASURING FINANCIALIZATION

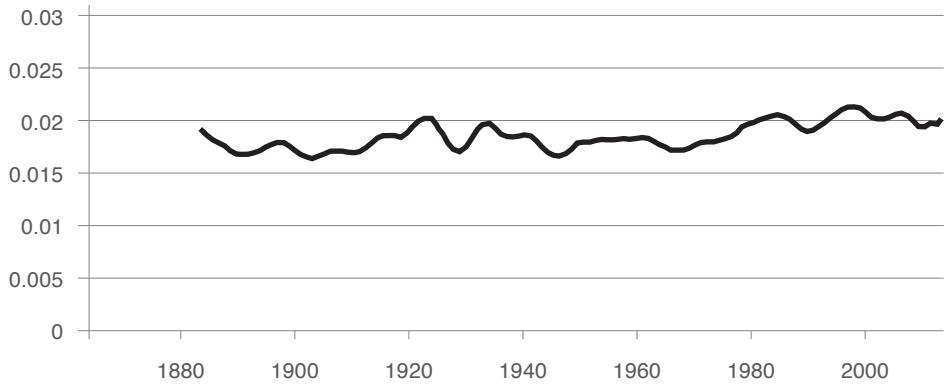
Demonstration of the existence of financialization and its significance to the economy requires the evaluation of changes in the net cost (*i.e.,* efficiency) of the capital intermediation service experienced in the economy over time.

A groundbreaking study of intermediation costs by Thomas Philippon of New York University's Stern School of Management reaches dramatic conclusions.[17] Philippon postulated that advances in technology should have increased the efficiency of intermediation, an inescapable outcome under EMH.[18] The study used the neoclassical growth model (which focuses primarily on productivity, capital accumulation and technological advances) to examine financial intermediation in the United States over a 140-year period. Philippon constructed an index that measures the unit cost of financial intermediation. His work indicates that the finance industry has become less efficient in providing intermediation services over time. He summarizes his findings as follows:

> The second main point is that the finance cost index has increased since the mid-1970s. This is counter-intuitive. If anything, the development of information technologies (IT) over the past 40 years should have disproportionately increased efficiency in the finance industry. How is it possible for today's finance industry not to be significantly more efficient than the finance industry of John Pierpont Morgan a century ago? [The data] presents a puzzle for future research.

The findings are illustrated by a chart from his study, reproduced below as Figure 1.

Figure 1. Quality-Adjusted Cost Index

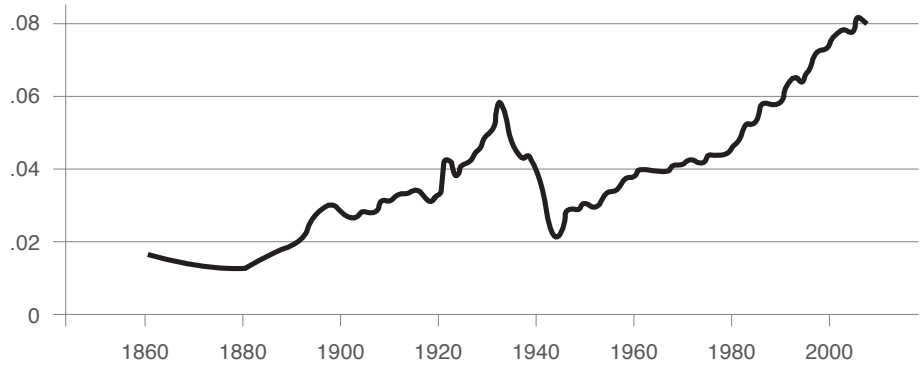


† *Phillppon, 2008*

Figure 1 shows that the only time over the 140-year period that the Financial Intermediation Cost Index was comparable to the current era of deregulation was the Great Depression. High costs of intermediation make sense in the Great Depression when intermediation virtually ceased to exist—there was even a "bank holiday" for a period. But in the deregulation period, banks were profitable and investment capital was increasingly plentiful.[19] Reasoning under the tenets of EMH, Philippon correctly concludes that this is absolutely counter-intuitive. But from the perspective of an observer of trading behavior and market evolution, his results make perfect sense.

Key measures of the relative size of the financial sector reinforce Professor Philippon's findings. During the period since the 1970's, the financial sector share of the economy has increased to unprecedented levels, growing from 3.8% to 8.2% of the GDP, [20] while the manufacturing and services sectors have become relatively smaller (See Figure 2).

