

LIST OF SUPERVISED DOCTORAL AND MASTER THESES

A. Finished PhD Theses

Title: **Developing Countries in the Context of Climate Change Mitigation and Energy System Transformation**

Author: **Jan Steckel**

Submission: **March 2012**

Abstract:

This thesis addresses the role of developing countries in the context of climate change mitigation and energy system transformation. It starts from the hypothesis that mitigation of climate change might form a major dilemma for developing countries, as it potentially negatively affects their development.

In order to provide robust costs estimates of mitigating climate change, three state-of-the-art integrated assessment models are compared taking into account different dimensions that are relevant for the structure of mitigation costs: technologies, the stabilization target, and the timing of mitigation policy.

First, it is found that renewable energy and CCS are most critical for achieving low mitigation costs. Second, a more ambitious climate stabilization target can significantly increase global mitigation costs. Third, delaying collective international climate policy until 2030 renders the stabilization of CO₂ at 450 ppm impossible, while a delay to 2020 increases global costs by at least 50%. In this case, Europe and the US can benefit from early participation. Exporters of emission allowances, i.e. developing countries like India, in contrast, can profit from delayed action, as the value of their exportable carbon permits increases.

Particular emphasis is put on China due to its outstanding success with respect to poverty alleviation in recent decades, going hand in hand with highly increased carbon emissions. Applying an extended Kaya analysis we can identify economic growth to be the major reason for emissions growth, outnumbering the continuous carbonization of the energy system. Numerical model results underline the importance of future decarbonization efforts in China for climate change mitigation on the global scale. Its current domestic climate policy is in line with model results for a medium ambitious stabilization target.

Some argue that the production-based accounting scheme applied today by the United Nation's Framework Convention on Climate Change (UNFCCC) disadvantages carbon-exporting developing countries and is thus not in line with its basic principles, such as 'common but differentiated responsibilities'. In this line of argument, changing towards a consumption-based accounting scheme might facilitate the participation of developing countries. In this thesis it can be shown that in the presence of a global carbon market the role of the accounting scheme can be neglected, as soon as the initial allocation of emissions is negotiated. This puts in perspective recent calls from developing, carbon-exporting countries like China to change from the current production-based accounting scheme. Whether the accounting scheme is beneficial for carbon-exporting countries depends on the chosen allocation scheme. High transaction costs related to consumption-based accounting would favor the current, production-based, accounting scheme once a carbon market with binding caps is in place.

Finally, the role of energy in development processes is assessed and found to be tremendously important. Countries that have achieved high or very high development levels all have crossed a certain threshold in energy consumption. One explanation for the existence of thresholds is identified to be the demand for energy-intensive goods in developing processes generated by the up-take of infrastructure. Scenarios by numerical models generally project that reductions of carbon emissions in developing countries will be achieved not only by means of decreasing the carbon intensity, but also by making a significant break with the historically observed relationship between energy use and economic growth. The existence of energy thresholds in development processes challenges the generally optimistic results of numerical models: on time scales acceptable for developing countries the decreases in energy consumption implied in numerous mitigation scenarios are unlikely to be achieved without endangering sustainable development objectives, such as universal energy access.

Title: “Refreshing Democracy” - Economic Assessments for Climate Policy in the Light of Pragmatist Philosophy

Author: Martin Kowarsch

Submission: July 2012

Abstract:

The thesis analyzes and discusses the heated topic of economic advice for climate policy from a philosophical perspective. The guiding question is: What is an appropriate theoretical and normative framework for critically evaluating and improving the economic assessments by the IPCC? The backdrop of climate policy and of science in policy are explained in Part I. Part II then develops a general evaluative-normative viewpoint for the IPCC's role in policy-making in terms of the “pragmatic-enlightened model” (PEM) of the science-policy interface, based on Deweyan pragmatism. Also with the help of this general model, Part III critically explores the economics of climate change underlying the IPCC's recent assessment report AR4, as well as parts of this report itself. Finally, based on the findings of the previous Parts, Part IV presents elements of a tentative guideline, useful either for improving the IPCC's upcoming economic assessments of climate change, or for evaluating existing ones. If the IPCC followed these ideas, the IPCC would act as an “honest broker” of different viable policy options, which represent, inter alia, different ethical-political standpoints and crucial uncertainties, but also include a thorough analysis of the possible consequences of the technological, economic and other means to the respective policy target. Offering such scenarios - developed by sciences in close co-operation with policymakers and “the public” - with transparent value judgements could thus help the IPCC to regain legitimate trust as well as to refresh the idea and practice of a well-informed and rational democratic public debate.

Title: On Strategies for Avoiding Dangerous Climate Change: Elements of a Global Carbon Market

Author: Daniel Klingefeld

Submission: December 2011

Abstract:

What are the prospects for averting dangerous climate change and which strategies offer promising avenues for successfully tackling this global challenge? This dissertation looks at these questions from three interrelated angles:

I begin with a study of the possibilities and limits of transnational cooperation in climate policy, in which I show that current trends in international negotiations are by no means reliable indicators of the potential for cooperation in the future. Building on an evaluation of traditional game-theoretic approaches, I expand the cooperation space by introducing elements of regime theory, where intertwined interests and the need for partners in changing coalitions leads to an increased propensity for working together. Yet even regime theory does not capture the full dynamism of interest formation at the national level: the aggregation of evolving individual preferences and changing normative worldviews leaves the distinct possibility of more cooperation in the future on condition that cosmopolitan principles gain stronger prominence.

The thesis then investigates the normative underpinnings for avoiding dangerous climate change and looks at policy instruments for emissions management. The United Nations Framework Convention on Climate Change (UNFCCC) constitutes the foundation for international efforts in this area, substantiated more recently by international discussions on limiting global average temperature increase to no more than 2°C. I argue that from a risk management perspective and as a focal point, a common global target is useful to spur coordinated action. In view of the constraints for limiting global emissions and the need to involve developing countries, a comprehensive carbon market embedded in a policy mix to address further market failures appears best-suited to respond to a number of key policy criteria derived in the discussion, such as environmental effectiveness, cost effectiveness, and equity.

