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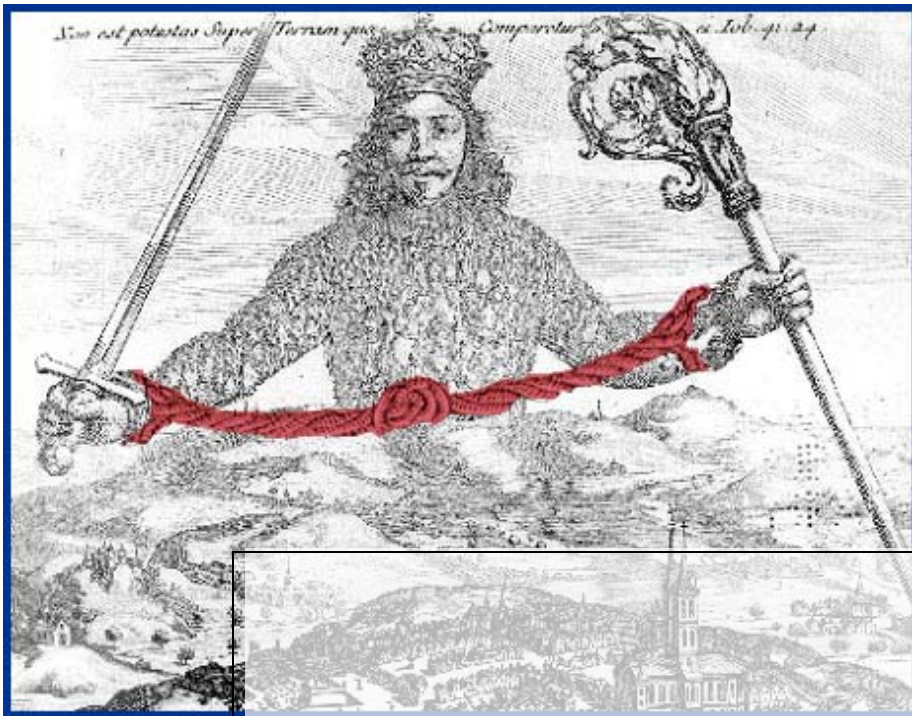
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Economics, Institutions and Adaptation to Climate Change

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Abstract:

Adaptation to the consequences of climate change has attracted increasing interest as a necessary complement to greenhouse gas mitigation. Economic approaches to climate adaptation are rarely articulated and discussed explicitly despite many benefits of such a framework-level discourse. Therefore, this article investigates how climate adaptation is framed and approached in economics and attempts to contribute to the development of economic frameworks of climate adaptation. First, the paper identifies and critically reviews four major strands of current adaptation economics: estimation of adaptation benefits and costs, strategies for adaptation, the role of markets and governments, and policy instruments for adaptation. While having their merits, serious methodical difficulties prevail. Moreover, the applied neoclassical framing seems too narrow to capture the plethora of governance challenges and normative criteria revealed in adaptation policy discourses and in the multidisciplinary adaptation literature. The second part of this article outlines an institutional economics approach to climate adaptation that addresses caveats in the current state-of-the-art and offers additional concepts to study climate adaptation. Moreover, promising methods and strategies for adaptation research are presented and future research directions suggested. Finally, the paper assesses the normative foundations of climate adaptation economics and their implications for positive adaptation research.

Keywords: Economics of Climate Change Adaptation, Institutional Economics, Governance of Climate Adaptation, Adaptive Capacity, Barriers, Normative Economics.

JEL classifications: B52; D02; D63; D78; Q54.

1. Outline of the problem

Climate change has long been predominantly framed as a problem of mitigating greenhouse gases, i.e. the sources of anthropogenic climate change are addressed. In contrast, the basic alternative of adapting to the consequences of climate change such as increased risks of flooding, droughts and storms has received little attention until recently. The field of economics of climate change has been no exception to this rule. Mitigating global warming certainly remains a core aspect of climate policy, as there are substantial barriers or even limits to, and costs of, climate adaptation (Stern 2006; Adger et al. 2007; Adger et al. 2009; Fankhauser 2010). However, acknowledging that many locations worldwide face risks of serious climate change impacts (e.g., Parry et al. 2007) and that effective global mitigation will at least be further postponed have led to an increasing interest in the question, how individuals, organizations and societies can adapt to unmitigated climate change.

Despite the growing importance of climate adaptation economic frameworks of this challenge are rarely articulated and discussed explicitly. However, the potential benefits of such a framework-level discourse are manifold and include clarifying and updating the relevant research problems, defining coherent analytical concepts and providing effective methods to analyse them. Moreover, a useful framework may provide a language to compare and carefully integrate multidisciplinary results to foster cumulative learning (Ostrom 2005). In this sense a useful framework is promising to leverage the strengths of economics as a social science for the interdisciplinary study of climate change adaptation.

Against this background, the article attempts to contribute to the development of economic frameworks of climate change adaptation. Most of the existing contributions rely on a welfare economics framing. Section 2 reviews and critically assesses this literature and its current findings. Subsequently, section 3 outlines concepts and methods for an institutional economics approach to adaptation. It also shows how this framework may broaden the scope of adaptation economics both in terms of the governance challenges addressed and the normative criteria used in a coherent approach and how this may contribute to interdisciplinary adaptation research. Moreover, it assesses the normative foundations of climate adaptation economics. We conclude that an institutional economics approach can significantly contribute to the agenda of climate adaptation economics by addressing caveats in the current state-of-the-art and by offering a well-founded approach and concepts for climate change adaptation (section 4).

2. State-of-the-art in the economics of climate change adaptation

Most of current adaptation economics is pivotally concerned with the consequentialist efficiency of adaptation. Efficient adaptation is conventionally understood as the “set of adaptations that maximize the net benefits of adapting” (Mendelsohn 2006:204). Accordingly, efficiency is defined as an attribute of the outcomes of adaptation and is precisely given, if the (interpersonally aggregated) benefits of reduced damages and realized opportunities from climate change exceed the (aggregated) costs of the adaptation efforts (Callaway et al. 1998; Mendelsohn 2000; Klein 2003). Section 2 reviews the four core themes that climate adaptation economics has focused on so far: estimating benefits and costs of adaptation; strategies for efficient adaptation; the role of markets and governments; and policy instruments for adaptation.

