Recognizing the Economy as a Complex, Adaptive System: Implications for Central Banks

A. Lessons from the Past

It will be argued in this Chapter that the way in which monetary policy is conducted needs to change fundamentally. Past practice, based on the assumption that the structure of the economy is both knowable and controllable, is simply wrong. A philosopher would say we have made a profound ontological error by misreading the fundamental nature of the object of our attentions. In reality, the economy is a complex and adaptive system, like many others in nature and society, and cannot be well understood or closely controlled. Recognizing this fact should have profound implications for economic policy in general but monetary policy in particular. Adapting to this new analytical framework will be the principal millennium challenge for central banks, and will also raise questions about the political framework relating central banks to governments.

Recent global economic developments bear witness to the inadequacies of the analytical framework which has guided monetary policy over the last few decades. The single minded and successful pursuit of price stability by central banks has not provided the "strong, sustainable and inclusive growth" sought by the governments of the G20. The strong, global growth seen during the years of the "Great Moderation" came to an abrupt end with the economic crisis that erupted in the advanced market economies in 2007. Moreover, that crisis now has global reach and threatens still more serious economic problems in the future. Every geographical area has easily identifiable imbalances that threaten its future growth and prosperity, and other regions in turn. Finally, income and especially wealth inequality within nations worsened everywhere prior to the crisis, and these trends have continued since.

In short, highly expansionary monetary policy provided strong growth for a while, but it was neither sustainable nor adequately inclusive. Indeed, it will be argued in this chapter that highly expansionary

monetary policy has actually contributed materially to both economic and financial instability (unsustainability) and to perceptions that the gains from stronger growth and from international trade have been unfairly shared among the social classes (non-inclusiveness). The social and political implications of these shortcomings are now becoming increasingly evident[1].

A particular shortcoming of prevailing analytical models is how little emphasis they put on supply side developments. In pursuing price stability prior to the crisis, central banks failed to recognize that low inflation in the in the 1990's, and subsequently, was not due to inadequate demand that required monetary easing. Rather, it was due to positive supply side shocks associated with technological advances and the re-entry of China and other "command and control" economies back into the world trading system. More recently, central banks have also failed to see how easy monetary policies could lead to a vicious circle of resource misallocations, lower potential growth[2], and the apparent "need" for still more easy money[3].

As well, on the demand side of the economy, central banks failed to see the dangerous implications of the cumulative increase in credit and debt also associated with easy monetary policies. Over time, these "headwinds" have threatened less demand, not more, constituting another vicious and downward spiralling circle. All of these analytical shortcomings attest to the need to see our domestic economies, and even more the global economy, as complex systems or even systems of systems[4].

The adaptive aspect of our economies also needs to be underlined. Both the real and financial sectors have evolved under the influence of new

[1] The rise of "populist" political movements to confront entrenched "elites" is a byproduct of these shortcomings. They have arisen now because, while distributional issues always matter, they take on increased importance when growth is weak as is typical of a post crisis period. There are, in fact, legitimate sources of political concern of a more secular nature. See Acemoglu and Robinson (2013) and Wedel (2009).
[2] For convincing documentation see Borio et al (2015).
[3] It has become fashionable to assert this in the context of a Wicksellian model. Lower potential growth lowers expected profits and the "natural" rate of interest. It is then contended that the financial rate of interest must be lowered as well. As discussed below, this argument does not stand up when the economy is viewed as an evolving system over time.
[4] See Haldane (2015)

technology and the general trend towards deregulation and liberalisation. Global trade and cross border interactions were rising until very recently, with emerging market economies becoming globally important. Initially, financial systems were national, bank based and characterized by a high degree of cartelisation. Over the years however, this changed profoundly with a move towards globalisation, securitization (not least the rise of "shadow banking") and a considerable degree of consolidation. In sum, the economy provides a highly dynamic and shifting structural backdrop for monetary policy, both influencing it and being influenced by it.

