

THE ADVANCE OF TECHNOLOGY AND MAJOR BUBBLE COLLAPSES:
HISTORICAL REGULARITIES AND LESSONS FOR TODAY

Carlota Perez

Universities of Cambridge and Sussex, UK and Tallinn University of Technology, Estonia
www.carlotaperez.org

Engelsberg Seminar on "The future of capitalism Ax:son Foundation, Sweden, June 2010

The current crisis is not an accidental event in the financial system. It is a historically recurrent phenomenon endogenous to the market system. It results from the way technological revolutions are assimilated. Such major collapses signal the need for a structural shift in the forces guiding growth and innovation from financial to production capital and to the return of an active state. If history is a guide, a global golden age may lie ahead

All bubbles are about greed and herd behaviour regulation tries to avoid their worst excesses, but some bubbles are also about the installation of technological revolutions and making overall paradigm shifts. The crash of 1929 and the twin collapses of 2000 and 2007-8 are of this type. Recovery from the consequences of those bubbles requires major institutional innovation to enable the real economy to flourish. The basis for making those statements is the evidence of regular historical patterns of diffusion and assimilation of technological revolutions in the economy and society.*

There have been five technological revolutions in 240 years: the first was the 'Industrial Revolution' from 1771, with the introduction of machinery for textile factories and the construction of a national network of canals for trade (the "internet" of the time). From 1829, we had the age of steam, coal, iron and railways; from 1875 there was the age of steel and heavy engineering (electrical, chemical, civil, naval), when cheap high-quality steel made it possible to build fast transcontinental railways, rapid steamships (replacing sailing vessels) and transoceanic telegraph. All that led to the first globalisation, with worldwide sourcing (and pricing) of minerals as well as counter-seasonal trade in agriculture.

In 1908, Ford's Model-T inaugurated the age of the automobile, oil, petrochemicals and mass production and in 1971, Intel's microprocessor launched our current age of information technology and telecommunications. This information era is only half way through its diffusion path. If history is a guide, it has twenty to thirty years of deployment ahead, while serving as a platform for innovation in all the other sectors and for opening new radical paths in production and lifestyles. The next revolution is likely to bring the age of biotech, bioelectronics, nanotech and new materials, in some combination, depending on unpredictable scientific breakthroughs that may open low-cost and all-pervasive innovation trajectories. Each of these revolutions drives a great surge of development and shapes growth for half a century or more.

Why call them revolutions, though? Because they go far beyond the powerful set of new industries; they also transform the whole economy providing a new techno-economic

* For a complete discussion see: Perez, Carlota (2002) *Technological Revolutions and Financial Capital: the dynamics of Bubbles and Golden Ages*, Cheltenham, Elgar, and also (2009) "The Double Bubble at the Turn of the Century: Technological Roots and Structural Implications", *Cambridge Journal of Economics*, Vol. 33, No. 4, pp. 779-805

paradigm –or common sense best practice– for all. What is most visible, of course, is the powerful cluster of interdependent new and dynamic industries and infrastructures. These result in explosive growth and structural change including the replacement of the industries that had been the engines of growth during the previous surge. On the other hand, each of these revolutions provides new multi-purpose technologies, infrastructures and organisational principles that are capable of modernising all the existing industries too. The result is a quantum jump in innovation and productivity potential for all. The whole process involves a massive change in the overall direction of change, transforming the opportunity space and the ways of living, working and communicating.

The paradigm shift taking place since the 1970s and 1980s has involved the replacement of the logic of cheap-energy and transport by that of cheap-information and its transmission. This translates into massive changes in all aspects of business: from seeking high-volume “mass production” of identical products to a combination of even higher volume flexible production lines with many low-volume niche products; from closed pyramid organisations to open interactive networks; from stable routines to continuous improvement; from considering personnel as human resources to valuing them as human capital; from working to fixed, medium or long-term plans to identifying goals to be achieved with adaptable strategies; from inter-national trade and investment to the global economy; from three-tier (large-medium-small or luxury-standard-budget) to the logic of highly segmented markets and from considering the environment as an “infinite” resource to seeing it as a limit and as a guide for innovation. It is indeed a radical change in managerial best practice ‘common sense’.