Figure 2. GDP share of U.S. Financial Industry

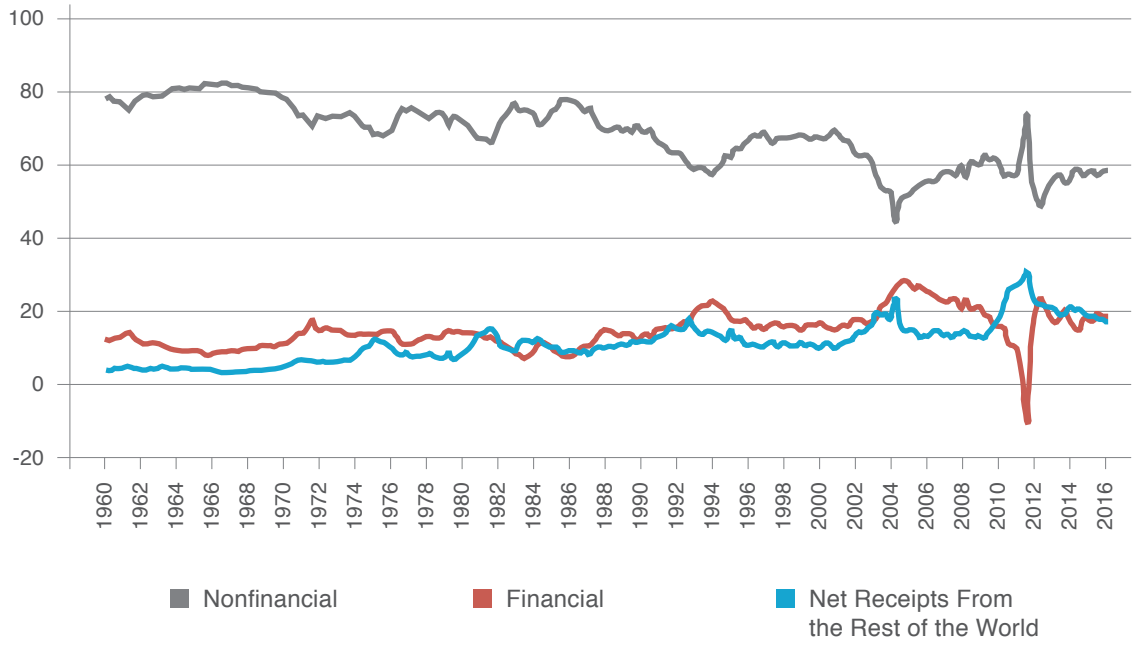


† *Phillppon, 2008*

Growth of the financial sector is not necessarily a problem if the services provided by the sector provide commensurate value to the overall economy. But if it does not cause the whole pie to grow, value is simply reallocated to the beneficial owners of financial firms. This drains resources that could be put to uses that would increase the productivity of the overall economy and the public's wealth. It has been demonstrated that the connection between financial sector growth and the growth of the productive manufacturing and service sectors is at best tenuous.[21] It might benefit the owners of financial firms (and bonus recipients), but to the extent that it only transfers wealth, it does not benefit the broad economy. The only way to assess this is to value the performance of the financial sector in executing its most basic task: providing efficient intermediation between sources of capital investment and productive consumers of capital investment.

Perhaps equally as telling is the financial sector share of profits in the entire economy. Figure 3 is a chart prepared by Yardeni Research that tracks 60 years of data on financial sector profits. The data illustrate that the financial sector profit share has ranged from 8 to 34 percent,[22] and it remained in the 20–30 percent range in recent years despite the financial crash of 2008.[23]

Figure 3. Corporate Profits by Industry (as percentage of corporate profits)



† *Includes Inventory Valuation Adjustment (IVA) and Capital Consumption Adjustment (CCAdj).*
Source: US Department of Commerce, Bureau of Economic Analysis.

Another indication of the increased size of the finance relative to the economy as a whole is the dramatic increase in gross domestic credit extended by the banking sector (other than credit extended to the U.S. government) as a percentage of GDP. The credit extended was 229 percent of GDP in 2012, while in 1980 the amount was 120 percent.[24]

This growth of the financial sector was not driven by increased demand for financial services generated by financial needs of other business sectors over the recent time period.[25] It is also clear that this cannot be explained as an outgrowth of the value of exporting financial services by U.S. institutions.[26] The explanation lies in the structure of the domestic financial system.

SIGNIFICANCE OF FINANCIALIZATION

A cogent explanation of Professor Philippon's findings is critically important. The answer is not simply the huge increases in trading volume. As we shall see, the findings are caused by the properties of specific trading practices. The great increase in trading volume in recent decades is a byproduct of those practices and amplifies their effects.

Financialization, representing the growth of trading activity that benefits intermediaries without commensurate improvement in the efficiency of capital allocation for productive uses, is a threat to U.S. productivity on several levels. First of all, the productive manufacturing and service sectors have been increasingly short-changed. An increasing share of the available capital is being devoted to trading activity that extracts value from the financial markets rather than facilitating investment in productive assets and businesses. Think of capital intermediation as a pipeline with investment capital on one end and consumption of capital on the other. The pipeline consists of the matching function, including secondary market trading and much if not all of the derivatives market. The cost of the pipeline is increased by several factors. For example, the uncertainty of the prices generated by secondary market trading affects prices required by investors. And high prices and risks associated with derivatives used to reconcile sources and uses of capital also increase costs. These are burdens on the growth of the manufacturing and service sectors and a drag on innovation since the costs of raising capital have increased beyond levels that are necessary.

Moreover, in down cycles, money pumped into the system increasingly fuels value-extracting trading rather than recovery from high unemployment in the typical business cycle. Federal Reserve policy during a recession is designed to make cheap funds available so that productive assets will be acquired or put back into service and jobs will be created anew. In a highly financialized economy, however, increases in the money supply may be channeled into yet more unproductive financial activities, resulting in much weaker stimulus for production and job creation.

This explanation appears to fit with fundamental and ominous changes to the business cycle that emerged over the last 35 years, as recession-driven unemployment proved increasingly resistant to the medicine of corporate profits and GDP growth. In the recoveries

following the last three recessions (1990-91, 2001 and 2007-2009), the return to pre-recession employment levels has taken much longer than was the case in previous recessions. Between the Second World War and 1990, employment rates recovered fully within eight months of the trough of each recession. In the 1990/91 recession, the recovery period was 23 months, and in 2001 the period was 38 months.[27] The employment recovery period for the recent recession, assuming recovery occurs, is unknown but far longer.[28] In short, the effect of a recession on employment has gotten progressively worse. There are likely several factors behind this phenomenon, including globalization and automation. Financialization, however, by diverting monetary stimulus away from productive investment, may be the most important source of progressively weaker recoveries since the early 1990s.

This suggests an important factor in business-cycle policy. In a financialized economy, monetary stimulus in a down cycle is less effective than it was in a non-financialized economy. Fiscal stimulus would be relatively more effective. The practical issue is that the ability to employ fiscal stimulus is highly constrained by political polarization. We have yet to see the long-term effect of high levels of monetary stimulus in a financialized economy, but it is apparent that it has not adequately addressed unemployment caused by the recent recession.

Financialization also competes for the capital of manufacturing and service companies that often find participation in the financialized investment markets more profitable than their underlying businesses. Goods and services are more expensive and productive activities are foregone because their costs cannot be justified. Funds are deployed to financial investments that echo the yields derived by intermediaries rather than to innovative and productive manufacturing and service businesses. Employment opportunities are restricted and consumption is burdened.

