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*Brain Stimulation and Genetic Engineering:
Quantum Leaps to Improve the Future of
Humanity (with Implications for the
Economics of Climate Change)*

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We (mankind) are facing

- Huge dangers!
- Great opportunities!
- At the same time!

Compared to 100 yrs ago

- The danger that the whole of mankind may become extinct within either 100 yrs or 1,000 yrs has increased by at least 10 times.
- Nuclear wars, global warming, other environmental disasters, misuse of technology (e.g. nanotechnology), etc.

But, if we managed to avoid extinction

- Almost certainly (>99%) increase our welfare (net happiness) by >100 times in 100 yrs, and >1,000 times in 1,000 yrs!
- By brain stimulation (BS) of pleasure centres.
- By genetic engineering (GE).
- Expected welfare still higher.

We are at the cross road of

- Jumping into Hell (extinction)
- Leaping into Heaven (bliss).
- 跳下地狱？走上天堂？
人类面临灭亡与极乐十字路口
- The huge difference never been bigger.

The fruits of

- BS could be achieved in 5 yrs,
- from the start of a project to promote its widespread use.
- GE within 10-100 yrs.

- Positive reward of BS was discovered by Olds and Milner (1954) .
- Rats willing to cross a painful shock grid to obtain BS.
- pleasure so intense, rats prefer BS to food and sex, and if not stopped, will seek stimulation til exhaustion.
- Humans, *'patients [with] emotional or physical pain experienced such intense pleasure with stimulation that the pain was obliterated'* (Heath, John and Fontana 1968, p.188).

BS as a 'primer' of well-being

- Heath (1964, p.236) reported, '*strong pleasure [from brain stimulation] was associated with sexual feelings, and in most instances the patient experienced spontaneous orgasm ... This patient, now married to her third husband, had never experienced orgasm before she received ... stimulation to the brain, but since then has consistently achieved climax during sexual relations.*'

Solving social problems

- Social problems as drug addiction, crimes and (mental) depression, etc. largely solvable with the widespread use of BS.
- In comparison to BS, the use of addictive drugs like heroin is a very inefficient and dangerous method of achieving a 'high'.

Addiction?

- BS addiction is not dangerous to health.
- Strong evidence: proper use (Patterson and Kesner 1981) of BS over a sustained period for a long time (few hours daily over years) has proved quite safe. (See also Bolognini , et al. 2009 , Deuschl, et al. 2006 , Lozano, et al. 2008, Weaver, et al. 2009, Nitsche, et al. 2008, *Wassermann , et al. 2008.*)
- *Limit use to 7-10pm?*

- Rats choose to use EBS until exhaustion but humans only for “up to half an hour daily” (Sem-Jacobsen, in Delgado 1976, p.484).
- Relative to other pleasures and objectives, the pleasure of BS not compelling for humans (Bishop, Elder and Heath, 1964; Valenstein, 1973, p.28).
- Perhaps God made us this way so we could eventually provide happiness not only for ourselves but also for animals.

Beauty of BS

- 1. No loss of novelty value like TV, etc.
- 2. No diminishing marginal utility.

Unnatural?

- 300 yrs ago: sitting in the living room for hours looking at the shadows in a box.
- All civilized things are 'unnatural'.

Will God approve BS?

- If I were God, I would want my creatures to enjoy.
- No commandment against BS.
- If not why create us this way?

- 详见财经网，黄有光博客：
- <http://blog.caijing.com.cn/>

Genetic Engineering

- 主要增加粮产, 医药治疗 .
- 长期 : 改造我们自己。
- 快乐水平大致基因决定。
- 多消费不能增加快乐, 乐极生悲。
- 选择乐观、外向等基因。
- 直接减低痛苦, 提高快乐水平 ;
- 改良健康, 提高智力, 延长寿命。

Yes, have to be very careful

- With sufficient safeguard, the danger of extinction or comparable disasters <
- The danger of extinction of 'business as usual' without serious attempts to address environmental protection
- The difference of benefits are many thousands times!

