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# Opportunities and Challenges of Climate Adaptation Policies

Republic of Moldova

Armand Fouejieu

SIP/2024/002

IMF Selected Issues Papers are prepared by IMF staff as background documentation for periodic consultations with member countries. It is based on the information available at the time it was completed on November 28, 2023. This paper is also published separately as IMF Country Report No 23/429.

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**Opportunities and Challenges of Climate Adaptation Policies, Republic of Moldova**  
**Prepared by Armand Fouejieu**

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**ABSTRACT:** Moldova is more vulnerable to climate change than the rest of Europe, due to its (i) higher sensitivity to changes in climate conditions (reflecting its heavier reliance on agriculture, a comparatively-larger rural population, high dependence on energy imports and limited diversification of energy supply sources, and limited financial resources to provide high-quality public services); and (ii) weaker adaptive capacity to climate shocks (due to its comparatively weaker disaster preparedness strategy, low adaptation in the agriculture sector and poorer quality of infrastructure). Adaptation investments can substantially reduce output losses caused by natural disasters, are more cost-efficient than responding to disasters ex-post, and can contribute to boost Moldova's long-term economic growth and support its development objectives.

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SELECTED ISSUES PAPERS

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[Republic of Moldova]

Prepared by Armand Fouejieu

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# Opportunities and Challenges of Climate Adaptation Policies<sup>1</sup>

*Moldova is more vulnerable to the adverse impact of climate change than the rest of Europe, due to its (i) higher sensitivity to changes in climate conditions (reflecting its heavier reliance on agriculture, a comparatively-larger rural population, high dependence on energy imports and limited diversification of energy supply sources, and limited financial resources to provide high-quality public services); and (ii) weaker adaptive capacity to climate shocks (due to its comparatively weaker disaster preparedness strategy, low adaptation in the agriculture sector and poorer quality of infrastructure). Strengthening resilience to natural disasters will require significant adaptation investments in the coming years. This paper shows that such investments can substantially reduce output losses caused by natural disasters, will be more cost-efficient than responding to disasters ex-post, and will contribute to boost Moldova's long-term economic growth and support its development objectives. However, due to limited domestic financial resources in a complex economic environment, Moldova cannot finance the most-needed adaptation investments without endangering public debt sustainability or hindering its growth potential. Therefore, external support will be critical to help meet the adaptation needs. In addition, continued progress on structural reforms (including on enhancing public investment efficiency, governance, the efficiency of education expenditure, strengthening the business environment and crowding in private investments) will support Moldova's readiness to fully benefit from climate adaptation investments.*

## A. Introduction

**1. Moldova is particularly vulnerable to the challenges posed by climate change.** Although its contribution to global CO<sub>2</sub> emissions (0.026 percent) is one of the lowest in Europe, Moldova is among Europe's most vulnerable countries to climate change. Given a high share of agriculture in its economy, Moldova is heavily dependent on weather patterns, making it sensitive to the increasing frequency and intensity of extreme weather events. The country faces a rising threat of droughts, erratic precipitation, and extreme temperature fluctuations, all of which can significantly impact crop yields and food security. Furthermore, Moldova is prone to flash floods and landslides, exacerbating the vulnerability of its infrastructure and population. The socio-economic consequences of climate change in Moldova are compounded by its status as one of the poorest nations in Europe, making it challenging to finance and implement comprehensive adaptation and mitigation strategies. As global climate change continues to unfold, Moldova stands at the frontline of its adverse effects compared to other countries in Europe, underscoring the urgent need for both national and international efforts to enhance the country's resilience and sustainable development.

**2. While the authorities have ambitious emission reduction targets and adaptation goals, the persistent global changes in climate conditions will continue to pose major risks for Moldova if urgent adaptation actions are not taken.** To achieve these objectives, the Moldovan authorities have developed a set of strategies and plans (see Annex VII of the November 2023 Moldova Staff Report) to guide their policies.

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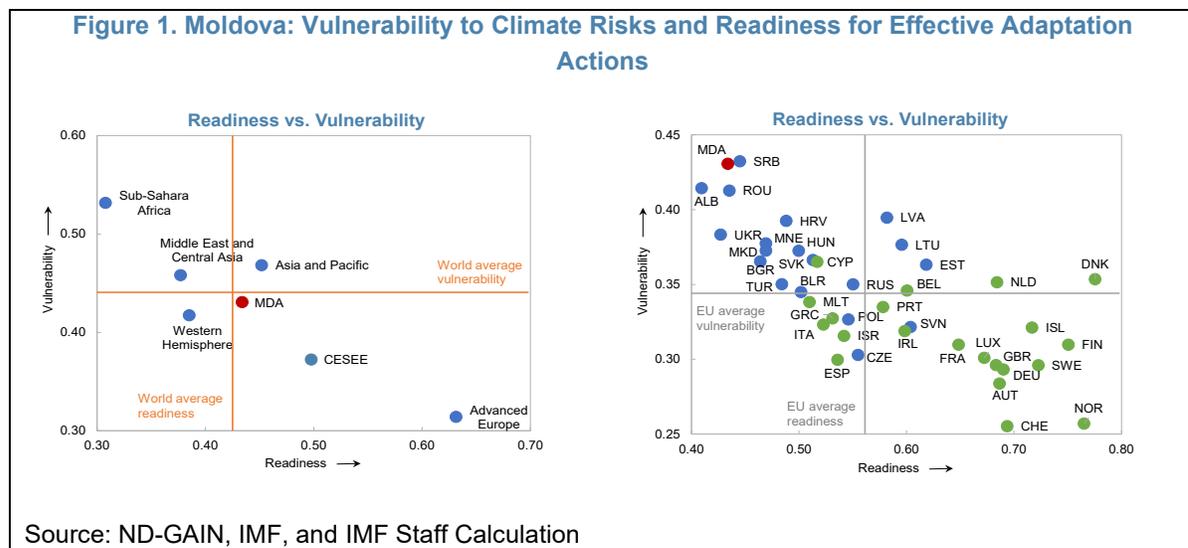
<sup>1</sup> Prepared by Armand Fouejieu (EUR), with excellent research assistance by Dennis Zhao. Helpful comments were received from Mark Horton.

However, the Moldovan economy has been confronted with multiple crises in recent years—including the COVID-19 shock, spillovers from Russia’s war in Ukraine, the energy and cost-of-living crises, and a drought in 2022—and incurred large and persistent output losses. In this complex environment, financing for investments to build climate-resilient (or adaptation) infrastructure will be challenging.