Finally, we need to recognize the complex implications of simultaneous changes arising in different parts of the economy. In the limit, changes in individual parts of the economy which seem to improve economic efficiency can actually make the system as a whole less stable. The globalization and technical progress referred to above clearly raised our efficiency in producing global goods and services. Various developments in the financial sector also provided efficiency gains. The single minded focus of monetary policy on price stability was also thought to be a positive innovation. Yet, put all together, these positive developments produced the serious problems that now face the economic system as a whole.

In summary, the principal lesson from the past is that the economy should be treated as a complex, adaptive system; an ecosystem rather than a machine. Suggestions of this sort can be dated back to ancient times. More recently, they have come to be associated with the work of the Santa Fe Institute[5], and still more recently, work being carried out under the auspices of the Institute for New Economic Thinking (INET) and the OECD[6] among others. A recent book by David Simpson (2013) draws links between the Classical School of economics and modern complexity economics. The latter seems to be able to address the wide

[5] For a fascinating account of the origins of the Santa Fe institute, and an early meeting between physicists and economists to discuss complexity, see Waldrop (1992). It is telling that the Chapter which describes this meeting is entitled "You Guys Really Believe That?"

[6] INET has sponsored many projects, including ongoing work at the Martin School at Oxford University. The OECD, recognizing its failure to predict the crisis, founded an ambitious institution-wide project called New Approaches to Economic Challenges. In this context, the OECD has organized a number of conferences on how the insights of complexity economics might be applied to practical policy making.

range of issues that preoccupied the former. How do we achieve, not just strong growth, but sustainable and inclusive growth? In contrast, mainstream macroeconomic thinking, as practiced by academics and increasingly by central banks, has had a much narrower focus. However, in spite of its limitations, the mainstream view has not yet been adapted to embrace this alternative way of looking at the economy.

B. Throwing Off the Old Analytical Order

The analytical frameworks (and econometric models) still used by most central banks are based on a large number of unrealistic, simplifying assumptions[7]. These are needed in order to ensure the economy is (in principle) both understandable and controllable. In almost every respect, however, they conflict sharply with the assumptions suggested by treating the economy as a complex, adaptive system. Moreover, these assumptions effectively rule out any analysis of the important issues of sustainability and inclusiveness which, as noted above, are now part of the policymaker's objective function.

Perhaps most important, it is assumed that the economy tends automatically and quickly to revert to full employment and to low inflation, supposing that the latter is the objective sought by the central bank. Otherwise put, the economy will revert to a desirable "equilibrium". Similarly, financial markets generate prices consistent with underlying fundamentals. Money, credit and debt generally play no role, while stocks and cumulative processes have also tended to be ignored. Single "representative agents" stand in for the many millions of diverse households and firms. Moreover, these agents maximize their individual lifetime utility (given perfect knowledge of the future and the nature of the economy), without any recourse to emotion or the good of others. Finally, all shocks follow a Normal distribution whose properties do not change over time.

Taken all together, these assumptions yield highly linear forecasts which rule out the unexpected consequences of policy changes, not least radical changes to monetary policy. In short, in the world described by

[7] For particularly biting criticisms see Buiter (2009) and Romer (2016)

this analytic framework, central bankers can easily achieve their inflation objectives and really bad outcomes simply cannot happen.

At the least, this conclusion might be thought curious. There is now a huge set of historical studies documenting past economic and financial crises, to say nothing of this most recent one[8]. As well, the lack of realism of many of the assumptions underlying current models has been repeatedly and convincingly demonstrated. For example, years ago Mandelbrot provided evidence that changes in stock market prices were determined by a Power Law distribution rather than a Normal (Bell curve) distribution[9]. For a more recent example, year ahead forecasts by the IMF (and most others) of economic growth in the major economies has been revised down nine years in a row. Similarly, inflation has come in under the forecast value for a similar period of time. These outcomes must throw into doubt the fundamental assumption of a rapid return to "equilibrium".

