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Seminar 3: Are economic growth and sustainability compatible?
University of Cambridge, 3 - 4 December 2009

Introductory Lecture: ***'Prosperity without growth?'***
Prof Tim Jackson, Centre for Environmental Strategy, University of Surrey and Sustainable Development Commission

In his opening lecture, Tim Jackson outlined the arguments in his new book on *'Prosperity without Growth: Economics for a Finite Planet'*, focussing on the need for a new ecological macro-economics[1]. He began by setting out the 'dilemma of growth' – that economic growth is unsustainable, at least in its current form, but 'de-growth' (the shrinking of the economy) is unstable because, under present conditions, it would lead to rising unemployment, falling competitiveness and continuing recession. He argued that only a relative decoupling of environmental impact from economic growth has so far been made - for example, whilst world GDP has grown by 50% since 1990, global CO_2 emissions have grown by 40%. To achieve the target of keeping global temperature rise to 2°C above pre-industrial levels would require a 130-fold improvement in carbon intensity to around 6 gCO_2/$ by 2050, for 9 billion people in the world to achieve an equitable income at around current European levels, if industrialised economies continue to grow at 2% per annum, whilst other nations catch up. Even with presumed technological improvements, we have no idea what this sort of world would look like. In the UK in recent years, growth has been driven by the pursuit of novelty for status consumption and increasing (labour) productivity, funded largely by personal debt, which has grown to over 100% of GDP, whilst the household savings ratio has dropped below zero. Tim Jackson argued that a different engine of growth is needed, in order to retain economic stability whilst remaining within ecological limits.

This new engine of growth would be based on ecological investment delivered by ecological enterprise. Ecological investment would target renewable energy and preservation of ecosystems and biodiversity, but would be likely to require lower rates of return over longer periods, and changes to the ways in which productivity and profitability of investments are measured, to move away from a focus on GDP growth. This would be likely to require restructuring of financial markets and a greater role for the public sector. Ecological enterprise would focus on supporting flourishing of people's lives, through low carbon, resource-light and/or non-material ways of people's needs. These 'Cinderella economy' activities would be primarily service-based, and focussed on providing jobs and supporting communities. These would not deliver high productivity growth, as conventionally measured, and so a structural shift would be required into more labour-intensive activities rather than high labour productivity areas, in order to maintain jobs. In turn, this challenges the idea of a consumer society, and implies the need to create an 'alternative' prosperity, based on social and psychological flourishing and the importance of participation. This would require building people's capabilities, and investment in public goods and shared public spaces, which is in conflict with the prevailing values of the current economic

[1] T. Jackson (2009), 'Prosperity without Growth', Earthscan, London.

system. Tim Jackson's key message was that 'another world is possible', but that it would look quite different to the current world.

He ended by summarising the main policy measures, based on these ideas and drawing together a wide range of research:

Establish the Limits
1. Establishing clearly defined resource/emissions caps.
2. Fiscal reform for sustainability.
3. Promoting technology transfer and ecosystem protection.

Fix the Economics
4. Developing the macro-economics of sustainability.
5. Investing in public assets and infrastructures.
6. Increasing financial and fiscal prudence.
7. Improving macro-economic accounting.

Change the social logic
8. Sharing the work and improving the work-life balance.
9. Tackling systemic inequality.
10. Measuring capabilities and flourishing.
11. Strengthening human and social capital.
12. Reversing the culture of consumerism.

Discussion
In the discussion following his talk, Tim Jackson outlined the main responses that he had received so far from policy-makers:

(1) Government doesn't really care about growth.
(2) The analysis represents a failure to see outside disciplinary limits, and a better integration across economy and ecology is needed.
(3) Growth in industrialised countries is needed to help bring growth and poverty-reduction in developing countries.
(4) This agenda would need international agreement to be enacted.

He noted that, whilst there is some merit in these points, they do not seriously detract from his argument.

In response to other questions, he argued that the running out of cheap sources of energy might force structural change in the economy before climate change does, but that the above recommendations would still hold. He argued that conventional economics displays an extraordinary leap of faith in technological innovation to deliver social solutions, and that, whilst technological innovation has an important role to play, social innovation is equally or more important. He agreed that 'getting the prices right' by 'internalising social and environmental externalities' is important, but can only deliver solutions within broader ecological macro-economic reforms. He argued that analysis shows that it is necessary to re-introduce resources (R) back as a factor in the production function, since most of growth comes from this factor rather than a general 'technological progress' factor. In response to a question about the implications for local and regional economies, he argued that a strategy of chasing 'high-end' jobs was bound to fail, and that local and regional governments should focus on creating high socially-valuable jobs.