2.1. Estimating benefits and costs of adaptation

A first branch of this literature attempts to quantify the costs and benefits of adaptation (e.g., World Bank 2006; Stern 2006; UNFCCC 2007; UNDP 2007; ECAWG 2009; World Bank 2010). The gross benefit of adaptation consists of both reduced harmful climate impacts, i.e. the difference between the potential damages without adaptation and the residual damages after adaptation, and the beneficial impacts utilized through adaptation. The net benefits are the gross benefits minus the costs of the adaptation efforts (Agrawala/Fankhauser 2008). Methodically, the estimates of impacts are usually based on a combination of climatic and economic models and valuation techniques. Comprehensive Integrated Assessment Models include scenarios of emission paths and the resulting patterns of climatic changes. They translate these biophysical changes into socio-economic consequences and assess the impacts in terms of absolute or relative costs and benefits (Tol 2009, Eisenack 2010). Only if impact assessments take different levels of adaptation into account, the difference between the impact estimates are estimates for adaptation benefits (Agrawala et al. 2008).

On the other side of the balance, the costs of adaptation consist of all valued opportunities lost to afford the adaptations (Parry et al. 2009). More operational definitions of adaptation costs are needed for quantitative estimates, but vary considerably. For instance, the IPCC defines them as the “[c]osts of planning, preparing for, facilitating, and implementing adaptation measures, including transition costs“ (Baede et al. 2007:76), and the World Bank for developing countries as “the costs of development initiatives needed in the developing world to restore (future) welfare to levels prevailing before climate change“ (Nahrain et al. 2011:1005).

The adaptation costs and benefits literature has been reviewed in detail by Agrawala et al. (2008), Parry et al. (2009), Fankhauser (2010), and Nahrain et al. (2011). The overall picture shows broad ranges of annual cost estimates at a global scale, e.g., \$US 49-171 bn. by UNFCCC (2007), and for developing countries, e.g., \$US 28-67 bn. by UNFCCC (2007) and \$US 70-100 bn. by World Bank (2010). More detailed sectoral, country- or region-specific cost estimates as well as benefit estimates are only fragmentally available (Agrawala et al. 2008).

Although comparing costs and benefits appears conceptually straightforward, operationalising this task faces severe difficulties. Fankhauser (2010:28) identifies four current major knowledge gaps in “[i] the scope of analysis (whether all relevant impacts and countries are considered), [ii] the depth of analysis (whether, for a given impact/country all relevant adaptation options and needs are considered), [iii] the costing of measures (whether all relevant costs are included), and [iv] the treatment of uncertainty (how uncertainty about future change affects costs)”. He argues that “[t]hese shortcomings are a reflection of just how difficult it is to measure and cost adaptation” (ibid.). The first major source of difficulties is intricacies in defining adaptation, and its costs and benefits. These terms may cover measures that reduce exposure or sensitivity to change only or also much broader means that enhance adaptive capacity. They may comprise adjustments to anthropogenic climate change only or to natural climate variability as well, and frequently include the need to account for overlaps with other aims such as mitigation or general development. Estimates of costs and benefits diverge greatly with different concepts of adaptation (Agrawala et al. 2008; Ackerman/Stanton 2011; Smith et al. 2011). The second major source of difficulties arises from the uncertainty and diversity that surround adaptation. Uncertainty is importantly due to missing and/or uncertain information about the possible impacts and adaptive capacities in local contexts as well as about future greenhouse gas emissions, the response of the carbon cycle and the global climate system, the translation into regionalized and localized climatic changes and non-climatic developments (Adger/Vincent 2005, Fankhauser 2010).

As detailed in section 3.2 adaptation is also diverse including multiple stresses and impacts, exposure units, actors, means, targets, baselines, scales and levels, dynamic feedbacks and thresholds.

These difficulties raise severe methodical challenges for quantitative estimates including fundamental uncertainty and the possible scope, depth and tractability of models. Related to this, estimates have been criticised for their low validity. Cost-benefit analyses also require normative presuppositions about determining which cost and benefit categories matter, how future welfare is discounted, and how costs and benefits are interpersonally aggregated (Klein 2003; Van den Bergh 2004; Kuch/Gigli 2007; Agrawala/Fankhauser 2008; Fankhauser 2010). Adaptation assessments are further complicated by the fact that there is no obvious common metric for adaptation. While different mitigation actions may be compared according to their reduction of carbon dioxide equivalents, there is no comparable, 'natural' metric for adaptation benefits (Stadelmann et al. 2011).

Taken together numerical estimates of adaptation benefits and costs can be helpful for raising public awareness and for quantitative appraisals of adaptation programmes and projects (Parry et al. 2009). However, clear numbers appear easier to interpret than they actually are given the numerous analytical and normative assumptions that are needed to generate them. Due to the methodical difficulties it is an open question how valid and precise quantitative estimates of adaptation costs and benefits can become (Klein 2003).

2.2. Strategies for efficient adaptation

The second domain of current adaptation economics investigates strategies for efficient adaptation. Contributions identified several recommendations at a very general level. First, against the background of fundamental uncertainties and long time horizons it seems an advisable adaptation strategy to increase "the flexibility of systems to function under a wider range of climate conditions, as well as their robustness to withstand more severe climatic shocks" (Fankhauser et al. 1999:68). Second, missing knowledge is an important barrier for efficient adaptation. Improving the availability of, and access to, climate relevant information could address this. A third type of strategies attempts to foster overall development, e.g. by investing in health and education. This may increase the ability to adapt to a broad range of climatic hazards and would be justifiable even in the absence of drastic climate change. Fourth, risk-enhancing activities such as settling in increasingly flood-prone areas often prevail. Accordingly, a worthwhile strategy is to identify and reverse these maladaptive trends (Klein/Tol 1997; Fankhauser et al. 1999; Stern 2006; Agrawala/Fankhauser 2008; World Bank 2010). These general strategies may be helpful to serve as heuristics for adaptation decision making. However, they certainly need operationalisation to be applicable in particular cases (Hallegatte 2009).

