Climate change, wars, and the natural rate of interest

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This paper: “orders of magnitude” estimate of shifts in global savings-investment curves

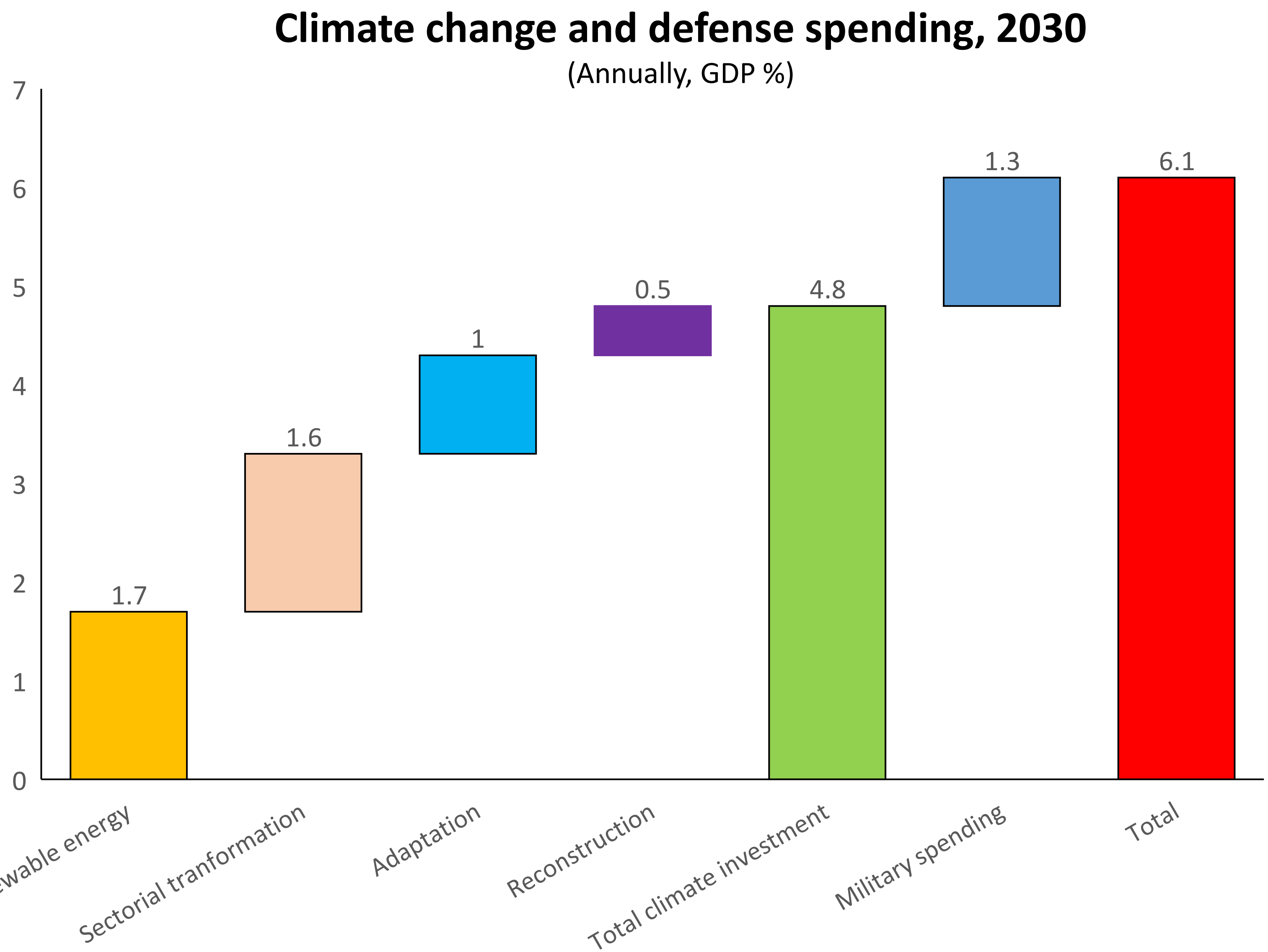
- Interest rates worldwide have risen significantly at both the short and long-end of the yield curve, after a decades-long downward trend which stimulated a heated debate about secular stagnation and its implications for monetary policy (operating near the ZLB more often) and fiscal policy (structural vs. countercyclical role).
- Higher rates may still reflect the impact of contractionary monetary policy due to post-pandemic inflation. Yet even as most central banks have begun policy normalization (many more than halfway towards current estimates of R*), long-term yields have not declined.

Will R* be higher in the next decades, relative to previous trend? This paper: Probably YES.

- Our argument:
  - While some forces may push **global savings curve** outward, a handful of drivers pushing the **global investment curve** outward are an order of magnitude higher
- Our approach: we compile and contrast estimates on two key drivers of **additional** investment
  - Climate transition (consistent with NDCs): 5-6 USD tn per year (2030).
  - Defense (consistent with pre-war patterns of rearmament): 1-2 USD tn. (until major conflict or de-escalation).
  - Altogether: 6-8 USD tn additional expenditures per year --about 25-30% of current global investment.

These costs are probably too high to be incurred in the next decade. Key uncertainties: timing (nature of investment) and other policies (fossil fuel subsidies)

- **Climate change costs cannot be avoided**.
  - Choices involve timing, which affects the nature of investment.
  - Path #1. Pay transition costs (5-6 USD tn) NOW → **protect** physical (& natural) capital.
  - Path #2: pay higher damage costs (20-30 USD tn) LATER → **rebuild** capital destroyed by waves of climate damage.
- **Rearmament costs can be avoided**.
  - Will they? Has the increase in interest rates or inflation prevented previous wars, or the expenses in preparing for them?

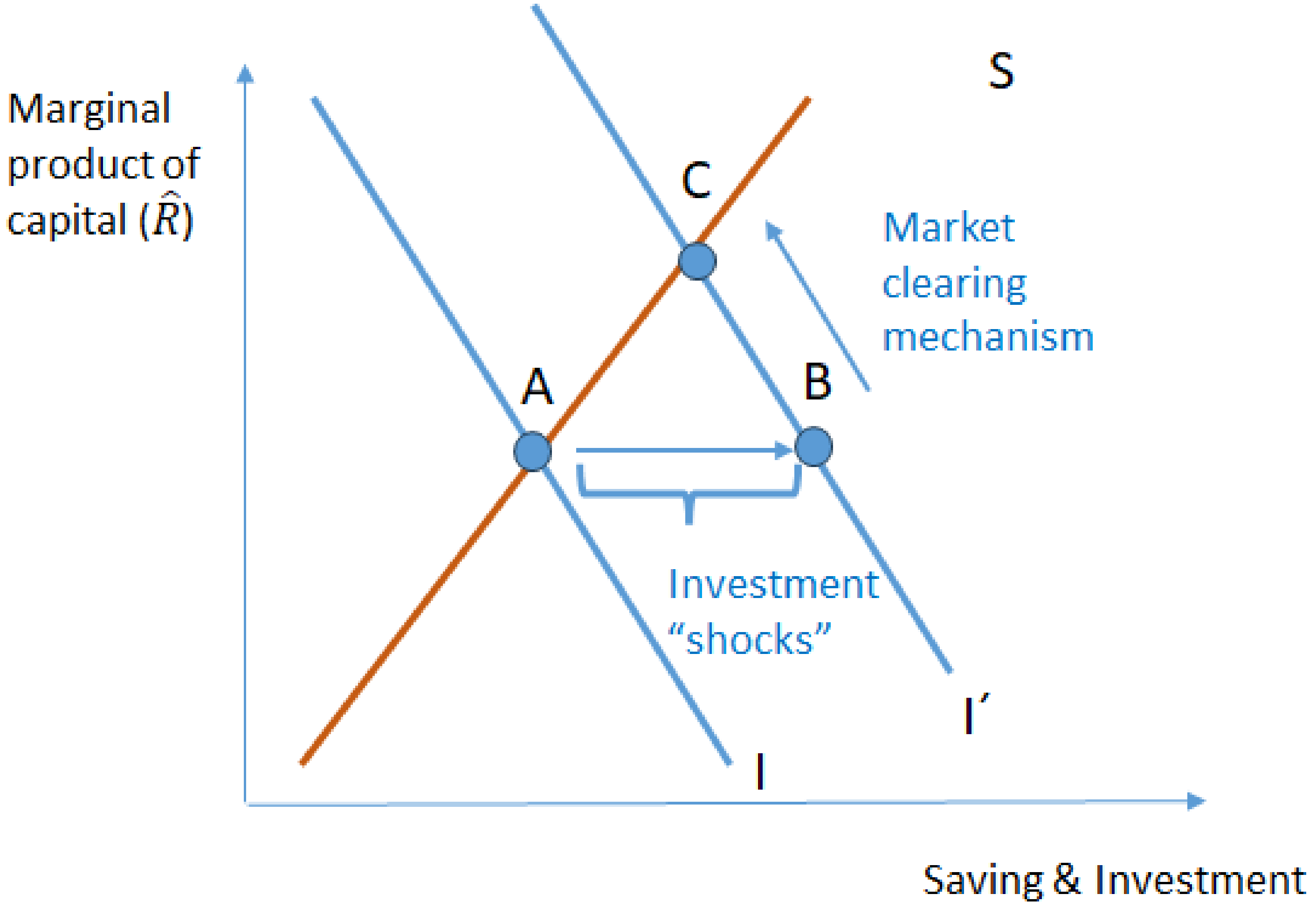


Overview: simple aggregate savings-investment equilibrium.

