The Actuarial Profession
making financial sense of the future

Pensions conference and exhibition 2012
Oliver Bettis



# Resource and Environmental Limits to Economic Growth

31 May 2012

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## Resource and Environmental Limits to Economic Growth

1. Key messages for pensions actuaries
2. A long term view of growth; we live in an exponential world
3. Resource and environmental limits to economic growth?
4. Making sense of the data: The “Limits to Growth”
5. What is the actuarial profession doing?
6. What could it mean for actuarial advice?

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## Key messages for pensions actuaries
## The core issue

- The economy has grown exponentially since the industrial revolution.
- Most pension promises are pre-funded, on the assumption that exponential growth will continue.
- But are our assumptions about exponential investment returns realistic?
- Might we hit biophysical limits to growth within the next few decades?

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## Key messages for pensions actuaries
## Implications for actuarial advice?

- Potential for fundamental changes to economic variables used to value pension liabilities:
  - gilt yields; inflation; equity returns; corporate bond yields
- Uncertain impact on investment returns and sponsor covenant strength
- How might this affect:
  - amount of funding required?
  - where to invest that funding?
- How can the associated risks be managed?
- How does this affect the advice pension actuaries give today?

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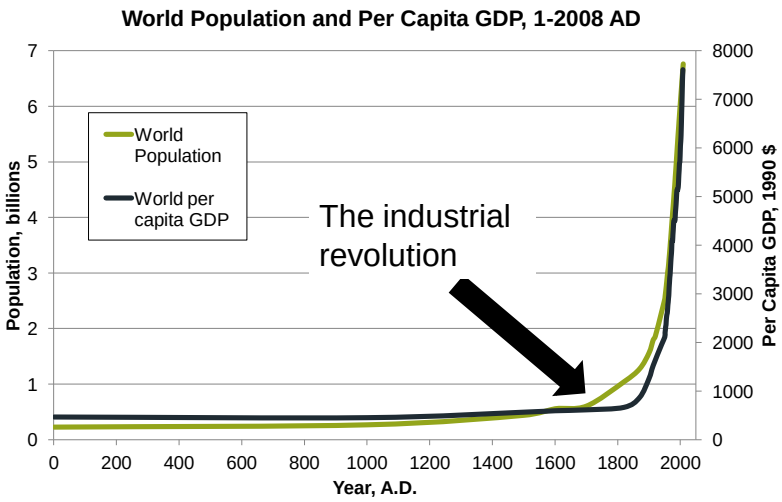
## Resource and Environmental Limits to Economic Growth

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## 2. A long term view; we live in an exponential world
### A Long Term View of Growth




Source: Maddison 2008 http://www.ggdc.net/MADDISON/oriindex.htm

## 2. A long term view; we live in an exponential world
### Why did the industrial revolution start in England?

**"*Energy and the English Industrial Revolution*"***

By Sir Edward Anthony Wrigley:

- Professor of Economic History at Cambridge University
- President of the British Academy 1997-2001.

- Answers the question, "Why didn't growth stop?"
- Fossil fuel allowed us to escape the limits of land.
- England had easily accessible coal deposits.
- Adam Smith and David Ricardo would have considered as absurd the notion that economy could grow by fixed % per year.

*Wrigley, E. A. (2010), *Energy and the English Industrial Revolution*, Cambridge University Press, Cambridge, UK

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## 2. A long term view; we live in an exponential world
### The importance of energy to our economy



Road transport



Aviation



Heating and lighting



Construction

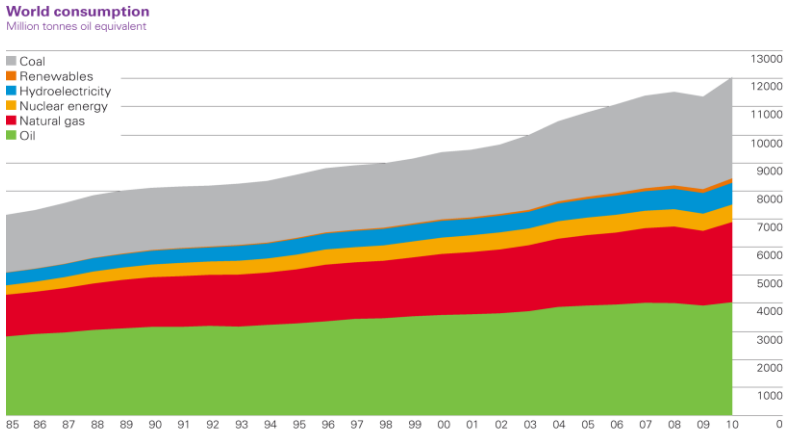


Mining



Food production

## 2. A long term view; we live in an exponential world
### World primary energy consumption




World primary energy consumption grew by 5.6% in 2010, the strongest growth since 1973. Growth was above average for oil, natural gas, coal, nuclear, hydroelectricity, as well as for renewables in power generation. Oil remains the dominant fuel (33.6% of the global total) but has lost share for 11 consecutive years. The share of coal in total energy consumption continues to rise, and the share of natural gas was the highest on record.

Source: BP Statistical Review of World Energy 2011

- Our industrial civilization uses about 13 Tera Watts for machinery.
- Estimated net primary productivity of Earth's ecosystems ≈70TW on land.

## 2. A long term view; we live in an exponential world
### Why are Fossil Fuels so Useful?

- Fossil fuel is very energy dense
- Oil is particularly useful as it is liquid – easy to transport
- Energy content of 1 barrel of oil = manual labour of 30 people for 1 month.

**"Energy Slaves"**

- UK energy consumption per person = 125kWh per day* (= 5.2kW per person)
- 1 person produces ~ 75 Watts sustained power
- UK citizens use ~ 70 "energy slaves"

* Refer: www.withouthotair.com - David MacKay, 'Sustainable Energy Without Hot Air'

## 2. A long term view; we live in an exponential world
### We are addicted to oil

We are addicted to fossil fuels, especially oil.



"Here we have a serious problem: America is addicted to oil, which is often imported from unstable parts of the world," George W. Bush, 2006 State of the Union address

Source: http://articles.cnn.com/2006-01-31/politics/bush.sotu_1_energy-research-union-speech-advanced-energy-initiative?_s=PM:POLITICS

## 2. A long term view; we live in an exponential world
### Exponential Growth

"The greatest shortcoming of the human race is our inability to understand the exponential function"

– Professor Albert Bartlett, Colorado University

- The exponential function arises whenever a quantity grows or decays at a rate proportional to its current value.
- For example, compound interest.

Source: http://www.albartlett.org

There is a great presentation about exponential growth at this web address.

## 2. A long term view; we live in an exponential world
### Exponential Growth

**Well known rule of thumb for doubling time**

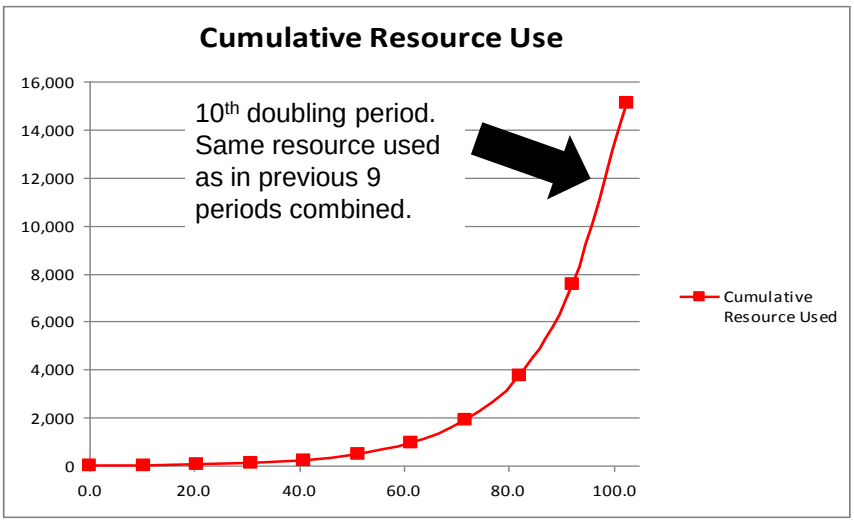
- Approx. doubling time = 70/(Growth Rate in %)
  Reason: 70 ≈ 100*ln(2)
- E.g. 7% p.a. growth means doubling time of 70/7 = 10 years

**Not so well known rule of thumb for cumulative resource used during doubling period**

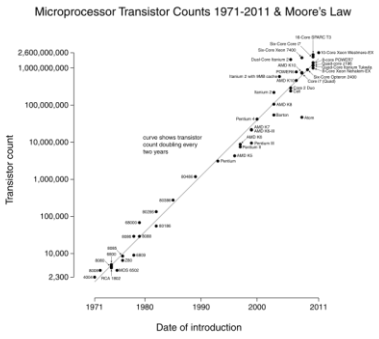
For a resource which is used up at a constantly increasing rate:

- In the time it takes to double the rate of use, the amount of resource used will be the same as the resource used in all prior doubling periods combined.