Another strategic question for efficient adaptation concerns its timing. For instance, building dikes against flooding risks too early would impose early construction and regular maintenance costs on society while being of little benefit. Building dikes too late would inundate valued land (Mendelsohn 2006). Theoretical analyses demonstrated that delaying adaptations could be beneficial, if improvements in adaptation technologies or knowledge can be expected (Mendelsohn 2006; Agrawala/Fankhauser 2008). On the other hand, "early adaptation is more likely to be relevant for long-lived investments, measures with a long lead time, and measures where subsequent retrofitting would be expensive" (Fankhauser et al. 1999:71) and may avoid irreversible losses and high-cost disaster relief measures (Ackerman/Stanton 2011).

2.3. The role of markets and governments for adaptation

A third strand of current adaptation economics is concerned with the governance of adaptation. In this vein the role of markets and governments for adaptation are investigated and the neoclassical rationale for economic policy is applied. This assigns a role to governments, if and only if markets fail to generate efficient results. Markets are generally seen as mechanisms to coordinate autonomous adaptation. If all benefits and costs of adaptation accrue to an individual actor, markets create price signals of relative scarcities under a changing climate. In an ideal market these allow resources to be allocated to the uses with the highest articulated willingness-to-pay. In this sense and in this ideal case, autonomous adaptation is expected to lead to efficient adaptation, as the own best interest would motivate individuals to adapt until marginal benefits equal marginal costs (Mendelsohn 2000; 2006; Stern 2006; Osberghaus et al. 2010).

However, an enabling environment is decisive for autonomous adaptation. Individuals will adapt within the boundaries of their adaptive capacity as defined by their informational, budgetary, institutional, technological and other constraints and opportunities (Stern 2006; Kuch/Gigli 2007; Osberghaus et al. 2010; Hallegatte et al. 2011). Contributing to a conducive environment for autonomous adaptation is identified to be a first role of governments (Fankhauser et al. 1999). Governmental responsibilities within this domain include establishing and guaranteeing a functioning system of property rights, correcting informational problems of moral hazard and adverse selection in insurance markets, and financing research and education about climatic change, impacts, vulnerabilities and adaptation (Berkhout 2005; Stern 2006; Aakre/Rübelke 2010; Osberghaus et al. 2010). Governments would also need to facilitate autonomous adaptation by regulating natural monopolies, internalising spillovers of innovations in adaptation technologies, overcoming legal or economic distortions of markets, and intervening if adaptations of one group increase the vulnerability of others (Fankhauser et al. 1999; Berkhout 2005; Mendelsohn 2006; Agrawala/Fankhauser 2008; Hallegatte et al. 2011). These governmental activities are ‘indirect adaptation policies’ in that they shape the decision environment of private actors (Aakre/Rübelke 2010).

The second role assigned to governments by normative neoclassical economic theory is that of ‘direct adaptation policies’. In these cases the government is the operating or financing agent on behalf of its citizens (Aakre/Rübelke 2010). The provision of public goods such as dykes, early-warning systems and the protection of biodiversity is the major instance under this category (Berkhout 2005; Mendelsohn 2006; Osberghaus et al. 2010). In contrast to the first role that targets adaptive capacity of private actors, direct adaptation policies lower exposure and/or sensitivity of the governed social entity, e.g. the nation, or enhance the capacity for future collective action. In all cases consistency with related policies is required for efficient adaptation. For instance, policies on economic and population growth could affect vulnerability and need to be taken into account for efficient adaptation (Fankhauser et al. 1999; Stern 2006).

These first two rationales for governmental adaptations are based on its efficiency enhancing function. Some economic contributions add a third class of justifications based on other normative principles than efficiency. Osberghaus et al. (2010) argue that security of supply could rationalise governmental intervention in sectors such as water, energy and food, the goods of which would be “indispensable for economic production and individual welfare” (ibid., p. 843). Due to short-term highly inelastic demand market prices would rise steeply in situations of severe scarcities after an extreme event. This would be “an efficient outcome, but unacceptable if we recognise that the government should provide for the most basic human needs” (ibid.).

Several economic contributions assign a role to governments based on fairness or justice considerations. A regularly observed pattern within and across societies is that those most at risk from climate change have the lowest capacity to adapt (Stern 2006; Adger et al. 2007). Thus, a low level of adaptation in these parts of society would be attributable to the lack of capacity of the most vulnerable (Berkhout 2005). The efficiency of autonomous market adaptation would be based on the low ability of the most vulnerable to express a higher demand for adaptation-related goods and services. Using vertical equity as a normative heuristic, Osberghaus et al. (2010) argue, a governmental responsibility would be to protect the most vulnerable from severe damage, e.g. by giving lump-sum transfers or ensuring access to basic energy services for low-income households. In a similar vein, Fankhauser et al. (1999), Berkhout (2005) and Stern (2006) acknowledge that climate change might severely threaten entire livelihoods. They argue governments need to establish social safety nets or short-term disaster-relief programmes to insure against potential short-term hardships of weather-related disasters.

To sum up, the economic literature in this field applies the neoclassical rationale for economic policy based on the concept of market failure to identify roles of governments for adaptation. By doing so they presume the required political and market institutions to be given. Moreover, they introduce the state exogenously and assign the role of solving market failures to it without assessing whether a central public agency has the capacities and the incentives to do so. In order to increase usefulness the analysis needs to assess why a presumed market failure prevails in a situation with no appropriate action being taken, and which endogenous dynamics could lead to a change. After applying the neoclassical rationale many contributions proceed to discuss further governmental roles based on other normative principles than efficiency. However, these principles are introduced in an ad-hoc and arbitrary manner. A more systematic approach to include normative criteria is attempted in section 3.5.

2.4. Policy instruments to incentivise adaptation to climate change

If there are roles for governments in adaptation, which policy instruments are at their disposal to incentivise adaptation? A small literature within the economics of adaptation is beginning to deal with this question. This section provides a typology and description of recurrent policy instruments that may facilitate adaptation in many sectors.

Several aspects need to be taken into account with this typology: Adaptation is a cross-cutting issue involving multiple sectors and governance scales (Adger et al. 2005). The application of instruments to a specific adaptation problem requires due attention to the particular context of the situation to be effective and efficient. Moreover, there can be instruments not listed below that are specific to one sector or governance level (Smith/Lenhart 1996). In addition, adaptation does not only involve implementing new instruments. In many cases such as in development cooperation, spatial planning and coastal defence existing policies, measures and practices rather need to be reformed to incorporate climate change considerations.

Table 1 provides a typology and description of adaptation policy instruments. The in-depth analysis of their working properties for adaptation is beyond the scope of the current literature in adaptation economics and of this article and must be left to future research.

