8 EXPLAINING BUBBLES

The Financial Crisis of 2008 and its economic consequences have spawned an enormous academic literature across the spectrum of empirical and theoretical scholarship. Yet the number of rigorous works of historical analysis that take financial discontinuities as their focus is limited. The two that stand out are Charles Kindleberger's *Manias, Panics and Crashes: A History of Financial Crises*, originally published in 1978 and updated in 2011 by Robert Aliber, and Carmen Reinhart and Kenneth Rogoff's recent contribution, *This Time is Different: Eight Centuries of Financial Folly*. The former indicates by means of its subtitle that its authors evaluate "manias" largely in terms of the panics and crashes that follow. The latter is the definitive chronicle of currency debasement, debt default and banking failures. Bubbles, recent and long ago, have attracted less attention.[1]

Manias and the Credit System

A first step toward comprehending the dynamics of bubbles is to distinguish the consequences of speculative excess in the credit markets from the effects of speculative excess in the equity markets. Manias that infect

[1] C. P. Kindleberger and R. Z. Aliber, *Manias, Panics and Crashes: A History of Financial Crises*, 6th edn. (New York: Palgrave Macmillan, 2011), and C. M. Reinhart and K. S. Rogoff, *This Time is Different: Eight Centuries of Financial Folly* (Princeton University Press, 2009).

the credit system generate the great financial crises and subsequent contractions in real economies. Such contractions are inevitable when – as is necessarily the case in the real world – markets are incomplete and effective hedges are unavailable. As Franklin Allen and Douglas Gale conclude in *Understanding Financial Crises*:

> When markets are incomplete, financial institutions are forced to sell assets in order to obtain liquidity. Because the supply of and the demand for liquidity are likely to be inelastic in the short run, a small degree of aggregate uncertainty can cause large fluctuations in asset prices. Holding liquidity involves an opportunity cost and the suppliers of liquidity can only recoup this cost by buying assets at firesale prices in some states of the world; so, the private provision of liquidity by arbitrageurs will always be inadequate to insure complete asset-price stability. As a result small shocks can cause significant asset-price volatility. If the asset-price volatility is severe enough, banks may find it impossible to meet their fixed commitments and a full-blown crisis will occur.[2]

A compromised banking system that is counting its losses from funding speculative projects necessarily reduces the supply of credit, on which all economic activity depends. Equity bubbles, by contrast, tend to leave relatively little wreckage behind. The run-up to the Great Crash of 1929 was financed only to a limited extent by credit, even before margin requirements were imposed by the authorities to limit borrowing to fund the purchase of stocks. Lester Chandler calculates that, at their pre-Crash peak, total loans to Wall Street brokers and dealers amounted to less than 10 percent of the value of shares listed on the NYSE.[3] A recession did follow the crash in equity prices in October 1929. But it took the successive wave of banking crises in 1931–1933 to freeze the market economies of the world into the Great Depression.

Kindleberger and Aliber and Reinhart and Rogoff agree that "private debt surges," often fueled by an influx of capital from abroad – a "capital flow bonanza"[4] – are the critical conditions that precede financial crises. Kindleberger and Aliber expand on this theme:

[2] F. Allen and D. Gale, *Understanding Financial Crises* (Oxford University Press, 2007), pp. 127–128.

[3] L. V. Chandler, *American Monetary Policy, 1929–1941* (New York: Harper & Row, 1971), pp. 31–32.

[4] Reinhart and Rogoff, *This Time is Different*, p. 157.

> The cycle of manias and panics results from the pro-cyclical changes in the supply of credit; the credit supply increases relatively rapidly in good times and then when economic growth slackens, the rate of growth of credit has often declined sharply . . . During the economic expansion investors become increasingly optimistic and more eager to pursue profit opportunities that will pay off in the distant future while the lenders become less risk-averse. Rational exuberance morphs into irrational exuberance, economic euphoria develops and investment spending and consumption spending increase.
>
> There is a pervasive sense that it is "time to get on the train before it leaves the station" and the exceptionally profitable opportunities disappear. Asset prices increase further. An increasingly large share of the purchases of these assets is undertaken in anticipation of short-term capital gains and an exceptionally large share of the purchases is financed with credit.[5]

Kindleberger and Aliber here invoke the qualitative model developed by Hyman Minsky – his Financial Instability Hypothesis – which has two theorems. First, "the economy has financing regimes under which it is stable, and financing regimes in which it is unstable." And, second, "over periods of prolonged prosperity, the economy transits from financial relations that make for a stable system to financial relations that make for an unstable system."[6] The credit system and the economy at large progress (or degenerate) through successive stages of confidence and risk-taking. The initial, conservative stage is that of *hedge finance*: the operating cash flows of borrowers are sufficient both to service outstanding debts and to repay them as they mature. As expectations of borrowers and lenders are validated by experience, they jointly move into the phase of *speculative finance*. Operating cash flow is sufficient to make timely payment of interest, but the principal must be rolled over and refinanced to prevent default and hence is exposed to changing market conditions: this is the speculative element. Finally, the system moves into the stage of *Ponzi finance*, where debtors must borrow the interest they owe to indulgent lenders in order for the fiction of solvency to be maintained.[7]

[5] Kindleberger and Aliber, *Manias, Panics and Crashes*, p. 13.

[6] H. P. Minsky, "The Financial Instability Hypothesis," The Levy Economics Institute of Bard College Working Paper 74 (1992), pp. 7–8.

[7] H. P. Minsky, *Stabilizing an Unstable Economy* (New Haven, CT: Yale University Press, 1986), p. 70.

I knew Minsky well during the last decade of his active career, before and after he retired from Washington University in St. Louis to join the Levy Economics Institute at Bard College. We were introduced, appropriately enough, by a fellow board member of the Mark Twain Banks. Thus, at a time when he and his work lay beyond the scope of mainstream economics and finance, I had the opportunity to grasp his prescient analysis of the historically unprecedented emergence of big-state capitalism. As the super-bubble of 1982–2007 unfolded stage by stage, this proved to be an extraordinarily valuable advantage.

Big-state Capitalism

It took interacting transformations in the institutional, intellectual and technological environments to produce the super-bubble. The first was the emergence of big-state capitalism from the aftermath of the Depression and World War II. Whether the change was principally driven by political commitments to public welfare, as in Europe, or by commitments to national security, as in the United States, the weight of the state in the national economy increased from about 10–15 percent *circa* 1929 to more than 30 percent in the United States, and as much as 50 percent in parts of Europe. As Minsky understood, here was the critical institutional bulwark against "it" – a Great Depression – happening again.[8]

To explain the stabilizing role the big state plays, Minsky identified the three complementary contributions that substantial fiscal deficits make to a financially stressed economy: they generate income and employment; they generate cash flow that protects the corporate sector from the reduction in revenues generated by household decisions to save rather than spend; and they supply low-risk investment instruments for investors when the state issues securities to finance its own negative cash flow. Minsky continues:

> The effect of Big Government on the economy is much more powerful and pervasive than is allowed by the standard view which neglects the financial-flow and portfolio implications of a government deficit. The standard view focuses solely on the direct

[8] H. P. Minsky, *Can "It" Happen Again? Essays on Instability and Finance* (New York: M. E. Sharpe, 1982).