Session 1 – Compatibility of economic growth and environmental sustainability
'Reconciling Economic Growth and Environmental Sustainability'
Prof. Paul Ekins (UCL Energy Institute, University College London)

Paul Ekins began his talk by setting out the accepted economic principles for sustainable economic growth, and arguing that these were systematically broken by the economic systems in industrialised countries, which led to the crash of 2008. He argued that we must start by getting right the basic conception of how the human economy relates to the natural environment, and that the language of 'externalities' is completely inadequate to understand the dependence of human economic activities on natural systems. The economy is a large and growing sub-system of the biosphere. It is important to distinguish between three types of growth:

- Physical growth: growth in the amount of matter/energy mobilised by the economy - *indefinite growth of this kind is impossible in a finite physical system*.
- Economic (GDP) growth: growth in money flows/incomes/value added /expenditure - *there is no theoretical limit on this kind of growth*.
- Growth in human welfare:
  - *dependent on sustaining environmental functions*;
  - *has a complex relationship to economic growth (though, ceteris paribus, more money is better than less)*;
  - *dependent on many other factors (employment, working conditions, leisure inequality/income distribution, relationships, security/safety of the future).*

Environmental sustainability depends on the maintenance of important environmental functions and the natural capital that maintains them. An aspiration for sustainable economic growth must recognise the need for sustainable use of resources and ecosystems and be rooted in the laws of thermodynamics. Analysis measuring the 'sustainability gap' between present values of key environmental indicators and their sustainable values indicates that, on average, it would take 51 years to bridge this gap at current rates of improvement. This highlights the imperative of delivering absolute decoupling of physical impacts from financial growth. For example, to achieve stabilisation of atmospheric concentration of CO_2 at 450ppm, assuming ongoing economic and population growth (3.1% p.a. real), would need an improvement in carbon productivity (GDP/carbon emissions) by a factor of 10-15 by 2050, or approx. 6% p.a.. This 10-fold improvement in carbon productivity in 40 years contrasts with the 125 years the U.S. took to achieve the same improvement in labour productivity, and would be very hard to achieve within a system in which firms still have a strong incentive to improve labour productivity. The headline conclusion is that sustainable, green growth is technologically and economically feasible, but it would require sustained, wide-ranging and radical policy interventions to bring about technological revolution and change lifestyles. These interventions would be resisted by affected economic sectors (e.g. energy) and households who want to keep current lifestyles (e.g. transport), or attain Western lifestyles.

Climate change presents an unprecedented policy challenge, but the Stern Review set out the main planks of the policy response needed. Carbon pricing, through carbon taxes and/or emission trading is necessary but not sufficient, and also needed are

- Technology policy: *low-carbon energy sources; high-efficiency end-use appliances/buildings; incentivisation of a huge investment programme*; and
- Removing other barriers and promoting behaviour change.

Given that, in a market economy, pricing is key to resource efficiency, investment and behaviour change, it is worth asking – if it was politically feasible to increase resource prices to necessary levels, what would this do to economic growth? Optimists argue that 'costs' are really investments and can contribute to economic growth over the longer term; that 'learning curve' experience suggests that the costs of new technologies will fall rapidly; and that resource efficiency policies can spur innovation, new industries, exports and growth. Pessimists, on the other hand, argue that constraining resource use is bound to constrain growth, since cheap, abundant energy and other resources are fundamental to industrial development. Paul Ekins argued that there is hope for an affordable economic cost, since changes in lifestyle can be achieved at nil cost; improved energy efficiency can be achieved at low or nil costs; and a switch to renewable/low carbon energy can be achieved at a low cost as a percentage of GDP. Supporting micro-economics evidence comes from the greenhouse gas abatement cost curve produced by McKinsey[2], which suggests that a stabilisation target of 450ppm can be achieved through abatement options at negative and low cost below EUR40/tCO_2e. In addition, the Socolow wedges outline a set of technological options for cuts of 1Gt of carbon per year by 2050, and evidence from learning curves shows learning rates of 10-20% for new energy technologies.

