Technology rules!

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Summary

This thesis deals with climate change, technology and reciprocity. Climate change is defined as the climatic consequences of human-induced higher atmospheric concentrations of greenhouse gases[1]. Climate change has a number of adverse impacts, such as more frequent and stronger droughts and sea level rise, both of which would threaten people's livelihoods. These effects can be prevented by reducing greenhouse gas emissions to the atmosphere or sequestering greenhouse gases; this is called climate change mitigation. Greenhouse gas emissions have been rising consistently over the past decades, and it is projected that they will continue to rise rapidly, leading to potentially catastrophic climate change if unabated.

Low-carbon technology is one of the means to mitigate climate change and defined as know-how, methods, procedures, experience of successes and failures, physical devices and equipment to reduce greenhouse gas emissions. Technology thus encompasses hardware, software and orgware. For instance, for wind energy technology, the hardware is the wind turbines themselves, software could be the human capacity to operate and maintain wind turbines, and orgware could be the enabling legislation.

The increasing urgency of climate change evidenced in scientific assessments like the IPCC has placed the problem firmly on the international policy agenda. Many countries have adopted mitigation commitments and are implementing policies and actions. Despite all this action, it is unclear however whether a new international treaty on climate change, envisaged to be agreed in December 2009 in Copenhagen, will have wide coverage and will be environmentally effective.

A characteristic of successful international agreements is reciprocity – a perceived equivalence of benefits between parties to an agreement. This is particularly required for international environmental agreements, where there is no international enforcing entity that can hold parties to their promises. Hence, for a successful climate agreement, it is necessary to explore ways of balancing benefits between parties. One way, explored in this thesis, would be to agree on low-carbon technologies directly, rather than indirectly through emission reduction targets and economic incentives. This leads to the central research question: Can technology-oriented agreements provide greater reciprocity and thus improve the effectiveness of the international regime for climate change mitigation?

From a political economy point of view, a stable climate is a public good, which because of cooperation problems is underprovided. Climate change can only be fully addressed through collective action of many nations in the world: no country can solve the problem by itself. International cooperation on climate change, however, is extra difficult because of a deep distributional imbalance: the vulnerability for climate change impacts is highest in countries which hold little responsibility for the problem, while the cost of mitigating climate change is highest in less affected countries. In international relations, such an imbalance is called "asymmetric externalities", as opposed to symmetric externalities, where all parties have a roughly equal stake in the causes and the solutions of the problem. The consequence of the climate change problem structure is that countries with high greenhouse gas emissions and low climate change damage costs have a strong incentive to free-ride on an agreement to reduce emissions. This is the central barrier to international cooperation on climate change: a specific agreement to reduce emissions is not in the interest of those countries that should most urgently act.

[1] This is a simplified version of the definition in the United Nations Framework Convention on Climate Change: "change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods."

The only way of providing countries facing high mitigation costs with incentives to reduce emissions is to give them something in return; in other words, to provide reciprocity. In a feasible international agreement, all parties involved should perceive sufficient reciprocity to incur the cost of the treaty. This means that reciprocity might have to be higher for those parties with high mitigation costs and low climate change impacts. Only if all sides perceive sufficient reciprocity, an agreement can be self-reinforcing, i.e., attractive for countries to sign and want to carry out the terms of agreement. Self-reinforcing agreements are helpful in any policy, but particularly in international environmental agreements where no entity exists that can coerce nations to participate or comply, for instance through a fine or another intervention.

Agreements on emission reductions do not offer reciprocity to all parties, so there are weak incentives among parties to comply. This became clear as Kyoto Protocol was implemented. The Kyoto Protocol is an agreement to reduce emissions, and was agreed despite the distributional characteristics of climate change. However, the effectiveness and the contribution it has made towards providing the public good was weakened because of the distributional problem structure. The defecting countries face high costs of mitigation and have economic interests that prevailed over the need to reduce emissions.

The Kyoto experience provides lessons for the involvement of emerging developing economies in a future climate agreements. Even if only one major industrialised country would defect from the future agreement to reduce emissions, emerging economies would have no incentive to incur costs for reducing emissions, even though they have a strong interest to prevent further climate change. After all, the problem is not going to be solved unless all major industrialised countries commit to emission reductions.

Parties can perceive reciprocity in three ways: through the benefits of preventing climate change, through associated benefits of emission reductions in other policy fields, and through other means of compensation or reward. The post-2012 literature and climate negotiations have so far focussed mainly on economic instruments, such as an international cap-and-trade system or a global carbon tax. Although these instruments in theory are more cost-effective, they are unlikely to make agreements self-reinforcing. Their exclusive focus on the short-term costs of commitments and mitigation actions hides the long-term, intergenerational benefits of preventing climate change.

The reciprocity that needs to be provided to countries for reducing emissions could be decreased if there are associated benefits of emission reductions and mitigation actions in other policy fields. Such co-benefits of climate mitigation might provide an incentive for parties to agree on emission reductions, and comply with them. Energy efficiency and renewable energy, for example, can lead to improved security of energy supply and better air quality. In order to decrease the reciprocity needs, these co-benefits need to be visible and as specific as possible. They also need to be recognised as co-benefits by countries. This thesis provides an exploration of co-benefits and possible linkages of climate policy with other fields. The conclusion, however, is that their specific reciprocity of co-benefits is insufficiently recognised to enable an emission reductions-based agreement.

