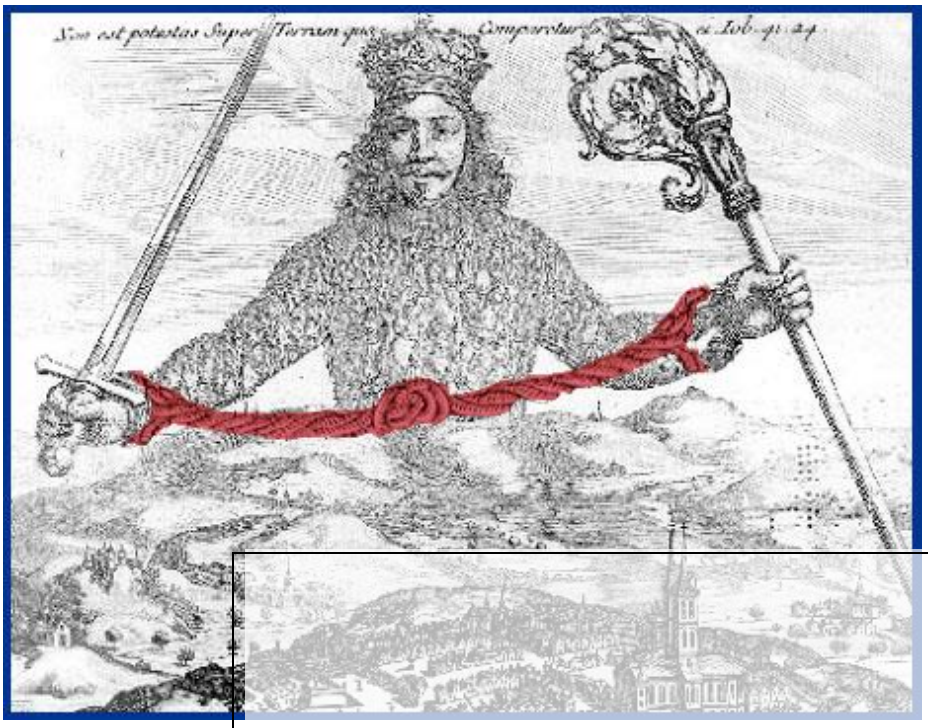

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A Diagnostic Approach to the Institutional Analysis of Climate Adaptation

Christoph Oberlack* and Bernhard Neumärker**

*Department of Economic Policy and Constitutional Economic Theory, University of Freiburg, Germany. E-Mail: christoph.oberlack@vwl.uni-freiburg.de

** Department of Economic Policy and Constitutional Economic Theory, University of Freiburg, Germany. E-Mail: bernhard.neumaerker@vwl.uni-freiburg.de

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University of Freiburg
Institute for Economic Research
Department of Economic Policy
Platz der Alten Synagoge / KG II D-79085 Freiburg
www.wipo.uni-freiburg.de

A Diagnostic Approach to the Institutional Analysis of Climate Adaptation

Christoph Oberlack*[+], Bernhard Neumärker*

* University of Freiburg, Institute for Economic Research, Department of Economic Policy and Constitutional Political Theory, Platz der Alten Synagoge, 79085 Freiburg, Germany.
[+] Corresponding author: christoph.oberlack@vwl.uni-freiburg.de, Tel.: +49-761-203-2331, Fax: +49-761-203-2322.

Abstract:
Economics has a key role to play for understanding vulnerability and adaptation to climate change. However, economic approaches to climate adaptation are rarely articulated and discussed at a framework level. This article first reviews and critically assesses welfare economics approaches to climate adaptation and, secondly, develops a novel institutional economics approach to climate adaptation. Concepts and tools of welfare economics have contributed to assessments of benefits and costs of adaptation; outlined strategies for adaptation; identified responsibilities of the public sector and described policy instruments for adaptation. However, the neoclassical framing of collective action based on the concept of market failure seems too narrow to do analytical justice to the multitude of governance challenges associated with adaptation. Adaptation economics seems underequipped with analytical tools to study the role of institutions for climate adaptation. Therefore, an institutional economics approach to climate adaptation is developed and illustrated. This approach contributes to integrated economic analyses of climate adaptation in three major ways: First, by broadening the scope of climate adaptation economics; second, by delivering a diagnostic framework of climate adaptation that enables the analyst to explain adaptation processes in a systematic manner, synthesizes findings from a large number of research efforts, places particular research questions, governance problems and results in a broader context, and can guide the design of theoretical and empirical inquiries of climate adaptation; third, by offering research strategies and methods for developing generalisable and valid insights in the face of pronounced heterogeneity and diversity of climate adaptation.

Keywords: Economics of Climate Adaptation, Institutional Economics, Governance of Climate Adaptation, Diagnostic Framework.

JEL classifications: Q54; B52; D02; D78.

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1. Introduction

Adaptation to the impacts of climate change has attracted wide interest as a necessary complement to greenhouse gas mitigation. Mitigating global warming remains a core domain of climate policy, as there are substantial costs, barriers or even limits to climate adaptation (Stern, 2006; Adger et al., 2007; Adger et al., 2009; Fankhauser, 2010). However, climate change exposes many locations worldwide to environmental hazards (e.g. Parry et al., 2007) and effective global mitigation remains to be delivered. Therefore, understanding how individuals, communities, organizations and societies can adapt to climate change has become increasingly important. In an economic perspective climate adaptation can be defined as action undertaken by individual or collective actors in response to, or in anticipation of climate-related changes, of environmental conditions (Eisenack/Stecker, 2012).

