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Capitalism, Technology and a Green Global Golden Age: The Role of History in Helping to Shape the Future

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Beyond the Technological Revolution is a four-year research project led by Carlota Perez, as a continuation of the work done for her 2002 book Technological Revolutions and Financial Capital.

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Capitalism, Technology and a Green Global Golden Age: The Role of History in Helping to Shape the Future

Carlota Perez

Growth without technology or sustainability without growth?

The increased awareness of the role of technology and innovation in the economy has not yet found a clear expression in orthodox economic theory – or in the growth strategies being applied across most of the advanced world. There are currently widely divergent opinions on the likely impact of information technologies on growth and employment. While the optimists claim that these technologies, guided by the market, will eventually bring growth,¹ the naysayers counter with predictions of high unemployment and low growth.² At the same time, a significant proportion of the environmental movement has been calling for zero growth, ‘de-growth’ or similar, essentially blaming technology for climate change and other environmental and social ills.³

In this chapter, I shall argue that what all of these divergent views on technology and growth share is the absence of a proper historical understanding of innovation: of its nature, of the interactions it generates in the economy, and of the regularity in the technological upheavals from which innovation has sprung since the first Industrial Revolution. Although it is difficult to find an economist today who will not accept that innovation is a key driver of economic growth, it remains almost impossible for them to express its impact adequately in orthodox models. Increases

¹ See for example Atkinson (2015); Brynjolfsson and McAfee (2011)

² Gordon (2012); Cowen (2011)

³ For example: Jackson (2009); Latouche (2010)

in labour productivity through the change in proportions of labour and capital do reflect process innovations, but the impact of radical product innovations can neither be expressed nor predicted. Such truly new capital goods and infrastructures as (historically) steamships, railways and computers, which cost less and less at the same time as their influence on growth and society becomes more and more powerful, are probably the most dynamic inducers of growth. The specific nature of these technologies is not easily measurable, and there are hardly any comparable statistics of such “game-changers” across the past two centuries, so they are routinely ignored. Yet this oversight is a waste of one of the richest sources of knowledge about how growth comes about and how jobs are created and destroyed.

Similar problems with measurement and analysis have led many economists and policymakers to see a conflict between growth potential and environmental concerns. Orthodox economics has long struggled to deal appropriately with the role of natural resources in the economy. Decades of low and decreasing cost of energy and raw materials made it seem reasonable to ignore their impact, and thus both the concept of output per hour and of the ambitiously-named ‘total factor productivity’ fail to measure the productivity of resources. Nor have many attempts been made to incorporate the role of innovation in resource use. In 1956, Solow proposed that the nature of technology should be recognised as being wider than just the contributions of capital and labour, measuring its total contribution as the unexplained ‘residual’ after those had been taken into account.⁴ Half a century later, with environmental and energy issues becoming pressing concerns, Ayres et al. suggested introducing the efficiency of energy into the models.⁵ But such approaches do not go very far in analysing the role of concrete innovations in productivity and growth, much less in guiding growth and employment policy. Over recent years, as the high volatility and uncertainty of resource prices have become the ‘new normal’, energy and materials conservation and raising the productivity of resource use have increasingly become strategic business goals.⁶ Yet such innovation is not taken into account in the usual analyses of growth. Instead, the environmental regulations that have prompted such innovations are often perceived as growth suppressors.⁷

⁴ Solow (1956)

⁵ Ayres et al. (2002)

⁶ Dobbs et al. (2011)

⁷ See for example: Christiansen and Haveman (1981); Palmer et al. (1995)

Meanwhile, the calls for zero growth or de-growth coming from the environmental movement also stem from an incorrect assumption: that the only possible patterns of growth available are those of the resource-based forms of mass production which shaped most of the twentieth century. Both these opposing camps see a conflict between economic growth and environmental concerns. Yet both have largely ignored the evidence that new information and materials technologies, if well guided towards environmental ends, have the potential to radically reduce the material and energy content of consumption patterns and production methods. Such a direction for innovation can stimulate profitable investment, bring growth, and allow millions of new consumers in the developing world to adopt highly satisfying lifestyles – albeit very different in kind to 20th century notions of good living. This possibility was identified as early as 1973 by Chris Freeman and other evolutionary economists at the University of Sussex, who argued that well-directed technological change could curb waste and excessive use of energy and resources without bringing growth to a halt.⁸ Such studies have snowballed since, with ‘green growth’ analyses and associated policy proposals now beginning to emerge even from mainstream economic organisations such as the World Bank and OECD. The 2014 report of the Global Commission on the Economy and Climate, *Better Growth, Better Climate*, has been particularly influential.⁹ Yet in wider economic and environmental debate the confusion persists. The need to understand the processes of technical change and the ways in which major new technologies have historically been assimilated and shaped since the industrial revolution is as urgent for the environmental movement as it is for orthodox economics.

This chapter therefore seeks to connect an understanding of innovation as an economic process with the possibility of enabling new patterns of growth in a global ‘green’ direction. It will show how, historically, the innovation potential of each major technological revolution has been shaped and steered by government, society and business in periods that are very similar to the present, when the recessions following major bubble collapses have led to widespread fears of joblessness and secular stagnation.¹⁰ It will argue that this pessimism is a recurrent phenomenon based on the stalling of innovation, after major bubble collapses, in spite of the existence of plenty of technological possibilities.¹¹ It results from the decoupling of the financial sector from the production economy during the boom and its reluctance to take risks investing in the real economy after the experience of

⁸ Cole et al. (1973); Freeman and Jahoda (eds.) (1978).

⁹ Global Commission on the Economy and Climate (2014); see also Jacobs (2012)

¹⁰ Hansen (1934); Summers (2012)

¹¹ Brynjolfsson and McAfee (2011 and 2014)

the crash. The necessary 'recoupling' has historically involved a paradigm shift in direction for the economy and society as a whole. The chapter will therefore argue that a radical change in policy is now needed to tilt the playing field strongly towards green growth and green innovation as the new direction for our age, and that such policies can bring back growth and jobs and reduce inequality.

Technological revolutions and economic development

The history of technological revolutions

Technological progress is commonly misperceived as continuous. Economists typically take the British Industrial Revolution of the 1770s as the start of the industrial age, and the commencement of the process of constant 'development' and economic growth which has transformed the West and to which the less developed countries aspire. Nevertheless, a number of analysts have recognised additional breaks or 'industrial revolutions' in the sequence, such as a second major leap forward in the late nineteenth century, and, increasingly, the 'digital revolution' of the current times. On the other hand, a recent view holds the prospect of a significant reduction in technology-driven growth in the West, using the term 'secular stagnation' originally used in the 1930s.¹² A closer analysis of past patterns of change reveals that these views are a simplification of the historical record.