In order to estimate the macro-economic cost of carbon reduction, it is necessary to use models that integrate cost data, by combining representations of the energy system and the economy. Good models are 'garbage in – garbage out', in that the outcomes are determined by how rigorous and robust are the assumptions and characterisations within the model. Stern concluded that the expected annual cost of achieving a stabilisation target of 500-550ppmCO_2e would be around 1% of GDP by 2050 (±3%). Work done by Paul Ekins, Neil Strachan and colleagues for the UKERC Energy 2050 Report using the UK MARKAL MACRO model indicated a reduction of GDP of 0.2% to 1.6% by 2050 for a 60% emissions reduction target.

Finally, Paul Ekins reported the results of work that he and colleagues had done on environmental tax reform (ETR) or green fiscal reform (GFR), i.e. shifting of taxation from 'goods' (like income, profit) to 'bads' (like resource use and pollution)[3]. This showed that in countries that had already applied ETR, this had resulted in a 0.3% rise in GDP. Scenarios for meeting the EU 20% carbon reduction target by 2020 showed small GDP changes of +0.6% to -0.6%, rising to +1.0% to -0.3% of GDP, if the effects of innovation are accounted for. In these scenarios, labour productivity goes down, but employment goes up, because more people are employed at a lower income. The work of the UK Green Fiscal Commission showed that changes in world oil prices would be likely to have a greater effect on GDP than changes in energy prices due to ETR, with GDP changes of ±1% to achieve a 15-20% reduction in GHG emissions by 2020. The evidence suggests that ETR would constrain growth unless it led to innovation in low-resource technologies, which it would do so, but this may need to be supported with complementary policies.

[2] McKinsey Quarterly, 'A cost curve for greenhouse gas reductions', February 2007

[3] COMETR: Competitiveness effects of environmental tax reforms, 2007 http://www2.dmu.dk/cometr/; petrE: 'Resource productivity, environmental tax reform and sustainable growth in Europe' www.petre.org.uk; UK Green Fiscal Commission www.greenfiscalcommission.org.uk

Paul Ekins concluded that even a 3% of GDP cost of stringent mitigation by 2030 would only result in a one-year delay in reaching the same level of GDP, assuming a continuing growth track of 3% per annum. There is no evidence that strong action to mitigate climate change will have much higher costs or halt economic growth completely. However, low impacts on growth assume low-carbon technological development consistent with past experience *and* no special productivity improvements from cheap/plentiful/concentrated energy (fossil fuels); *or* technological developments (e.g. fusion) that achieve this in other ways. This raises the questions that if the economic costs are low, why is carbon reduction so difficult politically? He argued that developing and deploying the technologies will require huge investments in low-carbon technologies right along the innovation chain (research, development, demonstration, diffusion), and that financing this investment will require a substantial shift from the UK's consumption-oriented economy of today to an investment economy that builds up low-carbon infrastructure and industries. Hence, it is not technology or cost that are the constraining factors to climate change mitigation, but politics – related to people's attachment to consumption rather than savings/investment, and aspects of high-carbon lifestyles.

'A Green New Deal: Climate change mitigation as an economic stimulus'
Dr Alex Bowen (Grantham Institute on Climate Change and the Environment, LSE)

Alex Bowen began his talk by arguing that climate change is a test case for whether our political system can solve environmental challenges. We know broadly speaking how to break the link between consumption growth and emissions growth. We can lay out the challenge analytically, but so far we can't solve it politically. However, he argued that we can get a long way by applying the theory of public economics properly, as shown by authors such as Kenneth Arrow and Joseph Stiglitz. There is a clear need for stronger environmental policies, to address issues such as biodiversity loss, water scarcity and pollution, all of which are likely to be exacerbated by human-induced climate change. Recent work by Alex Bowen and colleagues at the ESRC Centre for Climate Change Economics and Policy (CCCEP) has examined the effects of the 2008-09 recession on climate change mitigation[4]. This found that historically recessions have mitigated emissions increases, but that, if there are no policies in place to promote climate-change mitigation, the current recession will delay the point at which the world experiences a 2°C global temperature rise by only around 21 months for a typical recession, and by five years for a '1930s-style' recession. There are a number of benefits to early climate-change mitigation action:

- induces innovation sooner (by enabling learning, scale and network effects);
- recognises that diffusion of new technologies takes time;
- encourages action by establishing a credible policy framework sooner;
- reduces the need for premature scrappage of capital;
- enables action to be strengthened if climate change proves more serious;
- provides greater benefits for win-win opportunities.

