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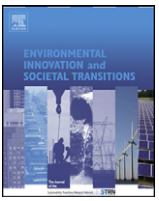

Economic crisis, long waves and the sustainability transition: An African perspective

Mark Swilling*

Sustainability Institute, School of Public Leadership, Stellenbosch University, PO Box 12358, Die Boord 7613, South Africa

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ABSTRACT

To make sense of the global crisis and a possible transition, many re-interpret the past as a set of successive long-term development cycles that could repeat in future. At the same time environmental pressures have resulted in the notion of a green economy. It is argued that the current global economic crisis simultaneously marks the end of the post-WWII long-term development cycle, the mid-point of the information age and potentially the start of a new era of sustainable development. It must be recognised that only certain futures are being imagined with Africa's options largely ignored. As African growth rates rise as demand for its resources increase, it is necessary to question whether Africa is appropriately positioned to take advantage of the next long-term development. The new discourse of 'resource nationalism' is promising, but only if governance modalities can be found that can transcend the resource curse.

1. Introduction

The two related but distinct features of the post-2007 global economic crisis have been the persistence of debt-driven recessionary conditions in Europe and North America, and the rise of the so-called 'BRICS-plus' economies in Asia, Africa and Latin America. Excluding South Africa, African economies in particular hardly felt the impact of the recession with most of the key economies continuing to experience average economic growth rates not seen since the 1960s. At the same time, a growing body of popular and academic literature has turned to long-wave theory to contextualise the crisis and predict

* Corresponding author. Tel.: +27 0 21 8813196.
E-mail addresses: Mark.Swilling@spl.sun.ac.za, swilling@sun.ac.za

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the system dynamics of possible future trajectories of transition. While long-wave theory certainly helps to overcome the problem of seeing the crisis as a surprising accident that will soon be rectified by rational economic policy interventions, it suffers from a tendency to focus on global logics that are presumed to apply to all regions thus ignoring the specificities of regional dynamics. Both angles are needed: a sense of longer-run historical trajectories and appreciation of regional specificities.

This paper engages the growing literature on sustainability transitions and long-wave theory from a 'global South' perspective. It will be argued that the persistence of the global economic crisis can be attributed to a 'blocked transition' caused by the failure to dislodge the hegemony of finance capital and break the 'carbon lock-in'. A transition will most likely only emerge when the following conditions are in place: finance capital has been disciplined; the digitization of production and consumption is further extended under the leadership of productive capital; and the installation of the 'green-tech' revolution driven by finance capital is accelerated in response to deepening ecological crises. This perspective is then applied to two discussions: the 'green economy' proposals that have emanated from several agencies and the call by the United Nations Conference on Trade and Development (UNCTAD) for the "sustainable structural transformation" of African economies. Both applications confirm that a balance is needed between an understanding of long-wave perspectives and analyses of regional specificities.

In Section 2 the current global economic crisis is defined as a 'polycrisis' that can, in turn, be usefully understood from the perspective of long waves of historical development across different temporal scales. Section 3 describes the primary socio-metabolic transitions – the agricultural and industrial revolutions – in order to propose a template for thinking about what may turn out to be the 'green-tech revolution'. Section 4 describes the dynamics and modalities of technological revolutions and argues that we may be moving into a new phase of global development that is driven by both the deployment phase of the Information Age and the installation phase of the green-tech revolution. Section 5 takes this argument further by suggesting that the post-World War II period ending in the economic contraction of 2009 can be seen as a long-term global development cycle that has now come to an end. The next cycle will not only be shaped by the usual financial and economic drivers but also now by ecological drivers. Section 6 then applies this conceptual framework to an understanding of the emerging green economy discourse. Whereas Germany, South Korea and China may be emerging leaders of the emerging green-tech revolution, in Section 7 Africa's options are reconsidered in order to highlight the significance of regional specificities non-aligned with more dominant trajectories in the rest of the world. Section 8 provides a conclusion that poses some key questions for future research.

2. Rethinking the polycrisis from a long-wave perspective

The global economic crisis has generated a new literature that draws on long-wave theory to re-imagine present and future landscapes. They represent what Geels (2010) would refer to as clusters of discursive and cultural ontologies of probable futures. These include consultant's advisories and popular literature aimed at business audiences (Allianz Global Investors, 2010; Bradfield-Moody and Nogrady, 2010; Rifkin, 2011); the policy-oriented research-based literature generated from a variety of academic, UN, advisory and consulting agencies (Hargroves and Smith, 2005; McKinsey Global Institute, 2011; Smith et al., 2010; Stern, 2007; United Nations, 2011; Von Weizsacker et al., 2009) and the theory-laden academic literature (Gore, 2010; Pearson and Foxon, 2012; Perez, 2009, 2010b; Swilling and Annecke, 2012). These texts have all to a greater or lesser extent drawn on a tradition (originating in the works of Kondratieff and Schumpeter[1]) that depicts economic history in terms of a succession of long-term waves or cycles of economic development lasting between 40 and 60 years (for useful overviews of the main schools of long-wave – or what Foxon calls 'co-evolutionary' – thinking see Foxon, 2011; Köhler, 2012).[2]

[1] See Kondratief (1935) and Schumpeter (1939).

[2] What is left out of this review are long-wave perspectives originating in evolutionary economics that do not include a reference to ecological cycles – a perspective originating in Nelson and Winter (1982) and expressed at a popular level in many references within business circles to supercycles – see report from global banking firm Standard Chartered (Standard Chartered, 2010).

The flowering of this intellectually diverse literature needs to be understood as a response that may satisfy a deep cultural desire to make sense of seemingly chaotic dynamics by invoking the logics of historical trends, but it may also be a reasonable response to what Edgar Morin has referred to as the "polycrisis" – a nested set of globally interactive socio-economic, ecological and cultural–institutional crises that defy reduction to a single cause (Morin, 1999:73). Instead of seeing the crisis as an accident of history, long-wave theory provides a set of heuristic conceptual framings that make it possible to depict the crisis as a particular moment in a much wider and deeper set of historical trajectories that have not only occurred before but can be expected to unfold in future in more or less predictable ways. But before proceeding to elaborate this framework, it is necessary to recognise the critiques of long-wave theory (for reviews of these debates see Broadberry, 2007; Fagerberg, 2003; Rosenberg and Frischtak, 1983; Verspagen, 2005) and the relationship between long-wave theory and the Multi-Level Perspective (MLP) (Köhler, 2012).