My research, which builds on the work of Chris Freeman, Giovanni Dosi and other evolutionary economists,¹³ confirms the view of Kondratiev and Schumpeter that there have been, not one or three, but five distinct 'technological revolutions' since around 1770, driving what can be called successive 'great surges of development'. The first of these surges was indeed the Industrial Revolution. The introduction of mechanisation, the development of factories with water power and the associated network of canals radically changed ways of working and living and saw the ascendance of Britain as a world power. The second upheaval, from 1829, based on coal and steam, iron and railways, brought the rise of the educated and entrepreneurial middle class. Then, from 1875, the age of steel and heavy engineering (electrical, chemical, civil and naval) saw the proliferation of trans-national railways and trans-continental steamships, enabling an intense development of international trade and the first 'globalisation'. That period witnessed the emergence of Germany and the US as challengers to British

¹² see particularly Gordon (2014)

¹³ Schumpeter (1939); Kondratieff (1922); Dosi, Freeman, Nelson, Silverberg, and Soete (1988)

hegemony. In 1908, with the launch of Ford's Model-T, the age of the automobile and highways, of oil and plastics, and of universal electricity and mass production shook up patterns of working and living once more. In this instance, the US led the way, harnessing the interrelated technologies and infrastructures to produce the great surge of development that created the mass-produced, suburban American dream. Most recently, in 1971, the year that Intel's microprocessor was launched, our current age of information and communication technologies (ICT) was initiated.

It is important to emphasise that, when identifying these shifts as 'revolutions', we are not referring only to the radical new technologies themselves. True, each of these technological leaps has brought with it a whole new set of interrelated innovations, industries and infrastructures. But it is the potential of these technologies to increase productivity across the whole economy that makes them truly revolutionary. Their propagation changes the relative cost structure of production in most sectors, by providing new powerful and cheap inputs (such as steel in the third shift, oil in the fourth and microelectronics in the current one). They unleash innovation potential that typically leads to synergistically-connected chains of new products and to the renewal of mature industries. The new infrastructures – from canals to railways, to steamships, to highways and electricity, to the internet – allow wider and deeper market penetration at decreasing costs. And their application gradually transforms organisational models and the 'common sense' criteria for best practice in production and innovation across all industries. The result is what can be described as a 'techno-economic paradigm shift', which leads to a profound transformation in ways of working and consuming, changing lifestyles and aspirations across society.¹⁴

Perhaps the greatest of these technological upheavals was the one brought by mass production and the automobile in the first decades of the twentieth century. The major leap in manufacturing productivity made the so-called 'American Way of Life' – or a variation of it – accessible to the great majorities of people in the advanced nations. The transformation of agriculture, through mechanisation, petrochemical fertilisers and pesticides, increased food production enormously, while the introduction of cheap plastics to replace natural materials supported the mass consumption of low-cost appliances and clothing and the innovations of disposable packaging and bottling. It was a major shift from the world of paper and cardboard, horses, bicycles, trains and tramways, and it blurred the previously clear separation between city and countryside as the automobile enabled suburban sprawl.

¹⁴ see Perez (2002 - particularly chapter 2 - and 2009)

A regular pattern of diffusion

Although each of these revolutions has been distinctly specific, due to its technical characteristics and also to historical, political and other contingent factors, certain features do recur each time. Such recurrence is explained by the fundamental ways in which the market economy and society generate and assimilate the paradigm-changing processes of technical change.¹⁵ Every time, the great surge of development driven by each revolution has taken half a century or more to spread unevenly across the economy. And each has occurred in two distinct periods – installation and deployment – with a ‘turning point’ or transitional phase in the middle that has been marked by a bubble collapse and a shorter or longer recession (see Figure 1).

Figure 1
The historical record: Bubble prosperities, recessions and golden ages

No., date, revolution, core country	INSTALLATION PERIOD	TURNING POINT	DEPLOYMENT PERIOD
	'Gilded Age' Bubbles	Recessions	'Golden Ages'
1st 1771 The Industrial Revolution Britain	Canal mania UK	1793–97	Great British leap
2nd 1829 Age of Steam and Railways Britain	Railway mania UK	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 USA Autos, housing, radio, aviation, electricity	Europe 1929–33 USA 1929–43	Post-war Golden age
5th 1971 The ICT Revolution USA	Internet mania, Telecoms 1990s emerging markets Global financial casino&housing 2000s	2000-03 2008-20??	Global sustainable 'golden age'?

We are here

(*) Note an overlap of more than a decade between Deployment 3 and Installation 4

Source: Based on Perez 2002 and 2009

The first period, installation, is characterised by the turbulent times of Schumpeterian ‘creative destruction’.¹⁶ Financial capital drives the process, funding the emerging entrepreneurs and innovators to explore the vast potential made possible by the new technologies. Historically, it is a time of ferocious competition, during which the ideology of laissez faire tends to shape the behaviour of governments. This permits financial capital to override the entrenched power of the

¹⁵ Perez (2002), chapters 4-5.

¹⁶ Schumpeter (1942: 1994)

production giants of the previous paradigm, enabling the modernisation (or destruction) of the mature industries and spreading a new 'common sense' across both the business world and society – turning to 'normal' many processes, practices and expectations that would have been inconceivable only decades before. This frenzy phase of extravagant 'Great Gatsby'-esque prosperity also facilitates a necessary over-investment in the new infrastructures, in order that coverage (whether of canals, railways or the Internet) is broad enough for widespread usage. This enables the paradigm to diffuse from niche to mainstream.

However, installation also involves painful social disruption and adaptation. The diffusion of the new paradigm leads to a massive displacement of old skills and to polarisation between new and old industries, regions and incomes. As the mature industries of the previous paradigm that do not manage to modernise decline and the new industries choose 'greenfield sites', major shifts occur in the location of jobs. The contrast between the bankruptcy of Detroit and the ascent of Silicon Valley is a dramatic example of this in the current shift away from the Age of Oil and the Automobile to that of ICT. At the same time, the free market ideology, which plays a role in encouraging the abandonment of the old way of doing things and of propitiating the new, also leads to economic instability and, eventually, begins to stifle genuine growth rather than promote it. Unrestrained by regulation, financial capital becomes increasingly speculative, moving further and further away from investments in production until the paper economy of the stock market decouples from the 'real economy' of goods and services, taking off from the performance of the companies they represent. Thus, we see a flourishing of casino-like financial instruments, such as those that fuelled the sub-prime mortgage and toxic instruments boom in the US in the 2000s, in order to mobilise the increasing amounts of investment funds looking for easy gains.