## 2. A long term view; we live in an exponential world
### Cumulative Resource Use @7% p.a. growth

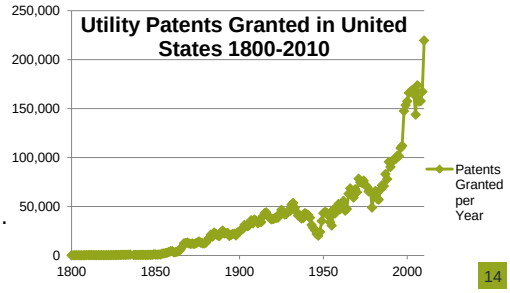


## 2. We live in an exponential world
## Technology and knowledge




**Moore's Law**
The number of transistors that can be placed inexpensively on an integrated circuit doubles approximately every two years.

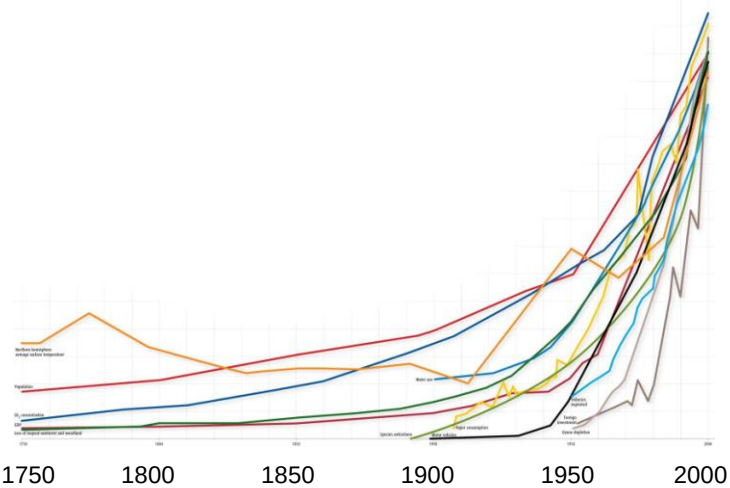
**Intellectual Property**
No. of patents granted illustrates the explosive growth in human knowledge.




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## 2. We live in an exponential world
## World growth trends 1750-2000




1. GDP
2. Population
3. Paper consumption
4. Motor vehicles
5. Foreign investment
6. $CO_2$ concentration
7. Loss of tropical woodland
8. Water use
9. Species extinction
10. Fisheries exploited

Source: New Scientist 16 October 2008
http://www.newscientist.com/article/mg20026786.000-special-report-how-our-economy-is-killing-the-earth.html

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## 2. We live in an exponential world
### World GDP Growth Trends

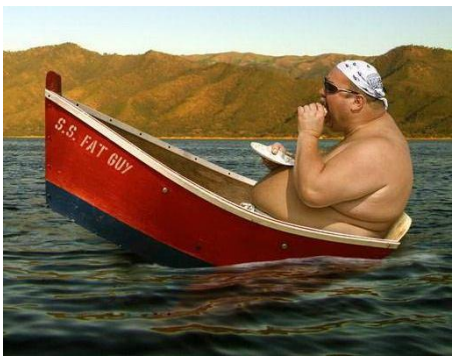
- World GDP has grown at average rate of c.3% per year in recent decades (in real terms).
- Doubling time at 3% p.a. is just over 23 years.
- From 2012 to 2100 is almost 4 doubling periods.
- World economy would grow 14 times as large in 2100 as it is now.

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## 2. A long term view; we live in an exponential world
### Is growth always good?

- Many things have an optimal size – further growth is bad
  - E.g. People!




Question: Is <u>economic</u> growth always good?

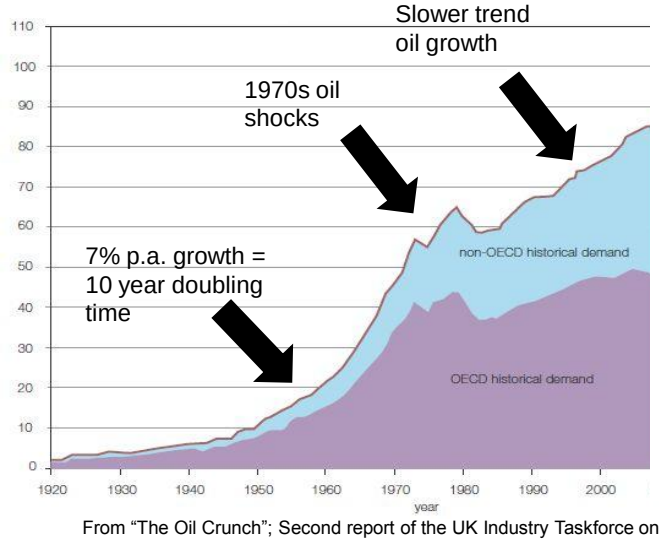
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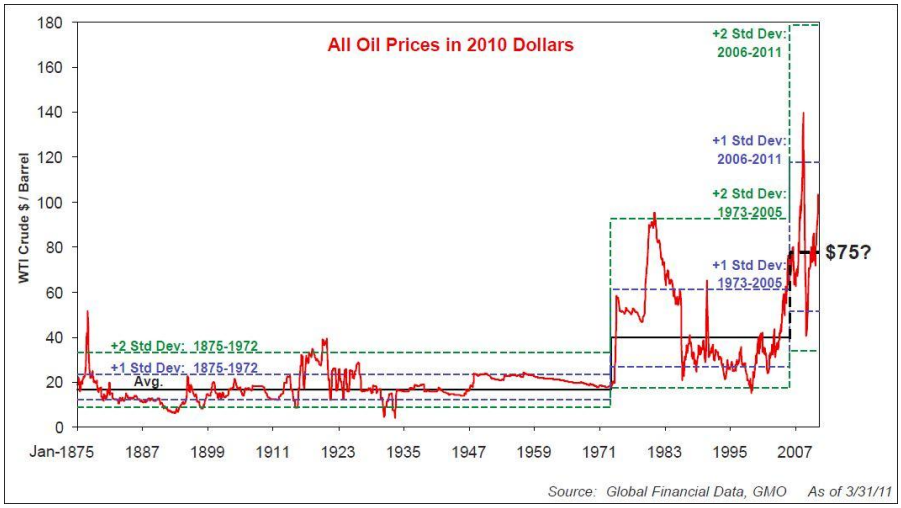
## 3. Resource limits to growth: Peak oil
### Global Oil Production Since 1920




Was no accident that the original "Limits to Growth" study was published in 1972.

From "The Oil Crunch"; Second report of the UK Industry Taskforce on Peak Oil & Energy Security (ITPOES) , February 2010 http://peakoiltaskforce.net/

## 3. Resource limits to growth: Peak oil
## Oil Prices since 1875




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## 3. Resource limits to growth: Peak oil
## IMF World Economic Outlook, April 2011

**Baseline scenario 0.8% p.a. oil growth for 20 years.**

- Minimal effect on economic growth (reduction of <0.25%)

**Two alternative "peak oil" scenarios: Greater decline in oil (-2% p.a. instead of +0.8%); and greater dependence on oil.**

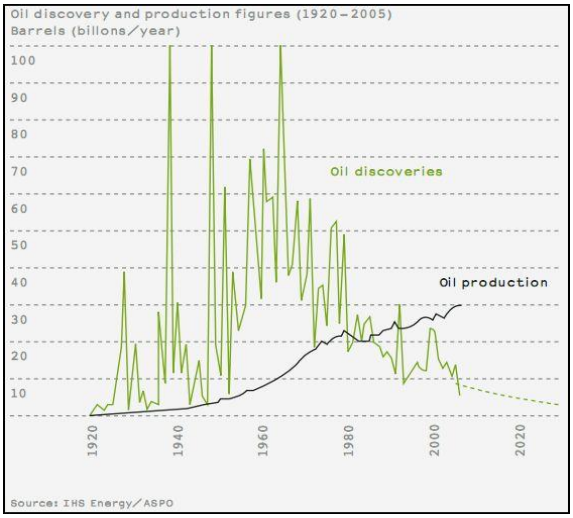
- Result was much larger loss of GDP than baseline (3 to 4X in first scenario and double in second scenario).
- Oil price increases 800% over 20 years.
- Additional adverse effects possible from interdependencies.
- Oil-exporting nations may keep more oil for themselves.

