

The Da Vinci Code of Climate Change Economics

or

**What are the real benefits of avoiding predicted
climate change, and what are the costs?**

Tim Curtin
Emeritus Faculty,
Australian National University

A presentation to The Lavoisier Group's 2007 Workshop

'Rehabilitating Carbon Dioxide'

held in Melbourne on 29-30 June 2007

The Da Vinci Code of Climate Change Economics
Or
What are the real benefits of avoiding predicted climate change,
and what are the costs?

*Lavoisier Group Workshop: Rehabilitating carbon dioxide
Melbourne, 30th June 2007*

Tim Curtin
Emeritus Faculty, Australian National University

Abstract

This paper points out deviations by the Stern Review from the normal tenets of cost-benefit analysis, especially in its assumption that declining marginal utility of income is a basis for its very low social discount rate, and its disregard of the opportunity cost approach to the role of discounting in investment analysis. The Review's inadequate treatment of the price effects of emission abatement cap and trade measures is also found in an Australian report "Deep Cuts in Greenhouse Gas Emissions". This paper questions the claims of the IPCC and the Stern Review that the predicted warming climate over the next 100 years will have serious adverse economic consequences for the poor everywhere and above all in Africa. Finally, the paper suggests that attempts to reduce carbon emissions by systems of caps and trades are unlikely to produce any net reductions in emissions.

The Da Vinci Code of climate change economics is a formula tucked away in an appendix to an early chapter in the *Stern Review* and has perhaps attracted more attention from economists than almost any other section of the *Review*. Not many have noticed that while the formula is intended to justify Sir Nicholas Stern's wildly overstated estimate of costs of climate change, if we do not begin vigorously to mitigate greenhouse gas emissions, and his equally grossly under-estimated costs of achieving those reduced emissions, the formula itself is riddled with enough inaccuracies and inconsistencies to justify a sequel by Dan Brown to his novel *The Da Vinci Code*.

Stern's Da Vinci Code is this equation¹

$$\rho = \eta (\dot{c}/c) + \delta \quad (1)$$

where ρ is the holy grail in its manifestation as the discount rate, or the "rate of fall of the discount factor" (*Review*: 52), η is the elasticity of the marginal utility, i.e. the rate of change of the utility derived from an extra unit of income as our income level increases and is deemed to be 1.0 at all times, (Guo *et al.* 2006), \dot{c}/c is the rate of

¹ The equation originates in the "neo-classical" discounting rule with its claim that if "we discount later enjoyments in comparison with earlier ones, [that] is a practice which is ethically indefensible and arises merely from the weakness of the imagination" (Ramsey 1928:543). Ramsey then in Part I of his paper abstracts from discounting.

growth of consumption (usually assumed by Stern to be 2% pa), and δ is the da Vinci factor, or “pure time discount rate” (*Review*:52), (usually referred to as the “pure rate of time preference” as in Guo *et al.* 2006:207), which Stern sets at only 0.1 because he expects the world to end in 2100 with a probability of 0.095 (just under 10%).² Stern even states (2006:53) that if $\delta = 1.5$, that implies a probability of 77.7 per cent that the world will not last 100 years with or without climate change mitigation. If this reminds anyone of Bishop Usher’s meticulous calculation that the age of the world is only 6,000 years or so, that is not a coincidence, because Stern does see himself as some sort of Old Testament prophet, except when he becomes imbued with Islamic views on the rate of interest, as we shall see. Tol and Yohe (2007) have also noted the suggestion that if the probability of extinction is as high as nearly 10 per cent within 100 years, avoiding this possibility should have a higher priority than mitigating climate change, because a 10 per cent probability of total extinction must outweigh a 90 per cent probability of climate damage of just 5 per cent of global GDP.

Putting that on one side, Stern’s da Vinci equation is developed in Section 2A.2 of the *Review*, “**Discounting: a very simple case**”. Here the *Review* (51) states “the key concept for discounting is the marginal valuation of an extra unit of consumption at time t , or *discount factor*, which we denote by λ ”.³ The *Review* (52) somewhat inconsistently adds that its “discount factor” is nothing of the sort, by redefining λ as “the marginal utility of consumption” while “the rate of fall of the discount factor (sic) is the discount rate (sic) which we denote by ρ ” (2006:52). In the calculus that means that ρ is the first derivative of λ and cannot also be as defined in (1), Stern’s code. The declining marginal utility of consumption (if any) is not the same thing as time preference, which is what really underpins the concept of discounting, and Stern’s claim that the former is the same as the latter is one of the many justifications for Richard Tol’s assertion that Stern is not fit to teach economics (see below).⁴

Standard texts give quite different justifications for discounting. For example Edwin Mansfield’s *Managerial Economics* (1993:A-1): “one of the basic propositions in managerial economics [is that] *a dollar received today (i.e time t) is worth more than a dollar received a year from today (i.e time $t + 1$)*...because one can always invest

² Nordhaus (2006) believes that in practice δ was Stern’s “social discount rate”. Astonishingly, Stern in the Appendix to his *Review*’s Chapter 2 that sets out his da Vinci code, *never* discloses what is the value for ρ that he used to discount future costs of climate change to present values. It is also to be noted that the da Vinci equation does not appear in any textbook on managerial finance or project appraisal. These content themselves with the standard equations for discounting cash flows and deriving the internal rate of return. For example, Mansfield (1991) mentions neither declining marginal utility in his exposition of discounting principles, nor discounting in his exposition of marginal utility. Similarly, Ramsey’s classic paper