- Shifts to S or I affect the marginal product of capital, $\hat{R}$: average returns on stocks & bonds of different risk, maturities.

- If additional investment needs arise, they can crowd out other current uses of savings → but this amounts to movements along the new **I** curve (not leftward shifts of it), and thus represent the **market clearing mechanism working through a higher equilibrium $\hat{\boldsymbol{R}}$**.

- Link between $\hat{R}$ and yields along the yield curve ("risk-free" govt. bonds) and R^* (risk-free, short-term rate) will depend on the evolution of corporate and government risk; maturity, liquidity premiums, etc. x



Related literature

1. **Long term trends on interest rates:** Rogoff et.al (2024); Schmelzing (2019); Del Negro et al (2019).
    - Long-term downward trend in real rates (Rogoff et al., 2024; Schmelzing, 2019): demand for safe assets, demographics, low growth. Debate persists about a potential reversal driven by fiscal and demographic pressures (Del Negro et al., 2019)
2. **Safe asset shortages in the global economy:** Caballero & Farhi (2017), Caballero, Farhi & Gourinchas (2016, 2017).
    - Excess global demand for safe assets before the pandemic. This led risk-free interest rates to fall since the 1980s.
3. **Structural determinants of longer-run neutral interest rates: Beningno et al (2024),** Ferreira and Shousha (2023, 2024) Holston, Laubach, Williams (2017, 2023), Laubach & Williams (2003, 2016), Obstfeld (2023).
    - Role of demographics, productivity, and demand for safe assets, partially offset by higher supply of safe assets recently .
4. **Climate Change investment needs estimations:** *Bouckaert, Stéphanie, et al. (2021), Black, Mr Simon, Ian WH Parry and Karlygash Zhunussova (2023).*
    - Quantify investment needs for NZ (electricity generation & industries) consistent with NDCs. García-Macia, et al. (2024). Iyke, Bernard Njindan. (2024) quantify fiscal impacts of various climate policy packages raising debt by 45-50 percent of GDP by 2050.
5. **Macro effects of geopolitical conflicts:** Rockoff (2015), Hall and Sargent (2022, 2023); Kliesen and Wheelock (2023); Eydam and Leupold (2024), Ferguson et.al., (2024).
    - Geopolitical conflicts, especially major wars, tend to have profound and lasting macroeconomic effects, including heightened inflation, increased public debt, and expansions in central bank balance sheets.

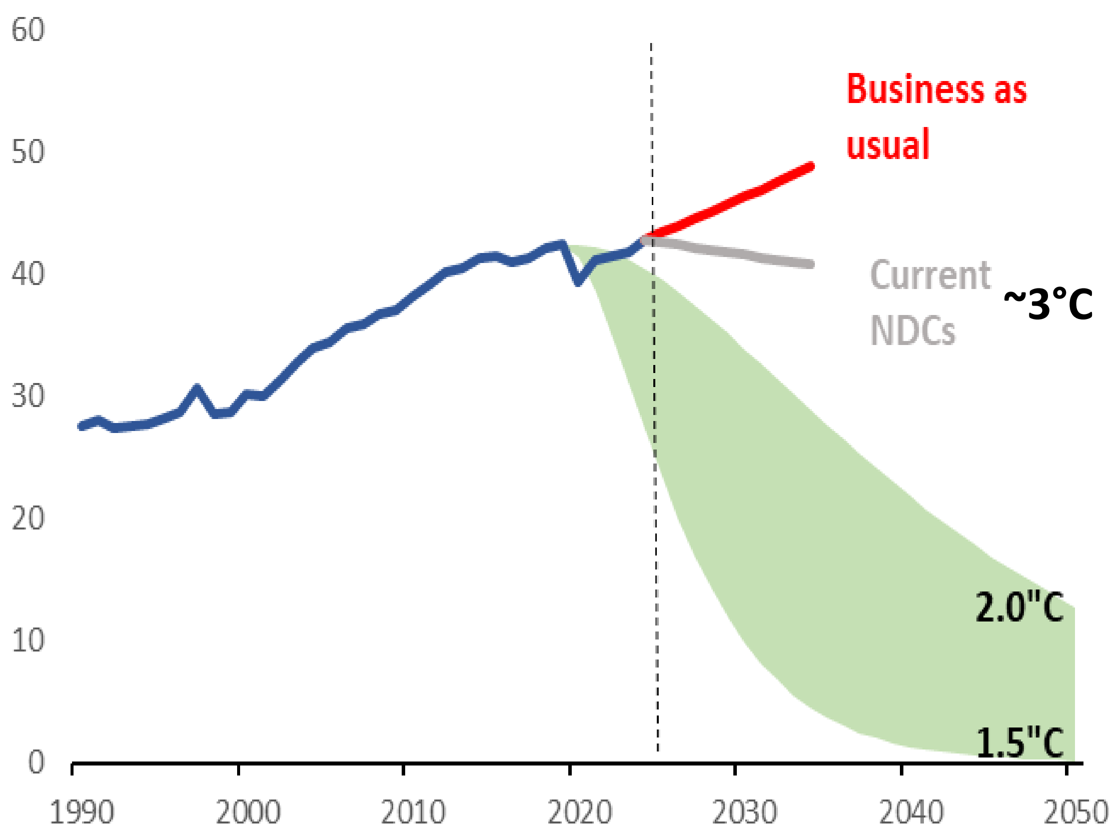
Agenda

1. Climate change: 5-6 USD tn per year
2. Pre-war rearmament: 1-2 USD tn per year
3. Timing considerations and other policies
4. Other factors and link with policy rates

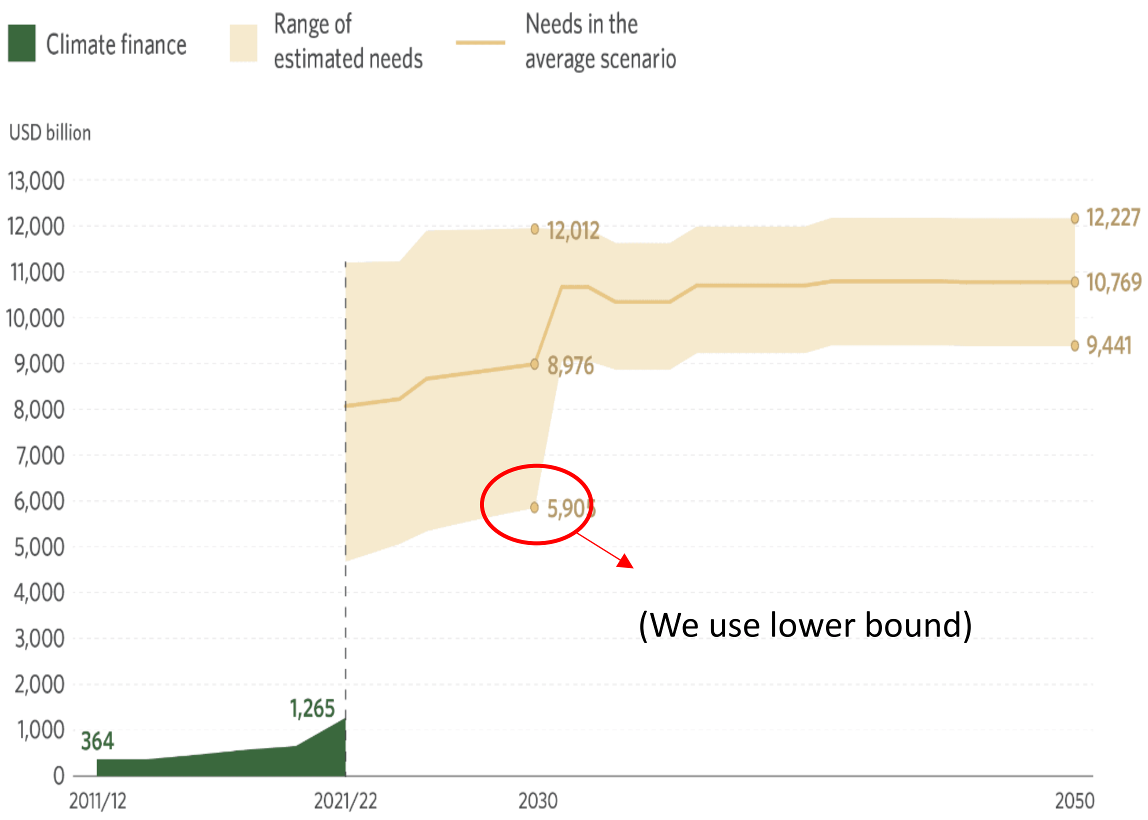
1. Climate Change: 5-6 USD tn. per year in 2030

Current NDCs NZ commitments demand investments in mitigation and adaptation. The orders of magnitude are huge. They are also urgent to avoid decades-long exposure to T° increases above 2°C, which increase tipping-point probabilities non-linearly. We use the lower bound of CPI´s range of investment needs.