Source: IMF World Economic Outlook – April 2011

http://www.imf.org/external/pubs/ft/weo/2011/01/index.htm

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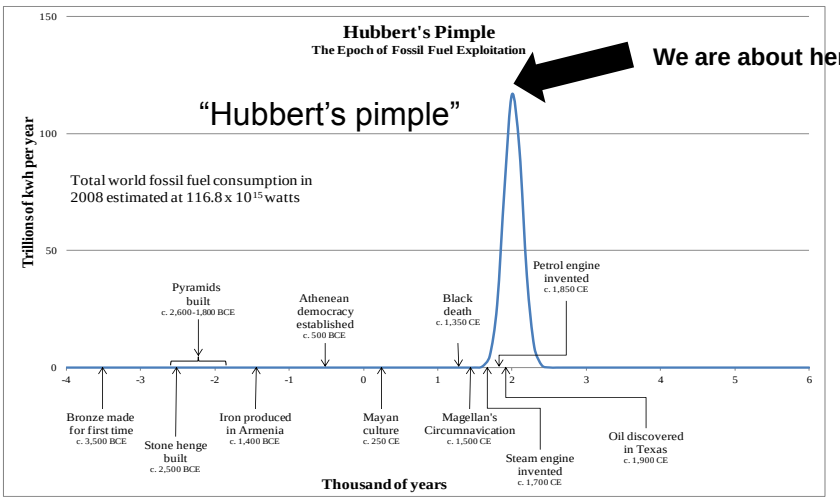
## 3. Resource limits to growth: Peak oil
## Oil Discoveries versus Oil Production




"Discoveries of new deposits peaked as far back as the 1960s and 1970s. Now a number of countries in addition to the UK and the USA, for instance, have reached their production limits. The quantity of oil being pumped out of the earth exceeds new discoveries."

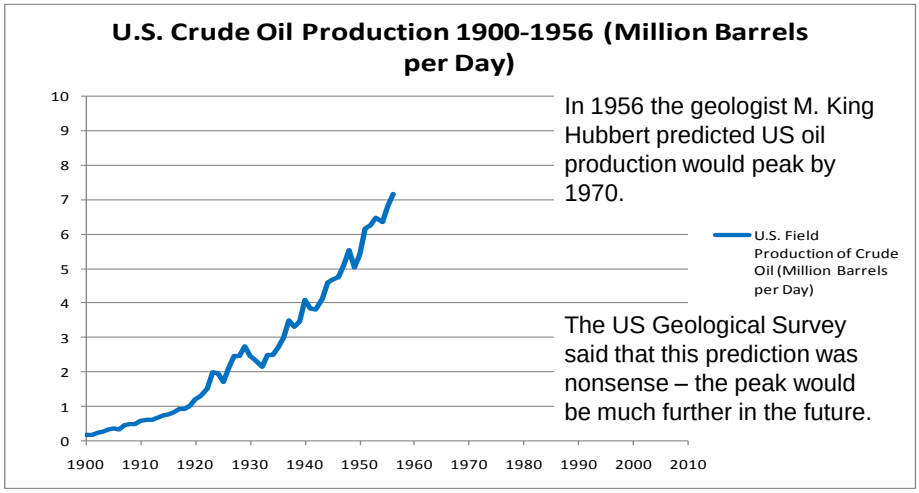
Source: Munich Re Foundation 2009 Report page 28
http://www.munichre-foundation.org/StiftungsWebsite/Publications/2009report_Publication_summary.htm

## 3. Resource limits to growth: Peak oil
## Global Fossil Fuel Use – A Long Term View




**Source:** http://www.actuaries.org.uk/research-and-resources/documents/climate-change-and-resource-depletion-challenges-actuaries-review-I adapted from Professor Charles A.S. Hall, State University of New York http://www.esf.edu/efb/hall/ After Hubbert, 1969

## 3. Resource limits to growth: Peak oil
## United States Oil Production 1900-1956




In 1956 the geologist M. King Hubbert predicted US oil production would peak by 1970.

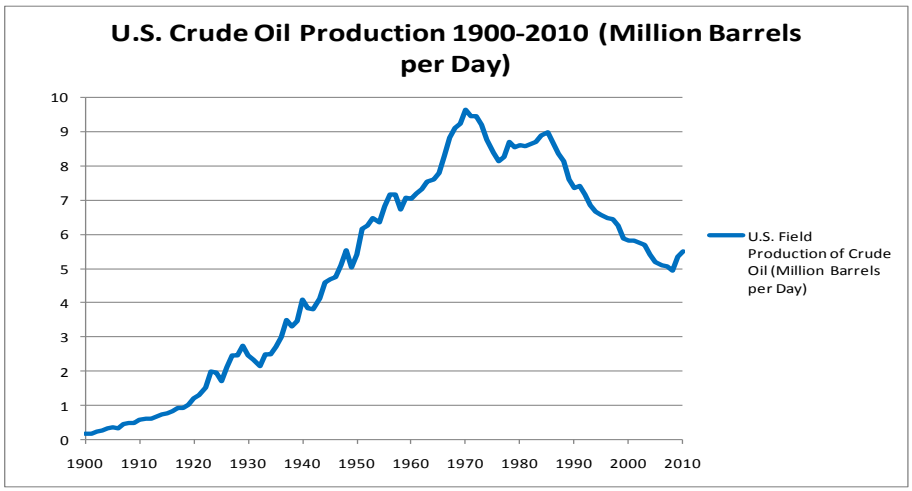
The US Geological Survey said that this prediction was nonsense – the peak would be much further in the future.

Source: United States Energy Information Administration http://www.eia.gov/

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## 3. Resource limits to growth: Peak oil
## United States Oil Production 1900-2010

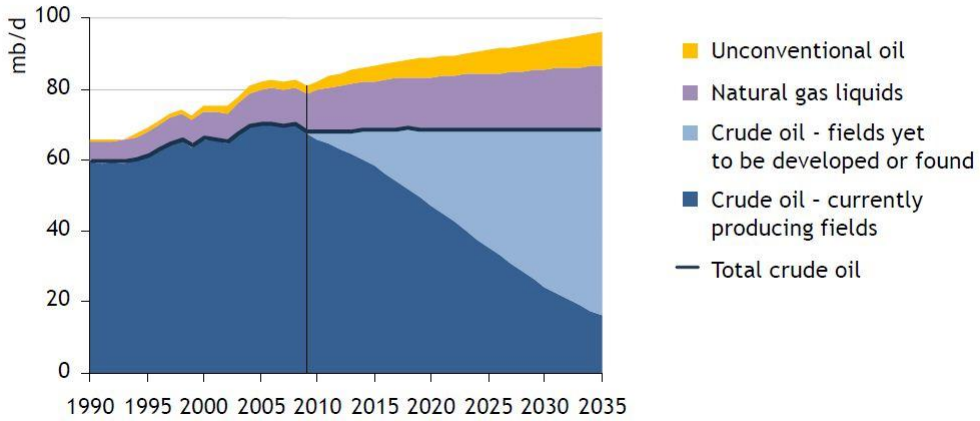



Source: United States Energy Information Administration http://www.eia.gov/

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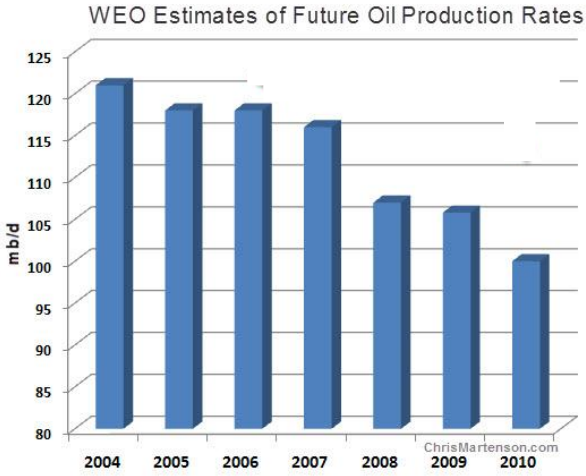
## 3. Resource limits to growth: Peak oil
### International Energy Agency WEO 2010

World oil production by type in the New Policies Scenario




Source: Lecture Fatih Birol, Chief Economist of the IEA, at Imperial College, 18 January 2011
http://www3.imperial.ac.uk/newsandeventspggrp/imperialcollege/naturalsciences/climatechange/newssummary/news_20-1-2011-13-4-51

## 3. Resource limits to growth: Peak oil
### IEA: WEO forecasts in years 2004-2010




In the 2004 WEO forecast of oil price until 2030:

- Baseline forecast was $25 a barrel.
- "High" scenario was $35 a barrel.

Source: Chris Martenson summary of IEA WEO's http://www.chrismartenson.com/

## 3. Resource limits to growth: Peak oil
### Some reports on resource constraints

- Feb 2010 – UK Industry Task Force on Peak Oil, 2nd Report

*"The next five years will see us face … the oil crunch."*

- June 2010 – Lloyd's 360 Report, Sustainable Energy Security

*"We are in a period akin to a phoney war", Lloyd's CEO R.Ward*

- June 2010 – Tullett Prebon research "Dangerous Exponentials"

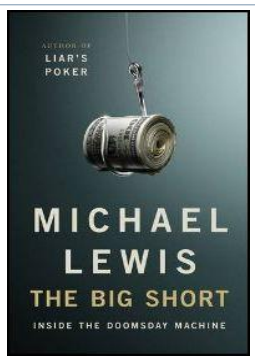
*"… impending collision between economic system that must grow and finite resources which cannot grow."*

- April 2011 - GMO letter to investors *"Time to wake up: Days of abundant resources and falling prices are over"*
- April 2011 - IMF World Economic Outlook. Models oil scenarios.
- May 2012 – IMF Working paper "The Future of Oil"

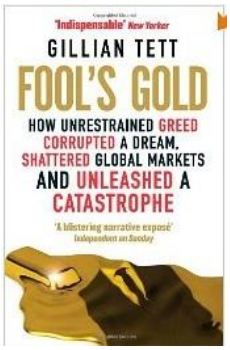
Weblinks to sources in Notes area

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## 3. Resource limits to growth: Peak oil
### The Energy Crunch: Another Credit Crunch?