**3. This paper investigates the sources of Moldova’s vulnerability to climate risks and evaluates opportunities and challenges related to potential adaptation investments.** Based on a large set of comparative indicators, we show that Moldova’s vulnerability arises from a disproportionate sensitivity to climate disruptions, partly reflecting specific country characteristics, and considerable adaptation gaps to changing climate conditions (Section B). We use the IMF’s Debt-Investment-Growth and Natural Disaster—DIGNAD—Model (Section C) to simulate the impact of climate adaptation infrastructure investments on resilience to climate shocks and long-term economic growth and to explore the implications for debt sustainability of different financing options. The results (Section D) suggest that adaptation infrastructure can significantly reduce output losses from natural disaster and mitigate scarring. We also find that such investments will support sustainable long-term growth, which ultimately can reduce inequality and support Moldova’s Sustainable Development Goals (the most vulnerable population may disproportionately benefit from adaptation investments, since natural disasters tend to have larger impact on the poorer and those more exposed to climate risks). In addition, the growth benefits would be greater when complemented with reforms to improve public investment efficiency. However, due to limited domestic financial resources, external support—ideally on grant or concessional terms—will be critical to help meet Moldova’s adaptation needs without endangering debt sustainability. The authorities’ program under the IMF’s Resilience and Sustainability Facility (RSF) can play a crucial role in that respect. Also, continued progress on ongoing structural reforms will bolster Moldova’s readiness for effective implementation of adaptation actions (Section E).

## **B. Vulnerability to Climate Change and Readiness for Adaptation Actions**

**4. Moldova’s vulnerability to climate disruptions exceeds the EU average.** Moldova is one of the countries most vulnerable to natural disasters in Europe; it is also among the least prepared countries for effective implementation of adaptation actions (Figure 1). This section discusses specific related aspects, based on the Notre Dame Global Adaptation Index (Box 1).



## Exposure and Sensitivity

**5. Although Moldova's exposure to the adverse impact of climate change is broadly similar to that of other emerging economies in Europe, past climate disasters have been more costly (Figure 2).** Moldova stands out among CESEE countries and advanced economies (AE) in Europe due to the disproportionate economic costs it has borne from climate shocks, the largest toll in past three decades—close to 12 percent of 2019 GDP, cumulatively, compared to an average of 3 percent in the region. The human and social impact of adverse climate events is also largest in Moldova when compared to emerging Europe, with on average 3 percent of the population affected by past natural disasters in the past 30 years. ND-GAIN projects Moldova's exposure to climate change to remain broadly aligned with the rest of CESEE countries (while significantly above AE), although risks appear to be larger for the agricultural sector (suggested by the index capturing the projected change of cereal yields).

**6. The higher costs of climate disasters partly reflect specific characteristics that make Moldova more sensitive to climate shocks.** Moldova's sensitivity stems from its greater reliance on agriculture, with a significant portion of the labor force employed in this sector and agriculture representing, on average, 13 percent of overall GDP over the past 20 years. Climate-induced disruptions, such as extreme weather events and variations in precipitation patterns, directly impact agricultural production, resulting in substantial economic losses. A comparatively-larger rural population in Moldova also heavily depends on subsistence farming and agriculture as a source of income, making a substantial share of the overall population more vulnerable to the impact of climate change. Moldova's dependence on energy imports (more than three-quarters of gas and electricity is imported) and limited diversification of energy supply sources also represent sources of vulnerability. Additionally, limited domestic financial resources, which translate into higher dependence on external financing for healthcare and other social services, also imply higher sensitivity to climate-related events, since these resources may become unavailable or insufficient when a shock hits. The interplay of these specific country characteristics accentuates the economic and social repercussions of adverse climate events in Moldova relative to peers.

### Box 1. Moldova: Notre Dame Global Adaptation Index (ND-GAIN)<sup>1</sup>

The ND-GAIN is composed of two aggregate indices: a *vulnerability* index, measuring the propensity or predisposition of human societies to be negatively impacted by climate hazards; and a *readiness* index, capturing preparedness to make effective use of investments for adaptation actions thanks to a safe and efficient business environment.

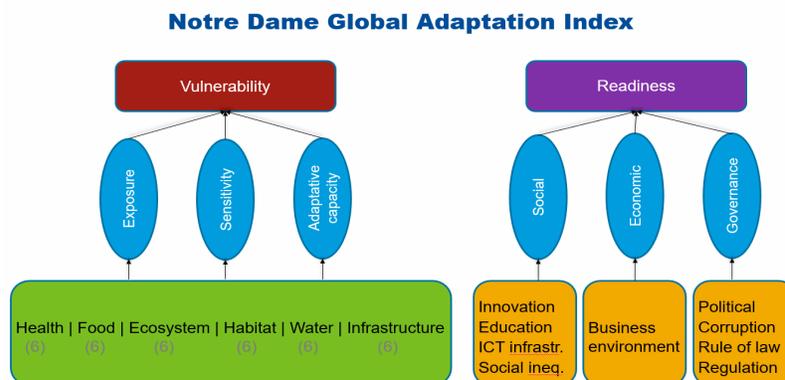
The vulnerability index is broken down into 3 sub-indices:

- *Exposure*: The extent to which human society and its supporting sectors are stressed by future changing climate conditions. Exposure in ND-GAIN captures physical factors external to the system that contribute to vulnerability.
- *Sensitivity*: The degree to which people and the sectors they depend upon are affected by climate related perturbations. The factors increasing sensitivity include the degree of dependency on sectors that are climate-sensitive and proportion of populations sensitive to climate hazard due to factors such as topography and demography.
- *Adaptive capacity*: The ability of society and its supporting sectors to adjust to reduce potential damage and to respond to the negative consequences of climate events. In ND-GAIN, adaptive capacity indicators seek to capture a collection of tools (e.g. disaster preparedness strategies) readily deployable to deal with sector-specific climate change impacts.

Each of the three sub-indices are constructed based on data covering six sectors: health, food, ecosystem, habitat, water, and infrastructure.

The readiness index also encompasses three dimensions:

- *Economic*: Capacity of the economy to attract adaptation investment.
- *Governance*: Capacity to promote and maintain a sound governance/institutional framework, which can contribute to attract external financing and support deployment of adaptation actions and adaptation-related policies.
- *Social*: Social characteristics, including wealth, education, and access to technology, that can help support resilience to extreme climate events and foster implementation of adaptation strategies, as well as innovation capacity that can support identification of adaptation solutions.



1/ See [Notre Dame Global Adaptation Initiative](#) and related technical notes for additional details.