Table 1:

Policy instrument	Description	Examples
Regulatory measures	Standards, requirements, bans, prescriptions, or plans defined by public administration and valid for private, public and civic actors.	Land-use planning; performance standards; building standards.
Public service	Asset or service delivered by public organisation(s) alone.	Publicly financed and managed hospital or other infrastructure.
Public private partnerships	Contractual relation between public organisation(s) and private sector actors to collaboratively deliver assets or services. Types of contracts include, but are not limited to, divestiture, concession/licence and lease contracts.	Shared construction, maintenance and/or operation of public infrastructure; R&D for adaptation technologies and their implementation.
Loans, guarantees, subsidies	<ul style="list-style-type: none"> - Loan: repayable debt. - Guarantee: collateral security to back a loan. - Subsidy: financial incentive bound to a certain activity or attribute, e.g., grant, tax reduction, price support. 	Subsidy for climate-proofing of buildings; providing start-up finance for microfinance organizations (Agrawala/Carraro 2010).
Taxes, fees and charges	Monetary transfer to the state, with the function to (a) increase the individual costs of maladaptive behaviour or (b) to raise public funds for adaptation.	(a) Water or land-use taxes; (b) Adaptation Levy on the CDM.
Market instruments: Tradable permits, quotas, and related market mechanisms	Use of market price signals and the interaction of supply and demand for adaptation-relevant goods and services, e.g., through establishing a system of adaptation credits (Callaway 2004).	Payments for ecosystem services (if related to climate change).
Insurance schemes	Instruments to share climate-related financial risks. Types (Fankhauser et al. 2008): <ul style="list-style-type: none"> - Indemnity-based insurance - Index-based insurance - Weather derivatives - Catastrophe Bonds - Other 	Crop insurance.

Table 1: Policy instruments to promote adaptation to climate change (source: authors' compilation based on Kuch/Gugli 2007, Fankhauser et al. 2008 and Butzengeiger-Geyer et al. 2011).

2.5. Further topics in climate adaptation economics

In a dynamically evolving field of inquiry it is never possible to pin down every contribution in easily comprehensible strands of literature. Apart from those mentioned above, other topics in climate adaptation economics include international adaptation finance (e.g., Barr et al. 2011; Bowen 2011; Fankhauser/Burton 2011), and the interrelatedness of mitigation and adaptation (e.g., Lecocq/Shalizi 2007; de Bruin et al. 2011).

3. Adaptation to climate change in an institutional economics framework

This third section shows how an institutional economics approach may broaden the focus of adaptation economics both in terms of the addressed governance challenges and the normative criteria used in a coherent approach. Section 3.1 outlines the analytical basics of an institutional economics approach to climate change adaptation. Section 3.2 refines this analytical perspective with public choice and institutional diversity considerations. Sections 3.3 and 3.4 outline a plethora of challenges for adaptation governance, argue that the neoclassical framing does not seem capable to cope with it and describe an adjusted IAD-framework as a consistent meta-theoretical tool for analysing adaptation governance. Section 3 closes with an analysis of the normative foundations of climate adaptation economics (3.5).

3.1. An institutional economics approach to climate change adaptation

Vulnerabilities and adaptive capacities are to an important part the dynamic and aggregated result of decisions and actions taken by numerous actors such as individuals, households, private firms, civic organizations, local, regional and national governments and international organisations. In an economics perspective institutions gain relevance as they shape the behaviour of individual and collective actors and hence affect the processes and outcomes of social interaction. Conceptually, institutions shape the actors' decisions and interactions by prohibiting, prescribing or allowing certain actions or outcomes. They define positions, procedures, rights and duties. They are sources of constraints, rewards, or punishment. By framing mental models, institutions influence what counts as rational, which values and which notions of justice find application in a situation. By providing predictability and defining procedures they mitigate or regulate conflicts and enable cooperation. By assigning rights and positions they distribute power and authority (March/Olsen 1989; North 1990; Ostrom 2005; Paavola/Adger 2005; Vatn 2005; Young et al. 2008).

Adaptive capacity, barriers and drivers of adaptation are useful concepts for studying climate adaptation. Adaptive capacity is usually conceived as the ability or the potential of actors or systems to adjust to change (Smit/Wandel 2006; Engle 2011). Within a framework that analyses adaptations as actions we can define adaptive capacity more precisely as the action space of an individual or collective actor at a certain point in time. It is given by the set of options and constraints for adaptive action that cannot be altered by the actor within the timeframe of a given decision (Eisenack/Stecker in press). Adaptive capacity of a collective entity, e.g. of a state or organization, either denotes the action space of its agents, e.g. the government, to make effective decisions, or the collection of action spaces of the involved individuals. This concept of adaptive capacity also allows dynamic analyses. Factors that impede the process of adaptation may be called 'barriers to adaptation' (Moser/Ekstrom 2010). In contrast, the dynamics that foster adaptation processes can be called 'drivers of adaptation'. Capacity constraints and barriers (resp. drivers) are the impairments (resp. facilitating factors) for reducing vulnerability to climate change. This framework suggests putting them to the core of the institutional analysis of climate adaptation.

Thus, the basic analytical problem of adaptation to climate change in the framework presented here is how different institutional arrangements enable or disable the involved actors to adapt successfully to climate related changes in their biophysical environment by shaping their adaptive capacity as well as the barriers and driving forces in the adaptation process.

3.2. Refining and broadening the institutional approach to adaptation: public choice and institutional diversity arguments

This basic analytical problem can be refined by public choice and institutional diversity arguments. The neoclassical economic approach to adaptation governance (see sections 2.3 and 2.4) distinguishes between individual adaptation coordinated via markets and collective adaptation by governmental authorities. It models market participants as being self-interested and economically rational. In contrast, the government is assumed as a benevolent actor who is able and willing to realize the collectively best policies. The government is the exogenously introduced authority to correct market failure. This approach has regularly been criticised for being methodologically and theoretically inconsistent and for yielding policy recommendations that face severe difficulties to be implemented in the political process. For example, Congleton (2006), Shughart II (2006) and Sobel/Leeson (2006) applied a rational choice approach to the politics of addressing Hurricane Katrina in the US in 2005. They revealed numerous severe coordination and free-rider problems in the political and administrative process that inhibited adaptation to the hurricane. These public choice considerations strongly suggest that the political and administrative process needs to be endogenized in a coherent economic theory of climate adaptation. The normative assignment of responsibilities to governments risks to miss the underlying problem structures of adaptation governance. One of the core questions would be how different political and administrative institutions change the incentives for public agents to address capacity, barriers and driving factors for adaptation.