Recent modelling work suggests that the costs of stabilising at 450ppm would be up to 1.5% of GDP, provided that we do climate policy in a sensible way[5].

[4] A. Bowen et al. (2009), 'The implications of the economic slowdown for greenhouse gas emissions and targets', CCCEP Working Paper 11, http://www.cccep.ac.uk/workingPapers.htm
[5] B. Knopf and O. Ednhofer (2009), 'The economics of low stabilisation: implications for technological change and policy', http://www.pik-potsdam.de/members/knopf/publications/knopf_chapter11.pdf

The key elements of climate change policies are:

- A pervasive and steadily rising price for greenhouse gas emissions;
- The promotion of a shared understanding of what is responsible behaviour for firms and individuals in the face of the climate change threat;
- Tackling the market failures (and policy distortions) standing in the way.

These market failures are well-known and include the under-provision of research and development, inadequate and asymmetric information about how to save energy and the difficulties in establishing new networks for energy supply, such as smart grids. It is understood that these have had little management attention in the past, because historically energy costs have been a relatively small proportion of overall costs. It is also important to address policy distortions, such as fossil fuel subsidies, and to ensure the cost-effectiveness of policy implementation, in order to maintain economic and political support.

The proponents of a Green New Deal argue that the current global downturn makes tackling these market failures easier, as there are lower opportunity costs (temporarily unemployed workers), scope for temporary public spending increases, and potential for a boost to growth through fiscal stimulus. If policy measures are designed effectively, there may be higher benefit from spending on public goods under current conditions. Work by Alex Bowen and colleagues at the Grantham Institute argued for a fiscal stimulus of 4% of global GDP, of which 20% or around $400 billion a year should be focussed on a 'green' stimulus[6]. In fact, over $512 billion or around 16% of total stimulus packages across industrialised countries have been pledged, but this figure is over a number of years. The literature on business cycles can also inform thinking, but we need to be careful about drawing implications from this recession to other business cycles. In particular, effects may vary between local and global, and between open and closed economies. This recession has hit the current generation's welfare hard, but may also have permanently lowered the global growth trajectory. It has also affected the use of 'cap-and-trade' measures to price carbon to the levels needed to promote innovation. He closed by arguing that a better understanding of political economy is needed to understand why climate change mitigation policies are not being implemented strongly enough.

Discussion

In the discussion following the two talks, it was argued that the 1-2% of GDP costs quoted may hide much bigger sectoral and national changes, which are what policy-makers really worry about. In response, Paul Ekins argued that there has to be an enormous shift from consumption to investment, and hence much greater incentives for saving. In response to the suggestion that environmental tax reform would largely just shift carbon-intensive production to developing countries, he argued that this strengthens the need for a global agreement at Copenhagen. He argued that indefinite GDP growth is not an oxymoron, that income is an important part of welfare, and that politicians value GDP growth because people value GDP growth. Alex Bowen argued that a mix of policy measures is needed, to address carbon pricing, technology policy and stimulating behaviour change. Similarly, Paul Ekins argued that a mix of the use of price mechanism and regulatory drivers could stimulate significant technological and behavioural change, as shown by the impact of the fuel duty escalator.

[6] A. Bowen et al., 'An outline of the case for a green stimulus', Grantham Research Institute and CCCEP, http://www.cccep.ac.uk/pdf/AnOutlineOfTheCaseForAGreenStimulus.pdf

Session 2 – Climate policies and long-run drivers of growth
'Relax about GDP - implications for climate and crisis policies'
Prof. Jeroen van den Bergh (ICREA, Univ. Autonomous Barcelona)

Jeroen van den Bergh began his talk by arguing that economics is very confused about the direction of causality between GDP growth and things that we value, such as happiness, reducing environmental pollution, creating employment and technological progress. From a complexity perspective, it is not necessary to understand the full extent of economic complexity, just sufficient insight is needed to design policies and remove barriers. These barriers include (hidden) subsidies, the pre-occupation with growth, vested interests, lack of global government, and free riding (collective action problem). 'Transition' policy to a low-carbon economy is important, but not a substitute for a good pricing policy. There is a need to avoid risk of ineffective policies, which could lead to rebound or leakage effects, and there is no alternative to correct energy prices as an information source, though additional policies may be needed, such as 'unlocking' and education for preference changes.