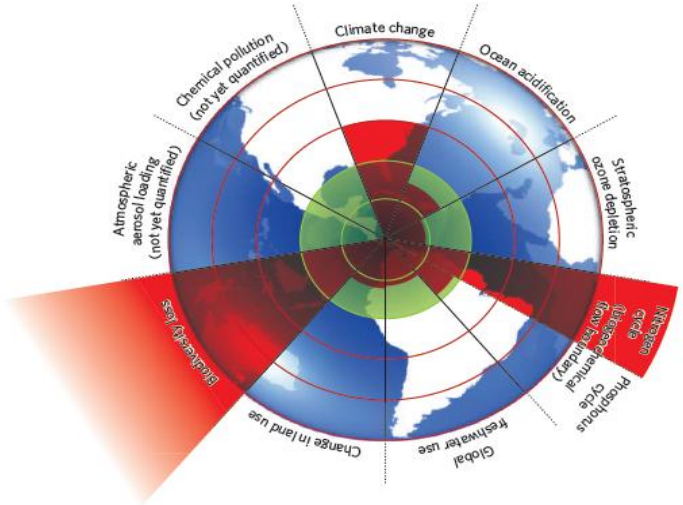



Two excellent books telling stories about people that saw the credit crunch coming.




- Not many people predicted the severity of the credit crunch.
- But some people did predict it - it was predictable.
- Why did so few people predict the credit crunch?
- What can we predict today?

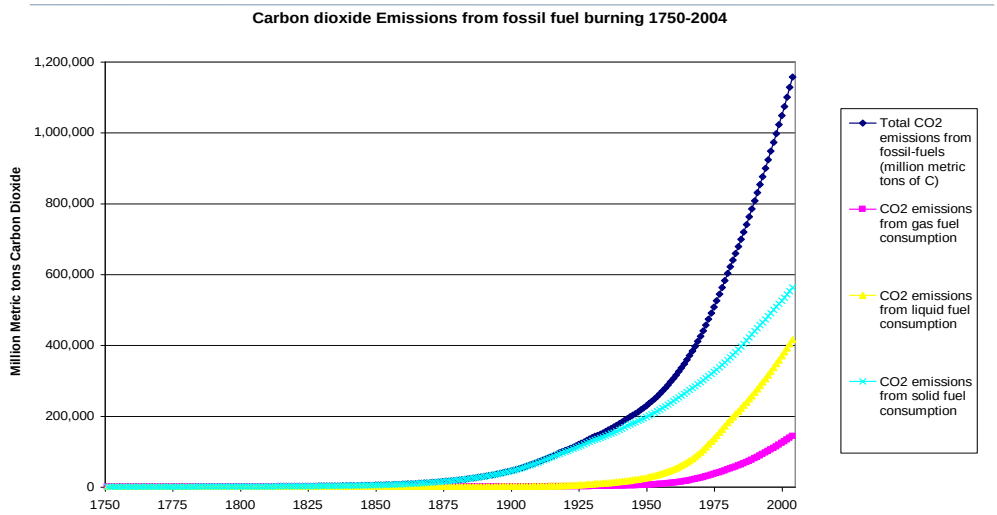
# 3. Environmental limits to growth
## Hard-wired environmental limits?



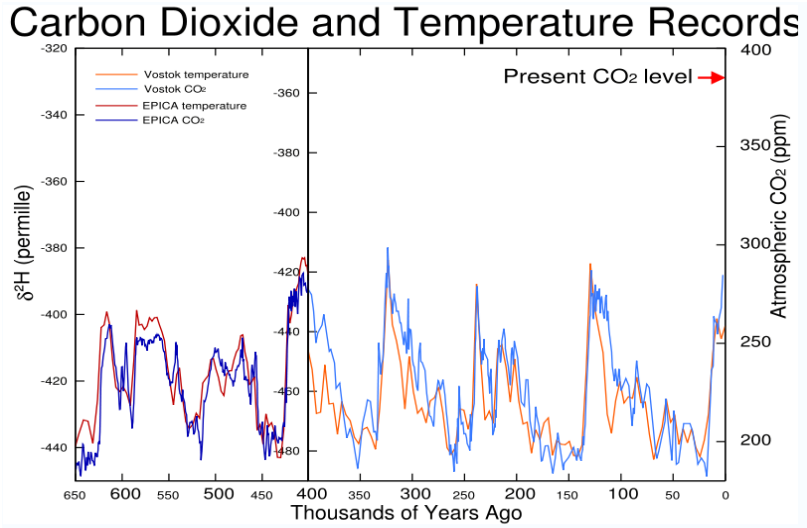

From Rockstrom et al "A safe operating space for humanity", Nature 2009

http://www.nature.com/nature/journal/v461/n7263/full/461472a.html

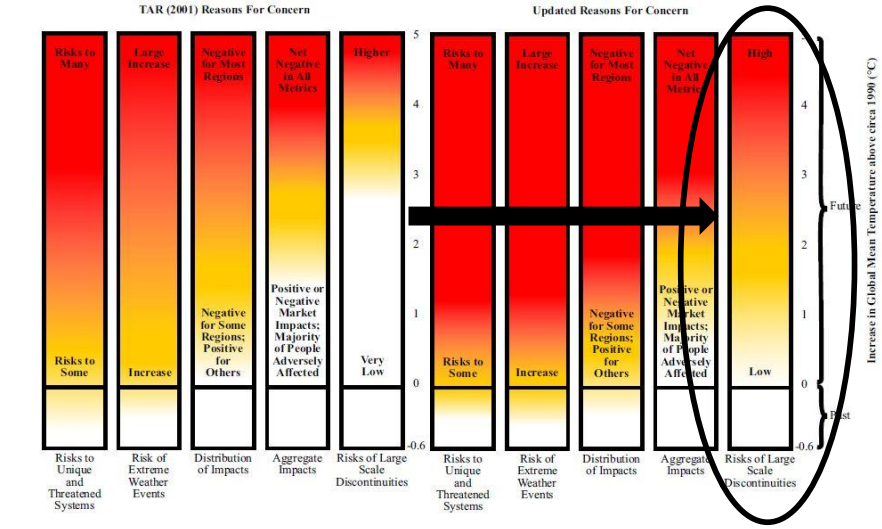
# 3. Environmental limits to growth: Climate change
## Cumulative $CO_2$ emissions from fossil fuels



## 3. Environmental limits to growth: Climate change
### Temperature versus $CO_2$ concentration




## 3. Environmental limits to growth: Climate change
### Updated "Reasons for Concern"




From: Smith et al PNAS

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## 3. Environmental limits to growth: Climate change
## NAS - Climate Stabilization Targets 2011

- Fossil fuel $CO_2$ emissions have created new epoch.
- Human activities will largely determine the evolution of Earth's climate.
- Man-made $CO_2$ stays in the atmosphere a long time.
- Future generations may be locked into a range of impacts, some of which could become very severe.
- E.g. For 4°C temperature increase, c.9 out of 10 summers warmer than warmest ever experienced in late 20th century.

Source: "**Climate Stabilization Targets: Emissions, Concentrations, and Impacts Over Decades to Millennia"** http://dels.nas.edu/Report/Climate-Stabilization-Targets-Emissions-Concentrations/12877

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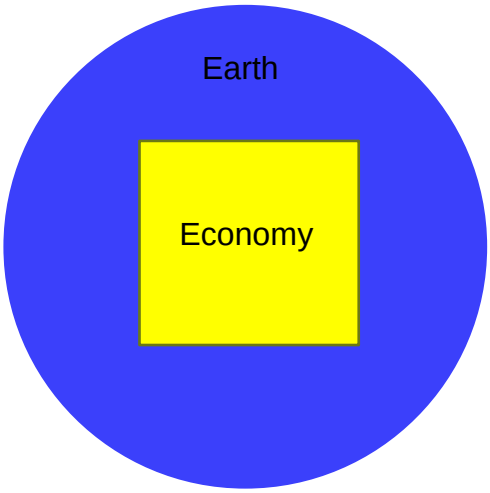


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## 4. Making sense of the data: The Limits to Growth
### The human economy is a subset of the Earth




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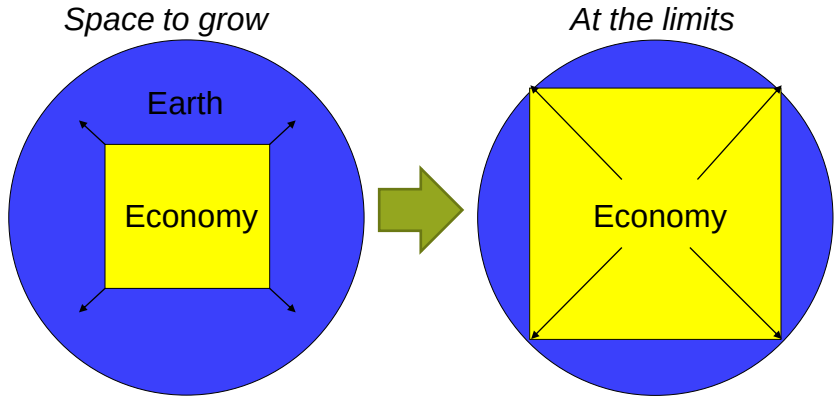
## 4. Making sense of the data: The Limits to Growth
### Link between problems

- Climate change
- Other environmental problems e.g. biodiversity
- Oil depletion
- Other resource depletion e.g. phosphorus

All driven by increasing consumption by humans – caused by exponential growth of population and the global economy.