Indeed, in the past, as now, every installation period has culminated in a major bubble followed by a major crash. In the 1790s and 1840s the canal and railway manias ended in panics; the bubbles of the first globalisation collapsed in the 1890s in Argentina, Australia, the US and several other countries; and the 'Roaring Twenties' ended in the crash of 1929. In each case, the basic infrastructure and technologies of the new paradigm had been installed so that the full growth potential of the revolution could be realised across the entire economy. Yet, reverting to 'business as usual' after such crashes does not work. Business has fundamentally changed; economic growth now requires a radical redirection in order to use the new potential for investment and innovation in a convergent way

across the economy. At the same time, the crash reveals the workings of the financial casino, and this revelation, together with the unemployment and income inequality that regularly accompany it, have historically set the political conditions for unleashing a second period: that of deployment, which is characterised by more harmonious growth than in the bubble booms. But before this can occur, finance has typically been regulated and reoriented so that it serves the production economy once again. Immediately following the crash, private investors have become risk averse and are not ready to fund the expansion. Thus, after the major collapses, the state has historically stepped in to play an active role in favour of investment and growth.¹⁷

Why we are now in the equivalent of the 1930s and 40s

What is critical to understand, firstly, is that the recessions that follow the mid-surge crash result, not only from speculation and panic, as is commonly believed regarding the current economic crisis, but also from the structural changes brought about by the new paradigm itself. Each technological revolution is based on an interrelated set of new technologies, industries and infrastructure networks that develop in intense 'feedback loops', providing markets and suppliers for each other, lowering production costs and increasing profitability – in the way that computers generated markets for micro-chips, the Internet for computers and both of them together for the iPhone.¹⁸ It is these synergies between the new technologies, industries and infrastructures that are the hallmark of a technological revolution and the basis for its rapid growth in the initial decades of diffusion.

These revolutions also provide a new potential to transform and enable innovation in other industries. In the current shift, we have already seen the initial impact of creative destruction. ICT has transformed many pre-existing industries, and opened the way to new opportunities, from turning tangible products into services, to the creation of the home office and the globalisation of production and trade. It has also changed some of the patterns of consumption towards greater information-intensity as well as towards more generalised innovativeness and entrepreneurship – individual and collective – using networks and platforms. But its transformative work is far from done. As has been the case with previous revolutions, the next few decades may be as different from the bubbles of the 1990s, 2000s and the recession of the 2010s as the golden age of the 1950s and 1960s differed from the roaring 1920s and from the depression of the 1930s.

¹⁷ A fuller account of these processes can be found in Perez (2002)

¹⁸ Freeman and Louçã (2001)

The second period in the diffusion of each revolution is 'context dependent' deployment. The new set of possibilities is disparate and often unconnected. It is referred to as 'potential' precisely because it can be used and shaped in different ways and because profitability depends on relative costs, dynamic demand and the availability of synergies in terms of suppliers, skills, distribution networks and customer learning. Hence the potential inherent in each revolution requires the choice of a direction in order to come to fruition: in other words, an orientation for innovation is necessary, applicable across multiple and disparate industries, which can generate synergies advantageous to all of them.¹⁹ For policy makers the key insight is that this direction is neither pre-determined nor automatically defined by the technologies of the revolution. Rather, historically it has resulted from a combination of factors: the constellation of lifestyle-shaping goods and services made possible by the technologies; the ability of investors, entrepreneurs and governments to recognise the potential of these products; the political ideologies of those with the power to affect their deployment; and the socio-historical context in which they emerge. Politicians and policy makers in the past did not count on historical hindsight, so the successes or failures of deployment directions can be ascribed to the intuitive quality of the leadership and to the relative power of the various interests at play. At present, with a greater understanding of the processes at work, the direction can become a conscious socio-political choice. In order to visualise the breadth of the range available, suffice it to note the marked differences in the direction given to the potential of the mass production revolution by Hitler, Stalin and the Keynesian democracies of the West.

In the United States, which was at the forefront of that revolution, the installation period began in 1908, bringing a new highway-based infrastructure, the spread of electricity, the communication device of the radio and the promise of aviation. Optimism – and investment – in this brave new world was high, accelerated by the WWI production boom. But, by the 'roaring' Twenties, investment had turned speculative; it was a bubble prosperity; a 'Gilded Age'.²⁰ The Great Depression that followed made it difficult to recognise the vast range of viable innovations and of potential mass markets connected with plastics, energy intensive materials, electrical appliances and the personal automobile. At the time, assembly line manufacturing and the mechanisation of agriculture generated the same fears of unemployment and 'secular stagnation' that globalization, robotics and artificial

¹⁹ Mazzucato and Perez (2015)

²⁰ Twain and Warner (1873)

intelligence do today.²¹ Yet the greatest boom in history was just around the corner – a great surge of consumer-pulled growth, given direction by the practice of suburbanisation and the ideology of the American Dream. This consumerist way of life that went on to fuel economic expansion for decades was not merely the sum of the new products and infrastructures made possible by the mass production paradigm, but resulted from a synergistic combination of political and societal choices. It was the measures of the welfare state, such as free (or subsidised) education and healthcare, labour union-secured salaries, and a progressive tax structure, along with complementary institutional innovations such as the credit system, unemployment insurance and mortgage guarantees, which made it possible for the growing numbers of the population – including blue collar workers – to aspire to a suburban home and the new lifestyle. Thus, the social safety net and suburbanisation, together with the Cold War, defined the optimal space for successful profitable innovation with dynamic, reliable and synergistic markets. On the global stage, complementary institutional innovations, such as the World Bank, the IMF, the GATT, the Bretton Woods agreement on the ‘gold dollar’, the UN (and, ironically, also the Cold War) stabilised international economies and trade, furthering the positive sum game created between business and society.

A similar process of state-enabled convergence in innovation has occurred during every deployment period. Each technological revolution makes feasible a wide range of new inter-related infrastructures, production equipment and life-shaping goods and services. Yet it is in a process of socio-political choice that the specific set that will flourish from the new range of the possible is fully defined. Historically, that choice – particularly in the Western market societies – has not required coercion, but rather is driven by aspirations for the lifestyle that the new goods and services provide. The rich and educated tend to be the pioneering adopters, with increasing layers of society copying their example.

In the mid-nineteenth century, the age of steam, coal, iron and railways saw economies of scale in production and transport that led to the emergence of ‘Victorian living’. The British middle classes established an industry-based urban lifestyle (different from that of the country-based aristocracy) which gradually spread to the new bourgeoisies in other countries. The age of steel and heavy engineering, which built the transcontinental and transoceanic infrastructure networks that led to the first wave of globalisation, similarly brought the cosmopolitan lifestyles of the Belle Époque to the European and American upper

²¹ Brynjolfsson and McAfee (2014)

and middle classes, later spreading to the upper classes of the world. As with the 'American Way of Life' of the postwar period, each of these styles became the model of 'the good life' and, as such, shaped the consumption patterns and desires of the majority, provided secure growing markets and guided innovation trajectories.

We are now in a crucial moment in history similar to the 1930s, requiring thinking and measures as bold as those of Keynes, Roosevelt and Beveridge,²² and as ambitious as the Bretton Woods agreements. Unemployment and inequality are increasing due to globalisation, new technologies and the decoupling of finance from the economy during the prosperous bubble period. Critically, the 'American Way of Life' of the last paradigm brought patterns of consumerism, disposability and profligate use of energy and materials that now confront the world with major environmental challenges, not least that of climate change. Up until now the ICT revolution has done little to change this: mass use of computing technologies has indeed added to global energy and materials demand. But our current information era is only half way through its diffusion path. If history is a guide, it has twenty to thirty years of deployment ahead. We have indeed witnessed a rash of new products and increasingly changing consumption patterns over the past two decades due to the widespread installation of these 'general purpose' technologies, yet their capacity to transform every single industry and activity is only in its early stages. There is a huge potential for innovation that is technologically feasible but still risky and uncertain in terms of markets and profitability. What is lacking is a direction that responds appropriately to the current contextual conditions and the specific wide-ranging innovation potential now installed. The playing field needs to be tilted to achieve something similar to what suburbanisation did in the post-war boom. In the next section, it will be argued that a 'green' direction and full global development — together — form a direction that is capable of unleashing the vast potential available on a growth path that could lift all boats.