³ The *Stern Review*’s definition of the “discount factor” is inconsistent with that in one of the most widely used and reprinted financial textbooks, Brealey and Myers (1996:12) where their “discount factor” is simply the discount rate, i.e. the reciprocal of the applicable interest rate, $1/(1+r)$, whereas Stern’s discount rate is ρ in $\rho = \eta (\dot{c}/c) + \delta$. **These equations are not the same!**

⁴ Probably LSE did not reappoint Stern for his teaching skills (he is unlikely to do any teaching) but for his connections with the Treasury, the source of all largesse for LSE at the Treasury.

money that is available now and obtain interest on it” (Mansfield’s italics). Thus \$100 saved today would be worth \$106 in a year if the interest rate is 6 per cent, which is more than \$100 in a year’s time. Even Ramsey admits that “if I can borrow or lend at a rate r I must necessarily be equally pleased with an extra £1 now and an extra £(1+r) in a year’s time, since I could always exchange the one for the other. My *marginal rate of discount for money* is, therefore, *necessarily r* ” (1928:553, my italics). Stern’s comment asserts that nonetheless \$106 in a year’s time will be worth less than that because in effect marginal utility falls faster than the compounding effect.

Stern’s so-called “discount factor” λ is absent from the investment textbooks, for the good reason that it is not a discount factor but a version of the hoary nineteenth century economists’ “diminishing marginal utility of money”.⁵ That does not have a time dimension, since it simply asserts that at any time *including the present* we will value some extra money less per dollar than we value the last dollar of our previous holding, and there is indeed no connection between the elapse of time and the utility of money. Ramsey was careful to keep the rate of discount for utility separate from that for money, unlike Stern, who produced nothing but muddle by conflating them.

Stern’s next assertion is that ρ , “the rate of fall (sic) of the discount factor (sic) (λ) is the *discount rate*” (2006:52, his italics). Thus Stern’s discount rate inhabits a different world from Mansfield’s, since his has nothing to do with time and is simply a restatement of the declining marginal utility of income of long defunct economists. But it is not the case that a dollar in a year will have less *utility* than a dollar now when received in a year’s time, only that when valued today, it is less valuable than today’s dollar. Wage or salary earners receiving \$50,000 in the course of 2006 will not value that more highly than the \$50,000 they receive during 2007 as they receive it, *cet.par.*, even if prior to 2007 they may well have “discounted” it in the manner described by Mansfield above. There is no reason why the *utility* one derives from one’s house and lifestyle should be less in the year of current consumption than it was in the previous year, even if in 2006 the “present value” that year of what was then the future value of 2007’s income was less than the 2006 value. The London Stock Exchange would be a very strange animal if it had to maintain past year’s valuations of this year’s company performance, more so if it had to *reduce* this year’s valuation in accordance with Stern’s da Vinci equation with either its fictitious λ “discount factor” or ρ , its bogus “discount rate”.

The next term in Stern’s da Vinci equation is η . But just as ρ is “**the rate of fall of the discount factor**” (λ), so also is η “**the elasticity of the marginal utility of consumption**”, as derived from λ , which “**is essentially the discounted marginal utility of consumption along the path**” (Stern: 52). In effect ρ , η and λ are either the same – or aspects of - the same entity and that means, in terms of Occam’s Razor, Stern’s da Vinci is serially over-determined.

⁵ The British Government’s Treasury’s Green Book (2003) whilst using a version of the da Vinci equation that is close to Stern’s also provides a Table of the “discount factors” that apply to money but not to utility, since given the applicable interest rate, we can use the discount factors to derive the present value of money accruing at any given time in the future, whereas the utility discount factor has to encompass both the time dimension and the lower unit valuation of extra money, and not even HM Treasury has been able to produce a table showing this hybrid.

Clearly Stern’s discounting has nothing to do with the concept found in finance textbooks, and ρ , η , and λ are all manifestations of Stern’s obsolete assumption that there is some measurable and always declining entity, the marginal utility of consumption (or income). The ever-increasing take-home pay of the CEOs of the top companies suggests that they suffer no loss of marginal utility from each extra million dollars.⁶

The *Stern Review* (52) does concede that η – the elasticity of the marginal utility of consumption – is “essentially a value judgment. If for example $\eta = 1$, then we would value an increment in consumption occurring when utility was $2c$ as half as valuable as if it occurred when consumption was c ”. (But then why do we need the inscrutable da Vinci equation? –is it just a diversion intended to give scientific verisimilitude to an otherwise bald and unconvincing narrative? Stern could have merely decreed like Humpty Dumpty that the discount rate for determining the present value of the costs of future climate change was whatever he said it was, in practice 0.1, irrespective of the persiflage of his equations. In effect that is what the *Stern Review* does in the end, for plugging in the sort of values it mentions, with $\eta=1$, and the rate of growth of consumption at 2% p.a. and $\delta = 0.1$, we then have an outcome that he totally disregards, since he actually used 0.1% as his “utility discount rate” and 1.4% as his “money discount rate” (Tol, in Quiggin 2007):

$$\rho = 1 * (1.02) + .01 = 1.021 \quad (2)$$

A real discount rate of 2.1 per cent is comparable with the current US Ten Year bond yield of 4.89 per cent less the 2.4 per cent increase in the CPI to date in 2007, i.e. 2.5 per cent (*The Economist*, 2 June 2007). However Stern does not provide this calculation, even though it produces a perfectly plausible real discount rate for the USA at least, which raises the question of why he bothered to develop and justify this over-determined and ultimately disregarded formula.

