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Partha Dasgupta & Amory Lovins

The lectures of Partha Dasgupta and Amory Lovins presented two distinct perspectives on the issues and solutions that arise as we begin to seriously analyize possible paths which will allow the stablization of the world climate. Technological advancement, economic theory and their interplay with human nature make for strange bedfellows. Cost of action, as compared with inaction, new sources of energy, better use of existing energy and the costs of mitigation are a number of the issues that arise in this interplay. Dasgupta analyzed the assumptions behind our chosen social rate of discount for the costs of addressing climate change and discussed whether development is sustainable when using metrics that account for human and natural capital. Lovins pointed out the huge profits available by addressing climate change through increased energy efficiency in the transportation and electricity sectors, which will thus allow us to win the oil and coal "endgames." In this chapter, we will summarize each of Dasgupta and Lovins's lectures and then present an analysis of their areas of overlap and their areas of disjunction.

Lecture 1 – Partha Dasgupta: Discounting Climate Change

How does the market (society) respond to the perceived future, and can it incorporate an ethical basis in regards to the distribution of resources? The use of social discount rates offers a method for public policy analysis in a world of decreasing resources, increasing population, and a rapidly changing climate. The model used is based upon the idea that social wellbeing can be represented by the sum of the consumptions levels of its citizens.

The pumping of green house gases into the earth's atmosphere since the industrial revolution has induced significant changes to the global climate system. Current modeling efforts and empirical observations indicate that the hardships incurred due to climate change will be magnified by the continued release of CO_2. Since both the magnitude and the rate of change are proportional to the concentration of CO_2 in the atmosphere it is clear that steps must be taken not only to reduced the release of CO_2, but also lower atmospheric concentrations to a sustainable level. Ultimately, we must achieve a carbon neutral economy.

A critical aspect to the challenge lies in the fact that there is an inherent tension between the cost of acting immediately and the cost of slowly placing controls on carbon in a gradual manner. Clearly, the longer we wait, the greater the concentration of CO2, and therefore, impact on the climate. And yet, the additional time increases the probability that new technologies will be developed and implemented that can the lower the cost to our economy.

Partha Dasgupta undertakes the task of developing an economic model to perform a cost benefit analysis of this question in his paper “"Discounting Climate Change", Journal of Risk and Uncertainty, 2008, 37(2-3), 141-169. The development of a time discounting rate for climate change allows the application of economic theory to provide insights into the financial dilemma of tackling climate change. Dasgupta explores the ethical implication of this model and illustrates possible results by considering the interpretations obtained by several prominent economists.

Work focusing on climate change by Cline (1992), Nordhaus (1994), and Stern (2006) have addressed this question, but have proposed diametrical opposite solutions. Nordhaus proposes gradual changes, while Cline and Stern favor immediate action. To explore the reasoning underlying these two very different courses of action, Dasgupta investigates the impact of two fundamental ethical parameters; the time discount rate and the elasticity of marginal felicity. It is significant to note that difference in not due to new climate research data.

The model is based upon the assumption that each person’s *felicity*, or wellbeing, depends solely in his or hers consumption level. The ethics underlying this parameter involve (i) the tradeoffs one must make between their current level of consumption, and the resulting consumption level that will be possible for futures generations, as well as (ii) the tradeoffs that can justifiably be made between various consumption levels enjoyed by all people presently. The first consideration is modeled by the time discount rate (δ) while the second is modeled by the elasticity of the social weight (η). Dasgupta argues that these two variables help to flush out the ethical nature of the issue by exposing the approach of how society determines a discount rate to future consumption.