He argued that 'GDP' is the fundamental problem, not 'growth'. GDP growth is good in some periods/countries, but is not generally necessary or sufficient for progress. We need to better understand why there is persistent political support for the GDP indicator. The shortcomings of GDP as an indicator of social welfare or progress are well-known amongst economists, but its role in economics, public policy, politics and society remains influential – this is the '*GDP paradox*'[7]. Denial of the importance of the GDP indicator by academic economists comes in two forms: (1) a belief that the impact of GDP information on economic reality is modest; (2) a belief that despite its shortcomings, GDP still provides useful information. In answer to point (1), it is clear that economic commentators, politicians and the public pay attention to GDP, and that consumers, firms, investment and governments act in response to GDP information and expectations, creating a self-fulfilling prophecy. In answer to point (2), no study shows that without GDP information, the economy becomes unstable. The alternative indicators to GDP that have been proposed all have their drawbacks, and it is probably better not to have an aggregate indicator at all.

Jeroen van den Bergh made it clear that being against GDP is not the same as being against growth, and that he took a neutral position on the need for growth as that is the logical consequence of ignoring GDP information. However, he argued that the goal of 'unconditional growth' is a constraint on the goal of improving human welfare, as it often frustrates good policy measures that would have direct benefits not measured by GDP. The growth aim is dominant politically, e.g. in the language of economic 'crisis', and ignores informal activities, such as unpaid child care. In particular, climate policy is frustrated by the goal of GDP growth, as economic cost-benefit analyses assume that less GDP growth is a cost.

One solution is to use '*happiness*' as an indicator instead of GDP. It has been established that people's happiness or subjective well-being is delinked from GDP growth above a certain threshold income. This leads to the hypothesis that climate policy will be less costly in happiness terms than in GDP terms. Similarly, the main

[7] J.C.J.M. van den Bergh (2009), The GDP Paradox, *Journal of Economic Psychology* 30(2): 117–135

concern of economic 'crisis' policy should be reducing unemployment as this has tremendous happiness effects. So, an important challenge for economics is to discover how we can get full employment without the constraint of unconditional growth. More work and employment may increase GDP, but this does not imply the reverse causality. The preoccupation with growth acts as a barrier to escaping the crisis by reducing people's confidence in the economic situation.

He concluded with the following recommendations[8]:

- to convince economists to pay attention to the GDP paradox;
- not against growth, but against GDP and unconditional/always growth (what Stiglitz has called 'growth fetishism');
- replace some macroeconomic advisors by psychologists;
- less focus on GDP may make a climate agreement easier to reach;
- less emphasis on GDP in 'crisis policy' means a willingness to trade-off employment vs income growth.

Discussion

In response to the talk, Paul Ekins argued that GDP is a good indicator of income, not happiness, and that lower income would matter to people, but this is not a good indicator of social welfare loss. In response to a question about how 'progress' should be measured, Jeroen van den Bergh argued that, in general, we strive for something – higher incomes – that doesn't make us happy. In response to a question on how to aggregate subjective happiness, he argued that poorer people's happiness should be weighted higher, e.g. by focusing on changes to median income rather than average income. He argued that it was necessary to focus on real, relevant indicators, that may be different for richer and poorer countries, such as the ISEW measure proposed by Daly and Cobb, and that we need separate benefit and cost indicators. In response to a question about why we shouldn't just change the definition of GDP, he argued that we can't hope or wait for a perfect alternative, and that GDP is such a big information failure, we should just get rid of it.

'Energy transitions, general purpose technologies and the challenge of low-carbon innovation'

Prof. Peter Pearson (Centre for Energy Policy and Technology, Imperial College)

Peter Pearson began his talk by raising the challenge of a third, low-carbon industrial revolution, and seeking to understand what we can learn for this from historical energy transitions and policies. How to get there from here means more than just substituting a few low-carbon technologies into existing uses and institutions. Low carbon technologies will need:

- *To be widely used and diffused*;
- *To experience continuous innovation and cost reduction*;
- *To change what we do with them and how*.