Whether one refers to the more classical Kondratieff cycles used by development economists (for a lead example see Gore, 2010), or the *S*-curves at the centre of the MLP (Grin et al., 2010) and the structural evolutionary approaches (Freeman and Louca, 2001; Perez, 2002), the obvious danger is that they are prone to techno-economic determinism: technological innovations do the 'acting' and socio-political institutions do the 'reacting'. One solution to this problem offered by the "coevolutionary framework" is to analyse the coevolution of socio-economic, institutional and ecological systems and their causal interactions (Foxon, 2011). Foxon and Pearson argue that long-wave theorists:

> "...are keen to stress that these attributes of technologies do not 'determine' wider socio-economic change, but they enable co-evolutionary changes in institutions and practices that, together with technology changes, give rise to significant macroeconomic impacts." (Pearson and Foxon, 2012:121)

Some writing from within the MLP school has given greater emphasis to institutions. By analysing the capacities for accessing new knowledge and managing change, it becomes possible to assess whether particular socio-technical regimes will adjust or be replaced by new regimes formed from alternative niche innovations (Smith et al., 2005). Furthermore, it is problematic to assume that there is a grand wave of economic development that somehow takes hold simultaneously everywhere and – using language from neo-liberal ideology – 'lifts all boats'. Instead, innovations originate in particular countries for quite specific well documented reasons related to institutions, culture, labour markets and economic dynamics (Pearson and Foxon, 2012). They then radiate outwards absorbing others into mutually reinforcing new economic and financial circuits, while still others get excluded from innovations and investments in human capital and institutional reform, or subordinated to providers of primary materials (for the uneven development impact of the information revolution see Castells, 1997). As radical geographers have argued for decades, it needs to be accepted that uneven development has been intrinsic to all the different phases of capitalist development since the start of the industrial era (Smith, 2008) – this being a theme pursued in more detail later in the discussion of Africa's challenges connecting to the next global development cycle and the roles that Germany, South Korea and China may be playing in the making of a sixth wave of 'green-tech' innovation.

Accepting the critiques of long-wave theory and the strong arguments in favour of coevolution and uneven development, a framework will be proposed here that differs from existing approaches because it deals with three interactive long-wave dynamics that operate at different temporal scales and with reference to different units of analysis:

- 'socio-metabolic transitions' that focus on the flow of materials and energy through socio-ecological systems across the pre-industrial, industrial and (potentially more sustainable) post-industrial epochs;
- 'technological revolutions' comprising the evolution of the five main clusters of 'general purpose technologies' (Lipsey et al., 2005) that have partially driven and shaped the fundamental changes in production and consumption during the industrial era; and
- 'long-term global development cycles' that focus on cycles of economic growth, prices, crises and 'creative destruction'.

Although there are huge bodies of literature that relate to each of these themes, leading contributions have been selected that effectively articulate the different but linked long-wave dynamics that operate at these different scales. Drawing on Swilling and Annecke (Swilling and Annecke, 2012), these are then synthesised not for the purpose of constructing a new 'grand theory of everything', but with the much more limited aim of assessing where we are in the global polycrisis and what the possible dynamics of transition might be at different levels of analysis. While admitting that any discussion of future trends are merely conjectures rather than certainties, it remains constructive to contribute to the storylines that could be considered by many who build future scenarios that often guide decisions that must be made today.

3. Socio-metabolic transitions

There is an increasingly common trend within academic and non-academic analyses of the crisis to identify purely economic causes of the crisis (of various kinds), followed by a set of conclusions about remedies that then add on at the end suggestions that the next phase of global growth will more than likely also be 'green', 'low carbon' or even 'sustainable'. This move amounts to an afterthought that recognises the negative economic consequences of 'externalities', but these externalities are left out of the analysis of the initial causes.[3] However, as Fischer–Kowalski points out it is only possible to refer to the unsustainability of a system relative to another system (Fischer-Kowalski, 2011). In order to do this, she argues, the unit of analysis needs to be the socio-metabolic flows of materials and energy through different configurations of coupled natural and social systems. This then helps explain the epochal transitions from one "socioecological regime" to another: from hunter-gathers to the agricultural socioecological regime some 13,000 years ago as soils, seeds and land became usable resources; from the agricultural to the industrial socioecological regime over 250 years ago as fossil fuels, metals and minerals were added to the resource pool; and the "inevitable but improbable" (Fischer-Kowalski, 2011:153) transition to a sustainable socioecological regime when it is no longer possible to depend on large quantities of non-renewable materials and cheap fossil fuels (Fischer-Kowalski and Haberl, 2007). By rooting the analysis of the polycrisis within the endogenous dynamics of material and energy flows, it becomes possible to anticipate futures where natural resources (and not just carbon) are used more sustainably as a necessary condition for the emergence of a future potentially sustainable long-wave of eco-economic development.

This perspective has been operationalised within the contemporary global policy space by UNEP's International Resource Panel which was established in 2007 to deal with global material flows, resource depletion and decoupling growth rates from rates of resource use (see http://www.unep.org/resourcepanel/). The IRP distinguishes between four categories of resources: biomass, fossil fuels, construction minerals and ores and industrial minerals.[4] By the start of the c.21st the global economy consumed between 47 and 59 billion metric tonnes of resources (which is equal to half what is physically extracted from the crust of the earth per annum). Between 1900 and 2005 total material extraction increased over this period by a factor of 8 and GDP increased by a factor of 23 for the same period (Fischer-Kowalski and Swilling, 2011). As reflected in Fig. 1, the result is relative decoupling between rates of resource use and global growth rates. However, the report argues that absolute reduction in resource use will be a necessary condition for a transition to a more sustainable global economy.

As the IRP Report shows, rising global resource use during the course of the c.20th corresponded with declining real resource prices – a trend that came to an end in 2000–2002 (see Figs. 2 and 3). Since 2000–2002, the macro trend in real resource prices has been upwards (notwithstanding dips in 2008/2009 and in 2012).

The McKinsey Global Institute report (which was published after the IRP report) generally confirms the trends identified by the IRP report (McKinsey Global Institute, 2011). The McKinsey report

[3] Of the literature cited thus far, the works by Allianz Global Investors (2010), Perez (2010b) – including her contribution to this volume) are representative of this approach.

[4] Note that water and land resources are excluded from this categorisation of global material flows – for a justification see (Fischer-Kowalski and Swilling, 2011:8–9).

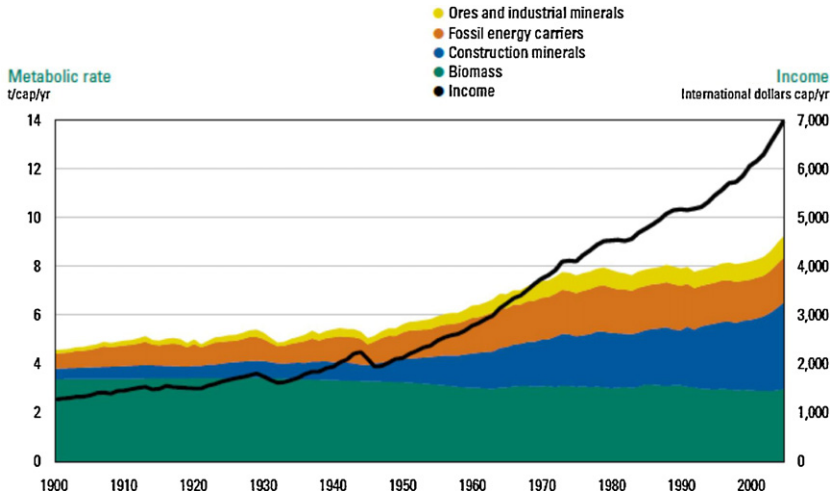


Fig. 1. Global metabolic rates, 1900–2005, and income.
Fischer-Kowalski and Swilling 2011:12.