“*We say that the "social rate of discount”, or the consumption rate of interest, between today's and tomorrow's consumptions is that additional consumption demanded, less unity. If ρ is that rate, society would demand $(1+\rho)$ units of additional consumption tomorrow as a price for giving up one unit of consumption today; meaning that society regards an additional unit of consumption tomorrow to be worth $1/(1+\rho)$ units of additional consumption today. In order to stress that society is deliberating over a consumption swap between today and tomorrow, we say that ρ is the consumption discount rate”.*

At this point, the important questions and assumptions surrounding how a society chooses consumption discounts rates can be explored. For instance, how do notions of intergenerational justice and equity become incorporated? And, what is the role of current market data in relation to future uncertainties? It is not evident that society should discount future consumption costs and benefits at a positive rate if the risks imposed by climate change are sufficiently large. Perhaps, capitol spent today will have a decreased value in the future. In the absence of climate risk assessment, the current reasoning for assuming a positive rate is that given that it is human nature to want it now, consumption has greater value in the present then future. And since, issues of justice and equality support the notion that consumption be similar across generations, it is postulated that society discount future consumption costs and benefits at a positive rate.

A Deterministic World

It is assumed that each generation's felicity is the sum of the felicity of its members and that an individual felicity is directly related to their level of consumption.

$W_0 = U(C_0) \; + \; U(C_1) / (1+\delta) + \ldots + U(C_t) / (1 + \delta)^t + \ldots = {}_{t=0} \sum^{\infty} [U(C_t / (1 + \delta)^t]$

This equation is an attempt to quantify the intergenerational wellbeing of society at t = 0. Changes in the value of U(C) represent increasing felicity, but the faster value of felicity changes, the greater the rate of consumption. An important aspect to this expression is that the difference of felicity of individuals between generations is treated identically as the difference between individuals within the same generation. This expression was used Cline, Nordhaus, and Stern as the basis for their work, and is used here to allow for the purpose of comparison.

The challenge lies in choosing the appropriate function U using the point of view that climate change is a public issue, as opposed to a one in the private sector, and that there is inherent uncertainty in our future climate. This raises a number of issues, some of which can be broadly categorized as philosophical, ethical, and altruistic.

Recalling that δ is the time discount rate used to obtain the intergenerational wellbeing $W_{0.}$ The next step is to consider how this impacts the consumption discount rate, ρ_t . The expression must include the total consumption rate as well as the percentage rate of change in consumption over a period of time, $g(C_t)$. Now, η, the elasticity of marginal felicity is determined by the curvature of the function U(C). The greater the value of η, the greater the curvature of U(C). When $\eta = 1$, U(C) goes as the ln C. Assuming that both $g(C_t)$ and δ are small, the expression reduces to: $\rho_t = \delta + \eta \, g(C_t)$. So it now possible to discuss the relationship between time, minimum of wellbeing, and forecast rate of change in consumption.

A key observation is that the consumption discount rate "*increases with both δ and $g(C_t)$, respectively, and increases with η if and only if $g(C_t) > 0$.*" Analysis of this equation show that as long as $g(C_t) > 0$, i.e., increasing consumption, then "*δ and η play similar roles in determining ρ_t; a higher value of either parameter would reflect a greater aversion toward consumption equality. Which may explain why it hasn't been uncommon to suppose that higher values of δ reflect a greater ethical concern for consumption equality*". Conversely, this implies that a negative increase in the rate of consumption growth leads to δ and η resulting in opposite effects. That is, an increase in the value of δ suggests that the value on ρ_t be increased at the expense of future generations.

Examples from the Economics of Climate Change:

Cline (1992):	$\delta = 0$;	$\eta = 1.5$
Nordhaus (1994):	δ = 3% a year;	$\eta = 1$
Stern (2006):	δ = 0.1% a year;	$\eta = 1$

We see that η is very similar in all models, but that δ is significantly larger for Nordhaus. The larger δ suggest that that rate of consumption increase in the future will not be of equal social worth. Therefore, this may explain why Nordhaus proposes gradual changes in response to climate change, while Cline and Stern favor immediate action.

Lecture 2 – Partha Dasgupta: Sustainable Development & Green National Accounts

Partha Dasgupta articulated the theory of evaluating whether development is sustainable using metrics that account for human and natural capital, and the role these stocks have in providing future wellbeing. Commonly, the gross national product (GNP, the value of all the goods and services produced in an economy) or the gross national income (GNI, the value of all the income by wages, salaries, profits, interest and government income) is used to evaluate the wellbeing of a nation, because these represent the maximum amount of consumption by a nation. Dasgupta argues that this consumption does not adequately encapsulate wellbeing because it neither takes into account the investment in human capital, nor the exploitation of natural capital, both of which have impacts on the future consumption of an economy.