Global greenhouse gas emissions, GtCO2 per year



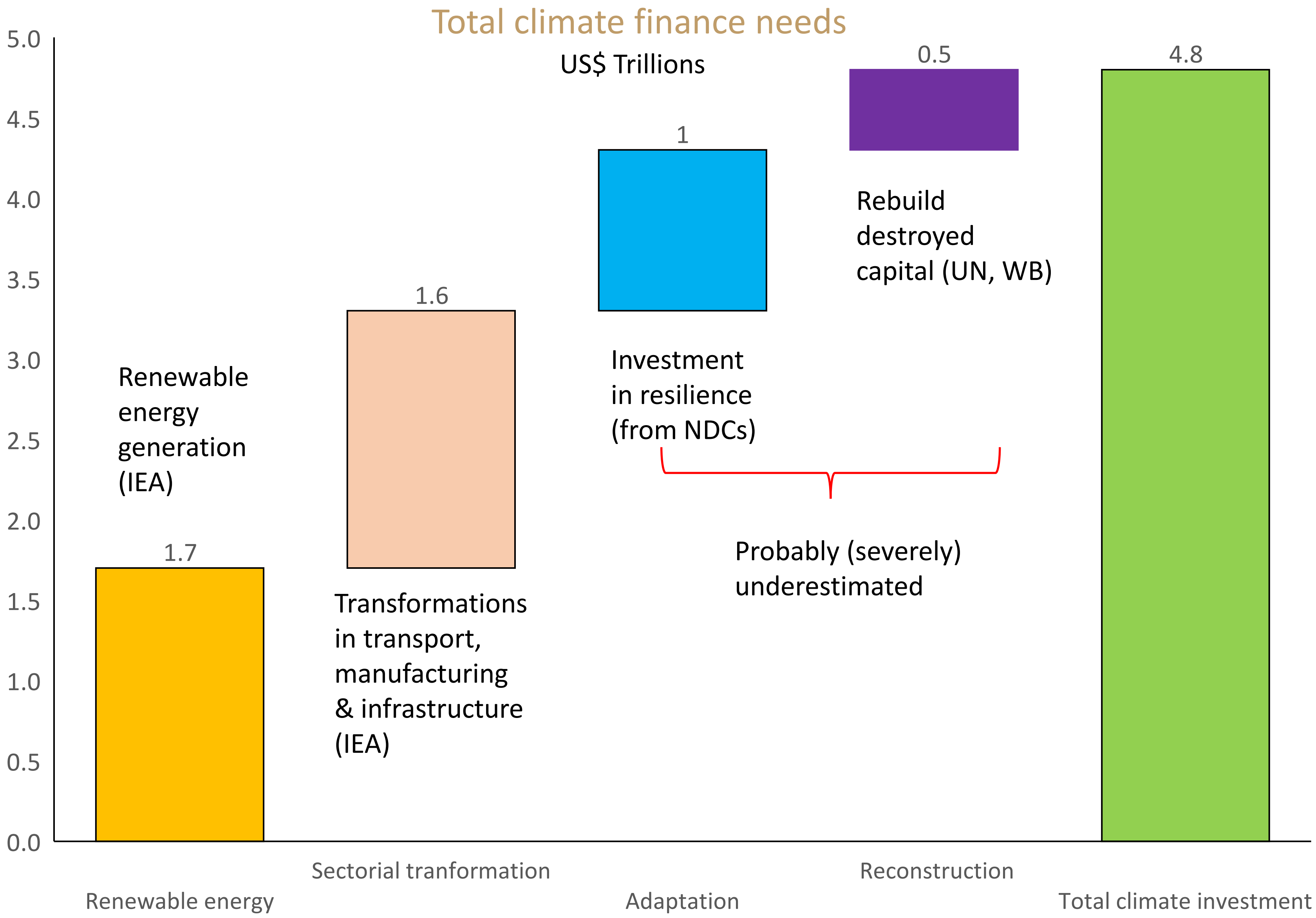
Climate investment level to reach NZ in 2050



Source: Climate Policy Initiative

Sources: IPCC 2022, FMI y CPI 2023

Key investment needs: 1. Renewable energy, 2. Sectorial transformation, 3. Adaptation (resilience), 4. Rebuild destroyed infrastructure.

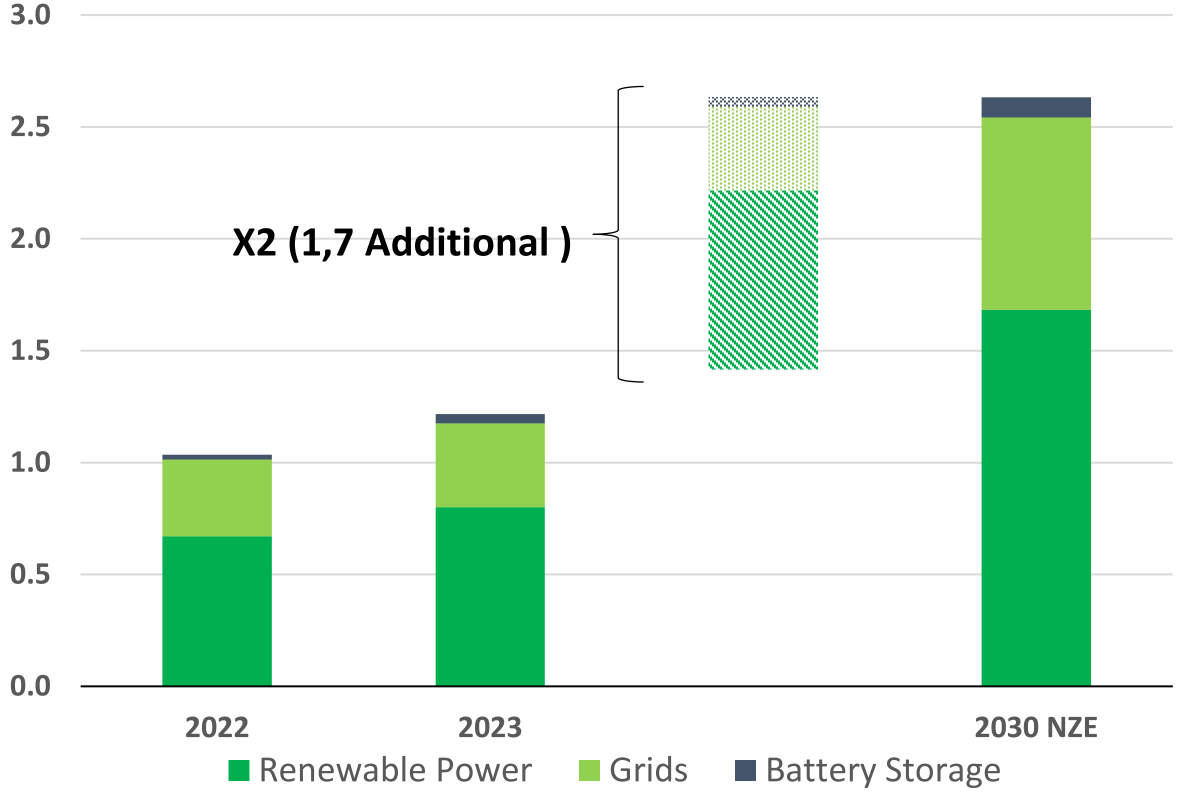


Sources: CPI , FMI, IEA 2024, UN 2024, GCA 2024 and WRI 2022

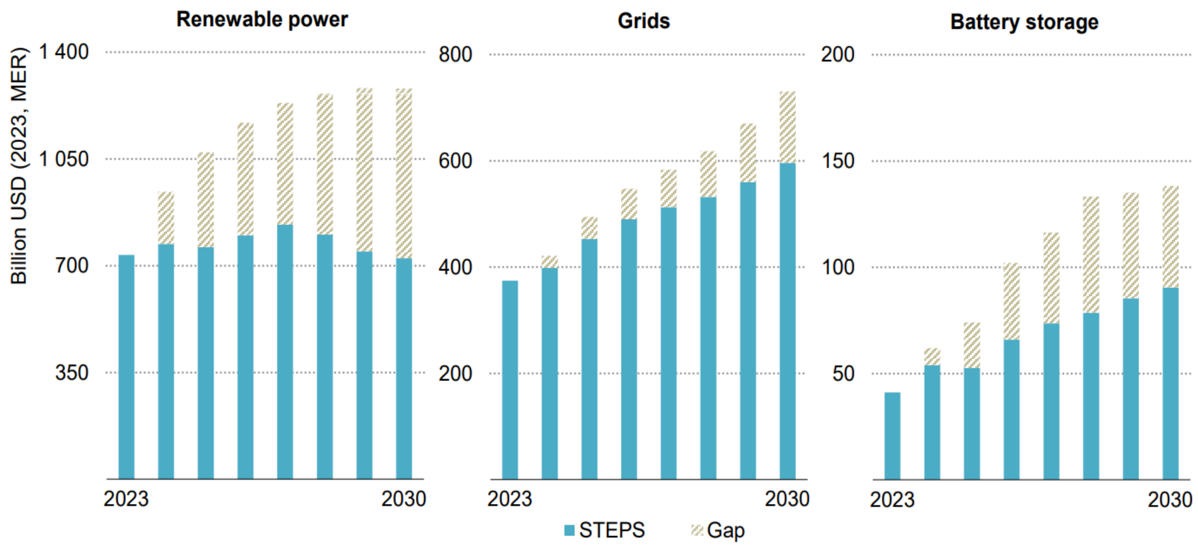
[Backup energy transition]

1. Renewable energy: new sources of clean energy generation, grid resilience, storage and transmission → doubling of investments to triple renewables capacity.

