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Evidence-Based Support for Adaptation Policies in Emerging Economies

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Abstract

Climate change is increasingly evident, and the design of effective climate adaptation policies is important for regional and sectoral economic growth. We propose different modelling approaches to quantify the socio-economic impacts of climate change on three vulnerable countries (Kazakhstan, Georgia, and Vietnam) and design specific adaptations. We use a Dynamic General Equilibrium (DGE) model for Vietnam and an economy-energy-emission (E3) model for the other two countries. Our simulations until 2050 show that selected adaptation measures, in particular in the agricultural sector, have positive implications for GDP. However, some adaptation measures can even increase greenhouse gas emissions. Focusing on GDP alone can lead to welfare-reducing policy decisions.

Keywords

Climate Change, Climate Adaptation, GDP Growth, Sectoral Loss, Country Models

1. Introduction

In recent years, the impacts of climate change have become increasingly evident worldwide, in terms of both magnitude and frequency. Climate change poses a significant and urgent challenge for environmental and socioeconomic development and entails serious risks in the medium to long term. Its consequences reinforce the necessity for approaches to evaluate the consequences of climate hazards and potential adaptation strategies for a country's economy. The latest IPCC (2022a) report confirms the urgency to act quickly and comprehensively. Climate change is already in progress and will continue to accelerate in the upcoming decades due to the inertia of natural systems. As an option for action, "climate-resilient development integrates adaptation measures and their enabling conditions with mitigation to advance sustainable development for all" (IPCC, 2022b). For policymakers, evidence-based projections are fundamental to implementing appropriate economic policies. These may incorporate shifting investments to low or zero-emission technologies (mitigation) and actions that minimize adverse effects in sectors particularly affected by climate change (adaptation).

The significance of adapting to climate change was once again highlighted at the United Nations Climate Change Conference COP27, and a consensus has been reached to offer financial aid for losses and climate-related damage to vulnerable countries. Policymakers need tools to assess the macroeconomic impacts of sector-specific economic risks and benefits (raising awareness) as well as different sectoral adaptation strategies (preparedness) to initiate the transition to a climate-resilient economy and integrate results into long-term strategies.[1] Multiple adaptation options and evaluations exist for key economic sectors and climate hazards, up to now mainly for developed economies. Nevertheless, macroeconomic impacts and cross-sectoral effects of climate change and adaptation that go beyond individual economic sectors are frequently disregarded, particularly in emerging economies. To advise policymakers on the economic effects of climate change and on the impact of suitable climate adaptation measures to decrease economic losses, extensive and comprehensive data collection is necessary. Furthermore, it is essential to share data on a broader range of topics, including climate-related risks and loss, sectoral and regional characteristics, and interdisciplinary collaboration.

We propose utilizing the CRED approach, developed under the programme "Policy Advice for Climate Resilient Economic Development", that facilitates long-term economic planning by incorporating the costs of climate change and the advantages of mitigation and adaptation policies. We have collected data from three vulnerable emerging economies: Vietnam, Kazakhstan, and Georgia. These nations were chosen for their distinct climate zones and diverse climate hazards, as well as for the accessibility to sectoral and regional expert knowledge, which is crucial for model implementation. All case studies incorporate macroeconomic, structural and labour market data, as well as climate-related data. We consider country-specific adaptation policies due to the different economic structures and climate hazards in each country. Kazakhstan and Georgia are both vulnerable to droughts, while Vietnam is affected the most by climate change-induced sea-level rise. Different views foster comprehension of global, national, and regional model-building principles and procedures.