## Adaptive Capacity and Readiness

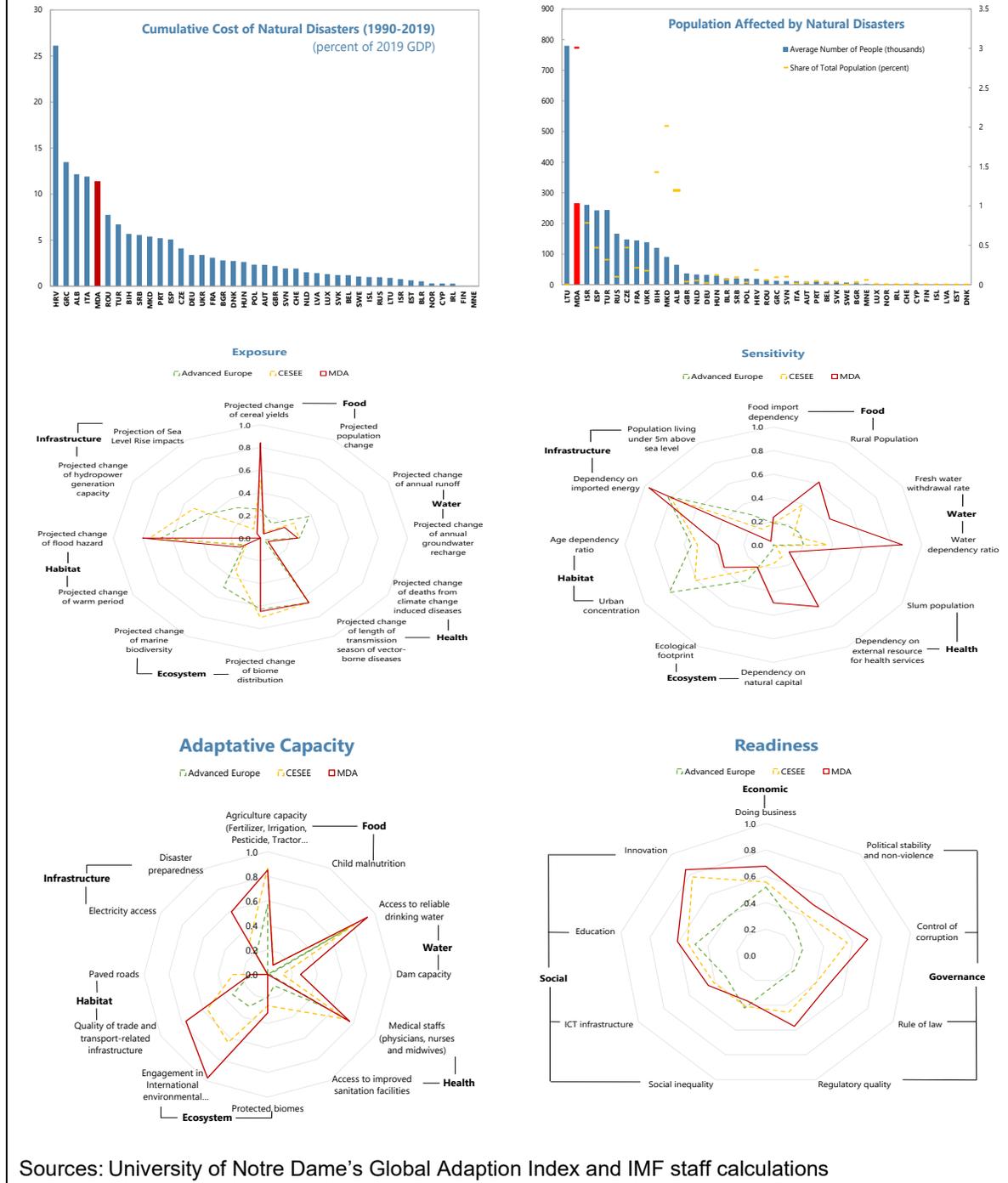
**7. Challenges in adapting to changing climate conditions also contribute to magnifying the impact of climate shocks in Moldova (Figure 2).** The comparatively weaker disaster preparedness strategy especially hinders Moldova's ability to effectively cope with climate shocks, as shown by the ND-GAIN data. While similar to other CESEE countries, adaptation in the agriculture sector—captured by irrigation capacity and availability of fertilizers and automotive infrastructure—is below AE and EU averages, weakening the sector's capacity to withstand natural disasters. The quality of infrastructure, including transport and trade-related infrastructure, is also below CESEE peers and AE averages. Reliable access to water and water storage infrastructure and capacity represents another area of weakness in Moldova's capacity to adapt to stresses caused by climate change. These adaptation deficiencies expose the country to more substantial and far-reaching consequences when faced with changing climate conditions, resulting in relatively larger impact on the population and the economy.

**8. While adaptation gaps are large, Moldova appears to be comparatively less well prepared for effective implementation of adaptation actions (Figure 2).** Governance challenges, for example, characterized by relatively limited institutional capacity and lack of coordination among key stakeholders, can hinder the translation of adaptation strategies into actionable measures. Although Moldova's governance quality has improved in recent years, some key governance indicators (political stability, control of corruption, respect of the rule of law, regulatory quality) remain below CESEE and EU averages, stressing significant scope for further improvement. Moldova also lags behind peers in Europe regarding its social readiness for strong adaptation measures. The ND-GAIN index measures social readiness through innovation, education, ICT infrastructure, and social inequality. Finally, a less-favorable business environment may curtail private sector involvement/investment in adaptation infrastructure, and/or limit the potential to catalyze private investment for adaptation action.

## C. A Framework for Evaluating the Macroeconomic Impact of Climate-Resilient Infrastructure: The DIGNAD Model

**9. The DIGNAD (Debt-Investment-Growth and Natural Disaster) model is a dynamic general equilibrium model describing a small open economy.** It can help quantify and assess the impact of climate disasters and different policy scenarios for investment in adaptation infrastructure (Box 2 summarizes key theoretical underpinnings of the investment-growth nexus and fiscal adjustment embedded in DIGNAD). The model encompasses three main and interdependent blocks (Buffie et al. 2011; Marto et al. 2018; Aligishiev et al., 2023):

Figure 2. Moldova: Costs of Past Natural Disasters and Sources of Vulnerability and Readiness



- The *private demand* block describes household consumption and saving decisions, with two types of households (savers who have access to financial instruments and liquidity-constrained households who do not). Both types of households face an intratemporal decision that determines their supply of labor, whereas savers also face an intertemporal decision that determines savings. Households earn labor income, receive remittances from abroad and transfers from the government, and consume domestically-produced and imported goods.
- The *private supply block* describes firm decisions on labor and capital demand. Tradable and non-tradable goods are produced by two representative firms following a Cobb-Douglas production function with capital and labor inputs. Firm output also increases with total factor productivity (TFP), which, in turn, depends on the stock of public infrastructure (climate-resilient infrastructure and standard infrastructure).
- The *policy block* depicts a set of financing options to cover government investment plans in standard or climate-resilient infrastructure. Fiscal instruments include consumption taxes, labor taxes, and net transfers to households. The government can also issue commercial debt (domestic and/or external), external concessional debt, or receive grants or other forms of costless external financing. Government policy choices can be assessed using two perspectives in the model. First, a strict fiscal rule framework, whereby taxes adjust automatically to close the financing gap created by new investment and prevent excessive accumulation of debt. Second, a framework where there is no automatic adjustment of taxes, and debt financing is allowed.