Despite the growing importance of adaptation economic approaches to this field are rarely articulated and discussed explicitly at a framework level. The benefits of such a framework-level discourse are manifold. They include clarifying and updating the relevant research problems and directions, 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).

This article reviews welfare economics approaches to climate adaptation, critically assesses its merits and shortcomings and, based on this, presents a novel institutional economics approach to adaptation. As section 2 details the welfare economics framing of adaptation is used for assessing costs and benefits of adaptation, identifying efficient adaptation strategies, assigning roles to governments and markets, and analyzing policy instruments for adaptation. A major criticism outlines that the neoclassical perspective is too narrow to do analytical justice to the multitude of governance challenges associated with climate adaptation. Many of these challenges are of institutional character. However, many details of how to analyze the role of institutions with an economics perspective remain largely unclear. Therefore, an institutional economics approach to climate adaptation is developed and presented in section 3. In essence, it comprises a diagnostic framework of climate adaptation and an economic method for analyzing the role of institutions for climate adaptation. Section 4 illustrates the functionality of this approach by focusing on barriers to municipal adaptation in developing and transition countries. Section 5 concludes.

In conclusion, this institutional approach can contribute to the evolving agenda of climate adaptation economics in three major ways: First, it offers a distinct subject of analysis, the diverse set of institutions that shape adaptive behaviour. This significantly broadens the scope of climate adaptation economics. Second, the approach contains a diagnostic framework that (i) provides a method to explain climate adaptation processes and outcomes in a systematic, non-arbitrary manner, (ii) carefully integrates research from a large number of disciplines to foster cumulative learning, (iii) places particular research questions, governance problems and findings in a broader context, and (iv) can be used in the design of theoretical and empirical inquiries of climate adaptation. Third, the approach contains methods to develop valid theoretical generalizations in the face of a large diversity of adaptation situations (diagnostic approach and archetypes).

2. Climate change adaptation in a welfare economics framework

Welfare economics is pivotally concerned with the efficient allocation of resources to competing uses. Efficient adaptation is conventionally understood as the "set of adaptations that maximize the net benefits of adapting" (Mendelsohn, 2006:204). In these terms efficiency is an attribute of the outcomes of adaptation and is precisely given, as long as 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 structures, reviews and critically assesses the welfare economics of adaptation.

2.1. Assessment of benefits and costs of climate 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 estimates of impacts are estimates for adaptation benefits (Agrawala et al., 2008).

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 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. For instance, these terms

may cover measures that reduce exposure or sensitivity to change only or also much broader means that enhance adaptive capacity. Adaptation may relate to anthropogenic climate change only, to natural climate change and variability as well, or even to a range of climatic and non-climatic stressors and goals that are relevant in the community that needs to adapt. The 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). In addition, the picture of adaptation is also divers including a broad range of potential impacts, exposure units, actors, means, targets, baselines, scales and levels, dynamic feedbacks and thresholds. As a result of these methodical challenges quantitative estimates are criticised for their low validity. Moreover, cost-benefit analyses of adaptation require normative presuppositions how costs and benefits are interpersonally aggregated, which values count, and how future welfare is discounted (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 (Persson, 2011; 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, resulting clear numbers appear easier to interpret than they actually are given the numerous analytical and normative assumptions that are needed to generate them. These methodical difficulties remain shortcomings for the validity and precision of estimates of adaptation costs and benefits and can lead to moving normative predefinitions from the political arena into the economic analysis (Klein, 2003).

2.2. Strategies for efficient climate adaptation

A second domain of climate adaptation economics investigates strategies for adaptation. The literature identified several recommendations at a general level. First, if fundamental uncertainties and long time horizons related to impacts of climate change are the problem, it seems advisable 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). This can imply to choose investments with shorter replacement cycles, plan with safety-margins, institutionalize long-term planning horizons and favour reversible choices (Hallegate, 2009). Second, missing knowledge is an important barrier for efficient adaptation. Accordingly, strategies to improve the availability of, and access to, climate relevant information could address this. Third, strategies to foster overall development, e.g. by investing in health and educational systems, may increase the ability to adapt to a broad range of climatic hazards and could be justifiable even in the absence of drastic climate change. Fourth, as long as risk-enhancing activities such as settling in increasingly flood-prone areas often prevail it is a worthwhile strategy to invest in reversing these maladaptive trends (Klein/Tol, 1997; Fankhauser et al., 1999; Stern, 2006; Agrawala/Fankhauser, 2008; World Bank, 2010). To sum up, these general strategies may be helpful to serve as heuristics for adaptation decision making. However, they need specification to be applicable in particular cases (Hallegate, 2009).

The timing of adaptation is another question of strategic importance (Zehaie, 2009). 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 if adaptation may avoid irreversible losses and high-cost disaster relief measures (Ackerman/Stanton, 2011). On the other hand, Mendelsohn (2006) and Agrawala/Fankhauser (2008) showed that delaying adaptations could be beneficial, if improvements in adaptation technologies or knowledge can be expected.

If minimizing the costs of climate change is the problem, the focus moves from efficient adaptation to analyzing synergies, conflicts and the optimal mix of mitigating climate change and adapting to its impacts (e.g. Tol, 2005). This literature has been reviewed in details in Heuson et al. (2012).

2.3. The role of markets and governments for adaptation

A third strand of adaptation economics investigates roles of markets and governments for adaptation. The neoclassical rationale for collective action is applied which assigns a role to government, if and only if markets fail to yield efficient results.

Markets are mechanisms to coordinate autonomous adaptation by private actors. 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 meaning and case, markets are 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; Osberghaus et al., 2010).