Therefore, the CRED approach utilizes global and regional climate models to gather data in the respective country. Second, CRED builds on nationally and internationally available knowledge for the translation of damages and the effects of adaptation measures into monetary terms. Third, CRED involves na-

[1] https://unfccc.int/process/the-paris-agreement/long-term-strategies.

tional climate change experts and decision-makers for socio-economic long-term planning. Hence, long-term planning is improved with this knowledge gained from the effects of climate change and adaptation measures. The approach allows for flexibility across different countries in terms of sectoral and regional aggregation. In Vietnam, a Dynamic General Equilibrium (DGE) model has been implemented that emphasizes the supply side. This implies that on the one hand, the optimization can represent economic adjustments under these conditions quite well, on the other hand, it can also lead to numerical problems, which can complicate its use by model builders. In Kazakhstan and Georgia, similar macro-econometric economy-energy-emission (E3) models are applied, which are more demand-side oriented and less price-sensitive in the feedback mechanisms (Großmann et al., 2023). Comparing national scenario results can help policymakers to identify highly effective and beneficial adaptation measures for the economy, employment, and the environment.

2. Macroeconomic Modelling and Climate Change Adaptation

2.1. Climate Change and Macroeconomic Modelling

Climate change leads to economic shocks that can affect either the demand or the supply side of the economy. On the demand side, climate change can cause changes in private (household) or public (government) consumption and investment, business investment and international trade. On the supply side, climate change leads to changes in the productive capacity of the economy, acting through the components of potential supply, i.e. labour, physical capital and technology.

The impacts on the economy associated with climate change and climate change policy can be divided into two categories (Batten, 2018). In addition to the direct risks of climate change, transition risks associated with efforts to reduce greenhouse gas emissions (GHG) and the transition to decarbonised production processes can also have economic consequences. It is crucial to examine the different channels through which these impacts occur and their time horizons (short, medium, or long term) and account for the interactions between climate change, climate policy, and economic activities, as well as the adaptation and transformation processes of economic development.

Direct (or physical) risks of climate change can be further classified as "acute" risks (e.g., extreme weather events (EWE)) or "chronic" risks (e.g., rising sea levels), which accumulate gradually over long periods. Studies focusing on the consequences of the physical risks of climate change in the short term (1 - 3 years) and medium term (4 - 8 years) are mainly concerned with the consequences of EWE, such as floods or storms. A general overview of the economic consequences of natural disasters is provided by Cavallo and Noy (2011). In addition to the immediate supply-side disruptions to production and corresponding economic losses as a result of such disasters, there are also possible demand shocks in the form of disrupted foreign trade, increased uncertainty, or negative wealth effects (Batten et al., 2016). Losses in capital stock can also lead to output losses in the medium term. Looking at the long-term impact of climate change beyond 2045, the focus is on the effects of changes in temperature and precipitation, which may lead to reduced labour productivity, as indicated by studies such as those by Kahn et al. (2021), Acevedo et al. (2020), and Hübler et al. (2008).

In the literature, various models are applied to evaluate the effects of climate change and adaptation policies, along with possible interactions. Macroeconomic models are the core of this process to assess different adaptation options along with their modelling results. Generally, five types of models can be identified: 1) "Integrated Assessment Models" (Nordhaus 1997, 2017a; Nordhaus & Sztorc 2013) play a central role in this literature, as they represent the economy and climate transparently in a unified model framework and enable scenario analyses. For instance, Hsiang et al. (2017) use a micro-founded sectoral bottom-up approach with damage functions to identify the economic damages of climate change in the US. 2) Computable General Equilibrium (CGE) models are used to provide a detailed regional or sectoral level analysis that is particularly relevant for transition risk modelling (McKibbin & Wilcoxen, 1999, 2013; Chateau et al., 2018, Jaumotte et al., 2021). 3) Macroeconometric models, like CGE models, can be quite detailed in terms of economic sectors and regional coverages and are useful for evaluating alternative climate policies. A major difference is that macroeconometric models do not assume that consumers and producers behave optimally or that markets reach equilibrium in the short term. Instead, they rely on econometrically estimated parameters based on historical data and relations to simulate the dynamic behaviour of the economy (Nikas et al., 2019; Lehr & Lutz, 2020). 4) Furthermore, dynamic macroeconomic models extended by climate components can also be found in the literature. These include, for example, dynamic stochastic general equilibrium models (DSGE models, Heutel, 2012; Hassler & Krusell, 2018). These can be used, for example, to investigate how climate protection policy should optimally react to cyclical fluctuations. 5) In addition to theoretically motivated and/or micro-founded models, time-series econometrics methods are also used, such as structural panel vector autoregression (Ciccarelli & Marotta, 2021).

