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Ilan Noy and Tomáš Uher*

The Climate Adaptation Trilemma

“Oh, but this is not on the Earth!”
said the little prince.
The fox seemed perplexed, and very curious.
“On another planet?”
“Yes.”
“Are there hunters on that planet?”
“No.”
“Ah, that is interesting! Are there chickens?”
“No.”
“Nothing is perfect,” sighed the fox.

THE TRILEMMA FRAMEWORK

As defined in the most recent IPCC Assessment Report (AR6), *adaptation* in human systems is “the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities.”¹ The same glossary also defines *adaptation options*: “The array of strategies and measures that are available and appropriate for addressing *adaptation*. They include a wide range of actions that can be categorized as structural, institutional, ecological or behavioral.”

What is not defined is how policymakers can choose between these different options. It is clear that well-designed climate adaptation policies, matched with appropriate emission reduction policies, are necessary for building resilience, protecting communities, and sustaining economic stability in the long term, in the face of the growing challenges associated with climate change. The basic challenge facing policymakers when deciding between adaptation options is that successful climate adaptation requires the weighing of trade-offs between various social, economic, and environmental objectives. These trade-offs can sometimes be difficult to conceptualize and consequently assess and quantify. It is that conceptualization that we focus on here.

Our framework posits what we call the “Climate Adaptation Trilemma” (henceforth the Trilemma). Its structure is adopted from the International Monetary Trilemma (i.e., the Mundell-Fleming Trilemma – see, for example, Obstfeld et al. 2005). A trilemma defines three different objectives and posits that only two of these objectives are achievable with any policy or combination of policies.

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¹ See <https://apps.ipcc.ch/glossary/>.

KEY MESSAGES

- **Climate adaptation requires weighing trade-offs associated with every adaptation policy choice**
- **Trade-offs can be described as a Trilemma of choosing between two out of three goals: reducing inequities and hardship, incentivizing risk reduction, and fiscal sustainability**
- **Three main approaches dominate adaptation and align with these goals: government investment, private adaptation, and risk finance and insurance**
- **Economic assessments of adaptation policies should increasingly strive to include ancillary and indirect effects and quantify the Trilemma trade-offs**
- **Combinations of adaptation policies should be designed to minimize trade-offs and maximize synergies**

Put differently, no policy combination can achieve all three objectives.

Ultimately, with adaptation we would like to guarantee that people’s lives are improved, given that weather extremes are becoming more intense, more frequent, and more costly because of anthropogenic climate change and sea level rise, and other ecosystem changes are also increasingly posing a challenge for coastal and forest communities, and to others elsewhere. When designing policies for achieving this overarching goal, we have three objectives that are widely considered as important to achieve:

1. We want policies to be *fiscally affordable*. The basic and non-ideological premise underlying that view is that taxes are almost always distortionary. So, it is always better, *ceteris paribus*,



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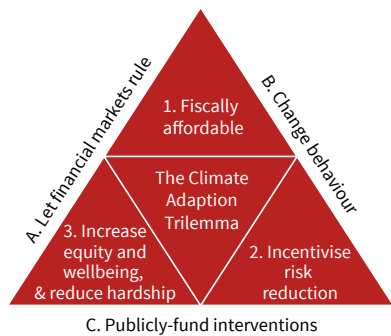
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Figure 1
The Climate Adaptation Policy Trilemma



Source: Authors' compilation.

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if we achieve our goals with fewer government resources.

2. We want to *incentivize smart risk management*, so that all the stakeholders involved “do the right thing” and do not exacerbate risks, and when making choices, they consistently choose those that reduce risk.
3. We want to *increase equity and reduce hardship*, or at the very least not exacerbate existing inequities and hardships with our actions, and increase personal *well-being*. Well-being is interpreted broadly here to encompass physical and mental health, community and cultural ties, and the environment communities have access to.

The Trilemma facing adaptation policymakers is that it is impossible to achieve all these three objectives with any adaptation policy choice (or possibly even with a mix of policies). No policy choice can be fiscally affordable, incentivize risk reduction, and enhance equity and well-being and reduce hardship. Any plausible policy choice will inevitably achieve only two of these three outcomes. Put differently, any choice will involve trade-offs and a compromise that will fail to fully achieve at least one of these outcomes.

In any adaptation toolkit, there are three main tools or levers that can be employed:

- *Publicly funded (and often mandated) climate adaptation programs* focusing on accommodation, protection, or relocation out of harm’s way.
- Enabling *risk finance and insurance markets* that are mostly centered on the main finance-providing institutions (especially banks and mortgage lenders), the private insurance companies, and any public insurer that exists (it is quite common for extreme events to be insured by a government entity or with a government backstop; see Paudel (2012).
- *Personal choice and private responsibility*. All else being equal, we prefer systems and tools that empower and incentivize individuals and households to “make the right choice” for their own well-being and benefit.