The market-state-dichotomy has also been criticised for doing little analytical justice to the diversity of structured human interaction (e.g., Ostrom 2005; 2010). Complementary to this, the adaptation literature has demonstrated that adaptation comprises highly heterogeneous situations. Table 2 illustrates important sources of this heterogeneity. A useful concept of adaptation governance needs to capture this diversity while remaining tractable. The market-state-dichotomy of two alternative arenas of decision-making appears to be at best a first heuristics that still misses a lot of the heterogeneity. The adjusted IAD-framework outlined in 3.4 attempts to offer a useful language to capture the diversity of adaptation situations.

The large number of possible institutional configurations is a clear challenge for institutional analysis. It seems helpful to distinguish between theoretical and applied institutional analysis to address this. Theoretical institutional analysis attempts to identify generalisable conclusions that hold for multiple cases. It seems promising for this level to focus on the working properties of institutions rather than classifying the rules themselves (Ostrom 1990). Then the guiding research question for empirically grounded theoretical institutional analysis is *how these institutional working properties shape adaptive capacity and/or barriers and/or drivers of adaptation in different (social, economic, biophysical, etc.) settings*. If the level of analysis moves to become more applied to specific cases, it should become easier to focus on particular rules or rule configurations, such as national adaptation policies or UNFCCC adaptation arrangements. The guiding research question at this level is *how these institutional arrangements embody working properties relevant in that case and how they shape adaptation in the action arena(s) under consideration*.

Table 2:

Dimension	Range
Governance levels	Local, regional, national, international, global.
Actors	Individuals, households, local communities, private firms, governmental, civic, research, international and other organisations, etc.
Institutional configurations	(1) Boundary-, position-, choice-, aggregation-, information-, payoff-, and scope rules. (2) Operational-, collective choice-, constitutional-, and meta-constitutional rules (Ostrom 2005).
Attributes of the involved actors	Worldviews, knowledge, values and preferences, power, communication.
Other situational variables	Resources, Technology, Information.
Climatic stimulus/ stresses	(1) Floods, droughts, storms, change of soil quality, precipitation, temperature, etc. (2) Anthropogenic vs. natural climate change and variability, extreme events, multiple overlapping goals and stressors, closing existing adaptation deficit (Fankhauser 2010).
Exposure units	Actors, infrastructure, natural resources, ecosystems, etc. (Eisenack/Stecker 2011).
Functional interactions	Linearities, feedback mechanisms, thresholds, cross-level interactions, social-ecological interplay, etc. (Gunderson/Holling 2002; Folke 2006; Nelson et al. 2007).

Table 2: Sources of heterogeneity of situations of climate adaptation (authors' compilation).

The heterogeneity of adaptation situations is clearly an obstacle for identifying generalisable conclusions. Therefore, developing useful theories of adaptation requires an appropriate notion of generality that is sensitive to the particularities of cases. Helpful methods to address this challenge are multi-tier, diagnostic frameworks of variables (Ostrom 2005; 2009; Moser/Ekstrom 2010), an effective interplay of induction, deduction and abduction (Bromley 2006; Schlüter 2011) and to aim at finding contextualisable institutional design principles instead of panaceas (Ostrom 2007).

Existing contributions about the institutional dimensions of climate adaptation identified a number of institutional attributes that are expected to be conducive for adaptation. These include the involvement of a variety of perspectives, actors and approaches, the facilitation of social learning, an enabling environment for autonomous adaptation, mobilization of leadership and resources as well as legitimacy, equity, responsiveness and accountability (Gupta et al. 2010). However, the knowledge base in this field is still limited in scope and depth. Authors of theoretical or conceptual articles frequently mention the need for empirical verification and existing empirical case studies and statistical investigations need synthesis to derive more general conclusions and enable learning across cases (Agrawal 2010; Gupta et al. 2010).

3.3. Coping with the plethora of challenges for adaptation governance

The multidisciplinary literature about climate change adaptation, vulnerability and resilience has revealed a plethora of governance challenges for climate adaptation. This section describes briefly some of the major challenges and subsequently discusses how insights into these may be integrated in an institutional approach to adaptation in a methodically coherent way.

- *Individual and social learning processes, science-policy-interface and deliberative processes:* Dealing with uncertain or missing information is a frequent challenge for climate adaptation (Adger/Vincent 2005). There also seem to be significant barriers in the process of individual cognition and the culture(s) of a society, e.g. due to inertia of established worldviews and shared mental models (Grothmann/Patt 2005; Heyd/Brooks 2009). Understanding processes of individual and social learning is therefore crucial for successful adaptation (Pelling et al. 2008; Pahl-Wostl 2009). Closely related to the learning literature are investigations of the interface between science and policy (Weichselgartner/Kasperson 2010) and of the role of discourses and deliberative processes (Hobson/Niemeyer 2011).
- *Scale and multi-level-governance:* The process of adaptation often involves multiple temporal, geographical and jurisdictional scales and levels (Adger et al. 2005; Cash et al. 2006). Trade-offs and complementarities can exist between different levels and scales. Moreover, despite certain advantages overlapping and nested governance systems often also imply severe coordination and free-rider problems (Keskitalo 2010).
- *Fairness and justice of adaptation:* As a general pattern, vulnerabilities and adaptive capacities are unequally distributed both within and across societies (Adger et al. 2007). The fairness and justice dimensions of adaptation motivate a considerable body of literature (e.g., Adger et al. 2006; Roberts 2009; Grasso 2010). They are of particular relevance for the institutional analysis, as institutions shape the distribution of impacts, vulnerabilities and adaptive capacities (Agrawal 2010).
- *Power, legitimacy and adaptation:* Institutions imply a certain distribution of power among actors, including the power to frame collective problems, to control outcomes and to change institutions. A crucial question becomes what confers legitimacy on certain institutions and the resulting adaptations and how institutions shape adaptation through the distribution of power (Matthews/Sydneysmith 2010).
- *Climate change adaptation in the wider context of existing structures and practices, general development and multiple stresses:* Adaptation frequently involves the challenge to incorporate climate change aspects into existing structures and practices (Stern 2006). Adaptation also has important overlaps with general development, for instance, if health or educational systems are improved (Schipper 2007; Halsnaes/Traerup 2009). Moreover, actors or systems usually have to cope with multiple climatic and non-climatic stresses at one time and may pursue other goals than vulnerability reduction alone (O'Brien/Leichenko 2004; Eakin/Luers 2006).
- *Preconditions for autonomous adaptation:* Autonomous adaptation can be the most efficient way of adapting in many settings. However, preconditions have to be met for autonomous adaptation to be successful (section 2.3). Investigating these preconditions in more detail seems to be an under-researched, but worthwhile field of future research.