It is interesting to note that Gordon Brown’s Treasury’s *The Green Book: Appraisal and Evaluation in Central Government* (HM Treasury, 2003) deploys Stern’s da Vinci equation, albeit with different notation, and a different outcome:

$$r = \rho + \mu g \quad (3)$$

where $r = \rho$, $\rho = \eta + \delta$, $\mu = \eta$, and $g = (\dot{c}/c)$. The inability of HM Treasury and its Chief Economist to agree on algebraic notation may well tell us a lot about Britain’s new prime minister, given that he presided over this incoherence. However the Green Book did produce the following results from its version of the da Vinci code, that with $g = 2$ per cent, $\rho = 1.5$ per cent and $\mu = 1.0$, the “social time preference rate” would be 3.5 per cent over the next 30 years, but falling to 2.5 per cent by 2100.⁷

⁶ However these huge payouts could be interpreted as necessary compensation for declining marginal utility.

⁷ The Green Book cites various British economists (Newbery, Pearce, Scott) for its belief that declining marginal utility of consumption has something to do with discounting, even though their views have not made it to the standard textbooks.

Some have thought (Tol & Yohe 2006 amongst others) that in practice the *Stern Review* merely used the da Vinci number it first thought of, $\delta = 0.1$, which is really saying one should not discount future costs at all, as 0.1 is hardly different from zero, and a rate of 0.1 makes what would be a relatively small number in 2100 seem much bigger now, in terms of a percentage of world GDP.

Given the level of global GDP in 2005 (US\$35,000 Billion), if that grows as Stern states at 2.5 per cent p.a. from 2006 to 2100, it reaches US\$356,423 Billion in 2100. Then from Stern's damages from climate change at 5 per cent of GDP "now and forever", the damage in 2100 is US\$17,827 Billion. Discounting that at 0.1 per cent produces a Present Value in 2006 of US\$17,738 billion, or almost exactly 50 per cent of world GDP in 2006.

So that cannot be right. Given that 5% of world GDP in 2005 was US\$1,794 Billion, the Future Value of that sum in 2100 at the Stern rate of 0.1 per cent would be US\$1,973 Billion or only 0.55 per cent - and not 5 per cent - of world GDP in 2100. The implication is that in practice Stern discounted back from the future to derive an alarming estimate of the present cost of damage from climate change, and compounded from the present to get his low estimate of the cost of mitigating that damage.

In normal cost-benefit analysis one computes the present values of costs and benefits respectively at that interest rate which reflects the cost of financing the project in question. If the net present value (NPV) is positive at that rate, the project is worthwhile. Alternatively, if the ratio of the present values is greater than one, then also the project is worthwhile. Given his claims that the benefits of avoiding climate change by stabilising greenhouse gas emissions are 5 per cent of world GDP "now and forever", and the costs of doing so are just 1 per cent of GDP, presumably also now and forever, Stern's assertion is that the cost-benefit ratio of 5:1 is greater than one and his project is worthwhile. But his *Review* at no point provides the Present Values in 2006 of the flows from 2006 to 2100 of the costs and benefits of avoiding climate change. HIS RATIO IS NOT IN FACT THE RESULT OF A DISCOUNTED CASH FLOW ANALYSIS. To my knowledge no previous commentators have noticed this deviation of Stern's *Review* from normal discounted cash flow cost-benefit analysis.

Clearly in practice Stern's model is totally mechanistic or determinist, just like the da Vinci code. Thus he simply extrapolates world GDP of US\$35,000 billion in 2005/6 to 2100 at a 2.5 per cent p.a. growth rate, which reaches US\$356,542 billion. On a per capita basis, GDP per capita would be US\$8,526 in 2100 as against US\$5,384 in 2006 (if the world's population grows on average at 2 per cent p.a.) Stern's headline estimate of the cost of climate change at 5 per cent of GDP "now and forever" implies that the cost this year would be c.US\$270 per head, and that this would rise to US\$426 by 2100. **In effect Stern says that climate change is like Australia's GST (i.e. VAT), which is 10% now and forever, and therefore climate change damage at 5 per cent of GDP will cost us here in Australia only half as much as our GST (but only less than a third of VAT in the EU, where it is 18% plus).** If we have survived GST, perhaps we will after all survive climate change without doing anything much about it.

Stern's ethical view of the discounting process goes back to Aristotle, Plato, the Prophet Mohammed, the Catholic Church in the middle ages, and more recently, to economists like Ramsey and Harrod. The Prophet and some of the Popes outlawed usury, i.e. the charging of interest, even though that is the expression of the wholly natural preference of both humans and the animal kingdom for present pleasures rather than deferred. When that preference for the present is absolute, as it was in Australia before 1788, it was not so surprising for Captain Cook and the First Fleet to find that there had been no accumulation of capital at all in Australia over the preceding 50,000 years or so – with no evidence of structures or machinery of any kind. Jared Diamond attributes this to climatic, botanical (grasses that produced no edible grain), and soil factors, but the lack of an institutional structure for mobilising savings also seems to be pertinent. I noted above Ramsey's claim that discounting is "ethically indefensible, and arises merely from weakness of the imagination" - but he gave no reasons for this view and subsequently in his paper accepted the reality of discounting (1928:553). Harrod (1948) concurred: "...pure time preference is a polite expression for rapacity and the conquest of reason by passion" (cited in Price, 1993:101). However Harrod's own growth theory was critically dependent on real interest rates. It is strange indeed to find economists like these and now Stern in league with the Prophet Mohammed, especially when even the Catholic Church has moved on!

A recent report also shows the debilitating effect of low discount/interest rates in Japan. After a decade of close to zero central bank rates, its level of business investment is 60 per cent higher than the USA's relative to GDP. "The inevitable result is an abysmal return on new investment. Japan has far the lowest ratio of personal disposable income to GDP of any Group of Five country. Despite its low household savings, it also has the lowest level of consumption".⁸

Ironically Stern's choice of such a low interest rate for his discounting, adopted on the ethical, i.e. non-economic, grounds that it is wrong to value future generations' welfare less than our own, means that his estimate of damage to the world economy in 2100 does not have to be very large for it to cause alarm and despondency now. If the damage in 2100 was seriously large, i.e. more than the equivalent of a 10 per cent GST or VAT, then it would withstand normal real discount rates of around 2 per cent to 3 per cent (the current rate on US Treasuries less the expected rate of inflation from now to 2100) to produce a present value that would arouse some concern now.