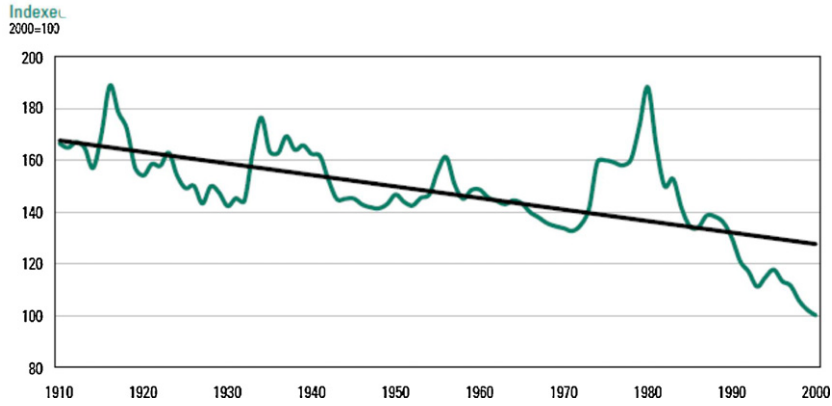


Fig. 2. Composite resource price index (at constant prices, 1900–2000).
Fischer-Kowalski and Swilling, 2011:13.

calculated that resource prices increased by 147% in the decade since 2000. Furthermore, up to $1.1 trillion is spent annually on what they call "resource subsidies". McKinsey argues that if resource subsidies are reduced, a carbon price of at least $30/tonne introduced and an additional $1 trillion per annum is invested in resource efficient production systems to meet growing demand, the result will be the creation of a whole new set of "productivity opportunities" with an internal rate of return of at least 10% at current prices. However, these are unlikely to become the focus for investments to drive economic recovery if resource subsidies continue to be defended by the institutionalised politically powerful interests of the dominant regimes of the mineral-energy complex who vigorously defend "carbon lock-in" (Pierson, 2000).

The problem, of course, is that epochal perspectives like those offered by Fischer-Kowalski are good at identifying the necessary conditions for a transition, but not the sufficient conditions. For this it is necessary to focus on the complex dynamics of accumulation, institutional power and technological change.

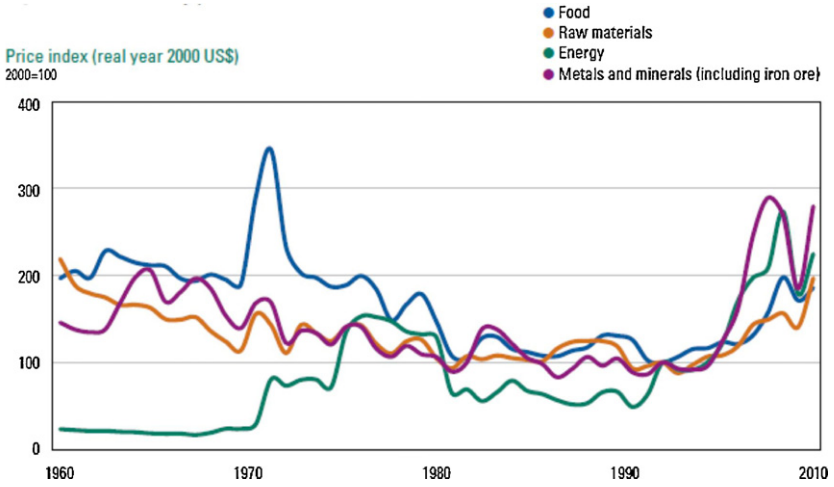


Fig. 3. Commodity price indices, 1960–2010.
Fischer-Kowalski and Swilling, 2011:13.

4. Technological revolutions

The substantial body of work by Venezuelan economist Carlota Perez has deeply influenced those who write about technological cycles. Because her core argument and understanding of the crisis is replicated in this volume, suffice it say here that she identified five 'transitions', each associated with specific technological revolutions that emerged at particular historic moments since the onset of the industrial revolution in the 1770s. Each followed the familiar *S*-curve with an installation and a deployment phase bifurcated by a financial crisis (Perez, 2002, 2007).

Perez has argued that the global economic crisis of the 'Information Age' (5th technological revolution) has, in fact, experienced a 'double bubble' – the so-called 'dot com' bubble of 1997–2000, followed by the financial bubble of 2004–2007. Perez has argued that these 'two bubbles of the turn of the century are two stages of the same phenomenon' (Perez, 2009:780). She argues against the Keynesian argument that explains the financial crisis as a 'Minsky moment' in terms of which debt markets have an in-built tendency towards financial instability, which can only be mitigated by increased state spending (Krugman, 2012). Instead, she argues that the most significant crises are triggered by the financial opportunities created by new technologies that result in 'major technology bubbles' that eventually burst. This is what the 'internet mania' of 1997–2000 was all about. However, instead of triggering an economic recession that would have necessitated extensive state intervention to prepare the way for productive capital to take over from financial capital after the bubble burst in 2000/2001, the post-crisis recession was mitigated by the rapid financialisation of the global economy that deregulation combined with the IT revolution made possible.

Cheap Chinese exports (achieved in part by 'artificially' keeping the value of the Chinese yuan down) not only brought down the cost of mass consumer goods (which effectively raised real wages), they also made it possible for China to become one of the world's largest providers of debt to developed world consumers via the purchase of massive quantities of government bonds. Indeed, the preference for liquid assets and quick operations within the paper economy that this created generated skyrocketing capital gains between 1996 and 2000, while profits in the real economy remained flat or even negative. After the 'dot com' crash, instead of interventions to restrain financial capital, the opposite happened as various interventions by the Federal Reserve and neoliberal governments around the world effectively allowed the paper economy to mushroom into a gigantic unregulated global casino (Gowan, 2009) – what former Prime Minister Gordon Brown liked to call 'light touch' regulation. The resulting bubble was a Ponzi-type 'easy liquidity bubble' driven by massive concentrations of investments in worthless paper assets (Perez, 2009).

For Perez, a key condition for a successful transition is the disciplining of capital gains-seeking finance capital to make way for dividend-seeking productive capital to drive the deployment phase. However, in her recent writing (especially her contribution to this volume) she has started to factor in environmental externalities by emphasising the role that innovations for greening the economy will play in the deployment phase of the 5th cycle. But it is unclear what will drive these innovations. Nor does Perez define a new historic mission for finance capital after it has been disciplined to make way for productive capital. It will be suggested that a solution to this problem lies in accepting that a 6th cycle – the 'green-tech revolution' – may be emerging that could in time – and should – be driven by finance capital. Surely this is the new historic mission for finance capital? And would this not create a growth-catalysing installation phase of an emergent 6th cycle to complement the deployment phase of the 5th? Perez is reluctant to accept this line of argumentation. Yet this may well be what is underway. To understand it, however, it is necessary to understand the long-term economic development cycle.

5. Global development cycles

To improve our understanding of the linkages between the socio-technical cycles that Perez has identified and the dynamics of global economic development, it is necessary to turn to the work of UNCTAD economist Charles Gore who, like Perez, elaborates a long-wave approach to the global crisis (Gore, 2010). He has located the socio-technical cycles described by Perez within what he refers to as the Kondratieff-like 'global development cycle' that began in the 1950s and ended with the global economic contraction of 2009. For Gore, a Kondratieff-type cycle cannot be equated to the technological cycles that Perez has in mind. While technological cycles typically follow the well-known S-curve (found in Perez and the MLP) of '*irruption-crisis-deployment*' (see Fig. 4B below), as Fig. 4A suggests the global development cycles adhere to very different logics. The global development cycles start off with '*growth-plus-price-inflation*' during the spring-summer period (1950s/1960s) ending in a stagflation crisis driven in part by over-investment in infrastructures during the growth phases (1970s). This is then followed by *growth-with-limited-inflation* during the autumn-winter period (1980s/1990s) ending in deflationary depression driven in part by diminishing returns on mature technologies while returns on the new technologies have yet to materialise (2007 onwards). Significantly, the first half of the cycle was dominated in the West by a Keynesian 'golden age' of welfarism, inclusion, solidarity and liberation (including decolonisation in the peripheries) within national development policy frameworks; while the second was dominated by neo-liberalism, exclusion, commodification, individualism and rising inequalities in an increasingly globalised world.

