CODA: THE POWER OF IDEAS

Throughout this book, in its first and second editions, a constant theme has been the challenge to mainstream economics represented by the economics of innovation. First of all, understanding the dynamics of the Innovation Economy requires mobilizing both a relevant political economics and a relevant financial economics. For innovation, as exhaustively explored through my own lived experience and through the historical evidence presented especially in Chapters 9 and 10, has been driven by the complex interaction of mission-driven state actors and financial speculators. Moreover, two core characteristics of the advance of innovation contradict a central dogma of neoclassical economics. Given the inescapable uncertainty that attends investment at the frontier, progress can only be made by trial and error. Consequently, toleration of waste – not static efficiency – in the allocation of resources is the central requirement. Any firm or centralized authority that ranks investment projects exclusively by the net present value of expected future cash flows has abdicated from the possibility of leadership.

In this context, the study of the Innovation Economy is the beneficiary of the creative destruction wrought by the Global Financial Crisis and the Great Recession. Jointly, they are signal examples of a destructive bubble in the financial system and the devastating economic consequences that follow. But there is one dimension along which they have played a creative, liberating role. This has been in the domain of ideas, specifically in the realm of academic economics and finance. My own perspective on the need for a reconstruction of mainstream neoclassical economics had its roots in my standing as what

might be called an "Old Keynesian": a theorist of economics rooted in Keynes's appreciation of the ontological uncertainty that is the context for forward-looking decisions, and the availability of cash as an instrument of self-insurance against such uncertainty. This perspective was cumulatively reinforced by the practice of venture capital: professional experience crystallized the recognition that excessive focus on efficiency is the enemy of innovation.

The first necessary step in constructing an economics relevant to the historical dynamics of the Innovation Economy necessarily begins by clearing away the radically misleading "micro-foundations" of the rational optimizing agent, endowed with that pretense of knowledge decried by Friedrich Hayek. Rather, what is needed is an economics rooted in the behavior of real human beings constrained to make decisions to spend or save, invest or hoard, without the ability to know in advance the full consequences of their individual actions, let alone the potential for coordination failure when their decisions intersect those of others. In imagining such an economics – an economics of Keynes, very much distinct from what had come to be called Keynesian economics – without knowing it, I shared a dream with a great economist of my generation, George Akerlof.

When Akerlof received the Nobel Memorial Prize for Economics in 2002, he stated that the motivation for his work on market failure due to asymmetric information was the dream of participating in the

> development of a behavioral macroeconomics in the original spirit of John Maynard Keynes' General Theory. Macroeconomics would then no longer suffer from the "ad hockery" of the neoclassical synthesis, which had overridden the emphasis in The General Theory on the role of psychological and sociological factors, such as cognitive bias, reciprocity, fairness, herding, and social status. My dream was to strengthen macroeconomic theory by incorporating assumptions honed to the observation of such behavior.[1]

In his lecture, Akerlof identified the failure of mainstream "modern macroeconomics" to account for a number of plainly observable phenomena: from involuntary unemployment to the excessive volatility of stock prices relative to fundamentals. And he invoked the rich array of

[1] G. A. Akerlof, "Behavioral Macroeconomics and Macroeconomic Behavior," *American Economic Review*, 92(3) (June 2002), p.411.

empirically confirmed, microeconomic theories that take what are logical impossibilities, in the view of the extreme neoclassical EMH and REH, and make sense of them. He concluded on an optimistic, if embattled, note:

> Keynes' *General Theory* was the greatest contribution to behavioral economics before the present era . . . Immediately after its publication, the economics profession tamed Keynesian economics. They domesticated it as they translated it into the "smooth" mathematics of classical economics. But economies, like lions, are wild and dangerous. Modern behavioral economics has rediscovered the wild side of macroeconomic behavior. Behavioral economists are becoming lion tamers. The task is as intellectually exciting as it is difficult.[2]

Indeed, it took the extreme wildness of the Global Financial Crisis and the Great Recession to open the disciplines up to the revolution in thinking that Akerlof anticipated and to which he contributed.

Efficiency as the Enemy of Innovation

Let me state explicitly why an excessive focus on efficiency is the enemy of innovation. Efficiency in the allocation of resources has always been a virtue of economics. When Allocation ate economics and the Efficient Markets Hypothesis rendered distribution of income fair by construction, and the Rational Expectations Hypothesis gave theoretical guaranty that all resources would be fully employed subject only to random external shocks, efficiency stood alone as *the* virtue. By definition, in efficient markets resources are optimally allocated to satisfy expressed individual preferences; free competition and the price mechanism ensure the absence of waste in a persistent general equilibrium. But any such notional economy is frozen outside of time. Recall the Arrow–Debreu theory of general equilibrium, where all the infinity of state-contingent possible transactions are executed once and for all. By construction, it is incapable of explaining the evolution of economic development driven by technological innovation.

On the contrary, taking economic waste seriously is both necessary and challenging. This I have come to do both as a theorist and as a

[2] *Ibid.* 428.

practitioner, concerned with the historical reality of two very different types of economic waste. First, in my doctoral study of the formulation of economic policy in the Great Depression, the presenting issue was what – if anything – to do about the pervasive waste to which Keynes addressed himself: the unnecessary, *bad*, macroeconomic waste of underemployed resources due to an inadequate level of aggregate demand in a stubbornly persistent short run. Then, as a reflective practitioner of venture capital over four decades, I came to appreciate the necessity of *good*, microeconomic waste on the long-run, supply side of the market economy: in the uncertain processes of scientific discovery, which have been the primary source of technological innovation over the past 200 years, and in the speculative exploitation of consequent inventions for commercially rewarding uses. I refer to the productive waste required for creative destruction in the Innovation Economy as Schumpeterian, in conscious disregard of Schumpeter's indictment of all political intervention in the market economy.