In spite of these shortcomings, central banks appear to have generally maintained the analytic frameworks in place prior to the onset of the crisis. That is strongly suggested by the fact that monetary policy since the crisis has essentially been "more of the same". Why is this so? One charitable interpretation is that, while central banks have indeed experienced growing doubts about the usefulness of their analytical frameworks, they see no policy alternatives. They have become "the only game in town". A less charitable interpretation is that they (or at least an important subset[10] of them) do continue to believe their policies will succeed in raising nominal demand and also that these policies, in spite of their increasingly experimental and totally unprecedented nature, will have only limited, undesirable side effects.

What might have induced such analytical rigidity in the face of so much evidence to the contrary? Thomas Kuhn (1962) suggests that needed

[8] The classic reference for past crises is Kindelberger and Aliber (2005). See also Schularik and Taylor (2009)
[9] See the references in Mandelbrot (2004)
[10] It should be noted that not all central banks are the same. See White (2011). The Bundesbank in particular has always been suspicious of mainstream (Anglo Saxon?) thinking, and has used a second, monetary pillar to inform their analysis of the longer run relationship between money growth and inflation. The European Central Bank has taken over this tradition, but seems increasingly to be drawing a relationship between credit (rather than money) and the possibility of deflation (rather than inflation) via a "boom-bust" cycle.

"paradigm" shifts in the natural sciences often take decades to achieve. Those who have taught accepted ways of thinking for a lifetime are loath to give them up. Yet, as shown in White (2013), monetary economists and central bankers have in the past repeatedly shown themselves willing to change their analytic frameworks in the face of "stubborn facts" that indicated that a change was required. Why then is this time different? The answer might be found in the more recent reflections of Daniel Kahneman (2013). He suggests that when belief systems are suddenly and surprisingly shocked by events, the reaction is not to question the beliefs in a fundamental way but to retreat deeper into them. After all of the self- congratulatory, central bank rhetoric around the "Great Moderation", the events following the onset of the crisis perhaps constituted just such a shock.

One can only speculate on what central bankers will do should the global economy weaken once more, perhaps in the context of further financial disorder. On the one hand, previous beliefs might be maintained inducing central bankers to "double down" on still more experimental policies. On the other hand, still more evidence that these policies were actually making things worse might trigger the desired paradigm shift. In the event, making this shift will be the main challenge for central banks in the coming years. Eventually reality must be recognized.

C. Embracing the Economy as a Complex, Adaptive System.

Complex, adaptive systems can be found everywhere. Nothing in nature[11] or society[12] seems linear and stable. Thus, it seems inherently odd to assume that the economy almost uniquely possesses these characteristics. Moreover, these systems have been well studied by other disciplines and share key properties. They are made up of many agents following simple rules, constantly interacting, and responding (evolving) in response to changing circumstances. Moreover, many such systems display "emergent properties"; that is properties that do not derive from the nature of the underlying components but the

[11] See Buchanan M (2000)

[12] For an interesting, nontechnical overview see Ball (2012). It contains chapters on predicting traffic, crowd movements, norms and decision making, how crime spreads, social webs, disease and epidemics, economic and financial systems, fostering cooperation, the development of cites and modelling modern conflict.

interactions between them. There is no equilibrium (except death) in such systems. Agent's actions are premised on assumptions about emergent properties, but actions change those properties in a never ending dynamic.

The application of this way of thinking to economics would seem totally realistic. The economy is in fact made up of many different sectors (consumers, companies, financial institutions, regulators etc.) each comprising many (perhaps millions) of diverse agents. Economic agents do seem to follow relatively simple rules (heuristic devices) to guide their economic activities, but rules which might well include concern for others as well as their own direct interests. Interactions between economic agents do create feedback effects and unexpected outcomes, often of a highly non-linear nature, as described in Section A. above.

