

Voluntary Pledges and Green Growth in the Post Copenhagen climate¹

Thomas Sterner

University of Gothenburg

Sweden

Abstract

A number of features set climate change apart from most environmental problems: It spans several generations forcing us to think in new ways about intergenerational fairness. Even more importantly, it involves a delicate problem of coordination between countries and other agents at a truly global scale. As long as it is very profitable to use fossil fuels, policy coordination must include basically all major economies. The costs are sufficiently sizeable to make it important that the policy instruments chosen encourage efficiency in abatement. Ultimately this means striving towards a single market for carbon. The importance of getting near-universal adhesion to a treaty makes fairness and procedure important but we know how difficult it is to build a truly global agreement. Some people, both environmentalists and business leaders see green growth as the magic bullet: we should stop talking about who gets to use fossil fuels and instead focus on who will lead us into the green valleys of the future and there reap all the benefits of being first. This sounds good but who is going to stop laggards from simply continuing to burn coal? This paper discusses the necessary ingredients for a long run Global Climate Strategy. At the end we will dwell on the “short run” issue of what policies to pursue in the mean time. As we wait for the final (and maybe elusive) Worldwide treaty, we must have a policy that makes sense and in fact is not only compatible with, but hopefully facilitates the development of this worldwide agreement! The last section will focus on what forms of “green growth” strategy are reasonable for this intermediate period that we are in and which may be end up being more long than short.

¹ I would like to thank Christian Azar and Maria Damon for very useful comments on earlier drafts.

1. Ecosystem threats to growth?

A recent article in the Harvard Law Review started with the short sentence “There is no alternative to Sustainability” (Nidumolu et al 2009). This seemingly obvious and innocent statement is actually new, path-breaking and in some perspectives still radical. Global recognition of the fact that human activity is hurting against the barriers imposed by nature is still not universal. Climate change is one of the areas in which the scientific evidence is clearest and yet even there it is still resisted by skeptics. I will take the basic science of climate change as given but by way of introduction also mention some more threats or limits to the health of our ecosystems.

The World Bank Global Development Report and other studies show ample evidence that climate change presents a dire threat not least to many tropical countries through sea-level rise, increased storm frequency, increased temperature or decreased rainfall in areas that are already at the margins where conditions for agriculture and even survival are already stretched to their maximum. Also the melting of glaciers may change patterns of river flow affecting very densely populated areas with tens and even hundreds of millions of inhabitants.

There is one aspect of the debate on climate change that I find particularly strange. It has somehow become an issue that engages strongly a minority – quite a vocal one admittedly of - Europeans and North Americans. In many developing countries the interest is fairly mild except in as much as the issue can somehow help restore dwindling donor interest in supplying financial flows. This is absurd. If a factory is about to pollute your fishing grounds – who would we expect to see on the barricades: the owners of the factory or the fishermen? There is some interest in adaptation issues, which are often closely related to general development issues. However as soon as mitigation is mentioned many people with an interest in development are uninterested. This is understandable because politicians in low-income countries already have such dire and difficult agendas and trade-offs to make, but it is still unfortunate. I have given quite a lot of talks in various African countries – just in the run up to Copenhagen and I would say that it is not for me to recommend any positions but I

would find it more natural if the people from say Bangladesh or Ethiopia were shouting at me to stop driving my SUV than to say that they are not interested in the issue.

The Millenium Ecosystem assessment analyses a series of often inter-related threats: “Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period in human history, largely to meet rapidly growing demands for food, fresh water, timber, fiber and fuel. According to the MA, More land was converted to cropland in the 30 years after 1950 than in the 150 years between 1700 and 1850. In the last couple of decades, human activities dominate the geobiochemical processes of Earth, we dominate much of the processes of photosynthesis, and we have destroyed 20% of the world’s coral reefs as well as 35% of its mangrove area. The MA goes on to say that although these changes have contributed to net gains in welfare, they have also implied degradation of many ecosystem services, increasing risks of nonlinear changes, and the exacerbation of poverty for some groups of people.

In some cases problems and their solutions may coincide: It may be the same processes that lead for instance to declining fish or forest stocks and to declining biodiversity. To some extent the policy measures taken can be designed to meet both goals. However this is not always the case. Sometimes a technique that would appear to help solve one problem may cause others and thus the multitude of restrictions suggested by the MA may combine to be a bigger problem than they appear separately. Several “alternative” energy supply technologies may provide examples. Growing biomass on a large scale and with inappropriate conversion technologies may be quite ineffective, may threaten biodiversity and maybe compete for land with food².

2. Global coordination required

² Nuclear energy is essentially carbon free but presents some special problems not least in an era of terrorism.

Turning again to climate change, let us take it as a given, that we have to act fast to arrest climate change – not least for the sake of the poor. The most important aspect of climate change is its truly global character. To start with, the effects are global. It does not matter where a ton of gas is emitted. This does in no way, mean that effects will be the same everywhere. In fact they are likely to vary strongly. They may be disastrous in some places and even beneficial in others.

The crucial feature in the context of this paper is that policy for climate change must be global because the pollutant is global. This is related to but much bigger than what is usually referred to as “carbon leakage”. Policy makers and industries have long had a tendency to cry wolf about pollution havens and the detrimental effects of environmental regulation on competitiveness. There is in fact very little empirical evidence so far that stricter environmental legislation really has induced industry to migrate. On the other hand, the environmental regulations put in place for conventional pollutants to date, cause fairly moderate costs to industry compared to drastic cuts in fossil fuel use. The shadow prices needed to reduce carbon emissions by 50 or 80% and eventually to eliminate them, will be high and it is obvious that there would be competitive advantage to locating in such a way that they could be avoided.

There can also be general equilibrium effects as tougher climate policies in some countries will tend to depress the price of fossil fuels thus encouraging fossil use in other countries. But the main effect is one of pure arithmetic: If a “coalition of climate countries” were to combat climate change and even if this coalition were large and determined so that it taxes³ fossil fuel heavily, would there not be a risk that this would be to a significant extent counteracted by developments in the rest of the World Economy. If say countries representing 80% of world emissions were to succeed in actually reducing emissions by 50%, the effect could still be undone by developments in the “fringe” 20%.

In the UNFCCC climate negotiations, for instance in Copenhagen, there is considerable frustration over the slow process lead by the United Nations. Part of this may be due to incompetence or even

³ We write tax here for simplicity but naturally the effect would be the same with any other regulations such as permits that raise the effective cost of using fossil fuel.

malevolence by some countries but to some degree, it is inevitable that a process involving two hundred countries will be slow. If there are risks in disregarding the “insignificant” countries and if all countries cannot agree effectively, what then might be an optimal coalition: This will again be a question of arithmetic if the “insignificant emissions” grow exponentially.

If the fringe in our example above were to experience a few percent economic growth at the same time as World coal and oil prices were falling (due to increasing taxation in the climate coalition countries), it would not be unreasonable that their use (and thus emissions) would grow at a rate of say 6% per year. This is less than half the corresponding growth rate of Chinese emissions after 2001. This is very hypothetical but note that in this case their emissions by 2050 would grow so much that in spite of the 50% reduction by the “main” emitters, global emissions would still more than double and the share of the “main” emitters would dwindle from 80 to 16 %!

	Today	2050
“Main emitters”	80	40
Insignificant fringe	20	205
Global Total	100	245

This scenario is of course, for many reasons, not realistic and it gets its numerical bite through the assumption of a really long time period – 40 years. Similarly we could show that 10% of emissions during say a 10 year period would play a fairly insignificant role – this represents the emissions from way over half the worlds countries. FIXA NUMMER. Therefore the “fringe argument” should not be used as an argument against any unilateral action by a significant coalition for a few years, but it does show that *in the really long run*, this is a problem of *joint action* and it is important to get all countries and sectors⁴ into a unified scheme. We will discuss more later, concerning the particular challenges

⁴ It is noteworthy that a similar argument applies to sectors such as airlines and shipping, that today account for an “insignificant” few percent of global emissions but are not regulated. If all countries of the world were to

this raises with some particular country groups. Suffice it for now, to point to a dilemma: It is not likely that a really broad – almost universal agreement comes out of a UN style negotiation with 200 countries, even less so that the agreement is timely and practical. An agreement with a very limited group of countries however will for the reasons we have pointed to, only work for a short intermediate period. The size of countries is heavily skewed and the smallest 100 countries have a total share in global GDP of less than one percent while the biggest three (counting the EU as one) have over half of global GDP. Naturally a fringe that only represents a percent of global GDP and emissions has essentially no numerical significance. But when a “fringe” gets to the size of 10-20% then developments there must be followed closely. This is not to say that one cannot start with a coalition representing 80% - this is already a broad and ambitious coalition that is difficult to assemble – but even a coalition of that size would need to consider developments in the fringe within a decade or two⁵.