**10. Natural disasters are assumed to affect GDP through three main channels:** (1) destroying the stock of public infrastructure, (2) destroying the stock of private capital, and (3) reducing TFP. Each of these channels has different macro-fiscal implications. The stock of public infrastructure can only be rebuilt by the government, generating fiscal costs that can be financed as described above. The stock of private capital can only be rebuilt by private sector investment, which is subject to adjustment costs. TFP is exogenous and can gradually recover to its pre-disaster level at an exogenously assumed pace. Natural disasters can affect the economy via two additional mechanisms. First, by increasing government borrowing costs through an increased risk premium on external commercial debt, which may be triggered by perceived higher risk of default after a natural disaster. Second, the efficiency of government infrastructure investment may decline because of limited government capacity to manage large-scale reconstruction, especially after a natural disaster.

**11. Another key characteristic of the DIGNAD model concerns the specific features of climate-resilient infrastructure.** The model assumes that the total stock of public infrastructure consists of two types of infrastructure: standard and climate-resilient. Climate-resilient (or adaptation) infrastructure reduces the output cost of natural disasters, while standard infrastructure does not. A larger share of adaptation infrastructure implies potential for larger mitigation of the impact of natural disasters (a more resilient economy). However, the cost of climate-resilient infrastructure is assumed to be higher compared to the cost of standard infrastructure (e.g., it requires more qualified and scarce technical skills, more expensive materials, or advanced technologies). Adaptation infrastructure is also assumed to have a lower depreciation rate (e.g., climate-proofed roads are more likely to withstand adverse climate events), and a higher rate of return (the low

existing stock of adaptation infrastructure in many low-income countries suggests that the rate of return of initial investments may be high).

### Box 2. Moldova: DIGNAD: Investment, Growth, and Fiscal Adjustment<sup>1/</sup>

The model captures the relationship between growth and investment via a neoclassical production function with labor, public and private capital, as inputs. The Cobb-Douglas production function type is described as follow:

$$Y_t = A_t (K_t^g)^\phi (K_t)^{\alpha} L_t^{1-\alpha}$$

Where  $Y_t$  is the output;  $A_t$  total factor productivity;  $K_t^g$  and  $K_t$  public capital and private capital, respectively; and  $L_t$  labor.  $\phi$  is the parameter capturing the rate of return of public capital.

The fiscal reaction function describes the debt trajectory as a function different financing options available to the government, fiscal revenues, as well as expenditure (including investment and transfers). The budget constraint takes the following form:

$$e_t \Delta X_t + e_t \Delta Z_t + \Delta D_t = e_t r_{X,t-1} X_{t-1} + e_t r_{Z,t-1} Z_{t-1} + r_{D,t-1} D_{t-1} + I_t^g + G_t - \Lambda_t - R_t - \sum_{j=1}^n \gamma_{jt} x_{jt}$$

Where  $e_t$  is the real exchange rate.  $\Delta X_t$ ,  $\Delta Z_t$ ,  $\Delta D_t$  are external commercial, external concessional, and domestic debt, respectively;  $r_X$ ,  $r_Z$ ,  $r_D$  their respective interest rate. Government spending covers public investment ( $I_t^g$ ) and public consumption/transfers ( $G_t$ ). The government receives grants ( $\Lambda_t$ ), other

revenues ( $R_t$ ) and tax revenues from income and consumption ( $\sum_{j=1}^n \gamma_{jt} x_{jt}$ , where  $\gamma_{jt}$  is the tax rate, and  $x_{jt}$  consumption or income from productive sources). Grants and external concessional loans are determined exogenously to the model. In absence of enough financing to cover the assumed expenditure, taxes and transfers are adjusted to close any financing gap.

1/ See also Melina and Santoro (2021).

## D. Closing the Adaptation Gaps and Building Resilience to Future Shocks: Opportunities and Challenges

**12. This section assesses the benefits of climate adaptation investments in enhancing resilience to climate shocks and supporting medium-to-long-term growth.** It also discusses policy challenges, especially with respect to financing, due to limited fiscal space in Moldova for the most-needed investments to address climate change risks. Finally, it investigates from an international donors' perspective, the intertemporal trade-off between financing adaptation investment *ex ante* or financing reconstruction *ex post*. The simulations are based on the DIGNAD model described in Section C.

## Baseline Calibration

**13. The simulations cover a 20-year horizon.** Key calibration parameters are presented in Table 1. It is assumed that the government may increase investment in infrastructure (standard or climate-resilient) during the first 5 years of the simulation period. A natural disaster hits in Year 6, and the reconstruction process starts immediately afterwards. The reconstruction period—the time needed for the government to rebuild the damaged public infrastructure—lasts 5 years. The natural disaster affects the economy through the three main channels discussed above (impacting both tradable and non-tradable sectors), as well as by reducing the efficiency of government infrastructure investment. We assume no impact on risk premium on government commercial external debt since Moldova has not incurred any new commercial debt on international markets in at least the past 5 years.

**Table 1. Moldova: Main Parameters Calibration**

Parameter Description	Values	Parameter Description	Values
Public infrastructure investment to GDP ratio	4.0%	Trend per capita growth rate in absence of natural disasters	6.0%
Public adaptation infrastructure investment to GDP ratio	0.0%	Value added in NT-sector	60.0%
Consumption tax rate (VAT)	20.0%	Efficiency of public infrastructure investment	65.0%
Labor income tax rate	12.0%	Ability of adaptation capital to withstand natural disaster	30.0
Public domestic debt to GDP ratio	9.6%	Cost ratio adaptation vs standard investment	25.0%
Public concessional debt to GDP ratio	26.0%	Initial return standard on infrastructure investment	25.0%
Public external commercial debt to GDP ratio	0.0%	Initial return on adaptation infrastructure investment	35.0%
Private external debt to GDP ratio	50.6%	Depreciation rate of public capital (standard infrastructure)	7.5%
Real interest rate on public domestic debt	4.0%	Depreciation rate of public capital (adaptation)	3.0%
Real interest rate on public external commercial debt	6.0%	Division of fiscal adjustment parameter - Transfers	20.0%
Grants to GDP ratio	0.5%	Division of fiscal adjustment parameter - Consumption tax	40.0%
Natural resources revenues to GDP ratio	0.0%	Division of fiscal adjustment parameter - Labor income tax	40.0%
Remittances to GDP ratio	14.1%	Public debt adj. between commercial external and domestic	50.0%
Imports to GDP ratio	58.9%		

## Standard vs. Adaptation Investment

**14. The first set of simulations aims at illustrating the benefits of climate adaptation investment.**

Three scenarios are explored:

- *Unchanged policies scenario.* The key macro-variables in the baseline are kept unchanged. Especially, there is no additional public infrastructure investment beyond what is assumed in the baseline.
- *Standard investment scenario.* It is assumed that an additional 2 percent of GDP is invested in public standard infrastructure, annually.
- *Adaptation investment scenario.* Two percent of GDP is invested in public climate-resilient infrastructure, annually, to strengthen Moldova's adaptation capacity (see Box 3 on the quantification of adaptation investments needs).

**15. We further assume that the government faces a tight budgetary constraint and fiscal policy is guided by a strict fiscal rule that does not allow for debt financing.** Also, no new external grants or concessional loans are available, beyond the baseline assumptions. Therefore, any new spending is financed through tax increases or expenditure rationalization (savings from lower public transfers). Alternative financing options are discussed in the next sub-section.