Huge happiness potential

- Should increase our willingness to sacrifice current consumption to safeguard our survival.
- A point missed by current environmental economics which concentrates on

Consumption Tradeoff

- Stern 2007 Review, Nordhaus 2007 and Weitzman 2007 JEL reviews, Cole 2008, Dietz & Stern 2008, Sterner & Persson 2008, Heal 2009, etc. emphasizes the discount rate.
- A million dollars 200 years from now has a present value of \$59,618 discounted at 1.4% p.a. (used in the Stern Review);
- Only \$35 discounted at 5% (a rate commonly used);
- A difference of 1,700 times! Reject Stern?

vs. Catastrophes Avoidance

- Focusing on the more important issue of catastrophes avoidance, urgent and strong actions may well be justified more.
- Happiness studies and technological advances reinforce the need for strong actions.

Ramsey's approach

- maximizes social welfare or the utility of a representative individual through time to infinity as a function of the consumption level of the contemporaneous period only.
- Ramsey's equation for the discount rate r :
- $r = \delta + \eta g$
- where δ = rate of pure time preference, η = elasticity of marginal utility (% decrease in MU as consumption by 1%), and g = per capita growth rate of consumption.

Time preference

- An individual may be myopic/impatient/irrational and has a positive pure time preference.
- Global warming: perspective is the whole society for both the present and future.
- Impartiality requires: welfare of future people treated similarly to the present (Ng 2005).
- No pure time preference should be entailed.
- A valid reason for ρ to be positive.

Future utility is less certain

- A discount rate to reflect this uncertainty is fully justified even with impartiality between the present and the future (Ng 2005).
- “Intergenerational impartiality: Replacing discounting by probability weighting”, *Journal of Agricultural and Environmental Ethics*, 2005, 18(3), pp 237-57.

What rate?

- The Stern Review adopts an annual uncertainty discount rate = 0.1%.
- Many regard this rate as being too low or prefer using higher rates. (See, e.g. Nordhaus 1994, 2007; Quiggin, forthcoming; Yohe 2006. A rate of as high as 3% has been suggested.)
- In my view, as the (constant, for simplicity) rate of pure survival uncertainty, the rate of = 0.1% is **VERY** excessive.
- Should be at least ten times smaller: < 0.01%.

Annual Risk of Extinction and Survival Probability

Probability of		Annual value of	
Survival till next	= 1%	= 0.1%	= 0.01%
100 years	36.6%	90.48%	99.005%
1,000 years	0.004%	36.77%	90.48%
2,000 years	(10⁻⁶) · 0.186%	13.52%	81.87%
5,000 years	(10⁻¹⁹) · 0.15%	0.672%	60.65%
8,000 years	(10⁻³²) · 0.12%	0.0334%	44.93%
10,000 years	(10⁻⁴¹) · 0.225%	0.004517%	36.79%
100,000 years	Virtually zero	(10⁻⁴¹) x 0.35385 %	0.0045377%

Our history

- Earth: 4.5 billion years.
- Life on earth: 3.5 - 4 billion years.
- Mammals: 200 million years ago.
- Primates: 40 million years.
- Great apes: 15 million.
- *Homo*: 2.5 million years.
- *Homo sapiens*: half a million years.

An important distinction.

- The higher probability of extinction due to factor (such as celestial collision) unrelated to global warming should increase our uncertainty discount rate δ and hence decrease our willingness to sacrifice our present consumption for future benefits.
- The higher probability of extinction due to global warming itself should increase our willingness to sacrifice our present consumption to avoid or reduce global warming.
- Because our sacrifice will help to reduce the probabilities of extinction.

- For measures that help to reduce/avoid catastrophes, δ should not be taken as given.
- Largely ignored in most analyses.
- If δ is taken as given, the problem is simply intertemporal consumption trade-off. Then, the higher the uncertainty discount rate δ , the less willing we should be to sacrifice current consumption for future consumption.

Ramsey's equation for discounting

- $r = \delta + \eta g$
- η = elasticity of marginal utility (% decrease in MU as consumption by 1%),
- Diminishing marginal utility the higher the consumption level, the lower MU. The higher growth rate g , the higher will future consumption be higher than the present one.
- Thus, ηg gives how much lower MU of consumption is less than that of a year before. [intertemporal comparability and unchanged utility function].

What values?