Due to the natural resistance and difficulty in assimilating such changes, each great surge goes through two different periods. The first half sets up the infrastructure and lets the markets pick the winners; the second half reaps the full economic and social potential. Each of these periods takes about 20 to 30 years. The *Installation Period* is a time of Schumpeterian “creative destruction”, a battle of the new paradigm against the old, when investment is concentrated in the new technologies, both to install the new industries and infrastructures and to modernise all the mature industries. During Installation, investment is led by financial capital, which funds the technological transformation and, in the excitement, also intensifies its casino-type activities until it decouples from the real economy building a major asset inflation boom that ends in a catastrophic collapse. That “gilded age” prosperity is characterised by income polarisation and by the changing fortunes and rankings of companies, industries, regions and countries.

The *Deployment Period* that follows is what historically has been considered a “golden age” i.e. the great British leap (with the Industrial Revolution), the Victorian Boom, the Belle Époque and the post WWII boom. Such prosperous epochs are unleashed by the policies that overcome the post-collapse recessions. They are a time of widespread application of the new paradigm for innovation and growth across the whole economy and of spreading the social benefits much more widely while, at least partially, reversing the income polarisation of the Installation Period. Investment is led by production capital, usually favoured by government policies and supported by a more regulated financial system. This period ends with the maturity of the technological revolution and its paradigm, the exhaustion of their potential for further innovation or productivity increases and the saturation of markets. All that sets the conditions for financial capital to look for other outlets, among which are the loans to faraway countries and the funding of new –potentially revolutionary– technologies.

Why this pattern? Why the role switch? Because the dynamics of the market economy is based on the interaction between two different and complementary agents: financial capital

and production capital. They are absolutely interdependent but fundamentally different in their character, objectives and capabilities. Production capital is the wealth creator. It is fixed and knowledge-bound; it has a long-term bias and is better for carrying growth and expansion within an established paradigm. Financial capital is in charge of reallocating wealth; it is flexible and mobile and has a short-term bias. It can massively redirect resources and “force” new paradigm diffusion.

This separation and the fact that technical change occurs by revolutions are at the root of the pendular patterns of capitalism from Installation to Deployment and back. When a technological revolution reaches maturity production capital becomes conservative. Financial capital then breaks loose, backs the new entrepreneurs, dismantles as much as it can of the institutional framework, overinvests in the new infrastructure and also uses the new technologies to innovate in instruments for financial speculation. When the resulting bubble collapses, the state needs to come back actively to regulate finance and favour the new and renewed production capital, which can then lead the expansion using the installed potential for growth and innovation. That is the moment we are experiencing now.

Figure 1 presents the historical record with the recurring sequence of periods of installation and periods of deployment for each revolution, with the post-bubble collapse recessions in between. Of course, this is a stylised description, because social reality is always much richer than the models that help us understand it.

Figure 1
The historical record: major bubbles, recessions and golden ages

	INSTALLATION PERIOD	TURNING POINT	DEPLOYMENT PERIOD
GREAT SURGE	"Gilded Age" Bubbles	Recessions	"Golden Ages"
1st 1771 The Industrial Revolution Britain	Canal mania	1793-97	Great British leap
2nd 1829 Age of Steam and Railways Britain	Railway mania	1848-50	The Victorian Boom
3rd 1875 Age of Steel and heavy Engineering Britain / USA Germany	London funded global market infrastructure build-up (Argentina, Australia, USA)	1890-95	Belle Époque (Europe) "Progressive Era" (USA)
4th 1908 Age of Oil, Autos and Mass Production / USA	The roaring twenties Autos, housing, radio, aviation, electricity	Europe 1929-33 USA 1929-43	Post-war Golden age
5th 1971 The ICT Revolution USA	Emerging markets dotcom and Internet mania financial casino	2007 -???	Sustainable global knowledge-society "golden age"?

↑
We are here

On this occasion, the mid-surge bubble happened in two stages. First, there was the NASDAQ boom, rooted in the success of the technological innovations in ICT, leading to the internet mania in the 1990s that collapsed in 2000. Then there was the boom of the mid-2000s, based on a plethora of financial innovations using ICT. Securitisation of mortgage

debt would never have been possible without computers and sophisticated software (which also helped make them opaque to the investors, the rating agencies and even to the emitting agents). The global trading of those and other synthetic instruments would have been impossible without the internet. But, neither would have happened without the easy credit provided by the policies of low interest rates and excess liquidity applied in the 2000s.