The other fallacy in Stern's discounting is that it abstracts from the normal use of the concept, which is to evaluate net flows of future costs of avoiding, *vis à vis* benefits from avoiding, climate change, against the *opportunity cost* of the funds or resources required to mitigate or adapt to the costs of climate change. This is a crucial distinction, and one that is totally disregarded by John Quiggin (2007).

His view is that:

In the case of the Stern Review of the economics of global warming, sensitivity analysis quickly reveals that the crucial parameter is the pure rate of time preference. ...If like Stern, you choose a value near zero (just enough to account for the possibility that there will be no one around in the future, or at least no one in a position to care about our

⁸ Andrew Smithers, *Financial Times*, 26 June 2007.

current choices on global warming), you reach the conclusion that immediate action to fix global warming is justified. If, like most of Stern's critics you choose a rate of pure time preference like 3 per cent, implying that the welfare of people 90 years (roughly three generations) in the future counts for about one-sixteenth as much as the welfare of people alive today, you conclude that we should leave the problem to future generations. So, responses to [the] Stern Review provide another kind of sensitivity analysis. If you don't care (much) about future generations, you shouldn't do anything (much) about global warming.

This is a false conclusion, not least because it merely parrots the *Stern Review's* allegation (2006:54) that "if you care little about future generations you will care little about climate change". However it is a serious perversion of the truth.

Let us begin with the Quiggin statement "if we choose a rate of pure time preference of 3 per cent implying that the welfare of people 90 years (roughly three generations) in the future counts for about one-sixteenth as much as the welfare of people alive today..." But if the global economy grows at 3 per cent per capita p.a. as is perfectly feasible given experience so far this century in China (GDP growth currently over 10 per cent p.a.) and India (8.1 per cent), with respective per capita growth rates of around 9 and 6 per cent) then in fact even the discounted (at 3 per cent) "welfare of people 90 years in the future" may well count *for more than the same* as the welfare of people alive today (China and India alone account for around 30 per cent of world population in 2007).

Moreover, our generation usually has an investment horizon of 30 years, which is the main reason why known 3P reserves of oil, gold, and other depletable resources are usually just 30-40 years worth of current consumption (BP's latest Report states that the world has proven oil reserves amounting to 40 years of current consumption) Furthermore, generations roll over seamlessly. Next year's coal project in China will also be based on a 30 year horizon, to 2037, and the one in 2008, to 2038 and onwards. If this 2007 generation accepted projects like Stern's with a less than 3 per cent real yield, next year's generation would be out of pocket relative to the cost of funds, which is actually 3 per cent real in Australia at the moment.

Above all, Stern – no doubt because of his World Bank background, and Quiggin, who has had no known career as an investment analyst - have long since forgotten if they ever knew the importance of the cost of funds as a determinant of the discount rate. For Gordon Brown to have proposed borrowing at the real Treasury Bill rate of 3 per cent to undertake say sea defence work now for avoidance of a flood risk that even Stern and the IPCC admit will not emerge before 2100 – and would create damage *at less than the cost of avoidance now compounded forward at 3 per cent p.a.* – would be the height of fiscal irresponsibility, which may well be why Stern found it expedient to leave the Treasury the day after Brown's 2006 budget statement totally ignored his *Review* (other than adding the price of a bottle of cheap wine to air fares).

Stern's *Review* in effect treats a damage valued at say \$100 in 2100 as equal to not much less than \$100 now, whereas I believe (along with Tol and Yohe 2006 and Nordhaus 2006) that it makes no sense to invest \$100 now to secure barely more than \$100 in 2100 when I could invest it and get \$105 *in a year's time*. **Constantly reinvesting to 2105 my heirs will then have \$12,524 from my \$100, and will be**

well able to cope with the damage of climate change valued at just over \$100 in that year by Stern's discounting.

Stern's claim to show that business as usual would result in falls in global GDP of "up to 20 per cent p.a. now and forever" was endorsed all too unthinkingly by those who should have known better, including Martin Wolf who gave Stern (a friend of his) ringing endorsements (November 2006) in the *Financial Times* and *The Australian*. Ironically it was the same Martin Wolf who equally enthusiastically endorsed (in the *Financial Times*, 20 December 2006 and *The Australian* next day) the World Bank's view (in its "Global Economic Prospects: managing the next wave of globalization", <http://www.worldbank.org>) that the size of the world economy will *double* by 2030 under a business as usual scenario, with nary a mention of Stern's "loss of GDP by 5-20% now and forever" or of policies to implement Stern's mitigation advocacy. Wolf added "neither environmental limits nor disease seems (sic) likely to halt the global economy over the next quarter of a century" – and did not even mention climate change.

Thus Stern's ethical discounting is a classic example of normative economics, i.e. policy driven economics aimed at some vision of what should be rather than what is or will be, whereas the positive or opportunity cost approach appraises all options, and selects that with the best financial outcome (or benefit:cost ratio) relative to the actual scarcity cost of current resources. In Stern's model, it matters not that there are no known current cash or economic costs of climate change, whereas there is a multitude of investment opportunities for both public and private funds that will earn enough over the next 30-50 years to cover the cost of the capital resources deployed to them, i.e. covering today's real interest rates on either public or private capital.