Here is the irony. The same appeal to economic efficiency serves both to rationalize the toleration of the bad, Keynesian waste and to limit the toleration of the good, Schumpeterian waste, and the double-edged impact is compounded by the interaction between the two effects. When Keynesian waste is at a minimum – that is, in a high-growth, fully employed economy – the consequences of Schumpeterian waste are likely to be more creative and less destructive. More innovations will be profitably exploited, and the people and capital stranded in legacy occupations will be more rapidly redeployed. And very much vice versa.[3]

Of course, economic inefficiency is not itself virtuous. And, of course, economists have long been aware of market failures. The literature on external economies and diseconomies and on imperfect competition induced by increasing returns to scale has evolved for generations since Pigou's defining work on welfare economics.[4] More recently, Nobel Memorial Prizes have been awarded to the theorists who

[3] With characteristic insight, Stiglitz modeled this phenomenon more than twenty years ago: J. Stiglitz, "Endogenous Growth and Cycles," in Y. Shionnoya and M. Perlman (eds.), *Innovation in Technology, Industries and Institutions: Studies in Schumpeterian Perspectives* (Ann Arbor: University of Michigan Press, 1994).

[4] As noted in the Conclusion, the Chicago School – in the form of Coase's Theorem – did define theoretically how rational actors could obviate the need for state intervention to correct externalities, given low enough transaction costs.

analyzed the consequences of asymmetric information between market participants[5] and those who evaluated psychological biases previously excluded from the discipline's domain.[6] The recognition of strategic behavior by market players operating under conditions of incomplete information but with meaningful market power has become widespread.[7] In financial economics, as discussed at length in Chapter 8, there has been a great blossoming of work on markets populated by heterogeneous agents whose expectations are ever imperfect and whose ability to stand against the market is limited in time and extent. Thus, there exists a reservoir of relevant work in microeconomics and in finance available to support a fundamental reconstruction of the discipline.

And, at the same time, the self-generated caricature of economics as a set of exercises in tracking, through mathematical models, the mechanical activities of omniscient agents rationally optimizing their utilities across markets and through time is fading away, even while it persists in popular accounts of "what's wrong with economics." In its place is emerging a much more complex, methodologically heterogeneous and nuanced range of scholarship that is much more intimately related to the behavior of real human beings, including their persistent inability to coordinate their activities into efficient equilibria. One instrument for accelerating and amplifying the process has been the Institute for New Economic Thinking (INET), which I have joined George Soros and Jim Balsillie (co-founder of Blackberry) in funding.[8]

A sign of great relevance is the recognition that economic and finance theories that begin by reducing ontological uncertainty to quantifiably measurable and manageable risk are not only intellectually illegitimate but positively dangerous. As discussed in Chapter 8, they rationalize the sort of inexcusable practices represented by "Value at Risk" models that: (1) by construction, ignored the extreme tails of the

[5] George Akerlof, Michael Spence and Joseph Stiglitz: https://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2001.

[6] Daniel Kahneman, whose collaborator Amos Tversky died before the award, https://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2002, and now Richard Thaler, https://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2017.

[7] See, for example, J. De Loecker and J. Eeckhout, " The Rise of Market Power and the Macroeconomic Implications," National Bureau of Economic Research Working Paper 23687 (August 2017).

[8] https://www.ineteconomics.org.

distribution of outcomes that are where the real trouble arises; (2) by construction, assumed that future states of the world will express the same distribution of outcomes as the past; and (3) in the name of "computational convenience," limited the examined past to as little as two or three years.

Even before the Crisis, Richard Zeckhauser of Harvard offered a schema for differentiating between: "Risk," relevant to environments where the probabilities of alternative states of the world are known; "Uncertainty," when the probabilities are unknown; and "Ignorance," when the possible states of the world themselves are unknown and the future is both unknown and unknowable.[9] In this context, it is noteworthy that the 2016 Nobel Memorial Prize in Economics went to Oliver Hart and Bengt Holmstrom, who have devoted themselves to exploring the "messy reality" of a world in which contracts cannot cover all possible contingencies – they are necessarily "incomplete" – and in which who controls the process of resolving the resultant conflict is of salient importance.[10] There is a certain resonance here with my own, forced and pragmatic, discovery of Cash and Control.

It is highly encouraging to see younger economists directly addressing the internals of decision-making under uncertainty, empirically parsing the effects on the behavior of firms of different types (short-run versus long-run) and sources of uncertainty. Thus, Barrero, Bloom and Wright find evidence that long-run uncertainty, such as caused in the UK by Brexit, will distinctively impact corporate activities with higher adjustment costs, such as R&D and investment.[11]

Methodologically, we may expect to see the discipline challenged as it seeks with rigor to model the complex interactions in economic and financial markets of agents heterogeneous across multiple dimensions: with respect to what they know, what they own, what they

[9] R. Zeckhauser, "Investing in the Unknown and Unknowable," *Capitalism and Society*, 1(2), Article 5 (2006), p.3. Appropriately, Zeckhauser holds the Frank P. Ramsey Chair in Political Economy. Ramsey was a brilliant (old) Cambridge scholar who did pioneering work on probability before his tragically premature death at 26.