Institutional systems themselves have attributes that enable or hamper societies to adapt to climatic changes.

- *Institutional change:* A changing climate often requires adjustments in the institutional system in order to cope with new situations. However, institutions change in a non-trivial manner. Institutional inertia (Harries/Penning-Rowsell 2011), institutional path-dependence (Burch 2009; Libecap 2011), incremental vs. abrupt institutional changes, and differential inherent stress management capacities (Young 2010) are relevant phenomena here.
- *Fit:* The fit of institutions with the social-ecological challenge is widely accepted as an important prerequisite for effective environmental governance (Young et al. 2008).
- *Rule-based vs. discretionary governance:* On the one hand, it is a core function of institutions to provide predictability in social interactions. On the other hand, adaptation is precisely about

adjusting structures and practices to new climatic conditions and thus requires a degree of flexibility (Kunreuther/Pauly 2006; Ebbeson 2010). How to deal with this potential trade-off is in many aspects an open question for future research.

To conclude, each of these items, while interrelated with others, constitutes an analytical problem in its own right. Against the background of section 2 it becomes apparent that the neoclassical approach to adaptation governance based on the concept of market failure seems too narrow to do analytical justice to these diverse problems. If seen in the light of the institutional dimensions of climate change adaptation insights into the above items importantly inform the institutional analysis about the manifestations and dynamics of barriers, drivers and capacity determinants for adaptation in different settings. They also remind to pay particular attention to the distribution of vulnerabilities, rights, power and resources.

Integrating these items in a methodologically and theoretically consistent way becomes crucial. Useful frameworks are needed that help to translate research problems and findings from one disciplinary language to another and, thus, foster common learning about climate adaptation. For adaptive capacity such frameworks exist and identify determinants of adaptive capacity including resources, technologies, infrastructure, social capital, institutions, and knowledge, although differences for different governance levels are reported (e.g., Yohe/Tol 2002; Ivey et al. 2004; Brooks et al. 2005; Adger et al. 2007; Tol/Yohe 2007). For barriers and drivers of adaptation efforts to develop such frameworks are ongoing (e.g., Moser/Ekstrom 2010; Biesbroek et al. 2011; Eisenack/Stecker in press). For the institutional analysis of adaptation an adjusted Institutional Analysis and Development (IAD) framework seems a promising conceptual groundwork to relate institutions with adaptive capacity, barriers, drivers, and outcomes of adaptation processes in a precise and systematic manner. This is detailed in the next section.

3.4. Adjusting the IAD framework to study climate change adaptation

The IAD framework offers an elaborated meta-theoretical concept to study structured human interaction and the interplay of social and ecological systems. Its focal unit is the action arena. This consists of the participating actors and seven situational variables: positions, action spaces, potential outcomes, action-outcome linkages, control of actors about these linkages, available information and the costs and benefits of actions and outcomes. Action arenas are structured by exogenous variables. The IAD distinguishes three classes of exogenous variables: rules, community attributes and biophysical/material variables (Ostrom 2005). In order to streamline the framework for climate change adaptation it seems useful to cluster these exogenous variables slightly different by focusing on the determinants of adaptive capacity. These could be usefully decomposed into institutional properties, resources, infrastructure & technology, attributes of the community, and biophysical variables. Concerning the participating actors the IAD framework suggests that theories need to make assumptions about three major behavioural variables: preferences (what kind of valuations actors assign to actions and outcomes), information and mental models (how actors acquire, process and use information), and the selection mode (how actors choose between different alternatives, e.g., maximizing, satisficing or using heuristics).

Within this IAD-framing adaptive capacity can be usefully defined as the space of possible adaptive actions as it is given by the exogenous variables of action arenas and perceived by the respective participant. A barrier (resp. driver) for adaptation is defined as an attribute of the situation that reduces (enhances) this action space or hampers (supports) actors to realize their capacity.

Table 3:

(1) Institutions
(2) Other exogenous variables of action situations
(3) Manifestation of action situation variables
(4) Behavioural assumptions about the participants
(5) Rationality principle

(6) → Adaptation outcome patterns (e.g., vulnerability)

Table 3: General method to explain the relation of institutions and adaptation outcomes (authors' compilation).

Table 3 depicts a general IAD-based method to systematically explain how institutions shape patterns of adaptation. The method proceeds by making assumptions about (1) the institutions of interest, (2) the other exogenous variables of an action arena, (3) the corresponding variables of an action situation, and (4) the behavioural variables. The formal rationality principle (5) – i.e. the explanatory principle that the participant will choose the alternative with the highest valued expected outcomes given her modes of valuation, information processing and selection – is needed to allow the analyst to explain or predict the participants' choices in a systematic manner. This explanatory principle is open to many forms of rationalities. What is presumed to be rational in a situation depends on the assumptions made in (1-4). The action-outcome-linkage included in (3) allows explaining or predicting how the individuals' actions aggregate to the resulting outcome patterns of this situation (6). A comparative institutional analysis would attempt to attribute differences in outcome patterns (6) to differences in the institutional setting (1).

The capacity constraints for adaptation are implied in the assumptions (1-4) as these determine the action space for adaptation. An explanation of how institutions shape adaptive capacity refers to the relation of assumption (1) and the perceived action space. An explanation of how institutions shape barriers and drivers refers both to the relation of (1) and (3) in a dynamic perspective on the evolution of the action space and to the translation of capacity into action.