Moreover in positive economics one observes that in general most of us do not borrow at 10% to buy a bond that will yield only 6 per cent gross (*cet.par.*), whereas in Stern's normative or ethically pure economics, it is quite in order for governments to issue bonds or treasury bills with a nominal coupon rate of 6 per cent as now in Australia, and a real rate after inflation of around 3 per cent, for a real yield of up to 3 per cent p.a., in order to invest in climate change measures that yield a positive return only if the discount rate is 0.1 per cent.

In positive economics the discount rate is the reciprocal of the interest rate. Alternatively if Stern is to be believed, we can all go out now and borrow at his 0.1 per cent discount rate. If only we could all refinance our mortgages or credit card debts at 0.1 per cent p.a.⁹

⁹ The contributions by Richard Tol to John Quiggin's blog (<http://www.johnquiggin.com>) are also relevant and deserve wider attention: "It is the authority of the argument that counts, not the authority of the one that makes the argument... I pity the students of the London School of Economics for two reasons, and of U Queensland for one. First, despite having at least 50 person years of technical support at his disposal, Nick Stern produced a report that has so many technical flaws that it would fail as a master's thesis in economics. Someone like that is not fit to teach economics... Second, the technical errors aside, Nick Stern placed political expedience above intellectual honesty — by a selective review of the evidence, taking an extreme position on ethical matters, both without alerting the reader to this, and by refusing to do sensitivity analyses. You (JQ) seem to applaud this attitude, but I think it

Stern in Australia

Turning now to a Stern-type model used here in Australia by Philip Adams and Peter Dixon of Monash's CoPS with their MMRF-Green model. The latest version of the Monash model was the basis of the economic modelling in the Report *Deep Cuts in Greenhouse Gas Emissions* commissioned from Allen Consulting by the so-called Business Roundtable and its sponsor the Australian Conservation Foundation. From my recent work (2007) on forestry issues in Papua New Guinea, I have come to realise that all statements by the ACF on the extent of so-called "illegal" and "unsustainable" logging in that country are seriously flawed to the point of being fraudulent, and so it is with its Allen Report.

Just as Stern was at pains both to maximise the economic damage we may expect from really quite modest and gradual climate change while minimising the costs, so also with this Allen Report. However this Report has nothing specific to say about either present or future damage from climate change, and contents itself with claiming that the costs of getting Australia's CO₂ emissions down to only 40% of the 2000 level by 2050 will amount to a reduction in the economy's growth rate of only 0.1%, i.e. from 2.2% p.a. to 2.1% p.a, or a reduction in GDP of \$1 billion in 2050, not even \$50 a head. If fixing climate change is so cheap, what is the rush, and can it be that serious a problem? No doubt this very low not to say trivial cost estimate played an important part in the adoption in 2007 by the Australian Labor Party's leader Kevin Rudd of the emissions reduction target of 60 per cent of the 2000 level by 2050 as modelled by the Allen report.

But the Allen cost estimate derives from very serious flaws in the Monash model. First, we may note that in an earlier version, Philip Adams et al (2001) used it to show that the cost of Australia merely reaching its Kyoto target of emissions of 108 per cent of the 1990 level by 2012 would require a tax on CO₂-e emissions at \$44.33 per tonne from 2005, while their latest effort (Allen 2006), with a much more difficult target, reducing emissions by 60 per cent of the 2000 level by 2050, proposes that this can be done with a tax starting at only \$0.7 in 2013, and reaching \$44 only in 2041. Wonderful that with his climate policy of masterly inaction John Howard has reduced the costs of securing much deeper cuts than required by Kyoto to a fraction of the cost

disqualifies you and [Stern] as honest brokers of scientific knowledge. You abandoned your position as policy analysts, and adopted the position of policy advocates. Advocates have a useful role in society, but they do not belong at university. ([January 7th, 2007 at 10:18 pm](#)) With professors like that, I would think twice before hiring students from LSE or UQ. The empirical evidence is that people and their governments have a pure rate of time preference between 2 and 4% per year (at least in rich countries); not 0.1%. Saying that Stern's discount rate is close to the market is just hogwash. In sum, the Stern Review is very selective in the studies it quotes on the impacts of climate change. The selection bias is not random, but emphasizes the most pessimistic studies. The discount rate used is lower than the official recommendations by HM Treasury. Results are occasionally misinterpreted. The report claims that a cost-benefit analysis was done, but none was carried out. The Stern Review can therefore be dismissed as alarmist and incompetent. *Richard Tol* [January 8th, 2007 at 8:24 pm](#) (see also Tol and Yohe 2007).

of achieving Kyoto. If only he could be sure of re-election, at this rate the cost of achieving the ALP's 60 per cent target would fall to nothing.

By way of illustration, let me mention that the impact of the Allen carbon tax of A\$0.7 as of 2013 on my electricity bill in Canberra would be a tenth of one cent per kWh – yet we are asked to believe that this would be enough in 2013 to induce major investment in emission reductions, whether by converting coal fired power stations to gas or constructing windmills. I fancy that windmills will need to be able to earn more than a tenth of a cent above the normal retail price of power per kWh which is all that Allen and the ACF are disposed to offer them in 2013.

Second, there is a major problem in economic modelling of how to handle price changes. Generally the modellers limit their extent and make very strong assumptions limiting the impact of such changes to those that their models can manage. These assumptions include amazing claims about price and income elasticities that are at variance with the academic literature.