Energy transition
(Trillions US$)



Gap in investment spending energy generation



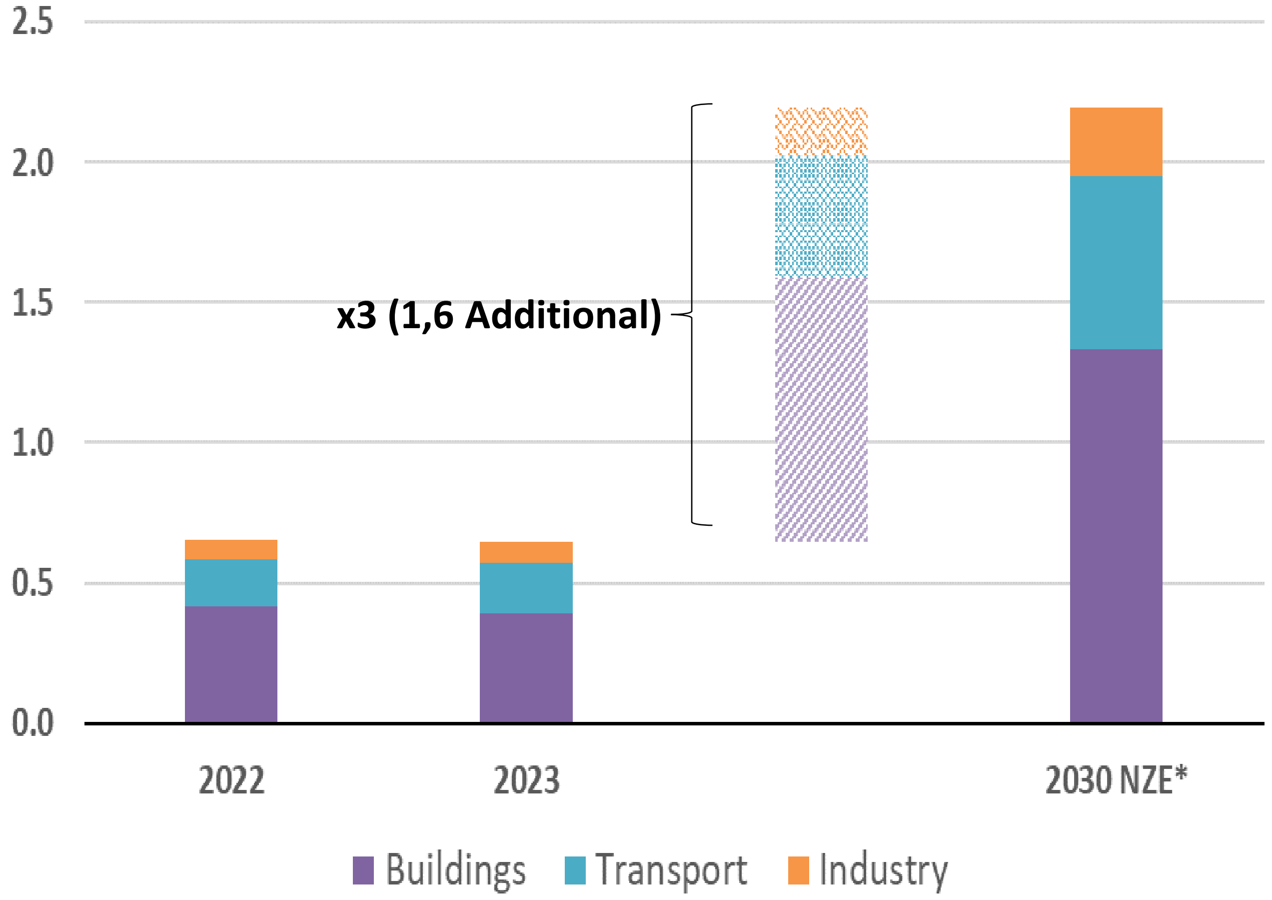
STEPS: States policies scenarios (NDCs, national plans and others)
NZE: Net zero scenario

[Background energy transition gap]

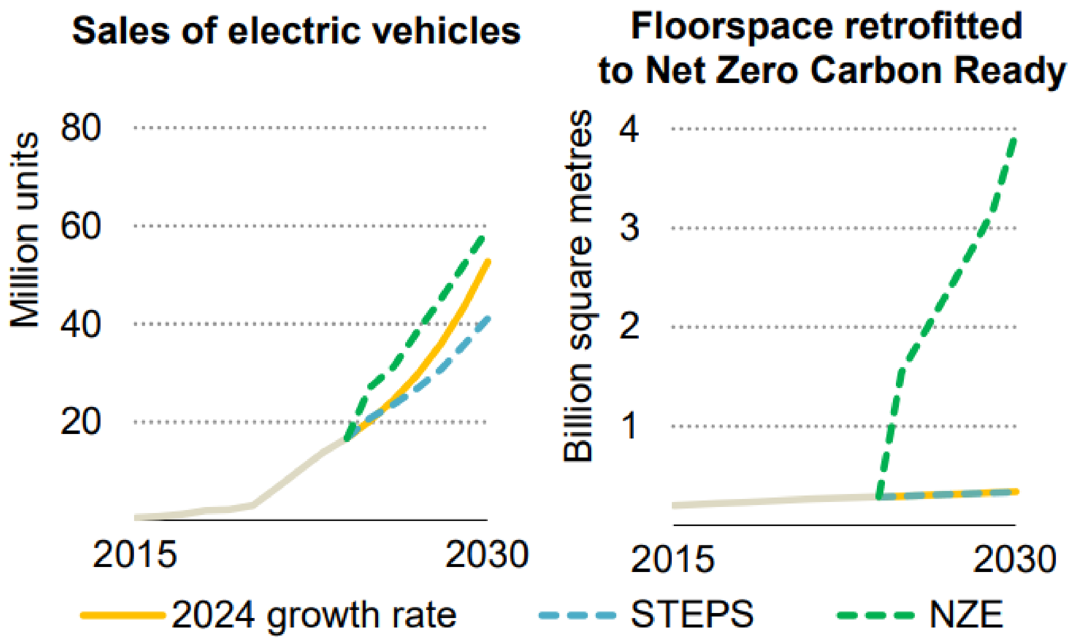
Sources: IEA 2024

2. Sectorial transformation: By 2030, investment in buildings nearly triples in the NZE Scenario (share of deep retrofits: 2.5% per year), heat pumps installed triples, and every new construction is NZ carbon ready. EV sales triples as 70% of new cars and more than half of buses and trucks sold are electric.