Whatever the immediate causes of the financial meltdown in 2007-08, the underlying causes are the same as in 1929 and other major mid-surge collapses. We are not only facing a financial crisis but also the need for a structural shift in the economy. Understanding this is crucial for distinguishing between the necessary regulation to avoid repetition of the worst excesses and the more fundamental task of finding effective ways of bringing about a sustainable global economic recovery.

Thus, such mid-surge bubble collapses have two faces: finance and the real economy. They require a solution in three steps.

1. “Intensive therapy” for the financial system, which this time has already been done (even over-done!)
2. Regulation and the redesign of the financial architecture, nationally and globally. This is still on the drawing board, being the object of intense power struggles. However, the most important element to change on this occasion, which is the setting of a global regulatory floor for what is inevitably a global financial system, is hardly being considered.
3. Enable a structural shift in the economy.

They all require institutional innovation but the first two will only be successful if they are geared to facilitating the third. The last time around (after the crash of 1929) it took more than a decade and a world war to establish the Bretton Woods agreements and the welfare state, which were an appropriate framework for the deployment of the mass production revolution. In the 1930s, Roosevelt’s New Deal was ferociously resisted by business arguing that such government intervention in the economy was a form of communism. It was only after the Second World War, which served as a dress-rehearsal for State-Industry collaboration, that the policies of the Welfare State were fully accepted. The various forms of that social-democratic covenant established a positive-sum game between business and the great majorities (seeing workers also as consumers). That arrangement brought the Post War Golden Age, the greatest prosperity ever experienced by capitalist societies.

The challenge faced by policy makers today is to bring about a Sustainable Global Golden Age. It must be sustainable because the environmental threats of global warming, limits to resources and pollution health-risks do not allow the continuation and extension of the current wasteful and energy-intensive production and consumption patterns. It must be global because the information revolution has created the conditions for the globalisation of the economy. Furthermore, these challenges are compounded by the fact that globalisation –in contrast with what some had been claiming until recently– does not eliminate the need for national and regional policies. In fact, it is through the action of such policies that the global territory becomes clearly differentiated in terms of specialisations and dynamic comparative advantages. And it is taking those into account (and trusting them to be stable) that global corporations choose the location for their diverse activities and local businesses can identify their own best areas of specialisation for both domestic and foreign markets.

Facing this complex policy challenge, will require a disposition for bold institutional change, the combination of Keynes with Schumpeter, as well as a deep understanding of the potential for growth provided by the diffusion of the current information technology paradigm.

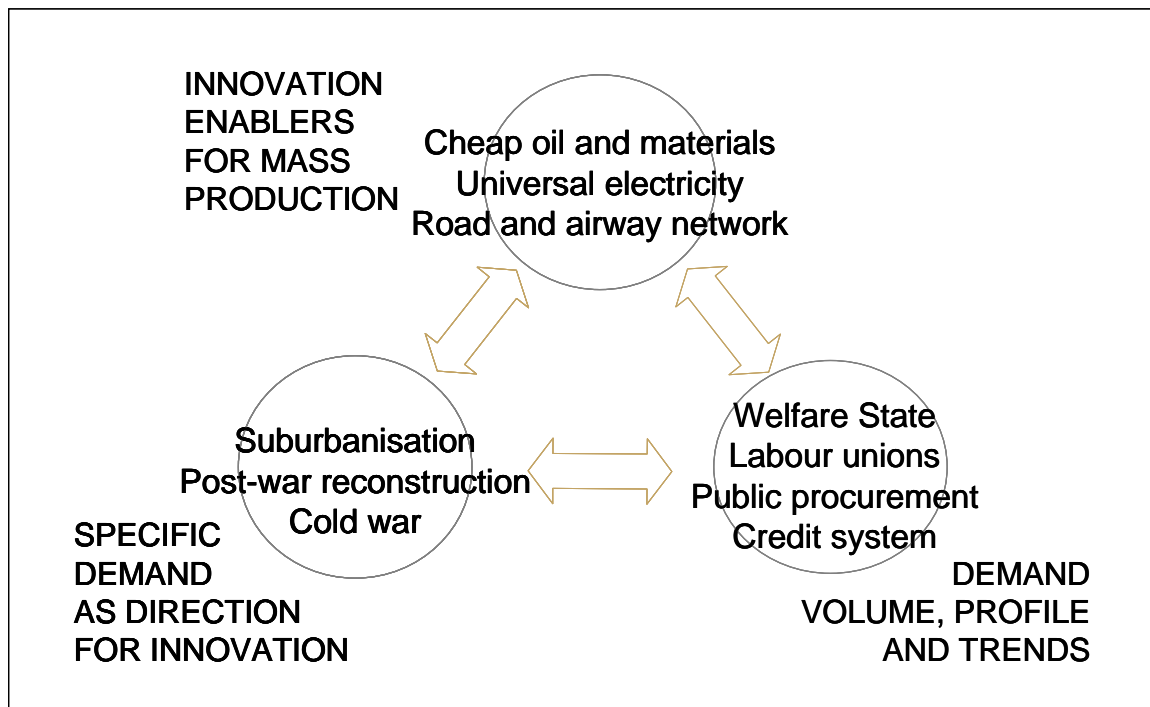
It is important to understand that all that technology provides is a substantial –and specific– potential for wealth creation in a range of possible directions. That potential serves as the space upon which economic and social forces will stage their confrontations, negotiations and compromises and reach decisions to shape the future.

