



GRESHAM COLLEGE
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Is the party over? Sustainable hopes Transcript

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IS THE PARTY OVER? SUSTAINABLE HOPES

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Good evening Ladies and Gentlemen. This is the first lecture of Gresham College's 2008/2009 academic year and the fourth and final year of my Commerce lectures. It's an honour to open the 410th season for Gresham, so before we start the lecture I reach one conclusion with regard to tonight's title, the Gresham party is not over.

As Gresham regulars know, it wouldn't be a Commerce lecture without a commercial. I'm pleased to announce that the next Commerce lecture will be "It's A Mad, Bad, Wonderful World: A Celebration Of Commercial Diversity", here at Barnard's Inn Hall at 18:00 on Monday, 17 November. I would also like to plug our next Commerce event - this coming Tuesday, 23 September at 18:00 at East Wintergarden in the Docklands, Bill Emmott, the former editor of The Economist, will be speaking on "Asia's Rivals: The Implications For The World Economy Of Developments In China, India And Japan", followed by the Gresham and Universities Superannuation Scheme presentation of the Farsight Award for the year's best long-term investment research report and a reception. Please note that you have to register for the Sir Thomas Gresham Lecture in the Docklands on the website.

An aside to Securities and Investment Institute, Association of Chartered Certified Accountants and other Continuing Professional Development attendees, please be sure to see Geoff or Dawn at the end of the lecture to record your CPD points or obtain a Certificate of Attendance from Gresham College.

Well, as we say in Commerce - "To Business".

Hungover - We've Had A Problem Here

[SLIDE: OUTLINE]

Sustainable economics implies development without depleting natural resources or harming the environment. Can economies grow forever or are there limits to growth? Can capitalism handle zero-growth, or should we expect catastrophic implosion? Will China, India and other developing economies save the world, or destroy it? These are tonight's questions. I hope that tonight's lecture provides you with some inspiration and that all the apocalyptic thoughts I'm about to present don't remind you too much of the lyrics from Prince's song, Party Like It's "1999" - "... when I woke up this mornin, Coulda sworn it was judgment day".

[SLIDE: A THNEED'S A FINE-SOMETHING-THAT-ALL-PEOPLE-NEED!]

"Look, Lorax," I said. "There's no cause for alarm.

I chopped just one tree. I am doing no harm.

I'm being quite useful. This thing is a Thneed.

A Thneed's a Fine-Something-That-All-People-Need!"

[Dr Seuss, 1971]

The Lorax is a children's environmental tale written by Theodor Seuss Geisel [1904-1991], better known as Dr Seuss, in 1971. This short book of 62 pages (but with big type and lots of pictures!) presents "a Dr Seuss fable for the slightly more able". The principal character is a bitter, self-loathing industrialist, the Once-ler, who tells the remorse-full tale of how he so thoroughly destroyed the environment that his own company was ruined. The Lorax is a creature in charge of the environment who speaks "for the trees, for the trees have no tongues". The Lorax is, if truth be told, a rather prissy, know-it-all, and his relationship with

the Once-ler fairly accurately parodies the stereotype of industrialist and environmentalist relationships. The Once-ler explodes at one point:

"Well, I have my rights, sir, and I'm telling *you*

I intend to go on doing just what I do!

And, for your information, you Lorax, I'm figgering

on biggering and BIGGERING and BIGGERING and BIGGERING,

turning MORE Truffula Trees into Thneeds,

which everyone, EVERYONE, *EVERYONE* needs!"

[SLIDE: UNLESS...]

The tale is simple. Having developed advanced Super-Axe-Hacker technology to chop down the Truffula trees to make Thneeds for an increasingly affluent and fast-growing population, the Brown Bar-ba-loots, Swomee-Swans and Humming-Fish leave to elsewhere for food and to escape the smogulous smoke and Gluppity-Glupp/Schloppity-Schlopp pollution.

"Now all that was left 'neath the bad-smelling sky

was my big empty factory"

the Lorax...

and I."

Ultimately, his warnings repeatedly unheeded, the Lorax too disappears "by the seat of his pants" leaving a scene of industrial devastation behind and one word, "Unless". The Lorax is pictured on the cover and throughout the book. The Once-ler is never seen, presumably out of shame. If children from five to eight years old can understand the interactions of the environment, population, consumption and technology in a short story, can't adults?

[SLIDE: TRUAX]

Rather predictably given the nature of the relationship between the thick-skinned Once-ler and the hectoring Lorax, The Lorax was parodied in a timber industry response, Truax, where Truax is to the Once-ler what Guardbark is to the Lorax. Of course in the Truax tale, Guardbark changes his mind about logging and timber products. So now the poor children have two stories to choose from. Is either one right? I've attended a fair few seminars, conferences and debates where the room became polarised between the Loraxs and the Once-lers. Lorax's - hair-shirt greenies who claim that environmentalism and capitalism cannot coexist. Once-ler's - leave-me-alone, I've-got-a-job-to-do, money-to-make, damn-the-consequences business people. Pessimists, optimists, all trying to work out how to share the planet.