[10] https://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2016. See O. Hart, "Incomplete Contracts and Control," *American Economic Review*, 107(7) (2017), pp.1731–1752. The seminal paper on the subject was S. J. Grossman and O. D. Hart, "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration," *Journal of Political Economy* 94(4) (1986), pp.691–719.

[11] J. M. Barrero, N. Bloom and I. Wright, "Short and Long Run Uncertainty," National Bureau of Economic Research Working Paper 23676 (August 2017).

consider reasonable (if not "rational"), what they value, and with respect to their toleration of risk. What's more, economists have begun to appreciate that these "preferences" adapt in response to experience: they are dynamic, not fixed. And that makes modeling economic behavior even more difficult.

It is a fact that across all the natural sciences, as understanding of the complexity of the universe has grown, scientists invented and came to rely on methods of computer simulation, the construction of digital mini-worlds: first in physics, then in chemistry and now in biology. In economics, computer simulation has been deployed by macro-modelers to calibrate their wildly unrealistic dynamic, stochastic general equilibrium (DSGE) models against the statistical patterns in the national income data in pursuit of a spurious form of validation. The alternative mode of simulation represented by agent-based models, however, has been broadly rejected, for fear that "anything goes": any outcome sought can be realized by tiny tweaks to initial conditions or behavioral parameters.[12] Moreover, economists have embraced identification of the conditions of sustained equilibrium, preferably unique, as the methodological gold standard for theorizing. Yet we may expect to see the construction of "exploration models" in the spirit of the systems dynamic approach that introduced me to computers forty years ago, where the agents are defined in terms of what they can observe and what they can control. And in the contingent world which economics is condemned to address, identification of multiple possible equilibria should rightfully be judged a feature, not a bug.[13]

[12] Some economists have defied the common opinion of the discipline: see, for example, the work of Giovanni Dosi and colleagues: G. Dosi, G. Fagiolo and A. Roventini, "Schumpter Meeting Keynes: A Policy-Friendly Model of Endogenous Growth and Business Cycles," *Journal of Economic Dynamics and Growth*, 34 (2010), pp. 1748–1767.

[13] A recent paper with the highly relevant title "Macro Needs Micro" by Fabio Ghironi of the University of Washington makes precisely this point, challenging macroeconomists to draw on the rich reservoir of relevant microeconomic analysis. He even goes so far as to suggest (albeit in a footnote) that, given the complexity of such holistic approaches, "Agent-based modeling is another research area that should receive more attention": F. Ghironi, "Macro Needs Micro," National Bureau of Economic Research Working Paper 23836 (September 2017). Available at http://www.nber.org/papers/w23836. See also the argument for agent-based models in Richard Bookstaber's *The End of Theory: Financial Crises, the Failure of Economics, and the Sweep of Human Interaction* (Princeton University Press, 2017).

In the meantime – and understandably, given the magnitude of the shock to theory, especially in the field of macroeconomics – academic scholarship has shifted in recent years toward a greater preponderance of empirical work. Prime examples of this focus have been offered above, notably including the work of David Autor, Nicholas Bloom and Raj Chetty and their respective colleagues, just to invoke the first three letters of the alphabet. The phenomenon has been analyzed by a consortium of scholars:

> The empirical shift in economic scholarship is a *within-field* phenomenon ... In the early 1980s, development and labor were the only fields in which the majority of weighted [by influence] publications were empirical. The weighted empirical share has since grown in all fields ... Even macroeconomics, criticized in the wake of the Great Recession for an excess of ivory-tower theorizing, has seen its empirical share grow by over 50 percent ... The shift in citation shares toward empirical work is even stronger than the publication shift ... [From] less than 30 percent of weighted citations in 1990 ... the empirical citation share is now almost 50 percent.[14]

The logically consistent abstractions of EMH and REH evidently failed both economics and the world a decade ago. In consequence, more and more economists are returning to study of that world. In doing so, of course, they too enjoy the abundance of data generated by the increasingly digitalized economy and the abundance of computing resources available to analyze those data.[15] This is undoubtedly a good thing, even while we must not lose sight of the fundamental fact that good empirical work depends on creative conceptual thinking.

Rediscovering the Multiplier

One particular focus of empirical work has been on a subject of fundamental importance to policy concerned to reduce the incidence of that bad Keynesian waste: what are the macroeconomic consequences of

[14] J. Angrist, P. Azoulay, G. Ellison, R. Hill and S. F. Lu, "Economic Research Evolves, Fields and Styles," *American Economic Review: Papers and Proceedings*, 107(5) (2017), pp.295–296.

[15] An exciting and relevant resource for such work is the Institute for Research on Innovation & Science at the University of Michigan: http://iris.isr.umich.edu.

changes in the volume and financing of government expenditures? In other words, under what conditions – if any – can the state stimulate economic recovery and growth? Recall that the macroeconomics derived from the Rational Expectations Hypothesis provides no room for fiscal stimulus to be effective since, on the one hand, all resources should be expected to be fully employed already, but if there is transient unemployment due to a random shock, then market participants will so adjust their behavior to counter-balance any government initiative. In this instance, they would reduce their spending to provide for the future tax increases that would be required to service the debt incurred by the state ("Ricardian equivalence").

This is a subject of particular significance to me, given that my thesis supervisor at Cambridge had been Richard Kahn, the inventor of the very concept of "the multiplier." Estimating the size of the multiplier has been a contentious subject in the academic literature. It is nonetheless clear that its magnitude is context-dependent. It is also clear that it will be at a maximum when economic resources are grossly underemployed and when monetary policy is accommodating, as was the case in Britain between the Wall Street crash in 1929 and the international crisis of the summer of 1931, when Kahn formulated the then-novel concept.

