

European Recovery Project



21st April 2014
(Revised 19th May 2014)

FAO: Dan O'Brien, Chief Economist, IIEA

CC: Brendan Halligan, Chairman, IIEA

RE: Kick-off Discussion (March 27 2014)

Dear Dan,

Thank you for the opportunity to participate in your recent discussion on the European Recovery Project.

The origins of this note stem back to a request received from Brendan on two occasions, July 2nd 2011 and again on October 5th 2011, to prepare a note to elaborate on ideas that I initially captured in emails to him on those same dates. I've copied them below for posterity.

Any originality I can claim is only in the putting together of two areas of keen personal interest, energy and banking, while the real credit goes to the economists pioneering their respective fields. Although I am taking advantage of fortuitous timing. The exercise of preparing this note required reflecting on and documenting a personal journey of discovery over the past decade. The latter served as a useful reference to the several dozen important pieces of the puzzle, which I'll attempt to summarise below.

The most significant aspect of the journey that must be highlighted is the ending of three secular debates that I've observed raging over the past decade, although their origins are much older. For the purpose of this summary, they will be the starting point for what follows:

- Anthropogenic Climate Change: it is real and we are causing it [IPCC AR5, 2014]
- The end of cheap oil: conventional crude oil peaked in 2006 [IEA, 2011]
- Banks have the power to create and allocate credit and are not simply neutral intermediaries between savers and borrowers [Bank of England, 2014]

Modern society is as fraught with conflicts of secular dogma as was medieval society with religious dogma. To acquire a new world view, a change of paradigm, is comparable to a religious experience.

Professor Steve Cotgrove (1982)

However, accepting the above, the last point in particular, has profound implications for conventional neo-classical economic theory, and more importantly, its proponents. The vast majority of economists, certainly any in positions of authority with regard to setting economic policy, are orthodox neo-classical economists. What Professor Richard Werner, in the introduction to his ground-breaking book, [New Paradigm in Macroeconomics](#) (2005), describes as the dominant paradigm. It is dissatisfaction with both the explanatory and predictive power of this theory which has led to the formation of institutions such as [INET](#) and [ISIPE](#).

I believe that during the last financial crisis, macroeconomists (and I include myself among them) failed the country, and indeed the world. In September 2008, central bankers were in desperate need of a playbook that offered a systematic plan of attack to deal with fast-evolving circumstances. Macroeconomics should have been able to provide that playbook. It could not. Of course, from a longer view, macroeconomists let policy makers down much earlier, because they did not provide policymakers with rules to avoid the circumstances that led to the global financial meltdown.

Narayana Kocherlakota, President, Federal Reserve Bank of Minneapolis (2009)

This paper uses the lens of macro-economic history and builds on our earlier work to present a sharper picture of the role of credit in the business cycle. A primary challenge going forward is to redesign monetary and financial regimes to mitigate systemic crises (Turner 2009). Our results also add clarity at a time when it is still being argued that “[e]mpirically, the profession has not settled the question of how fast recovery occurs after financial recessions” (Brunnermeier and Sannikov 2012) and when, beyond academe, political debate rages over what the recovery “ought” to look like.

Jordà, Schularick, Taylor (2013)

The financial crisis presents both an ethical and an intellectual challenge to economics, and an opportunity to reform its study by grounding it more solidly in reality.

Colander et al (2009)

The End of Banking Fairy Tales

The publication last month (Mar 2014) by the Bank of England of their [papers on money in the modern economy](#) (McLeay et al. 2014b; McLeay et al. 2014a) finally consigns to the history books the notion that banks are neutral intermediaries in the economy, connecting borrowers with lenders. The power to create and allocate credit is arguably the greatest socially constructed power man has ever bestowed on another (Graeber 2011).

This admission by the Bank of England gives enormous credence to the work of Professors Richard Werner at the University of Southampton, and Steve Keen at the University of Western Sydney. Both of whom have laboured long and hard to disprove a fiction that economists and bankers have long upheld. They have also been ardent critics of neo-classical economic theory, Walrasian equilibrium theory in particular. Most importantly, both appear to have independently developed, although finding common source in the work of [Minsky](#), disaggregated credit models for economic growth.

Werner argues in his disaggregated credit model that economic growth is driven by new credit creation, but only by that which is invested in increasing the productive capacity of the economy, i.e. new credit created for asset speculation only fuels asset price inflation and does not lead to long-term economic growth. The power to create and allocate credit, the defining characteristic of a bank, is a social good that should be regulated accordingly (Werner 1997; Werner 2005; Bezemer & Werner 2009; Werner 2012). Werner also argues that central bank intervention to control the quantity of money in circulation, Quantitative Easing (or its many other names (Werner 2010, p.9)), can only be effective if directed towards the productive economy, and the power to create and allocate credit is a social good that should not be held exclusively by private banks (Werner 1997; Werner 2005; Bezemer & Werner 2009; Werner 2012). The figures below show the correlation between GDP and credit created for increasing the productive capacity of the economy in Japan and the Czech Republic.

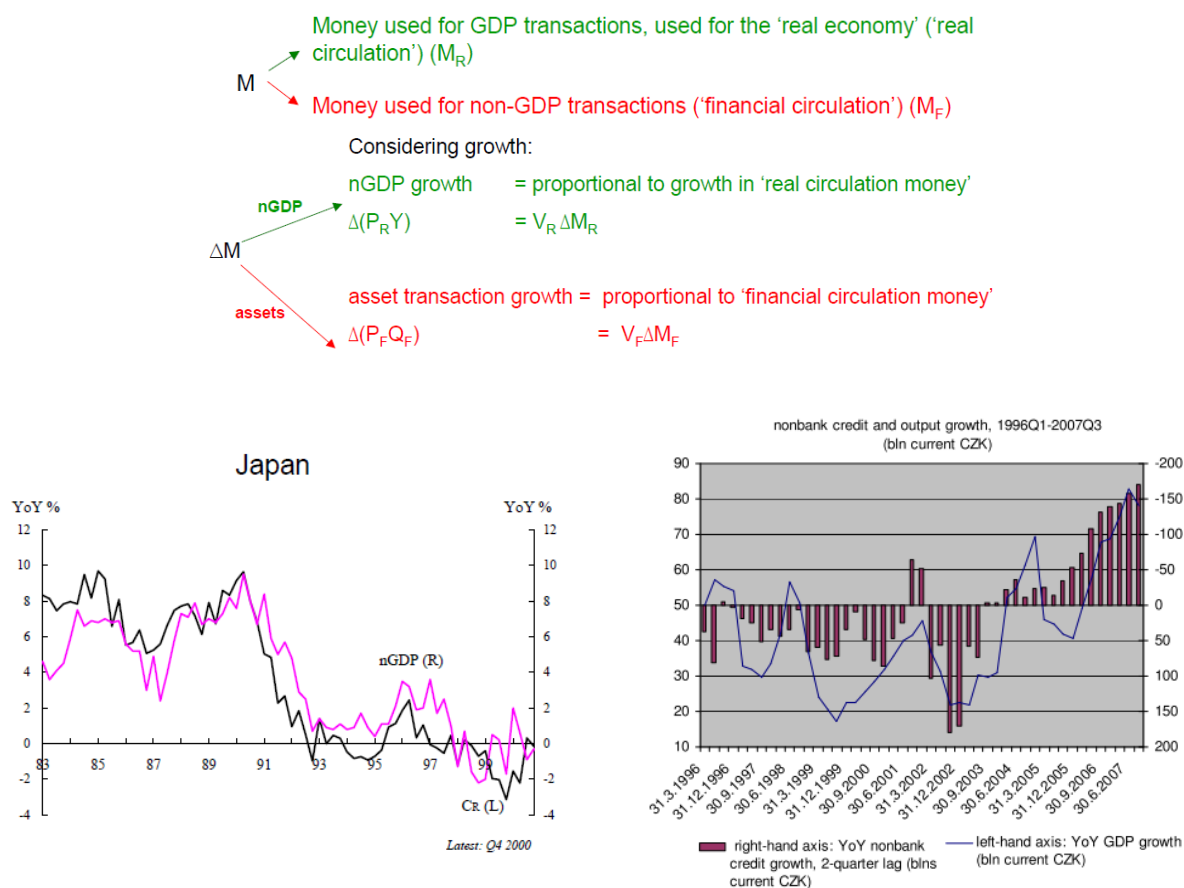


Figure 1 Explaining Growth: driven by credit creation for GDP transactions (CR), not interest rates or fiscal policy; Werner (2010, p.32)

Figure 2 lagged real-sector bank credit constraints and nominal output growth in the Czech Republic, 1995-2007 (Bezemer & Werner 2009, p.26)

Keen cites Minsky: if we are to fully comprehend how market economies really behave, "it is necessary to have an economic theory which makes great depressions one of the possible states in which our type of capitalist economy can find itself." (Minsky, 1982a, p. 5) Keen goes on to state that general equilibrium theory is not such a theory. By combining a Graziani model of a pure credit economy with a Goodwin growth cycle model of Minsky's Financial Instability Hypothesis (FIH), Keen was able to recreate the Great Depression and the Great Recession in his modelling environment (Keen 2013), shown in Figures 3 and 4 below.