[SLIDE: OKAY, HOUSTON, WE'VE HAD A PROBLEM HERE]

We have big problems. Pollution pervades air, land and sea. Our putrefied rivers gleam and boil. Our waste litters landscapes. Our atmosphere warms up while our biodiversity drops down - emblematic polar bears drown in the arctic. Then the facts:

" extinction rates are 100 to 1,000 times their pre-human level, threatening more than 10% of birds and mammals, 8% of plants, 20% of freshwater fish and 5% of seafish. Following the planet's five previous mass extinction events, humans are racking up one for themselves, some scientists estimate that this Holocene extinction event will eliminate half of today's species by 2100;

" 47% of all forests have been destroyed by mankind and "up to 50 percent of the Earth's photosynthetic potential is directly appropriated for human use? [Sachs, 2008, page 68]

" 15% to 35% of mankind's water use is unsustainable;

" one-third of the world's fisheries have collapsed and total global fisheries collapse is projected within the next fifty years

while the seas grow increasingly acidic;

... mankind has more than doubled CO₂ levels and, all things being equal, to stop increasing CO₂ levels we'd have to plant the equivalent of the entire land area of Spain, or two United Kingdom's, every year forever.

To work you up to a crescendo of disgust is only a matter of reciting all that's been ruined or lost till you beg me to stop. If I keep going, you'll find me as annoying as the Lorax. There are good news points of rivers being renewed, of sulfur dioxide and CFC emissions being curtailed, and of brownfield land being reclaimed. There are many good plans to halt or reverse environmental damage from reforestation programmes to moving beyond the Kyoto Protocol. But I don't want to let you, or me, off the hook - mankind has damaged the earth and on present form shall alter the earth substantially, mostly to its detriment, for some time to come. Further, what we're losing is irreplaceable. We can't yet build a spaceship to take people to Mars, as we are unable to build a closed biosystem that can last three years. We still don't understand our own ecology, and we can't escape.

[SLIDE: FEED THE WORLD FROM A FLOWERPOT]

I don't want tonight's lecture to get bogged down in a litany of scary factoids. Since the time of Malthus the debate has been between those who believe that mankind can cope with growth and those who, like Malthus, predict that population growth will lead to scarcity and, ultimately, a world in which we wouldn't want to live. The absurdity of some optimistic growth equations is lampooned in a slide that used to do the rounds of Economics departments.

Environmental Identity

"Assuming constant returns to scale and infinite sunshine, then with fixed inputs of a flowerpot & soil, and variable inputs of seeds, fertilizer & water, one farmer could feed the world from a flowerpot." This economic witticism illustrates the law of diminishing marginal returns. In real life, adding more and more seed, fertilizer and water to fixed inputs of soil results in decreasing returns to scale. Kenneth Boulding pointed out, "Anyone who believes exponential growth can go on forever in a finite world is either a madman or an economist." [http://en.wikipedia.org/wiki/Kenneth_E._Boulding] Environmental sustainability is a tough equation.

I'd like to introduce you to one scary simplifying equation around which we can structure tonight's talk, I-PAT. The I-PAT equation has its origins in a 1970's debate among the ecologists Paul Ehrlich, John Holdren and Barry Commoner. Their arguments were whether population growth or post-World War II production technologies were more responsible for environmental degradation. Ultimately, various academics have used the resulting I-PAT equation as their jumping off point for musing on environmental futures.

[SLIDE: GET IT DOWN PAT!]

Now, you'd expect after 21 Commerce lectures on the importance and subtlety of measurement, that I'd obsess over a measure of environmental impact, and you'd be right. The terms of the I-PAT equation are I (environmental impact), P (population), A (affluence or consumption) and T (technology). Basically, as population and affluence grow, the environment will increasingly degrade. Commoner pointed out the importance of technology resulting in I-PAT. I-PAT is the jumping off point for many academics and forms the accepted core for much work, including that of the Intergovernmental Panel on Climate Change (IPCC). Let's start examining I-PAT with the term P, population.

Population

[SLIDE: ELEPHANTS EVERYWHERE]

The "elephant in the room" or "elephant on the table" is shorthand for an issue that everyone knows but wishes to ignore despite its significance. I've noted before that "the elephant in the environmental sustainability room is population". Martha Campbell claims, with some justification that "the population-environment connection has become a taboo subject", "too sensitive".

[SLIDE: OUT OF CONTROL]

Today's world population is estimated at over 6.7 billion people. This graph shows you the exponential nature of that growth.

Someone once asked me, "what would Jesus have paid for environmental sustainability?" Well, at the time of Jesus there were only 170 million people on the entire planet, so not a lot. It took millennia to reach 1 billion people in 1800. Having spent most of the past two millennia growing across the planet, population growth in the last century has been made possible by medical advances and the Green Revolution. The exponential growth imperative of a single species, "go forth and multiply", meets the boundaries of the biosystem in a huge clash.

[SLIDE: IN MY LIFETIME]

123 years to double to 2 billion, 33 years to get to 3 billion, and we've been adding about a billion people in just over every dozen years since 1960.