> and secondary effects of government spending . . . on aggregate demand. The expanded view allows both for the cash flows that other sectors need in order to fulfill commitments and for the need for secure assets in portfolios in the aftermath of a financial disturbance.[9]

Throughout the super-bubble, government deficits were complemented by aggressive central bank interventions whenever needed. In the United States, these came to be personified as the "Greenspan Put." First successfully deployed in response to the stock market crash of 1987, then offered in support of the extended resolution of the savings and loan crisis from 1989 to 1994, it was repeated in 1998, when the blow-up of Long-Term Capital Management capped the Russian and Asian debt crises, and again invoked when the dotcom/telecom bubble definitively burst in 2001. On each occasion, the Fed reduced its policy interest rate and aggressively supplied reserves to the banking system.

George Soros has echoed Minsky in attributing the super-bubble to the increasing credibility of government commitments to underwrite the health of the private sector:

> What made the super-bubble so peculiar was the role that financial crises played in making it grow. Since the belief that markets could be safely left to their own devices was false, the super-bubble gave rise to a series of financial crises . . . Each time a financial crisis occurred, the authorities intervened, merged away or otherwise took care of the failing financial institutions, and applied monetary and fiscal stimuli to protect the economy. These measures reinforced the prevailing trend of ever increasing credit and leverage, but as long as they worked, they also reinforced the prevailing misconception that markets can be safely left to their own devices. It was the intervention of the authorities that saved the system; nonetheless these crises served as successful tests of a false belief, and, as such, they inflated the super-bubble even further.[10]

Moritz Schularick and Alan Taylor quantified Soros's observation, taking a long view from 1870 to the present. In the earlier epoch of small-state capitalism, until 1939, the ratio of bank loans to the broadly

[9] Minsky, *Stabilizing an Unstable Economy*, p. 21.

[10] G. Soros, *The Soros Lectures at the Central European University* (New York: Public Affairs, 2010), p. 39.

defined money supply grew at an annual rate of just 0.11 percent, compared with an annual growth of 2.19 percent – twenty times greater – in the postwar era. And this is before account is taken of the emergence of the nonbanking sources of finance, the "shadow banking" system of securitized vehicles and hedge funds that proliferated from the 1980s. Schularick and Taylor's conclusion echoes that of Soros:

> The stable relationship between money and credit broke down after the Great Depression and World War 2, as a new secular trend took hold that carried on until today's crisis. We conjecture that these changes conditioned, and were conditioned by the broader environment of macroeconomic and financial policies: after the 1930s the ascent of fiat money plus Lenders of Last Resort – and a slow shift back towards financial *laissez-faire* – encouraged the expansion of credit ... Aiming to cushion the real economic effects of financial crises, policy-makers have prevented a periodic deleveraging of the financial sector resulting in the virtually uninterrupted growth of leverage we have seen up until 2008.[11]

Thus, the maturation of the Three-Player Game reflexively contributed to the game's systemic instability.

Modern Finance Theory

The second enabling factor in the generation of the super-bubble took place in the realm of theory. Modern finance theory equipped the players both with tools for defining and deploying novel securities and with strategies for trading and hedging them. Theory also rationalized the retreat of the regulatory state. As Minsky correctly predicted, only action by the authorities "to control, constrain and perhaps even forbid the financing practices that caused the need for lender-of-last-resort activity" could prevent its recurrence. Instead, in the political domain the super-bubble was accompanied by the repeal of Glass–Steagall in 1999 and the legislated exemption of derivatives from regulatory oversight in 2000. The consequence was the financialization of the economic system to a degree never before known.

[11] M. Schularick and A. M. Taylor, "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles and Financial Crises, 1870–2008," *American Economic Review*, 102(2) (2012), p. 1058.

The foundations of the theoretical revolution in finance were laid in the 1950s, when Kenneth Arrow and Gerard Debreu created the mathematical model of general equilibrium on the basis of the posited existence of an infinite array of contingent contracts specifying what goods and services are to be delivered where and when and under what conditions.[12] I have always thought of the Arrow–Debreu model of what is necessary for the notion of general equilibrium to be theoretically imaginable as a sort of existence *dis*proof: the world it defines is utterly contrary to the world we live in and know. But its mathematics was seized on as a road map toward the Utopia of complete and efficient markets, whose realization would eliminate any legitimate role for the state in the market economy beyond that of watchkeeper.

At roughly the same time, Harry Markowitz established the basis of the capital asset pricing model (CAPM) by defining risk as the statistical variance of a time series of stock prices.[13] Ten years later, Fischer Black, Myron Scholes and Robert Merton jointly and severally developed a method for pricing options that radically extended the range of financial instruments and the scale on which they were traded.[14] To hopeful theorists and practitioners alike, it seemed that the imaginary perfectly and perpetually hedged world of Arrow–Debreu was within their grasp. And so the theorists of academic finance weighed into this most contested front in the Three-Player Game.

Donald MacKenzie, in his comprehensive work *An Engine Not a Camera*, exhaustively explores the manner in which modern finance theory served not as a camera for representing the behavior of the financial markets, but as an engine for transforming them:

> Finance Theory has become incorporated into the infrastructure of financial markets in at least three ways: technical, linguistic and legitimatory. All three are most evident in the case of financial derivatives, the emergence and development of which have been

[12] K. J. Arrow and G. Debreu, "Existence of an Equilibrium for a Competitive Economy," *Econometrica*, 22 (1954), pp. 265–290.

[13] H. M. Markowitz, "Portfolio Selection," *Journal of Finance*, 7(1) (1952), pp. 77–91.

[14] F. Black and M. Scholes, "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy*, 81(3) (1973), pp. 637–654, and R. C. Merton, "Theory of Rational Option Pricing," *Bell Journal of Economics and Management Science*, 4(1) (1973), pp. 141–183.

> perhaps the most dramatic change in global finance since the start of the 1970s.[15]

At the technical level,

> Derivatives-pricing models implemented in software give large players in the derivatives market, notably investment banks, the ability mathematically to analyze and decompose the risks involved in their portfolios, and this is vital for their capacity to operate on a large scale in this market.