The emergent properties of the economic system would be the macroeconomic aggregates that we currently study. Moreover, explicitly identifying them as emergent phenomena would satisfy the desire for "micro foundations" much more effectively than the fiction of the Representative Agent. Further, this way of thinking puts the emphasis on dynamic efficiencies over time, the true source of rising living standards, rather than static efficiencies associated with resource allocation. Finally, the recognition of diverse agents invites an analysis of distributional issues.

Evidence from other disciplines indicates that complex, adaptive systems can behave in a stable fashion for long periods of time. Nevertheless, it seems also to be the case that they break down (fall into crisis) on a regular basis. Moreover, the magnitude of a crisis is inversely related to frequency as determined by a Power Law. Put otherwise, extreme events happen much more frequently than a Normal Distribution would imply, with cascade effects often at the heart of developments. The costs of these crises, to the extent they can be measured, can also be extremely high. The study of cybernetics was developed to help modulate such extreme events. While Wikipedia provides a long list of disciplines to which cybernetic insights have been applied, economics is notable by its absence.

Fortunately, even without recourse to the sophisticated mathematics of dynamic, non-linear systems, the simple embrace of the true nature of the economic system reveals many lessons. The extent to which they apply to governments in general as opposed to central banks in particular, is discussed in the next section. While many lessons can be identified, they all share one insight. Complex, adaptive systems can be influenced by policy but they cannot be tightly controlled. Policymakers should therefore be much more humble in their aspirations[13].

First, there is a trade-off between static efficiency and dynamic stability in complex adaptive systems. This trade-off is often labelled "fitness".[14] The lesson is that policymakers should influence the institutional structure with a view to increasing fitness[15]. Evidently, this raises issues of "how much is enough". More regulation might well increase financial stability, but still more regulation might well cut legitimate lending. This could eventually lead to recession, more bad loans and financial instability by another route. Moreover, too much regulation and tight controls can reduce the alertness of economic agents to both threats and opportunities. Ease of entry and exit is also crucial if evolutionary developments are to be encouraged while avoiding disruptive discontinuities. Finally, attention should be paid to how cascading effects are avoided in other complex systems; e.g. through accepting redundancy and therefore static "inefficiency".

The development of ACE models (Agent based Computational Economics) now provides some guidance as to which institutional reforms would increase fitness, supposing different patterns of assumed behaviour on the part of economic agents[16]. Guidance as to behaviour comes from various sources; not least laboratory experiments, with model validation coming in part from the capacity to replicate economic phenomena in the real world. Such models can also provide guidance about the effects of different policy rules on systemic stability. Advances

[13] For an important work advocating just such an approach, see Hayek's (1974) Nobel Prize lecture.
[14] See Beinhocker (2007)
[15] See Colander and Kuper (2014). For a more sceptical view of what is possible see Kirman (2016)
[16] For a recent review of where this modelling now stands, see Bruno et al (2016)

in both computing and data collection ("big data") imply growing scope for this kind of analysis.

Specifically with respect to the fitness of the financial sector, reliance on regulation to foster stability should be complemented by self-discipline and market discipline[17]. The former would be encouraged by rolling back public safety nets,[18] re-establishing banker's sense of fiduciary responsibility, changing compensation practices and making the threat of prison more compelling. The latter would be encouraged by improved auditing and accounting standards, by the reestablishment of "relationship" banking to encourage trust building, and by getting rid of unnecessary complexity.

Second, we must recognize that complex, adaptive systems will inevitably break down in spite of efforts to increase their fitness. The lesson is that the official sector should be prepared. This has both ex ante and ex post implications. Prior to a crisis, steps should be taken to taken to ensure the authorities, in particular central banks, have the instruments in hand needed to manage a crisis. Memoranda of Understanding between all involved parties, special bank insolvency regimes, and regular "war games" would also be recommended. During a crisis, central banks must provide lender of last resort functions, perhaps in both domestic and foreign (via swaps) currencies. Since crises can vary in significant ways, central banks should also have the legal capacity to respond flexibly[19]. While central banks should likely lead a crisis management team, Treasuries must also be involved if public money has to be spent.