The intertemporal wellbeing of the nation, as affected by policies that alter investment or exploitation of physical, human, or natural capital, is what makes Dasgupta's notion of wellbeing "sustainable". However, Dasgupta does not propose to redefine wellbeing by redefining wellbeing as the net-present value of consumption. Rather, he proposes to alter the definition of wellbeing from a flow concept (such as GNP, GNI, consumption, or investment) to a stock concept called comprehensive wealth (W):

$$W(t) = p(t)K(t) + q(t)L(t) + n(t)N(t)$$

where K, L, and N represent physical, human, and natural capital respectively, and p, q, and n represent the shadow values of K L and N respectively. The shadow value of each capital asset is an endogenous characteristic that represents the marginal increase in W if there were an additional unit of that asset.

Dasgupta makes the point that ideally each of these capital assets should be disaggregated so that each type of human capital (e.g. health and education) or ecosystem service provided by natural capital (e.g. water filtration or erosion control) has a shadow value that has a more concrete interpretation. However, his main point is that natural capital per se must be incorporated into the metric of a nation's wellbeing, which is not encapsulated even in such composite indices such as the UN's human development index (HDI), which combines GNP, literacy and life expectancy. Dasgupta argues that only the stock concept of W, which includes natural capital, is a sufficient metric for evaluating the sustainability of development post hoc, or the effects of investment policies that affect the stocks of assets in the future.

Lecture 1 - Amory Lovins: Winning the Oil Endgame

Technological entrepreneur Amory Lovins's key points can be summed up with the statement that new technologies not only offer solutions to climate change, but will also produce superior and sustainable products. Built upon the fact that it has been 36 years since the oil embargo and that the US has been developing a portfolio to replace oil at a 5th of the price, Lovins maintains that transformation can be accomplished by a business-led oil solution getting the US economy off of oil by the 2040's at $15 per barrel. This would be possible by conjointly increasing the efficiency and replacing oil by renewables; e.g. natural gas and biofuels as well as simplifying the manufacturing process by reducing parts per vehicle.

The feasibility of a reduction of our dependence on oil and flexibility in the economy was shown in the late 1970's into the 1980's when petroleum imports fell. Increases in efficiency are based on simplifying automaking, getting better performance by reducing the car mass through using carbon fiber composites instead of steel to create the car body. Lovins has evidence to show that carbon composites are safer, stronger and sources are inexhaustible compared to steel. More importantly, these carbon fiber cars are significantly lighter, and slippery, meaning that more force is transmitted to the wheels to move the car, thereby reducing cost of transport. After all as Lovins ponders, "Weight's only useful in steam rollers."

The approach to decreasing vehicle weight can be extended to airplanes, transport trucks, and eventually buildings. It is highly likely that this would occur as improvements in technology increase faster than we can use the improvements. This is exemplified by modified engines and electronically actuated valves that can be retrofit to existing engines. These valves reduce consumption by an innovative sequence of fuel and air injection opposite to what currently exists in the industry, thus redefining how engines work. In addition, technological improvements can readily be transferred across industries, e.g. military to civil, particularly when the military is not open to radical new developments, but the private sector may be. Decreasing weight leads to further efficiency savings and innovation that continue to reduce the carbon production.

The unique nature of Lovins's innovative design approach resulted in a new philosophy in car manufacture that addressed designing at the level of the whole vehicle. The designers of his unique modular car were asked to approach the problem from the perspective of an integrative design problem, and not as a series of multiple problems for each of the components. This resulted in independent design problems in which designing individual components are addressed and then integrated at the end. Lovins maintains that this integrative approach can be extended to smart garages for electronic cars or as he states, "power plants on wheels", to exchange information with smart grids and smart buildings, so that energy usage is optimized,; i.e. available when demand is high and reduced when demand is low. Lovins completes his lecture with a statement that reflects his life philosophy; "What ever is worthy is never impossible…And now is the time and we are the people with the solutions".