Elsewhere, Keen (2011a) argues that in a credit-based economy, there are three sources of aggregate demand, and three ways in which this demand is expended:

1. Demand from income earned by selling goods and services, which primarily finances consumption;
2. Demand from rising entrepreneurial debt, which primarily finances investment; and
3. Demand from rising Ponzi debt, which primarily finances the purchase of existing assets.

"Schumpeter's and Minsky's perspectives thus enable us to integrate credit, asset markets and disequilibrium analysis into an alternative macroeconomics. In a credit economy, aggregate demand is the sum of income plus the change in debt, and this demand is expended on both goods and services and purchases of existing assets. Debt therefore has both positive and negative connotations for the economy: it finances the expansion of economic activity via innovation and investment, but it can also cause asset bubbles and eventually, an economic crisis if too much of this debt is directed to Ponzi finance."

$$\text{Income} + \text{Change in Debt} = \text{Output (GDP)} + \text{Net Asset Sales} \quad (\text{Keen 2011b, p.30})^1$$

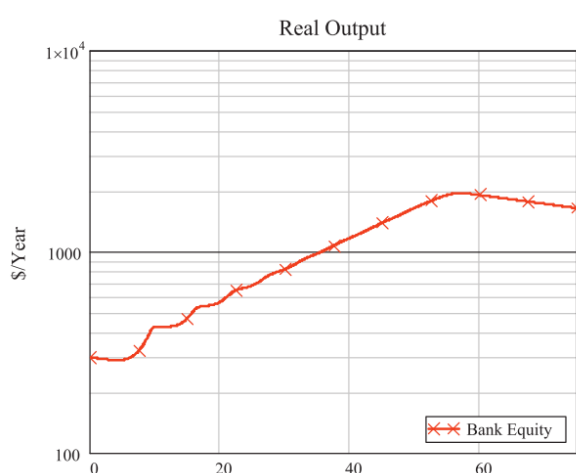


Figure 3 Cycles in real output diminish, followed by a sudden change to declining output

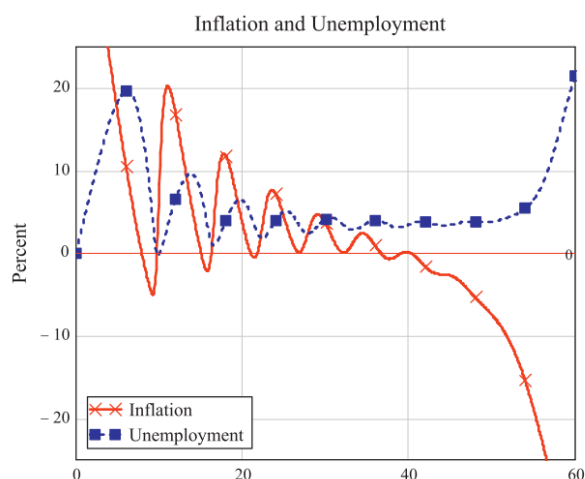


Figure 4 Apparent economic tranquility gives way to a deflationary collapse. (Keen 2013, p.229)

Keen's work is compelling, not only because of its explanatory power, but also by virtue of its rigorous employment of the [Scientific Method](#), an inductive problem solving approach. Werner makes the point that this is contrary to the deductive approach used for the development of much neo-classical economic theory.

Adair Turner, directly influenced by the work of Werner and Minsky ([Credit creation and social optimality](#) ECOBATE 2011), has picked up this issue with both hands and run with it. He is bringing this message to the mainstream and hopefully will be instrumental in driving the reform that this realisation makes essential: credit creation and allocation is a social good that must be regulated accordingly; and for economic growth, it has to be directed towards real entrepreneurial activity (Schumpeter) which increases the productive capacity of the economy ([Macroeconomic Policy and Economic Stability](#) INET Hong Kong 2013).

While such a policy can be adopted to prevent future credit crises, we must also contend with the challenge of emerging from our most recent credit crisis, the very task set by the EC which prompts this note. Koo's work on Japan and *Balance Sheet Recessions* is instructive in this regard (Koo 2011; Eggertsson & Krugman 2012). Koo argues that in the wake of a nation-wide asset price bubble collapse, a large portion of the private sector switches from profit maximisation to debt minimisation, and this change in dynamic has a depressing effect on aggregate demand: *The first casualty of this shift to debt minimization is monetary policy*. Koo argues that it is essential that the drop in aggregate demand in the private sector must be filled by government spending during a balance-sheet recession, deficit bedamned (not quite, he argues that the counterfactual would show that it costs a lot less than austerity in the long run).

Koo pays special attention to the peculiar pro-cyclical situation in the EC, where investors can chase higher bond yields without exchange rate risk. Koo recommends preventing non-nationals from buying government bonds to avoid this problem:

¹ Prof Keen's latest thinking (Keen et al. n.d.) updates this model, c.f. (Bernardo & Campiglio 2013, p.9; Kakarot-handtke 2014)

'Ending the eurozone's crisis will require a two-pronged approach. First, international bodies like the EU and ECB need to declare that member countries experiencing balance sheet recessions must implement and maintain fiscal stimulus to support the economy until private sector balance sheets are repaired. Second, eurozone member nations must declare that in ten years they will prohibit the sale of government debt to anyone other than their own nationals.' (Koo, 2011, p.31)

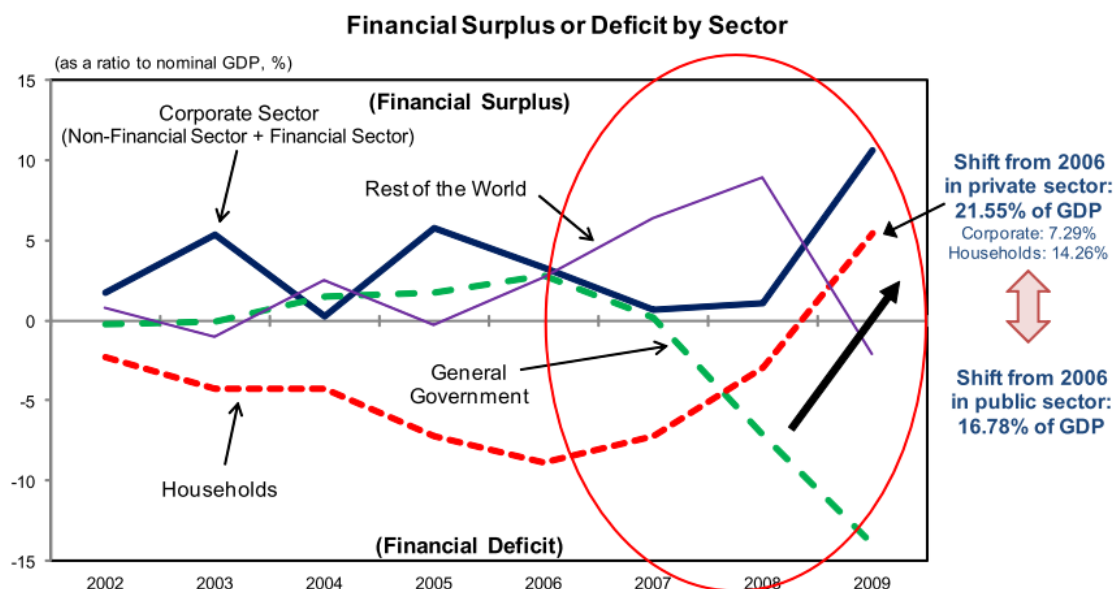


Figure 5 Ireland in Balance Sheet Recession: Massive Increase in Private Savings after the Bubble (Koo 2011, p.29)

Koo goes on to argue that *'how the money is spent is largely irrelevant during a balance sheet recession: the important thing is that the money be spent.'* (ibid, p.33) Werner and Keen would qualify this, that it must be spent on increasing the productive capacity of the economy. I will argue further below, that this needs to be qualified further still, as increasing the productive capacity of the economy can only be done through improving energy efficiency.