**16. The simulation results show the following (Figure 3):**

- *Pre-disaster.* New infrastructure contributes to boost GDP growth by about 1 ppt above the baseline during the investment phase in both investment scenarios. However, private investment and consumption contract due to the tax increase and the cut in public transfers.
- *Shock.* In the absence of investment in climate-resilient infrastructure (unchanged policy and standard investment scenarios), the climate disaster shock causes GDP to contract by about 6 percent (similar to the drought in 2009 in Moldova). However, the scenario with pre-disaster accumulation of adaptation infrastructure shows a GDP contraction of about 2 percent, suggesting that resilient infrastructure could absorb about two-thirds of the disaster impact on economic activity. Under the unchanged policy or standard investment scenarios, the public debt-to-GDP ratio increases from 35.5 percent to about 38 percent of GDP. The public debt ratio increases by a smaller magnitude under the adaptation investment scenario (to about 36 percent of GDP). Given the stricter fiscal rule assumed for these scenarios, the debt-to-GDP increase is exclusively driven by the denominator effect (change in nominal GDP).
- *Post-disaster.* The discussion on the post-disaster period focusses on how the economy recovers from the shock. Under the unchanged and standard investment scenarios, the simulations suggest that medium-term scarring is significant, with GDP growth remaining about 2.5 to 3 ppts below the steady state 5 years after the disaster (in the longer term, GDP growth stands at 1 to 1.5 percent below the steady state more than a decade after the shock). The long-term debt-to-GDP ratio is also slightly above the steady state, by about 1 ppt. Thanks to more resilient infrastructure that limits the destruction of capital stock, economic activity recovers faster under the adaptation investment scenario also supported by the smaller contraction of investment and consumption. GDP returns to the steady state level within 10 years after the disaster, while the debt-to-GDP ratio converges back to close to 35.5 percent of GDP by the end of forecast horizon.

**Box 3. Moldova: Quantifying Adaptation Investment Needs for Moldova**

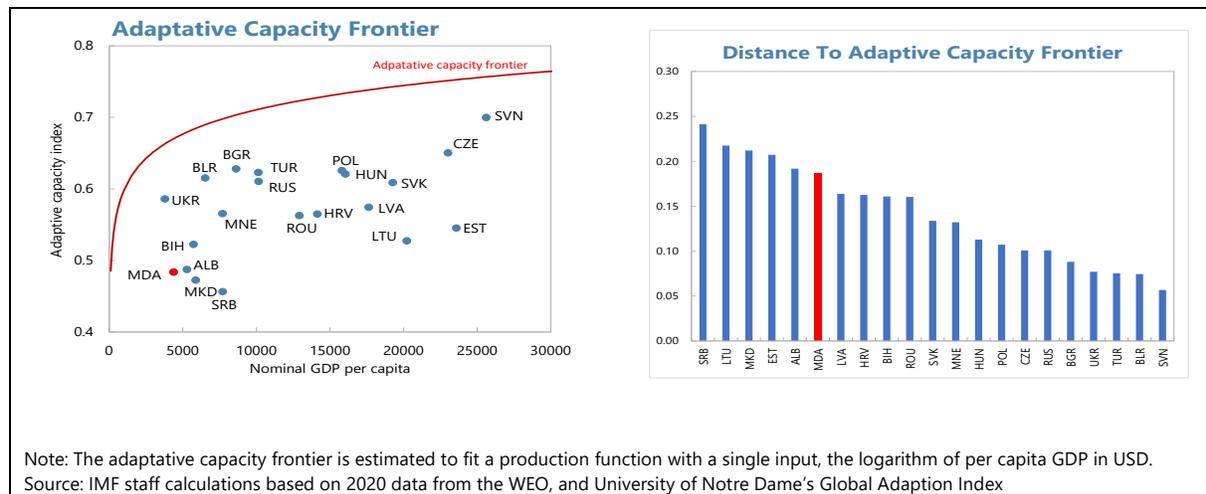
Quantifying the cost of adaptation investments is a difficult exercise as this involves a wide range of sectoral policies and processes to be put in place, all aiming to build resilience against future shocks, with impacts that are also difficult to estimate. For purpose of this paper, we rely on two approaches:

- A *sectoral approach*, based on an analysis from the World Bank on Moldova’s climate adaptation investment planning (World Bank, 2016). The analysis performs a quantitative assessment of adaptation investment opportunities and returns across target sectors. Based on estimated costs by sector, this assessment suggests that a total adaptation cost of about 2 percent of GDP per year over the next 10– 15 years is needed.