Five years ago, an exercise that drew on the models employed by the leading central banks proved broadly confirmatory in the context of the painfully slow recovery from the Great Recession haphazardly underway.[16] At approximately the same time, led by Giancarlo Corsetti, my Cambridge colleague today, the IMF published a comprehensive analysis of the varying consequences of fiscal stimulus under a range of economic and financial and fiscal environments, including those that represent a financial crisis: it concluded that "the responses of output and consumption to a public spending increase are strongly positive during such times, implying a fiscal multiplier of up to two."[17]At approximately the same time, Brad DeLong of Berkeley and Larry Summers, returned to Harvard from Washington, argued that, under prevailing conditions, debt-financed fiscal stimulus could literally

[16] G. Coenen, C. J. Erceg, C. Freedman *et al.*, "Effects of Stimulus in Structural Models," *American Economic Journal: Macroeconomics*, 4(1) (2012), pp.22–68.

[17] G. Corsetti, A. Meier and G. J. Müller, "What Determines Government Spending Multipliers?" IMF Working Paper (June 2012). Available at https://www.imf.org/external/pubs/ft/wp/2012/wp12150.pdf.

pay for itself through the higher revenues generated from the increased income that would be a multiple of the actual increase in expenditures.[18]

Most recently, Auerbach and Gorodnichenko, building on this work, have provided further evidence that

> [t]he effects of government spending shocks depend on a country's position in the business cycle. Expansionary fiscal policies adopted when the economy is weak may not only stimulate output but also *reduce* debt-to-GDP ratios as well as interest rates and credit default swap spreads on government debt, while the outcomes when the economy is strong are more likely to have the conventional effects.[19]

Whether or not any specific program of debt-financed stimulus would actually pay for itself, two long generations on, the profound insight of Kahn and Keynes has been resurrected. In this instance, it has not taken a war: only the greatest financial crisis since the time of its original formulation.

Rediscovering Distribution

Rediscovering the multiplier entails taking Stabilization seriously as both a challenge for policy and a subject of academic research. With possibly even greater strategic significance for the disciplines of economics and finance, the arduous accumulation of empirical evidence has progressively redefined their content with respect to the second lost subject of study: Distribution. The World Wealth and Income Database ("WID"), managed principally from the Paris School of Economics, was first presented in January 2011.[20] The significance of

[18] J. B. DeLong and L. H. Summers, "Fiscal Policy in a Depressed Economy," Brookings Papers on Economic Activity (Spring 2012). Available at https://www.brookings.edu/bpea-articles/fiscal-policy-in-a-depressed-economy.

[19] A. J. Auerbach and Y. Gorodnichenko, "Fiscal Stimulus and Fiscal Sustainability," August 1, 2017. Available at https://www.kansascityfed.org/~/media/files/publicat/sympos/2017/auerbach-gorodnichenko-aper.pdf?la=enhttps://www.imf.org/external/pubs/ft/wp/2012/wp12150.pdf.

[20] https://www.parisschoolofeconomics.eu/en/research/data-production-and-diffusion/the-world-wealth-income-database, and A. B. Atkinson and T. Piketty, *Top Incomes over the XXth Century* (Oxford University Press, 2014), and A. B. Atkinson and T. Piketty, *Top Incomes: A Global Perspective* (Oxford University Press, 2014). INET was one of the funders of the WID.

the data was universally dramatized with the subsequent publication (French edition, 2013; English edition, 2014) of Thomas Piketty's *Capital in the Twenty-First Century*. Piketty and his collaborator Emmanuel Saez of Berkeley have put Distribution as a subject both for academic scholarship and for political argument squarely back on the agenda. Much of the research now directed at the subject has focused on increased inequality within the lower segments of the distribution, where, as discussed in Chapter 12, substantial changes in the labor market driven by digitalization have generated a bifurcation between low-skilled and high-skilled jobs, with the mid-skilled jobs disappearing.

This real-world fact has powerful implications for theory, as it shows that, for a generation, compensation for the lower 80% has decoupled from the continued growth in productivity, as discussed in the Conclusion. It thereby calls into question the neoclassical story that wages equal the marginal contribution of labor to output. And stagnation of incomes and living standards for the great bulk of the population has had political consequences, too, contributing to the rise of populism. But the most extreme action has been at the top of the distribution: the famous 1% and, even more, the 0.1% and the 0.01%.

Much attention has been concentrated on the increase in CEO compensation over this period, both in absolute terms and relative to average income per head and the median worker's salary in the CEO's firm.[21] Of course, the rate of growth of CEO pay is a function of the financialization of executive compensation through stock options and related equity incentives, as discussed in Chapter 5. And even the rewards afforded to the CEOs of the largest and most highly valued corporations pale when contrasted with those whose compensation is most directly, albeit with much volatility, tied to investment performance in the capital markets: the general partners of hedge funds. As empirical work on the distribution of income and wealth spawns theoretical exercises in explaining causality, another front will open for appreciation of the intimate integration of the markets and institutions of the real economy and those of the financial system.

[21] See, for example, L. Mishel and A. Davis, "CEO Pay has Grown 90 Times Faster than Typical Worker Pay since 1978," Economic Policy Institute, July 1, 2015. Available at http://www.epi.org/publication/ceo-pay-has-grown-90-times-faster-than-typical-worker-pay-since-1978.