All the models mentioned have strengths and limitations, which have to be taken into account when assessing the consequences of climate change and development.[2] In most of the existing models, the incorporation of climate risks has been inadequate to evaluate specific adaptation policies. International models mainly evaluate climate change mitigation and make use of the international GTAP database (Aguiar et al., 2019).[3] At the country or subnational level, only a few models have been employed to quantify the economic impacts of climate change and adaptation measures, focusing on Europe and the US (Steininger et al., 2016; Hsiang et al., 2017; Lehr et al., 2020; Vrontisi et al., 2022). The CRED

[2]For a recent overview on strengths and limitations, World bank (2022).

[3]See e.g., United Nations Climate Change (2022) for a list of mainly global models, and Schwarze, R. et al. (2022).

approach goes in this direction but especially considers the specific natural and political conditions and lack of data availability on climate impacts in emerging economies. Adequate mapping of climate damages requires that climate data and results from sectoral models are integrated into macroeconomic models to depict the effects of climate change on various (socio-)economic variables. Based on the data availability and existing modelling experience in the selected countries, we apply different approaches for each country.

2.2. Modelling Approach

The CRED approach goes beyond these approaches in several ways, particularly by considering the specific conditions and data availability in emerging economies, and provides results that can be used by policymakers to prioritize adaptation measures. It builds on various input factors covering climate simulations from (inter)national climate models, the modelling of EWE, sectoral modelling and cost-benefit (micro) analyses (CBA) of different sector-specific adaptation measures (see Figure 1). The CRED approach uses a baseline scenario (business-as-usual, based on national long-term planning) where no adaptation measures are applied and the hazard remains constant over time, serving as a benchmark for comparison. For instance, in Vietnam, the baseline scenario considers an annual GDP growth rate of five percent until 2050, with a transformation of the economy from the primary sector towards the tertiary sector.

The following steps are chosen: First, the modelling of climate effects is employed in a simplified manner, utilizing existing global and regionalized models that are available in the literature and can be adapted for use in each country with limited effort. Second, CRED draws on historical, national and international data as well as expert advice, to facilitate the translation of damages and the impacts of adaptation measures into monetary terms. It also allows national decision-makers and experts to adapt internationally available knowledge to their specific country contexts. This approach enables a more comprehensive and accurate assessment of the potential consequences of climate change and the effectiveness of adaptation measures. National damage data of recent EWE can be directly used. Third, in addition to using existing models and data, the CRED approach also facilitates collaboration among national climate change experts and decision-makers for socio-economic long-term planning. By bringing together

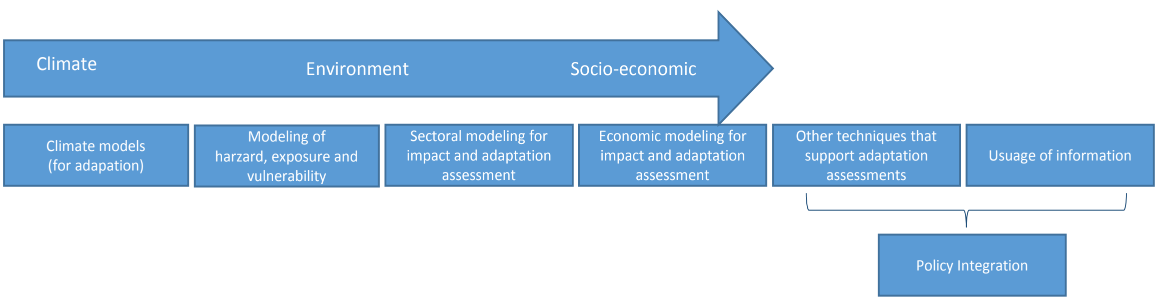

Figure 1. Adaptation modelling typology. Source: Own illustration based on Ebrey et al. (2021): p. 6.

stakeholders with diverse knowledge and expertise, the approach aims to enhance understanding of the effects of climate change and adaptation measures. Macroeconomic models are the core of this process and provide a tool for stakeholders to evaluate and discuss different adaptation options in conjunction with modelling results. Through this approach, national decision-makers and experts can develop a more nuanced understanding of the potential impacts of climate change, and identify the most effective adaptation measures for their specific country's context.