The final part of the dissertation turns to developing an implementation strategy that seeks to address the normative criteria of the UNFCCC while remaining cognizant of the current fragmentation of international climate policy efforts. Following an evaluation of the existing international climate protection architecture as well as an analysis of competing academic proposals for integrated carbon market solutions, I put forward the concept of a Modular Carbon Market (MCM): formed by an eminent coalition of cooperating states, it would comprise emitters from industrialized countries but include in particular also large transition economies. I develop elements of an institutional structure for joint emissions management, notably the role of a future World Climate Bank in overseeing the carbon market and in distributing auction proceeds to participating countries. The thesis then examines the challenges of managing the climate rent in developing countries and concludes by embedding the use of quantity regulation as a framework for multilevel action.

Title: The Calculus of Climate Policy: Carbon Pricing and Technology Policies for Climate Change Mitigation

Author: Matthias Kalkuhl

Submission: December 2011

Abstract:

This thesis examines the role of carbon pricing and low-carbon technology policies for reducing CO₂ emissions from burning fossil fuels. Policies are evaluated according to their impact on welfare, emissions, fossil resource rents and energy prices. For the economic analysis, small analytical partial equilibrium models and, most importantly, the elaborate numerical intertemporal general equilibrium model PRIDE (Policy and Regulatory Instruments in a Decentralized Economy)

are developed and studied. A major focus of these models lies on the intertemporal incentive effects of policies on fossil resource extraction and investments into new low-carbon technologies. An innovative strength of the PRIDE model is to calculate the welfare-maximizing potential of policies like carbon taxes and emissions trading schemes as well as subsidies, feed-in-tariffs or portfolio standards for renewable energy and carbon capture and sequestration (CCS).

The results indicate that a price on carbon emissions – established through a carbon tax or an emissions trading scheme – is the most important climate policy in the long run; reducing emissions permanently with subsidies on ‘clean’ technologies becomes very expensive. Technology policies, however, may have an important role in the short to medium run: First, technology policies addressing innovation market failures can increase welfare and reduce mitigation costs substantially even under a ‘perfect’ emissions trading scheme. Second, technology policies can serve as a temporary ‘second-best’ policy to reduce emissions when an ‘optimal’ carbon price cannot be established due to political economy reasons. Finally, technology policies may help to reduce the distributional conflict concerning fossil resource rents and the social conflict regarding increasing energy prices. The analytical and numerical results further highlight the relevance and the need of creating a global public institution that manages the use of the atmosphere and the associated ‘climate rent’ and fosters investments into low-carbon technologies.

Title: Uncertainty & Learning in Global Climate Analysis

Author: Alexander Lorenz

Submission: November 2011

Abstract:

Climate change, the 21st centuries challenge for cooperative human decision making, is surrounded by large uncertainties concerning the scientific understanding of the climate system, of climate change induced changes of natural and social systems and of the impacts of those changes on human economic activities and human welfare in general. Parts of these uncertainties will be resolved as science advances and new observations are made. This learning will allow to refine the decisions undertaken to cope with the climate problem.

This thesis is dedicated to examine the role of uncertainty and future learning in the formal assessment of optimal global mitigation strategies for global warming. The central contributions of this study are contained within three research articles.

The first article investigates the validity of the cost-effectiveness framework when applied to the case of climate targets under uncertainty and future learning. The study highlights two major conceptual problems of this formalism, namely the possibility of negative value of information and infeasibility of the whole decision criterion. As a consequence an alternative decision framework is proposed, the so called cost-risk analysis that avoids those conceptual problems but still remains based on climate targets.

The second article is motivated by the clash between the general scientific intuition that epistemic uncertainties about the climate system and climate damages should play a major role in determining optimal mitigation policies (and the resulting welfare gain compared to doing nothing) and the results from the integrated assessment models that show only insignificant influence of those uncertainties. We introduce a method of assessing the importance of uncertainty both in its impact on optimal policy and in its impact on the welfare gain from acting upon climate change. We then use a representation of the integrated assessment model MIND that allows to link the decomposed value of climate policy to the structural form of the functions representing the climate cause-effect chain, thereby understanding the negligible effect of uncertainty from the model

structure. Finally we propose some changes to the model structure that result in large impacts from including uncertainty.

The third article investigates the circumstances under which the anticipation of future learning about tipping-point-like threshold climate damages would be important for the determination of near term mitigation decisions. We show that this is only the case if the learning occurs within a narrow anticipation window. In this case far stronger near term mitigation is optimal to keep the option open to avoid the threshold in case it turns out to lead to severe damages. The location and width of this window is found to be sensitive to the DM's flexibility to reduce emissions. If reducing this flexibility in the MIND model, may this represent political or social barriers, the anticipation window moves towards the present and broadens considerably, thereby increasing the importance of including future learning into the analysis of climate change.

The articles are put into perspective by an introduction into the field that lays out the general linking research questions and general conclusions.

Title: Climate change and transition processes in developing countries: Integration of renewable energy sources in evolving energy systems

Author: Markus Haller

Submission: November 2011

Abstract:

Decarbonizing the electricity sector is of vital importance for mitigating greenhouse gas emissions due to increasing power demand, but also because of the broad portfolio of low carbon power generation options. Emission reduction policies are likely to incentivise an expansion of renewable power generation capacities far beyond current levels. This thesis investigates the question of how renewable power generation can contribute to mitigate CO₂ emissions. It analyzes the system integration challenges that result from large shares of variable and spatially dispersed renewable power generation, how an expansion of long distance transmission and storage capacities can facilitate system integration, and how system integration issues – and the availability of integration options – affect long term strategies for power system decarbonization. More specific, it investigates if (and how) Europe can reach its ambitious power sector decarbonization targets by expanding renewable generation capacities. These questions are addressed in a series of model-based studies. Results show that power system decarbonization in general and expansion of renewable power generation in specific play a crucial role for economy-wide mitigation efforts. They also demonstrate that investment decisions in transmission, storage and generation capacities are tightly interrelated. Adequate expansion of transmission and storage facilitates the integration of renewable supply, and limiting the availability of these options affects deployment and spatial allocation of renewable generation capacities.

Title: Climate Policy under Uncertainty

Author: Matthias Schmidt

Submission: August 2011

Abstract:

The challenges posed by climate change are unprecedented in scale and scope. Climate change is global in its origins and impacts. It involves time horizons of hundreds of years and many generations. And, last but not least, it is surrounded by great uncertainty, which is the focus of this thesis. More specifically, this thesis intends to contribute to the identification of climate policies that do justice to the pervasiveness of uncertainty in climate change. In its core it contains four research articles.