Third, given the uncertainties associated with the behaviour of complex, adaptive systems, policy should focus on minimaxing rather than maximizing. Otherwise put, the lesson is that the objective of policy should be to avoid truly bad outcomes. This implies a greater willingness

[17] White (2014).

[18] As noted below, central banks must continue to play a central role in the management of crises. However, what is also notable is how the scale and scope of safety net measures has altered and expanded over time. See White (2004).

[19] Some provisions of the Dodd-Frank Act in the United States are not helpful. Concerns can also be raised about the capacity of the US Congress to impede the implementation of the Fed's swap agreements with other central banks.

of central banks to accept small downturns that redress imbalances in the economy. This would support the Schumpeterian notion of "creative destruction". Moreover, by redressing imbalances on a regular basis, much larger downturns, with potential social and even political side effects, might be avoided. Finally, a minimaxing strategy would imply that highly experimental policies should be avoided until their potential side effects have been evaluated. This is, of course, standard practice in the pharmaceutical industry if not yet in central banking.

A corollary of this lesson is that monetary policy should be conducted in a more symmetric way, leaning against economic upturns as vigorously as downturns. Historically, it appears that the size of the latter is closely related to the size of the former. Studies of complex, adaptive systems in other disciplines also indicate that new control instruments can sometimes play a useful role. This would indicate that the use of so called "macro prudential instruments", to complement monetary policy in leaning against expansionary forces deemed excessive, might well be useful. Note, however, that this is a different role than is currently envisaged for using macro prudential instruments to allow "lower for longer" interest rates.

Fourth, the trigger for a crisis could be anything if the system as a whole is unstable. Moreover, the size of the trigger event need not bear any relation to the systemic outcome. The lesson is that policymakers should be focussed less on identifying potential triggers than on identifying signs of potential instability. This implies that paying attention to macroeconomic "imbalances" may pay bigger dividends than trying to assess financial instability through highly disaggregated "risk maps" of the sort currently being encouraged by the G20 and the IMF. The latter are not only expensive to monitor, but potential rupture points in the financial fabric can change rapidly in real time. Perhaps more important, serious economic and financial crises can have their roots in imbalances outside the financial system, as attested to Reinhart and Rogoff (2009)[20], Koo (2003) and many others.

[20] Reinhart and Rogoff note how a weak economy can destroy credit ratings and increase non-performing loans. Thus, damage can run from the real side to the financial side as well as running the other way. Koo emphasized excessive corporate debt in Japan, the need to delever, and a decade or more of very weak investment.

Which particular macroeconomic imbalances merit attention? Traditional models, which treat domestic inflation as the only macroeconomic imbalance of interest to central banks, are surely wrong[21]. This is all the more the case as domestic inflation seems increasingly under the influence of global forces. Similarly, reversion to a Wicksellian model that focusses on the gap between the "natural rate" of interest (near term expectations of profit) and the "financial rate" of interest can also be highly misleading. Today, many economists suggest that the "natural rate" has fallen sharply and therefore central banks should push down the financial rate as well. However, if expectations of profit have been reduced by other "imbalances", created by easy monetary policies in the past, it is not self-evident that the answer is "more of the same".

If the economy is a complex, adaptive system, attention should be paid to any significant and sustained deviation of macroeconomic variables that deviate from historical norms. While comforting explanations can sometimes be found, such deviations often indicate the rising probability of a crisis and/or the costs of a potential crisis. In this regard, the Bank for International Settlements has been a leader in identifying rising levels of credit and debt as harbingers of future problems. Closely related, they have also focussed attention on gross capital inflows as indicators of future instability, as well as other financial sector imbalances. Evidently, real side imbalances such as low saving rates prior to the crisis (US) and high investment rates (China) also deserve serious attention. As stressed by Turner (2016), developments in property markets should be monitored particularly closely given how often they have been at the root of subsequent problems.