Once again, this work promises to offer insight relevant to the economics of innovation as it intersects the study of industrial organization. For the alignment of management's interests with those of investors intensely focused on short-term performance feeds back to determine priorities in the allocation of resources within the enterprise. Incentives matter, as no economist of whatever stripe would deny. And the incentives have plainly come to weigh on the side of returning capital to investors as rapidly and efficiently as possible through stock buybacks versus investment in long-term and necessarily uncertain R&D. Only, it appears, the few digital giants – liberated from concern for stockholder demands by corporate charter (Alphabet [Google] and Facebook) and/or by extraordinary market dominance (Amazon and Microsoft) – can indulge in such efforts to push back the frontier. Of course, in doing so they are emulating the previous generation of effective monopolists: AT&T, IBM, DuPont, Xerox. We will see whether they will escape the challenge to effective innovation represented by extraordinarily profitable, established business models.

Reinventing Structural Economic Dynamics

More than fifty years ago, a brilliant young economist came to Cambridge under the sponsorship of my own mentor, Richard Kahn. Luigi Pasinetti applied himself as a graduate student to a lifelong program: exploring the complex network of industrial sectors that exists between individual economic agents and the aggregate economic statistical objects: consumption, investment, savings.[22] Pasinetti was building models to demonstrate the theoretical requirements for stability in an economic system whose different sectors evolve through differing rates of technological progress with differing consequences for the wages and prices through which they relate to each other and to final consumers over time.

In 1973, Wassily Leontief won the Nobel Memorial Prize for conceiving of the economy as a set of inter-related sectors, tied together

[22] See, among other contributions, *A Multi-sectoral Model of Economic Growth*, King's College, Cambridge, 1963; *Structural Change and Economic Growth: A Theoretical Essay on the Dynamics of the Wealth of Nations* (Cambridge University Press, 1981); and *Structural Economic Dynamics: A Theory of the Economic Consequences of Human Learning* (Cambridge University Press, 1993).

through the upstream production of outputs that served as inputs to downstream sectors, and empirically constructing input–output tables to reveal the linkages. In effect, Pasinetti was making those tables conceptually dynamic, with sectoral technical progress – increasing productivity – as the galvanizing force. But his work, while analytically rigorous, remained in the realm of theory.

Today, one of the most promising new domains of both theoretical and empirical work is summarized by its protagonist, Vasco Carvalho of Cambridge University, in the title of the best summary article in the field: "From Micro to Macro via Production Networks."[23] Carvalho is building on advances in network theory[24] plus the contemporary availability of masses of data and the computing resources to analyze the data. His work demonstrates how random shocks at the level of the individual sector or firm do not cancel themselves out but rather propagate through production networks, the empirically visible, dynamic version of Leontief's input–output tables and Pasinetti's theoretical constructs.[25]

Carvalho's research program has the potential for extensions of strategic importance both to our understanding and to policy. The links between sectors express elasticities of demand and supply and substitution: central concepts in economics that describe the rate at which quantities respond to changes in price. But those elasticities are not fixed: they can be increased by the expenditure of money over time. In turn, that investment in increasing elasticity must be financed, so differential access to finance for investing in increasing the elasticity of a given sector becomes another defining attribute in the complex production networks that generate macroeconomic behavior. Of course, this was exactly the challenge for the world's economy generated by the first oil crisis, as discussed in Chapter 11, when "stagflation" was the result of the cash-starved, inelastic response by industrial and household consumers to a radical change in the most important of all inputs. And this

[23] V. M. Carvalho, "From Micro to Macro via Production Networks," *Journal of Economic Perspectives* 28(4) (Fall 2014), pp.23–48.

[24] Notably S. Goyal, *Connections: an Introduction to the Economics of Networks* (Princeton University Press, 2007).

[25] For an empirical example of this work, see V. M. Carvalho, M Nirei, Y. U. Saito and A. Tahbaz-Salehi, "Supply Chain Disruptions, Evidence from the Great East Japan Earthquake," Cambridge Working Papers in Economics 1670 (2016). Available at https://www.inet.econ.cam.ac.uk/working-paper-pdfs/wp1625.pdf.

represents yet another place where building a bridge between finance and economics is required and will be productive.

Once again, there is direct application to the economics of innovation. Recall the story of the Best versus the Rest. The diffusion of advanced technologies with the potential to transform productivity and materially shift the elasticities of substitution occurs firm by firm, sector by sector. The consideration of the productivity puzzle in Chapter 12 revealed how misleading analysis exclusively in terms of aggregates and averages can be. So an economics of innovation that addresses the real-world phenomena will necessarily concern itself with the distribution of technological diffusion that lies at the core of "structural economic dynamics."

Inventing New Financial Macroeconomics

The Global Financial Crisis generated a vast array of evidence to contradict the notion that stable equilibrium, with the prices of assets equal to their fundamental values, could be assumed to be the prevailing condition of capital markets. The theoretical irrelevance of events in the financial system for the state of the economy was blown away. In its place came recognition of the inescapable integration of the dynamics of the financial system and the evolution of the macro-economy, even as argued by Keynes and Minsky. And those working on the frontier of economics and finance under the shadow of the Crisis had a store of knowledge and wisdom to draw on that had been sidelined for more than a generation. Mark Thoma, a thoughtful commentator on economics and the economy, remarked while attending INET's second conference in April 2011: "I've learned that new economic thinking means reading old books."

The initial academic response to the Crisis was a correspondingly vast array of analyses of the specific mechanisms and phenomena that drove the Crisis, from "fear of fire sales"[26] to the

[26] Douglas Diamond and Raghuram Rajan, two distinguished financial economists both then at the Chicago Booth School of Business, showed how an overhang of illiquid securities could so impair realizable prices that banks would choose not to sell them, with the consequence that their ability to lend was likewise constrained: D. W. Diamond and R. G. Rajan, "Fear of Fire Sales and the Credit Freeze," May 2009. Available at http://www.bis.org/events/conf090625/rajanpaper2.pdf.