The last time around, the policies applied included a wide set of changes on the national and international levels. Among the latter were the Bretton Woods institutions (the IMF, the World Bank and the role of the US dollar as standard), followed by NATO, the Marshall Plan and the “Cold War”. These shaped the direction of innovation in military and much of capital goods. Nationally, the Keynesian demand management mechanisms were applied together with the Welfare State, which performed income redistribution through taxation and turned the majority of the working population into mass consumers. The automobile, the State funded road networks and universal electricity made it possible to use cheap land outside the cities to mass produce suburban homes and accelerate the demand for electrical appliances and refrigerated and frozen foods. Mortgage support extended home-ownership further and further down the income scale, unemployment insurance guaranteed that instalment payments would be continued in recessions and counting on pensions encouraged people to spend their monthly income without much saving.

All those policies can thus be interpreted as having taken advantage of the existing opportunity space by providing a dynamics of demand, in both volume and direction, in such terms as will favour the specific potential of the mass production paradigm and to signal clear directions for innovation within it (see figure 2).

Figure 2

The demand opportunity space that shaped the Post War Golden Age



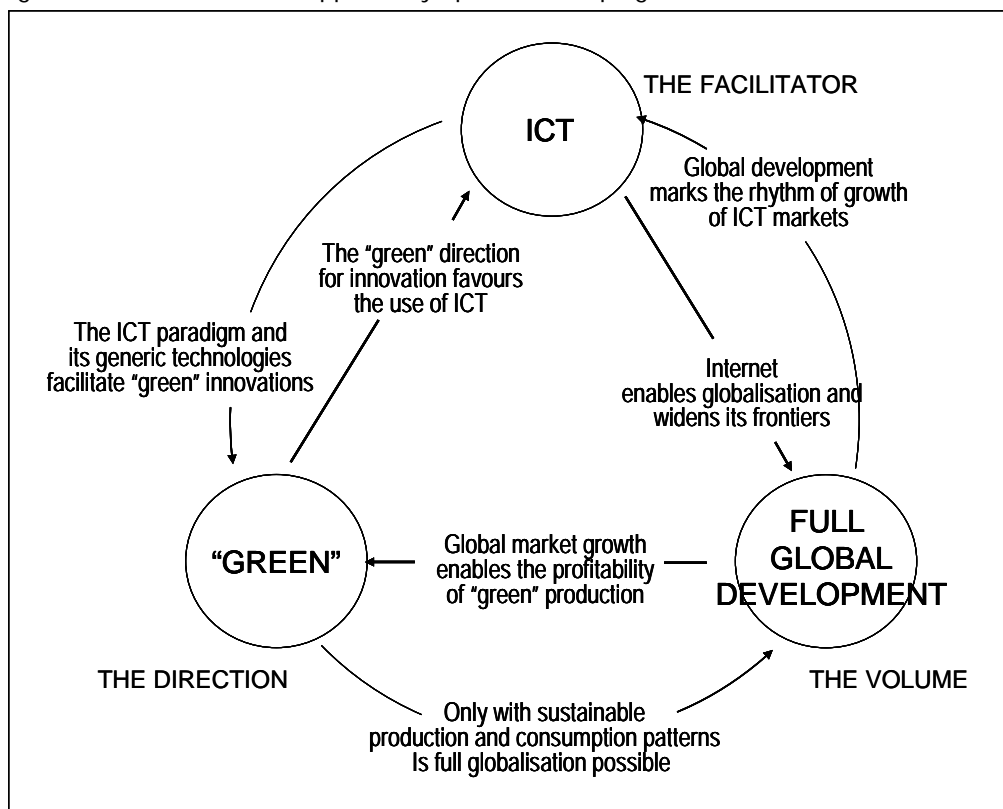
Is a similar shaping possible this time with the current opportunity space? Golden ages are about setting up a positive sum game between business and society (strongly biased games are unstable). In the current globalised world, stable growth would not only require a win-win arrangement within each country but also between developed and developing countries. Is such an arrangement viable?