Fifth, complex, adaptive systems are always changing. The lesson is that central banks must be careful not to fight the last war. For example, looking back on some of the post war crises associated with large capital inflows, the sources and destinations of those flows commonly differed. The Latin American crisis of the 1980's involved banks lending to sovereigns. The South Asian crisis of the 1990's had banks lending to

[21] White (2005)

non- sovereigns. Today, recent capital flows have involved nonbanks (largely asset management companies) buying non sovereign debt. Looking back on these events, central banks generally failed to identify the new faces of this old threat (capital inflows) to stability. Similarly, the expansion of "shadow banking" and the development of new financial instruments prior to the crisis received remarkably little attention.

Viewing the economy as always changing might also throw new light on the "rules vs discretion" debate. Haldane (2012) has suggested that increasingly complex financial systems need not be met with increasingly complex regulation. This suggests a similar question with respect to the conduct of monetary policy. On the one hand, it could also be argued that relatively simple rules for the conduct of monetary policy might provide the best framework within which to guide the evolution of the financial system. On the other hand, it could be argued that an evolving system requires an evolving policy response. This issue need more attention, perhaps through the use of ACE models as noted above.

Sixth, in complex adaptive systems, the future is unknowable. The lesson is that near-term forecasting, on the basis of past data, is simple extrapolation and essentially useless. At the least, central bankers (and the IMF and the OECD) should admit to the limitations of their knowledge, perhaps substituting alternative scenarios for forecasts. For the same reason, what economic agents face is not risk (where probability distributions are known) but radical uncertainty (where they are not known). This implies that the comfort given by risk management techniques may be largely illusory and that capital buffers (for unexpected losses) should be much larger than is currently demanded[22]. More generally, it suggests more prudent behaviour on the part of all economic agents, presumably including central banks as well.

Seventh, with many agents in a complex, adaptive economy, central banks should analyse the distributional implications of monetary policy

[22] This suggestion has been made by Admati and Helwig (2013). Indeed, there is something fundamentally odd about the risk weights underlying the Basel capital requirements. They seem to imply that regulators and bankers have some knowledge of the riskiness of each asset. However, this should guide provisioning for expected losses, not unexpected losses, which are assumed to come totally out of the blue. Perhaps this logic helps explain Admati and Hellwig's preference for a high level of capital relative to **unweighted** assets.

more explicitly. One reason is that distributional affects might alter the transmission mechanism of monetary policy. For example, low interest rates favour debtors and disfavour creditors. If the former have a lower marginal propensity to consume than the latter, the expected expansionary effects of the policy might be muted. Moreover, if monetary policy does contribute to rising inequality (of either income or wealth), the undesirable social implications of this should be explicitly recognized. Central banks would then have the motivation to muster convincing arguments as to why their policies were still doing more good than harm. Finally, if central bank polices are thought to have distributional implications, this will attract political attention since distributional issues are archetypically political. Such issues are discussed further below.

D. Central Bank "Independence" in a Complex, Adaptive Economy

Central bank "independence" has been oversold, as have been the costs of that independence being lost. The history of central banking and, more generally, the evolutionary development of government attests to this. Developments around the ongoing crisis indicate a further diminution of that "independence". Finally, explicitly embracing the economy as a complex, adaptive system clearly implies the need for more domestic cooperation between different agencies of government, including central banks. The fundamental domestic question is how the longer term policies needed for "strong, sustainable and inclusive growth" can be kept free from political influences driven by near term electoral prospects.

First, consider a look back in history. Central bank "independence" is in fact a very recent development in most advanced market economies[23]. After World War ll most of the large central banks were almost totally dominated by their respective Treasuries. It took the inflationary experience of the 1970's, allied with a growing belief in "efficient" and "self-adjusting" markets, to foster the cult of central bank independence in the major economies[24]. Moreover, it should also be noted that many emerging market

[23] Germany and some other central European countries that suffered hyperinflation in the 1920s and immediately after World War ll are notable exceptions.