Tripling Electrification in other sectors



EV and retrofitted scenarios up to 2030



STEPS: States policies scenarios (NDCs, national plans and others) NZE: Net zero scenario

[Background mitigation buildings, transport and industry]

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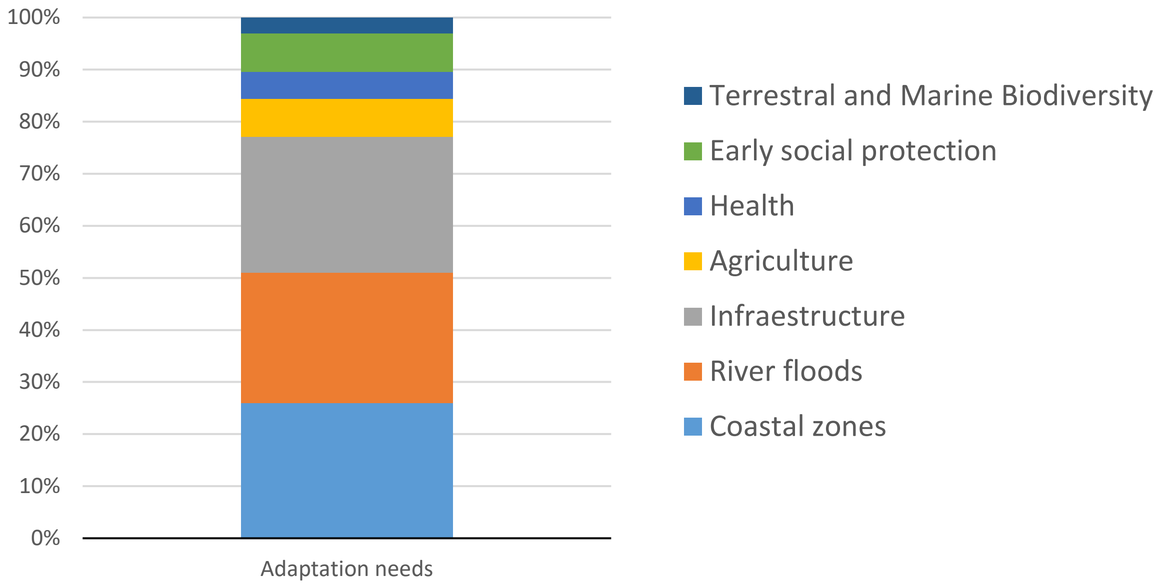
Sources: IEA 2024

3. Adaptation (resilience). It is increasingly necessary to increase investment in adaptation-resilience. More than half of the needed investment is demanded by low- and middle-income countries. Current and planned adaptation (NDCs) are largely insufficient, especially under non-linear climate damages.



	Annual adaptation finance needs as a percentage of GDP	
Region	**Median**	**Min - Max**
East Asia & the Pacific	0.7	0.1 - 1.9
South Asia	2.4	1.0 - 5.1
Latin America & the Caribbean	0.9	0.1 - 2.7
Sub-Saharan Africa	2.4	0.9 - 5.0
Middle East & North Africa	0.7	0.2 - 1.8
Europe & Central Asia	1.4	0.3 - 3.6
Global	**1.0**	**0.3 - 2.5**

- **Coastal zones:** Protection and beach nourishment. Increasing especially for +3°C scenarios. (i.e. sea walls and levees, floating and elevated structure) (Hinkel et al. 2013, 2014) (Lincke et al. 2018)
- **Infrastructure:** Building resilience in energy and transport (grid maintenance, EV public station, catastrophe backup energy generators, etc) World Bank (Hallegatte,Rentschler and Rozenberg 2019;Hallegatte et al.2019).
- **River floods:** Strengthening of existing dyke systems, implementing flood damage reduction measures for buildings, building of retention areas to store flood waters, and relocation of people and buildings from flood-prone to flood-safe areas**.** (Ward et al. 2017) (Lincke et al. 2018).
- **Health and early social protection:** Costs of disease control to address increases in malaria, dengue and diarrhoeal diseases and to address increased heat-related mortality, plus indicative costs of increased disease surveillance and covering entire sanitation health infrastructure resilient (WHO 2014).
- **Agriculture:** Impact on chronic hunger. Based on research, water management and infrastructure (FAO 2018).
- **Terrestrial, marine ecosystems and fishery:** Protected areas on land and sea, changes in catch potential (FAO 2018)(UNEP2022)

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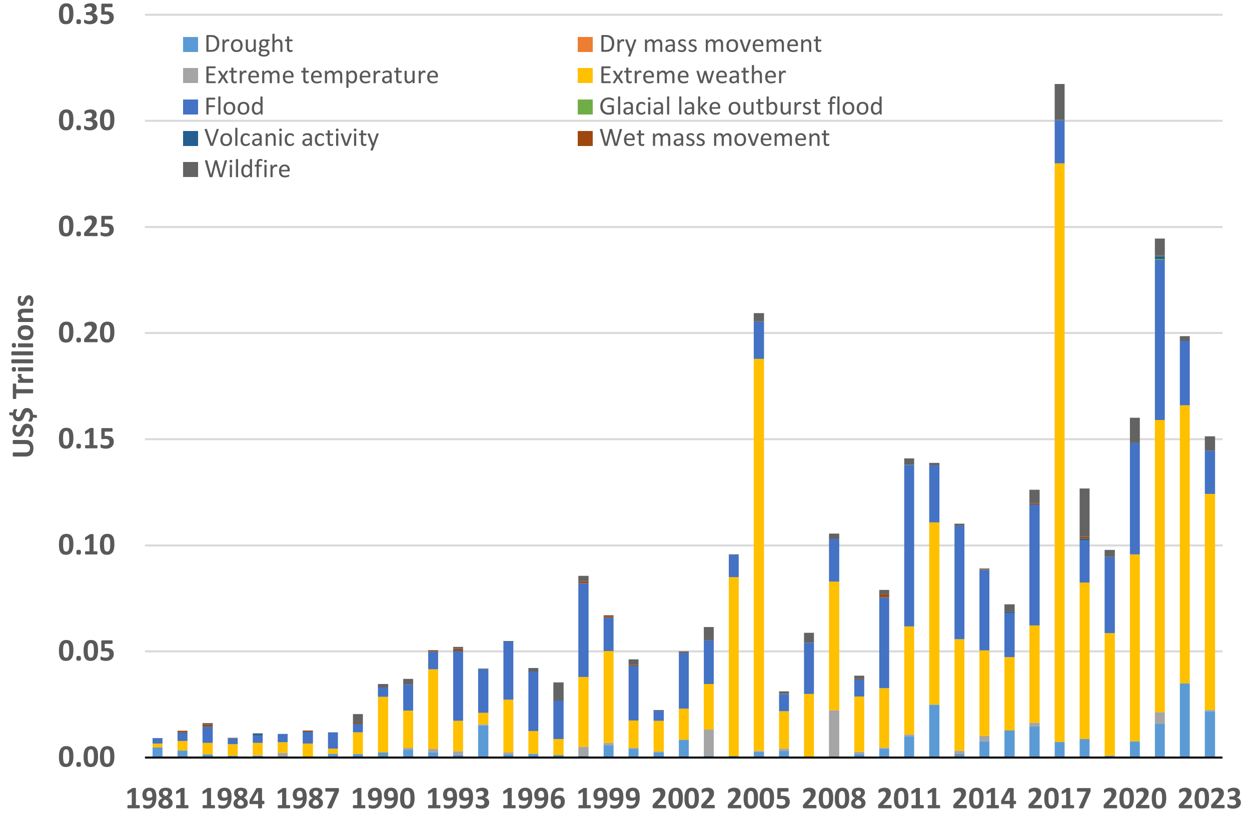
Sources: UN 2024, WRI (2023) GCA (2024)

4. Rebuild destroyed infrastructure. 7-fold increase in the number of natural disasters. Problem: current climate-macro models underestimate physical damages (NGFS 2024) → 0.5 USD tn is almost surely an underestimation. Recent evidence: significant impact on public debt (+10% GDP) after extreme events.

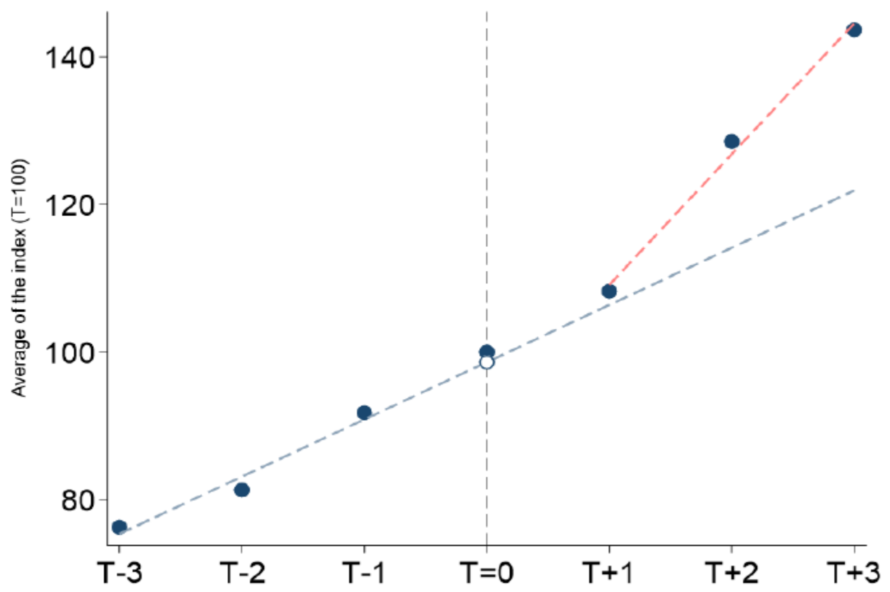
Global reconstruction cost from natural disasters. (all disasters excluding earthquakes)



Sources: EM-DAT, CRED / UCLouvain (2024)

Increase in debt levels before and after storms: (red dash line) Results from top 10 storms based on synthetic ranking of damages (blue dash line)