It is such thinking that leads Adair Turner to the conclusion that *'We should therefore cease treating overt money finance [OMF] as a taboo subject.'* (Turner 2013, p.41) Although he also notes: *'Within the Eurozone political construct, the case for keeping OMF in the taboo box remains strong'* (ibid, p. 38)

The End of Cheap Oil

Certain theories in physical science are so pervasively accepted as to be called laws, such as the law of gravity. First among them are Newton's laws of motion and the conservation of energy, and Lavoisier's law of conservation of mass, which Einstein brought together in his famous theory of relativity and $E = mc^2$ formula.

Second among them are the laws of thermodynamics, the second of which states that in a closed system, entropy always increases. We never observe the broken pieces of the vase assembling themselves from the floor back onto the table, only the reverse. Thus we take low entropy fossil fuels and, in the process of extracting useful energy, we produce high entropy carbon dioxide in the atmosphere.

It is such laws that underpin the science of climate change. The particular problem solving methodology, the Scientific Method, underpins the modern industrial age, and arguably defines progress. The scientific definition of energy is the ability to do work (measured in joules). The rate at which work is done defines power (measured in watts). The chart below demonstrates the sources and uses of energy in Ireland in 2012 (SEAI 2013, p.5). The average human needs about 2000 Calories per day, which is equivalent to about 100 watts (think of a human's average power requirement to get up and move around, think, etc, as the same as that of an old 100 watt light bulb, with an efficiency not much dissimilar).

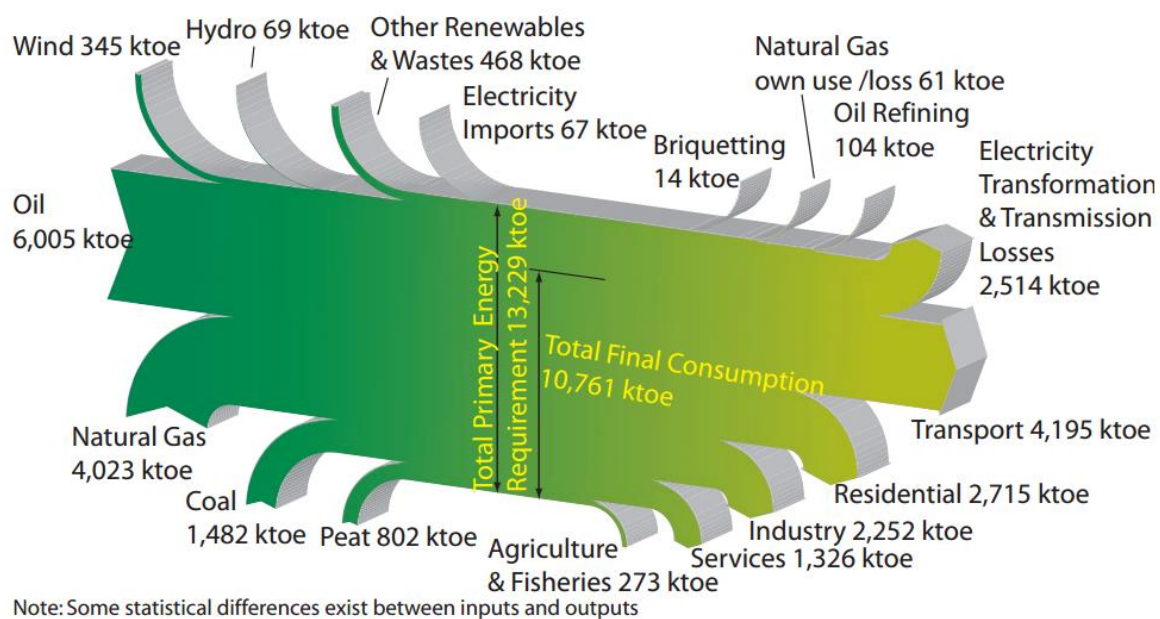


Figure 6 Overall Energy Flow in Ireland – 2012 (SEAI, ktoe: kilo tonne oil equivalent)

However, on a per-capita basis, each person in this country requires an additional 3,800 watts of power to enjoy the energy services that make our lives profoundly different from the 1 billion people in the world who have no access to modern energy. That's nearly 40 times more than we need just to live. Yet, it only costs about 5% of GDP. Ireland enjoys a GDP of ~€160 bn because of the access it has to physical power, both the energy and the technology to transform it. It is a simple physical fact that without it, the economy would look like that of the many countries which don't enjoy such access (IMF 2011).

Curiously, there is an almost perfect correlation between GDP and electrical power consumption. Yet attempts to develop a theory of causation appear to exist only on the fringes of economics, promoted by physical scientists or hybrid physicist-economists (Lindenberger & Kümmel 2011; Ayres et al. 2013; Warr & Ayres 2010; Ayres & Voudouris 2014; Ozturk 2010), with the notable exception of [Georgescu-Roegen: The Entropy Law and the Economic Process](#) (1971). While our political class appear acutely aware of the importance of energy. Simply consider the impact of Churchill's decision to convert the British Navy from coal to oil (Yergin 2012; Barr 2011), not to mention more controversial recent examples (Friedrichs 2010; Klare 2009; Commission on Energy & Geopolitics 2014).

So, while it is a truism to say that without physical power, there is no economy, there is nothing in the canon of mainstream economic theory to account for its role in the economy. Conventional economic theory assumes output contribution is equivalent to input cost share with perfect substitutability. If

that were the case, debates about solving climate change by eliminating the use of fossil fuels, oil in particular, would be moot, rather than very divisive, which unfortunately they are (Moe 2010).

Lindenberger et al argue that such assumptions do not stand up to empirical evidence. Recalling one of the comments at our meeting regarding standard economic growth theory, it uses a modified Cobb-Douglas production function, the Solow-Swan exogenous growth model, and attempts to explain economic growth through the accumulation of labour and capital and the ‘unknown quantity’, Total Factor Productivity, or ‘Factor-X’ as Brendan recalled it.

A theory that is forced to place the vast majority of its explanative power into something that it cannot explain is hardly credible. Yet it’s taught in every undergraduate economics programme.

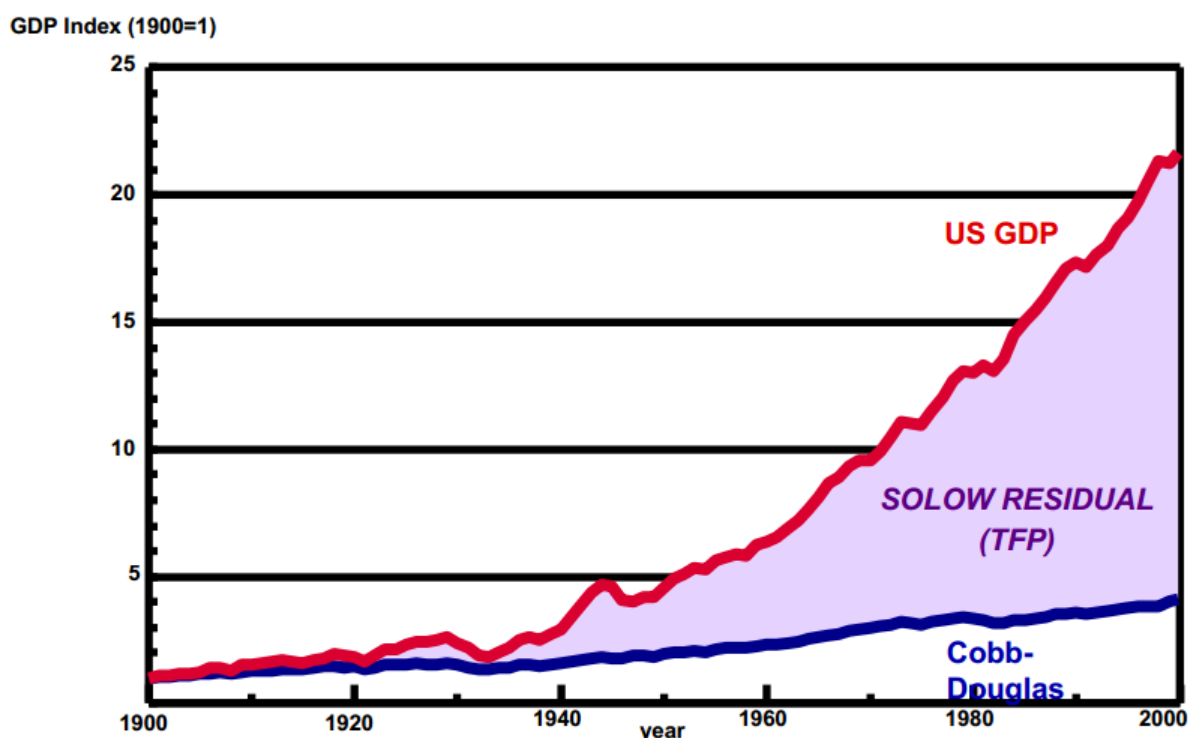


Figure 7 US GDP 1900-2000, Actual vs. 3-factor Cobb-Douglas function

Having developed a modified production function which both incorporates energy and permits output elasticities to be set empirically, Lindenberger et al argue that *‘energy and its conversion into physical work accounts for most of the growth that mainstream economics attributes to “technological progress” and related concepts. It decisively determines the economic state of nations.’* (2011, p.6015) Ayres & Warr make the distinction between useful and non-useful energy, of which only the useful component is productive. Thus, *‘with this formulation the efficiency of converting energy inputs into useful work is a key driver of growth.’* (Ayres et al. 2013, p.83). They conclude *‘the primary drivers of growth are capital deepening, and the increasing supply of energy or “useful work”.’* (ibid)