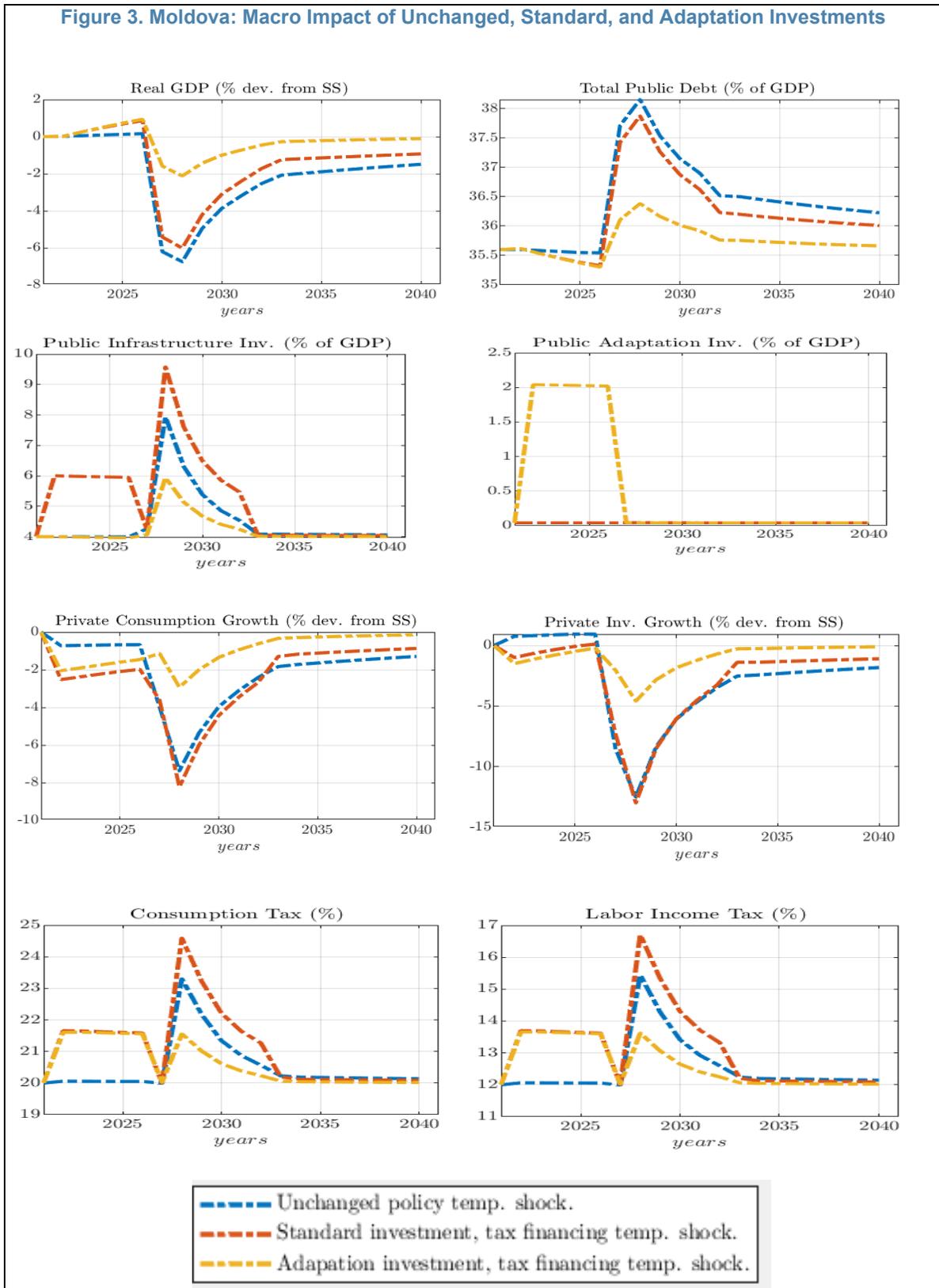
Sector	Objectives	Period	Cost (in ml. USD)
Agriculture & water management	Rehabilitation/Modernization of centralized irrigation system	2017-2040	975
	Investments in farm irrigation technologies	2017-2040	130
	Rehabilitation/Modernization of drainage infrastructure in irrigated areas	2017-2040	120
	Institutional Reforms/Capacity Building	2017-2040	140
Forestry	Ecological reconstruction of forests	2020-2029	91.3
	Ecological reconstruction of forest belts	2020-2030	4.9
	New forest belts	2025-2034	56.5
	Afforestation of degraded land	2023-2044	199.7
	Afforestation of degraded pastures	2023-2044	28.3
Health		2017 -	0.4
Water supply	Improve municipal and industrial water system & reduce 15% of losses	capex in 1 year	29.4
	Improving rural water	na	na
	100 mcm reservoir in lower Nistru & 25 mcm reservoir in upper Nistru & 1 mcm reservoir in Reut	construction over 5 years	24.9
Water supply and sanitation (WSS)	Rehabilitation of existing and construction of new WSS infrastructure	na	439
Flood prevention	Structural flood prevention	2020-2040	360.8
	Non-structural flood mitigation	2020-2040	136.6
Disaster response		2020 -	11
<b>Total</b>			<b>2747.8</b>

Sources: World Bank and IMF Staff Calculations

- A *frontier analysis approach*, whereby we estimate an adaptation frontier using the full sample of countries in Europe (the top performers being advanced economies), and compute the distance to the frontier for CESEE countries. Based on this approach, it is estimated that investment of about 2.5 percent of GDP per year in adaptation will be needed over the next 20 years to close adaptation gaps.



It is worth noting that Moldova’s 2020 Nationally Determined Contribution estimates adaptation investment needs to be 2.5 percent of GDP per year over the next 10–15 years. We use the lower bound of these estimates range (2 percent of GDP) for the simulations in the paper.



## Alternative Financing Options

**17.** In the following set of simulations, we explore several options of public financing of adaptation infrastructure, and their macroeconomic impacts, especially on public debt and medium-to-long-term economic growth (Table 2). We assume (i) an additional 0.5 percent of GDP of grant financing is available to the government annually (bringing baseline grant financing to 1 percent of GDP); and (ii) increased access to concessional loans by 1 percent of GDP annually.<sup>2</sup> This, however, leaves a financing gap of about 0.5 percent of GDP annually, to fully finance climate-resilient infrastructure. The government has two options to close the financing gap: (1) increase public commercial debt, or (2) mobilize additional tax revenues and/or generate savings from current transfers.

**18. Public investment efficiency.** We further assess to what extent improving public investment efficiency (PIE) could support investment outcomes and growth in the medium-to-long-term. For each of the financing options discussed below, we consider a scenario where PIE increases by 15 ppts to 80 percent, similar to top performers among emerging countries.<sup>3</sup>

	Debt financing	Tax and exp. rationalization
<b>Scenario 1</b>	All commercial debt	All tax and exp. rationalization
<b>Scenario 2</b>	Grant: + 0.5 ppt Concessional loans: + 1 ppt Commercial debt: ~	Grant: + 0.5 ppt Concessional loans: + 1 ppt tax and exp. rationalization: ~
<b>Scenario 3</b>	Grant: + 0.5 ppt Concessional loans: + 1 ppt Commercial debt ~ PIE: + 15 ppts	Grant: + 0.5 ppt Concessional loans: + 1 ppt tax and exp. Rationalization: ~ PIE: + 15 ppts

### Financing Option 1: Increased Public Commercial Debt to Close the Financing Gap

**19.** The simulation results for this financing option are presented in Figure 4. The scenario with additional grants and concessional borrowing (scenario 2) is compared to a scenario where such extra funding and cheaper borrowing are not available, and the government instead finances adaptation infrastructure exclusively by increasing commercial debt (scenario 1). In the latter scenario, public debt would peak at about 50 percent of GDP (from about 35.5 percent) and remain broadly at that level 10 years after the shock. In line

<sup>2</sup> Such concessional financing could include funds from the IMF's Resilience and Sustainability Facility, which is expected to catalyze additional financing from international donors to support Moldova's climate adaptation efforts.

<sup>3</sup> Public Investment Efficient measures the share of budgeted funds effectively used for the expenditure items they were allocated to (see Dabla-Norris et al., 2011, and Aligishiev et al., 2023).

with the simulation results discussed in the previous sub-section, new investment in adaptation infrastructure boosts growth by about 1 ppt above the pre-disaster baseline, helping limit the economic impact of climate disaster by about two-thirds, and reducing medium-term scarring.

**20. Under the scenario with additional grants and concessional loan financing, the growth impact of adaptation investment is larger** by about 0.2 ppt by the end of the investment cycle and over the entire post-shock period, implying significant cumulative economic benefits in the long term. This is driven, inter alia, by a smaller crowding out impact on private investment than public domestic debt financing would have generated under a fully-debt-financing scenario. The debt-to-GDP ratio reaches a maximum of 45 percent, before declining to 43 percent by end of the forecast horizon.

**21. The simulations also emphasize the role of PIE.** Improving PIE is found to further support the impact of adaptation investment on growth regardless of the financing modality. Growth stands at about 0.3 ppt higher by the end of the investment phase, thanks to strengthened PIE. Post-shock, the economy recovers faster, taking growth about 0.3 ppts above levels projected in the baseline annually over the forecast horizon.