The structure of the Trilemma framework can easily be seen in the diagram above and is essentially composed of these challenges.

If we choose to emphasize tool A (publicly funded programs), we will not achieve outcome 1 (fiscal affordability). Public accommodation, protection, or relocation programs are often very costly.

If we choose to emphasize tool B (risk finance and insurance), we are unlikely to be able to achieve outcome 2 (incentivize risk management), as financing systems, and especially limited-liability insurance, dull the incentives for households to reduce their risk.

If we choose to emphasize tool C (personal responsibility), we cannot achieve outcome 3 (increase well-being and reduce hardship), as the risks we face are not distributed evenly and have catastrophic implications for some households (often those households that are most vulnerable to them).

Ultimately, we will want to design a system that involves a combination of tools (A–C), and only imperfectly achieves our desired outcomes (1–3). Every single point within this triangle involves a consideration of the trade-offs between these three outcomes, and a combination of tools. This is a new framework, for which there are very few quantifications that currently exist of these trade-offs, and they all map these trade-offs into two dimensional frameworks.

Various studies analyze trade-offs associated with the implementation of climate adaptation policies and strategies (e.g., Foerster et al. 2015; Vigiúé and Hallegatte 2012; Eakin et al. 2009; Akinyi et al. 2021; Neset et al. 2020; Wiréhn et al. 2020; Noy 2020). In some of these, ways to avoid trade-offs in climate policies have been explored using concepts such as co-benefits (Mayrhofer and Gupta 2016; De Murieta 2020) or maladaptation (Barnett and O’Neill 2010). Typically, they considered trade-offs that fall within the “well-being/hardship/equity” objective in our framework, such as when outcomes for risk reduction are being traded off with socioeconomic or environmental impacts. For example, Foerster et al. (2015) focus on the trade-off between short-term risk reduction and long-term improved environmental impacts, and Vigiúé and Hallegatte (2012) consider the trade-offs between risk reduction, housing affordability, biodiversity, and other impacts of climate adaptation policies. Relevant to our framework, the examples of maladaptation identified by Barnett and O’Neill (2010) include: (1) adaptation actions that benefit a specific sector or group but disproportionately burden the most vulnerable populations with consequent implications for equity objectives; and (2) adaptation actions that reduce the incentives to adapt.

While the adaptation trade-offs considered in our framework do not appear to be comprehensively analyzed in the existing research, various studies look at individual parts of the adaptation Trilemma challenge. In the next few sections, we describe some of the two-dimensional trade-offs they outline, and con-

trast these with the three-dimensional framework we propose here.

GOVERNMENT PROGRAMS AND FISCAL SUSTAINABILITY

Government intervention in climate adaptation is beneficial due to multiple market failures, which constrain the likelihood that efficient levels of climate adaptation will be pursued by private actors. These market failures arise because of uncertainty, asymmetric and imperfect information sets, behavioral barriers, and constrained budgets and access to credit (Cimato and Mullan 2010; Aakre and Rübbelke 2010; Stern 2007).

The trade-off between publicly funded adaptation and fiscal sustainability is considered in several studies using macroeconomic modeling (Fouejieu 2024; Catalano et al. 2020; Bachner et al. 2019). Fouejieu (2024) finds that, in Moldova, public investment in adaptation infrastructure can, in the long run, significantly reduce future disaster losses, support sustainable economic growth and development goals, and increase equality. But given the country's limited domestic financial resources, such investment may risk endangering public debt sustainability without external support in the form of grants or concessional loans. Catalano et al. (2020) show that even though publicly funded risk reduction programs (e.g., infrastructure retrofitting investments) lead to higher GDP growth rates compared to reactive programs (e.g., disaster relief and reconstruction), the high fiscal costs of these programs and binding budgetary constraints lead to inevitable reliance by governments on reactive policies, often funded with international assistance post-disaster.

Bachner et al. (2019) consider the effects of public sector adaptation on both the expenditure and revenue sides of the government ledger, taking into account economy-wide feedback effects. They find that in the long run, public adaptation may ultimately increase the budget balance through reductions in climate change impacts and the needed post-disaster relief, less spending on unemployment benefits and other welfare programs, and higher tax revenues than in the counterfactual. Rashidi et al. (2019) conducted expert interviews and found that municipal climate adaptation policies are perceived to lead to enhanced creditworthiness, though whether that is indeed the case has not been tested.