The first article shows that the combination of uncertainty about climate damages with the fact that climate damages will be distributed heterogeneously across the population can be an argument for substantially stricter climate policy, i.e. stronger emissions reductions. The article also discusses how insurance and self-insurance can, at least theoretically, mitigate this result and thus permit weaker climate policy. The second article highlights some major conceptual problems of cost-effectiveness analysis of climate policies for given climate targets. The problems occur once it is taken into account that uncertainty will be reduced in the future, which is an important aspect of climate change. In consequence, we propose an alternative decision criterion that avoids the problems by including a trade-off between the probability of violating the target and aggregate mitigation costs.

The third article investigates the circumstances under which learning about tipping elements in the climate system is an argument for stricter or weaker climate policy. It shows that learning is an argument for stricter policy if it is expected to happen in a narrow “anticipation window” in time, and that it can be neglected otherwise. The fourth article reviews approaches to uncertainty in integrated assessment models of climate change with corresponding results. The complexity of the matter demands a variety of complementary approaches and a later synthesis of results. This article intends to summarize and structure this process and the respective literature. The research articles are framed by an introduction to the field and general conclusions.

Title: Reframing International Climate Policy: Essays on Development Issues and Fragmented Regimes

Author: Michael Jakob

Submission: June 2011

Abstract:

The research presented in this thesis is based on the hypotheses that (a) one of the main reasons why recent climate negotiations have failed to achieve significant progress is that they have not paid sufficient attention to the priorities of developing countries, and that international climate policy will increasingly be conducted within fragmented regimes in which the spatial or temporal flexibility to reduce greenhouse gas emissions is constrained.

Our empirical estimates for a cross-section of countries suggest that leapfrogging to more efficient and cleaner technologies in poor countries does not occur automatically and that without binding commitments to reduce GHG emissions, continued economic growth can be expected to bring energy consumption and carbon emissions in emerging and developing countries close to levels prevailing in industrialized countries.

For the case of China, we identify economic growth as the dominant factor behind increasing carbon emissions. Using an extended Kaya-decomposition, we find that the effect of economic growth exceeds the impact of the pronounced shift to coal that has taken place in China's energy systems in 1971-2007 by one order of magnitude. Numerical model results reaffirm China's

important role for a global, cost-efficient mitigation effort and underline the importance of lowering the carbon intensity of energy production to achieve emissions reductions in China.

Comparing the results from three state-of-the-art climate-energy-economy models emphasizes the importance of spatial and temporal flexibility of mitigation efforts: postponing a global climate agreement to 2020 could raise the costs of a 450ppm CO₂-only target by at least about half; with a delay to 2030 it may become infeasible to achieve. We also show that for individual regions early action can in fact reduce mitigation costs if the effect of avoiding lock-in of carbon-intensive energy infrastructure prevails over the higher costs associated with the additional mitigation burden borne by early movers.

In the absence of a global climate agreement a global carbon market could emerge in a bottom-up fashion by linking of emissions trading systems. In this scenario the occurrence of carbon leakage actually depends on which industries are linked under a joint permit market: a symmetric link from the EU to a system without full cap bears some negative implications but can still increase welfare if the gains-from-trade dominate. In the case of asymmetric linking (i.e. when the respective output goods are imperfect substitutes) leakage is prevented and may even become negative.

The occurrence of carbon leakage in a fragmented climate regime does not automatically justify the use of trade measures such as border tax adjustments. We show that neither production nor consumption-based approaches of accounting for carbon emissions constitute optimal policy instruments. Whether a consumption-based policy prevents or reduces leakage depends on specific parameter values. Empirical data suggest that if the EU or the US were to apply border tax adjustment on imports from China, carbon leakage would in effect increase.

Title: Investments in Liberalized Electricity Markets and the Low-Carbon Energy Transition: A Mixed-method Analysis of the German Case

Author: Michael Pahle

Submission: June 2011

Abstract:

Because of the high number of low-cost mitigation options the power sector will play an important role in combating global climate change. Given the current worldwide trend of liberalization, the main challenge is to incentivize investments in low-carbon technologies under market rules. This thesis investigates the combined questions of how investments are made in liberalized electricity markets, and to which extent climate policy instruments are effective in inducing cleaner technology choice. It uses Germany as a case study, where during the last years a considerable number of new coal power plants have been brought on the way. This "dash for coal", apparently contradicting political efforts to transform the energy system, serves as the guiding issue around

which several aspects of the aforementioned questions are investigated. The first analysis explores the drivers and decision factors that likely triggered the "dash for coal". Because no integrated theory of investments in liberalized electricity markets yet exists, it compiles a list of potentially influential economic, technological and sociopolitical factors in a first step. Examining these factors in more detail in a second step, it turns out that the extensive coal investments can be attributed to six main reasons. They are: (1) replacement requirements due to the nuclear phase out, (2) the onset of a new investment cycle in the power market, (3) favourable economic and technological prospects for coal compared to natural gas in the long run, (4) a status-quo bias of investors in regard to future renewable deployment, (5) explicit political support for coal, and (6) the ineffectiveness of public protest in hampering new projects. Two of these are looked at in more detail in the succeeding parts of this thesis.