However, an enabling environment is decisive for private 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; Hallegatte et al., 2011). Contributing to a conducive environment for private adaptation is identified as 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; Botzen/van den Bergh, 2009; Aakre/Rübbelke, 2010; Osberghaus et al., 2010). Governments would also need to facilitate private 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; Heuson et al., 2012; Konrad/Thum, 2012). These governmental activities are 'indirect adaptation policies' in that they change the context of adaptation decisions by private actors (Aakre/Rübbelke, 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/Rübbelke, 2010). The provision of public goods such as dykes 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 or sensitivity of the governed entity, or enhance the capacity for future collective action. In all cases efficient adaptation requires consistency with related policies such

as policies on economic and population growth that can affect the risk of impacts and the ability to adapt (Fankhauser et al., 1999; Stern, 2006).

While these first two rationales for governmental adaptations are based on efficiency improvements, some economic contributions add a third class of justifications based on other normative principles. 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. The authors argue this would be "an efficient outcome, but unacceptable if we recognise that the government should provide for the most basic human needs" (ibid.).

Moreover, several authors assign a role to governments based on principles of fairness or justice. It is a frequently assumed pattern within and across societies 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 rather than a deliberate decision (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 heuristics Osberghaus et al. (2010) argue a governmental responsibility would be to protect the most vulnerable from severe damage, e.g. by 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) argue governments would 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 collective action based on the market/state dichotomy and the concept of market failure to identify roles of governments for adaptation. By doing so it presumes the required political and market institutions to be given. Moreover, it introduces the state exogenously and assigns the role of solving market failures to it without assessing whether a central agency has the capacities and the incentives to do so. The normative assignment of responsibilities to governments risks to miss the underlying problem structures of adaptation governance. For example, analyzing public sector adaptation to Hurricane Katrina in the US in 2005, a range of authors revealed severe coordination and free-rider problems in the political and administrative process that inhibited adaptation to the hurricane (Congleton, 2006; Shughart II, 2006; Sobel/Leeson, 2006). These public choice considerations strongly suggest to endogenize the political and administrative process in an integrated, coherent economic theory of climate adaptation. Additionally, after applying the neoclassical rationale several economic contributions proceed to discuss governmental roles based on other normative principles than efficiency. These principles are added in an ad-hoc and arbitrary manner to the neoclassical rationale calling for a more systematic approach to the normative foundations of climate adaptation economics.

2.4. Policy instruments to incentivise climate adaptation

A fourth strand of adaptation economics investigates policy instruments that are at the disposal of governments to incentivise adaptation. This section provides a typology and description of recurrent policy instruments that may facilitate adaptation in many sectors.

Table 1 provides a typology and description of adaptation policy instruments. The in-depth analysis and assessment 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.

Several aspects need to be taken into account: 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. In addition, there can be instruments not listed below that are specific to one sector or governance level (Smith/Lenhart 1996). Moreover, 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:

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	- 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 and transfer climate-related financial risks. Types (Fankhauser et al., 2008): - 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)).

3. An institutional economics approach to climate change adaptation

3.1. The complementary role of institutional economics for the economics of climate adaptation

The previous section reveals that adaptation economics has frequently framed the governance of climate adaptation as a question of assigning roles to governments or private actors and choosing optimal adaptation strategies or instruments. This framing largely disregards the role of institutional settings within which political and private actors take adaptation decisions. Empirical and review studies have repeatedly confirmed institutions as an important determinant of climate adaptation (e.g. Adger et al., 2007; Engle/Lemos, 2010; Coleman, 2011). As a consequence, this framing leaves the field of adaptation economics underequipped with analytical tools to study the role of institutions for climate adaptation. Similarly, a thorough exposition of an institutional economics approach to climate adaptation is yet missing.

This third section presents a novel institutional economics approach to climate adaptation. It is based on the literatures about climate adaptation and institutional economics of natural resource governance. The text proceeds by outlining major institutional dimensions of adaptation (subsection 3.2) and an institutional economics perspective on climate adaptation (3.3). Subsection 3.4 presents the 'diagnostic framework of climate adaptation' which is at the heart of the presented approach. Based on this, subsection 3.5 outlines an economic method to explain processes and outcomes of climate adaptation in a systematic way. Subsection 3.6. discusses the notion of archetypes as a useful complement to the presented framework for building powerful explanations of adaptation.

3.2. Institutional dimensions of climate adaptation

This section describes major institutional dimensions of climate adaptation. It underscores the multiple linkages between institutional settings and climate adaptation.

- *Adaptation in multi-level governance systems:* Climate adaptation frequently involves multiple jurisdictional levels and types of collective actors (Adger et al., 2005; Cash et al., 2006). Despite certain advantages overlapping and nested governance systems often also imply severe coordination and free-rider problems calling for sound institutional arrangements for cross-level interactions (Keskitalo, 2010).
- *Individual and social learning processes, science-policy-interface and deliberative processes:* Dealing with uncertain or missing information is a frequent in 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). Therefore, understanding processes of individual and social learning is 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).
- *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 and the legitimacy of 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).
- *Preconditions for autonomous adaptation:* Autonomous adaptation can be the most efficient way of adapting in many settings. However, an (institutional) enabling environment is decisive for autonomous adaptation to be successful (cf. 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 actors 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 environmental change is widely accepted as an important prerequisite for effective environmental governance (Young et al., 2008).
- *Rule-based vs. discretionary governance:* On the one hand, a core function of institutions is 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 apparent trade-off is in many aspects an open question for future research.

Each of these items, while interrelated, constitutes an analytical problem in its own right illustrating the fundamental role of institutions for climate adaptation. Against the background of section 2 it becomes clear that the traditional concepts of collective action based on the concept of market failure seem too narrow to capture these problems of climate adaptation. Therefore, an institutional approach can significantly broaden the scope of the climate adaptation economics by offering a set of research problems, subject areas and corresponding analytical tools and methods.

