PACINAS
Public Adaptation to Climate Change

Macroeconomic effects of public adaptation to climate change

factsheet 1 2 3 4 5 6

Aim of PACINAS

The project PACINAS (Public adaptation – Investigating the Austrian adaptation strategy) addresses the costs of adaptation to climate change for the public budget and the associated macroeconomic effects. Case studies on city, provincial and federal level made it possible to estimate the current adaptation deficit and the potential future costs of adaptation up to 2050. The project focuses on adaptation costs due to extreme events such as flooding, mass movements and heat stress as well as on activity fields of the Austrian adaptation strategy (BMLFUW, 2012) with high relevance for the public budget (agriculture, forestry, water, protection from natural hazards, catastrophe management, transport, cities and urban green). PACINAS was carried out by the Wegener Center of the University of Graz in cooperation with the Umweltbundesamt, AIT and IIASA.

Context

Adaptation to climate change involves costs (see PACINAS Factsheet #4), but at the same time it reduces the negative impacts of climate change, resulting in benefits. These costs and benefits can be compared in a cost-benefit analyses, however, this involves a narrow analyses and does not capture the macroeconomic or economy-wide consequences, such as effects on employment, gross domestic product (GDP) or societal welfare. This factsheet reports on analysis in PACINAS that has assessed these macroeconomic effects.

Methodological approach

The economy-wide effects of adaptation are assessed with the COIN model (Bachner et al., 2015a), a computable general equilibrium (CGE) model for Austria which assesses the macroeconomic effects of climate change impacts for a +2°C scenario for ten impact fields (Agriculture, Forestry, Water, Energy, Heating and Cooling, Transport, Manufacturing and Trade, Tourism, Catastrophe Management, Cities and Urban Green) until the mid-century (2050).[1]

In the PACINAS project, the COIN model was extended to allow analysis of public adaptation. The study focused on those impacts with the highest budgetary importance (see PACINAS Factsheet #4): Agriculture, Forestry, Water, Catastrophe Management (including Protection from Natural Disasters) as well as Research and Development (as a supplementary adaptation activity).

This type of analysis provides important new insights on adaptation. Public adaptation affects operation and maintenance costs (e.g. contracting to spatial planning bureaus, maintenance costs for public infrastructure, labor costs) and it also affects public investment costs. The direct effect of these changes is a reduced climate change impact in each impact field (see Steininger et al., 2015, 2016). By investigating these benefits and costs, it is possible to assess the potential reductions possible in climate change impacts, how much this might cost, and therefore to investigate the efficiency and choices of adaptation.

To provide inputs to the model, extensive review and consultation was undertaken to understand the potential cost and benefits of adaptation.

For the Catastrophe Management impact field (flood protection), the analysis used results from a meta-analysis of flood protection measures from more than 80 projects in the period of 1991-2015 (Kuik et al. 2016). This meta-analysis reports that the effectiveness of adaptation, measured as the damage reduction (in €) relative to adaptation expenditures (in €), differs considerably by type of measure: “soft” measures (e.g. early warning systems) are more effective for every euro spent than “gray” measures (e.g. flood protection dams) and “green” measures (e.g. flood retention areas). Soft measures were found to have a benefit of € 11 for every Euro spent (on average) while the benefit of green and gray measures was € 2 and € 4 respectively.

Regarding the Forestry impact field, damage reduction potentials were estimated by experts. This found that damages could be reduced by 5% - 30%, depending on the type of impacts and adaptation measure (see Bachner et al., 2017 for details).

Concerning the Agriculture impact field, the analysis used expert estimates supplemented by the available literature. Based on the previous COIN analysis and additional literature (Mitter et al. 2015 and Schönhart et al. 2016), the central estimates are that agricultural crop yields in Austria could be increased by +10% with adaptation.[2] However, there is uncertainty around the potential impacts of climate

[1] The impacts on each impact field were assessed for selected impact chains in sectoral models or estimates by 19 research teams from Austria as part of the COIN project (Steininger et al., 2015).

[2] The increase refers to additional adaptation measures within a changed climate, relative to a scenario without climate change.

change on agriculture, as they are available from COIN, and therefore additional sensitivity testing needs to be carried out in further analyses.

Temporal development of adaptation-relevant expenditures by the federal government

To assess the economy-wide effects of public adaptation until the mid-century, the study developed a scenario for public adaptation over this period. Starting from today's adaptation-relevant expenditures[3] (see PACINAS Factsheet #4), we developed an indicative scenario for adaptation-relevant expenditures up to 2050.[4] This future estimate combines expert judgment on the additional resources needed for single adaptation measures (e.g. on soft measures such as monitoring systems), international recommendations on the useful timing and phasing of gray, green, and soft measures (Watkiss et al., 2014), and the mid-term budget forecast for the Federal State (BMF, 2015). Figure 1 illustrates this scenario, separated by type of measure and activity field. Since adaptation is a cross-cutting issue, those who finance adaptation are not necessarily also the beneficiaries. Protective forests, for example, are financed by the forestry sector, but it is often third parties who benefit from such measures.