Lecture 2 - Amory Lovins: Winning the Coal Endgame

Approximately fifty percent of the electricity currently consumed in the US is from coal. Thus, in order to transform our electricity use, we will need to win the coal endgame. This can occur through two electricity revolutions: efficient end use and low- or no-carbon decentralized energy sources.

The Rocky Mountain Institute is envisioning what an all-renewable, all-distributed electricity system might look like. Such a system would put efficiency and renewables on the top of the electricity consumption pyramid, followed distributed generation (which may or may not be renewable), then electric drive vehicles (EDV) and demand response (DR), and finally coal and nuclear. The latter two would be phased out by 2050. Because technology keeps improving faster than we're applying it, the savings from energy efficiency keep getting bigger and cheaper. As an example, California has saved $100 billion in capital investment by saving electricity. Many of those early savings were from appliance and efficiency standards. If all fifty states used energy as efficiently as the top ten users, the amount of coal used in the US would be cut by sixty-two percent.

The first electricity revolution, efficient end use, can be brought about by integrative design, which combines technologies to yield multiple benefits from single expenditures and make big savings cheaper than small ones. This runs directly counter to the law of diminishing returns, which states that as you save more, each efficiency improvement will be more expensive. Amory Lovins's house in Colorado is a primary example of efficiency through integrative design. When building his house, Lovins invested in super-insulation, super-windows, and ventilation heat recovery and thus saved the money that he would have otherwise spent on heating and cooling equipment. Additionally, the arch that holds up the middle of his house in fact has twelve different functions but was only paid for once. Costs can even be negative for retrofits of big buildings, such as the Empire State Building, which is being retrofitted by remanufacturing 6,500 windows onsite to be super-windows. This will save thirty-eight percent of the energy, with a three-year payback.

Importantly, efficient end use starts downstream to save the most energy and capital, and moves upstream, making each step of the energy conversion process more efficient. For example, two thirds of the energy going into coal power plants is lost at the plant and the grid. Losses are compounded along each step of the pipe until only one tenth of the original fuel energy comes out the other end of the power plant. Working backwards, one could optimize each step along the pipe for compounded savings instead of compounded losses. Each design can be made smarter, such as by removing right angles from pipes and replacing them with diagonals or smoothed curves to save motor energy. These sorts of lessons learned about energy efficiency are being combined in a casebook called Factor 10 Engineering (10xe), which aims to make engineering more efficient through demonstrated energy efficiency case studies.

The second electricity revolution, low- and no-carbon decentralized sources, has already begun; in 2006, micropower produced a sixth of the world's total electricity and a third of the world's total new electricity. In fact, $100 billion worth of capital investment went into micropower in 2008, which is almost as much as went into total fossil fuel generation worldwide. Low- and no-carbon decentralized sources are cheaper and have lower financial risk than larger carbon-based central power stations, and also allow one to avoid the unreliability of the grid. Decentralized renewable energy facilities can be constructed at or below the cost of new central plants. For example, new solar power beats new coal, even at zero carbon price. In fact, when building a new house, it can be cheaper to install solar power and not connect to the grid than to use conventional electricity sources and be connected to the grid.

As many of the low- and no-carbon energy sources become even cheaper, nuclear has become the costliest of these at the margin. The decline of nuclear will free up money and attention for better alternatives and also inhibits the spread of nuclear bombs. Photovoltaics, on the other hand, are nearing a commercial revolution. Allowing low- and no-carbon decentralized energy sources to compete in the market is positive because they are so competitive with fossil fuel energy sources and in fact need less storage and back-up than previously assumed.

Even within these rosy economic comparisons, there exist six conservatisms: integrative design, side-benefits of end-use efficiency, distributed benefits, integrating renewables to save their capacity, integrating efficiency to make them cheaper, and cost trends in favor of decentralized renewables have not been included. Their inclusion in economic comparisons would make the economic forecast for low- and no-carbon decentralized sources even more positive. An optimal strategy would be to diversify renewables by type and location (to avoid any discontinuities in energy supply), forecast them, and integrate them with existing supply-side and demand-side resources already on the grid.