Although Perez tried to link technological cycles to economic growth, in her later work she gave up this effort. Although Gore admits there is no evidence to support the notion that growth phases are driven exclusively by technological revolutions (Gore, 2010), he has enriched the overall picture by correlating the price cycles derived from Berry's work (Berry, 1991) with the socio-technical cycles derived from Perez's work. Read together these are very rough approximations of actual growth cycles without in any way suggesting that the actual complex drivers of economic growth at any moment in time are reducible to these long-wave dynamics. His key insight seems to confirm Köhler's argument that S-curves do not run consecutively (as represented by both the MLP and, to some extent, by Perez), but instead they tend to overlap with the deployment phase of a previous cycle and the installation of the new cycle acting as co-drivers of growth-oriented processes (Köhler, 2012). Specifically, Gore argues that the post-1970s growth phase was driven *both* by the deployment phase of the 4th technological revolution or Age of Oil ('Revolution A' in Fig. 4) *and* the economic consequences of the installation phase of the fifth technological revolution or Information Age ('Revolution B' in Fig. 4). Although ICT does not in and of itself determine economic growth, massive reductions in transaction costs (such as 'Just-in-Time' and 'flexible specialization' in production value chains) – that were made possible by ICT – had significant growth-oriented effects.

The global economic crisis not only marks the mid-cycle crisis of the fifth technological revolution, it also marks the end of the post-WWII global development cycle that ended in 2009 (Gore, 2010). This, in turn, opens up the possibility of the next global development cycle that could only emerge if radical institutional reconfigurations not only displace finance capital to unleash productive capital (following

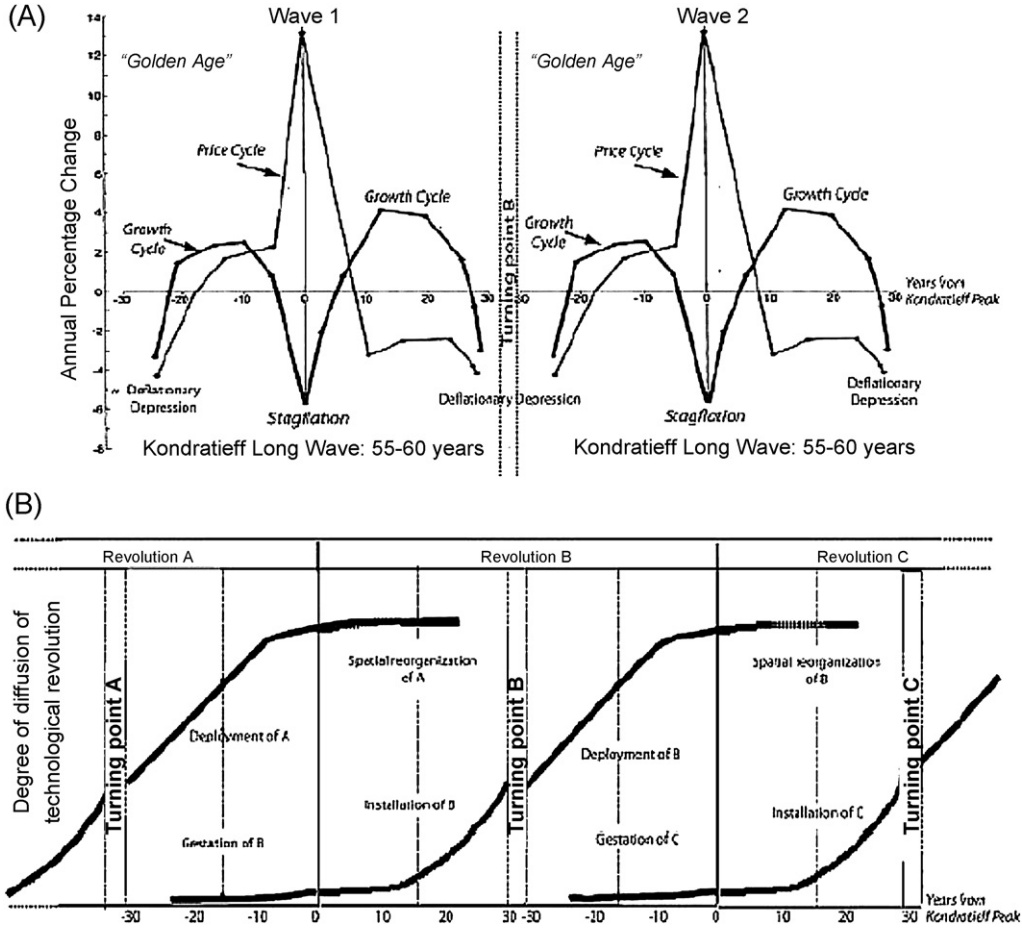


Fig. 4. The synchronisation of growth cycles, price cycles and the life-cycles of technological revolutions (A) growth cycles and price cycles in the Kondratieff long wave (base on the USA); (B) the life cycle of technological revolution.
Gore, 2010:718.

Perez's script), but also displace the powerful and highly subsidised regimes of the mineral–energy complex that depend on the continuities of "carbon lock-in" (Pierson, 2000).

This, of course, raises the obvious question about whether or not it is appropriate to conceptualise the possibility of a 6th technological revolution – or what will be referred to as the 'green-tech revolution' (for literature that explicitly refers to a 6th Kondratieff cycle see Allianz Global Investors, 2010; Bradfield-Moody and Nogrady, 2010; Hargroves and Smith, 2005; Von Weizsacker et al., 2009). Although the next section on the green economy will refer to the empirical evidence in support of this argument, it is clear that there is no need to conceptualise a 6th technological revolution if the global crisis is seen purely through the lens provided by Perez: from this perspective the global crisis is merely the mid-point of the information age which will be resolved when finance capital is disciplined and productive capital unleashed to drive the deployment phase (with 'greening' thrown in for good measure to mitigate the externalities). But if we accept the synthesis proposed by Gore, then conceptually we need to look for the *dual drivers* (which includes the deployment phase of the 5th and of necessity the installation of the 6th technological revolution) of the spring–summer period of the next global development cycle. It makes both conceptual and empirical sense to accept that if the appropriate politico-institutional reconfigurations emerge in response to a range of mounting but also

unpredictable pressures (e.g. global agreements on carbon prices, biodiversity restoration, resource depletion and restructuring of global finance), the deployment phase of the Information Age (driven by productive capital) and the installation phase of the 'green-tech revolution' (driven by finance capital plus, possibly, broad-based civil society-cum-social enterprise economies organised around decentralised renewable energy systems)[5] could well become the drivers of a sustainable global development cycle that results in improved (and ideally increasingly equitable) economic prosperity decoupling from rates of resource use.

Conceptualising the 6th technological revolution is a necessary move to link the start of a new global development cycle to a more fundamental socio-metabolic shift from a non-renewable to a renewable and ecologically restorative resource base. However, as suggested in Table 1, a 'green-tech' revolution may only really catalyse the much needed socio-metabolic transition after going through its own mid-point crisis sometime over the next decade or two (see Row 7 of Table 1 where it is suggested that this crisis point might emerge in the 2030s, but this may well be brought forward by accelerated natural disasters and/or critical resource shortages).