Two points are often made about demographic forecasts, one is that they are frequently wrong. The second is that among forecasting professions, demographers are the most accurate. William A Sherden assesses population forecasts as "a lot of accuracy, but not much skill". While it is easy to cite predictions that have failed to arrive, from Malthus in the late 1700's to the neo-malthusian Club of Rome and their *Limits to Growth* in the late 1960's and early 1970's, the Club's prediction of non-renewable resources becoming scarce and costly causing industry and agriculture to decline around 2010 is starting to look prescient.

I was born into a world with about 2.75 billion people and today that number is 250% higher. The highest rate of population growth was in 1963, 2.2%. Current net growth is about 1.1%. That's still about 75 million people net added per year, over 200,000 net people added per day. Overpopulation of any species is when the population or projected population exceeds the carrying capacity of an area or environment. If we're not there yet, look to the future.

[SLIDE: CROWDED FUTURE OR STATE OF NATURE...]

The United Nations Population Division ran some forecasts to 2300 AD using different total fertility rates. Today's global total fertility rate is 2.3. A fertility rate of 2.0 or lower implies a shrinking population. The UN estimates that population will peak at 9.2 billion in 2075 based on the critical assumption of a world total fertility rate of 2.0 by about 2050. More optimistically, with a fertility rate of 1.8 the world population in 2300 would be about 2.3 billion. However with a total fertility rate of 2.4, then the world population would be about 36.4 billion in 2300. A benign or bleak future completely depends on a sensitive 0.6 difference between 1.8 and 2.4.

[SLIDE: DEMOGRAPHIC TRANSITION?]

However there are two rays of light. The first is that the total fertility rate does seem to be dropping. UN forecasts before 2000 were for 12 billion in 2050 rather than 9.2 billion in 2075. The second glimmer is Warren Thompson's 1929 theory of demographic transition to explain the inverse correlation found between wealth and fertility within and between nations. He postulated four economic stages running from pre-industrial to developing to developed to mature, accompanied by population growth rates of subsistence, growing rapidly, stationary and declining. Some economists even propose a fifth, post-industrial, service-based economy with more rapidly declining populations. This slide of UN projections would appear to support the demographic transition theory as increasing wealth seems to result in population stabilisation and decline. Back in 1974 Karan Singh, a former minister of population in India, summarised demographic-economic transition - "development is the best contraceptive".

[SLIDE: WORLD POPULATION 2050]

This cartogram reflects the UN forecasts for 2050 which assume that total fertility rates will drop a bit. If we return to our I-PAT equation after this brief population discussion, we see our environmental impact in 2050 is very likely to be 50% worse. Let's turn to the second term in our I-PAT equation, affluence.

Affluence

We discussed a number of points about affluence and the pseudo-disease affluenza when we covered fads and fashions last December. What we didn't cover then was the enormous consumption gap between various parts of the world, at least when measured in GDP per capita. Affluence has rocketed. In 1950 there were 50 million automobiles. In 2008 there are 800 million. Goldman Sachs coined the term BRIC economies, Brazil, Russia, India and China. The world's average person is at

roughly Chinese levels of consumption. Currently the BRICs combined economies are less than 15% of the G6. Goldman Sachs estimate that, "if things go right", by 2025 the BRIC economies could account for over half the size of the G6 and by 2050 could be larger. To get an idea of the potential impact, if the average number of flights per person in the UK was applied by China in 2020 the implication is over a tenfold increase in global air traffic during the next decade or so. [Bruce Lloyd from Shaping Tomorrow's Foresight Network, 3 July 2008 - <http://shapingtomorrowmain.ning.com/forum/topic/show?id=933669%3ATopic%3A65138>] Perhaps another 800 million automobiles.

[SLIDE: DYING PLANET?]

Studies by the Millennium Ecosystem Assessment and by the United Nations Environment Programme have highlighted concerns over the depletion of natural capital, with more than half of the "ecosystems services" provided by nature being used unsustainably. WWF and Bioregional, in their One Planet programme, have come up with an evocative way of measuring increased affluence. Instead of asking whether the glass is half full or half empty, they wonder how large is the glass. They argue, and I have no reason to disagree, that we effectively exhausted the planet's environmental capacity to support current human lifestyles around the 5 billion person mark, about 1985. If everyone on the planet today lived at European levels of consumption, we would need three planet Earths. If everyone on the planet today lived at USA levels of consumption, we would need five planet Earths. Obviously, it's easiest to blame the rise of the east or the south for our future problems, but something like a quarter of China's carbon emissions are, according to the Tyndall Centre, produced in exports to the West. At the moment, it's Westerners who are unsustainable.

[SLIDE: KUZNETS' CURVE - INEQUALITY]

Again, there are a couple of rays of hope. Simon Kuznets, a Nobel prize winning econometrist came up with an inverted U-shaped curve to explain why as GDP per capita rises inequality increases. But after a particular point of industrialisation and urbanisation, economies become knowledge economies of increasing equality. A number of anthropologists would claim we went through a Kuznets' curve on development in that hunter-gatherers who survived infancy had a better life than early farmers and not until the post-industrial age did living standards for exceed hunter-gatherers. Kuznets' original curve is subject to some debate, but there is a widely touted environmental variant.

