Environmental regulation and low-carbon development

CHAPTER 9

Summary

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A study into regulatory determinants, innovation systems and economic outcomes

It is widely accepted that the consequences of anthropogenic climate change are among the greatest challenges of the future of humankind. Climate change has potentially devastating impacts on human health, agriculture, and water resources as well as ecosystems. Every world region will be affected, particularly least-developed countries, which are least able to adapt to climate change and thus will be affected the most severely.

Human behaviour and its consequences on the climate, the effects of climate change on humans, and potential benefits of mitigating climate change impacts, have been recognised as important areas of inquiry in the academic literature and given high priority in national and global politics. In order to change policies and unlock countries from high-carbon infrastructure pathways, it is important to detect the barriers and obstacles to low-carbon transitions, and develop arguments for a shift to low-carbon growth pathways by thoroughly studying the economic benefits of a transition towards more climate friendly economies.

The present research can be located in the area of political economy and sustainability transition research. It includes conceptual approaches as well as empirical case studies with real world observations to derive implications. Quantitative modelling approaches are used to explore interdependencies between drivers for environmental regulation, as well as the magnitude of economic benefits induced by a clean energy transition. Broad, and also concrete, country-specific analyses are applied.

Analysing the causal structure of environmental regulation drivers is a conceptual, introductory part of the thesis. The analysis of technology transfer mechanisms is undertaken from a technology-specific, component-level viewpoint, by explaining theoretically the missing aspects of economic development oriented technology needs assessments. For the questions on how to facilitate the technology transfer and adoption of renewable energy and energy efficiency technology in developing countries, a conceptual discussion and concrete case studies are provided. Similarly, with regard to the inquiry on economic benefits of a low-carbon transition, a broad, region-wide empirical analysis, as well as a concrete country analysis, is conducted.

Following the introductory Chapter 1, Chapter 2 provides an exploratory assessment of the concept of the drivers for environmentally friendly regulation. Determinants of environmental regulation have been identified in different studies. The chapter takes the analysis of environmental policy determinants one step further by also studying the interaction effects between the determinants and by trying to disentangle the causal structure behind environmental regulation. The work relates to the political economy of environmental regulation and capacity for environmental policy (Jaenicke, 2005). A political economy approach is adequate to study environmental regulation aspects as it puts particular emphasis on the nexus between political and economic actors. The different actors and institutions in the environmental policymaking process are described (Jaenicke, 2005). Further, the dynamic interactions between the different institutions in the policymaking process towards environmental regulation are assessed with the aid of

an econometric, structural equation model for a data set of 47 countries. The calculation of different path coefficients between institutions and actors allows exploring the theory by using empirical, cross-country data.

Green advocacy and governance capacity emerge as the main structural determinants of environmental regulation quality. Internet access is found to have a positive influence on environmental regulation through green advocacy and governance capacity. The influence of green advocacy and governance capacity on international environmental governance is through national environmental policy and not the other way around, while international environmental governance is influenced by factors outside the scope of this thesis. We also find that green advocacy depends more on the presence of a competitive green industry than on environmental activism, with respect to the influence on environmental policymaking. Statistically, 92% of the variance of environmental policy output could be explained by our structural model, which is very high for a model incorporating only structural factors.

Chapter 3 comprises an analysis of technology transfer mechanisms of renewable energy technologies (RET) by anchoring the research in the field of innovation systems in developing countries (see Lundvall et al., 2009). Merging climate change mitigation and sustainable development in developing countries is pivotal for a lasting transition towards low-carbon growth pathways. This chapter combines technology transfer and technology-specific aspects with sustainable development objectives.

It investigates to what degree technology transfer mechanisms have acknowledged climate technology-specific properties in its current frameworks and how those fit together with innovation systems in developing countries. Detailed technology complexity aspects, which are the core of the technology transfer and innovation systems discussion in this chapter, are combined with economic development potentials. Climate change policy usually emphasises the different actors and mechanisms, while the subject matter or hardware characteristics itself, in this case the RET concentrated solar power (CSP), solar photovoltaics (PV) and wind, are viewed through the perspective of the innovation systems and climate governance discussion. It is crucial to consider technology characteristics in order to design technology transfer mechanisms which foster technology transfer and at the same time serve the sustainable development aspect of international climate policy.

Local technology needs and socio-technical circumstances are important in order that economic development is induced by technology transfer. Yet, they are not sufficient conditions alone for successful technology transfer which delivers economic development. A strategy for the adoption of technologies, as well as a broadening of the domestic technology manufacturing base, needs to also consider the technology properties themselves in greater detail. The technology transfer process should emphasise the economic developmental purpose as well as the technical properties of technologies. Thus, I propose a detailed assessment of the technology and its potential for being adopted by suggesting that technology complexity assessments should be detailed in a

way that they can also approximate potential contributions to domestic economic development. I describe how the evaluation of technology complexity and of potential economic development, determined by domestic demand for manufactured goods and services, which could lead to job creation and added value, could be used to inform policymakers and create targeted technology transfer policies.