Growth drives our problems!

## 4. Making sense of the data: The Limits to Growth
### The human economy is a subset of the Earth




(adapted from Clapp and Dauvergne 2005: p.101)

## 4. Making sense of the data: The Limits to Growth
### Human impact on the Earth – a simple approach

$$I = P \times A \times T$$

- I = Impact
- P = Population
- A = Affluence (consumption per capita)
- T = Technology (environmental impact per unit of consumption)

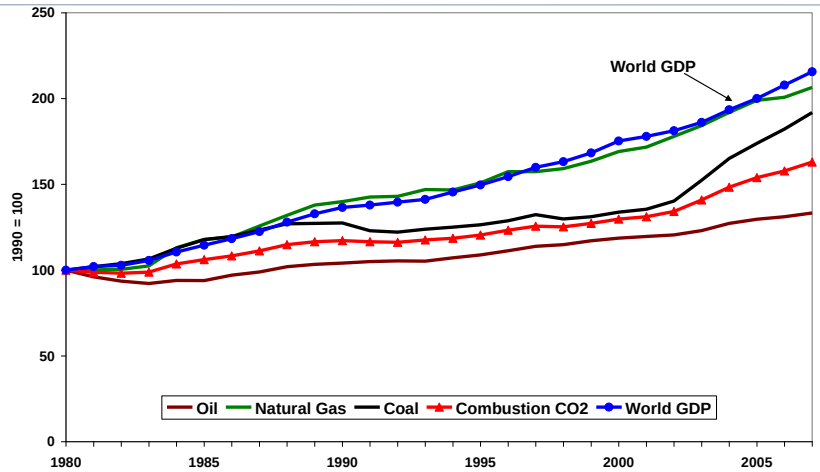
## 4. Making sense of the data: The Limits to Growth
### What about technology?

$$I = P \times A \times T$$

- If affluence and population grow, for impact to stabilize or shrink, technology must improve.
- But, since 2000, global carbon intensity of GDP has been increasing. Probably driven by increased coal use*.
- We are betting the house on technology. But it isn't working yet!

*Reference: "Reframing the climate change challenge", Anderson & Bows 2008
http://rsta.royalsocietypublishing.org/content/366/1882/3863.short

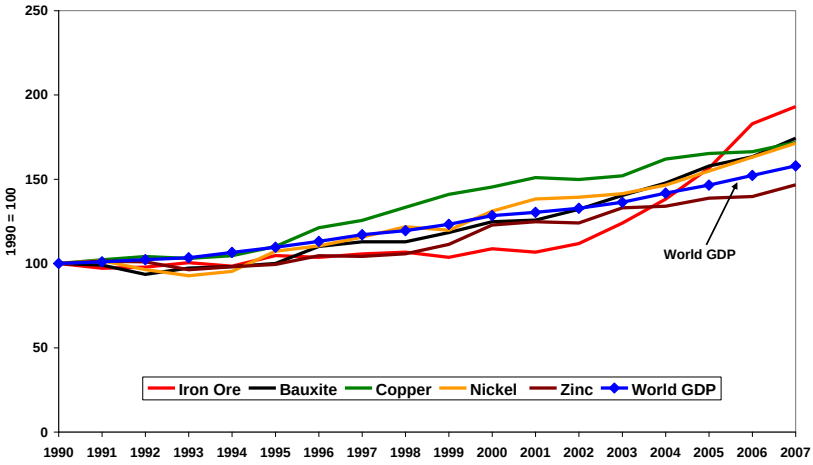
## 4. Making sense of the data: The Limits to Growth
### The myth of decoupling GDP from pollution




Jackson, T. (2009) *Prosperity Without Growth? Economics for a Finite Planet*, Routledge, London, UK.

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## 4. Making sense of the data: The Limits to Growth
### The myth of decoupling GDP from physical inputs




Jackson, T. (2009) *Prosperity Without Growth? Economics for a Finite Planet*, Routledge, London, UK.

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## 4. Making sense of the data: The Limits to Growth
### Scale of human impact: The Anthropocene Age

From The Economist magazine, May 2011

- Humans are reshaping the planet on a geological scale
- e.g. Athabasca tar sands, 30 bn tonnes of earth moved per year = 2x sediment flowing down all rivers in the world
- Moment of realisation, like Copernicus grasping that the Earth revolves around the sun.
- "It would be odd not to be worried."



You maniacs! You blew it up!

Source: The Economist – 26 May 2011 http://www.economist.com/node/18744401

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## 4. Making sense of the data: The Limits to Growth
## The "End of the World Syndrome"

- Joseph Tainter "The Collapse of Complex Societies"*
- Every age has its doomsayers. They've all been wrong.
- Need a scientific approach not value judgments.
- Is there data which shows that our age is objectively different?
  Yes!
  - Wealth
  - Fossil fuel use
  - Atmospheric $CO_2$ concentration c.390ppm
  - Population c.7 billion

*Tainter, Joseph A (2003. First published 1988), The Collapse of Complex Societies, Cambridge University Press, ISBN 0-521-38673-X,

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## 4. Making sense of the data: The Limits to Growth
## The Planet Under Pressure Conference

*Planet Under Pressure 2012 was the largest scientific conference leading up to the United Nations Conference on Sustainable Development (Rio+20), with over 3000 delegates.*




**State of the Planet Declaration:**

- "1. Research now demonstrates that the continued functioning of the Earth system as it has supported the well-being of human civilization in recent centuries is at risk…"

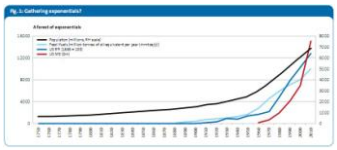
See: http://www.planetunderpressure2012.net/

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## 4. Making sense of the data: The Limits to Growth
## Just starting to enter the investment world

**1. Tullett Prebon (£0.5bn revenue), 2010**

- Impending collision between economic system and finite resources.
- "one of the most important changes in the lifetime of anyone reading this report"



"A forest of exponentials"*
Dr. Tim Morgan, head of research

**2. GMO Asset Managers (>$100bn assets under management)**
Jeremy Grantham, Quarterly Letter, April 2011: "Time to Wake Up"

- Days of abundant resources and falling prices are over forever.
- The world is using up its natural resources at an alarming rate.
- This has caused a permanent shift in their value.

*Chart from: Morgan T. "Dangerous exponentials: A radical take on the future" Tullett Prebon Strategy Insights issue 5, June 2010

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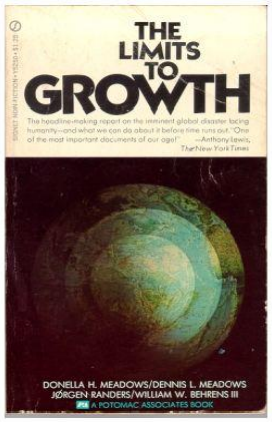


## 4. Making sense of the data: The Limits to Growth
## Why didn't anyone see this coming?

- Exponential growth has a simple mathematical formula.
- Why didn't anyone predict these problems decades ago?
- Answer: Someone did, but the message was forgotten.

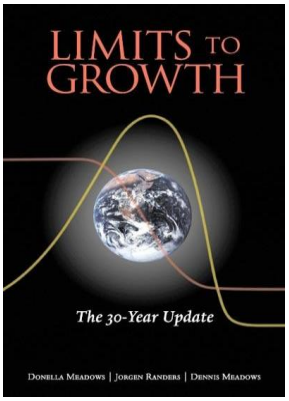
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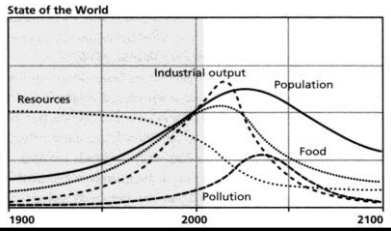
## 4. Making sense of the data: The Limits to Growth
### The "Limits to Growth" Study




The original 1972 study was updated in 2004

Example below of one of the indicative modelled scenarios (not a prediction)




## 4. Making sense of the data: The Limits to Growth
### The story of the "Limits to Growth"

- A group of systems scientists in MIT* were commissioned by the Club of Rome.
- The book "Limits to Growth" was published in 1972. Sold over 20 million copies.
- Was controversial, attacked by "cornucopians".
- 1970s oil shocks and "stagflation" appeared to confirm predictions.
- But in 1980s, cheaper oil let economies grow again. The "Limits to Growth" was forgotten.