(debt levels indexed to 100 on year storm strikes)



Source: Cavallo et al (IADB WP, 2024)

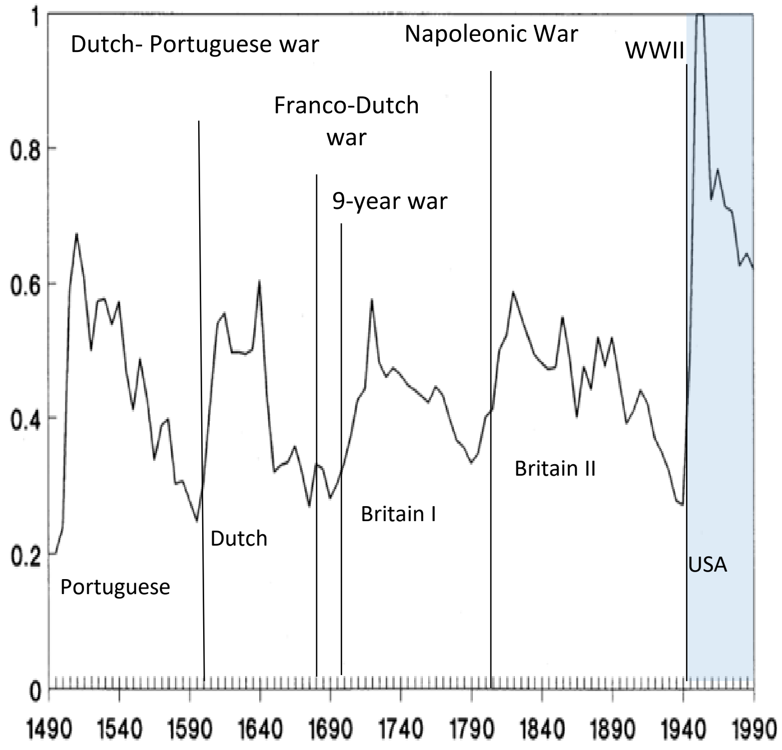
Note: The figure depicts pre - and post -trend lines and the pre -trend line projection up to "T+3 ." The short -term effect at "T is the difference between the actual debt levels and the counterfactual there is a significant acceleration in debt accumulation of 9.96 percent , which is the difference between post and pre -storm trends . Three years post -storm, debt levels are 17.9 percent higher than what would have been expected if the disaster had not occurred. These results are even more statistically significant if we rank storms by their economic damage (rather than using the synthetic index).

2. Pre-war rearmament: 1-2 USD tn. per year

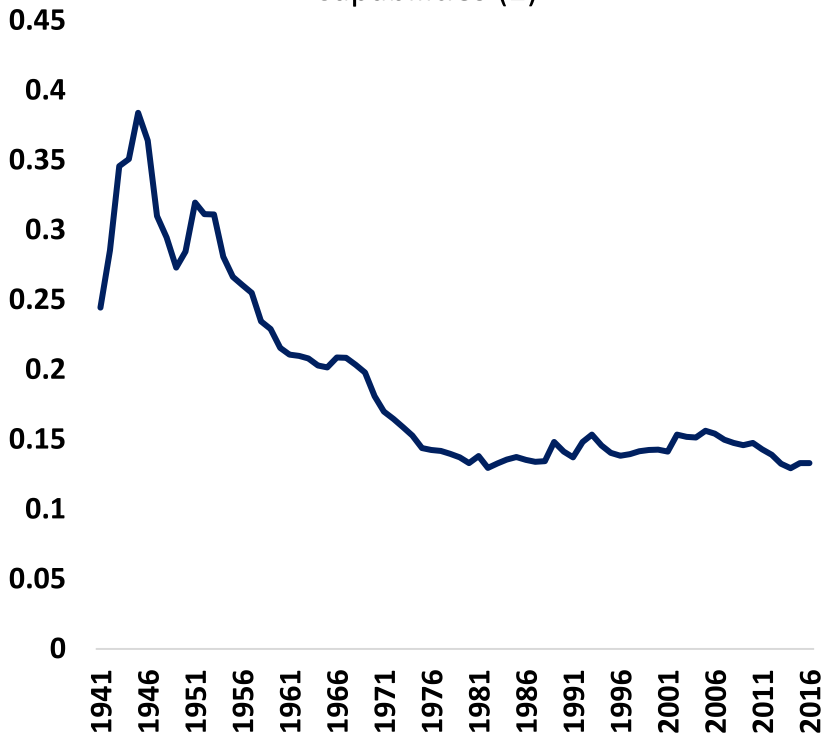
Current trends affecting the global environment (Dubik 2021) –technological change and inequality, multiple global competitors (dwindling military concentration) with success in using force to achieve goals, and ambiguity of global leadership— coincide with historic triggers of conflict.

Military Power Concentration

Navy Concentration Index (1)

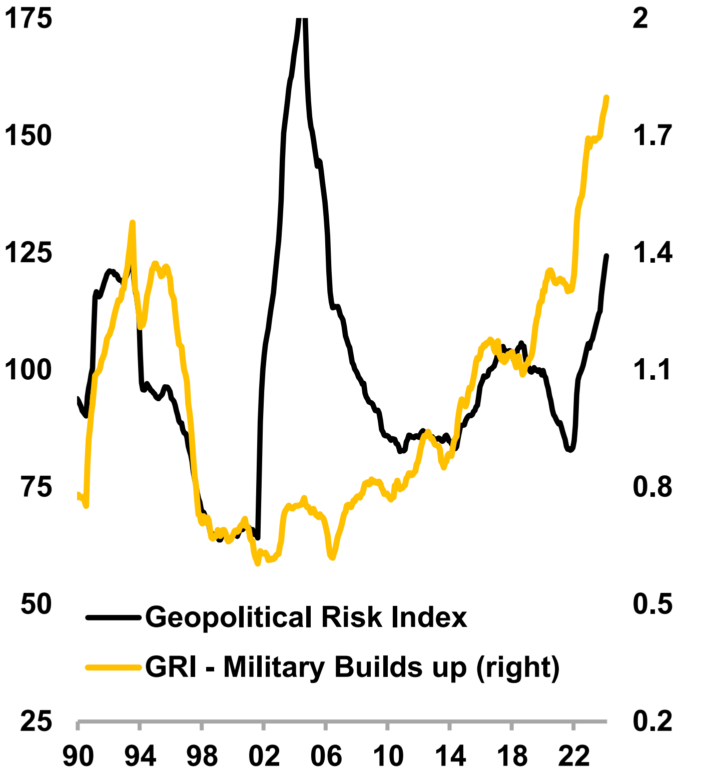


US Composite Index of National Capabilities (2)



Geopolitical Risk Index

(index; Contribution Index, 3-year average)



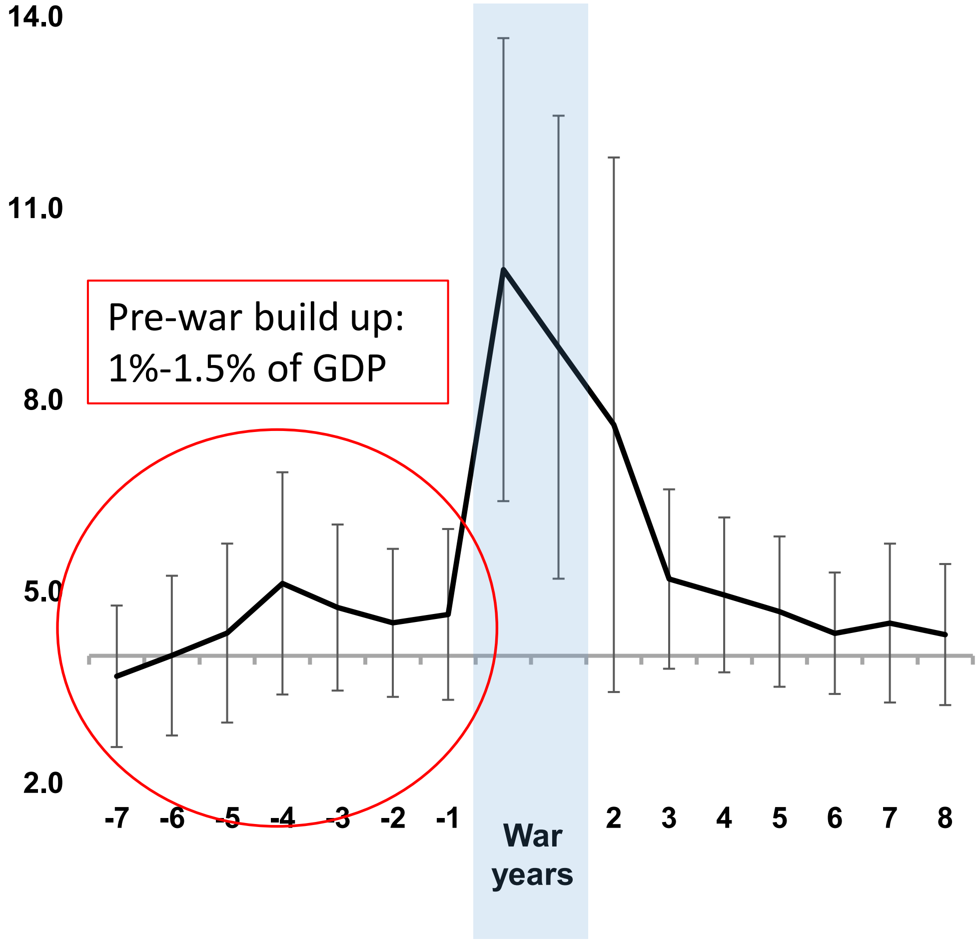
(1) The Long Cycle of World Leadership (Modelski & Thompson, 1988), and "K-Waves, Leadership Cycles, and Global War: A Nonhyphenated." (Thompson, 1993) (2) CINC determines states' annual share of global capabilities, by using six equally-weighted indicators of military and latent resources. It includes the military expenditure, military personnel, energy consumption, iron and steel production, urban population, and total population. WWII is not considered in the case of Russia.