ICT and the green direction

What is the 'green direction', and how is it related to the present ICT paradigm? As noted in the introduction, both 'zero growth' environmentalists and those in favour

²² Even bolder were the creators of the Swedish model, Rehn and Meidner, whose model of cooperation between business, government and trade unions brought the country to the first ranks in productivity, competitiveness, skills and wellbeing. That model became inadequate, once the mass production revolution approached exhaustion, as happened with the orthodox Keynesian recipes across the rest of the advanced world. See Meidner and Rehn (1951)

of unfettered markets see a conflict between economic growth and environmental concerns, despite the mounting evidence to the contrary coming from successful sustainable business models²³. This chapter argues that the ICT revolution has the capacity to facilitate wide-ranging sustainable innovations to radically reduce materials and energy consumption while stimulating the economy. It can significantly increase the proportion of services and intangibles in GDP as well as in lifestyles.

To understand the role of ICT in the green shift, it is important to clarify that, although many products and services will involve digital technologies, not all need to do so. Once you learn to network with computers and iPhones, you naturally network without them; once Spotify and Kindle teach you to access music and books from a shared source, rather than possess a collection of boxed CDs and a heavy-to-move library, you find it natural to share tools with your neighbours and so on. That is what a paradigm shift is about: a new common sense for innovation and behaviour with or without the actual technologies. All those trends that involve reducing waste and responding to needs in intangible ways are going in the direction of 'green growth'.

A very broad definition of 'green growth'

Part of the difficulty in understanding the notion of green growth may be the 'green' tag itself, which increasingly refers to avoiding climate change by reducing CO2 emissions through renewable energy or use of 'sustainable' products. Although renewable energies, resource efficient innovations and new environmentally-friendly materials are certainly key elements, they are not sufficiently far-reaching alone to revive growth. From a technological point of view, such product categories do not constitute a synergistic system, just as automobiles and plastics alone would not have been enough in the last industrial revolution: they do not lead to sufficient technological convergence in equipment, engineering, skills, or suppliers.²⁴ Rather, 'green' is one of the possible directions of stimulus for deployment of the general purpose technologies of ICT across every industry and sector in which challenges brought by globalisation and environmental degradation turn from obstacles to solutions. Thus, green growth should be seen as a 'mission-oriented' pathway to promote a major switch in production patterns and lifestyles, creating new sources of employment and well-being. It involves tilting the playing field in such a way that profitable innovation and investment opportunities will reinforce each other

²³ Ellen MacArthur Foundation (2015 a and b)

²⁴ Freeman (2008)

synergistically. This would create a positive sum game between business, society and the planet capable of addressing, not only environmental problems, but also (as will be discussed below) the issues of inequality and slow, jobless growth.

The previous section discussed why such a direction is needed to unleash innovation potential; but why should 'green' be seen as the most promising option? The massive technological transformations that occur across society with each major shift are also contingent on context and conditions. The new potential changes the context for development and opens successive 'windows of opportunity', while closing old ones – generating different scenarios for business and social action.

Increasingly, the greatest window of opportunity of the present day is the possibility of overcoming the contextual legacy of the previous paradigm; in this case, the environmental degradation and resource scarcity brought about by the age of oil and mass production. At the most basic economic level, mass consumption, combined with the new billions of middle-income consumers in the emerging world have led to a fast-growing demand for materials, energy and food in the emerging countries, increasing overall demand, exhausting the most easily accessible sources and pushing up marginal costs. The impact of climate change is only intensifying that effect. While the availability of cheap oil in the 1990s and of cheap labour in Asia in the 2000s enabled the old path of disposability to be perpetuated, the growing reality of dwindling resources and violent price hikes and drops has led to a perceptible shift in market context. We are no longer in the post-war era of clearly defined national economies with energy and materials abundance; we are now in a globalised economy and we have only one planet.²⁵

At the same time, the technologies of the ICT paradigm have been changing the context of what is possible. It is now infinitely easier to establish interactive local, regional and global networks for coordination of production and services. Where economies of scale once relied upon standardisation of both supply and demand, variety, specificity and adaptability are now handled easily with ICT. This is true not only in manufacturing; natural resources can be managed far more efficiently, with intelligent control systems being developed for everything from monitoring, extraction and irrigation to processing, sorting and distribution. Along with the organisational capacities brought by ICT, this is leading to the development of niche and custom markets and the hyper-segmentation of all markets, from produce,

²⁵ World Wildlife Fund and SustainAbility (2007)

energy and materials through manufactured goods to services. And market access enabled by ICT is open to all, from traditional farmers to innovative high tech companies, from organic vegetables to tailor-made alloys: consumer and supplier can locate each other directly.

A shift in consumer demand

Meanwhile, beginning with small-scale efforts by (mostly) non-profits, the concerns and values of the environmental movement have spread to a broader base of consumers and to larger and larger companies. As the negative impacts of climate change and environmental degradation have become more apparent, stock markets are increasingly acknowledging the risks and insurance companies are beginning to include it in their calculations.²⁶ Crucially, this shift in values combined with the economic realities of the market and the innovations made possible by ICT are redefining our concept of the 'good life', from one of standardised mass consumption to one that is custom-tailored and sustainable. The lifestyles of the wealthy and the educated younger generation reflect this already: a preference for organic, locally-sourced fresh foods rather than highly-processed ones; for natural materials and sustainable design; for cycling, car-sharing and recycling; for experiential rather than passive entertainment. It is a 'good life' that promotes high-quality individual health, which in turn is seen as dependent on environmental health – what might be called a 'green good life'.

Such a change in the shape of consumer demand opens up even further the potential synergies across industries inherent in what the ICT paradigm has made technologically feasible. Stimulated by a 'green' direction and underpinned by the model of a green good life, the transformative nature of ICT is capable of enabling innovation across the whole production spectrum, from the extraction of natural resources to manufacturing, distribution, logistics and reuse, and in the ways of organising production and consumption in multiple inter-related industries and societal applications. Each innovation brings with it a set of new 'problems', stimulating further innovation (in materials, equipment, processes, distribution and so on), which spur investments and can lead to entire new industries. This clustering of interdependent users and producers and of self-reinforcing capabilities results in

²⁶ For example, see, for the former, the FTSE's ESG (Environmental, Social and Governance) series of indexes, including the FTSE Environmental Opportunities Index Series and the FTSE4; for the latter, the speech by the Governor of the Bank of England's Ref to Lloyds of London insurance undertakers in Carney (2015)

synergies and support networks that make further innovations easier and profitable, as well as less risky.²⁷