The implementation of the CRED approach in the three countries was conducted under various conditions, as shown by the differences and similarities highlighted in **Table 1**. In general, we implemented two different types of models, and both types have proven to be useful. In Georgia and Kazakhstan, we established macro-econometric (dynamic) economy-energy-emission (E3) models and in Vietnam, a Dynamic General Equilibrium (DGE) model.

The E3 models are implemented in Microsoft Excel using the model-building framework DIOM-X (Dynamic Input-Output Models in Excel; (Großmann & Hohmann, 2019). Behavioural parameters are estimated econometrically on the basis of time-series data. They are less price-sensitive in the feedback mechanisms compared to equilibrium models. They are demand-side driven but also consider supply-side effects. Climate impacts and adaptation measures are implemented by adjusting appropriate model variables such as productivity, investments, or sector prices.

Dynamic General Equilibrium models are a standard macroeconomic tool that uses representative optimizing agents to assess the impact of different policy measures, and allow for a detailed breakdown of the economy. Accounting for different productivities across sectors allows us to understand how each of them evolves in the presence of varying climate circumstances. To consider the impact of climate change, the model uses sector and region-specific damage functions that affect labour and capital productivity.

In all models used in the CRED approach, the economy is divided into different sectors, such as agriculture and energy. This sectoral division is necessary for modelling the structural effects of climate change and adaptation measures. Additionally, the models used in Kazakhstan and Vietnam have the capability of regionalization, which allows for more localized and detailed assessments.

For all countries, the baseline scenario builds on long-term planning regarding GDP development and assumes no new policies for the environmental issues addressed and thus provides a benchmark against which policy scenarios can be evaluated. Climate change and adaptation scenarios were designed based on information and data related to the most relevant climate hazards, their sector-specific impacts, and suitable adaptation options. Specifically, the analysis is embedded in the RCP (representative concentration pathways) and SSP (shared socioeconomic pathways) framework, which simulates different climate change scenarios. By using these frameworks, the CRED approach can provide a comprehensive

Table 1. Key features of the three country models.

	Countries		
	Georgia	Kazakhstan	Vietnam
Available data	● Macroeconomic and sectoral data ● Labour market data (employment, wages) ● (limited availability for) climate scenarios, damage data and CBA of adaptation options		
	Energy balances	Energy balances and prices	
Regionalization	No	16 regions	6 economic regions
Model type	e3.ge model (economy-energy-emission)	e3.kz model (economy-energy-emission)	DGE-CRED model
Modelling specifics	● Excel-based model framework (DIOM-X4)[4] ● Macro-econometric (dynamic) Input-Output model ● Extended by environmental aspects such as energy balance, energy prices and emissions		MATLAB-based model framework
	Simulation model with a mid to long-term perspective (until 2050)		
Quantified climate change impacts	● Heat waves ● Extreme precipitation/flood ● Extreme winds ● Sea-level rise	● Heat waves ● Extreme precipitation/flood ● Extreme winds ● Droughts	● Temperature increase ● Forest fires ● Storms ● Sea-level rise ● Landslide
Evaluated adaptation measures	*agriculture sector* ● Investing in rehabilitating and expanding irrigation systems ● Investing in windbreaks ● *tourism and infrastructure sector* ● Investing in (re-) construction of coastline protection ● Investing in climate-resilient roads and bridges	*agriculture sector* ● Investing in rehabilitating and expanding irrigation systems ● Investing in precision agriculture: the case of parallel driving ● *energy sector* ● Expansion of underground powerlines ● Deployment of wind power and energy efficiency improvements in the housing sector ● *infrastructure* ● (Re-)construction of storm-proofed houses ● "Green Belt" mass afforestation (Re-) construction of climate-resilient roads	*agriculture sector* ● endogenous adaptation to climate change through disinvestment from highly vulnerable to less vulnerable sectors. ● private action, which is implicitly modelled by optimising agents. ● *housing* ● build houses with reinforced walls and bricks ● raise a house on stilts *forestry* ● mixed plantation ● transport ● roadbed elevation ● poly mere asphalt

Source: Großmann et al. (2023), Flaute et al. (2022), Großmann et al. (2022), Drygalla et al. (2023).

and nuanced understanding of the potential consequences of climate change under different policy scenarios.