The ecologist and mathematician [Alfred Lotka](#) ([Lotka-Volterra model](#)) proposed a modification to Darwin’s theory of evolution. He proposed that ‘natural selection’ is best understood as a struggle among organisms for energy. Thus he suggested that ‘fittest’ in the general Darwinian sense can be refined and specified more precisely as an ability to capture and use energy at a rate and efficiency more effective than another. The work presented above suggests we might understand productivity in a similar sense, so that we can refine our understanding of Total Factor Productivity to one of physical power output and energy efficiency (which specifies the amount of gross input energy required).

Because of its [incommensurability](#), the pioneering work introduced above is likely to be dismissed by proponents of the dominant paradigm. However, the role of triple digit price oil on recent economic performance should still feature more prominently in the discourse on the Great Recession, particularly in light of experience from the Seventies' oil shocks. The run up in the oil price to its peak in the summer of 2008 has caught the attention of several macroeconomists who study the role of oil in the economy, some since those oil shocks (Hamilton 2009; Hamilton 2011; Serletis & Elder 2011; Kilian & Vigfusson 2012).

Notably, the IMF attempted to put the issue on the political agenda in 2011 when it published research, now three years ago, in Chapter 3 of its [April World Economic Outlook: Oil Scarcity, Growth, and Global Imbalances](#) (IMF 2011). [Michael Kumhof](#), the economist at the IMF who built and operates the Dynamic Stochastic General Equilibrium (DSGE) model (2010), incorporated the work of Lindenberger et al into his to look at the macroeconomic impact of sustained high oil prices. Kumhof has presented in Dublin twice, most recently at the IIEA ([video](#), [slides](#)).

Jeff Rubin, former Chief Economist at CIBC, is the author of '[The End of Growth](#)' (2012). I'd recommend watching the interview with him at this link for an introduction to his thesis: [Jeffrey Rubin On Why High Oil Prices Stop Growth](#). He [spoke](#) in Cork at the [ASPO6 conference](#) I organised in 2007.

Clearly such a thesis would not be palatable to the EC, nor indeed the wider European and global society. The UK ERC's exhaustive analysis of the subject of oil depletion is worthy of study (Miller et al. 2009), although, the IEA's admission of a peak in 2006 is the crucial point. The outstanding question is what impact that will have on the long-term growth prospects for Europe, which the work of Lindenberger et al suggest, and as Rubin argues, could spell the end of economic growth as we've come to know it.

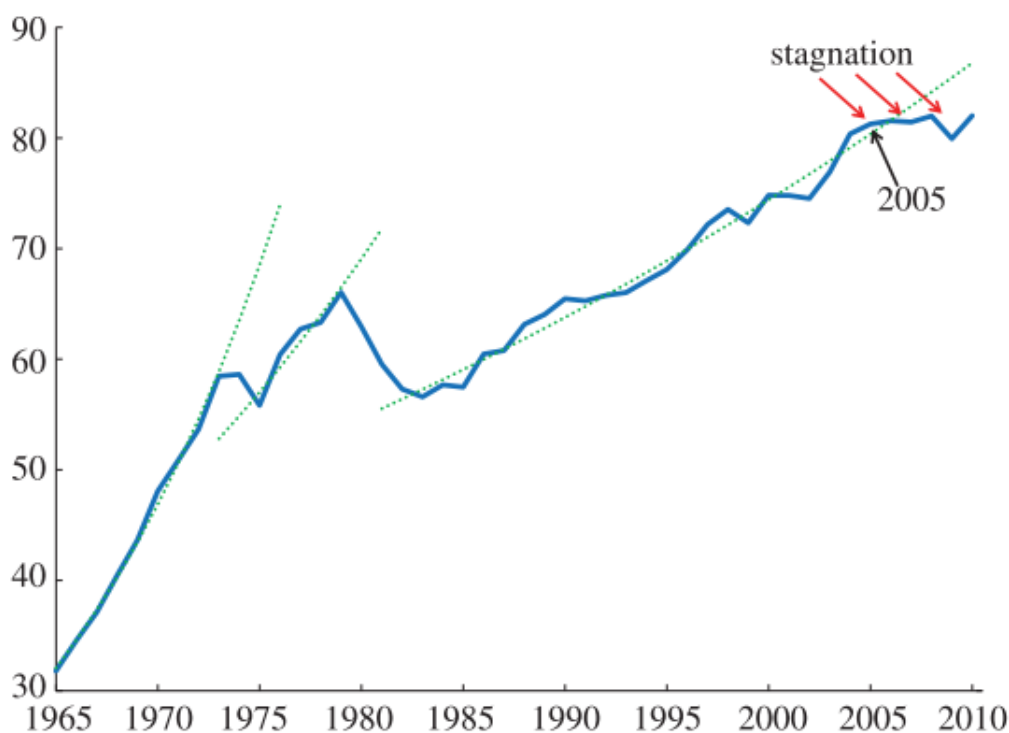


Figure 8 World crude oil production (in million barrels per day), from (Kumhof & Muir 2014, p.2)

The end of growth?

In attempting to synthesise a theory of economic growth which properly accounts for both the role of credit and physical power (energy sources and the technologies to harness them - efficiency), it's important to understand the primacy of energy in the equation. Credit is a social construct, we can, and have, created as much as we want of it, within the parameters of that construct (note Soros' [theory of reflexivity](#)). As Keen and Werner argue, the rate of economic growth will be determined by the rate of new credit creation applied to increasing the productive capacity of the economy. Increasing the productive capacity of the economy requires increasing the physical power supply to the economy, assuming no proportional increase in efficiency. Thus, if this theory is correct, new credit will only drive economic growth when physical power is not the limiting factor. If available low-entropy energy is the limiting factor, then that investment must be directed towards increased energy efficiency.

Per the law of conservation of energy, it is neither created nor destroyed, simply converted from one form to another, with increasing entropy. To use a finance analogy, as a global society, we need to transition from powering that society on our savings (fossil fuels are millions of years of sunlight accumulated into a very low-entropy form) to doing it on our current income, the constant flow of energy from the sun (relatively higher entropy). To extend the analogy, credit allocation determines the direction and pace of the economy, but only when there's an engine and fuel being supplied to it to provide power.

In order for that transition to happen smoothly, the physical power we derive from fossil fuels has to be replaced with low-carbon renewables. Recalling Figure 6 above, Ireland's average power consumption is 17,550 MW. Installed electricity power generation is 7,165 MW of conventional and 2,000 MW of renewables (EirGrid 2014). The renewable figure needs to double to reach our 40% target for renewable electricity by 2020. As typical capacity factors on renewable technologies are a third (or less) of their rated output, Ireland would require 17,550 turbines with nameplate capacity of 3MW (52,650 MW) to generate our current level of power consumption, a 25 fold increase over current levels (a very simplified calculation, large efficiency gains can be made by powering transport electrically). In light of the current protests against development of wind farms in Ireland, the scale of the challenge comes into acute perspective.

Thus, with the advent of a peaking in global conventional oil supply, and any future growth in liquid fuels coming from environmentally unfriendly non-conventionals, such as Canadian tar sands and fracking, we may be entering into a period of energy constrained economic growth (McGlade & Ekins 2014). The transition to electric vehicles is being spurred by rising oil prices and climate change policies, increasing the rate of penetration to off-set higher oil prices suggests a need for innovative policy instruments to accelerate the transition.

Having already introduced two sets of unorthodox economists attempting to introduce a new economic paradigm, I will conclude by introducing a third. As was pointed out in our discussion, there's more to life than GDP. The discourse on alternatives to the 'growth fetish' stem all the way back to the Club of Rome's [Limits to Growth](#), first published by Meadows et al in 1972 (2004), and many non-orthodox economists denounce it in no uncertain terms (Jackson 2009), particularly those within the environmental and ecological economic domain, led by economists such as [Professor Herman Daly](#) (Daly & Farley 2010; Daly & Townsend 1993). They argue that a sustainable economy is

one that doesn't grow, but exists in dynamic equilibrium, living within the limits set by the natural carrying capacity of the ecosystem, governed by the laws of thermodynamics.