For example, the Monash model that underpins the Allen Report asserts that the price elasticity as between alternative sources of energy is 5, that is, that a 1 per cent increase in the price of coal fired power is enough to lead to an immediate 5 per cent switch from coal to gas or renewables or even nuclear, and so on for each successive 1 per cent increase in the cost of coal power arising from the escalating carbon tax in their model. Philip Adams, chief author of the Monash model, offers no justification at all for this very high elasticity, no doubt because there is none in the literature. Mansfield (1990:99) refers to studies in the USA (e.g. Halvorsen 1977) showing that the cross elasticity of demand for electricity v natural gas was 0.2, well short of the 5 assumed by Adams.

More recently Gately and Huntington (2001) have pointed out the asymmetric effects of up or down changes in both price and income on energy and oil demand. Stern refers to a later paper by Huntington on a different topic, but abstains from noting the earlier paper, which shows that the long-run income elasticity of demand for both energy and oil is about 0.55 for OECD countries, and 1.0 or higher for non-OECD, and that these relatively high elasticities “will increase projections of ... carbon dioxide emissions” (2001:1). For an OECD country like Australia this means that if the economy grows by 3% p.a., oil demand will grow by 1.65 per cent p.a., even though that means oil intensity of GDP declines by 1.35 per cent p.a. (2001:16). This paper finds that for the faster growing non-OECD economies like those of SE Asia, the income elasticity of demand is between 1.09 and 1.18, which implies increasing energy intensity of their GDP growth, as China is showing in spades.

Crucially, they also show that the “speed of adjustment to changes in price is slower than to changes in income” (2001:2), which somewhat negates the ACF-Allen Report's implication of instantaneous response to changes in relative prices caused by an emissions tax or carbon trading. To spell this out, the Allen Report resorts to a 16 per cent annual increase in the carbon tax to offset the impact of increases in income on demand for energy, which implies an initial increase in the CPI (base 2013 = 100) of 0.16 in 2014, to 100.16, but rising exponentially, so that by 2050 the CPI will have risen to 328, all other prices the same according to Allen. Yet Philip Adams and his

Monash team do not consider this has any implications for real income in 2050 *vis à vis* the BAU level.¹⁰

Allen-Monash shyly do not disclose their Terms of Reference, but knowing the ACF as we do we can guess that that they suggested Allen would do well to demonstrate trivially low costs of achieving “deep cuts” to greenhouse gases. For example, Table 4.1 of their Report does not show, because Allen failed to total the figures (see my Table 1), that their model’s total increase in electricity generation for the period 2010 to 2050 is only 26 per cent, or less than 0.5 per cent simple a year (see Table 1 below, I have added the Total row omitted by Allen-Monash). This is totally absurd: from 1980 to 2004, Australia’s net electricity consumption increased 2.5 times, i.e from 81.58 billion kWh to 209.49 bn kWh, i.e five times more over 25 years than Allen-Monash envisage over the 46 years from 2005 to 2050 (IEA, *International Energy Annual 2004*, Table 6.2).

Similarly, nowhere does the IPCC Report on CCS (2005) spell out the implications of the costs of Carbon Capture and Storage (CCS) for household power bills, still less the Allen Report (*Deep Cuts in Greenhouse Gases*). The *Stern Review* and Allen Consulting take a sanguine view on the feasibility and likely costs of CCS. The latter imagines that its “deep cuts” could begin in 2013 with an emissions charge of only A\$0.70, albeit rising at 16 per cent p.a. from then until 2050 when it would reach A\$186, but until 2040 clearly at an unrealistically low level in terms of providing an incentive for installing either renewable energy systems or CCS. *Stern’s Review* (2006:592) admitted that without CCS, the cost of achieving emissions stabilization at *all* the targeted concentration levels would be *tripled*. Probably *Stern’s* view was based on IPCC (2005), which produced a wide estimated range for the costs of CCS per tonne of CO₂ avoided, at US\$40-90 for natural gas combined cycle, US\$70-220 for pulverized coal, and US\$40-220 for Integrated Combined Gasification Cycle (ICGC).

What do such figures mean for you or me? My current electricity costs (from ACTEWAGL in Canberra) amount to around A\$2,500 p.a. on total usage of 15,000 kWh, with a current CO₂ emission level of 22.32 tonnes. In effect one could say I am buying that amount of CO₂ for A\$2,500, or A\$15.6 per tonne. The IPCC cost estimates, taking the midpoint of their ranges, would add a minimum (without allowing for any mark-up) of A\$65 per tonne if ACTEWAGL use only gas with combined cycle, or A\$170 for pulverized coal, and A\$156 for ICGC. The implied additions to my annual bill are respectively A\$1,750, A\$4,572, and A\$3,500, bringing my bill to A\$4,250, A\$7,000, or A\$6,000 as the case may be.¹¹

I am happily in a position to afford such higher charges without inconveniencing myself by reducing my electricity usage at all, but what about the poor? The average

¹⁰ The underlying problem with the Monash model as deployed in the Allen report is that it assumes the economy will continue to use energy at the BAU rate despite the increase in energy prices, which bring about only a reduction in the emission intensity of that energy use, but at the same time discounts the effect its emissions tax on the price of energy has on the real income of the economy. The CPI will not in practice rise to 328 by 2050 when the relative weight of energy is reduced over time to reflect some degree of shifting from even low emission energy to other inputs or goods, but the welfare effect will remain large, as noted by Leonard Brookes (2004).

¹¹ The Australian Government’s Shergold Report (2007:119) estimates that with a carbon charge of only A\$30 per tonne, average household electricity bills could rise by up to A\$200 p.a.

household might well want to receive a subsidy of at least A\$2,000 a year – and that subsidy will presumably mean either even higher power bills for somebody like me or higher income taxes, or a bit of each.