If we conceptually embed our understanding of the 6th technological revolution and next global development cycle within the socio-metabolic dynamics conceptualised by Fischer-Kowalski and the IRP, then we can avoid the superficial consequences of the 'factoring in the externalities' approach. More importantly, we can also then expect the traditional economic drivers of change (shifts in power, technological change) to be overdetermined by the negative landscape pressures brought on by climate change, rising resource prices and the unrelenting degradation of biodiversity and eco-system services. As the McKinsey Report cited above suggests, and as some venture capitalists who have moved into the 'green-tech' investment space argue, as the global economy becomes increasingly unsustainable the returns generated by innovations aimed at 'repairing the future' could well be the drivers of the next industrial revolution. However, a "structurally blocked transition" (Gore, 2010) will persist if states in particular fail to facilitate this shift in power from finance to productive capital and if policies are not put in place to catalyse decarbonisation, biodiversity restoration and more sustainable use of resources (starting with immediate and rapid reductions in subsidies for unsustainable resource use).

Pearson and Foxon concluded that contrary to much contemporary optimism about the potential for a low-carbon industrial transition, a new cluster of low carbon "general purpose technologies" have not yet emerged to drive the next industrial revolution (Pearson and Foxon, 2012).[6] What they – and others – fail to identify, however, is a key cause of this problem, namely that finance capital has yet to discover its historic mission as the driver of the installation phase of the 6th technological revolution. The kinds of infrastructures that become the focus of mainstream investment flows over the next decade will provide the clues as to which trajectories are unfolding. As argued elsewhere, a key space to watch is investments in urban infrastructures because cities are rapidly emerging as the fulcrums of the next potentially more sustainable global development cycle (Hodson et al., 2012).

Table 1 summarises the synthesis of these approaches to socio-metabolic transition, technological revolutions and global development cycles. Rows 1, 2 and 3 capture the Kondratieff-like price and growth cycles, while Rows 7 and 8 depict moments of crisis and periods of inclusion/exclusion. Rows 4 and 5 summarise Perez's technological revolutions, revealing their non-alignment with the rhythms of the global price and growth cycles referred to in Row 1 (read together with Rows 2 and 3). Row 6 factors in the 6th ('green-tech') technological revolution and how this is not just a necessary driver for the spring/summer period of the next global development cycle (Rows 1 and 3) but is also a necessary condition for the socio-metabolic shift anticipated in Rows 9 and 11 (assisted by the dynamics of resource prices – Row 10). Obviously, none of the projections here for the 2010–2030s are inevitable. While they are dependent entirely on policy choices by a wide range of actors that must still be made, they do reflect patterns of what may be possible. Specifically, the initiation of the next global development cycle, driven by the deployment period of the 5th and the installation of the 6th technological revolution, could provide the conditions required for a fundamental socio-metabolic transition that could also be more equalising and inclusive.

[5] For this line of argument see Rifkin's notion of a shift from vertical to lateral power (2011).
[6] For a contrary view see Jänicke (2012).

Table 1
The global development cycle, 1950–2030s.

		1950s	1960s	1970s	1980s	1990s	2000s	2010s	2020s	2030s
1	Phase of Kondratieff cycle (Gore)	Spring		Summer	Autumn		Winter	Spring??		Summer?
2	Price cycle	Rising price inflation			Falling price inflation			Rising price inflation (driven by rising resource prices, debt devaluation & capital demand/interest rates		
3	Growth cycle	Growth acceleration		Growth deceleration	Growth acceleration		Growth deceleration	Stagnation	Growth acceleration, beginnings of deceleration from late 2030s?	
4	4th industrial transition (Perez)	Deployment phase			Maturity, but persistence of Oil Age socio-technical regimes			Decline?		
5	5th industrial transition (Perez)			Irruption	Frenzy		Crisis	Synergy		Maturity
6	6th industrial transition (Perez)						Irruption		Frenzy, start of crisis by late 2030s?	
7	Nature of financial crisis			Stagflation crisis			From 2007: deflationary crisis			Start of stagflation crisis from late 2030s?
8	Pattern of economic development	Equalising (welfarism, Keynesianism, actually existing socialism, decolonisation)			Unequalising (globalisation, privatisation, deregulation, markets)			Equalising? (rise of the BRICs, return of Keynesianism, developmental states, etc.)		
9	Resource flows (Fischer-Kowalski and Swilling)	Mainly biomass, 10-20bt/yr	Doubling of non-biomass materials, 20-30bt/yr	Non-biomass materials become dominant, increase to 50bt/yr				Two thirds non-biomass, 60bt/yr, relative decoupling	Relative and absolute resource reduction?	Absolute resource reduction?
10	Resource prices (IRP/McKinsey)	Declining resource prices				Rising resource prices			Stable/decling resource prices?	
11	Socio-ecological regime (Fischer-Kowalski)	Industrial socio-ecological regime					(Transition to) sustainable socio-ecological regime?			

(Compiled and adapted from Fischer-Kowalski and Swilling, 2011; Gore, 2010; Haberl et al., 2011; McKinsey Global Institute, 2011; Perez, 2010a; Swilling and Annecke, 2012; United Nations Environment Programme, 2011b; United Nations, 2011)

It remains doubtful, however, that conditions have matured to a point where the present interregnum can be transcended in a way that could result in a more sustainable outcome. While there is some debate about whether the low carbon and resource efficiency technologies have matured sufficiently (see Jänicke, 2012; versus Pearson and Foxon, 2012), what is becoming very clear is that the consolidation – through a spate of mergers and acquisitions – within the information and communication sector is preparing the way for the deployment phase of the Information Age. With a strategic focus on 'digitization' and 'integrated value chains', the conditions may well be in place for productive capital to take the lead (Acker et al., 2012). However, many analysts (including Perez and Gore) admit that this time round it might not be so easy to discipline financial capital to make way for productive capital. Marxists argue that the structural nature of contemporary global capitalism is such that finance capital is now endemically hegemonic because of the 'financialisation' of productive capital, with Enron the iconic case study of how an ordinary oil and gas company became a global financial trader (Altvater, 2009; Blackburn, 2011; Gowan, 2009; Harvey, 2009). However, this argument will weaken if the practical Keynesianism of the type expressed in the Stiglitz Report on how to restructure the global financial system without dismantling capitalism manages to be implemented as part of a radical shake-up of the global financial power structures (Stiglitz, 2010).

By 2012 there was little evidence of any fundamental restructuring of the global financial system thus confirming Gore's argument that the global crisis is a "structurally blocked transition" (Gore, 2010). We have the rivalry between China and the USA about the value of the Chinese currency; the ongoing financial instabilities in the EU, exacerbated by the multiple sovereign debt crises; the de facto bankruptcy of the USA masked by 'Quantitative Easing' (read: printing money) in a low interest environment; the relatively unfettered flow of speculative finance through global markets despite the Dodd–Frank regulatory reforms in the USA; the hoarding of cash as investors wait for short-term capital gains opportunities to return, instead of looking for long-term productive investments in the real economy; and national governments who, having experienced massive devaluations in the past, continue to build up currency reserves to counteract financial shocks, thus keeping much-needed investment capital away from productive investment.