A steady state economy is the goal that both Brian Czech and I ended up advocating. But the paths by which we arrived at our common destination were different. I saw things as an economist looking from within the economy outward toward its containing ecosystem. I saw the constraints put on economic growth by the fact that the biosphere is finite, non-growing, materially closed and receives a fixed rate of inflow of solar energy. My problem then was to study ecology and try to integrate it with economics.

Czech, as a wildlife ecologist and conservation biologist, looked from the ecosystem inward toward the growing economy and wondered how he and his colleagues could ever conserve ecosystems and species if the economy kept on growing and absorbing into itself ever more of nature. He concluded that his professional goal was doomed to failure in a world dominated by economic growth. His problem then was to study economics and to integrate it with ecology.

Figure 9 foreword by Herman Daly extracted from (Czech 2013)

By proposing that we give up ambitions for economic growth, either for ecological reasons or because they are imposed by energy limits, I haven't forgotten your point about debt sustainability (see my note to Prof FitzGerald at the ESRI below), nor have I forgotten about the several billion other people on this planet with very legitimate ambitions to live the lifestyle we enjoy every day. The idea that we might choose to destroy our ecosystem so that we might repay our debts has a curious resonance in a country that has experienced the record levels of emigration and economic hardship seen in Ireland since the banking crisis. History is replete with such tales (Diamond 2013).

Given the theories on credit creation presented above, the obligation to repay loans which had no social benefit, indeed, quite the contrary, simply inflated assets prices and concentrated wealth, needs to be legitimately questioned. Indeed, there are those who question whether or not a credit-based fiat money system is socially optimal at all (Benes & Kumhof 2012), specifically because of its requirement for perpetual economic growth (Lietaer et al. 2012).

However, in the absence of economic growth, the focus of public attention would undoubtedly switch to the thorny and politically uncomfortable topic of distribution – the heart of the real challenge we face.

Political Economy of Economic Theory – Is a new paradigm possible?

Thomas Kuhn (1962) argued in his account of the growth of scientific knowledge that researchers operate within generally accepted 'paradigms'. The process of shifting to a new, more advanced paradigm is not necessarily smooth, as the old paradigm is supported by those who have made a career out of its propagation. Lakatos (1970) argued that defenders of the 'old paradigm' (defined by him as a research programme) would adopt 'immunisation' strategies, such as the introduction of ad hoc assumptions, to try to 'protect' their 'core' beliefs against contrary empirical evidence — a practice already condemned by Karl Popper (1968) as unscientific. As the number of inexplicable facts rises ('anomalies', in Kuhn's terminology), the call for a new paradigm should become louder. The new paradigm must be able to explain at least as much as the previous approach and in addition also account for the many 'anomalies' of the old paradigm, thereby encompassing it.

A new paradigm must rise to the challenge of explaining at least the seven central empirical puzzles in macro- and monetary economics:

- (1) *The apparent velocity decline;*
- (2) *the identification problem of money, and*
- (3) *of what makes banks special (while incorporating this feature appropriately into a macroeconomic model);*
- (4) *why there are recurring banking crises;*
- (5) *the ineffectiveness of over a decade of interest rate reductions in stimulating growth in Japan (and a growing number of other countries), and, more generally, the link between interest rates and growth;*
- (6) *the success of the German and East Asian economic models, despite widespread government intervention and use of non-market mechanisms; and*
- (7) *the ineffectiveness of supply-side re- forms (deregulation, liberalization, privatization) in enhancing economic performance in Japan and other countries.*

from Werner (2012)

Thomas Kuhn famously described a paradigm as a coherent pattern of research organized around commonly shared theoretical propositions and models, and a paradigm shift or 'revolution' as the emergence of an alternative framework of common and shared analysis. A paradigm is, however, sufficiently open-ended 'to leave all sorts of problems for the redefined group of practitioners to resolve'

(Kuhn, 1962, p. 10) from Helm (2005)

'a new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it.'

Max Planck (quoted by Kuhn)

To Werner's seven anomalies above, I would add the role of energy in the economy. I came to economics late in life and have learned most of what I know through the eyes of critics of neo-classical theory. Scientists are trained sceptics, theories are only as good as the empirical evidence that supports them, and the brief discussion above highlights several instances where neo-classical economic theory can neither explain nor predict many observed economic phenomenon – the most dramatic example of which being the recent Great Recession, which prompts this work.

Professor James Watson, who shared the Nobel Prize with Crick in 1962 for elucidating the double-helix structure of DNA, has lectured on how the discovery was made. He describes in detail the work of several notable scientists which had just become available before their discovery and how, when they looked at it together, it was obvious what the structure had to be. In contrast, when Einstein published his theory of relativity in 1915, it was sufficiently ground breaking that it took some time for its implications to become socialised among his peers and suitable tests designed. The theory predicted that light would bend as it travels around the sun. When it was proven in 1919 during a solar eclipse, his theory found much wider acceptance. So it should be with Werner and Keen's warnings of a financial crisis, predicted by their theories (Bezemer 2009).

It was not until the Second World War that Einstein's theory found its first practical application, sadly, and much to his dismay, when America chose to put it to use in Japan. It also underpinned the expansion of a civilian energy programme, which subsidised the proliferation of atomic weapons. Watson and Crick's discovery is of such magnitude that we are only now beginning to enjoy, after many years of labour, its fruit in the development of pioneering medical treatments. Although its application in food production remains controversial and bioterrorism is an emerging concern.

There is nothing new to be discovered in physics now. All that remains is more and more precise measurement.

Lord Kelvin, 1900

Some people will be very disappointed if there is not an ultimate theory that can be formulated as a finite number of principles. I used to belong to that camp, but I have changed my mind. I'm now glad that our search for understanding will never come to an end, and that we will always have the challenge of new discovery. Without it, we would stagnate.

Professor Steven Hawkins, 2002 ([Godel and the End of the Universe](#))

It's remarkable to contrast the explosion of scientific discoveries in the early 21st century with the complacency emerging towards the end of the 20th, best expressed by Lord Kelvin above. Fukuyama appeared to express a similar sentiment in the political domain after the collapse of Communism (Fukuyama 1992). The classic archetype of Kuhn's theory of scientific revolutions is the one created by the emergence of a solar-centric cosmology attempting to replace the long-held and Catholic Church-endorsed geocentric theory. It's important to have epistemic theories for the socialisation and social construction of science, and the political economy of ideas (Bénabou et al. 2013). However, the track record suggests it's a multi-generational process to replace paradigms, particularly when the stakes are high. What stakes are higher than the promise of continued economic growth or the existential threat of climate change, two seemingly unstoppable forces pitted against one another?

In the economic domain, we have very serious challenges to resolve, but little time within which to resolve them. In order for over 6 billion, and growing, people on this planet to enjoy the quality of life and energy services that we in Europe take for granted, while not frying our planet in the process from climate change, it is going to require a profound change in how we source and use energy. The IEA estimates the cost at \$500bn a year from 2020 until 2030, double the current spend, which needs to double again after 2030, just to keep us under 2 degrees Celsius warming – the internationally agreed target (Fulton & Capalino 2014). We should note that these projections were prepared using conventional neo-classical economic models.

Meanwhile, our policy advisors and political leaders, grappling with a political body looking for a way out of the current economic malaise, are using economic theories that appear at best flawed, and at worst, dangerous. The public discourse, for the first time since the Great Depression, is only beginning to question again who gets to create and allocate credit, who gets access to energy (which sources?) and physical power (which technologies?), and our perverse obsession with economic growth at the seeming expense of social wellbeing, despite the overwhelming empirical evidence that they must be questioned. They are simply accepted norms, which only now, in the wake of the crisis, do we become aware again that they should be questioned. The stakes are undoubtedly very high indeed.

It's unfortunate that it requires a catastrophe of the magnitude of the financial crisis to create the space for such questions to get the chance to be aired (Homer-Dixon 2008). Thankfully, organisations like INET appear determined not to let a good crisis go to waste.

But although the doctrine itself has remained unquestioned by orthodox economists up to a late date, its signal failure for purposes of scientific prediction has greatly impaired, in the course of time, the prestige of its practitioners. For professional economists, after Malthus, were apparently unmoved by the lack of correspondence between the results of their theory and the facts of observation; a discrepancy which the ordinary man has not failed to observe, with the result of

his growing unwillingness to accord to economists that measure of respect which he gives to other groups of scientists whose theoretical results are confirmed by observation when they are applied to the facts.