[SLIDE: KUZNETS' CURVE - POLLUTION]

The environmental Kuznets curve is also an inverted U-shape where as GDP per capita increases environmental pollution increases. But after a particular point of wealth or standard of living people start to care about the environment and things get cleaner. There is some empirical evidence for direct pollutants decreasing with increasing wealth, but the evidence is weak or inconclusive for biodiversity, natural resource depletion or carbon emissions. A bit like applauding the drop in the total fertility rate while population continues to rise, we see the rate impact decreasing, but environmental impact continues to rise. After a point, the rate of energy intensity per additional unit of GDP drops, but this may not be due to better technology - it may be due to people above certain levels of affluence valuing items that have less energy intensity, e.g. services such as massages or information or games. The ratio of energy per additional unit of GDP has fallen in most developed countries, but total energy use still rises.

A second, exceedingly small, perverse ray of hope is that our numbers are wrong. Much of our analysis depends on national accounts. There has been justifiable criticism for decades that national accounts do not take account of resource depletion, as Hermann Daly warned the World Bank in his departure speech, "stop counting the consumption of natural capital as income." National accounts depend on GDP, but GDP is only a proxy. Ekins 920000, pages 56-58] points out that you can measure biophysical throughput, production, economic welfare and environmental growth, and GDP is only a poor proxy for the first three. Kuznets was instrumental in helping the US Department of Commerce develop GNP in the 1930's but he criticised GNP as an proxy for standard of living, pointing out that "the welfare of a nation can scarcely be inferred from a measure of national income". GDP does not take account of the social costs of maintaining environmental quality. On the one hand, dealing with natural disasters increases GDP. On the other hand, many activities that reduce harmful consumption, e.g. local electricity production & consumption or voluntary work or open software movements, reduce GDP. If we had a well-maintained environment and a lot of people living sustainably off the land we might reduce GDP markedly. While I concede that this hidden utopia is improbable, it equally points to future analytical problems in measuring affluence using GDP or even PPP.

[SLIDE: PPP WEALTH 2002]

If we return to our I-PAT equation after this brief discussion of affluence, we can see that, based on everyone reaching European

standards of living by 2050, increased affluence worsens our environmental impact by 300%. When combined with slightly optimistic population growth we expect things to be 450% worse in 2050. If we had used USA figures for target affluence, then 750% worse. If we imagine that the Kuznets curve idea is correct, then we could introduce another affluence term that might change things markedly, i.e. sacrificing consumer affluence for a better environment.

Technology

[SLIDE: TECHNOLOGY ENABLED]

Turning to the third term in our I-PAT equation, technology, we truly see a Janus term. Technology is good, technology is bad. It is difficult to measure technology's impact on the environment, so the surrogate used is normally something to do with energy intensity per unit of affluence. We saw that affluence based on GDP per capita is a bit unsteady, well so is energy intensity. Population and affluence are easier to research than T. As expressed in the I-PAT equation T is the "residual", everything that impacts the environment that is not population or affluence.

Technology has enabled population growth and increased affluence. I've noted elsewhere that the aberration when you look at a chart like this is that a bunch of naked apes in northern Europe and north America have spent the past 500 years increasing affluence because they haven't had to pay the environmental costs of doing so, with today's hot topic being carbon emissions from fossil fuels. Arguably carbon neutrality in a lower population world would involve mankind moving back to the tropics. But carbon is only one part of environmental damage. There are numerous other technological externalities we should account for, such as mineral extraction limits, biodiversity losses or even noise pollution. Much environmental impact could be "internalised" to the economy. The success of sulphur-dioxide internalisation has led to carbon-dioxide internalisation which, in turn, if successful will lead to many environmental issues being internalised to the economy, i.e. charged for. It is a reasonable assumption that in future, as we get more crowded, many more things will be internalised.

[SLIDE: ENERGY USE]

On the other hand, if technology has created some of these problems, perhaps it can solve them. A lot of scientists and inventors hope to find a "silver bullet", i.e. a technology that will eliminate or scrub carbon dioxide emissions, or clean polluted seas or remediate polluted land or generate energy without environmental impact. There are technologies we are unsure of, ranging from genetically-modified organisms, to new contraceptives to nuclear fission to fusion to carbon capture & sequestration that have the power to do enormous harm or good. Equally, technologies exist, such as nuclear weapons or tar sand exploitation, that might have seriously detrimental effects on the environment. Many environmentalists decry counting on future technological improvement, "techno-fixes". For them, controlling population and reducing consumption take precedence over waiting for technology to cure things. For some environmentalists it is an article of faith or ethics that behaviour must change so that people take responsibility for their actions as well as rely on improved technology; others rightly question whether techno-fixes exist or will be invented-for-the-rescue in time.

If we return to our I-PAT equation after this brief discussion of technology, we can see that the jury is out on technology. So I've introduced another up/down indicator.