3. The consequences of the long-run

Let us also briefly deal with the temporal dimension. Anthropogenic emissions are now of such a scale that they have a very big effect on natural processes that have periodicity of tens of thousands of years. Scandinavia, where this author lives, was covered by a few kilometers of ice during the last ice age and land is still rising faster than the sea level in this part of the World – due to the rebound effect. The weight of the ice masses had compressed land and it is “bouncing back”. By human standards this movement is so slow that the word bouncing seems strange yet it gives some feeling for the time dimension involved. The residence time of gases in the atmosphere varies between gases and over time with concentration and other factors in a complex way. In the case of carbon dioxide, a significant percentage (roughly a quarter) remains for many centuries. The warming also takes many years (decades and centuries) to reach equilibrium, largely due to the thermal inertia of

regulate all domestic emissions but forget about these international bunker issues they would quickly become numerically very important.

⁵ One may well assume that if the US, China, EU, India, Japan and other mayor countries representing up to 80 of emissions, were to agree, they could start to exercise very strong formal and informal pressure on other countries if they so wanted.

the oceans. In the historic record for the last half million years, the carbon content of the atmosphere oscillated very slowly between 200 and 280 parts per million (ppm). Such a cycle – between two ice periods would take on the order of 100 000 years. Now we are emitting carbon at such a rate that it adds 2 ppm per year (and accelerating) meaning that the corresponding change in carbon concentration only takes a few decades.

Changes in the composition of the atmosphere are increasing average temperature⁶ on Earth, although the processes are delayed and gradual. This in turn will have ecosystem effects as local weather, climate zones, wind and rainfall patterns and thus agro-economical zones transition. Ladies and Gentlemen, we are holding the W Bank ABCDE conference in Stockholm. A generation ago people skied here in the winter. Now electricity for the snow-cans is the biggest cost for ski-resorts and they even make artificial snow in Piteå on the arctic circle. Snow cover is receding towards the poles and mountains and the Arctic is soon ice-free in summer⁷. The change is more visible in the far North because temperature variations are magnified there and because the temperature change from say -1°C to + 1°C is very visible as ice and snow are replaced by bare ground. However very dramatic effects are to be expected in many places on Earth. Some areas that are already hot and arid (for instance in Africa) may only suffer moderate increases in temperature or decreases in rainfall but they are so close to the threshold for what is bearable for humans or what is feasible when it comes to agriculture that the effects may be catastrophic all the same.

In the major flood plains, for instance of Asia, enormous civilizations have been built that rely on regularities in water flow of the giant rivers such as the Ganges Brahmaputra and many others. The water flow in these rivers is partly regulated by glaciers that are now fast receding. Irregular water flow can imply longer periods of drought and increased severity of floods both of which can be lethal threats in densely farmed areas. Likewise sea level rise and increased storm damage can hit large

⁶ The increasing carbon content will also have other effects such as an increased acidification of the oceans that will have important biological effects for instance on those marine organisms that grow shells using calcium

⁷ Ironically this will probably lead to a new wave of oil drilling there as if we had not learnt anything.

areas that are very heavily populated for instance in Bangladesh and Bengal in India. The main reason to expect the most dramatic costs in terms of human welfare to be in developing countries is however that they have less access to skills, resources and technology for mitigation. Climate and other changes have combined to give us a dramatic move northwards of ticks that carry lime-disease and other infections. This is serious but in a country with public health care and good vaccinations, it is manageable. The effect would have been much worse in a low income country.

It should be clear that the scale of these effects is not to be measured in years or decades but centuries and millennia. Even a human generation is short by comparison and this has its significance when we turn, as we must, to the issue of intertemporal welfare comparisons. The bottom line for a proactive climate policy is the idea that our generation should make some sacrifices to the benefit of future generations. In this perspective, we need to ask ourselves not only what we wish to do for our children but more poignantly, for our great great grandchildren. The distance in time reduces personal contact and emotional engagement. The issues are also blurred by the limits to our understanding and imagination concerning future technologies, needs and thus also what will ultimately be perceived as costs and benefits in the future.

In the Stern review, the biggest source of uncertainty about “the cost” of climate change was due to the discount rate, which in turn is uncertain because we do not know future growth rates, we do not know the future distribution of income and we have difficulty valuing the welfare impacts today of changes in income in the distant future. Stern uses a discount rate of 1,4%/year which has been criticized as too low. The difference between using 1.4% or 3%/year if we are valuing a cost 200 years away is like the difference between 23 billion and just one billion. 3% (and even much higher) is definitely a more common discount rate for instance in the construction of power plants or roads but these are not calculations for which we regularly consider many centuries. I have argued elsewhere that there are a number of important factors that speak strongly in favour of low discount factors. One of these is that the composition of the economy must change. Growth is the force that underlies

discounting and if we are to have growth for hundreds of years we would become so much richer that it is hard to conceive and indeed misleading since the growth must be accompanied by big structural changes. 3% growth for 200 years for instance implies we become 370 times richer but it cannot be that we use 370 times more steel or meat – nor permit 370 times as high emissions of climate gasses. Thus relative prices must change to modify the sectoral composition of the economy and taking this into account is effectively akin to using a lower discount rate (Hoel & Sterner 2007, Sterner and Persson, 2008).

All this may sound like a rather technical digression. In fact it is one of the most burning of ethical issues. I am arguing in favour of the notion that we should take a greater responsibility for our actions today in solidarity with future generations who may suffer severe consequences of our inaction.

4. Cost efficiency in Climate policy: The need for a unique price of carbon

Climate policy will be expensive. This does not mean it will be prohibitively expensive or that we should not undertake this cost. To the contrary, the argument is that damages from climate change are likely⁸ to be much more costly than abatement and that it therefore makes good sense to invest in avoiding them. Those who oppose mitigation sometimes paint a bleak picture in which we are deprived of modern comfort and developing countries deprived of their prospects for economic growth if we tax fossil fuels. This is wildly exaggerated and the integrated assessment models used to illustrate the costs and benefits typically assume not only continued welfare but continued growth in welfare even under stringent climate abatement policies. (A typical integrated assessment model might come to the conclusion that the world economy would grow by 2,9% with abatement

⁸ There is much uncertainty in costs which complicates the matter. There is for instance a low but still positive probability of truly catastrophic damage. Assuming some form of risk (and maybe ambiguity) aversion, we are not only willing to pay to avoid the expected damages but also willing to pay a form of insurance premium to avoid even a small risk of really large damages.

compared to 3% in a hypothetical “business as usual” – that also neglects climate damages. Although this comparison is grossly inappropriate precisely since the damages are unaccounted, it is worth noting that even then, World income is assumed to increase but instead of taking say 100 years for income to increase tenfold it would take 102 years (Azar and Schneider 2002). Still we agree that the costs involved are sizeable and thus efficiency in climate policy design itself is an important goal.

One of the basic rules of instrument design is that efficiency requires the use of market based instruments (MBIs) that will ultimately give a simple, single price signal for all countries and sectors, see for instance Tyrole 2009. This is particularly true if the costs of abatement are heterogeneous. In this case the cost of abatement for instance in avoided deforestation in one country may be very different from the cost of abatement in the transport or industrial sectors of another country. If there is such a difference then the use of MBIs can save a large share of the total costs by allowing for flexibility in where abatement is undertaken. The more pronounced the heterogeneity of the costs, the bigger the savings in using MBIs and thus the more important is the predominance of a single carbon price throughout the World, (Stern 2003). The most significant emission reductions may well come from technologies that are yet to be developed. Another very important property of a clear price signal is that it will help incentivize research and development into new technologies which is fundamental for dynamic efficiency.