3.3. An institutional economics perspective on climate adaptation

In an economics perspective institutions, i.e. the rules and norms that guide human behaviour, gain relevance as they shape the decisions of individual and collective actors and, hence, the processes and outcomes of social interaction. There are several conceptual links between institutions and adaptive decisions. Institutions prohibit, prescribe or allow certain actions or outcomes. They define positions, procedures, rights and duties. They are sources of constraints, rewards, or punishment. By framing mental models of a situation, institutions influence what counts as rational and which values and notions of justice find application in that 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 have proven useful concepts for studying climate adaptation (Smit/Wandel, 2006; Engle, 2011). Within a framework that analyses adaptations as actions we can define adaptive capacity as the space for individual or collective action at a certain point in

time (Eisenack/Stecker, 2012). This action space is given by the set of adaptation options and constraints that an actor faces within the timeframe of the respective adaptation decision. 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, or the collection of action spaces of the involved individuals. In a dynamic perspective the factors that impede the process of adaptation can be called 'barriers to adaptation' (Moser/Ekstrom, 2010; Biesbroek et al., 2011). More precisely, by using the diagnostic framework of climate change adaptation developed here we can define a barrier as a functional interaction of CS-, GS-, R- and AA-variables (see figure 1) that impedes the adaptation process either by limiting adaptive capacity or by restraining actors to realize their capacity. In contrast, a functional interaction of these variables which fosters adaptation processes can be called a 'driver of adaptation'. Capacity constraints and barriers (resp. drivers) are the impairments (resp. facilitating factors) for reducing vulnerability to climate change through adaptation. The core research interest of an institutional approach to climate adaptation as detailed here is by which attributes institutions shape adaptive capacity, barriers and drivers of adaptation in different (social, economic, biophysical, etc.) settings.

3.4. A diagnostic framework of climate change adaptation

The task of building useful theories of climate change adaptation meets two interrelated methodical challenges: a large number of variables and a pronounced heterogeneity of adaptation situations. First, a very large number of factors has been revealed as affecting climate adaptation. There is no single combination of variables that determines adaptation processes and outcomes in all kinds of settings. Instead, settings differ in the types of relevant variables, their manifestations, relative importance, and interrelation. This diversity is partly due to the second methodical challenge, the large heterogeneity of adaptation situations. Table 2 illustrates major sources of this heterogeneity of situations. Both aspects significantly complicate the tasks of learning across cases and developing valid theoretical generalizations that may help designing effective, efficient and fair adaptation policies and strategies.

In order to make this diversity of adaptation situations and determinants more tractable while minimizing the risk to lose relevant information we adopt the idea of a diagnostic framework (Ostrom, 2005, 2007, 2008; Young et al., 2008). This is a classificatory framework that organizes variables which were found to shape climate adaptation. It partitions these variables into classes and subclasses on multiple conceptual tiers such that the lower-tier variables are subcomponents of the higher-tier variables. By doing so, it provides a set of variables potentially relevant in a case and helps to identify single factors or combinations of them that shape adaptation in one type of situations and not in others. In that way it helps diagnosing policy or governance problems. Importantly, a single study normally uses only a subset of these variables that is relevant in the respective setting. The selection of the variables, their conceptual tier and possible manifestations depends on the specific research or policy question and adaptation situation under investigation (Ostrom, 2007, 2008).

This diagnostic framework of climate adaptation is guided by the conceptual and explanatory groundwork of the Institutional Analysis and Development (IAD) framework (Ostrom, 2005). While the IAD framework was crafted to study all kinds of structured human and social-ecological interactions, we found it helpful to adjust parts of it to account for the particularities of climate adaptation. A similar effort was undertaken in the field of natural resource governance with crafting the SES framework (social-ecological systems framework, cf. Ostrom, 2007, 2009). The SES framework and the climate adaptation (CA) framework have sometimes overlapping, but conceptually different units of analysis making them appropriate for different uses (SES: natural resource systems; CA: exposure units that are exposed and sensitive to climatic stimuli).

Figure 1:

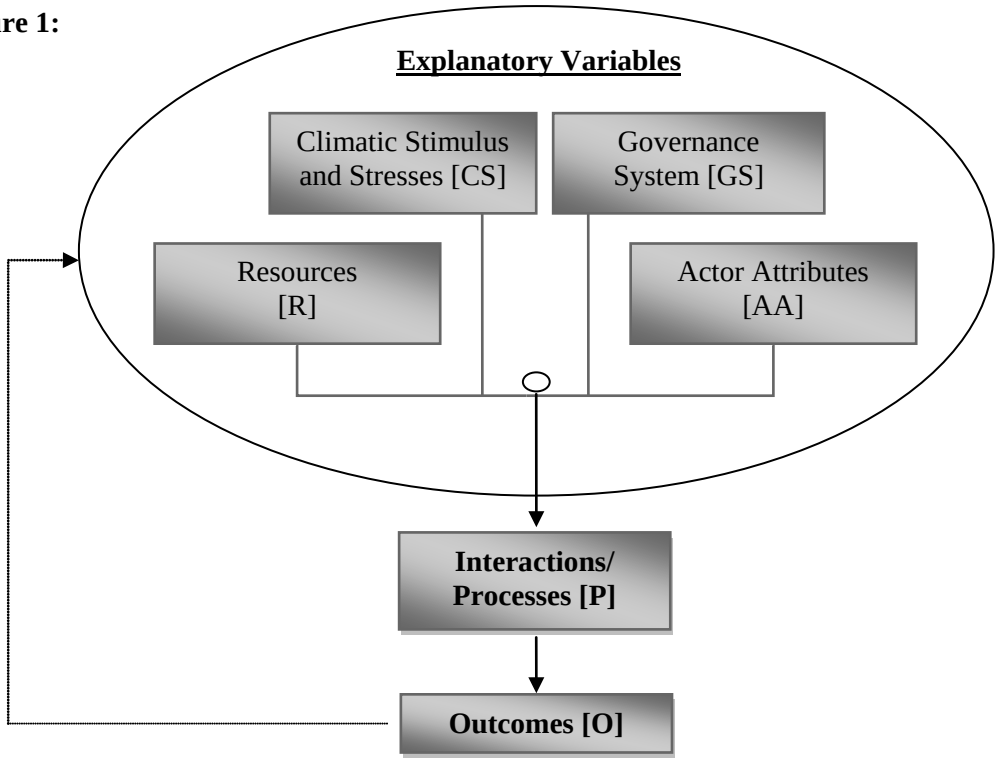

Figure 1: First-tier variables of the diagnostic framework of climate change adaptation (authors' compilation).

For developing the diagnostic framework of climate adaptation we used an open coding procedure drawing on an extensive review of several hundreds of publications in the literature about climate change adaptation, vulnerability and resilience that we identified through journal screening, web of science database search and cross-referencing. Starting with the original IAD framework (Ostrom, 2005) we adjusted its conceptual map as soon as an empirically supported finding from the adaptation literature could not be translated into the present language. We continued this procedure until a stable conceptual map of climate change adaptation resulted.

Table 2:

Dimension	**Range**
Climatic stimulus and stresses	(1) Types: e.g. floods, droughts, storms, precipitation, temperature change. (2) Attributes: intensity, frequency, regularity, predictability of stimulus/ change. (3) Non-climatic stresses and goals, e.g. poverty, economic development, civil conflicts.
Governance levels	E.g. local, regional, national, international, global.
Actors	Individuals, households, local communities, private firms, governmental, civic, research, international and other organisations, etc.
Exposure units	Actors, infrastructure systems, ecosystems, health systems, etc. (Eisenack/Stecker, 2012).
Institutional configurations	(1) Boundary-, position-, choice-, aggregation-, information-, payoff-, and scope rules. (2) Operational-, collective choice-, constitutional-, and meta-constitutional rules (Ostrom, 2005).
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 diagnostic framework of climate adaptation comprises multiple tiers. Figure 1 depicts the first-tier variables. Table 3 unpacks them into the second-tier, and partly third-tier variables and gives references for the variables. The first set of variables [CS-variables] captures properties of the climatic stimuli [CS1], i.e. the fast or slow, reversible or irreversible change in the ecological or biogeophysical conditions of an exposed unit (e.g. an increased likelihood of floods that endangers a riverine human settlement). Exposure [CS2] and sensitivity [CS3] to this stimulus determine the potential impact of the stimulus for the exposed unit, if no adaptation occurs (Turner et al., 2003). Concurrent non-climatic objectives and stresses [CS4] such as industrial development or demographic change add to climatic stimuli to shape individual, organizational and policy priorities. The second class of first-tier variables, resources [R], are a major source for means to adapt to climatic stimuli, e.g. through using new infrastructure and technologies [R1] or insuring against economic losses [R3]. The third class of variables on the governance system [GS] captures the institutional and organisational context within which adaptation decisions are taken, such as the attributes of rules-in-use [GS1/GS2] and the interplay between different levels of governance [GS3] (e.g. the formal municipal and informal neighbourhood organisations of the riverine settlement). Finally, the actor attributes [AA] map the socio-economic characteristics of the involved human actors, their number, attributes of inter-individual relations and their intra-individual behavioural attributes which have been repeatedly found to shape adaptation processes and outcomes.

The collection of CS, R, GS and AA variables creates a particular profile of an adaptation situation with a certain degree and distribution of vulnerability [P1]. Process parameters [P2], such as means, costs and incentives for adaptation, capture how the CS, R, GS and AA variables affect the adaptation decision-making of the involved actors. Adaptation activities [P3] are performed to different extent and may take many different types (Smit et al., 2000).

The outcomes [O] of effective adaptation may manifest in a change of exposure or sensitivity to a stimulus [CS2/CS3] or may lead to a change in one or more of the other CS-, GS-, R- or AA-variables [O1], and thereby altering capacity for future adaptation. Apart from this, adaptation activities may affect other processes [O2] such as reduction of greenhouse gases of the riverine settlement. Finally, a number of evaluative criteria for adaptations have been proposed to assess adaptations [O3].

This framework can be used for a number of purposes. First of all, it integrates and maps a large body of knowledge about the factors that shape climate adaptation processes and outcomes. Given the heterogeneity of adaptation situations (see table 2) the number of variables is still limited to serve the purpose of making the diversity and complexity of adaptation tractable. Second, the framework may be used in the design of theoretical and empirical inquiries. It helps to select the variables for a specific question under study while minimizing the risk to disregard relevant adaptation determinants. Third, the framework can place a particular research question, governance problem, model or finding in a broader context of adaptation research. By doing so it increases the likelihood of cumulative learning across single disciplines. Fourth, it can be used to explain climate adaptation processes and outcomes in a systematic, non-arbitrary manner as detailed in subsection 3.5. With these properties it is a conceptual groundwork for building useful economic theories of the governance of climate adaptation.