The situation is worse for what is admittedly Australia's largest CO₂-emitting industry, alumina and aluminium refining and smelting, which according to the Monash group emitted over 6 million tonnes of CO₂ in 1993/4. In reality by 2006 Rio Aluminium alone, almost all of whose operations are in Australia, confessed to CO₂-e emissions of double that, at 12 Mt. This Rio Tinto Division achieved net earnings of US\$746 Million in 2006. Cutting its CO₂-e emissions of 12 Mt by 60 per cent at say \$120 per tonne, about the IPCC's average cost for CCS, would cost US\$864 million, over US\$100 million above its net earnings in 2006 (see Table 2 below). Perhaps it's time for those of us who have them to consider selling our shares? More serious by far would be the impact of the closure of Rio Tinto Aluminium on Australian employment, exports, and the balance of payments.

A further sign of dubious science and economics is when agencies like the IPCC's Fourth Assessment Report and the British Treasury's *Stern Review* resort to political spin such as the claim that a warming climate will be specially damaging for the poor in general and Africa as a whole in particular, in order to win support for the models underlying this dire prediction. Not surprisingly, neither the IPCC nor Stern analyze actual economic performance in Africa over the 30 years since the current phase of global warming began. Had they done so, they would have had to explain why a country like Egypt has been able, despite, (or perhaps because of rising temperatures?) to double the *yields* of its production of its major food crops (wheat, maize) since 1980 (with rice not far behind, at 70%, FAO 2006). At the other end of the continent, South Africa also doubled its wheat yields between 1980 and 2005. The rising levels of atmospheric CO₂ since 1976 as well as the warmer temperatures may have contributed to this spectacular performance – and Beerling implies that precipitate measures to reduce CO₂ could be bad for agricultural yields (2005:116).

Be that as it may, if Egypt and South Africa, two of the most populous countries in Africa, seem to be doing quite well out of (or despite) climate change thus far. Perhaps that is less of a bogey than the IPCC and Stern would have us believe

The reality is that both the poor and Africa have little to lose from climate change, even in relative terms, and much more to lose from the steep rises in energy prices that are proposed by Stern and the IPCC. It is to distract attention from the latter that Stern/IPCC shed their crocodile tears for “the poor” everywhere, and when they do admit that even the poor in the rich western and Asian countries will suffer from rising energy prices, they propose special grants to offset that suffering, without admitting that these would *increase* the level of energy price rises faced by everybody else if we are to reduce greenhouse gas emissions by the claimed necessary 50-60% below 1990 or 2000 levels. For if the “poor” are enabled to maintain their energy demand come what may, this necessarily implies higher energy prices for, and/or deeper cuts in primary energy consumption by, the non-poor.

Moreover, just as the poor are always with us, they are also always relatively more numerous than the rest of us. Thus, while those with lower than average incomes individually pay less income tax than the individual with above average income,

collectively they pay a larger proportion of total income tax. So also with energy consumption: if the poor are exempted from carbon taxes and the like, the burden on the rest will be more than proportionate. No doubt those of us in the latter group could wear this, but it does not sound like an election winning program.

Finally, as one who has had some acquaintance with commercial forestry in Papua New Guinea, I feel I should register a protest at the extraordinary statements both in the Kyoto Protocol and in the Stern Review implying that the mere act of logging in itself releases carbon dioxide into the atmosphere. The IPCC default assumption is that *all* carbon in wood and other biomass from forests is oxidized in the year of removal. If that is the calibre of IPCC science on this issue it must raise doubts about the rest of its science. It is simply untrue that *all* harvested timber instantly releases carbon. Luckily for us, the Australian Greenhouse Office has modified this draconian view, and in its 1998 *Workbook* on measurement of emissions assumed that only some of wood products decay in the year of harvest, namely paper and the like. But this remains a furphy: books can last forever, and newspapers and cardboard are surprisingly indestructible. The *Workbook* assumes that panel products (fibreboard etc) would decay only over 10 years. This is also nonsense. The Australian Plywood Association lays down a minimum life for imported plywood of 50 years. Then the AGO lays down that furniture lasts only 25 years, surprising indeed to all Australia's antique stores with their stocks of furniture well over 100 years old. Finally, the AGO assumes that timber used in housing lasts only 50 years, another furphy for most of our own dwellings, including the house near Glastonbury where my grandfather was born, whose floor boards are still there after 700 years.

Naturally Nicholas da Vinci, I mean Stern, follows the IPCC default, that all deforestation necessarily means immediate emission of CO₂ (2006:196) and that even commercial logging "releases CO₂ from the cut trees" (606). It is true that the ancient British had largely deforested Britain by the time Caesar arrived, but timber harvested before then still exists on roadways (e.g. the "sweet track", Williams & Williams, 1992:31, built about 3,000 years before Caesar showed up). Large numbers of ordinary manors as well as stately homes and royal palaces across Europe still store timber logged as much as 800 years ago, including their furnishings. Moreover the AGO accepts that deforestation in the form of clearing land for agriculture does not necessarily imply instant 100 per cent net losses by emissions, as wheat and other crops use CO₂ in their photosynthesis, if not to quite the same extent as timber, and oil palm trees may even do better, as they grow so fast.

CONCLUSION

I noted previously that the Howard Government's masterly inaction on climate change until recently seemed to be paying off, as the costs of mitigation are declining so rapidly, according to the Monash modelers Adams and Dixon. An article in the *Financial Times* (reprinted in *The Australian* on Wednesday 27th June), reports new technology developed by Wow Energy in Texas, America, that if proven will further drastically reduce the costs of carbon capture and removal – if it works I may not after all have to sell my shares in Rio Tinto and Alumina. So with a little more inaction on the part of the government, we will with any luck escape the horrors of carbon emission trading, with its associated armies of inspectors and traders all engaged in an essentially unproductive and useless exercise – useless because when permits have

been issued to all current emitters at or pro rata within their current level of emissions, the subsequent trades between emission cutters and emission increasers can only produce ZERO *net* reduction emissions.¹²

In sum, Nicholas Stern's quest for the da Vinci code that will save the globe may seem in retrospect as no more than another of those episodes like the persecution of the Witches of Salem that occasionally beset the most rational and well ordered societies.