These are characteristics of what are called 'general purpose technologies' (GPTs). This suggests a key role for technologies such as smart grids (combining electricity and ICTs), but the historical evidence suggests that such general purpose technologies

[8] J.C.J.M. van den Bergh (2009), Relax about GDP Growth: Implications for climate and crisis policies, *Journal of Cleaner Production* (forthcoming); J.C.J.M. van den Bergh (2009), Safe climate policy is affordable – 12 reasons, *Climatic Change* (forthcoming)

take time to develop, with initially a low rate of diffusion. Their development may be slowed by path dependence, lock-in and sailing ship/last gasp effects, as described below. Moreover, evidence from the 1st Industrial Revolution suggests that relative prices of labour and resources, and access to physical and human resources, are important.

Energy systems are complex evolving entities and transitions involve interactions between fuels and energy-converting technologies; infrastructures; institutions; policy regimes; economic variables; environment and resources; and people. Britain's 1st Industrial Revolution from the 16th to 19th Centuries from a largely agricultural to a mainly industrial economy relied on using a fossil fuel stock (coal) for larger energy flows, which transformed growth and welfare. By 1650, half of the UK's final energy consumption came from coal, but the use of woodfuels took centuries to die out. Despite availability concerns, coal output and mining jobs did not peak until 1913. Economic historians such as Robert Allen have investigated the question of why the industrial revolution happened in Britain first. Allen has argued that the high wages and cheap energy and capital in Britain (compared to other countries) created a real return for labour-saving capital investments, such as steam engines, cotton mills and substitution of coal/coke for wood in metal manufacturing[9]. Work by Roger Fouquet and Peter Pearson has shown a negative correlation between energy prices and energy intensity (E/GDP) over five centuries. Successive technological substitutions have seen the cost of lighting fall to 1/3000 of its value in 1800 by 2000, leading to a 6500-fold increase in lighting use per capita, with high welfare benefits[10]. So, a long-run perspective suggests that new technology diffusion takes time, and that major productivity benefits of new technologies, such as steam engines or electric lights, were only observable decades after they were first introduced. Past transitions were not managed, and modern transitions could be faster, but it still takes time:

- to build new enthusiasm, infrastructure and institutions;
- to escape the shackles of path dependence;
- to overcome 'lock-in' and turn over old capital stock.

Some economic historians have argued that '*general purpose technologies*' (GPTs) have played a key role in past techno-economic transitions. These have three key features:

- *Pervasiveness*: have a broad range of general applications/purposes;
- *Technological Dynamism*: continuous innovation in the technology - costs fall/quality rises;
- *Innovational Complementarities*: innovation in application sectors – users improve own technologies, find new uses.

However, the penetration of a GPT in an economy involves a long acclimatization phase, in which other technologies, forms of organization, institutions and consumption patterns adapt to the new GPT. In this argument, GPTs such as steam engines, internal combustion engine, electrification and ICT raised productivity growth, but this took decades. The 'sailing ship' or 'last gasp' effect argues that the advent of a new technology may stimulate innovation in an incumbent technology,

[9] R. Allen (2009), *The British Industrial Revolution in Global Perspective*, Cambridge University Press
[10] Fouquet, R and Pearson, P J G (2003). 'Five Centuries of Energy Prices', *World Economics*, 4(3): 93-119; Fouquet, R and Pearson, P J G (2006): 'Seven Centuries of Energy Services: The Price and Use of Light in the United Kingdom (1300-2000)', *The Energy Journal*, 27(1)

making it more efficient and competitive, before it is eventually superseded by the successor technology. Estimates from learning curves for unit cost reductions in new energy technologies are often used to estimate the level of learning investments needed to make them competitive with incumbent technologies, but this often neglects the potential for cost improvements in incumbent technologies resulting from 'sailing ship'/'last gasp' effects.

Overall, Peter Pearson argued that the conclusion from the economic historical evidence is that major breakthroughs do affect aggregate productivity growth, but only slowly over a period of decades. It is important to recognize the complex interdependencies involved between technologies, institutions and users. The importance of relative prices and resources also has implications for the relative prices and availability of physical and human resources needed to drive risky low-carbon innovation.