As we shall see below, financialization is also integrally related to instability of the financial system that, in its extreme form, causes runs on the financial sector as have occurred three times in the U.S. in the last 100-plus years: the 1907 Panic, the Great Depression and the Great Recession of 2008. Excessive rents encourage risk taking as the short-term cost/benefit ratios incentivize risk over prudency. In addition, the recent history of financialization is characterized by high levels of complexity that favor intermediaries, especially those benefitting from market power, but also obfuscate balance sheet strengths and weaknesses, causing uncertainty as to counter party credit quality. And, as discussed below, complexity increases the damaging forces unleashed in market crashes.

Therefore, financialization is directly related to both the daily extraction of inefficient levels of value from the capital intermediation process and to the systemic risks embedded in the financial markets. Indeed, as described below, the extraction of value is enabled by the non-fundamental price anomalies that in their extreme form are at the root of system-threatening financial crises.

SOURCES OF EXCESSIVE VALUE EXTRACTION BY THE FINANCIAL SECTOR

A large percentage of the increased financial sector share of the economy and virtually all of the increased cost of intermediation is derived from trading.[29] Logically, extraction of value by the financial sector disproportionate to value it has added to the intermediation process must be the result of asymmetric information favoring financial intermediaries. This is simply the contrapositive of EMH, which holds that the trading markets are efficient and permit no arbitrage, barring external forces, because of broadly and evenly shared information. EMH is not illogical; rather, it is based on assumptions (*e.g.,* the broad and rapid perception of relevant information) that are, at a minimum, not useful.[30] Securities and derivatives trading functions to intermediate capital flows. Therefore increased cost of intermediation must derive from profitability of securities and derivatives trading resulting from asymmetric information favoring intermediaries.

A hypothesis explaining how this has occurred must take into account circumstances affecting the financial markets that have coincided with the unexplained (and counterintuitive to those predisposed to EMH) inefficiency of capital intermediation. Four primary circumstances appear to be relevant:[31]

a. Advanced information technology and quantitative analysis allow market participants with superior ability to use these tools to accrue advantages of asymmetric information. These information advantages have very little to do with the intrinsic fundamental value of a stock, bond or derivative. The information concerns market processes, motivation of market participants and esoteric risk metrics that are impenetrable to all but a few sophisticated institutions. As a consequence, the banks and hedge funds are tremendously efficient; but the capital allocation system is less and less efficient. These tools are more effective in complex markets that are, as a result, characterized by greater inefficiencies. This incentivizes those who enjoy asymmetric information advantages to increase the complexity of markets, at a cost to overall capital intermediation efficiency to the extent that they are able to do so.

b. Extraordinary market power in the hands of a narrow group of financial institutions empowers them to more effectively exploit asymmetrical information, in part by increasing complexity.

c. Any particular regulatory framework that defines the market structure either enables, inhibits or prevents that exploitation. The unregulated markets pre-Dodd Frank Act enabled exploitation. To some extent, this continues because the approach to regulation embedded in regulatory reform was primarily to improve market transparency and risk management rather than to fundamentally alter market structure.

d. An increasing number of investment practices and structures rely on money managers who are evaluated in ways that mask the inefficiencies in the capital intermediation process and block the potential for market discipline imposed by the investor community. In particular, they are tested more by results comparable to short-term market trends rather than by more comprehensive longer-term results. As a result, investors do not effectively discipline the intermediaries so as to curb the extraction of excessive rents, even though some investors perceive that it is occurring.

There are several trading practices and "financial products" that incorporate information asymmetry. For example, technology advances have led to the rise of high frequency, algorithmic trading using powerful computing capability and extreme information transmission capacity.[32] And derivatives trading, especially in bilateral markets that are less transparent, is characterized by information asymmetry based on advanced quantitative analysis.[33] The system works well if a) it produces prices for the deployment of capital to productive uses that are predominantly a function of fundamental information and b) the value extracted by the intermediaries as compensation is proportionate to the quality of intermediation.[34] Fundamental information is an objective concept, so if information is misperceived for causes endogenous to the marketplace, the misperception is not fundamental information. The cited examples, high frequency trading and derivatives trading, are characterized by prices that are anomalous in terms of fundamental information. As described in the cited papers, these anomalies are vehicles for value extraction in excess of that which is efficient in terms of capital intermediation.[35]

The concept of "complexity" is closely related to value extraction based on asymmetric information. As stated, asymmetric information is more valuable in complex environments. Therefore the financial sector is highly incented to use any forces within its power to increase the complexity of financial markets. In many areas, the large intermediaries have accrued tremendous market power. For example, the Office of the Comptroller of the Currency reports that, in the fourth quarter of 2012, more than 93 percent of all U.S. derivatives held by banks were held by just four large banks.[36] Since virtually all over-the-counter derivatives include a bank as one of the counterparties, the market power to increase complexity is very high.

It is evident that the relationship between information asymmetry and complexity has functioned as a feedback loop. Over an extended period of time, the profitability of information asymmetry has incented the use of market power to increase complexity, which in turn enhances the profitability of information asymmetry. This increased complexity has profound consequences for our understanding of how financial markets function.

FINANCIAL MARKETS AS DYNAMIC SYSTEMS

A widely shared, but by no means exclusive, view among economists is that the EMH has been discredited.[37] At a minimum, it explains phenomena that do not have usefully broad application.[38] Despite the clear flaws in the theory, however, belief systems die hard. EMH still informs policy and academic analysis. Influential individuals cling to decades-old shibboleths and those who benefit from the theory continue to pitch their arguments using its terms.