(J. M. Keynes, 1936, p. 33)

While I can happily offer economic theories that appear to offer better insight into the nature of the world in which we live, I have very little to say about managing the political economy of ideas so that such a better understanding might be more widely shared, and put to use in a timeframe commensurate with the challenges we face. I must leave that to leaders such as Adair Turner and Michael Kumhof.

To conclude, I believe a fruitful line of further enquiry would be to integrate a compatible form² of Lindenberg and Ayres production functions with Keen's monetary Minsky model, to form an Integrated Assessment Model (Weitzman 2009, p.15). This should point to the role of credit, physical power, and energy efficiency, as determinants of economic growth.

In the absence of such study, I will venture to speculate, on the grounds argued above, that the only legitimate reason to create credit is to invest it in increasing energy efficiency. However, in light of those same arguments, such study could also highlight the significant challenge of achieving economic growth in the face of peak oil and addressing climate change. The question of whether or not we really need or want perpetual economic growth, which presents yet further challenges to both conventional political and economic wisdom, may simply be overtaken by the physical reality of declining oil production and catastrophic climate change. The consequence of which leads one inevitably to question the wisdom of operating a credit-based money system which requires constant economic growth, and more importantly, is highly unstable in an economy not growing fast enough.

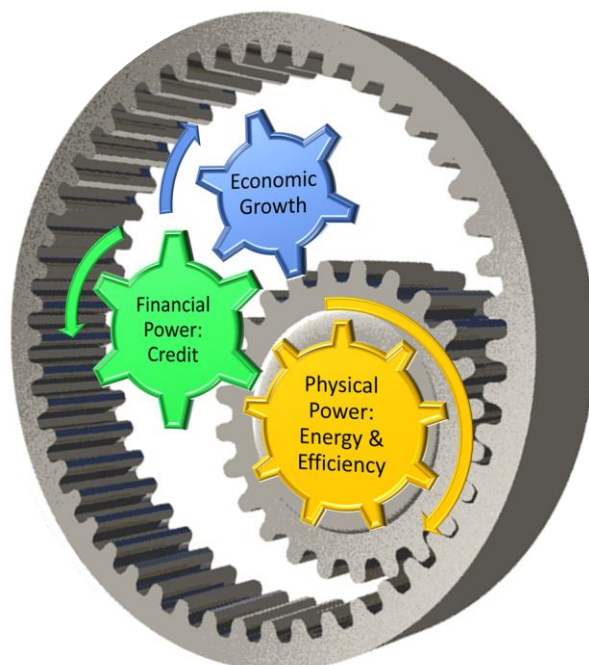


Figure 10 Author's model for powering economic growth in a constrained physical system

² There are commensurability challenges to integrating equilibrium and dis-equilibrium theories. See Hawkins reference above for similar challenges in the physical sciences.

Using that age-old analogy of the economy as an engine, just as an engine needs oil and air to create forward movement, so too the economy needs physical power and credit. We've got an engine that's designed to run on \$20/barrel oil when there's none left, and we've flooded it with enormous amounts of misallocated credit. We need a new clean engine.

I appreciate that I have pushed the boundaries of this discussion well outside the comfort zones of most people involved, but I suspect that is why Brendan invited me.

Kind regards, Richard

*It ain't what you don't know that gets you into trouble.
It's what you know for sure that just ain't so.*

Mark Twain

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The challenge of pushing back the frontiers of science, then and now



Figure 11 ‘Giant’ electro-magnet in Faraday’s Lab, circa 1850

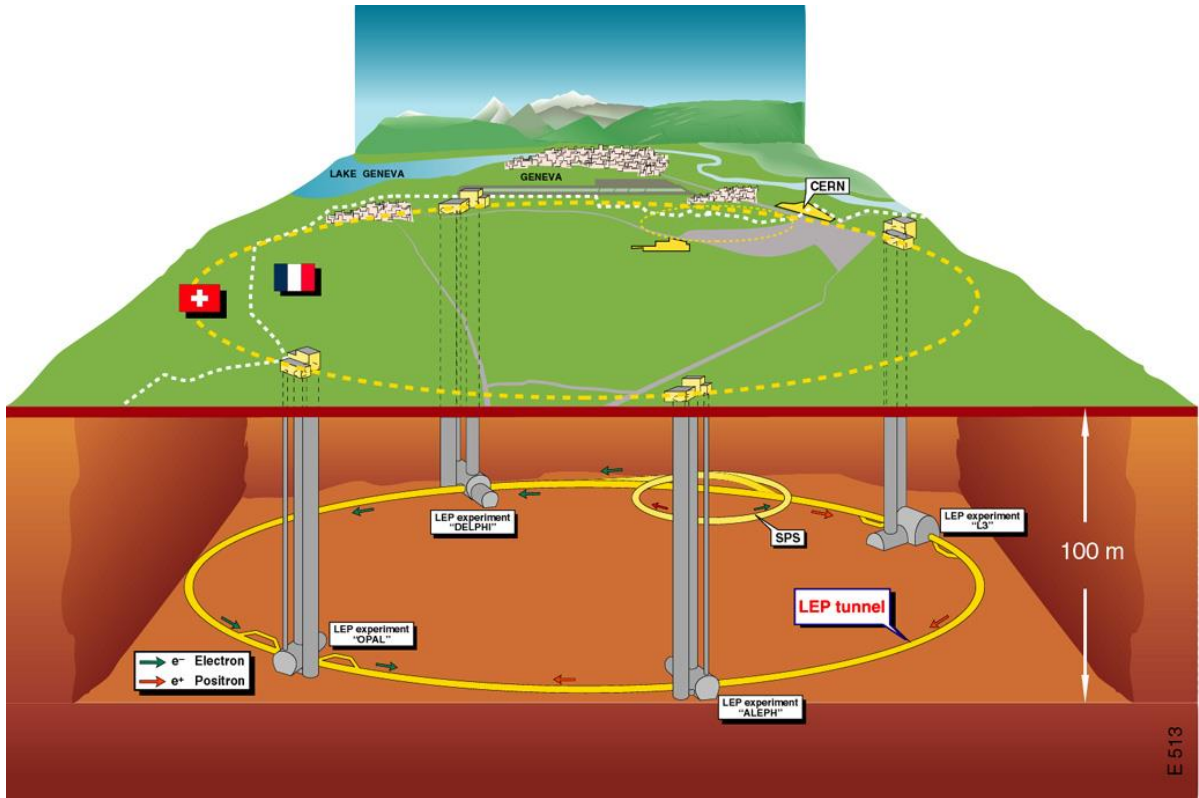
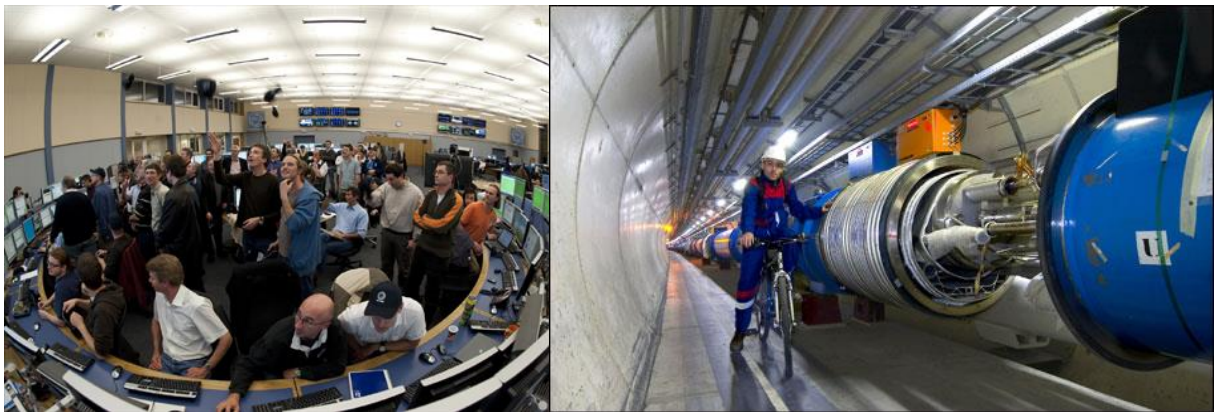


Figure 12 CERN Large Hadron Collider



Date: 2 July 2011 11:20

Subject: IMF Seminar: Ayres-Warr

To: Brendan Halligan brendan@cipaireland.com

Brendan,

Good to catch up yesterday.

Below is the link to the work of (and a video interview with) Ayres and Warr; 'Powering the Economic Growth Engine'

<http://knowledge.insead.edu/TheEconomicGrowthEngine090716.cfm?vid=276>

They do a fairly thorough demolition of the neo-classical economic model in their book.