In essence this is about achieving growth and wellbeing across society by increasing the proportion of services and intangibles, both in GDP and in the individual satisfaction of needs. Product innovation trends are already visible: custom-designed eco-friendly materials, conservation, recycling, reduction of material content per product and designing for durability and zero-waste. The notion of a 'circular economy' has entered the mainstream, with global corporations such as Phillips and Unilever championing the process. This promotes the gradual replacement of 'products' with 'services', particularly in the replacement of possession with renting. From commercial lighting systems and airplane engines to jeans, carpets and cars, the question has become: why buy when you have the option of 'renting' a product that is upgradeable, maintained and available on demand? There is increasing innovation towards making cities more liveable and less polluting, with the revamping of transport systems and the built environment, and the promotion of the 'sharing economy', in which ICT-enabled communication allows citizens to share goods, either through a centralised, fee-paying service, such as a car club, or using direct peer-to-peer exchange for such items as household tools and garden equipment. And lifestyle aspirations are stimulating industries in the areas of personal health and individual fulfilment – from innovations in local food networks to high-tech ICT and bio-science-driven preventive and personalised medicine, and the championing of the 'collaborative' and 'creative' economies. Some of these socially-driven processes could become an enriching complement to the traditional profit-driven economy, while enhancing the quality of life of the participants.

Thus 'green' as a direction is not about sustainability versus growth; instead, it turns the environmental crisis from an economic problem into an economic opportunity. In that sense it can be seen as a 'mission orientation' for investment across mutually reinforcing industries, in the same way that World War II, the Cold War and the 'American Way of Life' drove technological investment in the past. But it also involves multiple smaller innovations that are increasingly seen simply as lifestyle choices rather than 'green' issues, encompassing a wide range of changes in production and consumption that would stimulate growth, business creation and employment right across the economy. Such a direction would not only reduce carbon emissions and strengthen environmental sustainability, but could allow

²⁷ Lundvall (1992)

millions of new consumers in the developing world to share in good, healthy and creative lives. Indeed, in the same way that the boom of the previous lifestyle shift relied upon enabling the working classes of the advanced nations to benefit from the material comforts of suburbanisation, full global development is not only a desirable, but a necessary condition for a return to economic health today. It is to this that we shall turn next.

‘Green growth’, development, jobs and inequality

The green direction has to be a global issue. This is so for technological, environmental and economic reasons. ICT has made national borders invisible to all trade in intangible services and information, in particular to finance. Resource scarcity and climate change are planetary problems, both in the short term – a poor harvest in Kenya affects the consumer price index in the UK, for example – and in the long-term prognosis for overall environmental health. As already noted, it is not feasible for China, India and the developing world to grow along the old mass consumption model; a ‘green’ direction is a necessity in a situation where new millions are striving for the good life while facing finite resources and the threat of pollution and global warming. Finally, globalisation is an economic necessity: in order for the potential inherent in the current paradigm to be fully realised in this period of deployment, there needs to be demand on a global scale.

The quality and profile of domestic and global demand

In economic terms, any new ‘direction’ will only work successfully if the appropriate volume of demand is forthcoming. In the 1930s, Keynes wrote to Roosevelt that ‘putting most of your eggs in [the housing] basket’ was ‘by far the best aid to recovery because of the large and continuing scale of potential demand; because of the wide geographical distribution of this demand; and because the sources of its finance are largely independent of the stock exchanges.’ He added: ‘there are few more proper objects for [direct subsidies] than working-class houses’.²⁸ For that period, it was a good prescription, and was at the core of post-war economic success. It was in the nature of the main organisational innovation of that particular era – mass production – to reduce prices and increase profits the higher the volume of identical products. Therefore, the institutional innovations influenced by Keynes’ advice – such as mortgages, loans, unemployment insurance and pensions –

²⁸ Keynes (1938)

brought stable purchasing power to the working class and provided a specific demand-pull associated with a standardised model of home life.

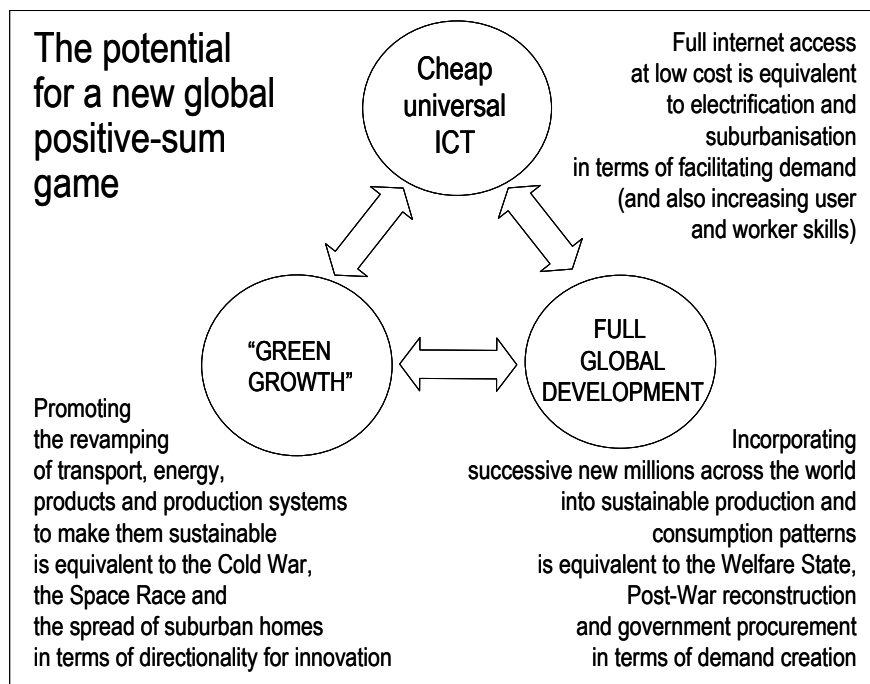
Today, the flexible production methods enabled by the ICT revolution allow for market segmentation and, in doing so, make differentiated products more profitable than highly standardised versions, which have, in fact become low-price 'commodities' with narrow profit margins. Furthermore, Keynes was dealing with what were – and more intensely became – national economies with clear borders separating domestic from export markets. Globalisation changes all this: taxes can be avoided because payments can cross invisible frontiers; interest rate changes can encourage finance to move masses of money from one foreign affiliate to another; and domestic income distribution can end up creating demand in and stimulating the economy of another country.

Meanwhile, the ICT revolution has brought a new potential for growth in the developing world, as shown by the enormous success of Asia, and the gradual rise of Africa and Latin America as exporters and innovators.²⁹ Cheap and ubiquitous internet access is already bringing education, services (such as mobile banking) and the opportunity to enter the global marketplace to corners of the world that did not have the infrastructure to fully participate in the previous paradigm. ICT-enabled innovations in the natural resource industries, from monitoring and extraction to the fabrication and niche sales of sustainable goods, promise an area of development for all resource-rich nations.³⁰ Facilitating and funding investment in the lagging countries of the developing world would create markets for green engineering, infrastructural and equipment technologies from the advanced world. The process would provide dynamic demand for both capital equipment and consumer goods between advanced, emerging and advancing countries. At the same time, through job creation in both the producer and user countries, it would not only lift many millions into better lives and reduce migratory pressures by creating jobs 'at home', but would incorporate new consumers and generate new trade flows for all (see Figure 2).