The conceptual model that better fits with the events of the recent past is that of newly revered economist Hyman Minsky: "[O]nce we admit that institutions are man-made and at least in part the product of conscious decision, we must also face the effects of institutional

arrangements on social results."[39] He writes "that almost all systems which are multidimensional, nonlinear,[40] and time dependent" are inherently unstable.[41] In Minsky's view, periods of market stability are destabilizing and markets are inescapably unstable. Markets are far from relentlessly efficient. The new paradigm described in the introductory paragraphs fits within Minsky's conception of financial markets.

Today's markets are consistent with Minsky's thinking, not EMH. The biggest reason is the differing assumptions regarding information that underlie the two sets of theories. While some information is broadly shared by market participants, the ever-increasing speed and capacity of information technology assures that the more powerful market participants will always enjoy an information advantage. Especially in modern, high-speed markets, it is the *perception* of facts—perceptions sometimes existing only for time periods measured in milliseconds—that is the driving force. Perceptions can be influenced using high-speed technology and tactics. Induced or altered perceptions of current circumstances, even for small periods of time, can introduce tremendous distortions that can be exploited using trade execution speed.

The complexity of the markets means that market participants with superior quantitative analytics can comprehend information that eludes others. For example, the complexity of measuring the risks and costs of derivatives creates misperceptions of their value that can be exploited. High-level mathematics has become a major market advantage that is unavailable to all but a few large institutions, which have the size and market power to convert this capability into profit.

To understand Minsky's theories in mathematical terms, it is helpful to view the trading market as a massive dynamic system that determines prices based on perceived information. Economists, physicists and mathematicians study the dynamics of systems, defined as sets of interacting or interdependent components that can be measured as an integrated whole. Traders (humans and computer-driven "trader robots") interact among themselves, either directly or in venues provided by service providers such as exchanges. The traders are system components. Their interactions produce prices for capital investment that can be identified at any given point in time. These prices are the measurement of the integrated whole. System dynamics describes models of how the components interact and the effect of this interaction on the integrated system.

Equilibrium Systems. For an EMH believer, the system constantly seeks equilibrium defined as fundamental value (though EMH adherents do not claim that the achievement of fundamental value at any time can be or needs to be measured).[43] It is like a sealed room into which a gas with a similar mass to oxygen's is injected. The gas will spread evenly throughout the room. EMH sees information like the newly introduced gas. Under the Hypothesis, price seeks equilibrium based on information relevant to the value of each security and derivative being traded in the market. Other costs of the intermediation process are kept to a minimum by perfect competition. If prices are efficiently established continuously, all day long, the intermediaries cannot charge much for the service they provide. There is

very little price distortion that can be exploited in the process of intermediation.[44]

A small perturbation will have a small effect on an equilibrium system and a large perturbation will have a large affect. The systemic response is proportional to the force of the perturbation because all elements of the system, being equally distributed, are equally affected. Therefore, systems in equilibrium are said to be "linear" since cause and effect can be graphed using a straight line. Because cause and effect are proportional in the equilibrium model of financial markets model, deregulation should result in prices and capital allocation that precisely reflect optimal values.

It is obvious that trading markets are not systems in equilibrium under all conditions, and in particular under conditions that are most important. The "Flash Crash" of May 2010 is a fine example of non-linearity. A single trade by a Midwestern mutual fund ignited a stock market free-fall that wiped out $1 trillion of value in a matter of minutes. This happened because computer-driven trading software misconstrued the implications of the mutual fund trade and automatically initiated sell orders that propagated throughout the market. This is just one example of nonlinearity and inherent disequilibrium.[45] In addition, the persistent inefficiency of the capital intermediation process suggests that equilibrium is not the predominant condition even on a day-to-day basis.

Thus, a useful system dynamics model for financial markets must be one that is consistent with Minsky's view of inherently unstable, multidimensional and nonlinear markets.

Fluid Systems. It is tempting to apply the fluid systems model described by Chaos Theory to modern financial markets. Weather has characteristics of a fluid system: the common analogy is that a butterfly flaps its wings in the Amazon rainforest and, through a series of unpredictable events, a hurricane strikes the Gulf Coast.

The central attribute of chaotic systems is that, even if the initial state of such a system is fully understood, its future state cannot be predicted. Yet one can observe forces at work in the financial markets that have predictable outcomes. In the Flash Crash example, the preconditions to the market sell off have been catalogued and studied so that we now understand the causes and effects. The occurrence of a price drop was completely predictable if one knew of the anomalous trade that triggered it. Explaining the force of the sell-off is the more intractable problem. That was driven by the interaction of the trading algorithms that were wired to sell everything if such a trade was observed, to react to the initial selling that was triggered and to continue reacting as the sell-off snowballed.

Organized Complex Systems. The trading markets are better described by a third type of dynamic system, characterized by phases of relatively stable organization and periodic transformations into radically different dynamics.[46] "The basic picture is one where nature is perpetually out of balance, but organized in a poised state—the critical state—where anything can happen within well-defined statistical laws." The standard illustration of such a system is a child at beach trickling sand into a pile. The sand she trickles first stays where it lands, forming a pile. If the grains were smooth, like marbles, the sand would never organize

itself into a pile. Friction from the irregular shape of the sand grains makes the pile coherent. Because of the complex variability of the grains of sand, the shape of the pile is unique. The shape of the pile depends on the collection of grains of sand and how they land. Thus, complexity is a core characteristic of Organized Complex Systems.

As the pile accretes, it becomes less stable so that additional sand increasingly does not stay where it lands. Ultimately, an avalanche is caused by adding sand that pushes the pile beyond its critical state. Such an avalanche is a "phase transformation," in the terminology of the physicists. This is very descriptive of financial markets characterized by Flash Crashes, bubble and burst cycles and bank runs, *i.e.,* market avalanches. Financial markets that are Organized Complex Systems would exist in multiple phases ranging from equilibrium to crashes, rendering statistical prediction based on universal probability distributions impossible.[47] The nature of these interactions is better understood as a process of constant reproduction and change, more like an evolving language than a bounded mechanical system.[48]

The potential force of the "avalanche" is greater if the system is more complex. The complexity of the irregularity of particles of sand allows the elements of the system to interact so that the potential force is stored until it is unleashed at the point of criticality. The complex characteristics of the modern financial markets are legion. The forces that hold the market in its apparently stable state until it reaches criticality include the obscurity of value of the securities and derivatives being traded and the interdependent trading operations that finance each other at the same time that they trade against each other.