Impact

[SLIDE: THE GODWHALE]

The observant among you will have noticed that I kept "impact" till last. How bad does it have to get before we really do something? In 1974, TJ Bass published a book, "Godwhale", another science fiction story about a distant future earth. The seas have died. A lone bio-mechanical harvester, half-whale/half-robot, roams the seas alone. Back on land the population hits 3.5 trillion. Only two orders of magnitude above the 36 billion in the UN's 2300 disaster scenario. 23,500 people/km² or 50,000 people/mile² or 235 people/hectare. In comparison, London's population density is just under 50 people/hectare. But Mumbai already exceeds the Godwhale scenario with just under 300/hectare. Civilized Seoul is over halfway there with 167/hectare. The 3.5 trillion were living but, as you'd expect, not as we'd know it. Recycling their waste and body parts, eating processed goo, living in cramped quarters under a brutal dictatorship. Battery people. We don't want that, but people have gotten used to a lot of things.

So we have to define and measure impact. There are many dimensions of impact. In a London Accord paper Alice Chapple of Forum for the Future points out that "while climate change is understandably the overriding concern at present, we are in

danger of making investments in unsustainable and commercially unviable options if we focus only on the immediate impact on carbon and fail to recognise the wider sustainability of the abatement measures being proposed." [Chapple 2007, pages 6-7] By focusing on one dimension, such as climate change for biofuels, other sustainability problems pop up, such as the loss of food-production. As no energy source will be free from negative impacts, Alice recommends a balanced assessment of natural, human, social, manufactured and financial capital.

A general definition of sustainability might be the capacity to maintain a certain process or state indefinitely. However, this would imply no change and no expectation of change. The seventh of the eight United Nations Millennium Development Goals is "Ensure Environmental Sustainability". Our definition of impact must equal our definition of sustainability. If we want to be sustainable forever, then impact must be zero.

[SLIDE: GEO-LOGIC ECO-LOGIC]

Think about this for a moment - sustainability on geologic time scales. We couldn't mine anything or dispose of anything unless it was on geologic time. As your fingernails grow at about the same rate as continental drift, we're talking about millimeters per year of landfill. Just enough permitted waste per annum that over a few million years the landfill returns under pressure to rock we can mine for the minerals and metals we failed to recycle. There is no point in talking about stabilizing carbon emissions; if we start today we have to eliminate them and accept that we might emit miniscule amounts again in a couple of hundred years or so when the historic CO₂ of the industrial revolution starts to be reabsorbed. In China last year I heard a great argument. Clearly the West with just under 1 billion people has accepted going up to nearly 400ppm of CO₂ for the past century, 120ppm above the historic natural rate for the past 10,000 years of 260ppm to 280ppm. Given that the West has used that 120ppm zone for a century, the West should be obliged to scrub 120ppm from the atmosphere so the Chinese can have their century using that zone and then, honest, they'll take their 120ppm out for the next lot to rent.

Dr Gro Brundtland's forward to the World Commission on Environment and Development's (the Brundtland Commission) report of 1987 "Our Common Future" is frequently quoted when referring to society's changing expectations - "What is needed now is a new era of economic growth that is forceful and at the same time socially and environmentally sustainable." Brundtland's report provides a working definition of sustainable development as, "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Brundtland's definition permits us to take future capabilities into account. We have to use our own judgement, for better or worse, to anticipate what future generations need and what they are able to do. It's not the definition with which I have trouble; I have trouble trusting my fellow man. We have a terrible record on inter-generational transfer. You need look no further than the immense under-funding of pensions. That's just money. But future generations are supposed to trust us on carbon emissions, cleanup costs and nuclear power. We don't really know what burdens we're imposing. We also have a terrible record on predicting either technology or economic growth over long periods. In sum, we don't know what future generations need nor of what they might be capable - and I don't trust us to decide.

Sustainable Future?

[SLIDE: MEMENTO MORI]

Ultimately, we have to decide on our own probability of extinction. Sustainability does not equal eternal life. We have to accept risk. We can choose to operate in such a way that the probability of going extinct is something like a 1 in 100,000 year or 1 in 1,000,000 year chance of collapse, but we need to make that choice. Setting the risk of collapse is not easy. We believe that complete ruin is rare, or we wouldn't have a post-apocalypse film industry in "On The Beach" or "Planet Of The Apes" or "The Omega Man" or "I, Legend". The Long Now project struggles, in quite interesting ways, to build a clock that would last just 10,000 years without intervention. Who is really comfortable with measures such as a 1 in 2,000,000 year chance of collapse or its tiny probability of 0.00005%? At these extremes we have to use models for which the data is extremely incomplete. Even if the past were a good guide to the future, our history of the past 2,000 years is patchy, let alone the 20,000,000 years we might want as data to feed a 2,000,000 year estimation model. As mankind has grown increasingly able in the last century to devastate the planet, our social discount rates haven't kept pace. As I mentioned in last year's Stealing The Silver lecture ["Stealing The Silver: How We Take From The Dispossessed, The Poor And Our Own Children", 12 November 2007 - <http://www.gresham.ac.uk/event.asp?PageId=4&EventId=641>] when people attempt to estimate utility discount rates (also known as the pure rate time preference) they often arrive, as does HM Treasury, at an estimate around 1.5%. Because people die, and the average annual death rate for adults is about 1.5%, this is not a surprising number. But it doesn't bode well for our

commitment to investments beyond one generation.