3.5. The normative foundations of positive adaptation research

The analytical concepts of adaptive capacity, barriers and drivers of adaptation necessarily have normative underpinnings. This is due to the fact that adaptation is a relevant governance problem only if a valued entity is at risk or may benefit from climate change. Moreover, inequalities and conflicts in vulnerability and adaptation may result from persistent social structures and incompatible values and interests. This raises the question whose and which values count and who is seen vulnerable. According to which regulative ideas is adaptation assessed? Inquiries of adaptation cannot avoid assumptions about their normative reference point when answering these questions at least implicitly, e.g. when formulating research problems and analytical concepts. This section first criticises the normative reference point of welfare economics, outlines an alternative contribution from constitutional political economy, integrates critique about this approach, and eventually draws implications for positive adaptation research.

The predominant normative reference point of current adaptation economics is efficiency, frequently understood as the maximum aggregated net benefits of adaptation (see section 2). Its approach is subject to severe criticism. Three types of critiques are relevant here. The first one refers to problems of operationalising this maximization paradigm. The diversity, long time horizons, potential irreversibilities and fundamental uncertainty surrounding adaptation lead to severe conceptual and methodical challenges (section 2.1). These aspects question how precise and valid quantitative estimates of social adaptation benefits and costs can become. Moreover, it has been acknowledged that utility or welfare is subjective in the sense that there is no general, cardinal and directly observable denominator for interpersonal utility comparisons (Buchanan 1959; Rawls 1971; Paavola/Adger 2005; Vatn 2005). Constructing artificial value scales, e.g. by using techniques of cost-benefit-analysis, involves assumptions with strong normative determinations about which values count, what is rational and how conflicting interests and values of individuals are aggregated in one or a few metrics. These presuppositions need to be made transparent to avoid implicit normative distortions of the positive analysis. If the results are precise numbers, it is frequently not easy to communicate these much more intricate and technical assumptions clearly. Moreover, these measurement and aggregation techniques arrive at their limits if incommensurable values are involved or if a non-utilitarian moral point of view is found to be more appropriate (Vatn 2005; Hunt/Taylor 2009). Taken together quantitative aggregate estimates may easily suggest a degree of positive and normative validity and precision that can hardly be reached in adaptation governance (Klein 2003; Van den Bergh 2004).

The second criticism objects the notion that welfare optimal adaptation is what constitutes good or successful adaptation. Maximizing aggregated net benefits of adaptation clearly follows a utilitarian moral point of view: morally good is what maximizes some aggregated measure of utility or welfare. Summarizing the ethical discourse about utilitarian and other moral points of view is beyond the scope of this article. However, the adaptation literature has developed many criteria to evaluate adaptation decision making (for overviews see Adger et al. (2005) and De Franca Doria et al. (2009)). Economic efficiency is one of these criteria. Many authors and decision makers certainly would agree that allocating resources to the most valued uses is a component of good adaptation. Highly inefficient adaptations could even make matters worse (Mendelsohn 2006). However, numerous other normative principles and regulative ideas have been proposed as well such as sustainability, fairness, justice, security of supply, effectiveness, and legitimacy. The notion of sustainable adaptation directs attention to the implications of adaptations in the long run and for overall environmental, economic and social integrity (Eriksen et al. 2011). Outcome and procedural, intra- and intergenerational fairness or justice seem relevant, as vulnerabilities and adaptive capacities are unequally distributed both within and across societies and because adaptations by one individual or group may affect others (Tol et al. 2004; Adger et al. 2007). The criterion of security of supply is proposed to ensure sufficient provision with goods that seem indispensable for human development and welfare in sectors such as water, energy, health and food (Osberghaus et al. 2010). Considerations of effectiveness highlight that adaptation can serve a broad range of objectives and that different adaptations usually influence outcomes to varying degrees at different scales and levels. For instance, actions can be adaptive in one dimension and maladaptive in another, e.g. opposed short- and long-term effects (Adger et al. 2005; Barnett/O'Neill 2010). Finally, legitimacy considers whether adaptations are acceptable to the affected actors (Adger et al. 2005). Clearly, these criteria emphasise different aspects of adaptation decision making and can be complementary or contradictory. In any case the literature about 'good adaptation' suggests that an approach tends to be blind on too many eyes, if it attempts to inform about sound adaptation decision making, but focuses on economic efficiency only.

The third direction criticises the systematic gap between the normative foundation and the positive analysis that exists, if the normative foundation of adaptation economics is the maximization of

aggregated net adaptation benefits. Van den Bergh (2004:385) discusses that optimality concepts for studies of collective issues are “based in a misplaced interpretation of policy for a complex climate-economy system as being analogous to individual inter-temporal welfare maximization”. In an institutional perspective adaptation governance may be best understood as the dynamic interplay of a multitude of interdependent public, private and civic actors within their institutional, social and biophysical context (see section 3.1). A normative foundation that focuses on the mutual agreement on rules fits much better to this notion of adaptation governance than a social maximization paradigm.

Constitutional political economy (CPE) as a branch of the new institutional economics offers a different reference point that may be used to address these caveats and to guide positive inquiries of climate change adaptation. CPE paradigmatically distinguishes between the constitutional and the sub-constitutional stage. The constitutional level comprises the design or reform of institutional arrangements. These shape the processes and their outcome patterns at the sub-constitutional level. CPE focuses on the subject, which institutional arrangements are in the shared constitutional interest of the participating actors. It transparently adopts the normative premise that “individuals are the ultimate sovereigns in matters of social organization, [i.e.] that individuals are the beings who are entitled to choose the organizational-institutional structures under which they will live” (Buchanan 1991/1999:288). The reference point for evaluations becomes, whether an institutional arrangement could have been mutually agreed upon by the affected actors. Thus, for aggregating potentially conflicting or incommensurable values and preferences the normative benchmark of CPE is not maximising an objectively defined social welfare function, but whether this aggregation follows rules which are in the common constitutional interest of the affected actors. A clarification seems appropriate. Most of today’s rules clearly have not been crafted with the explicit and unanimous agreement of all affected individuals. However, this does not necessarily imply normative rejection of these rules and the benchmark. Strict unanimity in collective choices would imply high political transaction costs of negotiating, delayed and failed decision-making and strategic disincentives for veto-playing. Therefore, it can be of common constitutional interest of the affected actors to implement a combination of enforceable rights for concerns of major importance and sub-unanimity rules for daily public decision-making in order to reach collective decisions effectively and efficiently (Buchanan/Tullock 1962; Vanberg 2005). In this argument, the normative benchmark of mutual agreement on rules remains in place, while collective decision-making in real-world contexts frequently involves agreement below strict unanimity.