The economy-wide effects of investments in different adaptation options and reduction of climate change effects are evaluated to compare adaptation measures and to identify those measures, or combinations of measures, that are most

[4]DIOM-X: Dynamic Input-Output Modelling Framework in Excel. Großmann and Hohmann, 2022, 2019.

effective for promoting economic development. The selection of adaptation measures is based on input provided by national experts and the availability of data.

Results from national sector models and analyses are incorporated into macroeconomic models and are complemented by other information available in the countries. In order to translate the impacts of climate change into monetary terms, data on previous damage events in the countries are used. By considering both the economic benefits and costs of different adaptation measures, the CRED approach enables decision-makers to identify the most effective and efficient options for promoting socio-economic development in the face of climate change.

We provide simulations until 2050 and encompass different economic sectors, which is necessary to model the structural effects of climate change and adaptation measures. The specific climate change and adaptation policy options considered vary among the countries, reflecting differences in natural spatial conditions, population density, and other socio-economic factors. The agricultural sector is important in all three countries, given its high vulnerability to climate change and its significant contribution to employment. Other measures, such as those related to transportation, buildings, and reforestation, were also considered in at least two countries. The selection was partly influenced by the availability of data on costs and benefits in each country. A detailed description of the approaches in the three countries can be found in the respective country reports (Großmann et al., 2022; Flaute et al., 2022; Drygalla et al., 2023). A comparison of the key features of the approaches is provided by a global report (Großmann et al., 2023) and summarized in **Table 1**.

3. Results

Assessing the macroeconomic effects of different adaptation options can help to prioritize measures for each sector and identify potential synergies or trade-offs with other policy goals, such as carbon neutrality. In the following, we present the macroeconomic impacts of selected adaptation measures for each country.[5] Given the different types of models used for each country, this article presents rather a general framework of possibilities of adaptation measures and their corresponding impacts than a comparison within or across countries.

3.1. Georgia

Georgia is a mountainous country: more than 80% of the territory is mountainous, and 20% of the country is located at 2000 m or more above sea level (World Bank, 2020). These natural conditions facilitate the occurrence of floods, debris flows, landslides and avalanches, mostly in the mountainous parts of the country and along the major rivers (UNDP, 2014). During recent decades, Georgia has

[5]National specific modelling details are described in the national reports and the global report, respectively. Available at https://www.giz.de/en/worldwide/79266.html.

experienced changes in climate trends, such as an increase in the frequency and severity of extreme weather events (EWE) like heat waves, droughts, and precipitation leading to landslides (USAID, 2016). Vulnerability modelling and cost-benefit analyses have been conducted to inform scenario building.

For instance, CBA on windbreaks from 2019 provides a breakdown of necessary investments and the potential yield increase in agriculture. However, the inclusion of the CBA results in the macroeconomic model highlights the need to consider financing and possible negative macroeconomic effects if farmers cannot allocate funds elsewhere or if state support is lacking elsewhere. Therefore, it is important not only to quantify the economic benefits of adaptation measures but also to analyse their broader interrelationships and sequence to make informed policy decisions about their effectiveness.

The agriculture sector in Georgia is projected to face more frequent and severe environmental weather events (EWEs), such as heavy winds and wind erosion, particularly in dryland regions. The baseline scenario assumes such an event is occurring every five years. GDP will be about 0.3% lower in years with assumed EWEs and 0.1% lower in other years. To assess the impact of various adaptation measures, including windbreaks, on the economy, Georgia utilized its macroeconomic model e3.ge. **Figure 2** illustrates the potential effects of windbreak investments on Georgia's GDP and employment levels.