Linguistically, "The theory offers a way of talking about markets, especially about markets whose complexity might otherwise be baffling." And, finally, decisively, in a way that legitimized a revolution:

> To say of a financial market that it is "efficient" – that its prices incorporate, nearly instantaneously, all available price-relevant information – is to say something commendatory about it, and that has been what orthodox financial economics has said about the central capital markets of the advanced industrial world . . . Derivatives were haunted by the impression, held not only by lay-people but by many market-regulators, that they were simply wagers on the movement of prices . . . Economists helped make the financial derivatives markets possible by providing initial legitimacy.[16]

The triumph was confirmed when the accountants and regulators bought into the doctrine of market efficiency by requiring that assets and liabilities be marked to market on the balance sheets of banks and of their customers, providing a potent accelerant to the systemic movement into the regime of Ponzi finance.[17]

It is an error to blame the theorists of finance exclusively for the catastrophe that ensued. The practitioners were all too inclined to short-circuit the mathematics in the name of computational convenience. Thus, what came to be established as the standard methodology for assessing potential loss – Value at Risk (VaR) – was the invention of practitioners who constructed a tool that excluded the most extreme possible outcomes, since it is defined to quantify what is likely to occur

[15] D. MacKenzie, *An Engine Not a Camera: How Financial Models Shape Markets* (Cambridge, MA: MIT Press, 2008), p. 250.
[16] *Ibid.* 251–252.
[17] H. S. Shin, *Risk and Liquidity* (Oxford University Press, 2010), pp. 9–10.

some specified 95 percent or 99 percent of the time. All too often the VaR methodology was implemented through models that assumed a "normal" distribution of returns, even though observation readily showed that the distribution of positive and negative returns on investment exhibits "fat tails," the statistical signals of bubbles and busts. Again, in the name of computational efficiency, the historical record that was examined to establish the distribution of returns was often no more than two or three years. And since the entire purpose of risk management is to limit possible gains in order to limit possible losses, managers incentivized by one-way compensation plans typically turned a blind eye while the traders in the front office, where the money was made – equipped with better computers and more testosterone – gamed the risk officers in the mid-office.

The capstone to the translation of modern finance theory into market-transforming instruments came with the invention of credit derivatives in 1997 and their subsequent hijacking. The original purpose of the young innovators at J. P. Morgan was to distribute and diversify the bank's book of corporate loans. Unlike corporate bonds, whose standardized contracts had enabled trading in more or less liquid markets for hundreds of years, loans were too customized to be liquid. The credit default swap enabled the bank to transfer the risk of default on a diversified portfolio of corporate loans, and thus reduce its required reserves, while still retaining ownership of the obligation and the relationship with the customer that the obligation represented. It was an unequivocal contribution to increasing the efficiency of the bank's management of its balance sheet.

Critically, however, the term *swap* in this context was and is misleading. The instruments that had emerged in the foreign exchange and fixed income markets involved the unconditional swap of two financial assets – a stream of fixed versus floating interest rate payments for a specified period, for example, or a defined amount of dollars for pounds. But a credit default swap contract is an entirely contingent arrangement whereby one party buys protection by paying a periodic fee to its counterparty, who in turn will pay an agreed sum only if and when an event, typically a default, occurs to a third, "reference" entity.

If this sounds like an insurance policy, in economic substance it is. But the entirely unregulated credit default swap contract differs from legally defined insurance in two critical respects. First, the protection seller is under no obligation to establish reserves against the contingent

obligations established by the contract. Second, the protection buyer need have no "insurable interest" in the referenced entity, so the instrument was as available to those who wished to bet on the health of an issuer of debt as to those seeking to hedge an already exposed position.

The attraction of this innovation was demonstrated by the explosive growth in the gross nominal amount of credit default swap contracts outstanding, from zero to $60 trillion in a decade. Credit default swaps provided the illusion of effective risk transfer and therefore entitled their purchasers to earn incremental returns from taking on more risk. But the effectiveness of the risk transfer was only as good as the access to cash of the weakest counterparty in the daisy chain. The regulators and the ratings agencies all bought into the fantasy that risk had been reduced by distributing more broadly exposure to the underlying pool of debts.

As would not have surprised Minsky, with the proliferation of credit default swaps came a radical shift in the nature of the underlying portfolios of securities whose risk of default was being distributed. From the relatively conservative, low-risk loans on the books of J. P. Morgan where it all began, credit default swaps were applied to any and all structured financial products, most notoriously to the collateralized debt obligations whose underlying assets were high-risk, subprime mortgages. Should the risk of default of the underlying liabilities ever become correlated in the real world beyond the financial sector, the daisy chain of risk transfer would turn into a chain reaction of liquidations.[18]

The IT Revolution and the Bursting of the Super-bubble

Finally, the impact of modern finance theory on modern finance practice would never have been realized except for the IT revolution. In no sector of the world economy did advances in computing have a more revolutionary effect than in finance. Here was a world peopled by smart, rich and intensely competitive players who were swimming in oceans of data. The trading desks rapidly moved beyond deploying computers

[18] G. Tett, *Fool's Gold: How the Bold Dream of a Small Tribe at J. P. Morgan was Corrupted by Wall Street Greed and Unleashed a Catastrophe* (New York: Free Press, 2009), chaps. 3 and 4.

merely to transact and record the growing volume of trades on the stock exchange. Traders mobilized computers to analyze data in order both to identify opportunities for profitable arbitrage and to create new instruments for trading, from swaps of currency and interest payments, to instantaneously updated stock indices, to asset-backed securities of all sorts, beginning with mortgages and extending to credit card receivables and student loans.

None of this profusion would have been imaginable, let alone possible to implement, without computers. Wall Street was the first commercial market that seized on the new, post-IBM architecture of distributed computing, arming its traders with high-performance workstations and networking them to databases that could both capture trades and provide the data to inform trading strategies. As I learned directly through OpenVision/VERITAS and then through BEA, Wall Street was *the* market for innovative IT. By making it possible to transform credit instruments that had traditionally been bought and held by lenders into tradable securities, computerization enabled the extension of the originate-and-distribute model from the equity and bond markets across the entire spectrum of credit, even as it also offered the false promise of constructing insurance against loss.

Hyun Shin has provided a rigorous analysis of the construction of the financial catastrophe of 2008 that pulls together its contributing elements. Underwritten by the Greenspan Put and the offsetting contributions of the big state at each stage of cumulating stress, the banks could maintain their target levels of leverage through the bursting of each bubble and out the other side. When the market value of their assets again rose, it was reflected in their balance sheets, spilling over into their equity while the value of their liabilities remained fixed. Thus, it reduced the ratio of assets and of liabilities to capital below the targeted level. The resultant excess capital could be deployed in more lending to the nonfinancial sector, and indeed it was.

Critically, when the supply of assets from the nonfinancial sector proved inadequate, the banks could lend to each other: taking in each other's washing, as it were, to push the assets of each back up to the desired level. And the supply of assets from the financial sector – defined and rationalized by modern finance theory and produced through the application of IT – was literally limitless.[19] However, no

[19] Shin, *Risk and Liquidity*, pp. 111–125, 153–160.

possible increase in the cash flows of the market economy could validate the excessive structure of finance. A modest uptick in late payments on mortgages was all it took to trigger the end of the game.