Chapter 4 offers a case study on the diffusion of renewable energy technologies in Kenya. The research is embedded in technology diffusion theory in an innovation systems approach. It considers policy frameworks and user preferences (as proposed by Lema and Lema, 2012) in conjunction with concrete examples of solar PV, wind and modern bioenergy technology adoption in Kenya. A detailed country survey has been conducted among RET importers and end users in order to discover the barriers and drivers for RET adoption in the country. The focus of the stakeholder survey is the supply and uptake of small-scale solar PV, wind and modern bioenergy technology. The chapter gives insights into the roles of different stakeholders in the technology adoption process in Kenya and highlights the barriers to adoption of the technology. As a result, the theory on technology diffusion is enriched by experiences from survey participants, giving insights into how domestic participants in the technology adoption process circumvent obstacles to technology deployment in the country. Findings on how weak innovation systems institutions can be substituted or bridged by national actors are added to the innovation systems literature.

It is found that the diffusion of renewable energy in Kenya is to a large extent dependent on government policies and regulatory conditions, that the RET sectors are young, that solar and biomass are the biggest two RET markets with solar PV being based on foreign technology and biomass mostly based on domestic technology and know-how. The foreign components of RE technologies are mainly from China and India, which means that they are based on South-South trade. Capabilities for adoption and technology creation in Kenya are revealed to be weak. Obstacles to the adoption of RET are: poor access to finance; an insecure business environment; low levels of foreign direct investment (FDI); and high tariffs. The weak innovation system made suppliers to bundle services of financial help, training, maintenance and repair, which has proven to be quite effective.

Chapter 5 presents an investigation of the uptake of energy efficiency measures in agro-industrial sectors in sub-Saharan Africa in Nigeria and Kenya. The case studies conducted in the cassava and maize processing industries give deeper insights into the analytical approach of energy efficiency technology oriented innovation systems.

The goal of the analysis is to obtain deeper insight into the problems associated with the adoption of energy efficiency measures in the context of weak environmental policy regimes and weak innovation systems. We investigate the responses of African actors and foreign suppliers to such problems. The overall conclusions are: i) that such measures are mainly undertaken for economic reasons (cost-efficiency); ii) that few firms studied in the agro-industries have adopted sophisticated energy savings

measures and that of those who have, many encountered problems; iii) that there is a great reliance on foreign suppliers of energy efficiency technologies in the case of maize millers, but less so in cassava processing; iv) that informal mechanisms of learning are an important source of learning; and finally v) that universities and public research institutes are unimportant sources of knowledge. In the cassava sector, complex technologies are commonly supplied as part of a package involving training and financial advice, with an important role for consultants and external advisors.

Chapter 6 provides a quantitative, economic development analysis of the transition to RET in the Middle East and North Africa (MENA) region and the export of electricity from solar and wind power across the Mediterranean to Europe. It applies a quantitative economic modelling framework in order to detect the major macroeconomic developments induced by RET deployment. A computational general equilibrium (CGE) model for the whole world is used, with a special focus on the MENA region, and adjusted for RET. This analysis is characteristic due to its disaggregated assessment of various RET in the model, such as CSP, PV, and wind as well as the exchange of large amounts of electricity between geographical regions. With regard to RET deployment trajectories, exogenous, renewable energy potential data are utilised. These are based on spatial and hourly renewable energy potential analysis for the MENA region. Other studies use only annual data (see Fragkos et al., 2012, Haller et al., 2012).

Different climate policy scenarios are compared with a baseline, business as usual scenario in order to discuss relative changes in levels of economic development until 2050. Findings of this analysis provide insights on the relative economic benefits for the MENA region if it were to embark on a low-carbon growth pathway and facilitate the exchange of electricity across the Mediterranean.

In some world regions the transition to RET has been framed in ambitious cross-country cooperative visions, like in the MENA region. It aims at providing electricity from renewable energy sources from MENA's desert regions to the entire MENA region as well as exporting electricity to Europe. According to other power system studies an integrated EUMENA power system based on more than 90% renewables is technically feasible and economically viable. We use a global general equilibrium model to evaluate the economic effects of a clean energy transition across the Mediterranean from a broader perspective, including not only the energy system but also the repercussions in other sectors of the economies. The results show that the extent of the wider economic costs and benefits for both regions depend on the type of strategy adopted to finance the build-up of the power plants and the expected development of the cost of the different technologies. Furthermore, the viability of a transition towards renewable energy depends to a great extent on the international climate policy.

Chapter 7 examines the economic benefits of a renewable energy transition in Egypt. While Chapter 6 gives an overview of potential macroeconomic development trajectories in the MENA region until the year 2050, Chapter 7 provides a detailed economic development assessment of Egypt. An Egypt-specific CGE model is used and

expanded by CSP, PV and wind technology. With regard to income distribution changes, and the poverty alleviation potential of RET diffusion up to the year 2020, this chapter provides insights into the economic aspects of RET deployment by assessing the renewable energy strategy of the Government of Egypt. The CGE model used in this chapter differentiates five types of households and tests different technology build-up trajectories. The economic effects of realising domestic renewable energy targets are calculated and compared with a business as usual scenario.

The recent political transition in Egypt has put much-needed policy reforms on hold. This chapter suggests that under certain conditions, fostering the national renewable energy strategy may be a promising way of giving an ailing economy an urgently needed boost by transforming its national renewable energy targets into reality. Based on the literature and results of the CGE model, we recommend that Egypt should focus especially on the generation of wind power. At least part of the newly produced energy should be channelled to the domestic market to ease existing supply constraints and to avoid excessive exchange rate appreciation. In addition, to maximise the benefits of renewable energy sources, the renewable energy strategy should be accompanied by a reduction of energy subsidies, which has already begun.