The results show that investments in windbreaks, compared to a scenario without adaptation, can lead to an annual increase of up to 1.4% of GDP. With higher GDP also employment increases by up to 0.7%, creating up to 12,000 additional jobs. This positively impacts sectoral linkages, resulting in increased wage levels and higher consumption expenditure of up to 1.1% per year. In particular, the agricultural sector benefits from increased production, not only due to increased yields resulting from the windbreaks but also because of the domestic production of seedlings required for the windbreaks.

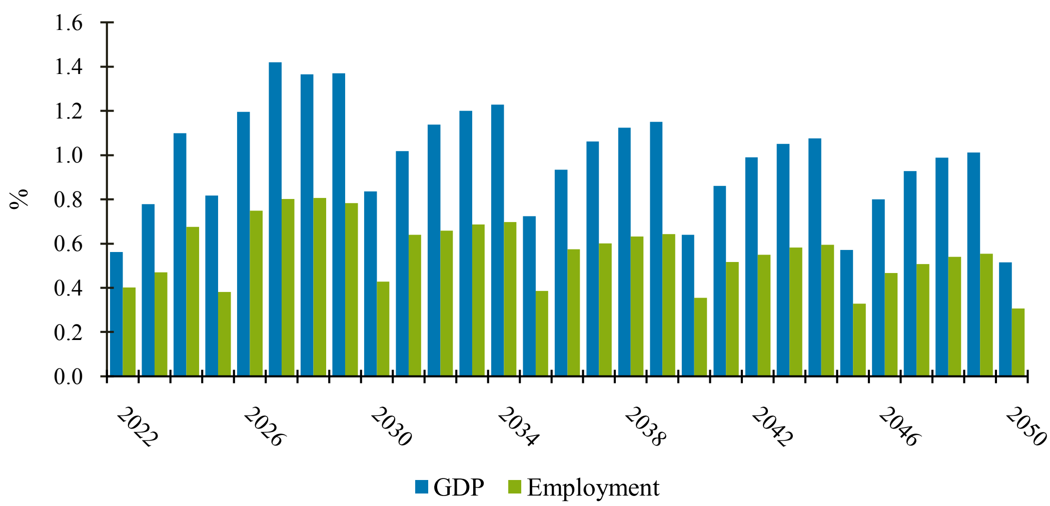

Figure 2. Economy-wide effects of windbreak investments: Difference compared to a scenario without adaptation. Source: own figure based on Flaute et al. (2022).

3.2. Kazakhstan

The e3.kz model applied in Kazakhstan shows the potential consequences of climate change and intensifies adaptation options that have beneficial impacts on the economy, employment, and emissions (win-win options). Droughts could reduce GDP by 1.4% to 2.4% in affected years, while impacts are small in other years. In response to the growing frequency and intensity of droughts caused by climate change, the macroeconomic model e3.kz was utilized to evaluate the economy-wide effects of investing in the rehabilitation and expansion of irrigation systems in Kazakhstan. The resulting effects on GDP and employment are depicted in Figure 3.

Investments in agricultural water infrastructure can lead to an annual increase of up to 1.2% in GDP compared to a situation without adaptation. With higher GDP also employment increases by up to 0.8%, as the green bars in the figure indicate. This is equal to up to 78,000 additional jobs. Even in years when droughts are not occurring, these investments can increase agricultural output. Other sectors along the value chain, such as food production or construction, indirectly benefit from the rehabilitation and expansion of water canals and reservoirs. However, a higher growth path can also lead to an annual increase in energy-related CO_2 emissions of up to 0.4%. This identification of potential trade-offs with mitigation efforts is crucial to laying the foundation for additional mitigation actions.