If not through emission reduction targets, what might one agree on that mitigates climate change and provides reciprocity? One could look at what mitigation actions inherently are. Many mitigation actions imply innovation and diffusion of technology. There is general agreement that the emission reductions required to address climate change will need to be achieved through major investments in a portfolio of technologies.

If accelerated innovation and diffusion of technology is to provide reciprocity, it should not only be seen as a means to reduce greenhouse gas emissions; it should be seen as a reward for a country signing up. Economic innovation literature suggests that accelerated innovation and diffusion of technology provides economic benefits as it shifts the production function – it allows for the possibility to generate more income and create employment opportunities with less input of resources. Other motivations for considering technology in international climate agreements range from improving the efficiency of markets for technological innovation to expanding opportunities for international agreement and spurring necessary socioeconomic and technological change. Theoretically, therefore, technology provides more reciprocity than emission reduction agreements. But how can technology be practically incorporated in an international agreement on climate change? This thesis introduces technology-oriented agreements; those international agreements that are aimed at advancing research, development, demonstration, and/or deployment of low-carbon technology.

Technology-oriented agreements have been implemented successfully to address problems other than climate change. They tend to fall into four categories: knowledge sharing and coordination; research, development and demonstration (RD&D); technology transfer; and technology mandates, standards, and incentives for deployment. Existing technology-oriented agreements appear in all categories and provide important lessons. They vary substantially in their designs, circumstances and perceived success. A conceptual conclusion, based on experiences and more general features of the different kinds of technology-oriented agreements, is that knowledge sharing, RD&D and technology transfer agreements are not likely to achieve significant greenhouse gas emission reductions on their own, and are better seen as complements, contributing to effectiveness of other policies.

Other technology-oriented agreements, focussed on implementation of the technology through mandates, incentives and standards, do appear to have the potential to be effective in environmental terms as a substitute for emissions target-based agreements. Such technology-oriented agreements would need to be applied on a sector-by-sector, if not technology-by-technology basis, which can be limiting practically. Such an approach may make the most sense in certain specific settings, in particular for highly trade-sensitive sectors, for sectors not otherwise covered by emissions trading programs, for sectors that can benefit from international coordination such as building codes, appliance standards, regulation of vessels for international transportation. Also situations where significant co-benefits can be recognised are better served by technology-oriented agreements.

Technology-oriented agreements are further explored in a number of hypothetical yet concrete treaties between a selection of countries. The agreements explored are in the field of sugarcane-based bioethanol, CO_2 capture and storage, nuclear energy, ammonia production, personal vehicles and cement. Although some of these agreements could be self-reinforcing and look promising, technology-oriented agreements are not a panacea. Costs can be high, compliance is by no means a certainty, and fragmentation and poor design could threaten environmental effectiveness.

A specific case of technology in the climate change framework is technology transfer to developing countries. Effective international instruments to facilitate technology transfer have been investigated by comparing the technology transfer effects of the Kyoto Protocol's market-based Clean Development Mechanism (CDM) and the Global Environment Facility, a technology fund. The outcome demonstrates that about half of project activities in the CDM use new or improved technologies that originate from outside of the host country, usually with knowledge transfer and capacity building. However, the CDM was not effective in all sectors nor in all countries; projects in end-use sectors such as transportation and energy efficiency are a small part of its project portfolio and the CDM selects those developing countries with the most conducive investment climate, leaving out least developed countries that arguably have the greatest need for investments in sustainable development. For technologies in sectors not prone to market mechanisms, a specialised technology mechanism or fund that would address institutional aspects of technology – including the development of technological innovation systems and enabling environments – is likely to be more effective. If a market mechanism is can overcome the collective action problems of emission reductions, it can provide a strong pull for mature technologies that face a level-playing field. In other cases, technology-oriented agreements appear better suited to address technology-specific barriers and market failures and can provide more reciprocity to parties involved. This conclusion appears to apply globally, but is magnified in the context of technology transfer to developing countries.

In conclusion, this thesis explored whether reciprocity in international climate agreements could be improved through international agreements focused on innovation and technology. In particular, the thesis analyses the role of technology-oriented agreements from different perspectives and explores their potential impacts. The main result is that technology-oriented agreements can provide more reciprocity than emission reduction targets, a finding that needs to be recognised in the climate negotiations. A number of recommendations can be made to enable technology-oriented agreements. First, technology-oriented agreements should reflect the characteristics of the technology they address and be aligned with the (vested) technological interests that prevail in the sector, to ensure a positive payback function of the agreements to important parties. Second, a smart combination of market-based and technology-oriented agreements would work best both for climate change in general and for technology transfer to developing countries, if collective action problems can be overcome. Third, if indeed market-based and technology-oriented instruments are combined, their co-existence under one regime is recommended over a fully fragmented regime. This is necessary to prevent problems related to lack of transparency and sketchy accountability that would compromise environmental effectiveness of the climate regime. And last, if technology-oriented agreements are applied as a replacement or as a geographically or functionally complement, they should be designed for technology implementation, to ensure both environmental and technological effectiveness.