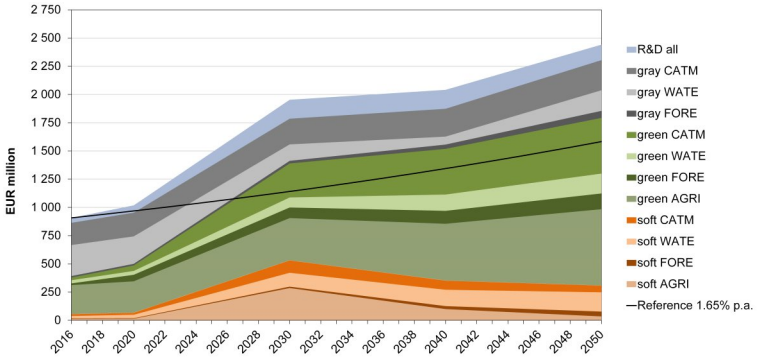

Figure 1: Indicative scenario for adaptation-relevant expenditures in public budgets (sub-classifications UG41-43) for impact fields Agriculture (AGRI), Forestry (FORE), Water (WATE) and Catastrophe Management (CATM) as well as for Research and Development (R&D) for the period 2016-2050

Source: PACINAS Working Paper #5 (Bachner et al. 2017)

As can be seen from Figure 1, expenditures on gray measures such as flood protection dominate in the current period up to 2020. However, this is because there is an ongoing investment cycle in the refurbishment of the water and wastewater network: an interesting finding in itself. This is planned to be completed by 2020, thus the scenario foresees a decline in investment in this category in the period 2020 to 2040; with a resurgence of investment from 2040 when the next investment cycle begins. This also highlights that there will be windows of opportunity for adaptation investment, i.e. cycles when it is easier to include adaptation.

In the current budget, expenditures on soft measures such as information provision and early warning systems are small compared to other categories, as they do not involve large capital expenditure. Nonetheless, they represent an early priority for investment and we assume a large increase in this category in period 2020 to 2030 to increase adaptive capacity[5] and scale up low-regret adaptation to the increasing climate change signal. The analysis also assumes a transition from gray to green measures after 2030, in line with anticipated increase in the expansion of retention areas, measures for rural development (Austrian Agri-Environmental Programme "ÖPUL") and forest management. Expenditures on Research and Development contribute to all impact fields and are assumed to increase up to 2030, to provide the evidence, learning and early planning for new challenges, and are projected to stay at this level thereafter. In total, expenditures of this indicative climate and adaptation scenario rise by 3% per year over the period 2016-2050. In comparison, other public expenditures are assumed to grow at the average economic growth rate of 1.65%.

Macroeconomic effects of public adaptation

According to Bachner et al. (2015b), when impacts from all ten impact fields are captured, climate change leads to negative effects on gross domestic product (GDP: -0.15%), welfare[6] (0.48%) and increased unemployment (+0.2%); for a "mid-range" climate change scenario, relative to a reference scenario in 2050, without climate change.[7]

In the remaining part of this factsheet, we focus only on the effects from climate change and adaptation in three impact

[3] Note that expenditures for rail infrastructure are excluded, since no impacts on rail infrastructure are modelled.

[4] The described scenario is only generic. Predictions regarding the actual development of adaptation-relevant expenditures are difficult to make, due to scenario and climate uncertainties.

[5] The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (IPCC 2014).

[6] Measured as changed consumption possibilities for households relative to the reference scenario without climate change.

[7] Since in COIN only certain impact chains have been quantified, these numbers should be interpreted as the lower bound of the costs of inaction. There is also a considerable range around the numbers, depending on lower or higher warming scenarios and climate model uncertainty.

fields, namely Agriculture, Forestry and Catastrophe Management.[8] Public adaptation in these impact fields reduces the economy-wide negative impacts. Figure 2 illustrates that the effect on GDP is slightly negative without adaptation and turns positive with adaptation (+0.07%); compared to a reference scenario without climate change, respectively. In the underlying scenario, adaptation therefore has a positive effect on GDP. The reasons for this are two-fold; first, there are positive effects from adaptation-specific productivity gains (Agriculture) and employment effects (e.g. in Forestry and especially due to the implementation of soft and green measures) and second, there are reductions of climate change impacts (e.g. less damages to protective forests due to bark beetles).