²⁹ Kaplinsky (2011)

³⁰ Kaplinsky (2005); Perez (2010); Marin et al. (2015)

Figure 2
Conditions for a sustainable global golden age



Source: C.Perez 2012³¹

New sources of employment growth

Once green growth is increasingly defined as a general direction for innovating across the global economy and for weaving a coherent fabric of producers, suppliers, services and skills, it is easier to see how it can become a solid route to jobs and growth. As noted, the green direction implies redesigning existing products and equipment as well as revamping buildings and infrastructures. This is a challenge for engineering that would open opportunities for high-tech reindustrialisation in the West. At the same time as this retrofitting effort, another major job-creating and export-promoting route is the design of sustainable production equipment and infrastructure adequate to the specific climatic and other conditions of the developing world, where in the past standardised equipment and processes – with inadequate scale and characteristics – have been adopted.

'Green growth' also supposes the return – and heightened importance – of product durability, accompanied by maintenance as a key service. After all, planned obsolescence and disposability were strategies for demand expansion in the face of saturated markets. The growth of the global middle classes, and of the wealthy (who

³¹ Perez (2012)

buy luxury products), can amply compensate for a drop in the sales of lower-quality, disposable products, while also countering what would otherwise be an uncontrollable rise in the cost of materials. Producing for the top of the range with the most advanced and safest technology possible and with high niche market profits is a better strategy under the new conditions. This could then lead to a very active rental sector for organising second, third and Nth hand markets in each country and across the world, along with the growth of disassembly, remanufacturing, recycling, reusing and other materials-saving processes. Information for 3-D printing replacement parts and the provision of regular upgrades for the maintenance of products could become standard practice. This would create a business model in which repair and reuse would take the place of planned obsolescence. The 'internet of things' with chips on each product could provide individual histories allowing appropriate pricing to enable a thriving rental industry. In the advanced world, such a business strategy would create great quantities of jobs for displaced assembly workers in maintenance, upgrading, warehousing, parts 'printing', distribution and installation; while design, redesign and many other creative industries and services would employ young university graduates. A 'green mission' would thus be equivalent to the combination of post-war reconstruction, the cold War and suburbanisation in terms of demand creation, employment and directionality for innovation.

Pendular shifts in income distribution

In addition to the creation of jobs, a green direction is also a path towards reducing income inequality, which is rightly a current source of economic and social concern. The history of technological revolutions shows us that this is nothing new. During the 'bubble' phase of each great surge, the new industries (such as those of Silicon Valley, pre-crash) and the financial world 'decouple' from the sluggish mature economy, and the extraordinary profits and capital gains that ensue lead both to highly unbalanced regional growth and to a concentration of income towards the top of the scale, particularly among those benefitting from the easy millions made in finance.

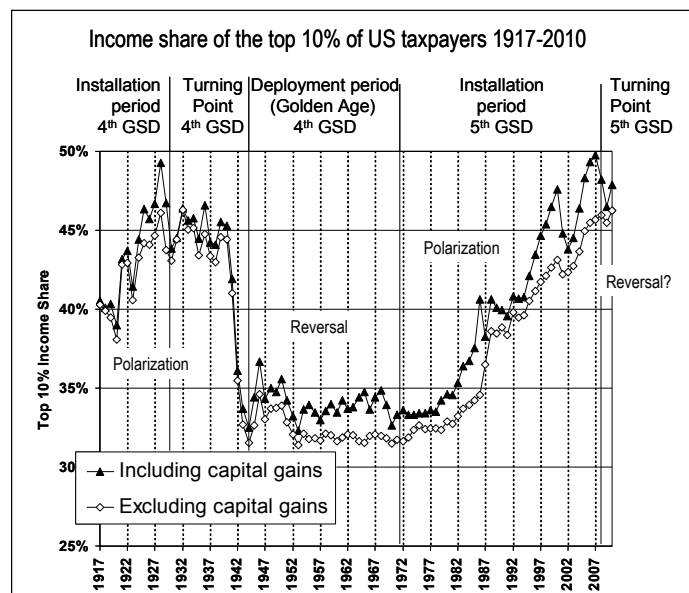
Thomas Piketty's work with Saez on inequality allows us to plot the changing distribution of income in the USA over the last hundred years against the recurring diffusion pattern of two technological revolutions (Figure 3).³² This shows the polarisation that occurred in the bubble prosperity of the Roaring Twenties, its

³² Piketty and Saez (2010; update of 2013)

reversal in the golden age of the 1950s and 1960s, and then the renewed polarisation during the installation period and the bubble collapses of the current ICT revolution. Figure 4 shows that there was indeed a pendular movement in inequality: the share of US taxpayer's income going to the top ten percent of the population in the two installation periods rises to 50%, whereas in the deployment period of the post-war decades it comes down to less than 35%. Equivalent differences apply to the top 1%.

Figure 3:

Pendular movement in the polarisation of income along each great surge of development in capitalism



Source: Perez 2012 using data and basic graph from Piketty and Saez (2010 update 2013, slide 6) with our period indications

It is notable that the historical Golden Ages, so-called because they spread prosperity across a much wider range of society, tend to occur after each major bubble collapse, overcoming the resulting recession and tending to reverse the revealed income polarisation. The Victorian boom, for example, saw reductions in hours of work, increases in wages and the provision of relatively decent workers' housing.³³ In the Belle Époque, new welfare policies were applied in Europe based on increases in taxes on the wealthy, including the spread of Bismarckian social insurance from Germany across most of the continent, such as that of Lloyd George's 'People's Budget' in the UK.³⁴ Much more far-reaching was the reversal in inequality engineered in the post-war welfare state of the advanced Western

³³ Bienfeld (1972)

³⁴ Bruun (1955:1990)

nations: the innovations in social institutions discussed above encouraged a clear direction in production and lifestyles.

Now, following a century in which consumer demand has become a significant driver of the economy and in which democracy has brought the whole of the adult population of the West into the political process, comparably explicit measures towards overcoming polarisation are in order. The current Welfare State – what has survived of it – was designed in a world of ‘jobs-for-life’. That is no longer the case for the majority of workers; this paradigm involves continuous change, flexibility and adaptability. Social expectations – and the ease with which the lives and riches of others can now be observed thanks to ICT technologies – mean that the current generations will not easily accept a declining level of welfare, either for themselves or for their children. As during previous post-bubble collapses, the expression of such frustrations can be seen in the rise of xenophobic and anti-immigrant movements, the attraction of disaffected youth to extreme fascist/religious groups, and equally in the growth of extreme left movements and in various bursts of protest such as those of Occupy or the indignados. Obstinate austerity policies making the majorities suffer the consequences of the financial casino and the national debt will do nothing but exacerbate the anger. Only a radical shift in policies can bring back healthy growth and stable societies. Providing criteria for doing that is the object of the final section.