It is useful to consider the behavior of the investors and banks that profited from the mortgage market crash in 2008 by shorting the market. The mortgage finance market was clearly an Organized Complex System: prime and subprime mortgages, floating, fixed and teaser rate mortgages, tranched bonds, credit default swaps based on mortgage-backed securities and ratings based on complex and opaque statistics, just to name a few complexities. These investors and undoubtedly others perceived that the mortgage markets were approaching a critical state of organization. The question for them was timing and the force of the impending burst of the residential real estate bubble. Though they may not describe their behavior in system dynamics terms, the critical step that they took was to short the market at the correct time. Others who chose a different timing experienced losses rather than profits from going short.[49]

A particularly disturbing feature of financial markets in the context of Organized Complex Systems is the measurement of the price risk of portfolios of financial holdings, as mentioned above. For example, as of this writing, JP Morgan Chase holds more than $3 trillion in assets, virtually all of which are subject to market price risk. Its market capitalization is about $182 billion by comparison. It can hold these assets because it and its regulators calculate the market risk assuming that if the market price of some portion of the assets goes down, the market price of other assets will go up. These hydraulic relationships are called "negative price correlations." The strength of the negative correlations depends on the historic behavior of the prices of the individual assets. The offsetting price risks result in a

calculated portfolio risk that is far lower than the aggregate of the risk of every single asset. In fact, the absolute size of the portfolio is much less important to calculated risk than its negative correlations.

The net risk, after offsets for negative correlations, determines in large part how much the bank and its regulators must set aside to provide for market losses. We can think of the $3 trillion as the pile of sand and the complex price correlations that determine net risk as the friction that holds the pile together.

But what of a phase transformation, or avalanche? This would be the consequence of a general market crash. As with the sand pile, we know that in a market crash virtually everything moves in the same direction. As panic sets in, all market participants become sellers and the correlations among asset prices become positive and approach 100 percent.[50] The premises behind the calculation of capital needed to assure against market loss are no longer true. The capital of the banks is inadequate and a run ensues.

Moreover, Organized Complex Systems are mathematically subject to "power laws." This means that if the potential "avalanches" are sorted according to frequency of probable occurrence, each category of increasing frequency represents a class of occurrence whose intensity is many times more forceful than the prior category. Intensity increases exponentially.[51] This relationship is most aptly analogous to the functionality of a Richter Scale (tectonic faults are Organized Complex Systems). A level 6.5 earthquake is many times more powerful than a level 6.0, although the probability of a 6.5 earthquake is not proportionally lower than that of a 6.0. This disproportion between probability and power derives from the complexity of the components of the seismic fault line that holds the system in place prior to the phase transformation in the form of an earthquake.

Commenting on wild market swings in August 2007 that created large losses in hedge funds, then Goldman Sachs CFO David Viniar said that "[w]e were seeing things that were 25-standard deviation moves, several days in a row."[52] He was ridiculed for the absurdity of the statement (25 standard deviation events statistically occur approximately once in 100,000 years), but it was actually very informative. Phase transformations under power laws result in dynamic conditions that are qualitatively different from those extant prior to the transformation. Statistics, such as Value at Risk, are not useful in describing the results.[53] Viniar, in his surprise, was reflecting the belief that historic market prices are predictive in future market conditions. In a Complex Organized System subject to power law, this reasoning is simply flawed.

Frequent earthquakes (and avalanches and market crashes) are less destructive because power law says that they are exponentially less forceful. That is why a ski patrol will induce smaller avalanches to reduce the forces building up in the complex snow pile. Conversely, conditions that delay an avalanche can cause the force to build up and be exponentially more destructive. Attempts to mitigate the effects of the avalanche, for instance by building

"dams" to impede its flows, are ultimately futile. The only way to reduce the violence of the release of pent-up forces is to reduce the complexity of the system.

CHANGING THE PARADIGM

Decision makers are still trapped in the logic of the EMH and equilibrium systems. They remain persuaded that regulations should be as light as possible to allow markets to achieve efficiencies through equilibrium that, in reality, do not exist.

Much of financial reform requires banks to set aside reserves as buffers against default. Under power laws, mere buffers against default could prevent a small series of financial avalanches only to cause the eventual avalanche to be exponentially more destructive. This suggests that setting money aside to weather the storm of a market crash in amounts based on historic negative price correlations within a portfolio is inadequate and very likely counter-productive unless the financial regulations also significantly limit permitted trading activities such that the system is less complex. To the extent that the financial markets become more complex, the inevitable avalanche in the form of a financial crisis will be more devastating.

Regulations that reduce complexity cannot stop periodic "avalanches," but they can lower the potential force of avalanches that occur. Such regulations would cause the interacting components of the system to be more like marbles than grains of sand.

The theoretical premises behind deregulation were flawed. But so are the premises behind much of today's new regulatory regime. Regulations that merely increase information transparency—access to information—are powerless against financial avalanches. That is because the meaning of the information is difficult to discern. And regulations that require more cash reserves simply delay the point of criticality, probably assuring that when the stored forces are released the avalanche is even more violent. Only direct reduction of complexity will work.

POLICY IMPLICATIONS OF THE NEW PARADIGM

The new paradigm has important implications for financial regulations. If the purpose of regulation is to ensure that financial markets efficiently carry out their core societal purpose of capital intermediation, then, in accordance with the theory expressed herein, regulations should be crafted with the specific purpose of reducing financial market complexity.