The second analysis deals with how emission certificate allocations had distorted fossil investments in favour of coal technologies. The EU Emission Trading Scheme (EU ETS), implemented in 2005, was set up to incentivize cleaner investments by putting a price on CO₂ emission through tradable certificates. However, in its first phase initial certificate allocations for new plants in Germany were technology specific, leading to a considerably higher number of total certificates for coal compared to natural gas. Because suppliers incurred windfall profits by passing-through the opportunity costs of these certificates, coal plants were expected to receive higher additional cash flows than natural gas plants, which effectively subsidized coal. In fact, results suggest that disproportionate windfall profits compensate more than half the total capital costs of a hard coal plant. Only auctioning of certificates or a single best available technology benchmark would have made natural gas the predominant technology of choice. This underlines that implementation details had a great impact on investment incentives, unintentionally increasing the edge of coal over natural gas rather than decreasing it. The third analysis leaves the level of the single investor and looks at how the market as a whole responds to a price on CO₂ under the situation of a nuclear phase out that induces considerable replacement investments. More specifically, it investigates technology choice and the optimal CO₂ price level from a welfare perspective. Motivated by the structure of the German market where four big suppliers own the major share of capacities, imperfect competition with strategic behaviours by these suppliers is assumed. Moreover, based on the finding of the first analysis, investments in coal plants are limited to the strategic suppliers, which adds a so-called technological market power. Model results indicate that in such a setting investments in natural gas occur at lower CO₂ price levels and more gradually than in a perfect competitive market. This happens due to the strategic reduction of output that increases electricity prices, which in turn makes natural gas profitable even when the comparative advantage in emission costs is still low. In a perfect competitive market though, investments switch from exclusively coal to exclusively natural gas when the CO₂ price is 37 EUR/t or higher. Furthermore, the impact of market power on overall welfare is relatively moderate and losses never exceed 1% if the price of CO₂ is set at the optimal level. This shows that a price on CO₂ can indeed be a suited instrument to induce investments into cleaner technologies, especially natural gas. Nevertheless, relatively high prices are needed for a fundamental transition, and it remains to be seen if this will become reality in the future.

Title: Investment Strategies for Climate Change

Author: Lavinia Baumstark

Submission: June 2011

Abstract:

The substantial threat of anthropogenic climate change implies the reducing of greenhouse gas emissions. This thesis deals with the costs and strategies of climate change mitigation. In particular, investment strategies for climate change mitigation are investigated. The thesis is separated into five parts each focusing on subquestions of the overall research question. After an introduction into the problem of climate change and the important macro-economic mechanisms for mitigation, these subquestions are answered in separate chapters. For the analysis, Integrated Assessment models are used.

First, the impacts of technological spillovers under climate policies are analyzed by means of a multi-regional model with technological change in form of interregional spillovers. Model results indicate that the higher the ratio between the spillover intensities for energy and labour efficiency, the lower are mitigation costs. As well, first-mover advantages and commitment incentives for climate policy scenarios are investigated. A multi-regional hybrid model with a more complex energy system is used for studying investments into energy technologies in detail. In climate policy scenarios the entire energy consumption is reduced, while renewable energy and CCS technologies are expanded immediately. Different regions follow quite different mitigation strategies. While ambitious climate targets can be reached with moderate global costs, the regional costs show a high variance. In addition, Integrated Assessment models are used to investigate what happens if the world will not agree on a climate friendly policy within the next years. The impacts of early investments into renewable energy technologies in first-best and second-best worlds are analyzed. Mitigation costs increase significantly, if the climate policy implementation is delayed. In contrast, early deployment of renewable energy technologies reduces the global costs. Within a five-region hybrid model the impacts of dynamics and direction of technological change under climate change mitigation are studied. It turns out that mitigation costs and strategies are quite sensitive to these variables. Further experiments indicate that the impacts depend on the set of available technologies. For studying the role of endogenous technological change for climate change mitigation, this model is extended by a new formulation of efficiency improvements. It turns out that investments into the efficiency of some energy sectors play a crucial role for low mitigation costs. In climate policy scenarios, the increased mitigation costs of technological restrictions can be overcome by R&D investments into energy efficiencies.

However, the results of this thesis demonstrate the important role of investment strategies for climate change mitigation costs. The world gains from early investments into both a broad portfolio of technologies and energy efficiencies. Thereby the immediate support and high diversity of investments mainly provide low mitigation costs.

Title: Towards a Global Carbon Market? Linking Systems, Adding Sectors

Author: Christian Flachsland

Submission: December 2010

Abstract:

International emission trading is prominently discussed as a policy instrument for mitigating global greenhouse gas emissions. The articles assembled in this cumulative thesis aim at enhancing the understanding of the economic and political implications of this climate policy approach.

Five potential future international carbon market configurations are identified and analyzed with regard to their environmental effectiveness, cost effectiveness, and political feasibility. It turns out that the choice between top-down and bottom-up architectures entails a trade-off between environmental effectiveness on the one hand, and political feasibility on the other. The basic reason is that at least initially a full global trading regime and the Kyoto approach promise to cover a larger fraction of global emissions, thus enabling more significant global emission cuts and providing better protection against carbon leakage. But while a high participation rate is beneficial from the global environmental point of view, it complicates political coordination due to the larger number of political parties, especially regarding the inevitable distributional challenges as well as the need for regulatory coordination. Regarding cost effectiveness, bottom-up linking of regional trading systems is the superior approach.

The analysis of linking regional cap-and-trade systems from a policymaker's perspective identifies a number of merits and demerits of this approach. Potential benefits include standard gains from trade; the possibility of 'anti-leakage' from linking a sectorally fragmented cap-and-trade system to asymmetric sectors in developing countries; enhanced policy stability by creating an additional vertical layer in the multi-level governance of domestic emission sources; elimination of competitiveness concerns across linked systems; and the political signal of a multilateral climate policy initiative. Potential disadvantages include welfare losses from deteriorating terms-of-trade and intensification of disbenefits from suboptimal policies; a range of distributional concerns; and the need for close regulatory coordination across linked systems and the related loss of sovereignty due to the inevitable spillovers of regulatory decisions.

Finally, this thesis examines the option of including the road transport sector into cap-and-trade systems. An empirical analysis of EU ETS road transport inclusion shows that this option does not raise competitiveness concerns from rising EU allowance prices. The point of regulation should be chosen upstream.

Title: Climate Change Policy in a Second-Best World - An Analysis of Policy Options under Conditions of Partial Cooperation and Uncertainty

Author: Robert Marschinski

Submission: December 2010

Abstract:

Starting from the premise that climate change policy-making takes place under considerable uncertainty and suffers from a lack of international cooperation, and that this prevents the implementation of a global first-best policy, the present thesis poses the second-best question of what can be done despite these constraints and compares different policy options.