A radical reshaping of the policy framework

This chapter has presented a dynamic picture of the context facing economists, environmentalists and, especially, policy makers. It has explained how the context changes with each successive technological revolution and along its diffusion path. Schumpeter did not exaggerate when he referred to those processes as ‘creative destruction’. Such destruction and renovation occur in the technologies and the economy and they also need to happen in the organisational, institutional and policy spaces.

A mental paradigm shift

For a company or for a society to get the most out of the potential offered by the new technologies of one of those upheavals, it has to assume that the way things were and the way we thought they should be are both obsolete until proof to the contrary. A new understanding and fresh thinking is required.

Yet the mass production revolution is still with us in its patterns of resource use, in its wasteful mode of consumption and in many of its production models. It is being copied in the emerging economies and aspired to in the developing ones; it is hankered after by the layers of impoverished unemployed in the advanced world and rightly made the main target of attack by the environmentalists. The ICT industries, whose strategies originally evolved in the boom of the 1990s, found oil at its lowest price and abundant, extremely low-cost labour available in Asia. Unthinkingly, they were led to adopt the planned obsolescence model generalised in the 1960s to overcome the limits posed by the saturation of markets. Thus the intangible nature of information technologies did not express itself in imaginative strategies with minimal use of materials and maximum upgradeability. Fortunately, that is now beginning to happen, alongside innovation in the reduction of energy use.

At the same time, these new technologies have transformed the structure and organisational model of most of the surviving corporations. Over the past thirty years, these have shifted from bureaucratic command-and-control pyramids to flexible networks spanning the globe, incorporating widely differentiated units in complex value-chains with varying degrees of competence and autonomy. Meanwhile, consumer behaviour, although still primarily oriented to the 'consumerist' mode, has been gradually moving away from the accumulation of products and towards personalised services, enabled by the use of computers, software and especially the smart phone.

The two areas affecting the economy where sufficient change has clearly not occurred are government and economics. In policy making, instead of moving from the intelligent Keynesian way of intervening, during mass production in a national context, to another intelligent way of doing so, in a world of globalised flexible information-intensive production, most politicians in power decided that the state should get out of the way to let markets decide. Fortunately for them and unfortunately for society, the fact that there was a new technological revolution to propagate did allow markets to be hugely successful in the 1990s and 2000s – until the two bubbles that resulted from the installation of the Internet and the invention of new financial instruments collapsed. In spite of the high cost of rescuing the banks and the rising inequality across society revealed by the recession, the shrinking of the state has continued, led by the vain hope that markets will find a way of bringing a miraculous revival if left to themselves. History has shown that this is the wrong moment for that. Yet the current economic orthodoxy, incapable

of explaining the crashes, holds on to an interpretation of how the economy functions that ignores the role of technology and the accumulated learning of the other social sciences. It has taken refuge in increasingly complex mathematical models, as if economics were more closely akin to physics. Worse still, these economists and many of their critics are still waging the ideological battles of the 1960s and 1980s, without realising that we are now in a completely different context, one that has more in common with the 1930s.

Economics needs to be truly evolutionary. If it wants to use models, it has to learn to represent structural change. At the same time, instead of pretending it can be a hard science, it needs to develop qualitative thinking and engage in 'appreciative theorising'³⁵ to enrich its quantitative methods and bring them closer to the changing social reality. It is interesting to note that practically all the macroeconomic tools and concepts that are being used today – from GDP to the natural rate of growth – were developed during the 1930s and 1940s in the context of mass production, the war effort and the development of the national welfare state.

According to the dogmas of the current orthodoxy, the credit crunch should not have happened, quantitative easing should have led to inflation and increasingly unfettered markets (without any 'crowding out' from the government) should have already achieved strong growth. Their recommended austerity policies have now gone on for eight years with appalling or feeble results; any CEO of a serious corporation, with an equivalent failure rate, would have been replaced years ago.

It is often said that one should never let a good crisis go to waste. We are now in a midst of what can be considered a crisis in terms of a deeply unbalanced global economy that is wasting a huge innovation potential. The battle is not between state and markets; it is between policies that will maintain uncertain growth and increasing income inequality and a direction that can bring a sustainable global golden age that can lift all boats. We could now use the existing transformative power of the new technologies in a direction that will turn environmental challenges into a solution to various social and economic ills.

Policy-making in the Deployment Period

One of the main differences between the installation and the deployment periods of each technological revolution is the source of dynamism. Installation is supply-

³⁵ Nelson and Winter (1982); see also Freeman and Louçã (2001), chapter 2.

driven; the new technologies are self-propelled and mutually reinforcing. Deployment is mainly demand-pulled; but not just by the quantity of demand, but also by its profile and dynamism. That is why it is not possible to apply the Keynesian recipes, which worked for mass production and in the context of relatively closed national economies, to countries operating in globalised conditions, with flexible production technologies and with growing intangible trade and financial flows across the internet.

The best pre-condition for successful policy making is having a correct interpretation of the nature of the changing context being faced. If the historical recurrence discussed in this chapter is correct, the relevant parallel is not the Thatcher-Reagan model applied in the 1980s, when the wealth creating and productivity-enhancing powers of the mass production revolution were exhausted, but rather the policies applied when that revolution was installed after the Roaring Twenties and was ready to be unleashed across the whole economy. Keynesianism and Bretton Woods were the transformative set of policies that created the new context to achieve both better business and better lives for all, through a sort of covenant between government, business and society, where all benefited. An equivalent covenant is needed at this time, with as many adequate norms, policies and institutions as were set up then.

Recent and current conditions are not a good basis for judging future scenarios. It would have been nearly impossible for people in the mid-1930s to imagine that those bedraggled, hungry, unemployed workers queueing at the soup kitchens could seriously aspire, just over a decade later, to a suburban home full of electrical appliances with a car at the door. It was also difficult to imagine widespread decolonisation to become the norm – be it through peaceful or violent means – when empires seemed stable and Germany was preparing to expand by force and change the maps of Europe and Africa. These are not times for maintaining the status quo or for trying to return to recent conditions. If the advanced world governments stay on the current austerity path, they will wait forever for the market to do the right thing for growth and social wellbeing. These are times to be as imaginative and bold as Keynes and Roosevelt and Beveridge were, but in full awareness of the specific nature of the current technological potential and of the opportunities it opens and closes.

There can be no return to the centralised bureaucracies of the 1950s and 60s, however successful they may have been during mass production times, but neither is it possible to bring back the unfettered market booms of the 1990s and 2000s.

Free-wheeling finance was successful at the turn of the century because it first had a technological revolution to install and then it had to spread the new economy across the globe. Both tasks were hugely profitable but are now basically complete. In the process, as has happened in previous equivalent bubbles, finance learned to make doubtful innovations that do not create wealth but merely lead to differential inflation, where financial assets increase their value faster than salaries, to the detriment of workers and small productive businesses. Massive bailouts have allowed finance to remain unscathed and focused on short-term speculation, expecting high returns from such activities. That context is also encompassing the behaviour of production companies, many of which have acquired the short-term profit expectations of the bubble years and are more engaged in stock buybacks, cost cutting, tax avoidance and quick deals than in R&D, training or other innovative activities with a longer term horizon.³⁶ As a result, massive amounts of money are sitting idle in the corporate world, in banks, financial companies and production ones. The longer this situation lasts, the harder and deeper the negative consequences on the economy and society.