The likelihood of optimal utilization of limited fiscal resources when choosing climate adaptation policies can be increased through the use of cost-benefit analyses. These should be combined with analyses of distributional impacts to consider impacts on equity (Bellon and Massetti 2022). However, the efficacy of cost-benefit analyses is limited due to large uncertainties and the absence of much of the required data, especially with regard to analyses that evaluate systemic changes.

FINANCE, INSURANCE, AND INCENTIVES FOR RISK REDUCTION

The ability of finance and insurance systems to incentivize risk reduction largely depends on their design. Insurance schemes that suppress pricing signals weaken incentives for risk reduction. Similarly, parametric insurance, a relatively new insurance product whereby payment is based not on the incurred loss (indemnity) but on a parametric index threshold, is more neutral in terms of changing incentive structures, but still does not provide any incentives for risk reduction (Jarzabkowski et al. 2019; Filatova 2014).²

In some cases, the presence of subsidized disaster insurance and other types of public financial assistance may limit climate adaptation. Druckenmiller et al. (2024) found that the removal of subsidized insurance and disaster relief in certain areas of the US Atlantic and Gulf Coasts reduced development in risky areas and facilitated climate adaptation.

Conversely to subsidized or flat-rate insurance schemes, risk-based insurance pricing does appear to incentivize risk reduction (Hudson et al. 2016; Filatova 2014; Warner et al. 2009; Hanger et al. 2018; Mol et al. 2020). However, existing disaster insurance systems do not often pursue full risk-based pricing practices. An analysis of 27 flood insurance schemes in low- and middle-income countries found that only a few schemes showed any link between risk transfer and risk reduction (Surminski and Oramas-Dorta 2013). Full risk-based pricing does not typically exist in high-income countries either (Owen and Noy 2019). A review of empirical studies on the effect of disaster insurance for risk reduction suggests that impacts on risk reduction appear to be quite modest (Kousky 2019).

Incentivization of climate adaptation through insurance appears to be limited by factors such as low insurance penetration, affordability concerns, low risk awareness, and a reluctance on the part of private insurers to focus on low-income insurance markets (Aakre and Rübbelke 2010). Implementation of risk-based disaster insurance pricing is associated, correctly, with reduced insurance affordability for populations residing in high-risk areas; this is often politically unwelcome. Hudson et al. (2016) find that while the financial incentives provided through insurance could reduce residential flood risk by 12 percent in Germany and 24 percent in France by 2040, insurance would be unaffordable for around 20 percent of households at risk of flooding. Their results further suggest that addressing affordability concerns through the provision of vouchers may be less costly than the expected total incentivized damage reduction. Risk reduction efforts may be essential in maintaining the long-term insurability of climate-related risks. As such, it may not be

² Similarly, risk reduction may be disincentivised if the public expects to receive post-disaster public financial compensation (Dari-Mattiacci and Faure 2015).

advisable to view risk reduction as being in a trade-off with insurance affordability, and these two aspects should perhaps be viewed as mutually reinforcing (Surminski 2014). In other words, no risk reduction would likely not imply unaffordable insurance, but rather no insurance at all. As regards the role of risk awareness, Rufat et al. (2024) found that the positive correlation between insurance coverage and home adaptation to flooding identified in Paris, France, was partially explained by awareness of official flood risk information.

PERSONAL RESPONSIBILITY AND WIDER BENEFITS

Private adaptation, which largely relies on personal responsibility and incentives to reduce risks, is more likely to be implemented when adaptation benefits accrue mostly to those making the adaptation investments in the first place. It may possibly drive sufficient adaptive responses in sectors with short planning horizons and where there is less uncertainty about future climate change impacts, but it is likely to have a limited role in other sectors (Stern 2007). Consequently, relying on privately led adaptation is unlikely to lead to sufficient adaptation outcomes and, as per our framework, is also unlikely to lead to substantial positive effects for the wider public and on equity.

Certain types of private adaptation actions can provide positive spillover effects for other actors and the wider public and essentially represent privately provided public goods. Examples of these actions can include farmers' management of vegetation complexity leading to a reduced landslide risk, or farmers removing barriers to flooding on their property and households maintaining non-paved gardens to reduce urban flood risk (Tompkins and Eaking 2012). Importantly, many of these cases of private adaptation are less likely to be implemented, as the implementing actors are unable to capture the full investment benefit. Tompkins and Eaking (2012) describe the three main characteristics of these privately provided public adaptation goods that can make their provision especially challenging: 1) a spatial and/or temporal mismatch between the good providers and beneficiaries; 2) the necessity for cooperation between multiple private actors to provide the good; and 3) a misalignment between private and public interests. The inadequate provision of these adaptation goods may require the development of novel institutional mechanisms and tools, and especially public subsidies, which could facilitate the achievement of better adaptive outcomes.