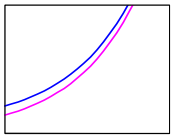
Time to rediscover the Limits to Growth?

*Donella H. Meadows, Dennis L. Meadows, Jørgen Randers, and William W. Behrens

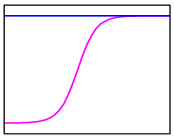
## 4. Making sense of the data: The Limits to Growth
### The "Limits to Growth" argument

- Endless physical growth in a finite world is not possible.
- If growth in consumption is not contained, humanity will exceed the carrying capacity of the Earth.
- Exceeding the carrying capacity of the Earth carries risk.

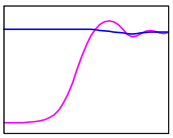
Continuous growth



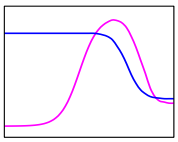
Sinusoidal Growth



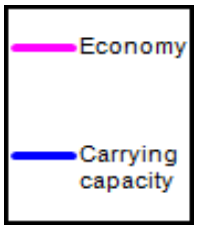
Oscillation



Collapse



The 4 possibilities for exponential growth.




## Resource and Environmental Limits to Economic Growth

1. Key messages for pensions actuaries
2. A long term view of growth; we live in an exponential world
3. Resource and environmental limits to economic growth?
4. Making sense of the data: The "Limits to Growth"
5. What is the actuarial profession doing?
6. What could it mean for actuarial advice?

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## 5. What are actuaries doing?
## UK Profession

- Resource & Environment MIG has >400 members
- Resource & Environment Panel set up to guide profession. Peter Tompkins chairs. Philip Scott has joined.
- Networking event held in September 2011. To be repeated this September.
- Research into the limits to growth has been commissioned. Led by Dr Aled Jones at Anglia Ruskin University.
- Launch event for Limits to Growth research in January 2013.

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## 5. What are actuaries doing?
## UK Profession – Literature Reviews

1st Review – November 2010

Broad range of climate change, environmental and resource issues covered

2nd Review – November 2011

17 actuaries reviewed 21 papers and reports

Continued coverage of broad environmental and resource issues, with particular focus on energy

3rd Review – estimated March 2013

Focus will be on the sustainability of the financial system

Search for “Climate change and resource depletion” on www.actuaries.org.uk for easy access to the reviews

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## 5. What are actuaries doing?

DEPARTMENT OF ENERGY & CLIMATE CHANGE

### Capital Markets Climate Initiative

"CMCI is a public-private initiative designed to support the scale up of private finance flows for low carbon technologies, solutions and infrastructure in developing economies…"

Climate Bond Certified

### Climate Bonds Initiative

*Co-founded by Nick Silver*

- *"We are looking for investment-grade returns that also address climate change.* ***The Climate Bond Standard will allow us to know that investment opportunities put before us will be the right ones*** *to build a Low Carbon Economy."*

— Jack Ehnes, CEO of California Teachers Retirement System

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http://climatebonds.net/



## 5. What are actuaries doing?
## International Profession

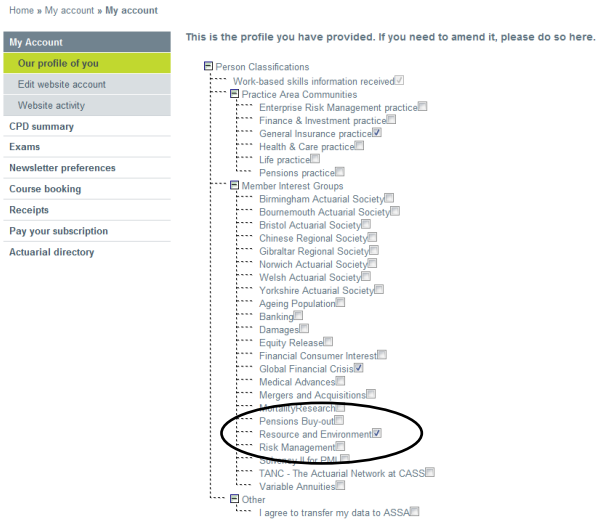
- United States: Society of Actuaries group to investigate resources, assisted by Professor Molly Jahn
- Casualty Actuarial Society Climate Change Committee
- IAA Environment Working Group
- Environment session at IAA meeting Los Angeles 25th May 2012




*"The Environment: A New Frontier for Actuaries" – What actuaries need to know – and do – about climate change, limits to growth and resource depletion.*

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## 5. What are actuaries doing?
## Tick the REG box if you want to keep up to date




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## Resource and Environmental Limits to Economic Growth

1. Key messages for pensions actuaries
2. A long term view of growth; we live in an exponential world
3. Resource and environmental limits to economic growth?
4. Making sense of the data: The “Limits to Growth”
5. What is the actuarial profession doing?
6. What could it mean for actuarial advice?

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## 6. What could it mean for pensions actuaries?

- Resource and environmental limits to growth could fundamentally change the pensions landscape:
  - The past may be a poor guide to the future
  - Current market prices may not fully reflect the risks
  - Risk assessments may underestimate the potential impacts
- How might this affect actuarial advice?
  - Have your clients considered the risks of limits to growth?
  - How do these risks affect the pension funding scenarios?
  - Does this strengthen the case for “green” investment?

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## 6. What could it mean for pensions actuaries?

- What does this mean for pensions more generally?
  - People will still need pensions
  - Actuaries are ideally placed to develop solutions
  - The Profession’s “Limits to Growth” project will provide a useful platform
- And what about wider fields?
  - Some actuaries are already thinking hard about these issues
  - This is about long-term (financial) risks and fits well with actuaries’ core skills
  - It is potentially a huge area of work for us; we can be leaders in this field.

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## Final Thought and Further Reading

Every time you see growth mentioned, question the assumptions that lie behind…

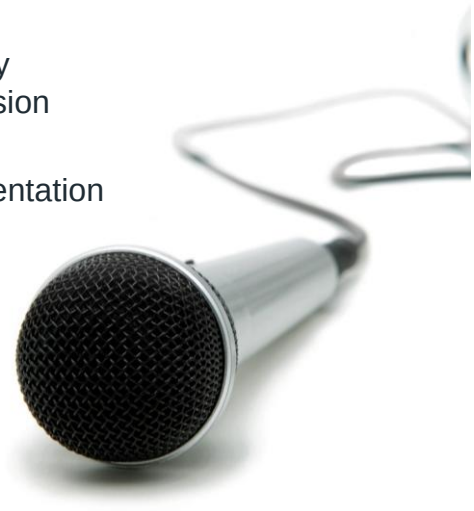
Further reading:

- http://www.planetunderpressure2012.net/ (science)
- http://www.withouthotair.com/ (energy)
- http://www.neweconomics.org/ (economics for sustainability)
- www.theoildrum.com (energy)
- http://www.energybulletin.net/ (energy)
- http://www.positivemoney.org.uk/ (financial reform)
- http://steadystate.org/ (CASSE – steady state economics)

## Questions or comments?

Expressions of individual views by members of The Actuarial Profession and its staff are encouraged.

The views expressed in this presentation are those of the presenter.



Feel free to contact me at:

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Also Twitter at

@OliverBettis

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## Limits to Growth: Additional Slides

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## Red Pill or Blue Pill?



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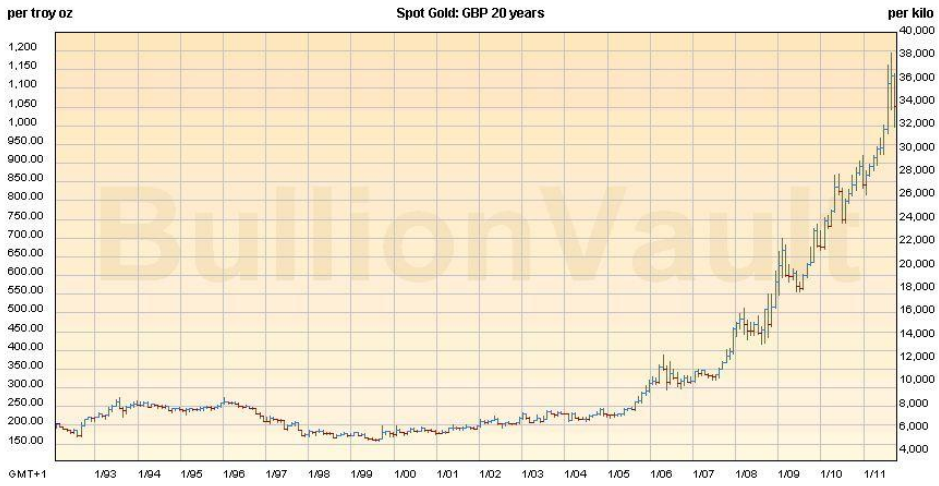
## Red Pill or Blue Pill?
## Why take the red pill?

- Solvency II
- We actuaries have the skill-set to understand what's going on.
- We are actuaries – we look at data and try to strip away bias every day of the week.