One of the scenarios in the IMF report is an attempt to adapt their model to a pseudo-Ayres-Warr scenario, and they explicitly reference their work.

Please let me know if I can help in any way with the organisation of this next event.

I was quite shocked to hear that we're losing the renewables debate. If you haven't had a chance to study it already, take a look at Kuhn's '[Structure of Scientific Revolutions](#)'. It's a great read and he argues that new paradigms don't triumph over the old based on rational arguments, because of the incommensurability of competing paradigms, they argue past each other. New paradigms succeed "*because its opponents eventually die*" (p151). Clearly our challenge is that we can't afford to wait that long, and those of the older paradigm are in their 50's and 60's and senior members of our community. Depending on your appetite for environmental policy literature, you might also enjoy Cotgrove's '[Catastrophe or Cornucopia: the environment, politics, and the future](#)'. It was published in 1982, but is probably more relevant today. I interviewed the author for my [masters thesis](#). He's got a great line in the book: "*Modern society is as fraught with conflicts of secular dogma as was medieval society with religious dogma. To acquire a new world view, a change of paradigm, is comparable to a religious experience.*"

Apropos new paradigms, given your economic background, I would also recommend Werner's '[New Paradigm in Macroeconomics](#)'. He too demolishes the neo-classical economic model. Interestingly, he proposes an alternative economic theory in which he hypothesises that economic growth is determined by the rate of money creation, which in a debt-based fiat system means credit creation. Sound familiar? Ayres-Warr's theory implies economic growth is determined by increased consumption of useful energy. Put the two together and, under the current system, you grow the economy by supplying more energy (and/or get more efficient) and get the banks lending. If Ayres-Warr and Werner's theories are more correct than the old neo-classical model, you get a better understanding of our current dilemma: energy supply and lending appear to have peaked. Each is holding back the other. Increasingly expensive energy is making it more difficult for people to service their current levels of indebtedness. Banks won't/can't lend and governments/businesses can't/won't borrow for the alternative energy investments required. Put another way, flat energy supply means no economic growth

(assuming no investment in greater efficiency), while our monetary system requires 2-3% growth per annum to remain stable - an intrinsically unstable situation. Hence my interest in the short term policy instruments to address this issue, which are resilience and finance related. When we get around to organising it I'd like to invite Prof. Werner to participate. He's currently Chair in International Banking and Director of the Centre for Banking, Finance and Sustainable Development in the School of Management at Southampton University.

You can listen to an interview with him about his forecast for the next round of banking crises at the link below (due to sovereign defaults):

<http://www.positivemoney.org.uk/2010/09/richard-werner-talks-of-the-next-banking-crisis-on-bbc-radio/>

I also did an interview with the Positive Money people during the week:

<http://www.positivemoney.org.uk/2011/07/positive-money-podcast-episode-3-peak-oil-and-its-effects-on-the-economy-with-richard-o-rourke/>

Kind regards, Richard

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From: **Brendan Halligan** brendan@cipaireland.com

Date: 2 July 2011 13:07

Subject: Re: IMF Seminar: Ayres-Warr

To: Richard O'Rourke richard@aspo-ireland.org

Cc: Lewis Owen Owen.Lewis@seai.ie, Jill Donoghue jill.donoghue@iiea.com

Dear Richard

Your thoughts are so stimulating that I suggest you flesh them out into a mini essay and offer it to Jill for use on the Institute's website as a blog. PLEASE. I'll follow up your suggestions for more summer reading.

Brendan

From: Richard O'Rourke richard@aspo-ireland.org

Date: 5 October 2011 07:57

Subject: Re: IMF Seminar: Ayres-Warr

To: Brendan Halligan brendan@cipaireland.com

Cc: Lewis Owen <Owen.Lewis@seai.ie>, Jill Donoghue <jill.donoghue@iiea.com>, Colin Campbell <colin@aspo-ireland.org>

Dear Brendan,

You invited me back in July to elaborate on some of the ideas below, apologies that I haven't been able to get to it before now, although in the meantime, I've had the opportunity to clarify further my thinking. The imminent arrival of Kumhof, Ayres, et al, has focused my mind, as has several other conversations and conferences on these matters. I hope the notes below help inform further discussion.

I attended a [conference](#) just last week which helped a great deal in clarifying my thinking on a question that's been on my mind (probably lots of minds) since the banking crisis broke. It was organised by [Prof Richard Werner](#) (a German economist teaching at Uni of Southampton's Centre for Banking, Finance and Sustainable Development). He's someone around which we should consider organising a follow-up to the IMF event next week. He invited [Adair Turner](#), Chairman of the [Financial Services Authority](#) (FSA) and [Committee on Climate Change](#) (CCC), an interesting combination, to address the audience on 'Credit Creation and its Social Optimality'. It's been videoed and I hope to send it to you once it's made publicly available - it's essential viewing. I also recommend you take a look at the New Economic Foundation's new book, which was launched at the conference: [Where does money come from?](#)

Werner's treatise on macroeconomics, '[A New Paradigm in Macroeconomics](#)', is the first economics textbook I've read, and read repeatedly. The second is Steve Keen's '[Debunking Economics](#)'. Having read both, I may be able to spare myself a great deal from the neo-classical canon. Werner explains in academic detail how it is that about 97% of the money in circulation is created by private banks as credit (a fact the standard economic models ignore). This is an idea that has struck me just as hard as when I first learnt of the phenomenon of 'Peak Oil'. Admittedly, it is something Colin Campbell explained to me when I met him first, but it took the financial crisis to compel me to understand it properly. Like energy before, I never gave much serious thought to where money comes from and, I suspect like most people, assumed it was printed by the Central Bank. Like peak oil, this appears to be a phenomenon that was well understood in the past, but our society has unlearned. The extent to which we've unlearned it has unnerved me at times when I speak to bankers and accountants, who get very upset when I try to discuss the topic with them. Much like the oil industry people I tried to talk to about peak oil. I refer you once again to Kuhn's '[Structure of Scientific Revolutions](#)' and [Cotgrove](#)'s quote: *Modern society is as fraught with conflicts of secular dogma as was medieval society with religious dogma. To acquire a new world view, a change of paradigm, is comparable to a religious experience.*

The implications of Werner's analysis are very serious indeed, for Ireland, and the global economy. He presents what he calls a disaggregated credit model for understanding economic growth and distinguishes between credit created for transactions that increase productivity (GDP transactions) versus those that fuel speculation and inflation, and produces very compelling evidence for his case, see graph below. He asks the question, why do we leave it up to private banks to make those allocative decisions? He argues that the power to create credit (the unique power of a bank) is a very important one (arguably the most important one) and, in stark contrast to the agenda of Central Bank independence, he calls for the opposite. He assumes that we can trust our politicians more than our bankers.

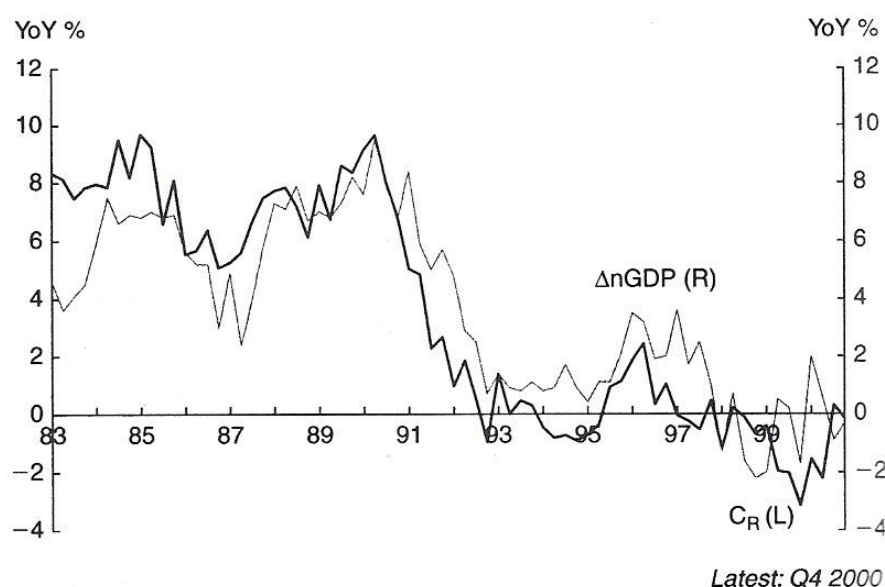


Figure 15.1 Japanese nominal GDP and credit creation used for GDP transactions

Sources: Bank of Japan; Cabinet Office, Government of Japan.