[24] Simpson (2013) notes that this kind of process is consistent with the way in which government institutions have always evolved. As the needs for services change, or prevailing theories change about how best to do

economies have never conformed to this ideal. While many of their central banks have formally adopted inflation targeting regimes, their respective governments have often subjected this regime to the objective of controlling the exchange rate or pursuing other objectives. The influence of the Communist party on the activities of the Peoples Bank of China is a rather egregious example of this form of behaviour.

Closely related, the word "independence" bears much closer scrutiny. In democratic countries, all government institutions need to be governed by three things; a mandate, a set of powers or instruments, and ways of ensuring accountability. Generally speaking, the mandate is provided by government and it is the government that tries to hold the central bank accountable. What this implies is that the term "independence" really means the capacity to use the central bank's powers free from political influence. This implies a much narrower meaning of the word than is generally understood[25].

Turning now to the influence of recent developments on central bank independence, there can be little doubt it has been further compromised. First, in the pursuit of quantitative easing, central banks have purchased many assets that could conceivably decline in price. Were the central bank's capital to be wiped out, it would surely pay a reputational price. Recapitalisation by governments, while not strictly necessary, would almost inevitably come with conditions attached. Second, many of the central bank's actions have had distributional implications. More narrowly, interventions in financial markets have altered prices creating winners and losers[26]. Some financial institutions seeking liquidity support from central banks have received it and others have not. More broadly, debtors have gained and creditors have lost. It has also been alleged that the already rich (with financial assets) have benefitted at the expense of the middle class. As noted above, all these distributional effects invite political oversight. Third, and perhaps most important, the failure of central bank policies to resolve the ongoing crisis has undermined their credibility and led to calls for more

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things (after a process of trial and error), government institutions will evolve in consequence. White (2013) traces out the almost continuous process of evolutionary change at central banks over the last 50 years.

[25] Again, Europe is somewhat of an exception. Since the Eurozone does not have a government, the European Central Bank has decided for itself what is meant by "price stability". Accountability has generally referred to ex ante accountability (explanation of policies) rather than ex post accountability (your fired).

[26] For example, the ECB's purchases of corporate bonds have had a big effect on interest rate differentials between companies. Equity purchases by the Bank of Japan have driven a wedge between the performance of the Nikkei and the Topix.

direct government action. It is increasingly evident that economies do not "self-adjust" back to a desirable equilibrium.

If embracing complexity means more integration between central banks and other agencies of governments, that process has already begun. In their pursuit of unconventional policies to stimulate aggregate demand, central banks have blurred the distinction between fiscal and monetary policy. Buying in longer term government bonds and replacing them with the shortest possible government liabilities (bank reserves held at central banks) is essentially debt management, and imprudent debt management at that. Moreover, the use of macro prudential instruments implies using existing instruments of financial regulation for the purpose of stabilizing the economy as a whole. This raises the issue of who is in charge? Unfortunately, under the pressure of events, these developments have occurred without adequate thought about the longer run institutional implications.

Looking forward to more normal times, the pursuit of "strong, sustainable and inclusive growth" immediately raises the issue of trade-offs between these objectives should they conflict.[27] Presumably only elected governments could make such value laden decisions, albeit preferably in the context of a cross agency committee[28]. At the same time, it remains important to agree upon institutional structures designed to minimize short term political interference in areas that should be left to technical experts, central banks and regulatory agencies in particular. Similarly, those structures should specify mechanisms for cooperation and, where possible, a clear allocation of responsibilities and associated accountability. Accepting the notion of a complex, adaptive economy implies that the future of central banking will be less "neat" than in the recent past. Nevertheless, if that is the reality, then central bankers and others must adapt to it.

[27] Sometimes they will not conflict. For example, more inclusive growth (say encouraging women and older people to participate in the work force) would encourage both stronger growth and more inclusive growth.
[28] This is a suggestion made in a recent Group of Thirty (2015) report

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