An often unremarked point about true sustainability is that we shouldn't make a permanent physical impact. Cultural impact perhaps, but physical impact no. Yet we do invest vaingloriously in the long term physical impact. A bit like Shelley's Ozymandias we want to make a mark - visible from outer space - whether it's pyramids or palms. I'm reminded of comedian Bill Bailey's quip about insurance, "your policy is riddled with theological inconsistencies".

Ultimate Solutions

[SLIDE: HORSES OR ELEPHANTS?]

So what are the solutions? More colloquially, are there any ways out? Some would turn from mankind to the macabre, the four horsemen of the apocalypse - death, famine, war, pestilence. When you think about the thousands of species, possibly over 100,000 per year, that go extinct, it's ironic to realize that the extinction of just a single species would solve the sustainability problem. Robert Socolow talks about needing seven wedges of change to avoid climate change. One wedge is biofuels taking up one-sixth of the world's farmland. Bright Princeton professor? Pah! I can solve climate change with just six wedges, all of them biofuels. In discussion I sometimes feel that a lot of environmentalists, even atheists, would welcome divine retribution. Let mankind pay the price with extinction.

Last week's Telegraph reported that William Hill celebrated Man's continued existence by taking £119 from punters at 1,000,000:1 on a bet that 10 September 2008 would be the end of the world as CERN's Large Hadron Collider was switched on - though without using advanced quantum physics I can't figure out how the punters might have collected their bet. Until recently, given SARS, HIV and avian flu, my money would have been on the pestilent horse not black holes, though lately with biofuels the famine horse has been coming up the inside. If there are any bookies in the audience who can prove to me that they'll pay up after the extinction event, perhaps we can make a book this evening.

There are dreamers who think that if we can just survive long enough we might reach to the stars, a bit like the recent Wall-e film, but I'd just as soon put my money on aliens saving us. Others count on government. Government has a poor record on the environment, as was well-demonstrated in eastern Europe. Though so does industry. Government has a poor record on sustainable finance, or 80% of the UK population in the private sector wouldn't be paying more towards the other 20%'s pension payments in the public sector than they save for their own. But then industry also has pension problems and can hardly hold its head up this week on "sustainable" finance. A sustainable financial system is likely to require more reserves, and more secure reserves. We can foresee increasing demands for low social discount rates for major environmental projects clashing with higher reserve requirements and tight money. Interest rates could rise massively leaving a gap in long-term funding, unless savings rise remarkably.

There is a real and genuine role for government, particularly in policy that makes markets work. One tough spot is biodiversity. Biodiversity is a good portfolio component. It gives us options. But we've failed to find a way to make biodiversity pay as a financial investment. Here there is a key role for government in the protection of raw land, e.g. set-aside or reserves or sanctuaries or corridors to protect biodiversity and give us future options. Though I agree with the Canadian environmentalist Dr David Suzuki's objection when he points out that, "the famous Brundtland Commission report Our Common Future which came out in 1987 coined the phrase 'sustainable development' and called for the protection of 12% of the land in all countries, a target which has absolutely no scientific basis and yet which very few countries have managed to achieve. But we are one species out of 15-30 million species on the planet and setting a target of protection of 12% of our land base for all the other species means that we seem to take it for granted that we can take over 88% of the land." Finally, when we are certain about what needs to be done, then Hardin and others are right to consider government coercion.

Still, given that I'm predisposed to avoid a human extinction event, I'd rather put my money on the four elephants on the back of that turtle that could drive a sustainable world - population control, changes in what we mean by affluence, new technology and price. On population control there is still great scope for driving down the total fertility rate. The availability of fertility control is still low in many countries, even illegal in many. Cultural change can help. Moreover, increasing affluence and confidence in affluence leads to declining total fertility rates. Remember that the UN had one scenario where world population in 2300, if we survive that long, was back to 2.3 billion, below the estimated carrying capacity of 5 billion.

Be Aware, Be Very Very Aware

[SLIDE: MAKER'S MARK]

But before we can address affluence, technology and price, we must confront what started this lecture, a presumed belief among environmentalists that the market system won't work and among free-marketers that things don't need to change much. For the environmentalists, Alastair McIntosh is a poetic and forceful writer, "At the end of the day, I don't believe that 'green capitalism' is the ultimate solution. I think that capitalism carries an intrinsic selfish dynamic that militates against right relationship with one another and the Earth." [McIntosh, 2008, page 74] Hackett reinforces this, "Market systems that are largely responsible for generating the wealth and cleaner production technologies enjoyed by high-income countries also reinforce the consumer culture and the problems associated with unsustainable consumption in the industrialized world."

I agree with Alastair that many changes are needed, from increased awareness through to cultural change. The Lorax leaves behind one clue, the word "Unless", which the Once-ler interprets as:

"UNLESS someone like you

cares a whole awful lot,

nothing is going to get better.

It's not."