While CPE offers a well-founded normative reference point, it is not without problems itself. A first point addresses the generality of its analyses. Adger et al. (2005) argue that cultural expectations and interpretations define what actors find legitimate. The diversity of these expectations and interpretations suggests that “there are no universal rules for procedures that guarantee the legitimacy of policy responses” (ibid., p.83). Accordingly, an analytical challenge is to identify the relevant values and mental models in the situation under consideration and to use the appropriate degree of generality. Other criticism claimed that social-contract based institutional analysis of vulnerability and adaptation faces the risk to be arbitrary and limited to formal-procedural considerations (Hotimsky et al. 2006). It may be arbitrary, because assumptions about the status quo or the ‘natural state’ have major implications for the perceived problems of social order, the analysis and the options for institutional change. Moreover, it may be limited to formal-procedural accounts, as long as no substantive assumptions about values and preferences are made.

These points illustrate how important it is for a CPE-based analysis to carefully and comprehensibly specify the analysed situation including who is involved, which preferences and values the actors hold and which worldviews, knowledge, power, and resources they have (e.g., Neumärker/Pech 2011). The

aim of the analysis determines how the analyst can specify these concepts. If the aim is to assess the moral legitimacy of institutions critically, the analyst can investigate the agreement of all *affected actors* to an institutional arrangement, e.g. also including future generations. The concept of a veil behind which decisions are taken, e.g. Rawls' veil of ignorance, has been developed as a helpful analytical tool for this task. If in contrast the aim is to identify realisable options for institutional reforms based on the status quo, the analyst may decide to pragmatically build on a thorough examination of the status quo focussing on the *involved actors* who have decision-making power. This might include, for instance, considerable inequalities of resources and power as a morally difficult, but maybe necessary starting point to identify realisable reforms.

Taken together these considerations about the normative foundations have several implications for a useful positive approach to climate adaptation. First, the analytical concepts of barriers, drivers and capacity for adaptation inevitably have normative underpinnings. In the CPE-based approach barriers, drivers and capacity are defined against the background of the individual valuations of the participants. These may be valuations that are idiosyncratic and/or shared by individuals. In order to identify the relevant valuations and problems of adaptation governance in a particular situation the analyst may use a range of techniques and sources. Data from interviews or process observations and documented principles such as those in the UNFCCC can indicate what participants value or have agreed about. In addition, normative concepts such as sustainability, fairness or efficiency originating from societal discourses can serve as regulative ideas for the positive analysis. This illustrates that by focussing on the participants' valuations instead of an aggregated social welfare function the CPE approach opens up adaptation economics to a broad range of normative criteria. Second, the suggestions for design or reform of adaptation governance need to be formulated and understood to be hypothetical instead of categorical imperatives. Only if the involved actors perceive the governance problems and the analysis to be relevant for them, they will be ready to use the results delivered in positive adaptation research. Third, if substantive assumptions about preferences, values, aggregation rules and other aspects of action situations are made, a CPE-based approach is in general open to investigate not only procedural, but also substantive questions of governance. In this context, cost-benefit-analysis may have a role to inform adaptation decisions, if time horizons are not too long-term, values commensurable, climate impacts transparent and normative presumptions such as aggregation rules and cost categories clear (Hunt/Taylor 2009). Yet, from a social contract moral point of view, using a cost-benefit-approach in adaptation decision-making needs to be justified to be in the common constitutional interest of the participants.

4. Conclusions and future research

This article investigates how economics frames and approaches adaptation to climate change and how institutional economics may contribute to the interdisciplinary field of adaptation research. Most of current adaptation economics relies on a welfare economics framing. It is concerned with the efficiency of adaptation outcomes. Accordingly, a major attempt is to estimate adaptation benefits and costs quantitatively. On the one side the resulting clear numbers may have a role in raising awareness and shaping public discourses. Additionally, the aim to objectify adaptation assessments is certainly important to avoid distortions of collective action on adaptation. On the other side the article outlined serious analytical and methodological problems of this seemingly straightforward approach. These question how precise and valid quantitative estimates of adaptation benefits and costs can become. Moreover, generating these estimates requires normative predefinitions about which values count, which cost and benefit categories matter, how to discount future welfare and how to aggregate costs

and benefits interpersonally. This could easily lead to moving normative distortions from the political arena into the economic analysis.

The framing of adaptation governance in current adaptation economics relies predominantly on the market-state-dichotomy and the neoclassical rationale of market failure. It has become clear that this concept is too narrow to capture the plethora of governance challenges and normative criteria discussed in the adaptation literature. Institutional economics may broaden the scope of adaptation economics by systematically focusing on the relation of institutions, capacity, barriers and drivers for climate adaptation and by adopting a constitutional approach for the normative foundation. A promising, but under-researched approach is to concentrate on the working properties of institutions for adaptation in order to find generalisable conclusions and foster learning across cases. If applied to particular settings such as national adaptation policies or UNFCCC adaptation arrangements, the analytical focus could move to specific rules or rule configurations. This would allow investigating how these embody the institutional working properties relevant in that case and how they shape the action arenas under consideration. An adjusted IAD-framework seems a promising meta-theoretical tool to guide institutional adaptation analyses in a systematic manner. Moreover, it enables to compare and carefully integrate multidisciplinary results of the adaptation literature.

A clear challenge for theoretical adaptation research is the large heterogeneity of adaptation. Promising methods to address this are multi-tier, diagnostic frameworks of variables, the dynamic interplay of induction, deduction and abduction and contextualisable design principles instead of panaceas.

Constitutional political economy (CPE) offers normative foundations for adaptation research that urge the analyst to start with the question which governance arrangements might be in the common constitutional interest of the participants in the analysed situation. The paradigm of mutual advantages from cooperation of interdependent actors, on which CPE is based, seems to fit better to complex and divers adaptation governance than the paradigm of social maximization of welfare economics.

Throughout the text promising questions for future research have been outlined. Identifying institutional design principles for adaptation is a major challenge. The elaborated literature on common-pool-resources may be helpful here. However, its findings need to be translated with caution, as the analytical problems of climate change adaptation and of common-pool resources are systematically different despite some overlaps. Moreover, a context-sensitive diagnostic framework of adaptation barriers and drivers would be an important next step for institutional research of climate adaptation.

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