Which brings me to the question I've been trying to reconcile. A study of Ayres-Warr's work, which I look forward to hearing being elaborated on Monday, on the role of energy in economic growth, suggests that energy, largely in the form of fossil fuels, and our technologies to harness it, has been the predominant driver of economic growth since James Watt invented the steam engine - something also omitted from the neo-classical orthodoxy. The negative impact of oil scarcity on the global economy will be elaborated by the IMF on Monday, and the findings from the UK ERC study, also to be presented, on future oil production concluded: *On the basis of current evidence we suggest that a peak of conventional oil production before 2030 appears likely and there is a significant risk of a peak before 2020.*

The news continues to be dominated by our financial crisis, which appears to grow more dire, and the energy security risk highlighted by the UK ERC doesn't even appear to be on the radar. Looking at this situation through the bifocals of Werner and Ayres-Warr makes for an

unpleasant vista when one considers the obvious (to many) alternative vista that is espoused by you and many others - namely that of making the appropriate investment in renewable energy sources while harnessing the many opportunities to significantly reduce our energy demand, so that supply and demand can meet at a place where we can still enjoy dignified and fulfilling lives.

By reconciling Werner's theory that economic growth is driven by credit created for productive use and Ayres-Warr's theory that economic growth is driven by the conversion of energy to useful work, we solve the problem of not only coming up with a necessary and compelling rationale - we've simply got to do it, but also the means of funding the transition to a sustainable society, what might be termed a resilient transformation.

The question remains however, at what point would we be convinced that these theories could be right, and then how would we go about changing the established order of things to get the transition underway. Recalling Kuhn: New paradigms succeed "*because its opponents eventually die*". Sadly I don't think we have that much time.

Hopefully we can discuss further on Monday.

Kind regards, Richard

PS I recommend adding anthropologist Graeber's [Debt: The First 5,000 Years](#) to your reading list.

From: Brendan Halligan brendan@cipaireland.com

Date: 5 October 2011 09:27

Subject: Re: IMF Seminar: Ayres-Warr

To: Richard O'Rourke richard@aspo-ireland.org

Cc: Lewis Owen Owen.Lewis@seai.ie , Jill Donoghue jill.donoghue@iiea.com , Colin Campbell colin@aspo-ireland.org , daithi o'ceallaigh daithi.oceallaigh@iiea.com

Richard

Even more thought provoking than I had anticipated. I repeat my suggestion that you turn this into an essay - it would only take a little editing. Perhaps you might be willing to present your thoughts to our Economists Group?

Warm regards

Brendan

From: **Richard O'Rourke** richard@aspo-ireland.org

Date: 24 February 2012 09:50

Subject: Integrated Assessment Modelling seminar - Dublin, April 17th

To: John FitzGerald john.fitzgerald@esri.ie

Dear Dr. FitzGerald,

I'm writing with regard to an integrated assessment modelling seminar being organised in Dublin for next April, in the hope that you will be able to attend.

Last October, ASPO Ireland and the [Sustainable Energy Authority of Ireland](#) (SEAI) hosted an energy security event at which the principle presenter was [Dr. Michael Kumhof](#) from the research team at the IMF: [Energy Security and Global Economics](#). Prof. Bob Ayres also participated in the event, co-author of '[The Economic Growth Engine](#)'. Dr. Kumhof developed the macro-economic model (GIMF) and ran the oil supply scenarios used in [Chapter 3](#) of the [April 2011 World Economic Outlook](#) published by the IMF. Dr. Kumhof is participating in the [INET conference](#) in Berlin in April and we are using the opportunity to invite him back to Dublin to participate in our seminar.

Last November, ASPO Ireland and the [Institute for International & European Affairs](#) hosted a [talk](#) by Australian economics professor, [Steve Keen](#), on his approach to macro-economic modelling based on a stock-flow model and dis-equilibrium economics (see Keen [1995](#), [2011](#)). Prof. Keen is also participating in the INET conference in Berlin and has also agreed to return to Dublin for our seminar on April 17th. He has worked with [CSIRO](#) to develop an integrated assessment model based on a loose coupling of his purely monetary model with CSIRO's [ASFF model](#), and used it to forecast energy demand and CO2 emissions in Asia and the Pacific region based on different scenarios ([Turner, Keen, Poldy: Integrated Assessment Model](#)).

The purpose of the seminar will be to compare and contrast approaches to macro-economic modelling and best-practices on the theoretical accommodation of energy and banking into those models, with a view to developing policy towards financing the transition to a low-carbon society, while enhancing resilience to the risk of short term supply price spikes and volatility.

The agenda for the day is a morning session among the modelling experts from academia and government, followed by a public briefing seminar at 1:30pm to conclude by 3pm. I'd welcome the opportunity to discuss the event in more detail with you by phone if there's a convenient time.

Kind regards, Richard

From: **John FitzGerald** John.FitzGerald@esri.ie

Date: 27 February 2012 09:35

Subject: RE: Integrated Assessment Modelling seminar - Dublin, April 17th

To: Richard O'Rourke richard@aspo-ireland.org

I am sorry but the team are likely to be occupied that day.

Professor John FitzGerald

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From: **Richard O'Rourke** richard@aspo-ireland.org

Date: 7 March 2012 23:01

Subject: Re: Integrated Assessment Modelling seminar - Dublin, April 17th

To: John FitzGerald John.FitzGerald@esri.ie

Dear Professor Fitzgerald,

Sincere apologies for the delay in responding to you, and many thanks for your reply.

It is indeed unfortunate that none of your research group can be available April 17th, but as it's 6 weeks away, someone's diary may free up in the meantime.

I noted in your [Review of Irish Energy Policy](#) commissioned by the Energy Institute, which had a specific focus on renewables and energy security, that the issue of oil security is not discussed in the same detail as gas or other issues considered in chapter 4. Of note is figure 1 which shows 52% of Ireland's primary energy supply coming from oil and your comment on the findings of Hennessy and Tol regarding electric cars.

I also noted how the Energy Institute in their [report](#), summarising yours and offering their own views on priorities, did highlight oil dependence and included in their conclusion:

Notwithstanding all that has been achieved and intended, oil dependence remains among the most significant long term risks. The risks and an appropriate policy response remain to be creatively communicated and addressed.

- *In relation to oil it will be essential to fully communicate the gravity of the outlook for prices and availability and at a minimum inform the market and raise the awareness of private investors on options.*

In your report '[Recovery Scenarios for Ireland: An Update](#)' (2010), I noted your *Low Growth* scenario assumes an annual average GDP growth rate over the period 2011-2015 of 3.2% (Table 3.2) and the deficit problem arising from this in Figure 7. Interestingly, the HERMES model which forms the basis for the macro-economic modeling approach used at the ESRI was developed following the oil shocks from the Seventies. Notwithstanding the modifications made to the HERMES model over the years to better reflect the Irish economy, it may be prudent to look at the global GDP forecasts produced by Dr.

Kumhof's model to study the impact on the Irish economy of the scenarios he considered. [On a side note, Chris Skrebowski, who will be presenting on [the economics of peak oil](#) on April 17th, notes that people who emerged from the experience of the Seventies' oil shocks warning of the need to reduce our oil dependence were badly affected by the collapse in prices in the Eighties, making them irrationally skeptical of new warnings of shortage. A cure for which may be the UKERC's exhaustive study of the phenomenon of [Global Oil Depletion](#). A contributor to the study, [Dr. Roger Bentley](#), will also be in Dublin next month]

Your colleagues may also be interested in contributions at our event from the research team at [CIRED](#) (Centre International de Recherche sur l'Environnement et le Développement) in Paris. They collaborated with the IEA in their 2007 World Energy Outlook, integrating their IMACLIM-R model with the IEA's World Energy Model (WEM), calling it [WEM-ECO](#). I direct you to two recent publications of note from the group:

- [Peak Oil through the lens of a general equilibrium assessment](#)
- [Climate policies as a hedge against the uncertainty of future oil supply](#)

Finally, while Professor Keen acknowledges in his [Debwatch Manifesto](#) (2012 p32) that in the long run, climate change and peak oil 'will ultimately make the financial crisis look trivial by comparison', the Great Contraction he warns we're currently experiencing is another important factor in the policy analysis and formulation challenge we face. His efforts to integrate his purely monetary model, which has demonstrated powerful explicative and forecasting ability ([Revere Award from RWER](#)), with a physical model, should elaborate further on the question of how to fund the transition to the low-carbon society. The systemic risk that rising oil prices present to our already over-leveraged banking system, not only in terms of depressing macro-economic activity as Kumhof warns, but also in terms of the risk it poses to undermining people's ability to service debt on houses in suburbs that require cars to get them to work, is also worthy of study [[Sexton et al \(2012\)](#); [Dodson & Sipe \(2008\)](#)].

Kind regards, Richard