History shows that capitalism is capable of reversing some of the worst ills it creates but only after experiencing a crisis. Financial collapses, wars, prolonged recessions and/or major social unrest have played that role.

A wave of green innovation enabled by ICT is possible, but unless it happens in a convergent way across most industries and countries, the potential innovations will remain risky and the market will not engage. Only a strong tilting of the playing field in favour of sustainable investment, with policies that are credible, consensual and likely to remain stable in time, will move finance from internally-oriented speculation to investment in the production economy.

A clear socio-political choice

Capitalism is only legitimate when enabling the successful ambitions of the few to benefit the many. Globalisation has improved the lot of many millions in the old 'third and second worlds' but by reducing many of the gains of the welfare state in what was called the 'first world'. The policy changes required are as bold, systemic and wide ranging as the Keynesian policies, the welfare state and the Bretton Woods agreements were in the previous similar moment. They will need to achieve a positive sum game between business and society but this time in a global scale i.e. between advanced, emerging and developing countries. The breadth and depth of

³⁶ Lazonick (2013)

the changes brought about by the spread of each technological revolution require an equivalent redesign of the institutional framework in order to unleash their full transformative potential. The best pre-condition for policy making is a powerful interpretation of the present moment; with such an understanding, it becomes easier to also imagine a new powerful set of policies to address the new times. The following are some of the kinds of policies which might be introduced.

- Don't tax labour, tax energy and materials: Redesigning the tax system (using digital databases) to tax 'bads' rather than 'goods' – for example, taxing resource and energy use instead of labour and consumption - would stimulate saving of materials and energy and encourage employment and consumer spending on intangibles.

- Regulate for durability and maintenance. Making producers responsible for the entire lifespan of their products would encourage the circular economy and manufacturing durability, as well as stimulating the growth of a rental and maintenance economy.

- Redesign the metrics with which to measure wealth production: As numerous studies have shown in recent years, GDP has very limited meaning and is even distorting in the knowledge economy. New metrics need to be designed to account for the use of energy and materials and to measure the various ways in which value is now created and wellbeing enhanced.

- Facilitate the sharing and collaborative economies: The proliferation of free internet-based services has inspired many to innovate in networks of sharing access to possessions, exchanging time and collaborating in creative projects. This is one of the routes along which ICT enables a green economy grounded in sustainability and focused on services and personal care.

- Move towards some form of basic income: Providing a minimum income in the advanced countries —such as the universal basic income currently being trialled in Finland, a negative income tax and/or workfare for community projects and services — is the necessary platform for encouraging the sharing and collaborative economies, the growth of voluntary organizations and of creative endeavours that could contribute to the quality of life both at the community level and through participation in global networks. In the 'green good life', wellbeing would increasingly be measured, not by possessions, but by positive experiences of healthy living, community sharing and creative involvement in networking and group activities. Any of the chosen systems of basic income distribution, plus

additional support for special cases, can take advantage of ICT and the debit card systems for its administration.

- Skill and reskill at the global level: Widespread agreement on the importance of education and skills needs to translate into a central part of a 'new new deal'³⁷ across the world, taking intelligent advantage of the power of ICT, including the increasing value of so-called 'Massive Online Open Courses' (MOOCs) and life-long education. Increasing the creative capabilities of the population of developing countries would improve their life chances, reduce migratory pressures and increase trade.

- Support development across the lagging countries: Just as the Marshall Plan aided the reconstruction of Europe, while increasing transatlantic trade, the international community needs to implement new and effective ways of giving support to development, recognising the new possibilities open by ICT and globalisation.³⁸ As discussed above, the rise of these countries would benefit advanced, emerging and developing nations, creating new and important trade flows in all directions.

- Reorient finance not by controls but by taxing short-term gains highly and lowering the rate with time, thus making it more profitable to invest in the real economy and to do so long-term. In addition, public investment in green research, development and market creation,³⁹ in revamping the built environment and in funding private green projects is necessary to provide support for the riskier innovations in the green direction and to increase the synergies for others to invest.

This list is far from complete – but it is a list that is grounded not only in the historical discussion above, but also in examples already being tried out and explored in villages, towns, cities and nations around the world.

Yet for such a radical shift to occur, it is important to go beyond the listing of potential policies and to examine both the process by which such policies are designed⁴⁰ and the type of organisations that are to implement them.⁴¹

- Modernise government itself: Abandoning the 'command and control' model of organisation has been part of the modernising paradigm shift experienced by companies in recent decades; little beyond the introduction of computers has taken place in governments in this respect. Instead, following a neo-liberal recipe, the

³⁷ Lundvall (2009)

³⁸ See Perez (2010) and Marin et al. (2015)

³⁹ Mazzucato (2013 a and b)

⁴⁰ Rodrik (2004)

⁴¹ Karo and Kattel (2015)

primary 'new' practice has been to outsource public services or to establish so-called 'public-private partnerships'. This has been done in the name of efficiency, and under the assumption that the private sector knows best and will save the state money. In most cases, as Colin Crouch shows in his chapter in this volume, such expectations have not been fulfilled.⁴² The worst consequence has been the weakening of public sector skills and the avoidance of necessary modernisation, which in turn has reduced the attractiveness of public service as a career for the most talented. Making the move towards creativity and flexibility for agile and knowledgeable government institutions is essential if economies are to be led to powerful and synergistic growth with increasing social benefits.⁴³

- Consensus building for policy design: The old mode of policy change has been for governments (typically one party) to introduce a new policy that elicits enormous resistance, encouraging lobbying, efforts at finding avoidance loopholes, and even corruption. This will not work in the current globalised economy. New institutional mechanisms are needed to ensure positive-sum outcomes by working with all the stake holders, from business to civil society. The process of policy design matters more and more.⁴⁴

- Devolution of national power: In a globalised world, it seems increasingly necessary to consider devolving part of national power, both down to local governments, cities and regions, and up to supranational entities. This is a daunting task, and one that confronts huge political hurdles. But when globalisation and differentiation have radically altered the conditions under which finance and the whole economy operate (illustrated by the ease of tax avoidance), supranational institutions with enforcing power will prove unavoidable.

What is clear is that the old recipes will not work now and have not worked in recent times. Neither will the simple austerity recipe of getting government out of the way and expecting markets to do it all without a clearly defined context with a certain and stable direction. We need serious rethinking, intense consensus building, global negotiations and determined leadership. The technologies capable of driving a sustainable global golden age are available; unleashing them successfully requires an understanding of the historical moment and the willingness to make a clear socio-political choice.

⁴² See also Drechsler and Randma-Liiv (2014)

⁴³ *Who Says Elephants Can't Dance?* is the title of Lou Gerstner's account of turning the huge IBM bureaucracy into an gigantic agile organisation, which can be a mirror for what can be done in governments. See Gerstner (2002)

⁴⁴ See Rodrik (2004)

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