Table 3:

	Climatic Stimulus and Stresses to the exposed unit [CS]	*References (example)*
CS1	Climatic stimulus/ change in ecological parameters (type, intensity, duration, frequency, regularity, predictability)	*Parry et al., 2007*
CS2	Exposure to climatic stimulus	*Parry et al., 2007*
CS3	Sensitivity against climatic stimulus	*Parry et al., 2007*
CS4	Concurrent non-climatic objectives and stresses (e.g. demographic change, competing land-use claims)	*O'Brien/Leichenko, 2004*

	Resources [R]	*References (example)*
R1	Physical Infrastructure and Technology	*Yohe/Tol, 2002*
R2	Assets, Financial Resources and Credit	*Yohe/Tol, 2002*
R3	Insurance	*Yohe/Tol, 2002*
R4	Information	*Ivey et al. 2004*
R5	Natural Resources	*Arnell/Delaney, 2006*
R6	Other Resources (e.g. labor)	*Tucker et al., 2010*

	Governance System [GS]	*References (example)*
GS1	Governance functions of the system of rules	*Gupta et al., 2010*
GS2	Properties of the rule system itself (e.g. inertia, path dependence)	*Gupta et al., 2010*
GS3	Interplay of Governance Levels (vertical/ horizontal)	*Keskitalo et al., 2010*
GS4	Attributes of Organisations	*Tompkins et al., 2008*
GS5	Modes of Organisation (e.g. market, hierarchy, network)	*Mendelsohn, 2006*

	Attributes of the Involved Human Actors [AA]	*References (example)*
AA1	Socio-economic Attributes (e.g. health, age)	*Brooks et al., 2005*
AA2	Number of Actors	*Barnett, 2008*
AA3	Relationship between Actors	
	a. Social Capital	*Pelling/High, 2005*
	b. Distribution of Power	*Engle/Lemos, 2010*
	c. Communication	*Ivey et al., 2004*
AA4	Behavioural Variables	*Grothmann/Patt, 2005*
	a. Preferences and Values	*Ivey et al., 2004*
	b. Mental Models and Skills	*Alessa et al., 2008*
	c. Awareness and Concern	*Amundsen et al., 2010*

	Interactions and Processes [P]
I1	Vulnerability to climatic and non-climatic stresses
I2	Process Parameters of Adaptation (e.g. means, costs, incentives for actors)
I3	Adaptation Activities (e.g. types, timing, duration, extent)

	Outcomes [O]
O1	Impacts on CS-, R-, GS- and AA-Variables
O2	Effects on Other Processes (e.g. climate mitigation)
O3	Evaluative Criteria (e.g. efficiency, effectiveness, fairness)

Table 3: Second-tier and partly third-tier variables of the diagnostic framework (authors' compilation).

3.5. An economic method to explain climate adaptation processes in a systematic way

A major research concern for the presented framework is to identify institutional design attributes that shape climate adaptation in a particular way. Building scientific explanations for this requires a method for relating institutional attributes and other explanatory variables with climate adaptation processes and outcomes in a systematic, non-arbitrary manner. In other words, this method should guide the analyst in building explanations why she would expect an institutional design A to lead to adaptation process or outcome X instead of process/outcome Y.

The framework offers such a method based on the explanatory context of the IAD framework. It explains adaptation processes and outcomes based on the behaviour of individual actors, but acknowledges that actors take decision within their surrounding institutional and organisational setting and the boundaries of their adaptive capacity. As the original IAD framework it is open to both formal, e.g. game-theoretic modelling as well as qualitative analysis (Ostrom et al., 1994, Ostrom, 2005).

Figure 2:

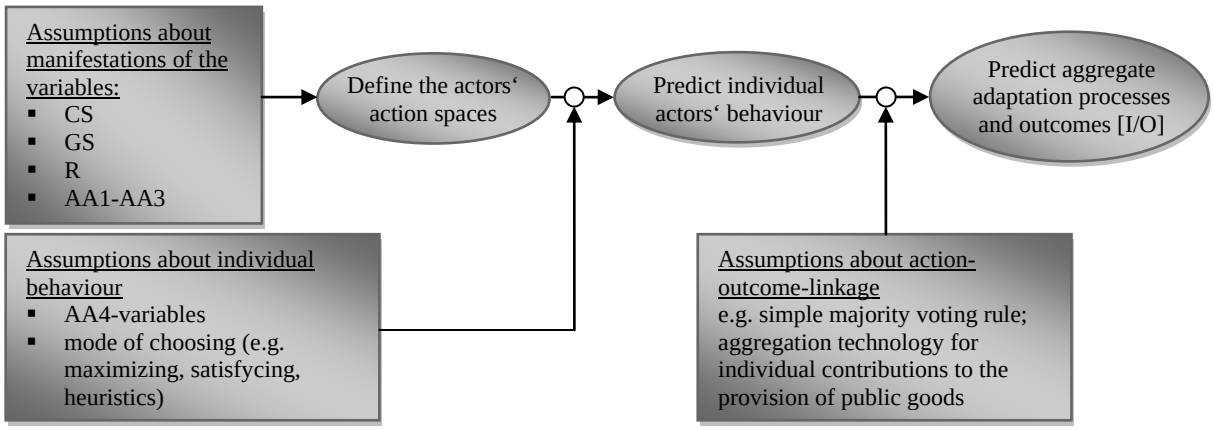

Figure 2: Heuristics of the diagnostic framework to explain climate adaptation processes and outcomes in a systematic manner (authors' compilation; explanation in the text).