In my view, the current opportunity space for a global positive-sum game involves three interdependent elements: ICT, “green” and full global development. Revamping transport, energy, products and production systems to make them sustainable is equivalent to post-war reconstruction and suburbanisation. Incorporating successive new millions and new territories into sustainable consumption patterns is equivalent to the welfare state and government procurement in terms of demand creation. Universal internet access at low cost is equivalent to electrification and suburbanisation in facilitating demand (plus supporting education, which in this case is the determinant of both capable workers and intelligent consumers). And, given the hyper-segmentation of markets typical of this paradigm, all countries can find spaces to specialise or respecialise in order to take advantage of market dynamism with tailored policy support. This is particularly urgent for the most advanced countries whose employment prospects are threatened by the emerging ones unless they identify alternative, adequate and fruitful directions for innovation and growth.

Those three forces defining the opportunity space are interdependent. Information and communications technologies (ICTs) serve as facilitators and externalities for all. Full globalisation provides the market volume growth and “green” provides the direction of innovation. (See figure 3)

Figure 3

Defining an interactive demand opportunity space for shaping a Sustainable Global Golden Age



ICTs are the main enabling instruments of sustainability, due to their capacity to monitor and control the use of resources and to aid in the design and redesign of environmentally friendly energy and production systems as well as replacing many products with services. In what relates to full global development, internet access is the social, economic and geographic frontier of the global market. Territories, companies or persons without internet access are excluded from the global economy, even if they are in the most advanced countries. So market volume is defined by the twin penetration of global investment and the internet.

Finally, the switch to a “green” economy is a condition for full global development, because sustainable production and consumption patterns are what can make full globalisation possible. We do not have seven planets so that every Chinese and Indian person can adopt the “American Way of life”. A global “green” economy would have to be based on product durability, high quality and good design rather than on planned obsolescence and excess fashion changes. Under these conditions, market growth for producers would depend on further and further global development; so that it is new consumers (rather than replacement purchases) that would provide market growth.

There is enough space and potential to lift all boats, but the markets cannot do it without the support of enabling policies.

Obviously, the most difficult element of this formula is the change in consumption patterns. It is very difficult, but it is nothing new. Every one of the great surges of technological transformation has radically changed lifestyles. Victorian living was based on types of manufactured products, both to build the houses in the cities and to fill them with utensils, furnishings, textiles, and so on, that were very different from that of the aristocrats but defined the “middle class” living style of the budding industrial age. At the turn of the Century, the world saw the emergence of a cosmopolitan lifestyle, including an acquired taste for exotic elements from abroad, learned by the much more frequent long-distance travels of the middle class. The “American Way of Life” incorporated the workers into the middle income layers of consumption through the spread of suburbanisation. No longer were there two distinct spaces, the rural and the urban, connected by the railways and defined by the stations. The automobile together with the telephone, electricity and the supermarkets occupied further and further circles of territory around the growing cities, expanding and deepening the consumption of energy-intensive and materials-intensive goods.

Each time around, the new living style is first adopted by the upper sections of the middle class (enriched by the easy profits of the Installation period) and then it spreads across geography and income layers. Imitation happens because that new lifestyle becomes the “luxury norm” and shapes the dreams of upward mobility of the majorities. The previous style is abandoned as old and obsolete in favour of the new and modern one.

Why has the world maintained the energy intensive, wasteful lifestyle that was the path to growth in the previous paradigm and not incorporated the potential for environmental friendliness provided by the current paradigm?