Sources: SIPRI, Correlates of War, NATO and Caldara, Dario and Matteo Iacoviello (2022), "Measuring Geopolitical Risk", Crisher, Brian and Mark Souva. Forthcoming. "Power At Sea: A Naval Dataset, 1865-2011 .

Wars increase military spending roughly 50% 5 years before conflicts, and more than 4-fold during them, relative to peace time. Higher expenditure persists by about 5 years. This is mostly met by higher public debt–which can increase by up to 40% of GDP–and inflation.

Military Spending (1)

(GDP, %)



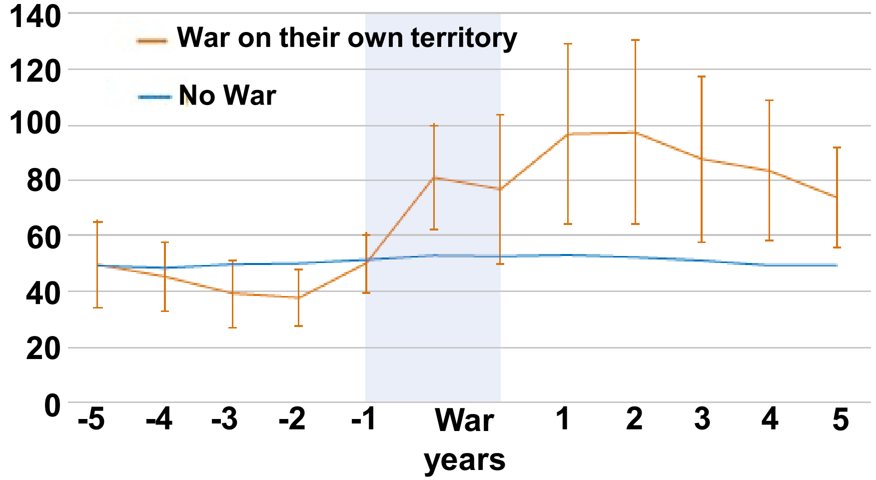
Historical Public Debt- Major wars 1899-2024 (2)

Increase in Gross Debt (% GDP) relative lo Avg. level 10-6 years before the war

	US	Advanced G20	Emerging G20
1-5y Before War	4,2	6,8	-13,4
During War	**15,4**	**13,6**	**8,6**
1-5y After War	40,6	15,9	-5,9
6-10y After War	26,5	8,1	-4,5
Gross Debt (% GDP) 2024	**121,0**	**119,2**	**75,8**

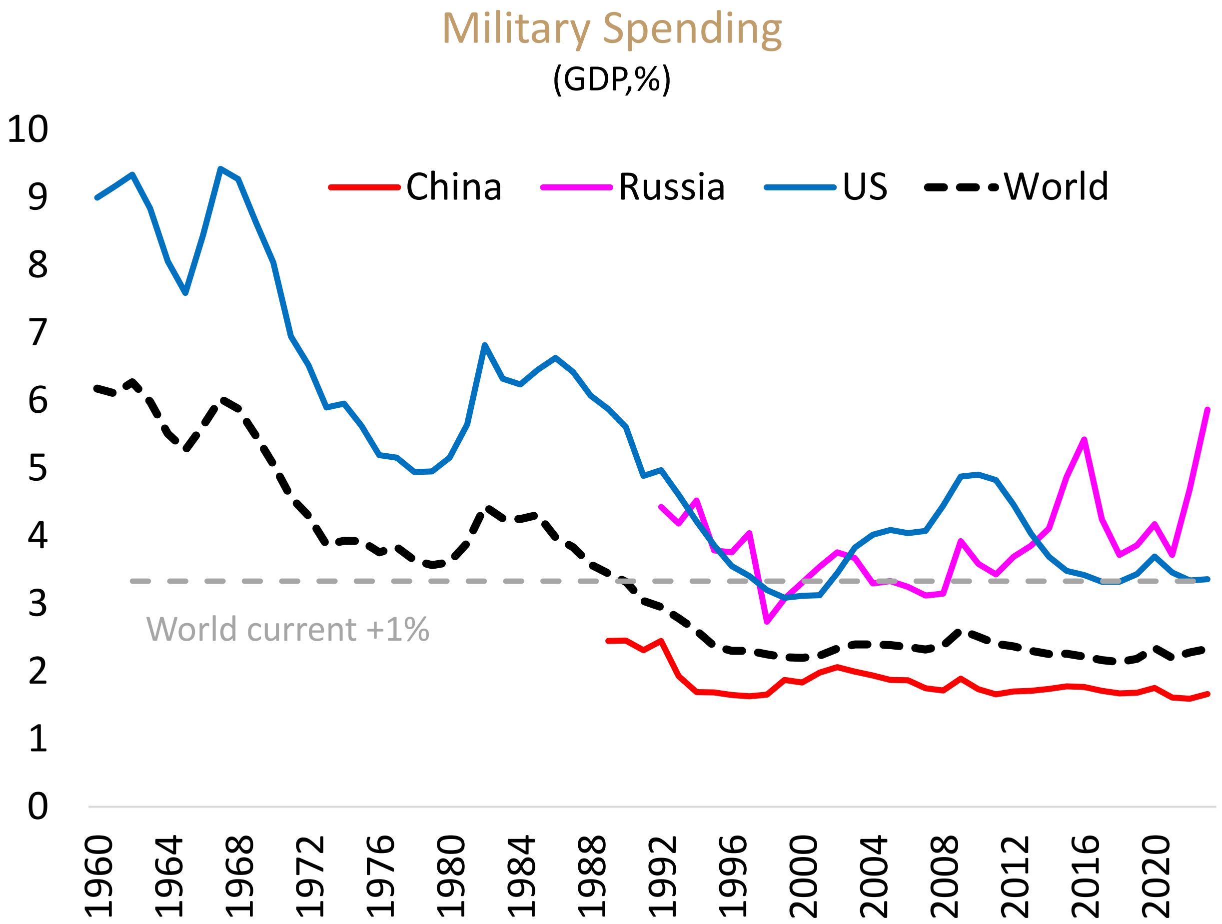
Gross Government Debt- Event study (3)

(GDP, %)



(1) Considers all wars between states since 1830 until 2007 and represents from the first and last year of wars. (2) WWII is not considered in the case of Russia. Sources: SIPRI, Correlates of War, Fred, Gabriel-Zucman.eu. (3) Estimated in Ch. 1 of "The economics of war and peace", by the European Bank of Reconstruction and Development.

After the end of the Cold War, spending declined to its lowest level in decades. While it hasn't seen significant increases yet, budget plans anticipate higher military expenditure in the coming years.



Military spending goals in selected countries

- In 2024, 18 Allies are expected to spend at least 2% of their GDP on defense – a six-fold increase since 2014.
    - Germany is spending around 1,7% of GDP and expected to reach NATO target by 2028.
    - France is spending around 1,9% of GDP and expected to reach NATO target by 2024.
- Japan is increasing military spending 16,5% y-y in 2024 and expect to increase a further 11% by 2027.
- China is increasing by 7,2% y-y in 2024.
- Russia increased it budget by 70% compared to 2023.