"run on repo."[27] A deeper and more systemic understanding has begun to emerge. Three examples of what may be called a new "financial macroeconomics" are illustrative.

Markus Brunnermeier and Yuli Sannikov have been refining "the I Theory of Money," where "I" stands for intermediaries. Far from excluding banks and related institutions from the core of the macro-economy, they place them at the center: their behavior is crucial to the evolution of the broader economic system. In explicit analogy with the coordination failure that Keynes defined in the *General Theory*, Brunnermeier and Sannikov define "The Paradox of Prudence":

> The "Paradox of Prudence" arises when intermediaries shrink their balance sheet and households tilt their portfolio away from real investment towards the safe asset, money. Scaling back risky asset holding is micro-prudent, but makes the economy more risky, i.e. it is macro-imprudent. Our Paradox of Prudence is in the risk space what Keynes' Paradox of Thrift is for the consumption–savings decision. The Paradox of Thrift describes how each person's attempt to save more paradoxically lowers overall aggregate savings. In our model attempts to reduce individual risks increases endogenous risks as the economy's capacity to diversify idiosyncratic risk moves around endogenously.[28]

In counterpoint, Nuno Coimbra and Helene Rey explore the consequences of behavior across a spectrum of financial intermediaries that differ in their tolerance of risk. Here the focus is on the central bank's potential policy conflict, a "clear trade-off between stimulating the economy and financial stability." The authors assert the advantages of their approach:

> First, it takes seriously the risk-taking channel in general equilibrium and therefore allows the joint study of the usual

[27] Gary Gorton and Andrew Mettrick, two distinguished financial economists at the Yale School of Management, dissected the disappearance of repurchase transactions as the primary source of liquidity for the banking system in the heart of the crisis: G. B. Gorton and A. Mettrick, "Securitized Banking and the Run on Repo," *Journal of Financial Economics* 104(3) (June 2012), pp.425–451.

[28] In 2016 Sannikov was awarded the John Bates Clark Medal by the American Economic Association for the most significant contribution by an American economist under 40; the citation made explicit reference to this work: M. K. Brunnermeier and Y. Sannikov, "The I Theory of Money," August 8, 2016, p. 3. Available at http://scholar.princeton.edu/sites/default/files/markus/files/10r_theory.pdf.

> expansionary effect of monetary policy – via a boost in investment – and of the macroeconomic financial stability risk, which is endogenous . . . Second, it is able to generate periods of low risk premium which coincide with periods of high endogenous macroeconomic risk.[29]

Perhaps most importantly, by providing a straightforward way to model the heterogeneous character of financial intermediaries, the theoretical contribution of Coimbra and Rey

> opens the door to a vast array of empirical tests based on microeconomic data on banks, shadow banks, asset managers, and so on. Indeed the heterogeneity can be in principle matched in the data with actual companies or business lines within companies and with their leverage behaviours.[30]

So innovative theory is constructed to enable further empirical analysis.

A third example of the post-Crisis integration of finance with economics at the level of macro theory is offered by Ricardo Caballero and Alp Simsek. Building explicitly on Brunnermeier and Sannikov, they show how financial markets and the markets for goods and services are tied together by the risk appetites and expectations of investors. Thus, the rate of interest that would generate an optimal degree of demand for real goods and services is also "a function . . . of risk-market conditions." In turn, risk-market conditions are a function of the relative wealth of optimists and pessimists:

> [T]hrough relative wealth effects the economy becomes extrapolative: booms breed optimism and recessions breed pessimism. Moreover, for any given level of average optimism, as the dispersion of beliefs rises the anticipation of this extrapolative feature exacerbates the depth of the drop in asset prices and recession.[31]

Again, bringing the financial system back into macroeconomics introduces the sort of disequilibrium dynamics that we observe in the real world. In doing so, it offers a macroeconomic frame within which the

[29] N. Coimbra and H. Rey, "Financial Cycles with Heterogeneous Intermediaries," National Bureau of Economic Research Working Paper 23245 (March 2017). Available at http://www.nber.org/papers/w23245, pp. 5–6.

[30] *Ibid*. 6.

[31] R. J. Caballero and A. Simsek, "A Risk-Centric Model of Demand Recessions and Macroprudential Policy," National Bureau of Economic Research Working Paper 23614 July (2017), p.4.

dynamics of the Innovation Economy may be realistically subjected to varying systemic conditions, including shortfalls in aggregate demand and limited access to financial resources. Such are the conditions in which the Innovation Economy has evolved for generations.

It Takes a Theory to Beat a Theory

The examples provided above signal a shift in the center of gravity of economics and finance: from models that leave the messy reality of life behind in pursuit of logical consistency over all possible goals, to work that both mobilizes evidence from that messy reality and takes seriously the requirement to address – not evade – it. As Diana Coyle of the University of Manchester has written:

> It takes time to change curricula, and institutional inertia makes new approaches too risky and difficult for young economists seeking academic jobs and promotions ... One might wish for faster change ... But the long era of hegemony for mainstream neoclassical economics is over.[32]

Andy Lo is Professor of Finance in MIT's Sloan School of Management and Director of its Laboratory for Financial Engineering. That is to say, he is one of the leading financial economists at work today and where he works is one of the citadels of modern economics and finance. That is why his new book, *Adaptive Markets: Financial Evolution at the Speed of Thought*,[33] represents so significant a break with mainstream, conventional theory and has the potential to accelerate the liberation of which Coyle speaks.