It is thus an important, and far from trivial, empirical question to ascertain how heterogeneous abatement costs are. In the meantime it is reasonable to assume they are quite heterogeneous since emissions emanate from such a wide variety of processes, economic sectors, techniques and countries involved. Notice that the broader the definition of the instruments used, the better. If all gases, sectors and countries are included and if both avoided emissions as well as the capture and storage of gases are allowed then a larger number of potential abatement solutions compete. The bottom line is as usual that the cheapest solutions are implemented first and that costs are saved by avoiding unnecessarily expensive abatement options. (Unfortunately, there are also

counterarguments to integrating all sectors in one policy instrument. Different rice cultivation methods for instance cause widely varying methane emissions. It is probable that modifying rice cultivation is a cheap way of reducing radiative forcing. However, at present, the uncertainties involved as well as the degree of complication in monitoring and verification probably make it impractical to include this at present in for instance a carbon trading scheme.)

This leads us to our next major concern which is about fairness. Suppose it were “efficient” in the sense just described (lower costs per ton of carbon avoided) to close down the production of bricks somewhere in a small town in Africa or India than to persuade a rich person to drive his SUV less. This example may sound exotic but I would argue that although simplified, it actually captures the very essence of the issue. We therefore need to ask ourselves whether such an exchange ever be ethically justified or fair? One simple first answer is that a necessary pre- condition under which it could be fair and ethically acceptable is if this happens through a voluntary exchange in which the users or producers of the bricks are more than sufficiently compensated by the car driver. Naturally I do not mean “voluntary” in the sense of a specific agreement between one brick maker and one motorist. I mean that neither of them is forced by mandate. The beauty of MBIs is that they can, in principle, achieve such exchanges in a manner that is efficient and fair and with limited transaction costs. This does however require *one policy instrument or* scheme that is broad enough to encompass both the brickmaker in India and the driver in the rich country. Designing this type of instrument raises the tricky issues of the allocation of rights⁹ and thus fairness to which we turn in the next section.

5. A Fair share

⁹ The reader is reminded that this initial allocation of rights is intended to make an instrument politically fair and acceptable. It should not influence where actual abatement is carried out (the latter should be decided by a comparison of marginal abatement costs).

There is general recognition that a climate treaty must have broad coverage. This does not necessarily imply that each country must be represented in a UN style negotiation, given the extreme skewness in country size mentioned above. It does imply that larger countries even in the developing World must be pulled in. This in turn requires deep consideration of fairness and equity issues, (see for instance Aldy and Stavins 2009). Those who take a particular interest in the welfare of the poor should see that there is opportunity in these facts. Looking at this again from the viewpoint of the low-income countries that aspire to rapid economic growth to catch up with the rest of the World, one must also understand that there is a feeling of considerable apprehension concerning the notion of emission ceilings which are perceived as potentially placing impediments on the road to progress.

Given the historical weight of not only colonialism but also the more recent history of broken commitments by the wealthy countries (for instance to reach certain percentages in development cooperation assistance), it is quite natural for developing countries to be very wary. Specifically in the climate area, it is also clear that an overwhelmingly large share of historical, accumulated, emissions come from the countries that are now rich. It is these accumulated emissions that have put us in the predicament we are. They will cause enormous costs to a number of developing countries. In fact this has already started since climate change is likely to be a factor in regional droughts and desertification even though we cannot yet prove that with certainty (particularly not for any one given incidence of drought). It is true there was not a general awareness of causation but one can still make the argument strongly that the rich countries should be prepared to pay some form of indemnity or to help pay for adaptation. Responsibility does not end there. Current emissions are still rising except in a very small number of nations. In spite of all the discussions since for instance 1992, the rich World continues not only its emissions – but emissions at an increasing rate!

Naturally . developing countries should be wary. They are confronted with a new and complicated set of issues in which the rich countries appear to be in a considerable hurry to coerce them into binding agreements that might be limiting their future prosperity and naturally they hesitate. A good

rule for difficult negotiations is to show that you have all the time in the World and are not interested in a quick deal. The pure arithmetic also implies that risks are greater for fast growing low-income countries than for slow growing rich ones.

Committing to a given emission reduction or emission level implies a cost of unknown size and thus a risk even for an economy that could grow at either 1 or 3% per year. However if you do not know whether your economy will grow at the aspired level of 10-12 % - or not all, then the uncertainty is so much higher. The difference over a 50 year period between 2,5% and 1% growth is a factor two. Between 5% and 10%, the difference is **tenfold** in GDP – and with constant energy intensities that means ten times the energy demand. On top of this, it is not unlikely that low income countries have less facility for adaptation since they have less technology and less flexible infrastructure to allow for the kind of rapid adaptation to new relative prices that would be necessary.

If the whole world were to be included in an agreement for emission reductions that is essentially the same as an agreement on emissions. Considering that emission reductions will be expensive, these emissions will be very valuable and it is natural there needs to be an allocation mechanism. A number of such principles are possible and have been proposed but we will limit the discussion here to two (grandfathering and per capita allocation) that appear to best exemplify the conflict of interest between rich and poor countries.

Grandfathering

Grandfathering means that future emission allowances for any agent should be a proportion of past emissions. USA emits some 5-6 ton per capita, Western European countries typically emit a couple of tons per capita (measured as tons of the element carbon per year) while poor countries such as India and most countries in Africa, only a few hundred kilos. Grandfathering of rights is also referred to as “prior appropriation” and common for instance in water law in California. Its most common form in the climate debate is simply Equal Percentage Reductions, EPR. In fact this is the foundation for much

of Kyoto and even more recent climate negotiations. Without reflection or analysis, EPR might seem to be a fair and “natural” principle: in the same way as a flat tax rate.

Under EPR, those who emit more do in fact have to abate more (in tons) – but they also get to use more of the resource. In fact if a rich country today uses ten times as much carbon as a poor country and both are forced to reduce by x percent, then the inequity will be exactly conserved; The rich country will always get 10 times as much of the resource. Kyoto was essentially the result of negotiations. These took grandfathering as their starting point which means equal percentage reductions. In fact they were not fully equal but the inequalities did nothing to even out carbon intensities – to the contrary! Australia with high emission intensity was allowed an increase of 8% while Canada and Japan were required to reduce by 6% and the US would have reduced by 7% and Europe by 8%¹⁰. The EU got the biggest reductions – not because they had high emission intensity but simply because they were keen on pushing through the deal! The fact that developing and intermediate countries were left without any numerical emission targets is a reflection of the fact that these countries appealed to a concept of fairness based on inequity – but while one might be sympathetic to these countries getting big allowances it is completely unacceptable for them to have no ceiling at all. Thus Kyoto had numerous flaws. There was not principle that could be updated or generalized for allocations – it was simply based on ad hoc negotiation with grandfathering as the base for the rich countries and no requirement at all for all other countries.

Equal per capita allocation

Those countries who feel that grandfathering is an unfair principle, often appeal to one of several other principles. These may include such factors as endowment and need: countries that happen to have large hydropower resources or even gas resources will find it easier to emit less CO₂ than those

¹⁰ The internal EU burden sharing agreement was more radical in its departure from pure grandfathering since the EU total of -8 % still allowed some countries like Portugal, Greece and Spain very substantial increases (27,25 and 15% respectively) while other countries undertook correspondingly larger cuts (most notably Denmark and Germany had cuts of 21% each). This burden sharing however is heavily influenced by such unique factors as German reunification and other internal EU politics.

whose only endowment is coal. Those with a very cold climate may argue that they need much energy for heating. We will not delve too much into this line of reasoning partly because it quickly becomes overly complex. If the argument that cold weather warrants high energy use and carbon emissions is accepted then similar arguments can be made for those countries that are so hot they need air-conditioning or those countries that happen to have bauxite mines and aluminium industries etc.