The bursting of the super-bubble in 2008 has had grave consequences for economic performance and for political agendas across the developed world. Nowhere have the consequences been more extreme, however, than in the disciplines of economics and finance, separated from each other's interdependent embrace a long generation ago and now in process of recombining. For the financial crisis and its economic consequences have shattered the assumption that financial markets are necessarily efficient and that they will reliably generate prices for financial assets that are locked on to the fundamental value of the physical assets embedded in the nonfinancial, so-called real economy. If that assumption were correct, economics and finance could go their separate ways, confident that each could take the efficiency of the other for granted. Now that it has most dramatically been proven *not* to be correct, understanding the contingent interaction of financial capitalism and the market economy has become a central issue in the reconstruction of economics hailed in the Coda to this second edition.

Market Reality Challenges Market Theory

As we have seen, bubbles in the prices of financial assets are found everywhere, and the more those bubbles are leveraged by the extension of credit, the greater "the grand piano smash" (my mother's term) that must follow. But it is the emergence of the asset price bubble itself – the divergence of the market price of an asset from the discounted present value of the cash flows that accrue to the owner – that has challenged theorists. Until lately, it was necessary for the most part to rely on higher journalism and popular history to explore this subject: from Daniel Defoe's *Anatomy of Exchange Alley*, replete with tales and denunciations drawn from the South Sea Bubble, to Charles Mackay's *Extraordinary Popular Delusions and the Madness of Crowds*, and on to John Kenneth Galbraith's *The Great Crash* and John Brooks's *The Go-Go Years*.[20] The most comprehensive and insightful volume is

[20] D. Defoe, *The Anatomy of Exchange Alley; Or, a System of Stock-Jobbing* (Stamford, CT: Gale ECCO, 2010 [1719]); C. Mackay, *Extraordinary Popular Delusions and the*

Edward Chancellor's *Devil Take the Hindmost*, published in 1999 just as the dotcom/telecom bubble was adding another chapter to his history of financial speculation.[21]

All attempts to model equity bubbles in rigorous fashion must begin by standing up to the founding dogma of complete and efficient markets. To repeat, this asserts the prices of financial assets incorporate all relevant information and correspond to the fundamental economic value of the real assets they represent. Originally presented as an empirical observation about the equity market, suggesting how hard it is for an investor to outperform the stock market index persistently, the Efficient Market Hypothesis (EMH) was extended to theoretical proof that markets would yield an efficient allocation of resources.[22] EMH came under early assault by Sanford Grossman and Joseph Stiglitz's demonstration of "the impossibility of informationally efficient markets": if there truly is no profit to be made by investing, there is no incentive to undertake the work required to generate the information that makes the market efficient in the first place. [23] Just how vulnerable the EMH has become in its successively weaker forms has been demonstrated by Hashem Pesaran, who rigorously explores the emergence of bubbles and crashes when the beliefs of heterogeneous investors converge at times of extreme hope of profit or fear of loss.[24]

Perversely, however, the most unrealistic response to the undermining of EMH proved for a generation to be the most influential within the discipline. Through the Rational Expectations Hypothesis (REH), the assumptions necessary to conclude that financial markets behave as if they were complete and efficient are displaced from the world out there to the mind of the "rational representative agent." This agent is supposed not only to have access to all relevant information and the capacity to process it, but also to have a model of what that information

Madness of Crowds (Petersfield: Harriman House, 2009 [1841]); J. K. Galbraith, *The Great Crash, 1929* (New York: Houghton Mifflin, 1988 [1954]); J. Brooks, *The Go-Go Years: When Prices Went Topless* (New York: Ballantine, 1974).

[21] E. Chancellor, *Devil Take the Hindmost: A History of Financial Speculation* (New York: Penguin, 1999).

[22] I owe this insight to Jose Scheinkman.

[23] S. J. Grossman and J. Stiglitz, "On the Impossibility of Informationally Efficient Markets," *American Economic Review*, 70(3) (1980), pp. 393–408.

[24] H. Pesaran, "Predictability of Asset Returns and the Efficient Market Hypothesis," in A. Ullah and D. E. Giles (eds.), *Handbook of Empirical Economics and Finance* (Boca Raton, FL: Chapman and Hall / CRC, 2010), pp. 281–312.

means – what processes generate the information and what their future realizations will be – that happens to be true.[25]

The overriding justification for the mind games of EMH and REH are that – if we suspend our disbelief and accept their premises – the markets of the financial system will efficiently allocate capital across the competing alternative projects available in the real economy. So advocates of EMH and REH begin by denying the reality that only imperfect information is available to economic and financial actors in the world in which we are doomed to live.[26]

Eugene Fama, a founding author of the EMH and recipient of the Nobel Memorial Prize in Economics, has persisted in his denial of the existence of bubbles in the equity markets.[27] He has elicited a detailed empirical response that confirms the reality: accelerating increases in stock prices, while they "do not predict unusually low future returns on average, *do* predict a heightened probability of a crash." What's more, "some characteristics of sharp price rise episodes do help predict future returns . . . Increases in volatility, issuance, the relative performance of new versus old firms, and acceleration tend to be predictive characteristics."[28]

At an even deeper level, the pursuit of allocative efficiency as the core economic virtue blinds its acolytes to the dynamics of the Innovation Economy, where the waste generated by experimentation is essential to progress and tolerance of that waste is a prime condition for leadership at the frontier. For when economic growth over time is driven by unpredictable bursts of technological innovation that is speculatively financed, the allocation of resources to research and development at any moment in time is bound to appear inefficient in static economic terms. Conversely, any attempt to express the Innovation Economy's dynamics as an exercise in "intertemporal optimization" by rational agents operating in efficient markets will sacrifice relevance

[25] Robert E. Lucas Jr., the founding theorist of the doctrine, summarized the path to REH in his Nobel Prize lecture: "Nobel Lecture: Monetary Neutrality," *Journal of Political Economy*, 104(4) (1996), pp. 661–682. Available at www. nobelprize.org /nobel_prizes/economics/laureates/1995/lucas-lecture.pdf.

[26] R. Frydman and M. Goldberg, *Beyond Mechanical Markets: Asset Price Swings, Risk, and the Role of the State* (Princeton University Press, 2011), pp. 55–102.

[27] See E. G. Fama, "Two Pillars of Asset Pricing," *American Economic Review*, 104 (2014), pp. 1467–1485.