- The Stern Review takes $\delta = 0.1\%$, $\beta = 1$, and $g = 2\%$, giving a discount rate of $r = 2.1\%$.
- Most commentators regard this as too small.
- Nordhaus (2007, p. 694) prefers a rate of 5.5% (from $\delta = 1.5\%$, $\beta = 2$, and $g = 2\%$);
- Weitzman (2007, p. 707) prefers a rate of 6% (‘a trio of twos’, i.e. $\delta = 2\%$, $\beta = 2$, $g = 2\%$).
- As an uncertainty discount, even $\delta = 0.1\%$ is excessively high.

= 1; too low

- total utility goes to infinity as consumption does. Obviously impossible as no one is capable of infinite happiness no matter how high is consumption, due to biological limitations.
- Weitzman (2007, p. 707) finds $\beta = 3$ reasonable. This, even with $\beta = 0$, still gives $r = 6\%$ (with $g = 2\%$).
- Is $g = 2\%$ reasonable?

Table 2
The number of times future output will be larger

After	Annual g = 1%	Annual g = 2%
100 years	2.7048	7.245
200 years	7.316	52.485
500 years	144.77	19,956.57
1,000 years	20,959.16	10⁸ · 3.98265
2,000 years	10⁸ · 4.39286	10¹⁷ · 1.58615
5,000 years	10²¹ · 4.04454	10⁴³ · 1.00198
10,000 years	10⁴³ · 1.63583	10⁸⁶ · 1.003963
20,000 years	10⁸⁶ · 2.676	10¹⁷² · 1.00794

- Growth may consist in services and leisure.
- Still, with productivity in the order of 10 to the power 172 times that of our current one implies that a single worker would be able to produce the value of output many quintillion times more than the value of the weight of the whole universe in gold in less than a tiny fraction of a second!
- Optimist as I am, I do not think that this would ever be possible, not to say in 20,000 years from now. Thus, economic growth may be at the level of 2-3% for many more decades; it must eventually slow down. Taking $g = 2\%$ indefinitely is thus misleading.

- Some truncate the time horizon, looking say at only the next one or two hundred years.
- Though the probability that we will survive more than two hundred years should be much higher than 50%, this simplification is not too misleading, if the problem is just that of intertemporal consumption tradeoff, especially if the discount rate is around or more than the more common value of about 5%.

- A stream of value worth \$100 in real terms from the year 201 **every year** through to infinity, discounted at 5%, has only a present value of **\$0.1156 in total!**
- This underlines the misleading nature of focusing on intertemporal consumption tradeoff for problems like global warming that have long-lasting effects and that may lead to catastrophic outcomes threatening our very survival.

- Weitzman (2007) correctly mentions that, in dealing with global warming, the expected growth rate should have ‘a thick left tail’ (p.718);
- but acknowledges that ‘we lack a usable economic framework for dealing with these kinds of thick-tailed extreme disasters’ (p.723). Weitzman (2009).
- The next section outlines a method in dealing with such catastrophes.

Towards an Economic Analysis of Catastrophes Avoidance

- Nearly two decades ago, I discussed ‘decisions (e.g. ... environmental protection...) that may affect the probabilities of the continued survival of the human race’ (Ng 1991, p.79).
- “Should We Be Very Cautious or Extremely Cautious on Measures that May Involve Our Destruction? On the Finiteness of Our Expected Welfare”, *Social Choice and Welfare*, 1991, 8(1): 79-88.

- Traditional economics, especially with the insistence on ordinal utility, cannot analyse catastrophes
- Which requires the comparisons of total utilities/welfares with marginal utilities.

3 Methods

- 1. Estimate willingness to pay to reduce risk of death by observing actual choices.
- 2. By asking people.
- 3. From postulated cardinal utility/happiness functions.
- Economists skeptical of the last two.
- Behavioural economics.