A more tractable and also very universal principle is that of equal per capita allocation. The principle of equal per capita allocation is used in a wide range of applications: it underlies our democratic principles for universal and equal suffrage and family planning in China (the one child per couple principle) or in war-time rationing, it is also used for instance to distribute a large share of the oil revenues in Alaska¹¹. The Alaskan example is perhaps especially interesting since Alaskan oil was found fairly recently and one might take this as a model for how to distribute an unexpected windfall profit.

Comparison of allocation mechanisms

Both grandfathering and per capita allocation have logical and intellectual appeal. Both are ubiquitous and can, and will, be defended passionately in a very wide variety of countries and socioeconomic or political contexts. In favour of grandfathering, its proponents can say it has the appeal of having been used, very definitely in important permit trading schemes such as the sulphur trading in the USA and as we have seen, partly used at least in Kyoto. It often seems to be taken for granted as countries compared their percentage reduction offers in the run-up to Copenhagen. On the other hand equal per capita allocation also has considerable pedigree as mentioned.

Most importantly it should be amply clear that in our context, grandfathering is beneficial to those with large emissions or fossil fuel use and equal per capita allocation beneficial to low income

¹¹ 25% of Alaskan state oil revenues are paid to a fund, the dividends of which are distributed on an equal per capita basis to all those living in the state. The remaining 75% are used to finance the budget and they also of course – benefit the citizens of Alaska although in ways that are perhaps less direct and obvious.

countries that use little fossil fuel. The following table shows the percentage share of global carbon emissions from fossil fuel and population for a number of countries grouped not by conventional categories but just for the purpose of this discussion.

Table 2 Shares in global emissions of CO₂ and world population for some countries

Country	Emissions	Population
China	22	20
USA	20	5
EU	14	7
India	5	17
Japan	4	2
Other major (1)	9	6
F. Sovjet (2)	9	4
Oil exporters (3)	11	10
Other	7	30
World	100	100

CO₂ emissions from the burning of fossil fuel only. Source Carbon Dioxide Information Analysis Center (CDIAC) of the US DOE.

1 Canada, South Africa, Korea, Australia, Brazil

2 Russia, Ukraine, Kazakhstan, Uzbekistan, Belarus, Turkmenistan, Azerbaijan, Tajikistan, Kyrgyzstan, Armenia, Georgia, Moldova, Mongolia

3 OPEC, Mexico, Malaysia, Oman, Trinidad and Tobago, Yemen, Brunei

We see that the USA has 20 % of World emissions but less than 5% of World population. Fossil based carbon emissions per capita are 5.2 Tons C, four times higher than in China (1,3 tC/cap) and twice the value of Germany, UK or Japan (2.6; 2.7 and 2.8 resp). If emission allowances were allocated by grandfathering the US would receive 20% of the global total while on a per capita basis, they would only receive 5%. We can also consider the domestic consequences in the USA if the whole World were to reduce emissions by 50%. With grandfathering the US allocation would have to be reduced also by 50% whereas with equal per capita allocation their share would be reduced by almost 90%.

Naturally any efficient and rational scheme would allow trading, so actual emissions do not necessarily need to be reduced so much – we are speaking here of allocations. The point is that the allocations would generate very substantial flows of revenue. For India the consequences would be somewhat the opposite to the USA. With a per capita allocation they would get a share equal to their population share (17%) whereas with grandfathering only 5%. In a situation where the whole World reduced emissions to half, the Indian allocation would still increase very significantly if allocation were based on per capita equity. Just for India the difference between grandfathering and per capita allocation would be 12%. If we were speaking (one day in the future) of limiting fossil carbon emissions to 4 Gtons globally this difference would be 0,5 Gt of C. This is almost 2 Gt of CO₂ and if the price of CO₂ were 50-100 \$/t it would be 100-200 M\$/year

Enclosure is a term used when a natural resource that is held in common or by no-one is turned into property (private or state). Originally the term was coined in England where common property or unclaimed land was open (literally) and private property was surrounded by a hedge. Hedges are cheap and self-perpetuating fences and they characterize the British countryside so one often has the feeling of driving through a green corridor. At least the seventeenth and eighteenth centuries were heavily marked by struggles originating in the enclosure of the commons. In the US, the great move West was similarly one giant creation of property as was the UN Law of the Seas when the nations of the World negotiated property rights for coastal states to 200 mile economic zones.

The atmosphere is perhaps the biggest enclosure ever. If emissions were limited to something like 15 Gt of CO₂ /year and each ton had a shadow value of 100 USD the annual rental value would be of the order of over a thousand billion USD. Naturally it matters to India if they receive 5 or 17% of such property! The values are also bigger than anything that is likely to be paid as a result of climate negotiations.

We thus have a very valuable natural “resource” (the opportunity of using the atmosphere to dispose of carbon dioxide and other climate gasses in the atmosphere) that will probably one day be

regulated. Its value is so large that it will presumably take decades to agree. This process started softly in the 1990s with Kyoto. The Law of the Seas started with a League of Nations conference in 1930, unilateral appropriation of its continental shelf by the US in 1945 and other countries thereafter. Formal negotiations thereafter took place in the UN between 1973 and 1982 and the treaty entered into force in 1994, some half a century in total. If it takes 30 years to negotiate the enclosure of the atmosphere, there would be a viable, all-inclusive and binding agreement in the mid 2020s. This may be quite an optimistic scenario but gives a perspective on the current negotiations which we will come back to.

6. Dealing with countries that do not (currently) want a climate deal

In spite of the somewhat sobering time perspective just sketched and the rather large resource rents at stake, I think one can make a case for some cautious optimism. This issue is clearly not as easy as the phase-out of ozone depleting substances in the Montreal Protocol which really concerned a rather small number of countries and producers and minor rents. It may indeed be much bigger and more complicated than the enclosure of the Seas. Still it need not be as complicated as global nuclear disarmament, the land conflicts of the middle east or the rights of immigrants from low income countries in rich countries such as the US and EU. Seen in the context of long run economic growth, the costs are, though large, as mentioned above, quite manageable¹².

We have entered a phase in which powerful countries are struggling to avoid carrying an unduly large share of the total burden. This is a struggle that could continue for another decade and certainly has the potential to get nasty but I would like to think that countries such as China, India, most OECD countries such as the EU, USA, Japan, Canada, Australia, N Zealand and some regional powers such as S Africa, Korea, Brazil will ultimately want to commit to some form of climate policy though only after

¹² According to the Stern Review, the order of 1 % of GDP. In the context of decades of growth at a few percent per year this is of course quite small.

a tough battle concerning the fairness of shares mentioned. In fact I would interpret both Kyoto and the Copenhagen Accord as part of this historic bargaining process.

These countries are a manageably small group of 10 major players (counting the EU as one) that together account for just short of 75% of current global emissions. We are still very far from any agreement between them but it is worth considering for a moment what would happen if only these countries agreed. One of the reasons for this is that we need to be prepared to avoid surprises that could disturb progress at that point. Unfortunately it is likely that at least the oil exporting countries would represent a serious policy challenge. These are countries that actually do stand to face a major economic loss through climate policy itself. Somewhat the costs depend on the type of policy used but for instance a tax in the consuming countries would significantly cut the large oil rents that has provided the economic backbone of these countries for decades. It is not difficult to imagine scenarios in which these exporting countries are economically ruined and something similar might apply to all fossil exporters. One should note however that since the carbon content of the various fossil fuels varies quite significantly, a correct carbon pricing would hit the exporters of coal (and heavy tar sands, oil shale deposits etc) much harder than conventional oil fields and gas would in fact benefit in relation to these other sources.