[28] R. Greenwood, A. Shleifer and Y. You, "Bubbles for Fama," National Bureau of Economic Research Working Paper 23191 February (2017), pp. 3–4.

in pursuit of rigor. So Giovanni Dosi characterizes the New Growth Theory developed by Paul Romer, Philippe Aghion and others:

> Innovation is endogenized into economic dynamics as either a learning externality or the outcome of purposeful expensive efforts by profit-maximizing agents. However, in the latter case the endogenization comes at . . . a major price . . . of reducing innovative activities to an *equilibrium* outcome of optimal intertemporal allocation of resources. Hence by doing that, one loses also the genuine Schumpeterian notion of innovation as a disequilibrium phenomenon – *at least as a transient*.[29]

Rational Bubbles

The core vulnerability of both EMH and REH is the assertion that price as set in the equity markets equals fundamental value, defined as the net present value of expected cash flows to be generated by the physical asset that underlies the financial asset. Explaining swings in asset prices not associated with any evident change in the fundamentals has challenged theorists for a long generation. In 1982, Olivier Blanchard and Mark Watson circulated a paper that took the aberration seriously: "Bubbles, Rational Expectations and Financial Markets."[30] While they maintain the standard neoclassical assumption that the data-generating process out there in the "real economy" is stationary and that the fundamental value of the traded securities is known, they could not statistically disprove the deviation of observed share prices from the present value of expected cash

[29] G. Dosi, *Further Essays on Economic Organization, Industrial Dynamics and Development* (Cheltenham: Edward Elgar, 2014), p. 7 (emphases in original). In their comprehensive survey of neoclassical growth theory, Aghion and his collaborator Peter Howitt explicitly consider the fundamental critique offered in A. Bannerjee and E. Duflo, "Growth Theory Through the Lens of Development Economics," in P. Aghion and S. N. Durlauf (eds.), *Handbook of Economic Growth* (Amsterdam: Elsevier North-Holland, 2005), pp. 473–552, before themselves noting the existence of "other important issues that either have been barely touched on or simply not addressed at all," such as "the impact of financial bubbles" and "the contribution of basic science and open research to growth": P. Aghion and P. Howitt, *The Economics of Growth* (Cambridge, MA: MIT Press, 2009), pp. 429–430 and 439–440.

[30] O. Blanchard and M. Watson, "Bubbles, Rational Expectations and Financial Markets," National Bureau of Economic Research Working Paper 945 (1982).

flows to be distributed to investors throughout the life of the issuing firm.

Three years later, Jean Tirole published a neoclassical model in which bubbles serve to transfer goods from the young to the old and are well behaved: that is, the bubbles grow at the real rate of interest in his toy economy.[31] In the informal notes appended to his formal model, however, Tirole observes both that the "financial market fundamental" of an asset, as defined above, may differ from its "real market fundamental," its value in actual consumption, and that there may exist "ambiguity about the definition of the real market fundamental."[32] His conclusion – that bubbles are "not inconsistent with optimizing behavior and general equilibrium" – served as a sort of blessing on the ability of mainstream neoclassical theory to accommodate apparently deviant market behavior, masking a deep tension that persists below and behind the formal models.

Though neither Blanchard and Watson nor Tirole attempted to identify the sources of the discrepancy, over the past twenty years an increasingly rich literature has emerged with exactly that object in view.[33] In 1990, Brad DeLong, Andrei Shleifer, Lawrence Summers and Robert Waldmann published their challenge to efficient market orthodoxy – known ever since as DSSW – in the University of Chicago's *Journal of Political Economy*. "Noise Trader Risk in Financial Markets" demonstrated how random trading by ignorant "noise traders" (Philip Carret's "stock market gamblers") could so increase the risks facing definitionally rational "arbitrageurs" that the latter could not afford to bet against the former.[34]

Seven years later, Shleifer and Robert Vishny carried the argument a major step forward in their paper "The Limits of Arbitrage."[35] Not only do the rational arbitrageurs face noise traders who can move prices randomly, but they are dependent on investors who evaluate the

[31] J. Tirole, "Asset Bubbles and Overlapping Generations," *Econometrica*, 53(5) (1985), pp. 1071–1100.

[32] *Ibid*. 1091–1092.

[33] See F. Allen, A. Babus and E. Carletti, "Financial Crises: Theory and Evidence," *Annual Review of Financial Economics*, 1 (2009), pp. 109–110.

[34] J. B. DeLong, A. Shleifer, L. Summers and R. Waldmann, "Noise Trader Risk in Financial Markets," *Journal of Political Economy*, 98(4) (1990), pp. 703–738.

[35] A. Shleifer and R. Vishny, "The Limits of Arbitrage," *Journal of Finance*, 52(1) (1997), pp. 32–55.

quality of their investment managers – the arbitrageurs – by observing short-term performance. As prices deviate farther and farther from what the arbitrageur (somehow) "knows" is fundamental value, motivating the arbitrageur to increase her bets against the market, the more likely it is that investors will pull their funds out and force liquidation – just when the "rationally" expected returns are at their most attractive.

Shleifer and Vishny model the instance when the noise traders are inappropriately pessimistic and drive prices down. In such a case, the use of leverage by the arbitrageurs can only exacerbate the decline, since the fixed burden of debt must be liquidated as the value of the collateral held against it declines. The power of this mechanism is now being documented in a huge and growing body of work explicating the dynamics of the Crisis of 2008. But the limits of arbitrage apply equally on the upside. The crucial factor is how conditions on the right-hand side of the investor's balance sheet – the terms on which she has access to funding – dominate management of the left-hand side of her balance sheet, her investment portfolio. These are what determine how long she can fight the tape and afford to be wrong.

A dramatic demonstration in the real world of the inverse Shleifer–Vishny model is provided by the disparity in outcome for two great investors, Warren Buffett and Julian Robertson, when they declined to participate in the dotcom/telecom bubble. Buffett's funding base – the accumulated insurance premiums of Berkshire Hathaway – was and is self-renewing and thus effectively perpetual: he manages a closed-end fund. The only recourse for a dissatisfied investor is to sell (or try to short) the stock, and, indeed, Berkshire Hathaway radically underperformed the NASDAQ and actually declined in absolute terms during the final two years of the bubble. But, while the dogs barked, Warren Buffett's caravan passed by. In devastating contrast, investors in Julian Robertson's Tiger Group of hedge funds were subject only to the conventional three-month lock-up. The Tiger Group peaked in assets and performance in 1998. In recognition of his long record of superior performance, his investors gave Robertson the benefit of the doubt, waiting until the first quarter of 2000 before they forced him to close down and return their remaining capital, precisely at the moment when the bubble passed through its apogee and burst.

Andy Haldane of the Bank of England has looked at the volatility of stock prices relative to retrospective measures of the relevant "discounted expected profit streams" and found that

> on average over the past century, U.S. stock prices have been three times more volatile than fundamentals . . . But the trend in the degree of excess volatility is also telling. Up until the 1960s, prices were around twice as volatile as fundamentals. Since 1990, they have been anywhere from six to ten times more volatile. Excess volatility in equity prices has risen as financial innovation has taken off.[36]

The Institutionalization of the Stock Market

In recent years, a research program has emerged to address the relationship between the institutional transformation of the equity markets over the past two generations and market behavior.[37] Of an aggregate US equity market valued at $27 trillion as of the end of 2016, mutual funds (including exchange traded funds) accounted for 70 percent,[38] up from about 7 percent in 1950.[39] Managers of "other people's money" such as mutual funds can afford to be wrong for only a limited time. As a recent IMF study suggested:

> "[T]he behavior of agents (institutional investors) managing capital on behalf of principals (asset owners) could be a source of friction demanding much closer scrutiny in the years ahead – particularly if incentives in the asset management industry induce procyclical behavior.[40]

[36] A. Haldane, "Patience and Finance," paper presented to Oxford China Business Forum, Beijing, September 9, 2010, p. 15. Available at www.bis.org/review/r100909e.pdf.