Figure 2 depicts the heuristics for explaining climate adaptation processes and outcomes. A situation where a local farmer community faces increasing drought risks for their agricultural production can serve as illustrating example. Assume this community is organised in a farmer association and has, by using majority voting, to decide whether to collectively finance a water reservoir to buffer the economic impacts of potential droughts. The manifestations of the relevant CS-, GS-, R-, and AA-variables in that setting let the analyst determine the action situation which importantly includes the action spaces of the individual actors, the distribution of costs and benefits of droughts and the water reservoir as well as the control that the individual actors have for the collective outcome. Assumptions about the AA4-variables (values and preferences; information processing mode; awareness and concern) and about the mode of selecting between alternatives (e.g. maximizing, satisfycing, using heuristics, cf. Ostrom, 2005) let the analyst predict the individual decisions about the respective alternatives, e.g. the individual voting behaviour of the association's members. In a final step, the function that describes the action-outcome-linkage enables the analyst to predict the collective outcomes or processes of adaptation that arise from the individual decisions. In our example this action-outcome-linkage is the majority rule stating that the association will finance the water reservoir, if and only if a majority of the association's members votes for this alternative. Other well-known

examples for action-outcome-linkages are the aggregation technologies (sum, weighted-sum, weakest link, etc.) for the provision of public goods.

This methodical procedure enables the analyst to attribute a change in adaptation processes and outcomes to a change in one, or in a combination, of the CS-, GS-, R-, or AA-variables in a systematic manner. This seems useful for extending adaptation knowledge in a structured, non-arbitrary and reliable way.

3.6. Archetypes as a complementary heuristics to determine the appropriate level of generality

The presented approach is a framework in the sense that it frames the concept of climate adaptation in a particular way and organizes a comprehensive set of potentially relevant variables of climate adaptation. It is not a theory or model itself, as it does not imply any specific hypothesis about which and how combinations of second-, third-, or fourth-tier variables affect adaptation processes or outcomes. Instead, the diagnostic framework can be used to formulate and provide context for this type of hypotheses. To be of value in the endeavour of building theories and models that are both generalisable across, and valid for, different cases, the diagnostic framework needs to be complemented by an appropriate notion of generality.

Pronounced heterogeneity and diversity of climate adaptation (see table 2) challenge the task of generalising across cases. Each case could differ from another on a multitude of dimensions making it very unlikely that there is a set of universal institutional attributes that are effective for climate adaptation independent from other variables (Ostrom, 2007). One research strategy to cope with this heterogeneity is to rely on an ideographic approach focusing on investigations of one or a few cases. While having merits for explorative and/or in-depth, context-specific research, pure ideographic approaches are likely to hamper learning and finding generalizations across a larger number of cases (Yin, 2003). On the other side, the “grand theory approach” of providing context-free models of adaptation will at best lead to very abstract conclusions, the applicability and usefulness of which will be very low (cf. section 2.2). There seems to be a trade-off between generality and context-specific validity of models (Eisenack, 2012).

The notion of archetypes has been developed to offer a third way to help determining the appropriate level of generality of models and theories. Archetypes of adaptation can be defined as attributes of situations and functional relations between a set of variables that describe and/or explain climate adaptation processes and outcomes in more than one, but not necessarily in all cases. One case, in turn, can include more than one archetype to be thoroughly understood. In other words, the task of constructing archetypes looks for conceptual and functional similarities across cases at an intermediate level of generality while allowing, first, that the explanation of one case requires multiple archetypes and potentially some case-specific assumptions and, second, that one archetype usually does not appear in all cases. The underlying hypothesis of this archetypes notion is that transferring insights and policy/strategy recommendations from one case to the other is possible, if these cases share archetypes (Eisenack, 2012). The notion of archetypes (and the related notion of syndromes) has been applied, inter alia, to analyze dynamics of environmental degradation at a global scale (WBGU, 1993; Schellnhuber et al., 1997), as well as the vulnerability of human-ecological systems to environmental and socio-economic change at a global scale (UNEP, 2007) and to hydrometeorological disasters in Latin America (Manuel-Navarrette et al., 2007).

For the purposes of the institutional approach to adaptation presented here the archetypes notion is a useful complement to the diagnostic framework. In the venture of building valid adaptation theories and models the heuristics of archetypes advises the analyst to relate the diagnostic framework's variables in such a way that the resulting models are as specific as possible (e.g. through the lowest-possible tier of variables), but describe features of the particular setting in a generalisable way and remain valid for a set of cases.

In contrast to the idiographic approach the archetypes clearly foster cross-case learning by revealing similarities and allowing for transferring insights and policy/strategy advice. In contrast to the grand theory approach of looking for panaceas the archetypes heuristics promises to identify much more usable policy/strategy advice as it searches for much more specific institutional design attributes that can be applied to a limited group of cases which share certain functional similarities relevant to explain adaptation in this particular set of cases.

4. Illustration of the functionality of the diagnostic framework: Municipal adaptation in developing and transition countries

This section illustrates the functionality of the diagnostic framework presented above. It focuses on the setting of climate adaptation by municipal public agents in developing and transition countries. As discussed in section 2 concepts and tools from welfare economics can be useful in this setting for several purposes: assessing aggregated benefits and costs of climate impacts and adaptations; outlining strategies that public agents may use for efficient adaptation; assigning responsibilities to the public sector in a normative way; and investigating policy instruments. However, they fall short of guiding the analysis of the governance of adaptation.

In contrast, the diagnostic framework of climate adaptation focuses analytical attention to the question how climatic and non-climatic stimuli, institutional attributes, resources and attributes of the involved actors drive or hinder climate adaptation by municipal agents.