Under conditions of partial cooperation, two questions of the second-best type arise: (i) What can already cooperating countries do to ensure their climate policies are effective and cost-efficient? (ii) How can the highest possible level of international cooperation be achieved? In this thesis, these issues are treated by assessing different institutional forms of emissions trading, in particular the 'linking' of permit markets, and, also, by adopting a game-theoretic view to analyze in how far trade

sanctions can help to broaden international cooperation. The results show (a) how institutional incompatibilities and general equilibrium effects could reduce the benefits of a linking agreement, and (b) that tariffs have a significant potential to increase participation in a climate agreement. Uncertainty, and how it affects different policy instruments, is the other second-best aspect investigated. So-called intensity targets, which index emission targets on GDP, are analyzed with regard to their effect on cost-uncertainty, and their compatibility with international emissions trading. The results suggest that due to the increased complexity and the potentially only modest benefits of an intensity target, conventional absolute targets remain a robust choice for a cautious policy-makers.

Title: Distributive Impacts of Global Climate Change Mitigation - Effects of Technology, Emission Permit Allocation and Energy Trade

Author: Michael Lüken

Submission: November 2010

Abstract:

The thesis provides an improved understanding of major drivers influencing regional mitigation costs. It analyzes the effects of the availability of low-carbon technologies, emission permit allocation schemes and energy trade on the welfare redistributions due to climate change mitigation. The methodologic novelty of the thesis is the consideration of the three dimensions of technology, permit allocation and energy trade in a comprehensive model framework (REMIND), together with the development of a formal economic decomposition method that renders a quantification of the impacts possible.

The analysis confirms (and sharpens) results from previous studies, on the relevance of a broad portfolio of low-carbon technologies and of endowments with tradable factors such as energy carriers or tradable emission permits for global and regional mitigation costs. But the thesis concludes that interrelations among the dimensions of technology and trade play a crucial role for the distributive impacts of mitigation. In particular, a broad portfolio of low-carbon technologies reduces the monetary equivalents of traded emission permits so that a variation of the initial permit allocation scheme has a lower redistributive impact. Also, the size of energy trade effects is subject to the availability of technologies. Finally, technologies can take the role to render a new trade flow possible, for example an electricity transmission technology, which turns an untradable endowment (e.g., a huge solar potential) into an indirectly tradable (by electricity generation).

Title: Endogenous Technological Change in Strategies for Mitigating Climate Change

Author: Kai Lessmann

Submission: 2009

Abstract:

This thesis suggests that induced technological change has the potential to reduce the burden that climate change mitigation puts on the economy. Furthermore, international cooperation on climate policy, which may trigger this induced technological change, may be achieved by linking climate negotiations to other issues. The starting point are two assumptions: first, action to mitigate climate change is necessary, and second, technologies will play a key role in this effort. There is empirical

evidence that technological change is induced by policies. However, previous assessments of such induced technological change (ITC) have been ambiguous. Moreover, a clear climate policy is required in order to induce the technological progress. However, the literature on international environmental agreements suggest that the prospect for global climate policy is not bright. This raises two broad research questions: First, what is the role of ITC for climate change mitigation? And second, how can we achieve a global policy that triggers this technological change?

Title: Imprecise probability analysis for integrated assessment of climate change.

Author: Elmar Kriegler

Submission: 2005

Abstract:

We present an application of imprecise probability theory to the quantification of uncertainty in the integrated assessment of climate change. Our work is motivated by the fact that uncertainty about climate change is pervasive and therefore requires a thorough treatment in the integrated assessment process. Classical probability theory faces some severe difficulties in this respect since it cannot capture very poor states of information in a satisfactory manner. A more general framework is provided by imprecise probability theory, which offers a similarly firm evidential and behavioral foundation, while at the same time allowing to capture more diverse states of information. An imprecise probability describes the information in terms of lower and upper bounds on probability.

Title: Carbon Capturing and Sequestration - An Option to Buy Time?

Author: Nico Bauer

Submission: January 2005

Abstract:

The thesis uses the MIND model framework as a hybrid model integrating an economic growth model of the Ramsey-type with an energy system model and a climate system model. The use of a hybrid model that integrates these various systems is suggested by the complex problem at hand and justified by the dynamics and feedbacks between the systems. The CO₂ emission mitigation options are related to investments and their social optimal timing and extent is computed by maximising an intertemporal social welfare function. Although this function is subject to various points of critique, it takes into account issues of intergenerational equity. The use of CCS and the other options depends on assumptions of various exogenous model parameters. The extensive sensitivity analysis undertaken in this thesis reveals that the property of CCS being an option to buy time is robust for a broad range of parameter values. It turns out that the potential to introduce

renewable energy technologies is highly important for the use of CCS. Imposing such a constraint reduces the ability to switch to alternative energy sources giving features of CCS like the leakage rate a higher significance. The more constrained renewable energy sources are, the more sensitive are the results regarding the extent and the welfare impact of CCS with respect to parameter variations of the CCS technology. Tight constraints on renewables and low leakage rates can even make CCS an option that will be used throughout the 21st century.

Title: Muster globaler anthropogener CO₂-Emissionen. Sozio-ökonomische Determinanten und ihre Wirkung

Author: Katrin Gerlinger

Submission: June 2004

Abstract:

The thesis analyses the main driving forces for CO₂ in different world regions. It uses the famous Kaya identity as a starting point for a cluster analysis. Based on cluster analysis, it provides ideal types of cluster sharing the same causes of non-sustainability. These ideal types are used as a socio-economic 'macroscope' which may enable researchers to identify patterns of sustainability.

B. Current PhD Students

Christoph Bertram; Preliminary title of PhD thesis: "Energy Efficiency and Climate Change Mitigation"

Benjamin Bodirsky; Preliminary title of PhD thesis: "Policy options for sustainable agriculture within the challenges of climate change"

Markus Bonsch; Preliminary title of PhD thesis: "Challenges for the landuse sector in the context of climate change, resource scarcity and increasing demand"

Steffen Brunner; Thesis submitted September 2012, Title of PhD thesis: "Climate Policy, the State, and the Problem of Credible Commitment"

Maximilian Franks; Preliminary title of PhD thesis: "Policy Instruments Portfolios"

Odette Deuber; Preliminary title of PhD thesis: "Trading-off short- and long-lived greenhouse effects – a multidisciplinary approach using the example of aviation"

Mary Louise Gifford; Preliminary title of PhD thesis: "Renewable Energy Development in Rural India: Market Development of Solar Home Systems in the Lighting Sector"

Florian Humpenöder; Preliminary title of PhD thesis: "Land use and climate change mitigation"

Fabian Joas; Preliminary title of PhD thesis: "Institutional Design for CO2 Reduction Policies in Emerging and Developing Economies"

David Klein; Preliminary title of PhD thesis: "Integrated Assessment of Biomass-to-Energy Conversion Paths in a Coupled Energy System and Land-Use Model."