[37] J. Lerner and P. Tufano, "The Consequences of Financial Innovation: A Counterfactual Research Agenda," paper presented to a meeting of the Commission on Finance and Growth, Watson Institute for International Studies, Brown University, December 10, 2010, p. 30.

[38] Data from the World Bank Databank. Available at http://data.worldbank.org/indicator/CM.MKT.LCAP.CD?locations=US, and Investment Company Institute, *2017 Investment Company Fact Book* (Washington, DC: Investment Company Institute, 2017).

[39] M. Breugen and A. Buss, "Institutional Investors and Information Acquisition: Implications for Asset Prices and Informational Efficiency," National Bureau of Economic Research Working Paper 23561, June (2017), p. 1.

[40] B. Jones, "Asset Bubbles: Re-thinking Policy for the Age of Asset Management," IMF Working Paper (February 2015), p. 5

Moreover, as a portion of all equity fund assets, index funds have risen from 4 percent in 1995 to almost 25 percent in 2016.[41] And index funds are contractually committed on a daily basis to tracking the movement of share prices, however volatile and extreme, thereby reducing the weight of countervailing, mean-reverting pressure in the market.

Recent academic work offers a formal demonstration of why all mutual fund managers, even those not constrained by indexing but measured and rewarded on *relative* rather than *absolute* performance, will gravitate toward following the herd, with consequences that undermine the EMH:

> We document that, as the fraction of benchmarked institutional investors increases, price informativeness drops – for the index and the non-index stocks. Intuitively, an increase in the share of benchmarked investors implies a shift toward a group of investors who trade less aggressively and acquire less information. Consequently, aggregate information acquisition declines and less information can be revealed through prices.
>
> Less informative prices make investments into the stocks riskier . . . The decline in price informativeness also naturally translates into a higher return volatility for all stocks in the economy.[42]

Once again, an innovation intended to extend the efficiency of the equity market likely has contributed to the increased divergence between prices and values, even as Grossman and Stiglitz argued a generation ago. Most recently, in a *reductio ad absurdum* of the privileging of transactional efficiency, computer-driven "high frequency trading" has come to dominate the volume of transactions on the equity markets. In pursuit of transient mis-pricing of securities relative to short-term trends and correlations with other security prices, computer algorithms are tuned to execute massive volumes of small orders to exploit apparent arbitrage opportunities while minimizing impact on price. What matters here is that more than half of equity trading volume has come to reflect strategies that by definition and design include no reference whatsoever to the elusive fundamental value of the underlying economic asset.

[41] Investment Company Institute, *2017 Investment Company Fact Book*.
[42] Breugen and Buss, "Institutional Investors and Information Acquisition," p. 3.

Behavioral Finance

Separate from the rational-bubble literature, a second major strand of theory has focused on the psychological traits of individuals to explain deviations from rational behavior as defined by the requirements of neoclassical theory. Daniel Kahneman received the Nobel Memorial Prize for the development of Prospect Theory, a tool for understanding how people evaluate – and typically favor – outcomes that are certain versus gambles that have an equal expected probabilistic value. Typically, subjects offered the choice between the certainty of receiving $1.00 and having a 50:50 probability of receiving $2.00 or nothing will opt for certainty. The quantity of expected value that a person will surrender in order to secure an outcome with certainty is precisely the measure of the person's risk aversion.[43] Perversely, neoclassical economists have seized on Prospect Theory to attribute the failure of the financial markets to behave as the models say they should to the stubborn determination of human beings to refuse to behave as theory would have them do.

More recently, a growing number of scholars have developed "models of speculative trading, driven by heterogeneous beliefs," as José Scheinkman and Wei Xiong characterize this work.[44] Following the collapse of the dotcom/telecom bubble, I discovered the research program of Mordecai Kurz of Stanford, which he characterizes as "Rational Beliefs." Kurz rigorously demonstrates that many models of how the world works are consistent with the statistical track record: thus, conflicting views of price relative to value may be equally "rational," and the risk that one's model is wrong adds "endogenous uncertainty" to the volatility inherent in future realizations of the economic fundamentals.[45]

In complementary fashion, Scheinkman and Xiong demonstrate how "overconfidence creates disagreement among agents regarding asset fundamentals." Critically, in purchasing shares, each investor

[43] D. Kahneman and A. Tversky, "Prospect Theory: An Analysis of Decision under Risk," *Econometrica*, 47 (1979), pp. 263–291. Kahneman's professional partner, Amos Tversky, had died before the award.

[44] J. Scheinkman and W. Xiong, "Advisors and Asset Prices: A Model of the Origins of Bubbles," *Journal of Financial Economics*, 89 (2008), pp. 268–287.

[45] See M. Kurz, "Rational Beliefs and Endogenous Uncertainty," *Economic Theory*, 8(3) (1996), pp. 383–397.

also acquires an implicit option to sell those shares to another, more confident investor:[46] "Agents pay prices that exceed their own valuation of future dividends because they believe that in the future they will find an investor willing to pay even more."[47] In so doing, they stimulate price increases and trading volume independent of any signal that the fundamentals have improved. Blanchard and Watson observed back in 1982 that this essentially Ponzi aspect of the bubble makes its demise inevitable, given that the supply of greater fools is finite.[48]

In 2007, Harrison Hong of Princeton, and Jeremy Stein, who later served as president of the American Finance Association, explicitly advocated the use of "disagreement models" from within the mainstream of financial economics. Hong and Stein reached back through Kindleberger and Aliber to recapture the notion of overtrading, which classical economists from Adam Smith to John Stuart Mill had deployed to identify episodes when speculation provokes increased trading volume as buyers purchase commodities to realize capital gains from their resale, rather than for actual use in consumption or production.[49]

José Scheinkman has used this "connection between high trading volume and bubbles" to differentiate behavioral finance from the rational-bubble literature:

> This relationship ... distinguishes models of bubbles based on heterogeneous beliefs and cost asymmetries from "rational bubble" theories. A rational bubble is characterized by a continuous rise in an asset's price. Investors are content to hold the asset at the current price, because they believe that they are compensated for any risk of the bubble bursting by a suitably expected rate of price increase. In contrast to models based on heterogeneous beliefs and costly short-selling ...[50]

And Hyun Shin has shown how the securitization of credit assets that used to be held to maturity by lenders had brought the disequilibrium dynamics of the stock market to the banking system:

[46] J. Scheinkman and W. Xiong, "Overconfidence and Speculative Bubbles," *Journal of Political Economy*, 111(6) (2003), p. 1183.
[47] Scheinkman and Xiong, "Overconfidence and Speculative Bubbles," p. 1183.
[48] Blanchard and Watson, "Bubbles," p. 8.
[49] Kindleberger and Aliber, *Manias, Panics and Crashes*, p. 30.
[50] J. A. Scheinkman, *Speculation, Trading and Bubbles* (New York: Columbia University Press, 2014), p. 10.