The Dodd-Frank Act's approach differs from the new paradigm. Its authors overtly intended to avoid fundamental changes to the financial markets.[54] Dodd-Frank creates rules designed to (a) promote management of the consequences of realized risk through larger and more reliable capital reserves and margining of derivatives; (b) increase derivatives market price transparency; (c) increase prudential regulatory oversight; and (d) increase the availability of operational data and regulatory authority that could aid in the winding up of failed financial institutions.

Some of these measures make trading generally more costly. As a result, complexity may be reduced as a by product. Others, such as derivatives price transparency, reduce the value of informational advantages. However, important and large portions of derivatives trading are exempted from transparency requirements.

On the other hand, suppression of small events can also lead to the occurrence of a large event. Much of Dodd-Frank is aimed at reducing the consequences of systemically important risks. Only direct limitation of complexity can effectively address capital intermediation inefficiency and systemic risk that is a consequence of such inefficiency.

There is also a practical concern. It is easy for regulators to conflate safety and soundness of the financial system with its profitability. So long as financial sector profitability is driven by information advantages and information advantages are most valuable in complex markets, the financial sector will be incented to increase complexity. It is incontrovertible that, compared to agents within the financial sector, regulators will be at a disadvantage in understanding new and complex financial market activities. Therefore, regulators are susceptible to drawing the conclusion that profitability from complexity increases safety and soundness, and to administering rules accordingly, reducing the serendipitous positive effects of Dodd-Frank on complexity. In reality, the profitability is a result of excessive rents that render the market inefficient and increase the likelihood of catastrophic financial crisis. Thus, regulators are very likely to administer rules in ways that are actually counterproductive in terms of their mission.

The best regulatory scheme de-emphasizes concerns with financial sector profitability. The financial sector must function profitably, but its functions must also serve the social purpose of enhancing productivity. Current levels of profitability, in both absolute and relative terms, are inconsistent with rectifying a system that is inefficient from a societal perspective.

Financial innovation in the era of advanced information technology and quantitative analysis is generating more costs than benefits in our society. This is particularly true with regard to innovations introduced by intermediaries whose incentive is to increase their profits. It is also true of many innovations by market infrastructure providers, such as exchanges, that are designed to attract the use of the infrastructure by intermediaries (liquidity providers) rather than to improve intermediation efficiency. Therefore, even innovations by infrastructure providers, which may lower transaction costs, are likely to also serve the interest of intermediaries in increasing the value that they can extract from the intermediation process.

Dodd-Frank is premised on the notion that the basic activities of the financial sector should be continued, but undertaken more prudently and fairly. Competitiveness of domestic financial institutions *vis-à-vis* non-U.S. institutions is actually a goal of Dodd-Frank, which is counterproductive in the context of competition across complex markets. All of this is based on a misconception of the value extracted and the value provided by the financial sector in its current form.

From a broader perspective, the Dodd-Frank regime is largely based on the same analytical construct that the financial sector has adopted from the foundational work of Black/Scholes/Merton in their option-pricing model published in 1973. Risk is valued and correlations are assumed using historic data and probabilities of their recurrence. This approach underlies the Value at Risk model that uses statistics to estimate potential financial risks of a portfolio. The regime is overwhelmingly devoted to erecting firewalls against the recurrence of the consequences of past market performance. Unfortunately, this model is a poor methodology for anticipating market results, especially in rarer but (under the principles of Organized Complex Systems) dramatically more catastrophic events. A model for regulation that is dependent on historic data to predict a range of future outcomes leads regulators to establish rules that address these outcomes. If the markets are viewed in the terms of Minsky's theories and Organized Complex Systems, this approach is, by definition, inadequate.

Specifically, regulatory approaches should assume a market that inherently experiences non linear phase transformations at different scales that transform its dynamics so that historic data becomes a poor predictor of future conditions. A good example of this is a hedging strategy that assumes historic negative correlations of price movements. At the point of criticality, price movements may become uniformly correlated and large. In other words, at the time it is most important, the hedging strategy may multiply the consequences of price movements instead of mitigating them.

In balancing costs and benefits of financial regulation, the presumption that innovations of the last 35 years have social value is not supported by analysis; in fact, such thinking is counterintuitive. Capital intermediaries are incented to innovate in order to increase intermediation inefficiency, not reduce it. Stifling, and preferably rolling back, innovation should not be presumptively evaluated as a cost to society and a burden on productivity. Instead, simplification of capital intermediation by narrowing the breadth of markets, reducing trading activity, and curbing the use of quantitatively complex derivatives constitute *per se* benefits that should be considered as such by policy-makers, regulators and courts.