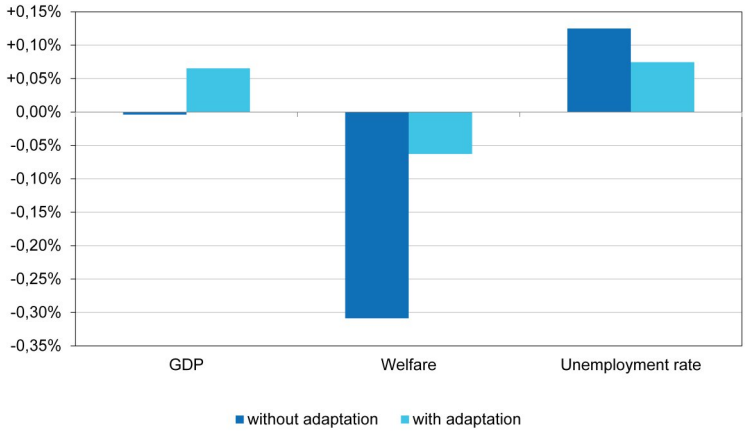

Figure 2: Effects of climate change (mid-range climate change scenario) for the impact fields Agriculture, Forestry and Catastrophe Management, with and without adaptation for 2050 (relative to reference scenario without climate change)

Source: PACINAS Working Paper #5 (Bachner et al. 2017)

When assessing the effects of adaptation on welfare, we find that the positive effect is stronger than for GDP. Without adaptation, climate change reduces welfare by -0.3% while with adaptation welfare declines only by -0.06% (both numbers relative to the reference scenario without climate change). Adaptation leads to a welfare gain because it reduces potential damages to private property and also generates additional income, as employment effects are positive.

Figure 3 illustrates how the three impact fields under investigation contribute to the total effect on GDP and welfare (as they are presented aggregated in Figure 2). When comparing the 2050 scenarios with and without adaptation, we find that the positive effect on GDP stems from Agriculture (productivity gains) and Forestry (especially due to the reduction of damages to protective forests). The total GDP effect ("total effect") even turns positive in the scenario with adaptation as compared to the scenario without. Positive effects on welfare due to adaptation result because of reduced damage costs in the impact field Catastrophe Management and the associated reduction in "forced consumption".[9] A positive contribution of adaptation to welfare also arises from the Agriculture impact field, where we observe productivity gains and thus a moderating effect on agricultural and food prices. In Forestry, we see positive welfare effects primarily because of the reduced damage to protective forests and thus more public means available, which are used to increase transfers to households. When looking at the total welfare effect it is still negative with adaptation (compared to a scenario without climate change), however less severe than without adaptation. Again, it is important to stress that adaptation is modeled in three impact fields only, namely Agriculture, Forestry and Catastrophe Management. Hence, we can interpret the results as a lower bound of possible positive effects of adaptation.

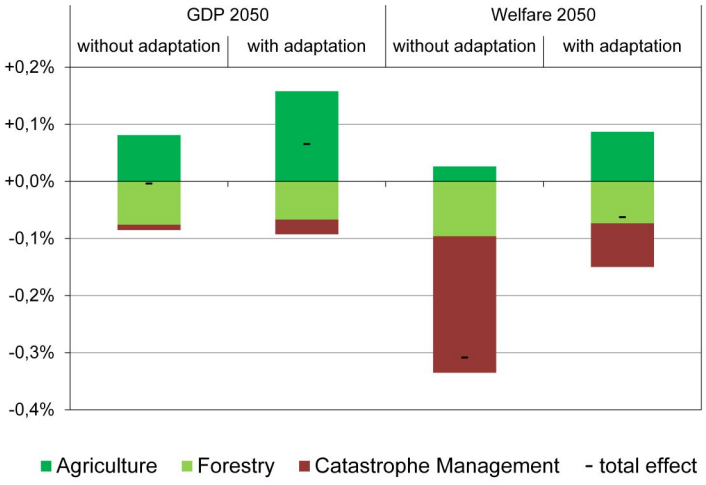

Figure 3: Effect of climate change on gross domestic product (GDP) and welfare with and without adaptation for 2050 (relative to reference scenario without climate change), distinguished by impact field and in total.

Source: PACINAS Working Paper #5 (Bachner et al. 2017)

[8] The impact field Water is included only indirectly as it bears a part of the adaptation costs of measures carried out in Catastrophe Management

[9] If consumption goods such as furniture and cars are destroyed or damaged by extreme events, they need to be replaced or repaired. These expenditure ("forced consumption") restore the original state before the event and therefore do not contribute positively to welfare; from the perspective of households, these expenditures reduce consumption possibilities for other goods.

Key findings

The macroeconomic effects of climate change adaptation in Agriculture, Forestry and Catastrophe Management are positive, compared to the climate change impact scenario without adaptation.

Climate change-induced negative GDP effects turn positive and welfare losses can be reduced to a fifth with adaptation measures in Agriculture, Forestry, Water and Catastrophe Management.

Climate change adaptation can lead to positive employment effects in the long term, when increasingly relying on soft and green adaptation measures.

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