> In an era when loans are packaged into securities and balance sheets are continually marked to market, the galvanizing role of market prices reaches into every nook and cranny of the financial system . . . When the price of a risky asset rises, the leveraged financial institution purchases more of the risky asset . . . But then, the additional purchases of risky assets . . . fuel the asset price boom further . . . The upward-sloping demand response has a mirror image in the downward phase of the financial cycle. When the price falls, the risk appetite of the leveraged institution falls so much that, in spite of the fall in the price, the desired holding of the risky asset falls. The supply response is downward-sloping. As price falls, more of the asset is dumped on the market, depressing the price further.[51]

Most recently, a powerful empirical confirmation of the role of *non*-rational expectations on the part of institutional investors has been published in the *American Economic Review*. Under REH, investors should know that at price peaks prospective returns will be lower, and at price troughs they will be higher. The authors summarize their contradictory findings:

> Investors' subjective capital gains expectations are a key element explaining stock price fluctuations. Survey measures of these expectations display excessive optimism (pessimism) at market peaks (troughs). We formally reject the hypothesis that this is compatible with rational expectations. We then incorporate subjective price beliefs with such properties into a standard asset-pricing model . . . The model gives rise to boom-bust cycles that temporarily delink stock prices from fundamentals and . . . matches the observed strong positive correlation between the price dividend ratio and survey return expectations which cannot be matched by rational expectations.[52]

Let us pause for a moment to celebrate publication in the world's leading economics journal of this signal exercise in confronting fundamentally mis-specified theory with conclusive, contradictory evidence.

[51] Shin, *Risk and Liquidity*, pp. 1, 10–11.

[52] K. Adam, A. Marcet and J. Beutel, "Stock Price Booms and Expected Capital Gains," *American Economic Review*, 107(8) (2017), p. 2352. The authors do allow the investors in their model to have rational expectations (i.e., ontologically unavailable knowledge) about the "fundamentals": the future movement of wages and dividends. Clearly the next challenge is to explore the consequences when investors know that they don't know what they can't know.

No One Knows Enough

In my view, the behavioral-finance literature we have been considering complements rather than contradicts the rational-bubble literature considered prior to it. The rational-bubble approach is useful because it shows that even adherence to the radical assumptions of REH cannot protect investors from the uncertainties of the real world: what is specified to be rational behavior by each individual itself generates the systemic phenomena of bubbles and crashes, yet another example of coordination failure. On the other hand, the behavioral-finance approach needs to be extended into the world beyond the financial markets.

I return to my first lesson in practical finance, about the process by which an objective analyst values a private company. The fundamental value of any company emerges from parallel exercises to mobilize necessarily incomplete information from the company's own historical financial results, from the market's valuation of problematically comparable companies, and from completed merger and acquisition transactions involving such companies. The degree of confidence with which one asserts the fundamental value will range along a spectrum that reaches virtual ignorance when a start-up proposal to commercialize a novel technology is under consideration.

To the extent that, embedded within both literatures, there is a residual faith in the touchstone of a knowable fundamental, it is missing the first reality of the equity markets. William Goldman, novelist and screenwriter, legendarily defined the law of Hollywood to be: "No one knows anything." The law of the equity markets is both softer and more complex: "No one knows enough, and everyone at some level knows that about herself and everyone else." Models of equity bubbles that privilege some set of investors as knowing more than any investor can know must be flawed.

Even more deeply irrelevant, however, are market models that begin by supposing the existence of a rational, representative agent. The capital markets are populated by a diversity of human beings with widely varying beliefs and degrees of confidence in their beliefs about possible future outcomes. The markets, after all, were invented to enable a range of participants to trade titles to assets with each other. And so the notion of a representative agent is incoherent,

justifiable only by the fanciful belief that trading activity will costlessly converge to the fundamental value that, by hypothesis, the representative agent already knows. The disappearance of such mythical folk from the leading journals of economics and finance is exactly the sort of post-2008 progress celebrated in the Coda to this second edition.

The phenomenon that terminated the dotcom/telecom bubble in 2000 stands witness. From the third quarter of 1999, the value of total distributions by venture capital funds to their limited partners rose sharply, from $3.9 billion in the third quarter of 1999 to $10.7 billion in the fourth quarter of that year, then almost doubled again in the first quarter of 2000 to $21.1 billion. This was by far the largest realization by venture capital firms ever. At the same time, the ratio of stock distributions to cash distributions increased from 1.27 in the third quarter of 1999 to 2.91 in the fourth quarter of that year, then peaked at 3.93 in the first quarter of 2000. By distributing shares rather than selling them and distributing cash, the venture funds could mark the value of their realizations at the market price before the impact of incremental sales from the previously illiquid supply was felt.[53] Having been locked up, typically for six months, by the terms of their contracts with the underwriters of the IPOs, venture capitalists were finally free to allow their limited partners to sell to the greater fools, and sell they did. But note: both generation and observation of this signal requires the existence of multiple traders in the market disagreeing with each other as to the relationship of price to value.

Shortly after the bubble burst, Eli Ofek and Matthew Richardson analyzed the "steep rise in the number of insider transactions" and drew the appropriate conclusion:

> Towards the latter part of 1999 and particularly in spring 2000, there were a large number of investors – insiders, venture capitalists, institutions and sophisticated investors – who were free to sell their Internet shares (through the unwinding of their lockup agreements). To the extent that these investors did not have the same optimism about payoffs the existing investors had, their beliefs would get incorporated in stock prices. As the amount of potential

[53] M. D. McKenzie and W. H. Janeway, "Venture Capital Fund Performance and the IPO Market," Centre for Financial Analysis and Policy, University of Cambridge Working Paper 30 (2008), p. 39.

> selling increased, this new class of investors (whether pessimistic or agnostic) began to overwhelm the optimistic ones.[54]

The increase in trading volume at the peak of the bubble directly contradicts rational-bubble models that would see volume decline as prices deviate progressively farther from the supposedly known fundamental. So it adds further confirmation to the work cited above on the excessive optimism of investors at market peaks and pessimism at market troughs.