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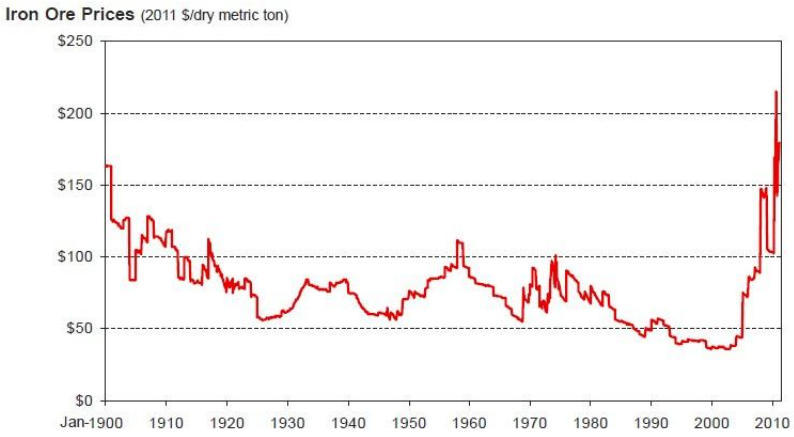
## Red Pill or Blue Pill?
## Shift from financial assets to real assets




Source: www.bullionvault.com

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## Red Pill or Blue Pill?
## Shift from financial to real assets: Iron Ore



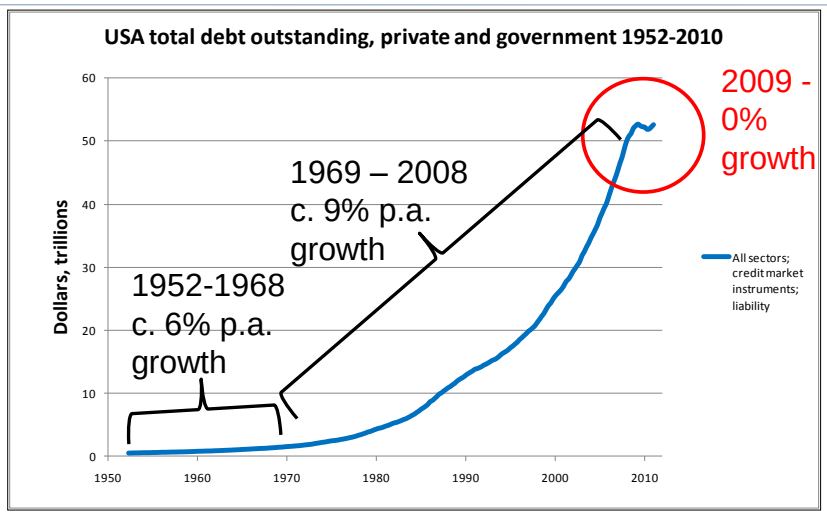

100 year low – then 110 year high within 8 years

Source: GMO Quarterly Letter, April 2011

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## Red Pill or Blue Pill?




Source: United States Federal Reserve data download program

http://www.federalreserve.gov/datadownload/

## Red Pill or Blue Pill?
## Opportunities for Actuaries

- The world needs unbiased forecasting – not optimistic or pessimistic. Actuaries are ideally suited for this role:*
  - Long term thinking
  - Base decisions on data; scientific approach
  - Experts in risk and modelling
  - Exponential growth is bread and butter
  - Experts in the financial system
- This is potentially a huge area of work for actuaries; we can be leaders in this field.

*We care about removing bias "Making actuaries less human: Lessons from behavioural finance" by Nigel Taylor http://www.sias.org.uk/siaspapers/listofpapers/view_paper?id=BehaviouralFinance.

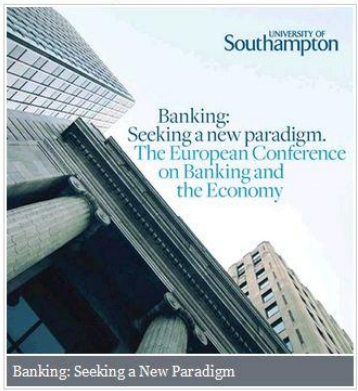
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## Red Pill or Blue Pill?
## One possible area – Reform of financial system?

Centre for Banking, Finance and Sustainable Development

European Conference on Banking and the Economy



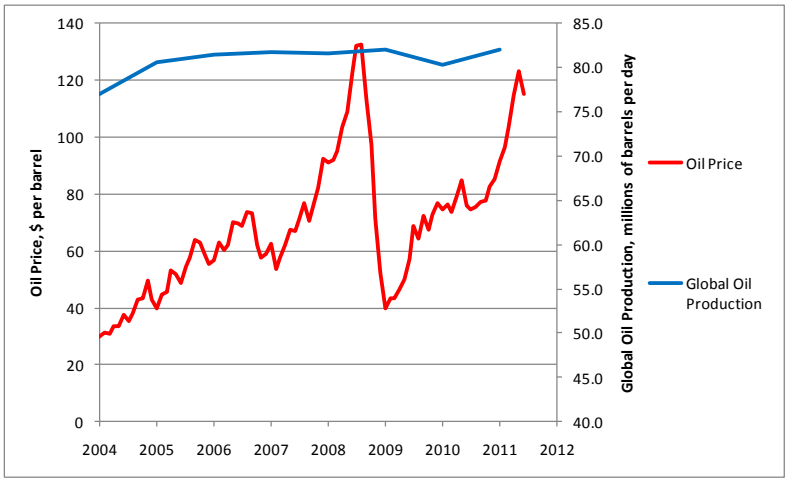

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IRFA Bronze Sponsor

This was a conference on 29th September 2011 organised by Prof. Richard Werner

Keynote speakers: Lord Adair Turner and Professor Charles Goodhart

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## Oil Price and Global Oil Production 2004- Supply has not yet responded to price signal

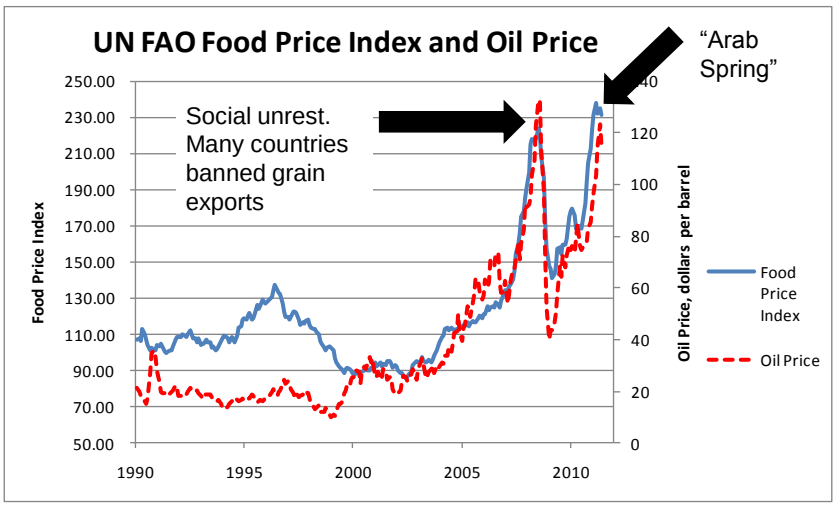



Sources: Oil Price – United States EIA http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=rbrte&f=m
Oil Production: BP Statistical Review of World Energy 2011
http://www.bp.com/sectionbodycopy.do?categoryId=7500&contentId=7068481

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## Oil and Food Prices




Sources: http://www.fao.org/worldfoodsituation/wfs-home/foodpricesindex/en/
http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=rbrte&f=m

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## What about alternative energy sources?

There are plenty of alternative hydrocarbons:

- Tar sands
- Oil shale
- Shale gas
- Coal (can convert to synthetic oil – “coal to liquid”)

However:

- Transport needs liquid fuel. There are no easy substitutes*
- The alternatives emit more carbon – this is highly dangerous

*Refer: Hirsch Report, 2005 for the US Department of Energy
http://www.netl.doe.gov/publications/others/pdf/Oil_Peaking_NETL.pdf

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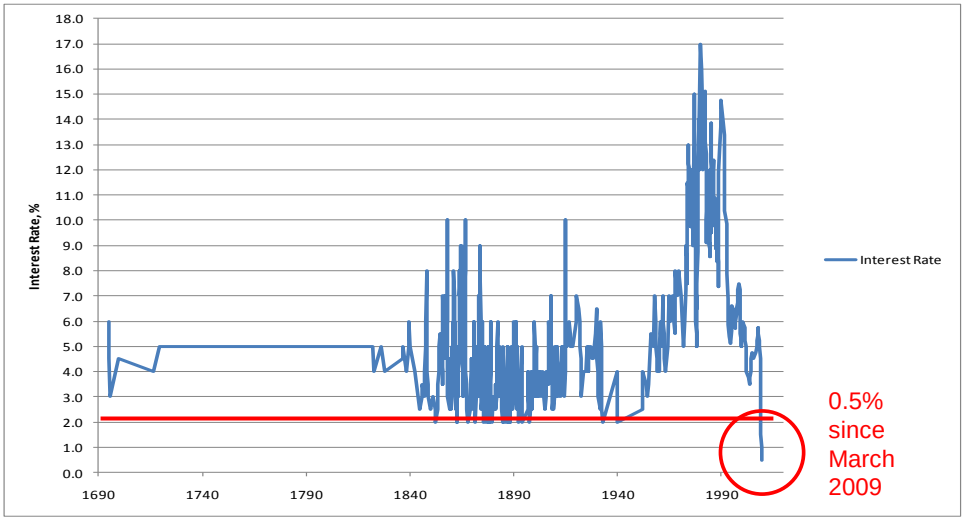
## Renewable Energy Sources