It is natural that oil exporters should be sceptical of climate economics, and It is easy to find instances of this type of attitude in for example the OPEC Bulletin. According to one quote from FORBES “Saudi King Abdullah, whose country holds the world's largest oil reserves, vowed to continue to provide enough supplies, but called on leading consumer states to cut taxes on petroleum products”, <http://www.forbes.com/markets/feeds/afx/2005/11/20/afx2347009.html>. Consistent with this kind of analysis the OPEC countries have been sceptical to climate change and tend to believe it is at least exaggerated in order for the OECD countries to be able to appropriate some of the oil rent. Consequently they have argued that they should get compensation for climate

policies that might reduce their income¹³. In fact it is stated in article 4.8 of the UNFCCC and articles 2.3 and 3.14 of the Kyoto Protocol that they should be compensated for lost export revenues.

Naturally some oil countries may take quite different positions. Norway for instance is not likely to be among those countries who actively obstruct international climate negotiations. Still it is instructive to study this group. In the table above I have included OPEC and a number of major oil exporters that together account for over 10% of carbon emissions worldwide. "Russia and the former soviet" group also have vast fossil resources which are exported and they account for another 10% of global emissions – with an even lower percent of global population.

We have reason to return at this point, to the discussion in section 2 concerning the importance of a very high coverage of countries in a global agreement. If a group of countries representing a 20% share of emissions continues to grow at say 5% or more it will represent a very serious threat to a climate agreement even if say 70-80% of current emissions were covered and in fact reduced according to plan. Wei et al (2010) analyze this situation as a dynamic strategic game and point not only to this possibility but worse, demonstrate that it would be in the strategic interest of the fossil exporting countries to subsidize domestic consumption more if the "climate-conscious" importers tax it more¹⁴. Subsidising domestic consumption in oil exporting countries has a series of advantages for the local policy maker: it helps keep up demand and use the production volumes produced, it generates some revenue (though less than international sales), it may attract some energy-intensive industries and it helps distribute the rent locally (within the oil countries themselves). Finally it will tend to weaken the effect of the climate tax that is hurting the economy of the exporters.

Already today, the domestic market in OPEC countries is considerable - accounting for around 20% of OPEC's oil extraction and the share is growing, see Gately (2007). Net exports of some oil producers such as Mexico have fallen drastically because the domestic market grew so fast - which in turn was

¹³ See for instance http://findarticles.com/p/articles/mi_qn4182/is_20000920/ai_n10140573/.

¹⁴ See also Liski and Tahvonen, 2004 for a similar analysis. Persson, Azar, Lindgren and Johansson 2007 provide an alternative view in which oil producers end up gaining from carbon taxation because the differences in carbon content of coal and oil imply that carbon taxation hurts coal much more than oil.

largely a result of the low domestic price. Virtually all developing country fossil exporters have very heavily subsidized fuels on their domestic markets¹⁵.

It is sometimes said that a good short-term strategy is to remove irrational subsidies to fossil use. I say that too – it is a good strategy but we should perhaps see that not only are these subsidies protected by strong lobbies, they may even be have some rationality in the struggle over rents between producers and consumers. The notion that producers of oil or other fossil fuels should be compensated for climate policy probably appears atrocious to some¹⁶. Particularly considering the much bigger damages that some countries face that have much lower income and no share in causing the problem. However it is in the Kyoto protocol and considering their power of retaliation it might be worth considering if there are smart ways of unlocking collaboration rather than pursuing policies that might evoke stubborn responses such as local subsidies. One natural direction to explore is to involve oil producing nations in the development of new solar alternatives. They have energy know how and infrastructure for storage, handling and so forth and might potentially be interested in collaborating on projects such as producing liquid fuels based on solar energy.

7. Sovereignty and Incentive compatibility

International policy making is much like domestic policy making except that an agreement among states – a climate treaty- must respect the sovereignty of the nation states. There are of course limits to sovereignty and there is inequity in power. Smaller nations (and nations with few resources) can of course more easily be “persuaded” or coerced into taking actions than can major states. The

¹⁵ In December 2007, when international bulk prices for gasoline in Rotterdam were 105 UScts/gallon, the retail consumer prices in some oil producing countries were as follows: Iran 18,4; Libya, 19,8, Kuwait 41,9, Qatar 32.8 and Saudi Arabia 22,2 Cts/gallon

¹⁶ In reality the relations between oil producers and consumers is much more complicated. They are cartels as are to some extent the companies that produce and sell oil. They are heavily dependent for savings and military alliances in particular with the USA and finally their best reaction to taxation is very complex. Their demand will for instance shrink also as an effect of falling oil prices and this would counteract the effect they have by subsidizing domestic consumption.

fact remains that on the whole, treaties cannot not just be designed to tell countries what to do. They must be designed to actually make it compatible with national interest to both join a treaty and to comply with its provisions. Barrett 2010 points to Kyoto as neither providing incentives to countries to participate nor to comply.

Admittedly, the problem of making regulations incentive compatible is also know from domestic policy making. Also individuals and firms need to be coerced and the power of the regulator is sometimes limited. It is also true that countries are quite rapidly forming into economic blocks and as the World economy becomes more “globalised”, the options for any particular country to obstruct what is in the interest of a majority of (influential) countries is circumscribed. Still there is no doubt that countries are quite different from citizens. Countries typically see to their national self interest when negotiating rather than thinking idealistically about the global commons.

Some observers are becoming deeply skeptical about formulating any all-encompassing climate treaty because it will always be in the interest of some groups to free ride and because of the complexity of such a grand undertaking. One might be more optimistic when it comes to the chances of forming a portfolio of international treaties on various different aspects related to climate change, certain of the gasses, technology, adaptation or international agreements for certain sectors of the economy (Stigson 2010, Barrett 2010).

8. Technology policy

Traditional analysis of climate economics assumes the main market failure is the existence of external effects (carbon emissions) or unmanaged common property resources (the atmosphere). There is however an additional market failure that is very important: that of R&D and the tenure security of intellectual property. Considering the gravity of climate change, there should be strong

incentives for R&D to solve the problem in one way or another¹⁷. Yet we do not see as much research as we would expect. The situation is partly similar to research for curing AIDS or malaria. If someone discovered a cure, there is considerable risk we would not respect patent rights. Most people would say: this is so urgent let us simply copy the invention and use it without paying royalty. This then, is one of the main reasons there is insufficient research and development of both drugs and cures for the climate change. The analogy is not fully fair: one of the inherent problems with drugs for many tropical diseases is that the patients have very low ability to pay, also because drugs are extreme when it comes to high R&D costs and low production costs. In the case of climate change, there is no doubt a potential market – but the uncertainty concerning the protection of intellectual property rights remains. There are numerous possible solutions although none is perfect. One is to drastically increase public funding for such R&D. Again there is a problem of common actions for the countries involved but a treaty to jointly stimulate R&D in new climate-friendly technologies is likely to be much easier to implement than an international treaty aiming to reduce fossil fuel use.

A research agreement is however far from enough. In the absence of a strong price signal there are numerous risks. First of all the research itself may be affected. If you give many dollars to researchers in a country where fossil energy is still cheap, they will do research but the question is if it is the right research? Suppose a shadow price of X\$ would have been appropriate but is absent. The researchers will publish articles maybe on the basic science related to photovoltaic principles – but not necessarily at the solutions that are most relevant for abatement at the shadow cost of X \$. Similarly one may wonder whether this research will lead to research *and development* that is focused on really abating carbon at a suitable cost. There is a clear risk this research remains unconnected to actual entrepreneurship or actual implementation of processes that would generate energy without carbon emissions at a suitable price.

¹⁷ It is an attribute of this problem that potential "solutions" can be as distinct as CCS, fusion, hybrid rice, the social engineering needed to make domestic fuel taxation politically acceptable or the fertilization of the seas with iron shavings...

Those who particularly study industrial economics and technology often emphasize the importance of going beyond R&D to study the actual phase in which small industries have to compete and survive. In the case of the energy sector, advantages to scale are very prominent as are perhaps learning by doing and technical progress. A combination of these factors can effectively create situations in which the barriers to commercialization are very high. Policies such as feed-in tariffs or subsidies to production can of course be more effective than just research grants. On the other hand, this presents a considerable challenge to policy makers since we also know that it is dangerous to pick winners and that subsidies can easily become self-perpetuating.