Two policy innovations can help bring about the electricity revolution. The first is feebates, under which individuals would pay a fee when buying a car that consumes more gas relative to other cars in that same class and would receive a rebate when buying a more fuel efficient car in that class. The second is decoupling of profits and energy sold and shared savings for electricity and gas. Under this mechanism, utilities are rewarded for cutting down on electricity bills rather than for selling more energy; they get to keep a portion of what they save the customer. This aligns utilities' interests with customers' interests and eliminates perverse incentives. In California, PG&E saved $400 million through decoupling in 1992; the customers got eighty-nine percent of this amount as lowered bills and the shareholders got eleven percent as dividends.

There are five myths about the coal endgame. The first is that the energy revolution is not happening. In fact, in 2006 US use of oil and coal energy went down. The second is that solutions have to wait for a global agreement. However, China is already prioritizing energy efficiency, even in absence of a global agreement. The third is that pricing carbon must happen first. Though pricing carbon is important and appropriate, it is neither essential nor sufficient. The fourth is that public policy must mean taxes, subsidies, and mandates. However, there are many other attractive policy instruments, such as feebates and decoupling. The fifth and final myth is that public policy is the only or the strongest key. While public policy sometimes works, it is most often slow and frustrating. Instead we must focus on innovation in technology, design, and competitive strategy, and business and its coevolution with civil society. Despite what economists might lead us to believe, markets are not perfect and untapped profits do exist, through end use efficiency and low- or no-carbon decentralized sources.

Analysis of the Dasgupta and Lovins Lectures

Having heard and summarized the lectures of Dasgupta and Lovins, we will now provide a short comparison between the two. Both lecturers approach global warming, its causes, and possible solutions from perspectives that have deep economic implications.

Dasgupta establishes that economics deals with climate change as an externality. As a consequence, our society is only confronted with climate change when parties decide to invest in measures to prevent or reverse degradation of the environment. Lovins approaches the climate change as a problem that is to be dealt with as non-externality. Markets have not functioned well;

producers should have produced many energy-efficient products by now, and customers should have already bought them. However, this has not happened. The essential correction mechanism–rising prices and consequently the widespread availability of more efficient competing technologies–can be put in place by actively guiding the players on the market.

Dasgupta indicates that one should not use regular market rates to discount the costs of fighting climate change. He further makes it clear that it is necessary to refine and adjust economic theory; we need to consider our perception of future consumption (as expressed 'g'), and therefore, costs of environmental changes need to be included in economy theory (potentially included g). He thinks that public sphere of international negotiations among nations is an ideal forum to work our beliefs about future consumption and its implication for the social discount rate. Lovins, however, shows in his presentations that a lot can be done within the private space about energy spillage. Fighting spillage is, according to Lovins, not so much a matter of investment but a matter of profits. Rather than searching for the solution at international levels, he influences individual business behavior and civil society, albeit sometimes through suggestions for national or international policies.

Dasgupta also sets out a basic outline of the conditions under which trust will arise between parties that may be interested in entering into an agreement. The fact that trust is a necessary element to bring parties to the table and have these come to solid agreement that are adhered to at all requires economic theory to include trust in its theoretical body, according to Dasgupta. Generally speaking one could say that conditions and trust do not go very well together. The more conditions present, the more trust is marginalized. In how far the assumption that trust exists or arises under certain conditions is workable may be questionable. Economic theory, in Lovins opinion, does not have much to do with, economic reality; the market–not economic theory–can provide the profit incentives for increased efficiency.

We believe that we need both politics and international society and market based mechanisms to tackle climate change. The international negotiating forum is where societies can express their values and make policy decisions. Markets can provide the profit-based incentives to move societies to de-carbonization through increased efficiency. Both Dasgupta and Lovins address issues that are essential if we want to tackle climate change.