The shifting balance of diverse opinions and degrees of confidence, as revealed through price and volume data observable by all market participants, in turn feeds back to condition the opinion and confidence of each. This is the information externality that pervades the market, inducing successively more sophisticated applications of game theory to elucidate market behavior. Shin has captured the dual role played by the prices of financial assets. On the one hand, they represent imperfect reflections of expectations of fundamental values. But, on the other, they are signals to action for investors:

> When the decision horizons of market participants are shortened due to short-term incentives, binding constraints, or other market imperfections, then short-term price fluctuations affect the interests of these market participants, and hence will influence their actions. There is then the possibility of a feedback loop, where anticipation of short-term price movements will induce market participants to act in such a way as to amplify these price movements.[55]

This is the phenomenon that George Soros, drawing on a lifetime of engagement with financial markets, has termed "reflexivity." And this is why, even when the fundamental is known, bubbles and crashes in asset prices are observed. Note the volatility of bond prices, where future cash flows are defined by explicit contract: prices of investment-grade bonds fluctuate, and term spreads and credit spreads move in and out, responding to different investors' expectations of the uncertain future, even while the payoffs remain known this side of default.[56]

All exercises in modeling the endogenous uncertainty native to financial markets and the decoupling of prices from any attempt to

[54] E. Ofek and M. Richardson, "DotCom Mania: The Rise and Fall of Internet Stock Prices," *Journal of Finance*, 58(3) (2003), p. 1131.

[55] Shin, *Risk and Liquidity*, p. 10. [56] I owe this insight to José Scheinkman.

define value reprise the famous "beauty contest" that Keynes deployed in the *General Theory*:

> Professional investment may be likened to those newspaper competitions in which the competitors have to pick out the six prettiest faces from a hundred photographs, the prize being awarded to the competitor whose choice most nearly corresponds to the average preferences of the competitors as a whole; so that each competitor has to pick, not those faces which he himself finds prettiest, but those which he thinks likeliest to catch the fancy of the other competitors, all of whom are looking at the problem from the same point of view. It is not a case of choosing those which, to the best of one's judgment, are really the prettiest, nor even those which average opinion genuinely thinks the prettiest. We have reached the third degree where we devote our intelligences to anticipating what average opinion expects the average opinion to be.[57]

In the same spirit, Andreas Park and Hamid Sabourian have shown how informed investors may be led by their observation of market action to abandon their own beliefs and choose to follow the herd or act against the crowd. As they do, they alternatively add to momentum or help market prices revert to the mean. In either case, their behavior is "rational" in that it is based on a calculus of expected value in the relevant short run, as they weigh their own "private information" against the evidence generated by the market.[58]

Finally, and fundamentally, in this term *rational* and in its antithesis, there is a nexus of confusion that infects both academic and popular discussion of how economic and financial agents think and act. Much of this originated with the hijacking of the term by the theorists of REH. For, as Roman Frydman and Michael Goldberg have written:

> A rational, profit-seeking individual understands that the world around her will change in non-routine ways. She simply cannot afford to believe that, contrary to her experience, she has found

[57] J. M. Keynes, *The General Theory of Employment, Interest and Money*, in E. Johnson and D. Moggridge (eds.), *The Collected Writings of John Maynard Keynes*, vol. 7 (Cambridge University Press and Macmillan for the Royal Economic Society, 1976 [1936]), p. 156.

[58] A. Park and H. Sabourian, "Herding and Contrarian Behavior in Financial Markets," *Econometrica*, 79(4) (2011), pp. 973–1026.

> a "true" over-arching forecasting strategy, let alone that everyone else has found it as well.[59]

But confusion is also created when the deployment of heuristics – rules of thumb that help investors make decisions under uncertainty – is branded as irrational. In the most basic terms, it seems inappropriate to call risk aversion irrational when over millions of years evolutionary pressures expressed Thomas Hobbes's vision of the human state: "worst of all, continual fear, and danger of violent death; and the life of man, solitary, poor, nasty, brutish, and short."[60]

Forty-five years of experience at the frontier where innovation meets the financial markets lead me to commend Frydman and Goldberg's effort to define a middle ground between the mechanical models of REH, on the one hand, and an anything-goes approach, on the other. Identification of qualitative signals for "guardedly moderate revisions" of forecasting strategies in light of new information is how prudent investors behave.[61] It corresponds to the "procedural rationality" that, a generation ago, Herbert Simon defined as the alternative to the utility-maximizing "substantive rationality" that had already come to render the neoclassical model "essentially tautological and irrefutable."[62]

In the spirit of the common sense deployment of the "conventions" invoked by Hume and Keynes, prudent, procedurally rational investors are forever trying to recognize whether the current regime in which stocks are trading is dominated by mean reversion or by momentum up or down, knowing that the longer one regime persists, the more surely it will shift to the alternative. The most creative theorists of finance and its most strategically oriented practitioners both recognize the pressing need for advancing a research program that begins with

[59] R. Frydman and M. Goldberg, "The Imperfect Knowledge Imperative in Modern Macroeconomics and Finance Theory," in R. Frydman and E. Phelps (eds.), *Rethinking Expectations: The Way Forward for Macroeconomics* (Princeton University Press, 2013), p. 27.

[60] T. Hobbes, *Leviathan*, ed. R. Tuck (Cambridge University Press, 1993 [1664]), chap. 13.

[61] Frydman and Goldberg, "The Imperfect Knowledge Imperative," pp. 36–37.

[62] H. A. Simon, "Rationality in Psychology and Economics, Part 2: The Behavioral Foundations of Economic Theory," *Journal of Business*, 59(4) (1986), p. 222. Also see H. A. Simon, "Rationality as a Process and Product of Thought," *American Economic Review*, 68(2) (1978), pp. 1–16.

such facts of financial life instead of the misleading formalisms of EMH and REH.

In sum, Cassius was wrong. The fault is, indeed, in our stars. Born into a universe in which the Second Law of Thermodynamics holds and time's arrow moves in one direction only, we cannot run the equations backward. We spend half our time arguing about the meaning of a past that we have actually experienced, and the other half speculating about an infinite array of alternative futures. In this context, attributing market inefficiency to the irrationality of investors is fundamentally misfocused. Rather, let us say that by and large they – we – do the best we can. We deploy the heuristics that evolved from our survival in such a universe to evaluate the more or less misleading patterns discernible in history's unfolding tapestry as more or less inadequate guides to our behavior.

There is a certain heroic quality to the struggle of the new finance theorists to model the behavior of market participants who know that they cannot know enough and that they have only a limited time during which they will be allowed to be wrong, to stand out against the crowd. I am convinced that Keynes would honor their efforts, even while pushing them to go further in accepting the ontological uncertainty inherent in the universe:

> We should not conclude . . . that everything depends on waves of irrational psychology. On the contrary, the state of long-term expectation is often steady, and, even when it is not, the other factors exert their compensating effects. We are merely reminding ourselves that human decisions affecting the future, whether personal or political or economic, cannot depend on strict mathematical expectation, since the basis for making such calculations does not exist; and that it is our innate urge to activity which makes the wheels go round, our rational selves choosing between the alternatives as best we are able, calculating where we can, but often falling back for our motive on whim or sentiment or chance.[63]

[63] Keynes, *General Theory*, pp. 162–163.