Discussion

In response to a question about what is stopping greater investment in (free) solar energy, Peter Pearson replied that harnessing solar energy is not free, and requires investments in capital, institutions and skills. He argued that low carbon technologies need to demonstrate desirable characteristics at an appropriate price, relative to the price of carbon. He said that lessons may be learned from historical experience, such as the promotion of coal-based liquid fuels in the 1930s, which attracted a coalition of support from industry, government and users. Tim Foxon asked how strong the evidence is for the case made by Freeman and Perez that new (general purpose) technologies are the key driver of GDP growth over the long-term, but that it takes time for institutions to align with the new technologies. Peter Pearson replied that, though there is good evidence, we need to use better measures of the effects of technology than GDP, in order to explain why, for example, the effects of steam power show up so little in the GDP statistics. Finally, in response to a question about what would be the likely effects of using more diffuse energy sources, such as renewables, on industrial development, he argued that this will require innovative activity on energy storage and transmission technologies, in order to be able to harness these diffuse energy sources economically.

Session 3 – Do we need steady state economics?
'The economics of enough'
David Fell (Brook Lyndhurst)

David Fell began his talk by asking why don't people wear hats any more? The social revolution between most men wearing hats and most not wearing hats happened in just one generation, and if we could understand such a relatively simple transition, we might be able to better understand more complicated transitions. He presented his story in three parts:

- *Positive* – what kind of thing is an economy?
- *Normative* – what is an economy for?
- *Prescriptive* – how could we design a better one?

He argued that the economy is displaying typical crises of adolescence, in the form of environmental crisis, systemic inequality and endemic ill-health. A more grown-up economy would be an 'economy of enough', which would involve reforming work, the accumulation of assets, conspicuous consumption and energy habits.

His conceptualization of the economy was as follows. Human societies are complex open systems, in which resources may be finite, but human ingenuity is not. They develop by a process of neo-Darwinian co-evolution, in which the structure of fitness landscapes determines the evolution and emergent properties arise at the macro level. Social networks influence the diffusion of change, and we are beginning to understand the mechanisms, drivers and critical paths. Institutions serve as commitment devices – they were fit for purpose at the point at which they evolved, but they can get locked in and influence other fitness landscapes, and so have power. Individuals have needs, ranging from basic needs to self-esteem, according to Maslow's hierarchy, and current institutions, designed to meet basic needs, may not be good at meeting higher needs.

The evidence for an adolescent economy is seen in the current environmental, social and economic crises. The natural resource crunch means that we are already reaching global environmental limits, in relation to GHGs, oil, water, minerals. Current inequalities and injustice are unlikely to be addressed, whilst the beneficiaries of injustice are at the controls. Evidence of activities harmful to psychological well-being, such as drinking, prescription drugs, recreational drugs, gambling, consumerism, mysticism, prompt the question - what would it mean to be going sane? Co-evolution occurs in and between higher and lower sub-systems with differential fitness requirements, to the systematic advantage of the requirements at higher levels, since larger entities (multi-national corporations (MNCs, Treasuries, academe) progressively shape the fitness landscape to their own advantage. This represents an evolutionary distortion, and calls for maturity, in the form of self-imposed limits, wisdom and choosing enough.

He argued that an 'economy of enough' should address four key co-evolved and inter-dependent areas:

(1) *The nature of work*:
This would move to tasks, instead of jobs, and create space for social entrepreneurs and a shorter working week, say 21 hours;
(2) *The accumulation of assets*:
This would focus on long-term security, through developing civic institutions and the return of trust;

(3) *Conspicuous consumption*:
This would aim to distance 'status' from 'consumption', by changing social norms and admitting fulfilment;
(4) *Energy addiction*:
To overcome our energy addiction would require greater heterogeneity and de-centralisation, and may require governments to take back some power from MNCs.

In closing, he argued that evolutionary concepts, such as Dennett's design space and re-shaping the fitness landscape, could provide powerful tools for understanding socio-economic change. To move away from 'growth' to 'change' requires key performance indicators for economies that are fit for purpose. A much greater emphasis is needed on demand-side management, through transition and coaxing diffusion. The direction of travel is more important than the destination – there are no 'final objectives'. The roles of politics, power and accountability are key, and a debate is needed on 'How much is enough?'. Complexity concepts such as 'emergence' mean that systems are highly unpredictable, and so learning is needed. Finally, the parable of the disappearance of the hat tells us that social change is possible, if we enable it.