3.3. Vietnam

Vietnam is projected to be one of the countries most severely affected by climate change and EWE, particularly due to rising sea levels and the increased frequency and intensity of typhoons and cyclones. Consequently, the country's infrastructure and population are under mounting pressure. It is essential to shift investment towards climate-resilient sectors and address the vulnerability of

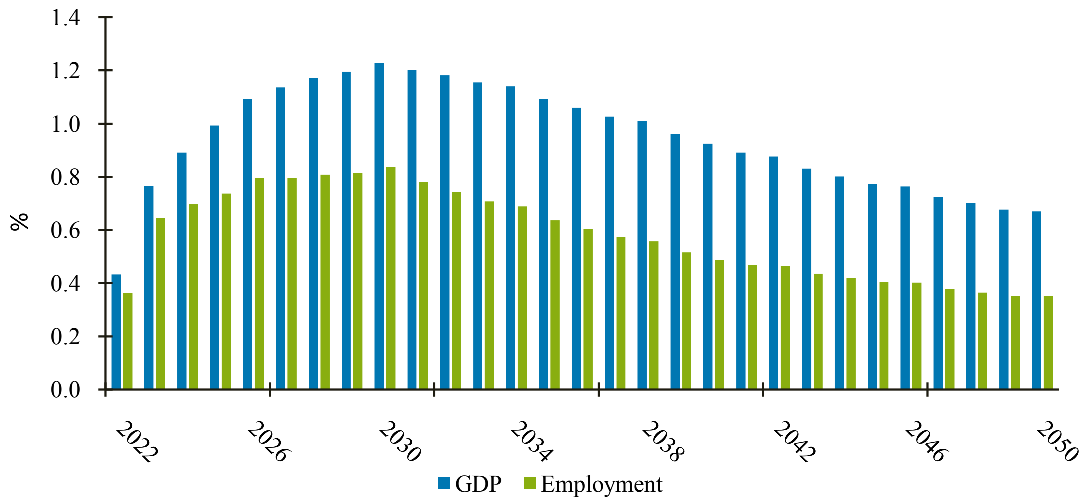

Figure 3. Economy-wide effects of irrigation investments: Difference compared to a scenario without adaptation. Source: own figure based on Großmann et al. (2022).

those sectors that are particularly impacted by climate change. To account for the effects of climate change, the model incorporates region- and sector-specific damage functions that affect the productivity of labour and capital. The model also uses various Shared Socioeconomic Pathways (SSPs), including the IPCC's SSP119, 245, and 585 (which represent scenarios with low, medium, and high levels of mitigation challenges), to provide a range of projections on how demographics, economics, and society could evolve globally in the next century. Our results confirm prevailing findings in the literature that Vietnam's GDP will be adversely affected by climate change. The model results indicate that lower productivity due to climate change will result in an increase in investment in capital stock, while consumption levels decline. Among the evaluated adaptation measures, the upgrading of the dyke system is the most important one. Figure 4 shows the different impacts on consumption and GDP when dykes are being built as an adaptation measure under the SSP 585 scenario in comparison to no adaptation investments. Importantly, the adaptation measure has a positive impact on social welfare, as illustrated by the consistently higher consumption in comparison to no adaptation, with between 0.2% and 0.6% per year in the figure. It should be noted that constructing dykes has a negative impact on GDP (and investments) and employment in the short, medium, and long term. This is because dykes prevent damage to the capital stock caused by events such as floods, which reduces the need for investments in reconstruction. Therefore, taking into account factors beyond the immediate effects on GDP is crucial for a comprehensive understanding of the economic consequences of climate change and related adaptation investments, i.e. the positive impact on private consumption.

4. Discussion

For Georgia, two adaptation options, investments in irrigation systems and windbreaks, were examined, and the analyses revealed that these measures provide co-benefits. By reducing damages during years with climate change effects,