Several other papers identify co-benefits of private adaptation. For example, Rahman et al. (2022) discuss solar-powered irrigation and mention co-benefits such as informal social group formation, increased financial strength, and improved employment opportunities. Rose (2016) describes co-benefits of disas-

ter risk management in the private sector including improvements to workers' health or a more generic contribution to economic stability. The identification and communication of these additional benefits is important, as it can be used to promote and upscale private adaptation efforts.

INTERACTION BETWEEN THE ADAPTATION TOOLS

A well-designed adaptation strategy that involves a combination of the three main adaptation approaches considered in the Trilemma may lead to beneficial synergies. For example, when insurance incentivizes private adaptation through premium discounts, this may lead to reduced insurance costs and consequently higher affordability, increased insurance uptake, and reduced hardship in the event of a disaster shock. On the other hand, certain combinations of different adaptation approaches may come into conflict. For example, the provision of post-disaster financial assistance may reduce disaster insurance uptake. However, limiting the provision of post-disaster compensation to insured individuals may have undesirable effects on equity and hardship (a Samaritan's Dilemma – see Deryugina and Kirwan 2018, and Raschky and Schwindt 2016).

As regards the interaction between government actions and personal responsibility, well-designed public policies can be used to effectively generate private adaptation. The government should communicate risks, offer incentives for the implementation of resilience enhancing measures, and establish regulations to prevent businesses from transferring risks to the public in cases where negative externalities are pervasive (Biagini and Miller 2013). In practice, public-private collaboration for climate change adaptation is often minimal and the potential synergies between the measures taken by people and their governments are not often recognized and exploited (Wamsler 2016). Improving this collaboration represents an important step toward facilitating transformative adaptation.

POLICY CONCLUSION

Multiple lessons can be drawn from the existing research that considers adaptation trade-offs, but our argument is that the full dimensionality of the Trilemma needs to be accounted for when assessing these trade-offs. The selection of public adaptation measures and their effects on fiscal sustainability can be analyzed through tools such as cost-benefit analyses, distributional impact assessments, and real options analyses. These assessments should adopt a comprehensive approach based on quantitative economic modelling and take into account both the expenditure and revenue sides of the government budget as well as ancillary and indirect effects. However, quantification of these effects is complex, and the uncertainties associated

with it have increased along with our growing knowledge of the many potential side effects. Nonetheless, the inclusion of these effects could sway any assessment in favor of adaptation measures involving substantial immediate costs but high indirect benefits (Bachner et al. 2019). Consideration of well-being and equity or other social issues may require going beyond quantifiable approaches and may require qualitative, non-market, and non-monetary assessments (Reif and Osberghaus 2020).

Collaboration between public and private efforts in adaptation is minimal and needs to be improved. Enhancing climate-related risk information and communication and therefore improving public awareness may enhance private adaptation, help align private and public preferences, and increase participation in insurance schemes. The potential for the development of novel institutional mechanisms and public-private partnerships that could support the provision of privately delivered public adaptation goods, thus increasing the synergies between these different approaches, should also be explored. These mechanisms could facilitate the strengthening of social contracts between populations and motivate collaboration for a collective good based on moral and ethical appeals (Tompkins and Eakin 2012), besides also assisting in reducing the inherent Trilemma trade-offs.

The currently existing links between disaster insurance schemes and incentives for risk reduction appear to be weak (or almost non-existent) as well as limited by both the competing priorities of stakeholders and constraints in information availability. Strengthening this link will require the provision of appropriate financial incentives such as through risk-based pricing or specific premium discounts programs. Supporting the implementation of risk-based pricing may, to some degree, necessitate alleviating affordability concerns. This could be done directly, for example through the provision of vouchers, or indirectly, through public disaster management investments (Kunreuther 2015). Furthermore, technological limitations, such as a lack of detailed local risk assessments required to differentiate premium levels, need to be addressed (Surminski and Hudson 2017). But insurance pricing alone may not always be sufficient to encourage risk-reducing behavior. Better provision of risk information and other regulatory measures may need to be employed.

Ultimately, adaptation strategies should be devised as a combination of the three main adaptation approaches in ways that minimize negative trade-offs and maximize synergistic effects. Up to now, decisions about climate adaptation trade-offs have almost always been made ad hoc and with little robust evidence to support them. With the availability of new data, new empirical tools, and new insights, quantification and more detailed and accurate assessments of the Trilemma trade-offs may be possible. As we increase our understanding of these trade-offs,

we may be able to devise more effective adaptation policies, and there may no longer be any justification for taking decisions in the dark.

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