1. "At its core, EMF implies that arbitrage opportunities for riskless gains do not exist in an efficiently functioning market and that if they do appear from time to time, they do not persist." See: Burton Malkiel, "The Efficient-Market Hypothesis and the Financial Crisis," Russell Sage Foundation (2012), http://www.russellsage.org/sites/all/files/Rethinking-Finance/Malkiel.%20The%20Efficient-Market%20Hypothesis%20and%20the%20Financial%20Crisis%20102611.pdf.
2. Originally articulated by University of Chicago economist Eugene Fama in "Efficient Capital Markets: A review of Theory and Empirical Work," *Journal of Finance* 25 (1970): 383-417, http://efinance.org.cn/cn/fm/Efficient%20Capital%20Markets%20A%20Review%20of%20Theory%20and%20Empirical%20Work.pdf.
3. EMH is closely related to the theory of Rational Expectations Hypothesis, which holds that opinions based on distributions that reflect objective reality will be uniform as long as common information is shared.
4. Roman Frydman and Michael Goldberg, "Financial Markets and the State: Long Swings, Risk and the Scope of Regulation," *Capitalism and Society* 4 (2009), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2209399.
5. Roman Frydman and Michael Goldberg, "Macroeconomic Theory for a World of Imperfect Knowledge," *Capitalism and Society* 3 (2008), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2209264.
6. Fundamental value refers to the intrinsic value of a stock, bond or derivative based on available information. In the context of a share of stock: "Fundamental analysis entails the use of information in current and past financial statements, in conjunction with industry and macroeconomic data to arrive at a firm's intrinsic value." S.P. Kothari, "Capital Markets Research in Accounting," *Journal of Accounting & Economics* 31 (2001): 105-231, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=235798.
7. The Capital Asset Pricing Model describes fundamental value for an individual investor. Its limitations in practice have been well catalogued. See Lynn Stout, "The Mechanics of Market Inefficiency: An Introduction to the New Finance," 2003, available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=470161.
8. Alexander Hamilton, "To the Speaker of the House of Representatives, 1790: Report on a National Bank, available at http://american_almanac.tripod.com/hambank.htm.
9. Michael Benton, "Thomas Jefferson on Banks," December 2012, http://aboutthomasjefferson.com/thomas-jefferson-on-banks/243; Thomas Philippon, "The Size of the U.S. Finance Industry: A Puzzle," November 2011, http://www.newyorkfed.org/research/conference/2011/NYAMP/Fed_Philippon_v1.pdf.
10. Thomas Philippon, "The Size of the U.S. Finance Industry: A Puzzle," November 2011, http://www.newyorkfed.org/research/conference/2011/NYAMP/Fed_Philippon_v1.pdf.
11. Simon Johnson and James Kwak, *13 Bankers: The Wall Street Takeover and the Next Financial Meltdown* (New York: Pantheon, 2010), 59.
12. An excellent example of this analytical approach can be found in a recent study of high-frequency trading. Charles M. Jones, "What Do We Know About High-Frequency Trading?" *Columbia Business School Research Paper 13-11* (2013), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2236201.
13. This period most often is said to commence with the election of Ronald Reagan in 1980. That is when deregulation, per se, became a policy of a political party in power.
14. Johnson and Kwak, *13 Bankers*, 59.
15. Gerald Epstein, "Financialization, Rentier Interests, and Central Bank Policy"(paper presented at the University of Massachusetts at Amherst, Political Economy Research Institute (PERI) Conference on Financialization of the World Economy, December 7 8, 2001, http://www.peri.umass.edu/fileadmin/pdf/financial/fin_Epstein.pdf.
16. Gretta R. Krippner, *Capitalizing on Crisis: The Political Origins of the Rise of Finance* (Cambridge: Harvard University Press, 2011), 27.
17. Thomas Philippon, "Has the U.S. Finance Industry Become Less Efficient: On the Theory and Measurement of Financial Intermediation," National Bureau of Economic Research (NBER) Working Paper No. 18077 (2012), http://pages.stern.nyu.edu/~tphilipp/papers/Finance_Efficiency.pdf.

18. Under EMH, price formation in the trading markets is inherently efficient as new information is incorporated rapidly into the marketplace. Thus, the cost of individual transactions defines the cost of capital intermediation. Technological advances likely reduce individual transaction costs (though this is not uniformly the case). Under EMH, the reduction of individual transaction costs through technology by definition reduces the cost of capital intermediation.

19. Krippner, *Capitalizing on Crisis*, 52-54.

20. Thomas Philippon, "The Future of the Financial Industry," *Stern on Finance* Blog, November 6, 2008, http://w4.stern.nyu.edu/blogs/sternonfinance/2008/11/the-future-of-the-financial-in.html.

21. Thomas Philippon, "The Evolution of the U.S. Financial Industry from 1860 to 2007: Theory and Evidence," November 2008, http://economics.stanford.edu/files/Philippon5_20.pdf; Williams J. Baumol, "Macroeconomics of Unbalanced Growth: The Anatomy of the Urban Crisis," *American Economic Review* 57(1967): 415-426.

22. "Corporate Profits in GDP," Yardeni Research, Incorporated, August 8, 2013.

23. These data may dramatically understate the real world phenomena, however. Investment bankers have traditionally been compensated primarily by bonuses. Bonuses are calculated with reference to the firm's performance and the individual's performance. Therefore an investment banker is, practically speaking, a participant in the profits and losses of the firm. This is even starker for traders at banks and hedge funds. These individuals receive a stake in the form of an allocation of firm capital on which to trade. They conduct themselves as if they are running their own individual businesses and sharing the profits with their employer. Therefore the calculation of profit share should include a very large percentage of the bonuses paid to investment bankers and traders.

24. World Bank, "Domestic Credit Extended by Banking Sector (% of GDP)," available at http://data.worldbank.org/indicator/FS.AST.DOMS.GD.ZS/countries/1W-US?page=6&display=default.

25. Thomas Philippon, "The Evolution of the U.S. Financial Industry from 1860 to 2007: Theory and Evidence."

26. Philippon, "Financial Intermediation."

27. Raghuram Rajan, *Fault Lines* (Princeton: Princeton University Press, 2010), 84-89.

28. The period has already exceeded 47 months. "Business Cycle Expansions and Contractions," National Bureau of Economic Research (NBER), http://www.nber.org/cycles.html.

29. For example, trading revenues for FDIC insured banks increased from 1984 twice as fast as other revenues up to the financial crisis and have recommenced their increase thereafter. "Annual Income and Expense of FDIC-Insured Commercial Banks and Savings Institutions," http://www2.fdic.gov/qbp.

30. It is likely that the equilibrium dynamics implied by EMH exist under certain market conditions, but that financial markets move through phase transformations into other dynamic conditions, discussed below. *See* Rossitsa Yalamov and Bill McKelvey, "Explaining What Leads Up to Stock Market Crashes: A Phase Transition Model and Scalable Dynamics," *Journal of Behavioral Finance* (2011), available at http://www.tandfonline.com/doi/abs/10.1080/15427560.2011.602484#.UhN0sFPailM However, even if this is accurate, the conditions in which EMH controls are infrequent and unimportant in terms of real world concerns.

31. For a further discussion, see Wallace Turbeville, "Cracks in the Pipeline, Part One: Restoring Efficiency to Wall Street and Value to Main Street," Dēmos (2012), http://www.demos.org/publication/cracks-pipeline-restoring-efficiency-wall-street-and-value-main-street.