David Klenert; Preliminary title of PhD thesis: "Quantitative Modeling of Climate Policy Instruments"

Sylvie Ludig; Preliminary title of PhD thesis: "The role of renewable energies in climate protection - Influence and interaction of capacities for production, transmission and storage of electricity"

Linus Mattauch; Preliminary title of PhD thesis: "Some models of sustainable spatial economics"

Robert Pietzcker; Preliminary title of PhD thesis: "Economic Analysis of Policy Instruments - Prices & Quantities Revisited"

Thomas Präßler; Thesis submitted October 2012, Title of PhD thesis: "Overcoming Barriers to Onshore and Offshore Wind Power Development – A Developers' Perspective on the Effect of Support Policies"

Niklas Roming; Preliminary title of PhD thesis: "Structural Change and Economic Growth"

Eva Schmid; Thesis submitted July 2012, Title of PhD thesis: "On the Exploration of German Mitigation Scenarios"

Iris Staub-Kaminski; Preliminary title of PhD thesis: "Domestic and International Policy Instruments"

Christoph von Stechow; Preliminary title of PhD thesis: "Assessing policy instruments for the promotion of low-carbon energy technologies"

Miodrag Stevanovic; Preliminary title of PhD thesis: "Climate Change Damages and Mitigation Options in the Land Use Sector"

Jessica Strefler; Preliminary title of PhD thesis: "Modelling of multi-gas emissions in an intertemporally optimal climate change mitigation strategy"

Falko Ueckerdt; Preliminary title of PhD thesis: "Integration of fluctuating sources of renewable energy into electricity grids"

Anne Zimmer; Preliminary title of PhD thesis: "Empirical data analysis of low carbon development"

C. Master and Diploma Theses

Title: Mobilizing the black resource? The effects of future coal extraction costs on regional climate change mitigation efforts
Diploma Thesis, in cooperation with TU Berlin

Author: Alexander Körner

Submission: January 2010

Abstract:

The decarbonization of the global energy system, as an option to mitigate intolerable climate change, is likely to lead to a reduced consumption of coal. Compared to a business-as-usual case without any constraints on carbon emissions, regions face opportunity costs due to not exploiting available coal deposits. The scope of this thesis is to analyze the impact of region specific availability of coal on global and regional climate change mitigation costs. In order to quantify this effect, the estimation of future coal extraction costs must be improved. For this purpose, a new extraction cost model based on region specific geological data as well as regional economic situation has been developed and implemented into the integrated assessment model REMIND-R.

Title: Governance under Time Inconsistency and Limited Credibility: What can we Learn from Monetary Policy for Climate Policy?
Master Thesis, in cooperation with the University Tübingen, Institute for Social and Behavior Sciences

Author: Lion Hirth

Submission: September 2009

Abstract:

This paper investigates the parameters and circumstances that determine the time inconsistency of climate policy, such as a carbon tax or a cap-and-trade system. If the best response to a problem changes over time, although the problem itself does not change, the response is "time inconsistent". Climate policy is time inconsistent because capital investments are irreversible. Once investments are sunk, profit-maximizing firms react differently to tax changes than before. Energy consumption reacts stronger on tax changes and greenhouse gas emissions react weaker. As a consequence, the optimal tax is lower once investment is sunk. Firms anticipate this relaxation of climate policy and are reluctant to invest in the first place. This results in an inefficient allocation with too much energy consumption, little abatement and too little technology investments. Institutional arrangements such as an independent "Carbon Bank" are discussed as a remedy. Also different types are discussed. It is argued that especially feed-in-tariffs can provide a feasible fix for time inconsistency because in contrast to carbon taxes they establish property rights.

Title: **Modeling Climate Policy Instruments in a Stackelberg Game with Endogenous Technological Change and Market Imperfection**
Diploma Thesis, in cooperation with the University Osnabrück, Institute for Mathematics / Computer Sciences

Author: **Matthias Kalkuhl**

Submission: **September 2008**

Abstract:

In this thesis, Matthias Kalkuhl has developed an integrated assessment model which determines and explains socially optimal as well as second-best policy instruments to achieve climate protection. Within the Stackelberg game approach, the government as leader is capable to consider the strategical behaviour of firms and households and market imperfections (e. g. technology spillovers and monopolistic markets). It provides a detailed assessment of a set of prominent climate policies by estimating their distributional effects for households' functional incomes.

Title: **Towards a Global Carbon Market - The Clean Development Mechanism's Current State and Future Prospects**
Diploma Thesis, in cooperation with the University of Flensburg

Author: **Jan Steckel**

Submission: **June 2008**

Abstract:

The Clean Development Mechanism (CDM) established under the Kyoto Protocol is the only instrument that includes developing countries into the international carbon market. However, the mechanism faces serious shortcomings, including high transaction costs and low environmental and economic effectiveness. Moreover, developing countries play a growing role with regard to greenhouse gas emissions and they need to increasingly decarbonize their economies. This raises the question how the CDM can be modified in an international climate agreement post 2012. For this thesis, various options for reforming the CDM are discussed. Particular emphasis is put on China as a key player in terms of emissions as well as political and economical weight. Sectoral no-lose intensity targets are identified as one promising option to include newly industrialized countries such as China into a post-Kyoto agreement, even though the instrument raises some questions in regard to economic and environmental effectiveness.

Title: **Assessing Dynamic Cost-Benefit Analysis of Climate Policy: The Stern Review**
Diploma Thesis, in cooperation with the Humboldt-Universität zu Berlin, Institute for Geography

Author: **Wasilis von Rauch**

Submission: **May 2008**

Abstract:

The Stern Review, published at the end of 2006, quickly raised a lot of discussion and feedback. This is mainly because it predicts high climate change related damages and relatively low costs for stabilising GHG concentrations at levels that would avoid the worst consequences. The Reviews' key policy recommendation for early and strong action is in contradiction with the so-called *climate policy ramp* which has been the preferred strategy among many economists so far. The thesis analyzes whether Stern's results are well-founded in terms of economic theory and modelling technique. For this purpose, the use of Cost-Benefit Analysis (CBA) in climate policy in general is discussed and best practice criteria for its application are defined. Following this, the Stern Review is analyzed using these best practice criteria alongside with several prominent critiques by other economists. The thesis concludes with a critical assessment of Stern's approach and its policy recommendations.