The problems are compounded by the obvious fact that the energy sector is characterized by big agents who have market power as well as the power to lobby. To some extent it may be desirable if the policy maker helps build alternative lobbies for new green technologies – but there is also the obvious risk of creating lobbies for technologies which turn out not to be the most appropriate. We already seem to have seen some of this in the case of some vehicle and fuel technologies such as some forms of ethanol use. In the future we may have to be quite careful with suggestions for various forms of geo-engineering.

9. The Copenhagen Accord

Many talks have been given the last few months trying to analyze what actually happened in Copenhagen. I think it is natural to see this neither as a dramatic failure nor of course as a great success but just another step on the rather long and arduous road. Keeping in perspective that climate change has such unusual characteristics helps in interpreting the situation. Enclosure of the global atmosphere is a complicated process involving directly asymmetric costs and benefits to many generations of countries that are worlds apart in their economic and political condition. The stakes are high and the perspectives concerning what would be fair and what actually needs to be done are

uncertain and asymmetric. It is reasonable to assume that negotiations will take decades and not months. It was thus utterly unrealistic to hope for a finished binding agreement in Copenhagen.

Before one gets to a binding agreement (if ever we do) it is natural that there are many rounds of negotiation since somehow baselines and principles for the negotiations need to be established as well as criteria. In this light the Copenhagen Accord is perhaps not so bad¹⁸? Some see it as a good starting point, while others are frustrated and point to the fact that the negotiations did not start in 2009 but in the 1990s. Kyoto was supposed to be a starting point and some nations were aspiring for a second more ambitious step now. Instead we have again an agreement based on voluntary participation and we all know that public goods are not properly provided by voluntary mechanisms. A decisive element that would have been desirable was therefore the notion of making the deal “binding” and the reductions of each country contingent on the participation and ambitious reductions by other countries. This is the characteristic of the “public good”. Consider the viewpoint of player “i” why make a big pledge of X if you can just as well make a small pledge of x? The only reason is if your own big and costly contribution is *matched* by equally big contributions by the other participants so that the overall collectively produced “public good” (in this case climate) is sufficiently big. In principle the EU position before Copenhagen of promising 20% if other countries did nothing and 30% if other countries were ambitious is in principle an example – but seemingly the only example of this kind of contingent strategy. Had World political leaders really been driven by a desire for maximum collective reductions in GHGs, we would surely have seen more of such tactical bids.

On the other hand the Copenhagen Accord is more ambitious in one truly decisive aspect: it actually undertakes to include at least the inner circle of all major emitters including not just the EU, Japan and other Kyoto members but also the USA, China and India. This also means that the parties to the

¹⁸ An experienced, senior negotiator, Ambassador Bo Kjellén commented that people tend to exaggerate. When negotiations appear to be going well, Victory is proclaimed but – as he pointed out – the results are often not quite as good as claimed. Not seldom has victory been achieved at the expense of hiding away some troubling details that tend to come back and haunt implementation in future rounds of negotiation. On the other hand when negotiations are said to have collapsed -, it is also the case that there is much to be salvaged and the situation may not be as bad as it seems.

Copenhagen Accord are so much more diverse in emission intensity and economic welfare that allocation and fairness become an order of magnitude more complex than in Kyoto and maybe this was one of the reasons why we did not get actual binding numerical targets.

The Copenhagen Accord had on April 13th been signed by 76 countries representing over 80% of World emissions. Their “pledges” can be broadly classified into three categories: reductions compared to 1990 (including as for the USA, reductions compared to 2005 or base years which can easily be translated into reductions compared to 1990); pledges of limiting increases in carbon emissions below a certain figure and finally reductions in emission intensity. The first category includes the USA, EU, Japan, Russia, Australia, Ukraine and some smaller countries – mainly formerly soviet ones, (the table below only shows countries with an emission share of more than 1% of the World total). These countries are on the whole slow growing rich countries and the former Soviet countries which essentially lost such a large share of industry after 1990 that they have an expected surplus of rights even with big reductions. The second category of countries includes fast growing middle income countries like Brazil, Mexico, S Korea, S Africa as well as Indonesia. Their pledges range from a few percent for Brazil to a 64% in the case of S Korea. Finally we have India and China that have the highest and perhaps most uncertain growth rates and which have chosen to formulate their pledges instead in terms of emission intensities. This on the one hand alleviates the uncertainty for the country inherent in unknown but potentially high growth rates and also on the other hand makes it possible to be seen to collaborate but at the same time to defend intensely their perceived right to higher allocation per capita in the long run. Finally there is a big group of countries that have basically made no numerical pledge at all – or not even joined. This includes most significant OPEC countries and most low income developing countries.

Table 3. Copenhagen Accord Pledges: Reductions, Ceilings on Increase and Reduced Intensities.

Country	Share of World's Total GHGs ^{a)}	CO ₂ Gtons per capita	Reduction by 2020 compared to 1990	Limited increase 2020 compared to 1990	Reduction by 2020 In intensity
China	16,64%	4,7			40 to 45%
United States	15,78%	19	4%		
European Union	11,69%	10	20 to 30 %		
Brazil	6,60%	15,3		Increase < 2 to 6 %	
Indonesia	4,73%	9,3		Increase < 22%	
Russia	4,64%	14	15 to 25%		
India	4,32%	1,7			20% to 25%
Japan	3,14%	10,6	25%		
Canada	1,86%	24,9		Increase < 0,25%	
Mexico	1,58%	6,6		Increase < 20%	
South Korea	1,30%	11,8		Increase < 64%	
Australia	1,30%	27,4	-4 to 24%		
Ukraine	1,14%	10,5	20%		
South Africa	0,98%	9		Increase < 48%	

a) CO₂ emissions from the burning of fossil fuel only. Source Carbon Dioxide Information Analysis Center (CDIAC) of the US DOE.

It is essentially impossible to state that a certain emission target for a group of countries for the year 2020 is or is not compatible with any particular long term climate goal (say for the year 2100). The ultimate concentrations and temperature response will depend not only on the inherently uncertain climate sensitivity parameters but also on what paths are followed after the year 2020, see www.chalmers.se/ee/cc2 where the reader may test how various emission pathways for Annex 1 and Non Annex 1 countries will affect atmospheric concentration and temperature. If, your mental image is that the first reductions are the most difficult (perhaps because they imply a break with a trend) then even small reductions now are a big achievement and will easily be followed by bigger reductions later. In that case the accord's pledges could perhaps be seen as promising. On the other hand, if we assume that marginal abatement costs are rising – which we usually do – then in fact the

first reductions are the cheap and easy ones and in that perspective the pledges do not look very impressive. In fact it seems many observers¹⁹ emphasize this and consider that we are far of very far from being on a path to limiting temperature rise to 2 degrees (although this goal is in fact mentioned or “reaffirmed” in the text of the accord). Rogelj et al (2010) call the pledges “paltry” and say they may even lock the World into paths leading to more than 3 degrees warming. They point to the fact that to meet 2 degrees would with the Copenhagen Accord as a starting point, require very dramatic cuts 2020 to 2050 and lament the fact that ambitious goals for 2050 were dropped, apparently in the very last moment, from the Accord. One might doubt the operative importance of goals for 2050 but just as temperature goals are important, visions of how to reach them are crucial. The advantage of discussing a vision for 2050 was also that fairness issues would seem more tractable in a long run time perspective (see Guesnerie and Sterner 2009).

If it was indeed a “failure” there are naturally many reasons for it and many who wish to share the blame liberally with others. Some blame the UN procedure for being slow and bureaucratic, some individual countries and even persons have been given a large share of the blame. We will not pursue this tack although these factors were no doubt present and important but rather look at the broad perspective: serious abatement is most effectively done when property rights are fully allocated. That is when there is an economic incentive for each agent who will otherwise pay the full cost of his emissions. The details of that allocation are however so valuable that the fight will continue for some time. To be optimistic we may see successive waves of more and more serious abatement between 2020 and 2060. We might now look back at the period from say 2000 to 2025 as a period in which the World took stock of the issue and the options and when property rights were defined (negotiated or fought).