32. Wallace Turbeville, "Cracks in the Pipeline, Part Two: High Frequency Trading," Dēmos (2013), http://www.demos.org/publication/cracks-pipeline-part-two-high-frequency-trading.

33. Wallace Turbeville, "Cracks in the Pipeline, Part Three: "Derivatives: Innovation in the Era of Deregulation," Dēmos (2013) http://www.demos.org/publication/derivatives-innovation-era-financial-deregulation.

34. Fundamental information is used here to mean information that is relevant to the present value of the future cash flows from the security or derivative, discounted at a rate that reflects risk. Myron J. Gordon, *The Investment Financing and Valuation of the Corporation* (Homewood, Illinois: Irwin, 1962).

35. Regulatory regimes define the boundaries of market structures. Under an ideal regulatory regime, markets would be efficient, i.e. observed prices would be equal to equilibrium prices based on fundamental value, and they would also be stable, i.e., deviate little (or not at all) from those equilibrium prices. The conceptual measure, then, is (1) the extent of deviation (reflecting asymmetric information and oligopoly power), over the long-run and the short-run, of observed prices from efficient, fundamentally sound, prices under the regulatory regime being evaluated; and (2) the degree to which that "spread" varies both over the short run and long run (non-fundamental volatility and price bubbles, respectively).

36. OCC's Quarterly Report on Bank Trading and Derivatives Activity—Fourth Quarter 2012," Office of the Comptroller of the Currency, http://www.occ.gov/topics/capital-markets/financial-markets/trading/derivatives/dq412.pdf.

37. Alan S. Blinder, Andrew W. Lo and Robert M. Solow, editors, *Rethinking the Financial Crisis* (Ithaca: Cornell University Press Services, 2012).

38. For example, the explanation of price bubbles and bursts is difficult under EMH. Advocates resort to the explanation that one trader may know the price is too high, but he or she does not know if other traders know. This does not help with understanding the forces that create price anomalies that lead to bubbles.

39. Hyman Minsky, *Stabilizing an Unstable Economy* (New York: McGraw-Hill, 2008), 9.

40. Linearity refers to a condition in which effects are proportionate to causes. Thus cause and effect can be charted using a straight line. Nonlinearity, as used by Professor Minsky means that effects are geometrically related to causes and, if graphed, would be depicted by an ever-increasing curve.

41. Minsky, *Unstable Economy*, 11 (footnote 9).

42. *See* Didier Sornette, *Why Stock Markets Crash: Critical Events in Complex Financial Systems* (Princeton, New Jersey: Princeton University Press, 2003). This and related work undertakes to predict market crashes. The predictive use of system dynamics is less relevant to this paper than its value as descriptive from an ontological perspective.

43. Malkiel, "Efficient-Market Hypothesis."

44. George Soros has described financial markets in equilibrium as an extreme case of negative feedback between market participants' expectations and the actual course of events, and market price bubbles as an extreme case of positive feedback. George Soros, "Session 1: Anatomy of Crisis--The Living History of the Last 30 Years: Economic Theory, Politics and Policy" (paper presentation at the Institute for New Economic Thinking (INET) Conference at King's College, April 8 11, 2010), http://ineteconomics.org/sites/inet.civicactions.net/files/INET%20C%40K%20Paper%20Session%201%20-%20Soros.pdf.

45. For an excellent explanation in the context of commodity markets, *see* Vladimir Filimonov, David Bichetti, Nicolas Maystre and Didier Sornette, "Quantification of the High Level of Endogeneity and of Structural Regime Shifts in Commodity Markets," (Pre Printed discussion paper submitted to the United Nations Conference on Trade and Development, March 21, 2013), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2237392.

46. Per Bak, *How Nature Works—The Science of Self-Organized Criticality* (Göttingen, Germany: Copernicus, 1996); Didier Sornette, Why Stock Markets Crash.

47. Rossitsa Yalamov and Bill McKelvey, "Explaining What Leads Up to Stock Market Crashes."

48. Tony Lawson, "Really Reorienting Modern Economics," (paper presentation at the Institute for New Economic Thinking (INET) Conference at King's College, April 8 11, 2010), http://ineteconomics.org/sites/inet.civicactions.net/files/INET%20C%40K%20Paper%20Session%206%20-%20Lawson.pdf.

49. One is reminded of the famous 2007 quote of Citigroup CEO Chuck Prince: "When the music stops, in terms of liquidity, things will be complicated. But as long as the music is playing, you've got to get up and dance. We're still dancing." See Michiyo Nakamoto, "Citigroup Chief Stays Bullish on Buy outs," *Financial Times*, July 9, 2007, http://www.ft.com/cms/s/0/80e2987a-2e50-11dc-821c-0000779fd2ac.html#axzz2b2e6P0Kx.

50. Tobias Preis, Dror Kenett, H. Eugene Stanley, Dirk Helbing and Eshel Ben-Jacob, "Quantifying the Behavior of Stock Correlation Under Market Stress," Scientific Reports 2 (2012), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2170038.

51. This is easily understood. Since the complexity that holds the system in its organized state is multidimensional, the force that is stored in an Organized Complex System increases exponentially as the size of the system increases.

52. Peter T. Larsen, "Goldman Pays the Price of Being Big," *Financial Times*, August 13, 2007, http://www.ft.com/cms/s/0/d2121cb6-49cb-11dc-9ffe-0000779fd2ac.html#axzz2cKoV7gyT.

53. Remarks of J. Doyne Farmer (videotaped presentation at the Institute for New Economic Thinking (INET) Conference at King's College, April 8 11, 2010), http://ineteconomics.org/video/conference-kings/networks-and-systemic-risks-j-doyne-farmer.

54. Robert G. Kaiser, *Act of Congress: How America's Essential Institution Works, and How it Doesn't* (New York: Knopf, 2013), 26.