From the perspective of an insider, Lo recounts the emergence to intellectual dominance of the Efficient Market Hypothesis and the Rational Expectations Hypothesis. As has long been recognized by critics outside the citadel – and as discussed at length above – EMH and REH depend on extreme abstraction from the real world and from the nature

[32] D. Coyle, "Economics in Transition," *Project Syndicate*, June 23, 2017. Available at https://www.project-syndicate.org/onpoint/economics-in-transition-by-diane-coyle-2017–06?utm_source=Project+Syndicate+Newsletter&utm_campaign=9cf84b7a0c-op_newsletter_2017_6_23&utm_medium=email&utm_term=0_73bad5b7d8-9cf84b7a0c-93569221.

[33] A. W. Lo, *Adaptive Markets: Financial Evolution at the Speed of Thought* (Princeton University Press, 2017).

of the human beings who inhabit that world. But, as Lo emphasizes, nonetheless they have held position as paradigms that have defined and conditioned research agendas for a long generation, while foisting on policy-makers a model of a macro-economy that supposedly could be relied upon (with the occasional nudge of an independent central bank) to deliver the best of all possible economic worlds.

The consummate failure of their legitimate offspring, the modern macroeconomic models, to account for the Global Financial Crisis and its consequences was a necessary condition for the reopening of the economic and financial mind. It was not enough. As Lo emphasizes, "it takes a theory to beat a theory": point assaults on specific vulnerabilities of the dominant paradigm are not enough. And an alternative theory is what Lo offers: the "Adaptive Markets Hypothesis." To do so, he rolls back the commitment of generations of economists to physics as the model for economics (at least, the physics that prevailed before quantum theory).[34]

The search for deterministic laws as universal as gravity and the definition of agents as mindless as the molecules of thermodynamics have defined the scope and purpose of economics and finance since the marginalist revolution some 130 years ago. Lo directly confronts the mathematical instantiation of neoclassical economics which saw off Keynes's assault on the economic thinking that had failed in the face of financial crisis and economic depression in the 1930s. This intellectual achievement will be forever associated with the work of the great MIT economist Paul Samuelson. And Lo explicitly acknowledges that Samuelson led the discipline up a blind alley to a dead end.

In its place, Lo proposes that we look to evolutionary biology as the relevant, framing metaphor for understanding the behavior of markets – markets for goods, and services, and money and capital – and of the human beings that populate and depend upon those markets. In doing so, he implicitly echoes the great Alfred Marshall, the first Professor of Economics at Cambridge, whose *Principles of Economics* defined the discipline for a long generation: "economics has no near kinship with any physical science," Marshall wrote in 1890; "It is a branch of biology broadly interpreted."[35]

[34] In this context, see P. Mirowski, *More Heat than Light: Economics as Social Physics, Physics as Nature's Economics* (Cambridge University Press, 1989).

[35] A. Marshall, *Principles of Economics,* Palgrave Classics in Economics (New York: Macmillan, 2013 [1890]), p.637.

Open-ended adaptation by purposeful agents to an ever-evolving context in which quantifiable risk fades into uncertainty and, beyond uncertainty, into impenetrable ignorance: this is the guiding vision Lo offers. It is also, as readers of this book will appreciate, the environment in which participants in the Innovation Economy exist. And we should honor, not disdain, the "heuristics" – the rules of thumb – that humans have developed as instruments for negotiating this unstable landscape. In turn, we should be open to methodological alternatives for exploring the space of inherently complex, evolving market systems. These will include adopting such simulation techniques as agent-based models, in addition to facing the forbidding challenge of extending closed-form, analytical models to encompass heterogeneous agents reflexively responding to each other's actions, all operating under varying degrees of uncertainty.

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Much is at stake for the conjoined disciplines of economics and finance and for the world at large, as the reconstruction of economics gains momentum. In the narrow terms of this book, understanding the dynamics of the Innovation Economy depends on progress in this endeavor. It will depend on this all the more so as the epicenter of innovation at the frontier moves eastward to China. For a reconstructed economics will need to address the dynamics of an Innovation Economy with Chinese characteristics. And those dynamics self-evidently are not reducible to the sort of EMH and REH models from which the discipline is finally escaping.

The extent to which economists reach across disciplinary boundaries to the other social sciences and beyond will be a critical measure of merit. Kahneman and Tversky demonstrated how scholars from another field, psychology, could so fashion their work as to make it consumable by economists.[36] But that is definitively not enough and the wrong way around. Behavioral economics won its place by stealthy intromission from outside, supported by institutions – the Russell Sage and Sloan Foundations – with independent positions outside the academy and distinctively long-term missions that cross the social sciences. It is more than time for economists themselves to be aggressively

[36] See D. Kahneman, *Thinking Fast and Slow* (New York: Farrar, Straus and Giroux, 2011).

reaching out, to learn from the other social sciences how to read the context – historical, sociological, political and moral – in which economic behavior evolves. The Global Financial Crisis itself represents overwhelming evidence of the need for such an expansion of the discipline.