Awareness programmes matter and are a good place to start, but they run into the sand rather quickly. In France, there is a movement called *décroissance* ("decline" or "ungrowth") that questions the sustainability of continuous economic growth. In 2006 the Sustainable Development Roundtable concluded that consumers were ready to be led a bit towards sustainability, but only if everyone else came along, "I will if you will". In 2007 Ipsos/MORI research concluded that, "the public is torn between competing and conflicting mindsets. As citizens they want to avert climate change but, at the same time, as consumers they want to go on holiday, own a second home, a big car and the latest electronic goods. They acknowledge their collective responsibilities but guard jealously their personal rights and freedoms." [Downing and Ballantyne, 2007] There is potential to move some of the affluence variable from increasing environmental impact to decreasing environmental impact, as shown in the revised equation with A (up arrow). For example, some people now pay voluntarily for carbon offsets, despite doubts about their efficacy. Economists have always recognized the centrality of sustainability. As I pointed out in an earlier lecture, in 1939 John Hicks defined income as "the maximum amount that could be spent without reducing real consumption in the future", i.e. sustainable.

On the other hand, a lot of free-marketers, or perhaps those who don't want to change the status quo, would find a strange sleeping partner in the President of France, "We haven't got to choose between saving the planet and growth. We need to have growth and save the planet. So we need a growth that consumes less energy and fewer raw materials. A new economy must be invented." [Sarkozy, 24 September 2007] I have to agree with the Wikipedia view, "In reality, sustainable development has tended to mean nothing more than ecologically more sensitive growth - a slightly reformed status quo." [Sarkozy, 2007] Free-marketers have waited, sometimes irresponsibly, for society to internalize the worst externalities. In fairness to them though, society only internalizes externalities when there's a crisis - when our backs are against the wall. So is our maker's mark that of demi-gods, consumers or just energy squanderers?

Be Pricey

[SLIDE: PRICEY BEHAVIOUR]

Back to my four elephants. If I had to choose a single one, and I don't, it would be price. Price really changes behaviour. We've gabbled for years about reducing mileage, but in the past year US road travel is down by 4.7%, well over 50 billion fewer miles annually and dropping. This has nothing to do with climate change awareness and everything to do with price. The price of US gasoline has gone from \$1.90 a gallon between 2000 to 2006, to \$2.80 in 2007, and \$3.70 during 2008. A one year decline in miles of 4.7% against a 32% price rise. Multitudes of small decisions all altered by price, not government advertising to reduce miles driven. I've argued before about the need to internalise externalities, but I don't think most environmentalists understand how far this could go, nor do most capitalists understand how far it should go.

In the time available I will explore two approaches to estimating how far things should go, reduced consumption (close to zero impact) and full recycling. Looking at reduced consumption, we can take the agreed minimum 450% impact we arrived at earlier and invert it. Thus, at a minimum, we need to reduce our impact to less than 22% of today's impact by 2050. For a number of reasons, I might argue for a stronger target for impact reduction, perhaps a 90% impact reduction, but at 78% reduction,

without major technological change, that's your car being replaced every 25 years rather than every five or a 50 year landfill lasting two and half centuries. It's one kettle for every five today, one room lit out of five, one car journey for every five, one airlight for every five. Social persuasion isn't sufficient. Not even close. But major price changes might be sufficient (of course price changes *and* persuasion would be better). Assuming -0.7 long-run elasticity holds for gasoline across a wide spectrum (not a very realistic scenario, not least of which because people would buy radically different cars and totally revise their logistics, but also geography, demographic distributions, total demand functions and other factors are complex), then UK prices might at least double from something like £1.10/litre today to consistently well over £2.20/litre.

While a 78% reduction may seem absurd, note that to bring UK CO₂ emissions per capita into line with global emissions per capita, we need to reduce our emissions from 10 tonnes to 1 tonne per person, a 90% reduction. Based on currently traded prices of (Euros)25/tonne of emitted CO₂ that implies an economic cost of (Euros)225 per person per year. Note also that numerous economists anticipate the long-term price to rise markedly with sums banded about of (Euros)40/tonne, (Euros)100/tonne and even (Euros)200/tonne, at which point we're talking ?7,200/family-of-four per year. Some people talk about a spending \$10trillion upgrading global electricity infrastructure over the next 30 years. The EU is talking about spending 0.5% to 1% of GDP, i.e. "60 billion per annum, just to start dealing with climate change. Others would spend double or quadruple. These costs may be overegged. Environmental impact may be subject to hysteresis, i.e. it may take a big push (e.g. sizable changes in incentives) to start down the road to sustainability, but once the transition towards a zero impact economy has started it may take little to keep it going. This is one reason I question gradualism in price movements. Perhaps the best thing is a large, sharp price shock that changes behaviour, as we've had with the oil price.