In my view there have been two major forces maintaining the old paradigm alive. One is the fact that the price of oil came down from the peak of the oil crisis in the 1970s and 1980s to an almost all time low in the late 1990s, precisely coinciding with the Internet boom. That brought back energy intensity (ruining most of the alternative energy projects that had grown during the high-price period) and moved the ICT industry towards disregarding materials and energy consumption (new products rather than the option of upgrading software).

The other force keeping the old paradigm alive was the incorporation of most of the countries of the communist world into the market system. Very low cost labour for manufacturing

together with an enormous growth of demand for the elements of the American Way of Life, made it natural for business to just keep making profits by perpetuating the old style with just modern designs and more flexible production systems.

But those forces are not permanent. Already the Chinese government is acting upon its decisions to reorient production towards environmental sustainability and the domestic market. And the cost of energy – and that of all the packaging materials (plastics and cardboard) – is likely to rise due to restrictions of supply in the face of high demand. This in turn is bound to affect the cost of transport and to change the relative cost structure, thus influencing the shape of globalisation. This could make possible that, eventually, the logic of the new paradigm will prevail.

However, there are many changes that require technological and regulatory innovations and affect behaviour and values: the return of maintenance and repair; arrangements for recycling, disassembly and materials reuse; zero waste and closed-loop production processes; the structuring of second, third and fourth hand markets with global operation, supported by recovery factories and long-term spare parts provision. All these activities would create many jobs and would increase the quality of life of different layers of population. Yet, they will require training and retraining efforts and will mean uprooting deep-seated habits in people and companies.

For the moment, one can already observe a set of important changes in consumer preferences in the upper layers of the income scale that do move away from those of traditional mass production times. Increasingly small is seen as better than big; natural materials as better than synthetic; multipurpose as better than single function and ‘gourmet’ food as better than standard. Luxury home design is now “minimalist”, health has become a direct concern favouring the replacement of processed foods by fresh organic fruit and vegetables as well as exercise for both relaxation and holidays. Global warming is seen as a real danger; solar power is considered luxurious; not commuting to work is possible and preferable and, whenever possible, shopping, learning and entertainment are done by internet communications.

These trends are likely to find their way into the great majorities, especially if they are promoted as the “good life” by advertising and the media and if they are further reinforced by the relative price of energy and materials. The latter will eventually rise by the forces of energy supply and demand, but could be intensified by carbon reduction policies. Historically such major changes in lifestyle have been moved by desire and aspiration. It is unlikely that invoking guilt or the fear of climate change would be capable of shifting more than an educated and convinced minority.

Of course, putting the accent on the difficulties of modifying consumption patterns does not mean they are the core of required public policy. The challenge of changing the conditions for innovation in favour of “green” involves an intelligent combination of regulation, subsidies, tax policy, tariffs, infrastructure expenditures, procurement practices and other means for tilting the playing field away from high carbon, high materials consumption and high waste. For instance, it is not possible to have a proliferation of investment in alternative energies while there is complete uncertainty about prices. It is reasonable to expect entrepreneurs to confront their own technological risks (which can be substantial) but not to also face the risk of future oil prices, which often depend on financial and political manipulation. And the incentives to invest in developing countries that are not among the “emerging” ones will also require institutional innovations as bold as the creation of the IMF and the World Bank were in their time. The Tobin tax on financial transactions could be one of the necessary sources of funding.

Before dismissing all this as utopian, it is worth placing oneself in the context of the low-wages and high-unemployment context of the 1930s and imagining the reception that would have met anyone suggesting that, in order to revive the economy, policies should be implemented to turn the workers into middle income consumers, with a house full of electrical appliances and an automobile at the door. In that same context, the idea of independence for the colonies seemed more than unlikely. One of the objectives of the initiators of WWII was precisely the occupation of new territories. Similarly, whoever might have suggested in the 1960s that some of the “hippie” values, such as organic food and natural materials, would become the premium segments in the future, would have been immediately dismissed. The historical evidence shows that the future is not the extrapolation of the recent past and viability needs to be judged in terms of new opportunity spaces.

The technological potential is there for capitalism to unleash a golden age of unprecedented prosperity across the globe. It is the ideological and political forces that are not yet ready to take the necessary action. Perhaps only longer or deeper recessions would create sufficient political pressure to try to understand the underlying causes of the crisis and to activate the political will to steer the world into a new growth path.

In sum, the crisis has opened a giant opportunity space for shaping the future into a global positive sum game between business and society and between humanity and the planet. Taking full advantage of that opportunity is the major challenge of our time.