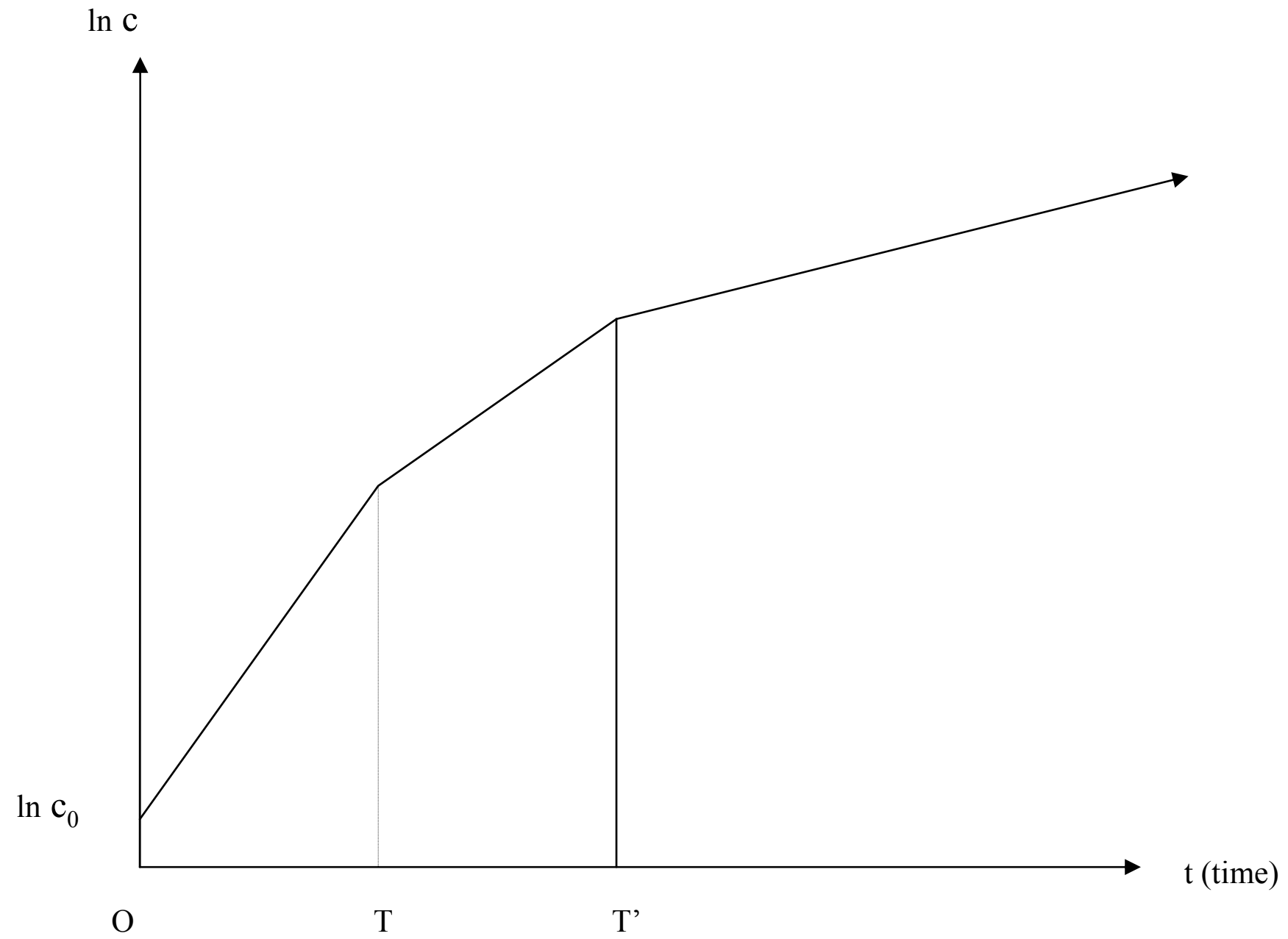
Happiness studies

- Results in happiness studies provide some clues.
- Suggest high value of total utilities relative to marginal utilities.
- Hence justities immediate and strong actions to reduce global warming.

Crux of the difference

- Consumption in the far future very unimportant as r should be large (5%).
- Very important to avoid/reduce catastrophes as expected future welfare (total utility) very high,
- And pure uncertainty discount should be very low ($< 0.01\%$).

An Illustration



- “Business as usual”: $EU1 = 151.34 + 97.24 + 3,208.87 = 3,458.45$
- Consumption trade-off only: $EU2 = 131.18 + 94.24 + 3,211.33 = 3,316.75$
- Catastrophes reduction: $EU3 = 126.04 + 93.87 + 9,751.07 = 9.860.98$.
- Potential strong support for immediate and strong actions at environmental protection.

Future Technological Advances

- Such as brain stimulation, genetic engineering discussed above
- That may lead to quantum leaps in our welfare
- Further reinforce the results of happiness studies.

**May we save ourselves from our
own destruction!**

Thank you!

- **刺激大脑，享受人生极乐；**
- **改良基因，打开生死玄关。**