It is however interesting to look at the structure of the Copenhagen accord from the viewpoint of a strategic game. We do not normally expect the voluntary provision of public goods to give good

¹⁹ Levin, K. & Bradley, R. (2010), UNEP (2010), Rogelj et al (2010) as well as Stigson (2010).

results. Why would individual countries pledging – each on its own – contribute very much to a global public good. Why not free ride? In this light one would actually expect countries to have volunteered almost nothing. In fact the incentives are maybe worse than that because of the ubiquitous nature of grandfathering in people’s minds. Why not reason as follows:

- If the USA got away with not ratifying the Kyoto protocol and now can have 2005 as a baseline when the EU and other Kyoto countries have 1990 as their baseline.
- If the pledges now are voluntary, but around 2020 or 2025 reductions will become almost mandatory then why make an ambitious pledge now? For 2012-2020, why not make a really loose pledge to get a good baseline for say 2025-2035?

There are definite signs that this has indeed occurred. As pointed out by Rogelj et al (2010), the Chinese target of reducing by 40-45% their emission intensity is considered *less ambitious* by far than their actual five year plans and current investment plans for the energy sector. It is also interesting to see that Chinese carbon emissions (as reported by), grew by 3% per year 1990-2001 and the growth rate then jumped to 13% per year 2001-2006. It is of course complicated to judge Chinese emissions and observers have pointed to poor accounting as an obstacle for instance for trading. It is however also clear that if ever there was a good moment to do a very detailed inventory of carbon emissions it is just before you enter into negotiations with a counterpart that believes strongly in grandfathering.

On the other hand, it is cheap to be overly critical to the Copenhagen Accord on this point. The slow bureaucratic UN process was not delivering a binding accord. There is a definite need for a global agreement which includes many diverse countries and begins to deal with issues such as Monitoring Reporting and Verification. Baselines must be established somehow and normally there might be an incentive to under-report. Possibly this is counteracted by this strategic use of grandfathering which creates an opposite incentive to exaggerate emissions. We need to balance incentive compatibility and fairness issues and there are few alternatives that are not subject to the kind of strategic bias

mentioned above. In Copenhagen it could perhaps be claimed that the strategic incentive for free riding was somewhat balanced by some feeling of honour and some element of prestige for those countries that took on serious commitments.

Domestic opinion pressure is also very important and we have therefore been studying opinions in China the US and Sweden in a unique survey (see Carlson et al 2010). We find that a large majority in *all three* countries believe that the mean global temperature has increased over the last 100 years and that humans are responsible for the increase. A somewhat smaller share of Americans, however, believes these statements, when compared to Chinese and Swedes. When WTP is measured as a share of household income, the willingness to pay is the same for Americans and Chinese, while again higher for the Swedes. This was somewhat of a positive surprise because I knew nothing of the attitudes in China. I do however have some experience of audiences including economics students, economists, policy makers and civil servants in Africa and typically I have found that the issues do not seem to be as prominent in those African countries I have visited as in Europe. Public education obviously has an important role to play.

10. Green Growth

I have tried to argue that this is a special period in history. The “enclosure” of the atmosphere is such a large creation of property and such a shift in developmental paradigm that it will take time to accomplish. The main obstacles include agreeing how to share costs. There are some dilemmas in this situation that affect the range of options for policy making before an international agreement is in place.

- We are in a considerable hurry to start reducing emissions but a global treaty implies large transfers of wealth and complex fairness issues that will take a long time to resolve and their size hinges partly on the availability of new technologies

- A global treaty would of course be easier to achieve if there were sufficiently good “clean technologies” available. However there is no (strong) incentive to develop such technologies before property rights are affirmed and a price signal in place as they would be under a binding and global treaty.
- To demonstrate that reductions are possible, proactive behavior is needed, someone must go first. However with the prevalence of grandfathering, proactive behavior is not only “not rewarded” but may actually be punished.

It is in here alternative paths need to be discussed. We need a policy that will make it easier to fulfill future national goals for any given country. Preferably, also we urgently need a policy that makes a global agreement more likely. It is here that “green growth” comes in. Green growth is attractive to some business, to some trade unions, to some researchers and to some environmentalists. It seems politically much easier to get acceptance for stimuli for green cars and green fuels than acceptance for higher fuel taxes although the latter are likely to be considerably more efficient in reducing carbon emissions. Also developing countries are more attracted by the idea of green growth and – not least relevant in the last couple of years – it fits nicely into the rather dismal state of the business cycle after the demise of several banks and the near demise of entire countries such as Iceland or Greece. The strong threat of a slowdown in global growth makes the lure of green growth all the more attractive. The question is what makes this a sustainable strategy?

Many environmentalists who have understood that total costs for abatement are not really big compared to potential damages, have been severely frustrated by the difficulty of reaching agreements that are perceived as fair with respect to the “sharing of the burdens”. Some of them suggest we abandon the whole “discourse” on burden sharing and instead formulate this “positively” as “competing to be first into the solar age”.

Even prominent heads of state have been enthused. In November 2008, Ban Ki-moon, together with President Yudhoyono of Indonesia, Prime Ministers Tusk of Poland and Fogh Rasmussen of Denmark wrote an article in the International Herald Tribune entitled “Crisis is opportunity”. They argue

“We do not need to await the arrival of new technologies, nor need we worry excessively about the costs of taking action. Studies show that the United States could cut carbon emissions significantly at low or near-zero cost, using existing know-how. For evidence, consider how Denmark has invested heavily in green growth. Since 1980, GDP increased 78 percent with only minimal increases in energy consumption. For businesses, such savings translate into profits. Poland has cut emissions by a third over the past 17 years, even as its economy boomed. Today, for example, European companies in the green tech sector enjoy substantial “first mover” advantages, accounting for one third of the world’s burgeoning market in environmental technologies.

With the right policies and financial incentives—within a global framework—we can steer economic growth in a low-carbon direction. With the right policies and the right incentives, we can be sure that developed and developing countries alike contribute to the cause of fighting global warming, each in their own way and without compromising every nation’s right to development and the economic well-being of its citizens. “

They go on to say that most forward-looking CEOs know this and therefore demand clear and consistent policies on climate change. Turning to the business sector, one of the most influential organizations is the World Business Council on Sustainable Development, WBCSD, the title of their latest annual report was “The Green Race is on”. The President’s message starts:

“We hoped the December climate talks in Copenhagen would deliver a clear new framework to manage climate change. It did not. But the year did deliver a new sense of the reality and urgency of the energy and climate agenda. Business leaders realized that they must help lead society toward solutions, stepping into political and diplomatic arenas previously alien to them.” ...At the same time, the Council’s own Vision 2050 Project began to document the spectacular breadth of business opportunity inherent in pathways toward sustainability.”

The message is that the “Green Race is on” between countries to transform to low carbon economies and to become the leading suppliers of resource efficient technologies and solutions. The countries that want to win must transform their own home market to build competences and scale and thereby comparative advantage. The sentiment conveyed is one of urgency and the risk of missing vital opportunities. Japan is portrayed as a leader in energy efficient solutions since they have the advantage of having correctly understood the opportunity provided already by the energy crises of the 1970s. The EU is considered the leader today with a market share of 40% in green technologies and plans for a 300% increase in R&D for green technologies but still there is concern that the EU is not building its domestic green market fast enough. The new administration in the US is portrayed as mobilizing the US innovation capacity to be world leader on green technologies. Jeffrey Immelt, CEO General Electric, is quoted as saying: *“Let’s not take this growth industry and give it to every other country in the world but the U.S”* (March 3, 2010). The WBCSD however considers that China may emerge as the winner since they have focused the next 5 year plan very strategically towards such goals. Also India is portrayed as a key supplier of low cost solutions based on their own domestic demand from a big & poor population.

Also UNEP has launched a special initiative entitled the “Green Economy Initiative”²⁰ which provides advisory services helping governments and corporations. It recommends stimulus to green industries such as renewable energy, improved (and ecologically sustainable) housing and transport solutions and so forth.