In a meta-analysis of adaptation by municipal public agents in developing and transition countries Oberlack and Eisenack (2012) use this framework to organize findings from empirical case-study material and map empirically revealed determinants of climate adaptation processes. As figure 3 shows they find that twelve factors are repeatedly hampering adaptive responses by municipal administrations in developing and transition countries. They can be clustered as "institutional deficits", "limited awareness and understanding", "constrained resources" and "presence of non-climatic stressors".

The framework is further used to explain the effects of these factors on adaptation processes (see figure 3). For example, a dysfunctional definition or distribution of political and administrative competences and responsibilities increases the transaction costs of municipal planning through raising the need of time-consuming internal and external coordination and duplication of efforts. It also enables municipal actors to refuse responsibilities for cross-sectoral tasks of adaptation implying that technically and economically available means are less effectively used. As a consequence, based on empirical case-study evidence dysfunctional competences and responsibilities reduce the extent, the pace and the effectiveness, but increase the costs of municipal adaptation to climate change.

Figure 3:

Barriers to climate adaptation by municipal governments and public administrations					
Barrier		**Effect**	**Barrier**		**Effect**
Institutional deficits			**Limited awareness and understanding**		
ID1	Dysfunctional definition or distribution of political and administrative competences and responsibilities.	c↑; um↓	AU1	Limited awareness and understanding of local vulnerabilities and adaptation options among public officials.	um↓; ma↑
ID2	Lack of coordination between public agencies.	c↑; um↓	AU2	Limited awareness and understanding of local vulnerabilities and adaptation options among urban stakeholders.	um↓; ma↑
ID3	Deficient communication between policy makers, municipal agencies, scientists and practitioners; deficient integration of local knowledge into municipal decision making.	um↓; ma↑	**Constrained resources**		
ID4	Reliance and/or dependence upon national policies and regulations	m↓; um↓; i↓	CR1	Constrained financial resources.	m↓
ID5	Scale Mismatch I: Long-term challenge vs. short-terminism of decision making	c↑; ma↑	CR2	Lack of reliable data and information about local climate change impacts and vulnerabilities.	m↓
ID6	Scale Mismatch II: Rapid environmental dynamics vs. slow reaction	m↓	CR3	Constraints on trained labour.	m↓
			Non-climatic stressors and goals		
			NC1	Conflicting development goals and urbanisation pressure.	c↑; ma↑

Figure 3: Barriers to climate change adaptation by municipal governments and administrations and their effects on adaptation processes (source: Oberlack/Eisenack, 2012).
Symbols for effects on adaptation processes: [m↓]: Constrained availability of means for public adaptation (e.g., financial, legal, organisational, technical, infrastructural means, knowledge and skills etc.); [um↓]: technically and economically available means are less effectively used; [c↑]: Increased costs of adaptation including transaction costs of public decision making; [i↓]: Reduced incentives for public adaptation; [ma↑]: Enhanced incentives for maladaptive activities.

To sum up, usage of this framework guides the analysis to be precise about the factors that enable or constrain actors to take adaptive actions. Moreover, it helps to organize these factors at multiple conceptual tiers and it enables to build explanations for the relation between a set of exogenous variables and process parameters and/or outcomes in a systematic, non-arbitrary manner.

5. Conclusions: Contributions of the institutional economics approach to economic analyses of climate adaptation

The major concern of this article is to contribute to the development of economic frameworks of climate change adaptation. This framework-level discourse yields several benefits which include clarifying and continuously updating the relevant research problems, giving new research directions, improving coherent analytical concepts and providing effective methods to analyse them. Moreover, a capable framework is needed as a language to compare and carefully integrate multiple disciplinary and multidisciplinary findings to foster cumulative learning.

For this task the article's first part (section 2) investigated current economic approaches to climate change adaptation. It outlined that current adaptation economics is predominantly concerned with the efficiency of adaptation. Accordingly, a major attempt is to estimate adaptation benefits and costs quantitatively. On the one side the resulting numbers can have a role in raising awareness and shaping public discourses. Additionally, the aim to objectify adaptation assessments is certainly helpful to reduce distortions of collective decisions on adaptation. On the other side serious analytical and methodical problems of this seemingly straightforward approach remain and challenge the validity and precision of quantitative estimates of adaptation benefits and costs. Moreover, generating these estimates requires normative predefinitions how to aggregate costs and benefits interpersonally, which values count, and how to discount future welfare. This implies the risk of moving normative predefinitions from the political arena implicitly into the economic analysis. Our survey of the state-of-the-art also found that the economic framing of governance arrangements for climate adaptation currently relies on the neoclassical rationale for collective action and the market-state-dichotomy. It has become clear that this concept is too narrow to do analytical justice to the manifold governance challenges surrounding climate adaptation, many of which are of institutional character.

The second part of the article (section 3) developed an institutional economics approach to climate change adaptation. This approach can contribute to integrated economic analyses of climate change adaptation in three major ways. (i) First, it broadens the scope of adaptation economics by offering a distinct set of research problems and subjects of analysis of fundamental importance to the governance of climate adaptation. (ii) Second, it delivers an analytical framework of climate adaptation that enables the analyst to explain adaptation processes in a systematic, non-arbitrary manner. It integrates findings from a large number of research efforts, places particular research questions, governance problems and results in a broader context, and can guide the design of theoretical and empirical inquiries of climate adaptation. (iii) Third, the multi-tier, diagnostic approach and the archetypes heuristics are methods that enable the analyst to determine the appropriate level of generality – depending on her research questions – to build theories and models of climate adaptation that are both generalisable and valid in the face of a pronounced heterogeneity and diversity of adaptation situations. These models in turn can be a valuable basis for designing tailor-made effective strategies for adaptation to the beneficial and adverse consequences of climate change.

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