Acknowledgments

The author is much indebted to Richard Tol for very helpful comments, and to Philip Adams, Bill Bowen, Ian Gould and Nicholas Kimani. The usual disclaimers apply.

REFERENCES

- Adams, Philip D., Brian R Parmenter, and J.M Horridge (2001). Analysis of Greenhouse Policy using MMRF-GREEN. Melbourne, Monash University, Centre of Policy Studies.
- Allen Consulting Group (2006). *Deep Cuts in Greenhouse Gas Emissions*. Melbourne, Allen Consulting Group.
- Australian Greenhouse Office (1998). *Workbook for Carbon Dioxide from the Biosphere. Workbook 4.2. Land Use Change and Forestry*. Canberra, AGO.
- Beerling, , David J. (2005), Evolutionary responses of land plants to atmospheric CO₂, in Ehleringer et al 2005.
- Brookes, Leonard (2003). Energy Efficiency Fallacies – a postscript. *Energy Policy* 32.8, June 2004, 945-947.
- Curtin, Tim (2007). What Constitutes Illegal Logging? *Pacific Economic Bulletin*, 22.1, 125-134.
- Ehleringer, James R., Durling, T.E, and Dearing, M.D. (eds.) (2005). *A History of Atmospheric CO₂ and its effects on plants, animals, and ecosystems*. New York, Springer.
- Gately, Dermot, and Hillard G. Huntington (2001). *The Asymmetric Effects of Changes in Price and Income on Energy and Oil Demand*. New York, C.V. Starr Center for Applied Economics, New York University.

¹² This is a glaring error in the Australian Government's Shergold Report. Its numerical examples showing how the cap and trading system it proposes would work fail to show the case where if Firm A reduces its emissions by say 10,000 tonnes of CO₂, and seeks to sell credits for that amount, it will fail to sell them all unless there is an equal demand by Firm B (or any others) for credits to allow it to increase emissions by 10,000 tonnes, for a zero net change in emissions. Ironically, there will only be a net reduction in emissions if firms seeking to increase their emissions seek to emit less extra in total than Firm A's reduction. That will result in a lower price for the credits and therefore less incentive for Firm A to reduce its emissions again, contrary to the claims by the Shergold Report.

- Guo J., Hepburn, C.J., Tol, R., Anthoff, D. (2006). Discounting and the social cost of carbon. *Environmental Science and Policy*. 9, 2006, 205-216.
- HM Treasury (2003). *The Green Book. Appraisal and Evaluation in Central Government*. London, HM Treasury.
- IPCC (2005). *Carbon Capture and Storage*. Nairobi, IPCC.
- Mansfield, Edwin (1990). *Managerial Economics*. New York, W.W. Norton.
- Mansfield, Edwin (1991). *Microeconomics. Seventh edition*. New York, W.W. Norton.
- Nordhaus, W. (2006). *The Stern Review on The Economics of Climate Change*.
- Price, Colin (1993). *Time, Discounting, and Value*. Oxford, Blackwell.
- Quiggin, John (2007). Reviewing the Stern review again; Discounting the future yet again; AEI and low value reputations <http://www.johnquiggin.com>
- Ramsey, Frank (1928). A mathematical theory of saving. *Economic Journal*, XXXVIII, 152.
- Shergold, Peter (Chair, Task Group on Emissions Trading (2007). *Report of the Task Group on Emissions Trading*. Canberra, Australian Government.
- Stern, Nicholas (2006). *The Economics of Climate Change*. Cambridge, CUP.
- Rio Tinto plc (2007). *Annual Report 2006*.
- Tol, Richard (2006). The Stern Review of the Economics of Climate Change.
- Tol, Richard S.J. and Gary W. Yohe (2007). A Review of the *Stern Review*. *World Economics*, 7.4, Oct-Dec. 2006, 233-250..
- Tol, Richard and Gary Yohe (2007). A stern response to the response of the review of the *Stern Review*, forthcoming.
- Williams, Robin, and Williams, Romey. (1992). *The Somerset Levels*. Bradford on Avon, Ex Libris Press.

PJ	Electricity by source			
	2010	2020	2050	% chnge 2010-50
Black coal	465.9	410.0	326.3	-29.96
Brown coal	199.1	164.1	72.3	-63.69
natural gas	134.9	197.1	289.5	114.60
Liquids	3.5	3.5	3.5	0.00
Hydro	64.8	74.2	84.5	30.40
biomass	18.5	37.9	193.5	945.95
Biogas	3.2	6.5	32.4	912.50
Solar	1.7	3.3	18.2	970.59
Wind	10.2	23.0	119.7	1,073.53
Total	901.8	919.6	1,139.9	26.40

Source: Allen "Deep Cuts", 2006, Table 4.1

Rio Tinto, Annual Report 2006

Gross turnover Rio Aluminium A\$	4,642,000,000
Gross turnover Rio Aluminium US\$	3,493,000,000
Wages & salaries US\$	296,400,000
Gross sales revenue, US\$	3,493,000,000
EBITDA, US\$	1,365,000,000
Net Earnings US\$	746,000,000
CO ₂ -e emission, t	12,000,000
- 60% reduction, t	7,200,000
IPCC average cost of CCS US\$ per tonne	120
CCS addition to costs US\$	864,000,000
Net Earnings after CCS US\$	-118,000,000.0