There is some welcome evidence, derived from detailed analysis of cross-disciplinary citations, that economics, while "among the more insular social sciences . . . is increasingly outward-looking,"[37] as Autor's and Chetty's work cited above exemplifies. And one project to redefine the basic curriculum of economics along these lines has been gaining traction. Led by Wendy Carlin of University College London, the CORE project has mobilized the work of some twenty collaborators to produce a first-year syllabus plus readings that starts with the world and works backward to introduce relevant economic concepts in historical, lived context.[38]

Reciprocally, in the domain of law, where the economics of efficiency and rationality had made powerful incursions, the impact of the Global Financial Crisis has signaled a retreat at least for some of the movement's former champions. Richard Posner, recently retired judge of the United States Court of Appeals for the Seventh (Chicago) Circuit, was a founder and leading academic, and then legal advocate, of Law and Economics.[39] Building on the work of Gary Becker and Ronald Coase, University of Chicago economists, Posner extended the virtue of efficiency to encompass not only civil but criminal law: "I argue that what is forbidden is a class of inefficient acts."[40] But in immediate response to the Crisis, Posner declared his apostasy in *A Failure of Capitalism: The Crisis of '08 and the Descent into Depression*.

[37] J. Angrist, P. Azoulay, G. Ellison, R. Hill and A. F. Lu, "Inside Job or Deep Impact? Using Extramural Citations to Assess Economic Scholarship," National Bureau of Economic Research Working Paper 23698 (August 2017). Available at http://www.nber.org/papers/w23698.

[38] See http://www.core-econ.org, and A. Jayadev, R. Sethi, W. Carlin and S. Bowles, "How Economics Is Forging Renewed Link with the Social Sciences," *Wire*, October 4, 2017. Available at https://thewire.in/184177/economics-forging-links-social-sciences. Initial funding for the CORE project was provided by the Institute for New Economic Thinking.

[39] The birth and growth to maturity of Law and Economics is closely examined in B. Harcourt, *The Illusion of Free Markets* (Cambridge, MA: Harvard University Press, 2011), chap. 6.

[40] R. A. Posner, "An Economic Theory of the Criminal Law," *Columbia Law Review*, 85(6) (1985), p.1195.

Implicitly invoking Keynes's Paradox of Thrift and anticipating the Paradox of Prudence soon to be defined by Brunnermeier and Sannikov, Posner explains how the pursuit of self-interest may lead to a destructive coordination failure rather than to the efficient equilibrium envisioned by neoclassical economics:

> It is no more realistic to expect banks to internalize the remote risk of economy-wide catastrophe that their lawful pursuit of profit creates than to expect people who fear loss of job and income in a depression to spend, not save, for the greater good, though if enough people save enough money in times of economic trouble, the result could be a disastrous deflation.[41]

Posner is not alone among the Chicago School for rejecting certain of its fundamental tenets. Addressing his peers, Chicago economist Luigi Zingales has recently published an essay, "Towards a Political Theory of the Firm,"[42] that follows on his impassioned assault, written for a popular audience, on the extent to which American capitalism has come to be dominated by giant firms and their political servants.[43]

As economists explore other fields for insights and techniques with which to interrogate the world empirically, they are finding it increasingly necessary to modify to the point of abandonment the assumption of rational, maximizing behavior, and to abandon, finally, the crusade to impose it on all social and behavioral disciplines. Instead, like other social scientists, they are condemned to find the meaning of action in the context in which it is embedded. A problematic example is provided by the adoption of randomized controlled trials ("RCTs") from medical science in the attempt to establish causality in economic behavior.

Economics Nobel Memorial prizewinner Angus Deaton and his colleague Nancy Cartwright have challenged economists to understand what is involved, first, in validating the experimental results (is the trial truly "randomized" and is it, in actual fact, "controlled") and, then, in

[41] R. A. Posner, *A Failure of Capitalism: The Crisis of '08 and the Descent into Depression* (Cambridge, MA: Harvard University Press, 2009), p.324.

[42] L. Zingales, "Towards a Political Theory of the Firm," National Bureau of Economic Research Working Paper 23593 (July 2017). Available at http://www.nber.org/papers/w23593.

[43] L. Zingales, *A Capitalism for the People: Recapturing the Lost Genius of American Prosperity* (New York: Basic Books, 2012).

extracting from the results guidelines for policy.[44] Outside of the clinical setting in which RCTs were developed and applied, the validity of their results again will depend on collaborative engagement with those other disciplines – history, sociology, politics, anthropology – to be drawn on for establishing context and thereby defining the possibility of randomizing and controlling the trial.

As the insularity of the discipline dissolves, economists now have an extraordinary opportunity to learn by contributing to the broader reconstruction of the social sciences in the age of digitalization. Once economics stood apart as *the* data-rich social science. But now social media and eCommerce and the digitalization of evidence of all sorts – from texts to archaeological artifacts – are submerging all social scientists in oceans of data. Economists have generations of practice in interrogating data and developing techniques for transforming raw data into meaningful information in pursuit of the identification of causal relationships. This methodological resource can be made available in collaborative fashion to scholars who, in turn, can enlighten economists on the complex, historically dependent cultural and sociological and political context in which economic behavior is embedded. Economics and social science generally – including, indeed, the economics of innovation – will be the better for such collaboration. And so, in due course, will the world.

Undoing the consequences of the Mont Pelerin Society's reconstruction of political and financial economics is a generation-long project. The Global Financial Crisis provided the occasion and the motivation. Here, progress is not to be measured by near-term outcomes of debate over specific policies. Rather, it is the context in which such debates are conducted in the long run that truly matters. Keynes's celebration of the "gradual encroachment of ideas" versus "the power of vested interests" should be what comforts and sustains us in these dark times.

[44] A. Deaton and N. Cartwright, "Understanding and Misunderstanding Randomized Controlled Trials," National Bureau of Economic Research Working Paper 22595 (September 2016). Available at http://www.nber.org/papers/w22595.