'How do we achieve a steady state economy?'
Daniel O'Neill (Sustainability Research Institute, University of Leeds)

Dan O'Neill began his talk by reminding us of the problem – economic growth is a primary policy goal of most governments, but there is a fundamental conflict between economic growth and environmental protection, and economic growth is no longer improving people's lives in developed countries. Economic growth is defined as an increase in the production and consumption of goods and services, and is typically measured using GDP. Most of the growth in the economy has come in the last century – from 1900 to 2000, the population grew 4-fold and per capita GDP grew 6-fold, leading to a 24-fold increase in size of the global economy from $2tn to $47tn. This means that the economy has expanded rapidly in relation to the environment, which provides resource inputs and assimilation of wastes, with environmental impacts strongly correlated with GDP. Technological optimists would argue that we could decouple economic growth from resource use, but so far only relative, and not absolute, decoupling has been possible, e.g. from 1980 to 2005, GDP grew by 116% and material intensity reduced by 30%, meaning that total material use grew by 50%. Also, for incomes above around $9,000 per person, self-reported happiness no longer correlated with GDP increases. These facts suggest that need for a steady-state economy.

A steady-state economy is defined in physical terms as having a stable population; stable per capita consumption; energy and material flows that are minimised and within ecological limits; and constant stocks of natural and human-built capital. It is characterised by:

- *Sustainable scale*: energy and material flows within ecological limits;
- *Just distribution*: reducing inequalities;
- *Efficient allocation*: but only using markets where appropriate;
- *High quality of life*: measured in relation to health, time, prosperity and community.

A model for the Canadian economy by ecological economist Peter Victor suggests that it is possible for an economy to have low levels of unemployment, poverty, debt-to-GDP ratio and GHG emissions, whilst GDP per capita stabilises[11].

In order to achieve a steady-state economy, countries would need to adopt the right macro-economic goal: the Steady State Economy. They would also gradually need to change existing policies from growth towards a steady state, including:

(1) *Limit resource use*: impose strict resource and emission limits, e.g. by imposing a cap-auction-trade system;
(2) *Stabilise population*: births plus immigration must equal deaths plus emigration;
(3) *Limit inequality*: must deal with distribution explicitly, e.g. by imposing a minimum and maximum income;
(4) *Reduce working hours*: shorten the working day, week and year, as technology progresses and efficiency improves, so that people receive the same salaries, but have more leisure time;
(5) *Reform the monetary system*: move away from fractional reserve banking, so that all money is created and spent into existence by the government, and banks have to borrow existing money in order to lend it;
(6) *Reform national accounts*: replace GDP with two sets of accounts: one measuring well-being, to be maximised, and one measuring resource use, to be minimised and kept within ecological limits.

Discussion

In the discussion following the two talks, David Fell replied that he did see some signs of moving away from an adolescent economy, e.g. better work-life balance, social entrepreneurs and some more responsible institutions, but these changes are fragmented, and it is not clear what the tipping point will be. He argued that, just as individual humans co-operate as well as compete, we need to evolve institutions that co-operate. He agreed that there is a need to get issues of inequality back on the political agenda. He also agreed that complexity economics needs to incorporate the latest understandings of co-evolution and 'fitness landscapes' or 'adaptive seascapes' from evolutionary biology. He argued that large organisations have multiple internal and external objectives, but that they could adopt different maximands, as shown by the example of the employee-owned John Lewis Partnership.

In response to questions, Dan O'Neill argued that there would be a larger role for government in a steady-state economy and complementary social change would be needed, but it would still be a capitalist economy. He agreed that there may need to be a complementary shift in the objectives of firms at a micro level. Other participants argued for a need to maintain incentives for innovation within a steady-state economy, and to maintain a balance between the state and the market.

Close

Tim Foxon closed the seminar by thanking all the speakers and participants for engaging and stimulating talks and discussions.

[11] P. Victor (2008), *Managing without Growth: Slower by design, not disaster*, Edward Elgar