***Financing Option 2: Mobilizing Tax Revenue and Expenditure Savings to Close the Financing Gap***

**22. The economic impact under this financing option (Figure 5) is very similar to the *Financing Option 1*.** The growth benefits of adaptation infrastructure before and after the shock, as well as resilience to climate disaster, are of comparable magnitude to the previous scenario. The growth outcomes are larger in the scenario with additional grants and concessional debt financing, compared to a scenario where adaptation investment is fully financed through taxes and expenditure rationalization. In the latter case, tax increases (on income and consumption) depress private investment and consumption, weakening the growth impact of public infrastructure investment. The positive impact of improving PIE is also in line with the results discussed in the previous scenario.

**23. However, debt sustainability implications are markedly different compared to the debt-financing option.** The debt-to-GDP ratio peaks at about 40 percent following the shock and declines gradually to 37 percent by end of the forecast horizon. This financing option therefore preserves public debt sustainability, while providing a similar growth and climate-resilience impact.

Figure 4. Moldova: Macro Impact of Debt Financing of Adaptation Investments

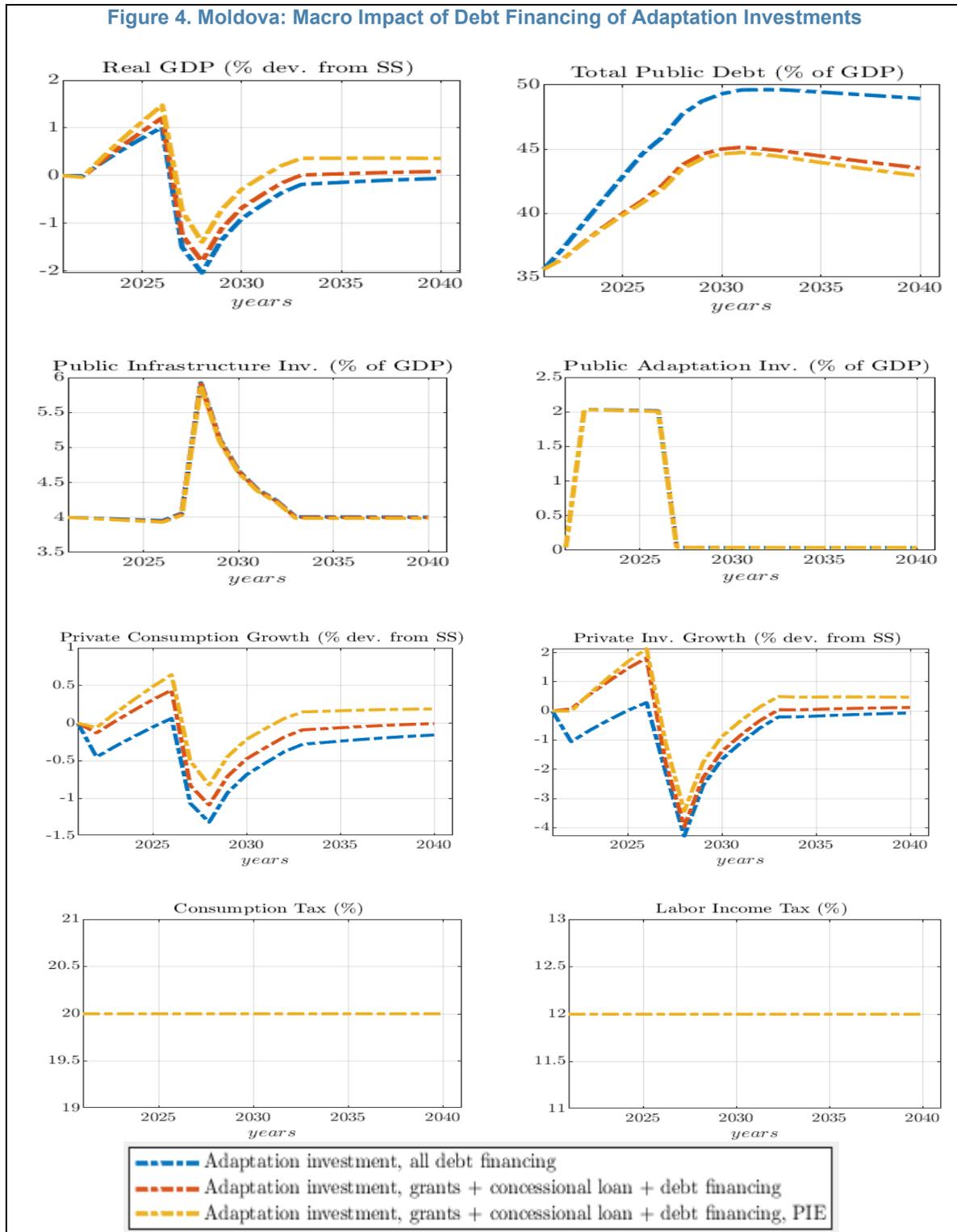
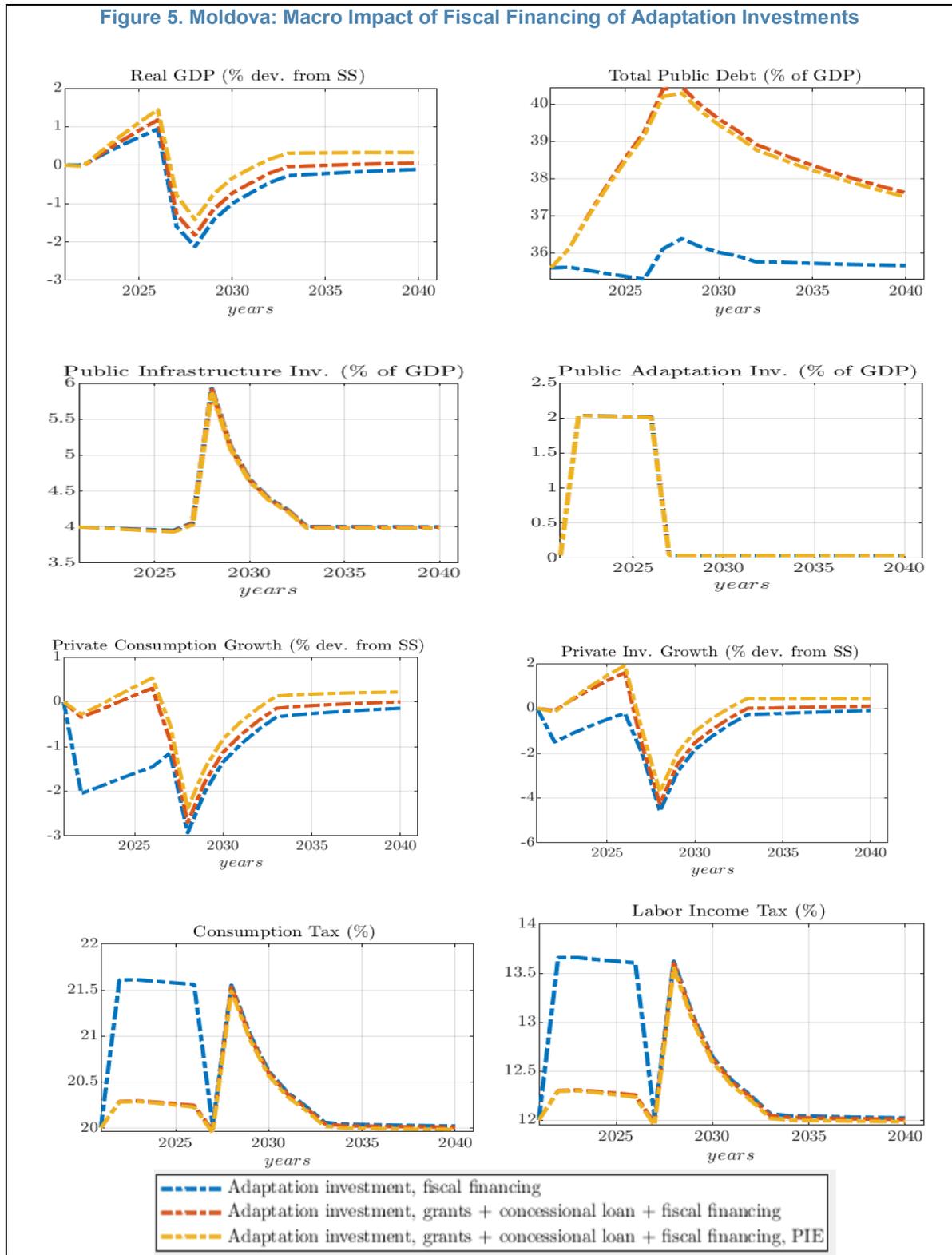