6. Making sense of the green economy

Recent years have seen a surge in the number of policy documents advocating a transition of some sort to a 'green economy' (see Association of Academies of Science in Asia, 2011; Barbier, 2010; European Commission, 2010, 2011; Jaeger, 2011; OECD, 2011; United Nations Environment Programme, 2011a,b; United Nations, 2011). In light of the argument thus far, the key question is whether these discourses represent more than just the greening of the Information Age: while this may be one outcome, do they rather reflect the start of a more fundamental paradigm breaking 'green-tech' revolution that could, in turn, become a co-driver of the next global development cycle?

In this volume Perez lays out the key characteristic for a technological revolution, namely "the explosive appearance of new products and processes, the fast growth of new industries and of the new infrastructures widening and deepening markets at lower cost. "Although it is still early days, the emerging low carbon and green-tech innovations appear to fit this description.

The green economy policy documents referred to above are significant because their focus has shifted from 'green growth' as a sector strategy (i.e. 'eco-industries') to a much wider focus on the 'green economy' as a general growth strategy. For Janeke, who has compiled the best recent review of these documents, this shift reflects the realisation by key policy elites that economically ruinous ecological disasters need to be prevented by introducing low carbon industrial policies that will be neither high growth nor zero growth (as advocated by Jackson, 2009). Instead, Janeke observes, what is envisaged is steady, long-term moderate growth based on "knowledge-intensive, innovative production which corresponds to a creative society with highly developed human and social capital" (Jänicke, 2012:19). Nevertheless, such a strategy is expected to deliver higher average growth over the long term (to 2050) to a conventional high growth strategy which will in all likelihood be undermined by climate change

and resource depletion (United Nations Environment Programme, 2011b). This is no longer an abstract policy idea – besides plenty of empirical evidence that it is possible to increase resource productivity by 80% (Von Weizsacker et al., 2009, see also the so-called Decoupling 2 Report of the International Resource Panel forthcoming) there are now concrete examples of where one could argue 'green-tech' has made an 'explosive appearance' within certain national economies with strong state support.

Germany, China and South Korea are the most likely key centres of 'green-tech' innovation and knowledge development (Jänicke, 2012). The Governments of all three have intervened decisively to redirect financial investments into the construction of substantial renewable energy, 'green' infrastructures and production capabilities. Despite vigorous opposition from dominant energy regimes (Stenzel and Frenzel, 2007), the introduction of Germany's feed-in tariffs from the late 1990s were particularly effective in creating the innovation niches and market conditions for a remarkably rapid diffusion of renewable energy technologies (Jacobsson and Lauber, 2006). The target of providing 20% of all energy from renewables by 2020 was exceeded by 2010, forcing government to set a new target of 35% by 2030 (Jänicke, 2012:15). There were 72 Districts in Germany that were 100% supplied by renewable energy by 2012. All this was achieved during a period of moderate economic growth rates (between 1% and 2%) coupled to relatively high rates of employment growth. The Desertec project in North Africa and technology licensing of major Chinese producers reflects the globalisation of Germany's new found 'green-tech' capabilities.

Wind power in China is similar: the initial target of 20 GW by 2020 was more than achieved by 2006, prompting a new commitment in 2010 that resulted in a revised target of 150 GW by 2020 (Jänicke, 2012:15). It is well known that China is now the largest producer of renewable energy, and this from a zero base in 2000. South Korea devoted the bulk of its stimulus investments to green investments (including renewable energy, energy efficiency and eco-system restoration) (Barbier, 2010:173–177). All three now see these investments as part of their competitive positioning in the global economy.

However, if the 'green-tech revolution' is to break out from the innovation niches within these lead centres, finance capital is going to have to discover its historic mission as key funder of this technological revolution. There are, however, two trends that suggest this is not going to happen easily. Indeed, without significant state intervention (to introduce carbon prices, a Tobin tax and similar measures) finance capital will remain locked into a short-term capital gains perspective that presumes that the financialisation of the global economy will remain the norm.

The first trend is reflected in the massive build-up of unspent cash in several major economies which clearly indicates that a shift in power from finance to productive capital has yet to emerge. By 2011 Gross Domestic Investment dropped to 16% of GDP in the USA which is below what it was in the early 1960s and way below the 1979 peak of 23%; and in the UK Gross Fixed Capital Formation dropped to just above 14% which is below what it was in 1960 and way below the 1990 peak of 22% (Zhengelis, 2012). Profits of American companies by early 2012 were higher than they have ever been in 65 years (Buttonwood, 2012). Instead of investing in expanded production, they are spending on mergers and acquisitions. As an alternative to both neo-liberal austerity and Keynesian fiscal expansionism, Zhengelis has proposed a growth-oriented policy framework to incentivise large-scale and rapid "additive" investments in low-carbon infrastructures to unlock this unspent cash.[7] These investments have two unique advantages: they can go to scale quickly, and they are responsive to long-term multi-year policy commitments (Zhengelis, 2012). This argument seems to be reinforced by the fact that 33 countries will have carbon taxes by 2013 covering 850 million people and approximately 30% of the global economy (Flannery et al., 2012). The German, Chinese and South Korean cases also seem to confirm that disruptive low carbon investments can go to scale much quicker than anyone thought possible. However, outside of these three contexts, there is insufficient evidence that this kind of green Keynesianism has much support. Even within these contexts, it is questionable whether they really are significant when compared to continued investments in high-carbon resource-intensive infrastructures (especially in China). This is an unsurprising trend: as argued by the MLP an installation

[7] See the McKinsey report for a detailed portfolio of low-carbon and resource productivity investments which could generate high rates of return, even if resource subsidies continue and carbon taxes are not introduced.

phase of a new technological revolution will typically come up against the obduracy of incumbent socio-technical regimes (Grin et al., 2010).

Given the enormous power of the large globalised financial investors, one could argue that the faith that analysts like Zhengelis and Janeke have in the power of policy interventions may be misplaced. Whether influenced by policy or not, what will really make a difference is the perceptions of sustainability held by the world's most powerful investors in the companies that will drive the installation phase of the 'green-tech revolution' – perceptions that reports like the one cited above by McKinsey are trying to change. The second trend, therefore, emerges from the first significant academic assessment of the sustainability commitments of the world's largest institutional investors and the sustainability commitments of 283 of the 'very large corporations' they invest in. Peetz and Murray found that while a significant number have joined one or more sustainability platforms, these commitments are undermined by the "short-termism" of equity and financial markets. They found that 36.9% of all shares in the 283 global corporations were owned by investors who had some form of formal commitment to climate change action. These 'climate interested investors' can – and do – make a difference where their share holdings are large enough (1.5% or above). However, the endemic price volatility of listed shares and the absence of a globally agreed way to price carbon over the long term reinforces what these authors refer to as a low-risk "short-termism" which, in turn, disincentivises the high risk investments that will be needed to drive the 'green-tech revolution' out of its niches and into the mainstream. They pursue capital gains, but in a financialised world where "short-termism" is coupled to low risk (Peetz and Murray, 2012).

In short, while most of the conditions for the 'explosive appearance' of a green-tech revolution exist, finance capital has yet to crowd into this sector to realise its potential beyond a few key lead centres. Unless governments intervene to reduce speculative profiteering in the financial markets, establish a global carbon pricing system and support sustainability-oriented innovations (Stamm et al., 2009), the green-tech revolution will fail to emerge as a key driver of the next global development cycle.