Naturally this is encouraging and one understands the temptations for environmentalists and politicians alike but we wonder will this growth be green enough? or better still: What policies make growth sustainable? A simple answer is of course that the increase in efficiency (in the use of ecologically sensitive inputs or waste products) must be more rapid than the increase in output.

²⁰ <http://www.unep.org/greeneconomy/>

More miles driven by more cars can only be sustainable if the average emissions per mile go down **faster** than the miles go up!

I would like to illustrate this issue with the transport sector since it is the sector I have done the most work on. There are many hundreds of studies on vehicle fuel demand (see for instance Dahl and Sterner, 1991a, 1991b, Goodwin et al., 2004; Hanley et al., 2002; Graham and Gleister 2002, 2004 for surveys). To simplify we can say that the fuel demand function is surprisingly constant and can be approximated by the function:

$$G = Y^a P^b$$

This means that fuel demand has an income elasticity of a – which is roughly equal to unity and a price elasticity of b which is roughly equal to -0.7 . This means that a ten percent increase in income will – if the consumers have the liberty afforded by democracy and market economics – choose to increase their spending on fuel by around ten percent. In rapidly growing middle income countries the elasticity is sometimes somewhat above one. The record highest value I have seen (in hundreds of estimates) was recently an estimate of an income elasticity of 3 for the last decade in China but this is truly an outlier and not likely to be confirmed in longer time series. The price elasticity is usually around -0.7 but this is a long run equilibrium value. It does NOT mean that consumption will drop like a stone by 7% if the price goes up by 10%. Instead it means that after a full set of adaptations has taken place, then in the long run the fuel demand will be 7 % lower than it would have been otherwise. In the short run perspective of a year, the fuel demand will only drop by maybe 1 or 2 % and even this will not be visible if there is say 5% growth rate because the observer will simply see an increase by say 4% (which for the econometrician comes “instead of” the expected 5%).

Now we are equipped to answer the grand question of how we make growth sustainable. Suppose we want to reduce emissions of carbon dioxide by 2% at the same time as income is increased by 4%

per year. Then clearly policies are needed that become tougher over time to compensate for the effects of growth. With constant taxes (even if they are high), emissions from the transport sector will increase 4% p a. To combine growth in income and a fall in emissions we need, in this particular case, the price to rise by 9% per year. Notice that 9 % per year is a very strong policy instrument which means prices double every eight years! Eventually prices of course become so high that one may wonder if the elasticities are constant over such a broad range of data and one may also eventually find that all kinds of alternatives are profitable such as public transport, solar powered cars in some form, but that is of course the purpose of the exercise and in principle the elasticities sum up all these reactions.

For other sectors such as buildings, industry and so forth similar mechanisms are at play but the elasticities will be different and in some cases it may be more difficult to replace fossil fuels (then elasticities will be lower). In other sectors there may be rapid energy saving technical progress or ready substitutes so that elasticities are higher. They are not very likely generally to be much higher than -0,7 so it is likely that overall fossil prices need to rise by at least 10% per year to make economic growth of 4% feasible. The mechanism we have discussed here is the demand side mechanism. Eventually energy prices will be so high that fossilfree alternatives can compete and then the price of energy does not need to rise.

Higher fuel prices are not very popular and tend to be attacked with whatever argument is at hand. It is sometimes said that higher fuel prices are inflationary. Granted that for an importing country, a price chock in imported fuel will have some at least temporary inflationary effect. However an environmental tax reform where fuel is taxed higher while some other factor is taxed less should not be inflationary. Budget deficits are also inflationary and if a fuel tax were to be used to eliminate a budget deficit, that would not have to be inflationary either.

Another argument that is often used is that fuel taxes hurt the poor. I am soon finished with a book that contains some 20 case studies for countries in different continents, with different cultures,

population densities and income level. I find that in the very richest countries, there could be a slight regressivity of the fuel tax itself although the overall regressivity of a tax reform depends on how the revenue is used. It is possible to make an increased fuel tax reform very progressive if you want. It turns out that there is not such a demand for progressive tax reforms these days. Most importantly in this context, I find that in low income countries, fuel taxes themselves are quite progressive.

Fuel taxes only represent one example albeit an important one. The real cost of the most efficient policy instrument (higher fuel taxes) is very limited. However they are not popular and therefore perceived as costly or difficult. Maybe if politicians were somehow “obliged” to raise fuel taxes, through an international agreement, there would eventually be some discovery that the costs are not really so high. Ironically other instruments such as banning cars over a certain age or mandating new green cars that run on alternative fuels etc, are sometimes perceived as easier to implement (again there are political economy reasons since for instance the car industry may be very positive to this type of instrument). One still needs to be a little wary in the balance between these instruments since the “green car” type of policy is actually very much more expensive in relation to limited gains in abatement – at least in the short run. Only if the technologies that are encouraged are truly green will these instruments promote a growth that is sufficiently green.

11. Discussion

I have in this paper discussed and even partly embraced some arguments, to which I feel ambivalent and I would like to end by summarizing my view on them. I have said that costs of abatement are big and we need to think of efficiency and that this implies both a unique price of carbon and a global agreement with close to total participation. Global participation in turn requires dealing with ethical issues of fairness and distribution. All these arguments are used enthusiastically by those who want no climate action and therefore they require some careful qualification. Those who are sceptical to climate action know that it is hard to negotiate a big global deal. It is particularly hard if there are no

positive and functioning examples of abatement or of low-carbon growth to point to. So we risk being caught in a catch 22: no local action before a global deal and no global deal because it is too complicated and there are no examples to follow. A unique price of carbon and a global agreement that is fair and efficient are not within reach in the short run.

Are we doomed to be caught in this catch 22? I think not and one of the keys is to understand that this is a big and long run process and different arguments apply to different stages in that process. Climate change will dominate discourse throughout this century. In the year 2040 we will be discussing how to deal with the next step since the actions after 2030 were not sufficient. We are still at the beginning and many of the issues we are discussing just first steps. The importance of cost efficiency, a global treaty and a unique price of carbon apply to the later stages in climate negotiations when we face the most difficult and expensive reductions in carbon intensity.

Costs are big – but not so big we should do nothing. The costs of inaction in the form of damages are likely to be much bigger. Through successful policy, the costs would actually never be visible since most of the “costs” do in fact take just appear as small almost minute modifications to long run growth rates. Green tax reform does imply some loss in consumer surplus but this is hardly noticeable to the individual: The main problem is rather political acceptability and the damage that can be done by lobbyists. Most of the costs of abatement will also come later. In the immediate future, marginal costs of abatement will be low hence the argument that we need global coordination and a unique global price of carbon is not so important *in the first years*. During this first period abatement actions should not primarily be judged by whether they are cost efficient but by whether they lead the overall process of bargaining and negotiation forward. Good examples are demonstrations of new technology that are likely to be copied or that can be used to argue for the feasibility of more stringent targets.

Even though the costs are small compared to damage and even very small compared to the expected and still possible growth in the economy they are still sizeable enough to require attention to cost efficiency. But the biggest importance of cost efficiency will come in the future when the tougher reductions are undertaken. It will take time before we have a unique price of carbon in the world since this is tied in with the difficult question of who appropriates the rent – or how the burdens are split. In the mean time we must live with an array of prices or shadow prices and gradually work towards unifying them as property rights become defined. In the mean time we must still reduce emissions – both to reduce pressure on the atmosphere and perhaps most importantly to learn. Today we are taking first steps and the critics sometimes say they are just symbolic: Examples include many of the experiments with “green” cars in Sweden or the USA as well as many of the CDM projects. They are sometimes accused of being “Just” symbolic. Well in a way this is true – they are partly symbolic, I prefer to see them as learning experiences, but whatever you call them they are extremely valuable. After the obvious difficulties of global negotiations, it is a good thing there is such enthusiasm for green growth. It is the job of politicians and opinion to make sure that it is green enough and for this tough policy instruments are still needed.

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