Title: Techno-Economic Assessment of Carbon Capture and Sequestration Technologies in the Fossil Fuel-based Power Sector of the Global Energy-Economy system
Master Thesis, in cooperation with TU Berlin, Institute for Energy Engineering (Dr. Thomas Bruckner)

Author: Yasaman Mirfendereski

Submission: May 2008

Abstract:

The objective of this thesis is to assess the integration of Carbon Capture and Sequestration (CCS) as one of the mitigation alternatives to fossil fuel-based power plants. In line with this objective, three main fossil fuel-based power plant technologies, Pulverized Coal (PC), Integrated Gasification Combined Cycle (IGCC) and Natural Gas Combined Cycle (NGCC) are modelled with and without CCS in the modeling tool IECM (Integrated Environmental Control Model). The model provides a framework to assess the techno-economics of the plants in question, thus delivering the corresponding data about emissions, costs and plant performance. Moreover, the power plants have to comply with the European large combustion plant regulation regarding the emissions of SO₂, NO_x and PM (Particulate Matter). The thesis analyzes, in particular, the effect of the variability of fuel type by introducing four different coals: Appalachian medium sulfur, Illinois # 6, Wyoming Powder River basin and North Dakota lignite. In addition to the fuel type, uncertainty is addressed to some input parameters and analyzed via Monte Carlo Analysis. In order to assess the contribution of CCS in the portfolio of other mitigation options, REMIND, a global hybrid model of energy system model and macroeconomic growth model developed by the Potsdam Institute for Climate Impact Research, has been used. In REMIND experiments, the corresponding technologies are evaluated with regard to the CO₂ emission scenario applied in the system, thus addressing the contribution of the technologies in question as matter of time and magnitude. Each coal type is separately investigated, thus emphasizing the effect of coal type, not just on the coal technologies but also on the technology choice in the whole energy system and further on the resource usage. In addition, sensitivity studies carried out in SimEnv tool indicate the effect of parameter variations on the model results.

Title: **Comparing CO₂ Mitigation Options in the Electricity Sector: Nuclear Power, Renewable Energy and Carbon Sequestration.**
Diploma Thesis, in cooperation with TU Berlin, Institute for Energy Engineering (Dr. Thomas Bruckner)

Author: **Markus Haller**

Submission: December 2006

Abstract:

The objective of this study is to assess the role of the three main CO₂ mitigation options in the electricity sector. These encompass the transition to carbon free technologies which rely on renewable or nuclear energy sources and the capture and sequestration of emitted CO₂ (CCS). To achieve this objective, experiments with a bottom-up model of the electricity sector have been performed. The model is a subset of a comprehensive energy system model that is currently being developed at the Potsdam Institute for Climate Impact Research using the modeling toolbox genEris. It determines an optimal investment time path by minimizing intertemporally aggregated energy system costs subject to resource and potential constrictions and a cap on emissions. One-factor learning curves are used to represent cost reductions due to learning effects. The model structure has been extended by a complex representation of the nuclear energy sector, including thermal and fast breeder reactors and the main energy and mass conversion steps of the front and back end of the nuclear fuel cycle. Furthermore, the model has been linked to the multi-run experiment environment SimEnv, and sensitivity analysis experiments have been performed to assess the behaviour of the model under different parameter assumptions. The experiment results show that the model is able to represent a wide range of possible future scenarios. The restriction of emissions accelerates the substitution of carbon intensive technologies. The use of CCS is highly sensitive to fossil fuel cost assumptions. The use of thermal nuclear reactors is limited by the restricted resources of uranium. Fast nuclear reactors and photovoltaic compete for the role as a singular backstop technology that dominates the electricity sector after the substitution of fossil energy sources. The results of this study will be used by further projects with the objective of integrating the energy system model into an integrated assessment tool which includes a macroeconomic growth model, a carbon cycle model and several geographic regions.

Title: **Social Conditions of Technological Change. The Case of Carbon Capture and Storage**
Master Thesis, Potsdam University, Faculty of Economics and Social Sciences

Author: **Christian Flachsland**

Submission: January 2005

Abstract:

This thesis aims at comprehensively exploring the social aspects of CO₂ Capture and Geological Storage Technologies (CCGS). CCGS is increasingly regarded as an additional option in a climate change mitigation technology portfolio. However, related research focuses almost exclusively on the engineering and geological aspects. This thesis adopts an interdisciplinary approach drawing together available research from engineering, geology, economics, political philosophy and sociology in order to systematically analyze the various socially relevant aspects of CCGS. Crucial

technical aspects and risks that are associated with CCGS are identified and comprehensively discussed. Relevant stakeholders are identified and their respective positions analyzed.

As technical feasibility will be necessary but not commensurate condition for the large-scale implementation of CCGS, four decisive social determinants of the viability of CCGS are identified, including (a) marginal costs of technology, (b) opportunity costs of investment, (c) economic costs induced by regulatory framework and (d) transaction costs resulting from social processes of communication, cooperation and conflict. Regulation will be required that addresses these issues. Selected regulatory issues that could be central in future debates about CCGS are discussed. Also, regulatory aspects that will have to be addressed by any future regulatory framework for CCGS are identified. Finally, with Carbon Sequestration Bonds and a certificate trade based regulatory scheme, two regulatory approaches for CCGS are discussed with respect to their ability to meet such requirements. In the conclusion, relevant future research tasks are formulated based on the findings of the thesis. In an appendix, a review of analyses of existing regulatory conditions for CCGS is provided.