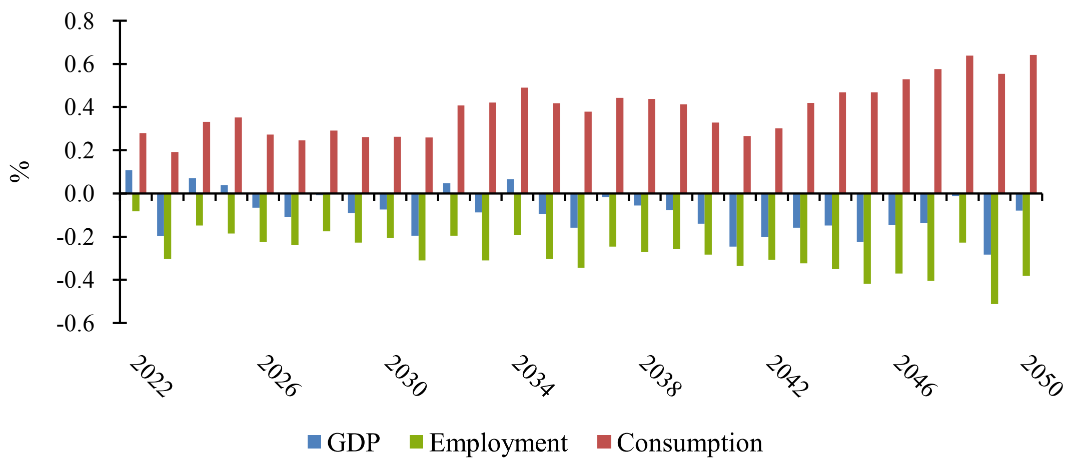

Figure 4. Economy-wide effects of investment in dykes: Difference compared to a scenario without adaptation. Source: own figure based on Drygalla et al. (2023).

crop yields can be increased annually. Kazakhstan reported similar results for adaptation measures in the agriculture, energy, and infrastructure sectors. In Vietnam, each adaptation measure generates significant returns compared to its estimated costs.

The choice of different modelling approaches prompts the question of which model is most appropriate. Models are based on different theories of macroeconomic interrelationships, which, depending on the country, the economic structure, the economic situation, and the question at hand, are differently suited to depicting the economic effects of climate change and adaptation measures (Nikas et al., 2019). However, all models have inherent limitations since they are just a simplification of reality. Especially about climate change, many research questions are still open.[6]

The climate change impacts studied vary due to the natural spatial conditions of the countries, but also due to differences in population density and other socio-economic factors. For instance, it is crucial to consider that certain EWEs, such as heat waves or storms, can have varying effects and thus comparable climate impacts can cause distinct damages in different countries.

Accordingly, the evaluated policy options differ partly among countries. However, the agricultural sector plays a key role in all three countries, as it is highly vulnerable to climate change. Adaptation measures vary depending on the focus of cultivation in each country. Measures in transport, buildings and reforestation were evaluated in at least two countries. The selection is partly influenced by the availability of data on their costs and benefits in each country.

Macroeconomic analysis can help reduce the effects of climate change. In addition, behaviors must also be adapted at the micro level. Therefore, it is equally important to support the adaptation efforts of affected households by providing information and advice (e.g., Kemal et al., 2022).

5. Conclusion

In the face of climate change, policy advice for climate-resilient economic development is crucial. The main challenges for policymakers in emerging and developing economies are the assessment of climate change impacts on economic growth and the identification as well as the implementation of policies to make countries more resilient to climate change. The CRED approach has been instrumental in quantifying the socio-economic impacts of climate change and designing specific adaptation measures as part of long-term strategies. The proposed framework supports understanding and mitigating the economic and social risks due to climate change. In all three countries, raising awareness of the necessity to adapt to climate change, sharing information and communicating on current and projected climate risks, as well as capacity development on climate change adaptation and the impacts on economic development have triggered and enabled climate resilient planning. Our results, which rely on expert

[6]See EU Commission (2021) and Rising et al. (2022) for further information.

knowledge as a key input for our modelling tools, contribute to achieving national adaptation objectives in national climate strategies, national adaptation plans and NDCs. However, the data availability and quality determine the accuracy of the results. To limit the trade-offs, mitigation and adaptation actions should be considered in a holistic approach to combating climate change. Mitigation should be climate resilient, and adaptation should not lead to an increase in GHG emissions. Furthermore, adaptation measures that primarily support the domestic economy are even more advantageous.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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