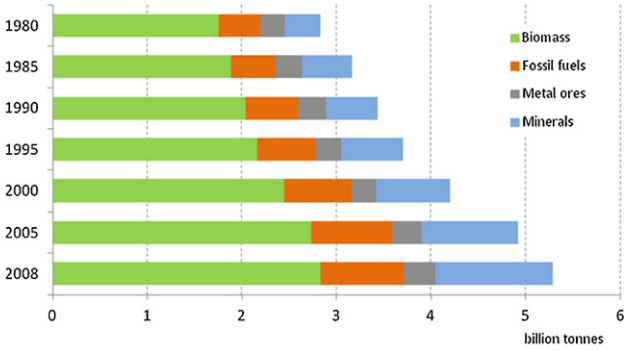
7. Can Africa transcend the resource curse?

As already noted, technological revolutions and global development cycles develop unevenly across geographical space. Africa's development experience confirms this most clearly. It is generally accepted that in contrast to Asia, Africa did not benefit from the dynamics of the post-WWII global development cycle, especially the second half. This, however, was not an inevitable outcome but rather a function of policy choices (Ampiah and Naidu, 2008; Southall and Melber, 2009). The question today is whether Africa will develop institutional responses to the resource curse in order to benefit from a potentially more sustainable global development cycle.

There is a new wave of optimism sweeping across Africa as growth rates climb, consumer spending rises and returns on investment rise above what is possible in most other parts of the world since the onset of the economic recession in 2007 (African Development Bank, 2010; McKinsey Global Institute, 2010). In reality, it was continued strong demand, despite the economic recession, for primary resources from other rapidly growing developing economies that has been significant in protecting Africa from the global recession. Although the boom in resource prices has clearly been a dominant driver of African economic growth, diversification has proceeded apace: resources were reduced to 24% of Africa's total GDP by 2009 (McKinsey Global Institute 2010:3).

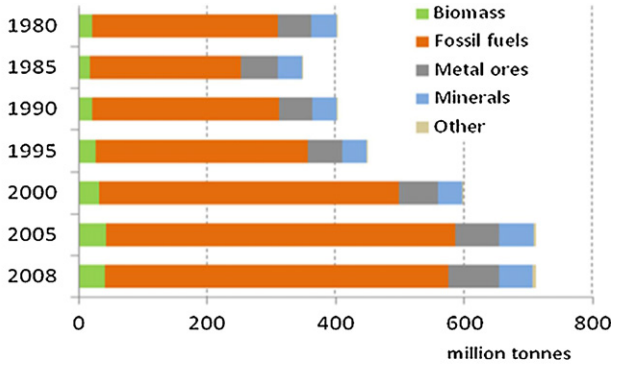
In 2000, the export of primary natural resources accounted for 86% of all exports from Africa (Mayer and Fajarnes, 2005:8). This was much higher than the rest of the world – the export of primary natural resources accounted for only 31% of all exports from all developing countries in 2000 and 16% of the exports from advanced industrial countries in the same year. According to the 2012 Report on Africa by the UN Conference on Trade and Development (UNCTAD), Africa is a net exporter of resources (United Nations Conference on Trade and Development, 2012). Fig. 5 shows that Domestic Material Extraction increased by 87% between 1980 and 2008 (from 2.8 billion tonnes to 5.3 billion tonnes). Fig. 6 reveals that exports have increased from 400 million tonnes to over 700 million tonnes, with fossil fuels playing a dominant role.

It is clear from Figs. 5–7 that Africa is a net exporter of non-renewable resources and a net importer of biomass. As far as fossil fuels are concerned, Africa exports 500 mt and imports 100 mt (mainly



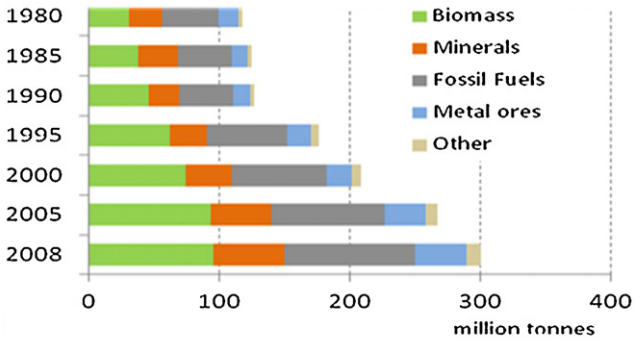
(Source: United Nations Conference on Trade and Development 2012)

Fig. 5. Domestic Material Extraction (billion tonnes), 1980–2008.
United Nations Conference on Trade and Development (2012).



(Source: United Nations Conference on Trade and Development 2012)

Fig. 6. Africa's Physical Exports (million tonnes), 1980–2008.
United Nations Conference on Trade and Development (2012).



(Source: United Nations Conference on Trade and Development 2012)

Fig. 7. Africa's Physical Imports (million tonnes), 1980–2008.
United Nations Conference on Trade and Development (2012).

refined fuels). Africa exports 14.5 mt of biomass, and imports 95.8 mt (mainly cereals followed by biomass-products – mainly vegetable fats and oils, timber and sugar crops). This clearly reveals Africa's role as a primary resource provider to the global economy and its dependence on the import of manufactured goods. This is not only unsustainable, it will not enable Africa to benefit from the next global development cycle.

Concluding what is the first review of Africa's future economic prospects from a sustainable resource use perspective, UNCTAD argues that:

> "[A]chieving sustainable development in Africa requires deliberate, concerted and proactive measures [by the State] to promote structural transformation and the relative decoupling of natural resource use and environmental impact from the growth process" (United Nations Conference on Trade and Development, 2012:131).

This is all very well, but it ignores the consequences of the 'resource curse' (Sachs and Warner, 2001). Paul Collier's classic and highly influential elaboration of the original resource curse thesis is as follows:

'[T]he political systems best suited to harnessing natural assets are those least likely to develop once natural assets have become important in the economy.' (Collier, 2010:1106)

The usual practice when comparing Asian states to African states is to insist on what Mkandawire calls the "impossibility thesis" – what was achieved in Asia during the last decades of the c.20th via interventionist developmental states cannot be achieved in Africa precisely because of the kinds of correlations that are reflected in the work by Collier and others (Mkandawire, 2001). Echoing the substantial literature on the Asian developmental state (Amsden, 1995; Chang, 2007; Chibber, 2003; Evans, 2010; Leftwich, 1995), Rock et al. conclude that "capitalist developmental states" that were built up in Asia to drive accelerated industrialisation from the 1970s onwards succeeded for two primary reasons: their "openness to the global economy as manifest in trade and investment policies", and their successful efforts to build state systems "capable of creating the kinds of selection environments or socio-political landscapes for the development of more productive socio-technical regimes" (Rock et al., 2009:246). They conclude that the institutional modalities of the capitalist developmental state in Asia are well suited to driving a sustainability transition, in particular the capacity to develop and implement long-term policy frameworks, regulatory and enforcement capabilities, the rapid incorporation into production systems of environmental standards required by external trading markets, and leadership abilities to forge knowledge partnerships that drive technological innovations (Rock et al., 2009). These are clearly the same modalities that would need to be in place in African states to realise the structural transformation that UNCTAD has in mind (Evans, 2010).