- There is a huge amount of renewable energy available: wind, wave, tidal and solar
- However, these energy sources are diffuse
- Problem is in capturing, concentrating and storing the energy
- This requires huge investment
- Can the investment be ramped up quickly enough to avoid “energy descent”? (i.e. decrease in per capita energy availability)

Refer: David Mackay “Renewable Energy Without the Hot Air”

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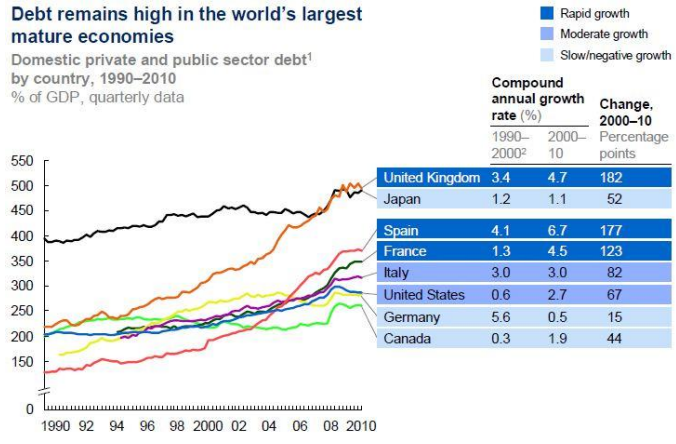
# Bank of England Base Rates since 1694




Source: Bank of England http://www.bankofengland.co.uk/monetarypolicy/decisions/decisions11.htm

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# McKinsey Global Institute
# Debt to GDP Ratios in Western economies




Source: McKinsey Global Institute 2010 "Debt and Deleveraging: The Global Credit Bubble and its Economic Consequences"

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## "… deleveraging has followed nearly every major financial crisis in the post-World War II period."

The four archetypes of deleveraging:

1) Austerity (or "belt-tightening) in which credit growth lags behind GDP growth for many years
2) Massive defaults
3) High inflation
4) Growing out of debt through very rapid GDP growth ?

My guess: High inflation is most likely. Inflation will be >10% within the next few years – although deflation is also possible.

Source for the four archetypes of deleveraging: McKinsey Global Institute 2010 "Debt and Deleveraging: The Global Credit Bubble and its Economic Consequences"

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## The credit crunch
## A risk management failure

- ``Yes, I found a flaw," Greenspan said in response to grilling from the House Committee on Oversight and Government Reform.



Ex Chairrman of the Federal Reserve Alan Greenspan, testifying to US Congress about the financial crisis, October 2008.

``We cannot expect perfection in any area where forecasting is required," he said. ``We have to do our best but not expect infallibility or omniscience."

## Worldview

- "Worldview" = beliefs, attitudes and values that make up our mental model of the world.
- Our worldview is our window on the world.
- It is also a filter. We tend to see only information that confirms our existing worldview.
- Psychologists call this assimilation bias.



Refer to: "Making Actuaries Less Human – lessons from behavioural finance"

## Cognitive Dissonance

Inconsistent cognitions produce dissonance (a state of unpleasant arousal) when:

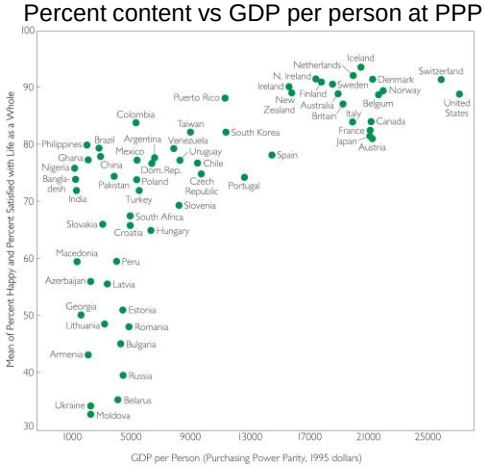
- You have freedom to decide
- You are committed to your behaviour
- The behaviour leads to forseeable adverse consequences

The easiest way to reduce dissonance is to **change beliefs**.

Refer: "Mistakes were made (but not by me)" by C.Tavris and E.Aronson

## Prosperity Without Growth
## Happiness versus GDP per capita

Percent content vs GDP per person at PPP



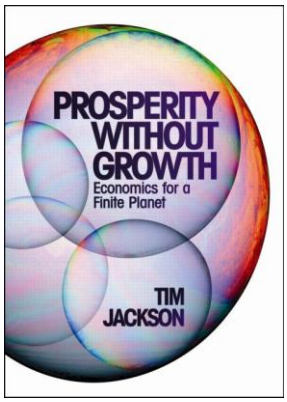

- When material needs are met, further wealth doesn't have much effect on happiness.

Source: Jackson, T. (2009) *Prosperity Without Growth? Economics for a Finite Planet*, Routledge, London, UK.

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## Prosperity Without Growth
## Summary of the argument




- Poor nations need growth for basic needs.
- For rich nations, much consumption is competitive. Competition induces anxiety.
- Trying to grow carries great risks and might not be possible much longer.
- For rich nations, it's in our self-interest not to grow any more.
- Trade wealth for leisure.
- Alternative steady state economics exists, we can change if we want to.

Source: Jackson, T. (2009) *Prosperity Without Growth? Economics for a Finite Planet*, Routledge, London, UK.

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## Prosperity Without Growth
## Economist and Nobel Laureat Robert Solow

"It is possible," says Solow, "that the United States and Europe will find that, as the decades go by, either continued growth will be too destructive to the environment and they are too dependent on scarce natural resources, or that they would rather use increasing productivity in the form of leisure. . . . There is nothing intrinsic in the system that says it cannot exist happily in a stationary state."

From Harper's Magazine, March 2008

## Prosperity Without Growth?
## JS Mill on the stationary state

**John Stuart Mill, Principles of Political Economy,1848**

"I cannot, therefore, regard the stationary state of capital and wealth with the unaffected aversion so generally manifested towards it by political economists of the old school. … **I confess I am not charmed with the ideal of life held out by those who think that the normal state of human beings is that of struggling to get on**; that the trampling, crushing, elbowing, and treading on each other's heels, which form the existing type of social life, are the most desirable lot of human kind, or anything but the disagreeable symptoms of one of the phases of industrial progress." [my emphasis]

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## Prosperity Without Growth?
## JM Keynes

**John Maynard Keynes, 1945**

"The day is not far off when the economic problem will take the back seat where it belongs, and the arena of the heart and the head will be occupied or reoccupied, by our real problems — the problems of life and of human relations, of creation and behaviour and religion."

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## Prosperity Without Growth
## Why are politicians so afraid of growth stopping?

Our economic system depends on growth because:

- Improving technology drives increasing productivity.
- Productivity growth means the same number of people can generate more goods and services.
- People need to consume those additional goods & services or unemployment rises.
- Therefore the economic system we have needs rising consumption to function.
- Fractional reserve banking system adds to instability.

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## Prosperity Without Growth
## We have a Culture of Exponential Growth

- Some things we “know” without learning. We “know” that economic growth is always good at all times, for everyone.
- These things that we “know” are cultural rules, not absolutes.



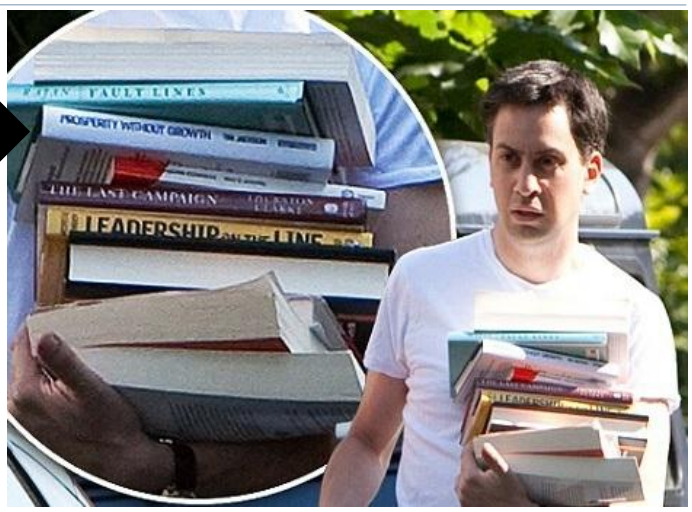
- The ancient Egyptians knew they should build pyramids.
- They were not built by slaves but by workers.

Source: http://www.nationalgeographic.com/pyramids/pyramids.html
and http://news.bbc.co.uk/1/hi/8451538.stm

## Prosperity Without Growth
## Maybe the time has come?

In Ed Miliband’s holiday reading – August 2011

“Prosperity Without Growth” by Prof. Tim Jackson




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