Figure 5. Moldova: Macro Impact of Fiscal Financing of Adaptation Investments



### Trade-Offs and Considerations for Donors

**24. As highlighted in the previous section, closing adaptation gaps may generate trade-offs among the need to bolster the stock of climate-resilient infrastructure, supporting economic activity, and maintaining debt sustainability.** Given costs and impact, it may be more reasonable and efficient to provide financial assistance to Moldova not only during the reconstruction phase, once a disaster hits, but importantly, before any disaster, to support resilient investments. This is particularly important given Moldova's limited financial resources, constrained access to commercial domestic and external debt, and limited fiscal space.

**25. This section aims to answer how large the net savings (or losses) would be if donors were to fund investments in adaptation infrastructure *ex ante*** (before a climate disaster), reducing the need to support reconstruction *ex post*. The analysis assumes that donors provide financial assistance for all reconstruction efforts following a disaster. We then calculate the net present value of future costs associated with such reconstruction in the event of a climate shock. The present value of future reconstruction costs is compared to the cost of investment in climate-resilient infrastructure *ex-ante*.

**26. Donors' net savings from supporting adaptation investments are large.** The results presented in Table 3 suggest that donors' savings would amount to about 17 percent of total *ex post* reconstruction costs if they were to support adaptation investments *ex ante*. These results are based on a disaster impact of similar magnitude of Moldova's past climate shocks. With global climate conditions continuing to deteriorate, future natural disasters will likely be of larger magnitude, and our analysis suggest that donors' savings would also be larger under such scenario. For example, donors' net savings would be equivalent to about 27 percent of reconstruction costs, should the impact of future natural disaster be 50 percent larger than historical shocks.

<b>Table 3. Moldova: Discounted Net Savings of International Donors</b> (In percent of reconstruction cost)	
<b>Magnitude of Hazard</b>	<b>Net Savings</b>
Average Impact	17.6
Average Impact + 30%	24.3
Average Impact +50%	27.3
Average Impact +100%	32.2

## E. Conclusions

### 27. **Moldova is one of the countries most affected by the impact of climate change in Europe.**

Moldova stands out among European countries due to the disproportionate human, social, and economic costs it has borne from climate shocks—the largest toll in Europe over the past three decades. Moldova's sensitivity to climate disruptions partly reflects specific country characteristics, including its heavier reliance on agriculture, a comparatively-larger rural population, high dependence on energy imports and limited diversification of energy supply sources, and limited financial resources for high-quality public services, with diversion of spending in times of external shocks. Challenges in adapting to changing climate conditions also contribute to magnifying the impact of climate shocks in Moldova. Especially, a comparatively weaker disaster preparedness strategy, low adaptation in the agriculture sector, poorer quality of infrastructure, and less reliable access to water and water storage infrastructure and capacity expose and will expose Moldova to more substantial and far-reaching consequences given increasingly changing and volatile climate conditions.

### 28. **Building resilience to future climate shocks will yield substantial benefits and calls for significant investments to close Moldova's adaptation gaps.**

This paper assesses the impact of investment in adaptation infrastructure on the resilience to climate shocks, as well the medium-to-long term economic growth. We find that adaptation infrastructure resulting from additional public investments can significantly reduce output losses from natural disasters and mitigate scarring. Especially, an accumulation of adaptation infrastructure equivalent to 2 percent of GDP per year over 5 years can reduce GDP losses from about 6 percent to 2 percent following a disaster. We also find that such investments will support sustainable long-term growth, which ultimately can reduce inequality and support Moldova's Sustainable Development Goals. Increasing PIE would also further boost GDP growth. Under the ongoing ECF/EFF program, Moldova has made progress and continues to advance in its governance reforms, including fiscal governance. Such progress, together with the implementation of the PIMA and C-PIMA recommendations, will help improve PIE.

### 29. **However, the analysis also reveals important challenges.**

- First, limited financial resources could delay adaptation investments, leaving Moldova in a precarious position when faced with future changes in climate conditions. We find that in the absence of donors' support, the Moldovan authorities cannot finance the most needed climate-resilient investment without endangering public debt sustainability or weakening growth potential. Therefore, external support (such as through the IMF's RSF) is critical to help Moldova close the adaptation gaps. The analysis also suggests that donors' savings from such support ex-ante (to build resilience) are large relative to reconstruction costs ex-post.
- Second, Moldova appears to be relatively less well prepared for effective implementation of adaptation actions compared to other European countries. This is due to governance challenges, gaps in innovation, education, and ICT infrastructure, and the comparatively less favorable business environment, as shown by the ND-GAIN index. Continued progress to strengthen governance (including thanks to the ongoing ECF/EFF and the EU accession process) will support Moldova's effort to improve resilience to climate

change. Boosting efficiency of education expenditure will support innovation, while ongoing efforts to promote the ICT sector will further strengthen Moldova's readiness to fully benefit from adaptation investments. Crowding in private investments for climate actions will also be critical to achieve adaptation objectives, and the authorities should continue their efforts to stimulate a favorable business environment. Reform areas related to the financial sector, under the RSF, will also help foster private sector's participation.

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