As Mkandawire shows and contrary to the "impossibility thesis", capable African developmental states have existed in the past and drove successful economic development across many African countries during the 1960s and 1970s. However, the combined impact of rent-seeking and the imposition of misguided neo-liberal prescriptions in Africa from the 1980s onwards not only resulted in minimising the role of states in favour of markets, but unlike the Asian case it also involved the hollowing out of state capacity in the name of 'civil service reform', privatisation and deregulation. This prevented African states from building the institutional/ideational capacity and class partnerships to take advantage (as many Asian states did) of the global capital and knowledge flows unleashed by globalisation in the 1980s and 1990s (Mkandawire, 2001). This now leaves them ill-equipped for whatever may happen next.

The gradual reassembling of the African developmental state may well be reflected in the recent continent-wide discussion about 'resource nationalism'. While these calls clearly have their dark side (The Economist, 2012), they do open up discussion about the need to generate greater social returns on resource extraction. Following Collier (Collier, 2010), to counteract the damage inflicted on political governance systems by the kleptomaniacal flow of resource rents, four positive institutional interventions aimed at promoting what could be called 'resource use integrity' are worth noting. The first relates to measures that undermine the propensity of resource extraction to corrupt and include the following:

- *Kimberley Process* which put in place a tracking system for diamonds - the Nigerian President has proposed a similar system for oil;
- *Extractive Industries Transparency Initiative* (http://eiti.org) which tracks resource extraction activities in order to place strategic information in the public domain;
- *Sovereign Wealth Funds* to capture and ring-fence resource rents.

The second set of interventions are aimed at improving the integrity of resource governance, including:

- replacing secret negotiations with extractive industries with public auctions;
- reducing annual levels of extraction to extend the life-cycle of the mine by ensuring stability through long-term agreements underwritten by an all-party consensus;
- Nigerian Fiscal Responsibility Act or the South African approach to mandatory reinvestment of resource rents in economic activity after mine closures ensures beneficial impacts of resource rents;
- instead of paying royalties in the form of monetary payments, build infrastructures that promote economic development (as preferred by the Chinese).

A third set of interventions are aimed at creating the basis for broad-based civil society mobilisation underpinned by information. Examples include the information provided by the EITI and UNEP's International Resource Panel (IRP) (http://www.unep.org/resourcepanel/), initiatives funded by the Open Society Foundation as well as stakeholder alliances such as the one created by the *Natural Resource Charter* movement that is spearheaded by an eminent group supported by renowned economists (see www.naturalresourcecharter.org).

Finally, a number of Maghreb countries have built endogenous capacity to integrate renewable energy into their respective energy mixes (Brand and Zingerle, 2011). Instead of leaving the Sahara's exceptional radiation resources for the exclusive benefit of the European grid via Desertec, these countries have realised that these resources are extra-ordinary untapped economic opportunities.

In summary, although the pessimism of the 'impossibility thesis' pervades much of the literature about Africa's options, rising economic growth rates, accelerating diversification and recent references to 'resource nationalism' may well combine to provide opportunities for the kind of 'structural transformation' that the UNCTAD Report has called for. However, much will depend on whether 'inclusive institutions' get built that can ensure that Africa takes advantage of the next long-term development cycle. This will entail building up the knowledge and productive capacities for sustainability-oriented innovations that could for once turn African resources into a blessing rather than a curse. This, in turn, will enable these economies to benefit from the next global development cycle, whatever it may turn out to be.

8. Conclusion

The global economic crisis will only come to an end when finance capital has been disciplined; the information technology revolution matures into its deployment phase under the leadership of productive capital; and the installation of the 'green-tech' revolution driven by finance capital is accelerated in response to deepening ecological crises. However, we face a structurally blocked transition superimposed on a socio-metabolic crisis reflected in rising resource prices. The consequences for Africa are highly contradictory: it benefits from rising resource prices, but also locks it into regimes that could be displaced by the green-tech revolution.

The failure to dislodge finance capital (by adopting, for example, the recommendations of the Stiglitz Report or a punitive Tobin tax), has had two key consequences. The first is that despite the considerable consolidations since 2007 in the ICT sector to drive the digitization agenda via greater value-chain integration, productive capital remains weak relative to finance capital which, in turn, undermines the growth potential of the deployment phase of the Information Age. The second is that despite the potential in the green-tech revolution, it lacks the magnitude of high risk investments needed to go beyond niche markets – investments that should be provided by capital-gains seeking finance capital with an appetite for high risk investments. Whereas a third of the world's largest

investors appreciate the significance of the green-tech revolution, most remain locked into low risk short-termism. State-owned investors in China may be a key exception.

A (slow) recovery driven purely by the deployment phase of the Information Age is, of course, one alternative. What then becomes the new historic mission of finance capital? But more profoundly, this option will be rapidly undermined by resource depletion, climate change and ecological breakdown. 'Greening' would then be invoked to 'mitigate' these externalities. To counter this 'weak sustainability' perspective, it will be necessary to accept that there are more fundamental socio-metabolic dynamics afoot with effects that cannot be grasped as merely inconvenient externalities. These dynamics make a sixth – so-called 'green-tech' – technological revolution necessary, although not inevitable. It has been argued that a green-tech revolution would be driven by the need to generate radical socio-technical changes that will make the required socio-metabolic transition possible. It was suggested that certain public policies in Germany, China and South Korea opened up niche innovations that have upscaled green-tech innovations at much faster rates than anyone initially predicted. These may, indeed, 'green' the Information Age, but the evidence does suggest they are incubating the installation phase of a 6th – the 'green-tech' – technological revolution.

This then provides the contextual framework for taking a fresh look at Africa's prospects and options. The fact that the last global development cycle largely worked to the disadvantage of African economies confirms the need for caution when using long-wave theory to explain a moment like the current global crisis: just as global growth does not 'lift all boats', nor is the crisis experienced similarly across all regions. Whatever the complex drivers of rising resource prices from 2002 onwards may be, they continued rising after the global crash and will in all likelihood continue to do so for some time thus reinforcing the dependence of many African economies on resource exploitation and exports. This is the most destructive effect of the resource curse – a disincentive to diversify. While the new discourse of 'resource nationalism' has its dark side, it could potentially foster a new discussion about the best use of resource endowments. Various institutional reforms were considered that could achieve this.

Two sets of questions flow from this analysis. One set relates to the blocked transition and the complex dynamics of finance-led globalisation. What measures could really discipline financial capital? Will consolidation in the ICT sector to drive the digitization agenda find the patient dividend-seeking productive capital it needs to realise its potential during the deployment phase of the Information Age? If ways could be found to discipline finance capital, what is its new mission? Answers to these questions will provide clues to the pace and shape of the next global development cycle.

When it comes to considering the options of (in particular resource-rich resource exporting) African countries, we need to track the evolution of the 'resource nationalism' discourse. Will this provide the basis for transcending the resource curse? What modes of governance are emerging that could facilitate the re-investment of resource rents in infrastructure, skills and sustainability-oriented innovations? Will it be possible to decouple economic growth rates from rising resource use?

By using long-wave theory modified by an uneven development perspective it has been possible to provide one way of making sense of the global economic crisis from the perspective of a particular set of resource-rich resource exporting African economies. While a 6th technological revolution is a distinct possibility, we have a blocked transition globally while resource importers benefit from the continuities of Africa's resource curse. Precisely where the bifurcation points in the system will emerge that could lead the way beyond the interregnum is impossible to predict with certainty. What is certain, though, is they do exist and may already be in place. What matters is who sees them first and how they seize the opportunities created.

> "The crisis consists precisely in the fact that the old is dying and the new cannot be born; in this interregnum a great variety of morbid symptoms appear." – Antonio Gramsci

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