Title: Transnational Corporations and Economic Development in Developing Countries. Assessing the Effect of Foreign Direct Investments on Economic Growth in Developing Countries with an Extended Solow Model
Master Thesis, in cooperation with the Institute for Sociology, University Zurich, April 2004

Author: Raphael Schaub

Submission: April 2004

Abstract:

The author has designed an extended Solow-model for exploring the effects of foreign direct investment on economic development. The extended Solow growth model has been proved as a comprehensive one because it includes the foreign capital stock on a per capita base, reinvested earnings and the ratio of foreign to domestic capital in addition to the other variables which are usually part of a Solow-model. The results based on the regression equation derived from this model are plausible and statistically significant for most of the samples. Generally, the results for the models based on income categories yield a good model fit and are within reasonable range. This holds true not only for the assessed effects of domestic and foreign capital on economic growth but also for the estimated capital's share in income. It turns out that foreign capital has a positive effect on economic growth in all tested samples. However, economic growth in very poor countries seems to be less affected by the presence of foreign capital as compared to, for example, middle income countries. These countries are not only poor but they also get very little foreign capital. The scarcity of capital in these countries might result in an economic condition where they are caught in a poverty trap. Therefore, it is very likely that foreign capital can contribute only to a very small extent to economic growth. The effect of foreign capital is also weaker in higher income countries which is likely to result from the widespread availability of capital in these countries. In addition, the high level of development in countries of the First World requires much larger financial and technological efforts to achieve productivity gains.

Title: Das Konzept von Lernkurven im Energiesektor - Beschreibung, Modellierung und Aggregation
Diploma Thesis, in cooperation with TU Berlin, Institute for Energy Engineering (Dr. Thomas Bruckner)

Author: Fabian Pieper

Submission: May 2003

Abstract:

The thesis explores methods of coupling of bottom-up and top-down models. It is a well-known fact that only the hard link between macro models and energy system models allows an explicit analysis of feedback loops between the macro-economic and the energy system. However, hard link coupling procedures are time-consuming and in many cases not feasible because of the inherent complexity of bottom-up models. The thesis shows that well-designed aggregation procedures of learning curves within the renewable energy sector enable macro modelers to use simple parameterized learning curves in their macro model without omitting crucial aspects of sector specific dynamics.

**Title: Stadt - Verkehr - CO₂
Diploma Thesis, in cooperation with TU Dresden, Institute for Geography,
Prof. Dr. H. Kowalke**

Author: Diana Reckien

Submission: August 2002

Abstract:

The aim of this thesis is to find major influencing factors of CO₂ emissions from road traffic in urban areas. The approach of the study involves a statistical analysis on the basis of the formerly 23 urban districts of the German capital of Berlin. Correlation and regression analyses of empirical data from the settlement structure, the traffic structure and income have found that the number of jobs per district and the share of the well-off population can best describe the CO₂ emissions from traffic in Berlin. Also the number of residents, the total built area, the number of cars and the amount of traffic area are positively related to the dependent variable. Therefore, the possibilities to reduce CO₂ emissions from road traffic for urban planners seem limited: a restriction of space dedicated to traffic and a change of transport means for commuting represent leverage points, according to the analysis. The other significant indicators are less able to be influenced by local and regional decision-makers—an alteration in the means of mobility to less CO₂ emitting alternatives is needed if CO₂ emissions from road traffic are to be extensively decreased.

**Title: Die Wirtschafts- und Verschuldungskrise Subsahara Afrikas - Von der
Notwendigkeit globaler Solidarität
Master Thesis, in cooperation with Technical University Darmstadt, Institute
for Sociology.**

Author: Maren Ewald

Submission: February 2001

Abstract:

The thesis reviews the relevant literature on the poverty trap and evaluates the impact of debt burden on economic growth and social development. Based on this analysis, a computer model is designed for assessing different strategies for reducing the debt burden for least developed

countries. The focus of this study is a comprehensive assessment of different types of Marshall plans proposed by international agencies.

TEACHING

2012 / 2013 Climate change, land use and infrastructures, Lecture and Tutorial, Technische Universität Berlin (Berlin Institute of Technology)

2012 The Economics of Climate Change; Lecture and Tutorial, Technische Universität Berlin (Berlin Institute of Technology)

2011 / 2012 Climate Change, Infrastructures and Urban Economics, Lecture and Tutorial, Technische Universität Berlin (Berlin Institute of Technology)

2011 The Economics of Climate Change, Lecture and Tutorial, Technische Universität Berlin (Berlin Institute of Technology)

2010 / 2011 Geographic Economics, Agglomeration and Climate Change, Lecture, Technische Universität Berlin (Berlin Institute of Technology)

2010 The Economics of Climate Change, Lecture and Tutorial, Technische Universität Berlin (Berlin Institute of Technology)

2009/2010 Climate Change and Geographical Economics, Lecture, Technische Universität Berlin (Berlin Institute of Technology)

July 2009 The Economics of Atmospheric Stabilization and Towards a Global Contract on Climate Change, Summer School on Global Sustainability 2009, Santa Fe, USA

2009 The Challenge of Climate Change: Concepts, Methods, Solutions, Lecture, Technische Universität Berlin (Berlin Institute of Technology)

2008/2009 Einführung in die Ökonomie des Klimawandels - "Apocalypse Now or No?", Lecture, Technische Universität Berlin (Berlin Institute of Technology)

2008 Climate change and what to do about it with Peter Lemke Lecture, Alpbach Summer School, 14- 21 August 2008, Alpbach, Austria

2006 Mindtreks Summer School, Lecture, 10-16 September 2006, San Cassiano, Italy. Senior faculty member with Hans-Joachim Schellnhuber.

2006 Social-Cost-Benefit Analysis and the solution of global problems. with C. Kemfert, Humboldt-Universität zu Berlin

2005/2006 Inverse Methods in Climate Science and Economics. Lecture, with H. Held, S. Rahmstorf, Potsdam University

2005 Models of climate and energy policy with C. Kemfert, Humboldt-Universität zu Berlin

2004/2005 Regulation of innovation in energy markets, Lecture with H. Held, C.C. Jaeger, Potsdam University

2004 On the design of instruments for economic policies under uncertainty, Lecture with H. Held, C. C. Jaeger, Potsdam University

2003/2004 Roadmaps towards a sustainable energy and climate policy, Lecture with H. Held, C. C. Jaeger, Potsdam University

2003 Introduction to the Earth System, Lecture with H. Held, June 2003 Max Planck Research School on Earth System Modelling, MPI Hamburg