[SLIDE: PARTWAY THERE]

Finally, I'd like you to consider a fully recycled economy. "Plastic PET bottles are the most common drinks containers in Switzerland, and 80% of them are recycled - far higher than the European average of 20 to 40%. But the Swiss do not recycle just because they care about the environment. There is a strong financial incentive. Recycling is free, but in most parts of Switzerland throwing away rubbish costs money." [BBC -<http://news.bbc.co.uk/1/hi/world/europe/4620041.stm>] Recycling, reuse and regiving are tough to measure. Belgium, Austria, Germany and the Netherlands appear to be at the 50% mark. The EU is discussing a recycling target of 50% of municipal waste and 70% of industrial, manufacturing and construction waste by 2020. In 2006 the US Environmental Protection Agency claimed a US recycling rate of 32% and DEFRA a UK rate of 27%. The UK government target is 33% by 2015. But what might it mean to hit the 78% recycling rate that I-PAT implies is a minimum, or more likely a 90% recycling rate?

One way to look at this is to think about the time it takes to build an economy. Following destruction via disastrous polices or war, building a modern industrial economy seems to take a generation or two. Think of Germany or Japan or Korea after war, or China 15 years ago. For the sake of argument grant me the mid-point, 45 years. After 45 years you have 100% of the consumption side built, but only 30% of the recycling side built. If your recycling target is 90% then, ignoring the fact that it will get a lot harder above 50%, a back-of-the-envelope calculation says that about 20 more years of economic growth need to be dedicated to getting recycling up to 90%. But that's 20 years without much growth elsewhere. On the other hand, an economy that was truly taxed on environmental impact, rather than labour or income, ought to be increasingly efficient.

Dance On My Grave

[SLIDE: JUDGEMENT DAY]

I've had complaints that these Commerce lectures don't provide easy ways to make money. Tonight, at the risk of being wrong and with the caveat you should seek professional advice, as well as that anything that can go down, can go down further, let's look at a few implications. If you believe in the apocalypse you could invest in anti-pestilence stocks, e.g. pharmaceuticals or emergency response companies, and make a lot of money, if you live. If you're optimistic, perhaps your Judgement Day will be found in "rapture" economics - economies growing their zero impact GDP sectors - the "weightless" sectors of human interaction such as entertainment, local tourism, software and media. More prosaically, as we know from previous lectures, scarcity is valuable, at the extreme scarcity is monopoly, thus:

.. environmental resources and other scarce resources will grow in value as population increases;

.. (I take it all back Dad) land, *they're* not making any more of it - and land on a safe coastline even better. *They're* also not making as much "old" stuff per head of population per year, so antiques and paintings might make good investments;

“ with increasing population and global competition in weightless industries, expect much more intensive educational requirements and valuing of advanced degrees, so invest in educational stocks;

And that leads me to the final point. A lot of people maintain that markets can't handle zero growth. That's just not true. Markets operate under conditions of scarcity to allocate resources accordingly. What is true is that society doesn't handle zero growth well, or negative growth at all well. Under zero apparent growth we are in danger of breaking an implicit social contract that we work towards a demonstrably better life in return for trusting market mechanisms. We are better off than our parents, and they than our grandparents. Can we build a society using markets that is clearly better off, as measured by I-PAT, but without an increase in goods we can touch and feel? Will we genuinely value environmental sustainability enough to vote in politicians year after year who tell us that we are working harder than ever "and GDP rose 3% this year", but we can't feel the difference in an improved standard of living? I can only wonder.

There is real hope that sustainable growth is achievable. The real social divide may not be between the hobbit-dwelling, hairshirt-knitting, vegetarian bloodhounds of the ultra-greens versus the Ferrari-fuelled, narcissistic, aimless airheads of conspicuous consumption - Ralph Nader and Jonathan Porritt versus Jeremy Clarkson and Paris Hilton. Far more likely the clash will be between equality issues and market freedom. The tough bit is we need both. As Paul Ekins concludes, "At present societies seem more inclined to try to realise growth-environment synergy than accept overall limits to growth". [Ekins, 2000, page 326] Environmentalists need to accept inequalities to get the benefits of markets. Free-marketers must accept limits to growth. Or we can all go partying with Prince:

Yeah, everybody's got a bomb,

We could all die any day,

But before I'll let that happen,

I'll dance my life away.

Thank you.

[SLIDE: DISCUSSION]

Further Discussion

1. Is the party over?
2. Is the social contract broken?
3. Is there a sustainable hope?

Further Reading

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"Commoner (1) demonstrated a system of dimensions by an amusing example: I (bottles) = P (capita) x A (gallons of beer per capita) x T (bottles per gallon). Although dimensionally correct, measuring affluence as gallons of beer per capita surprises.

Beer is really taste, not affluence. Bottles per gallon scarcely indicate technology. Bottles of inert silica scarcely seem to be a poisonous environmental impact. If roadside litter rather than poison was intended as the environmental impact, then I (bottles per mile) = P (capita) \times $A1$ (miles driven per capita) \times $A2$ (gallons of beer per mile driven) \times $T1$ (bottles used per gallon beer) \times $T2$ (bottles out the window per bottle used). This identity extends population, affluence, and technology to a clear impact in dimensionally correct terms. It shows the forces putting bottles along the road so that environmentalists might condemn them. Control birth, drive less, drink less beer per mile, empty larger bottles, and shun defenestration."

[Waggoner and Ausubel, 2002, page 7860]

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