- **A 1% global GDP increase in military spending seems modest compared to recent history.**

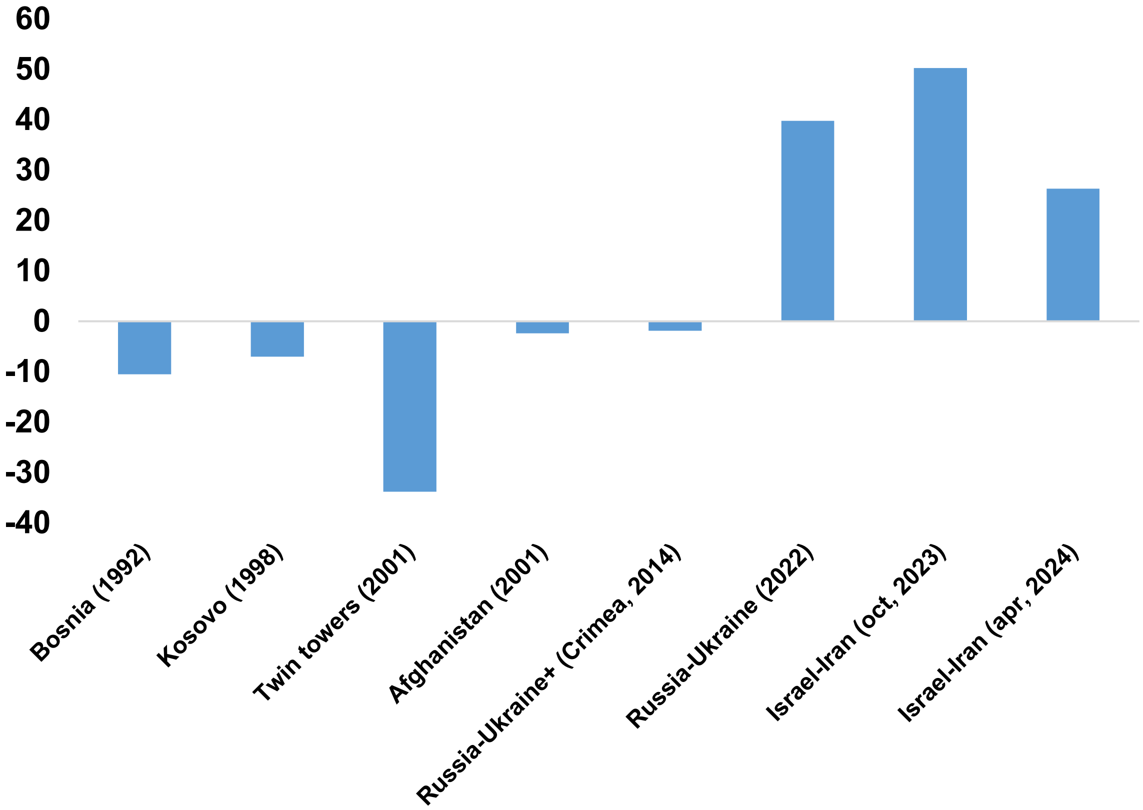
Background Ukraine   Background middle east

Source: NATO, SIPRI and Press releases

Indeed, higher defense spending could be staring to show up in market prices. Unlike traditional risk-off events, US long-term interest rates have been increasing in response to recent geopolitical tensions → likely reflecting a higher probability/magnitude of rearmament.

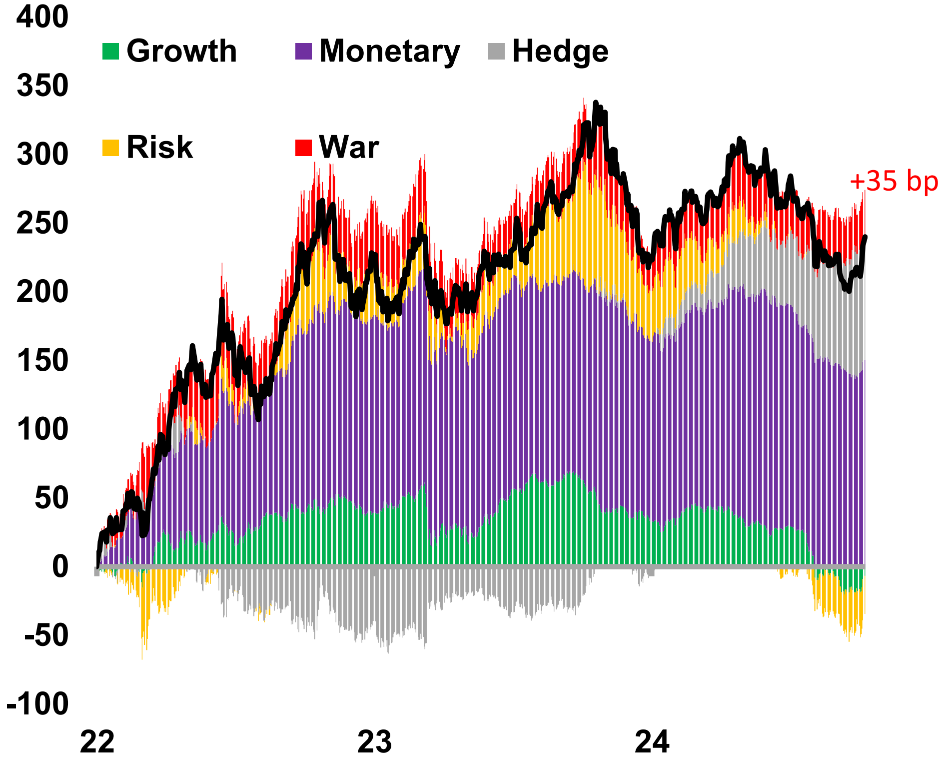
Reaction US 10y yield after geopolitical events (1)

(event study, basis points)



Decomposition US 10y yield (2)

(basis points)



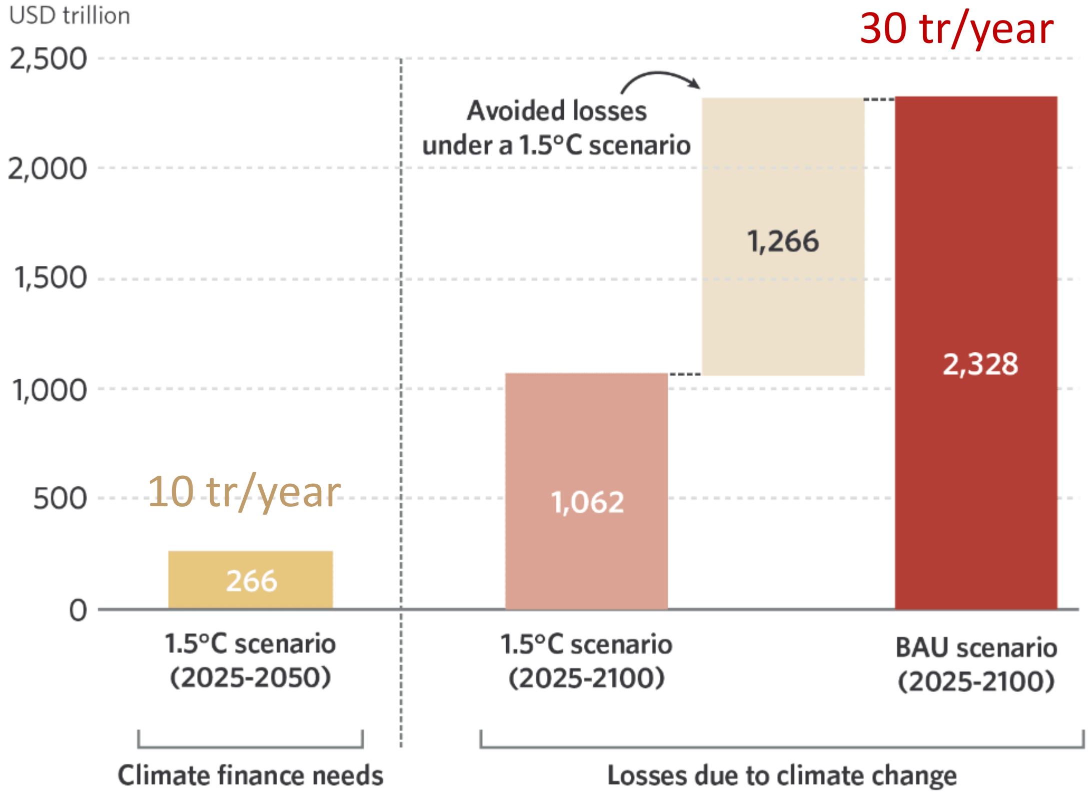
Methodology

(1) US 10-year yield change over 30 days centered on the event. (2) Sign restricted VAR *a la* Cieslak Pang (2021) where the war shock is identifyeid adding the oil price and defence and military related stocks. (2) Consider all wars between states since 1830 until 2007 and represent from the first and last year of wars. (3) WWII is not considered in the case of Russia. Sources: SIPRI, Correlates of War, Fred, Gabriel-Zucman.eu.

3. Timing considerations and other policies

Timing implications: at nearly 5-6 Tr/year, climate investment needs are by far the largest in coming decades. If not met, costs to society will come later, but will be far larger –and cost estimates don´t even consider tipping point scenarios.

Cost of inaction on climate change
(upper bound of available studies)*



Source: Climate Policy Initiative

These cost estimates include:

- Impacts on productivity
- Damage to assets and physical capital
- Lost travel and tourism
- Health and wellbeing

But they don´t include:

- Loss due to stranded assets
- Loss of nature and biodiversity
- Conflict and migration
- Tipping points in climate and/or nature

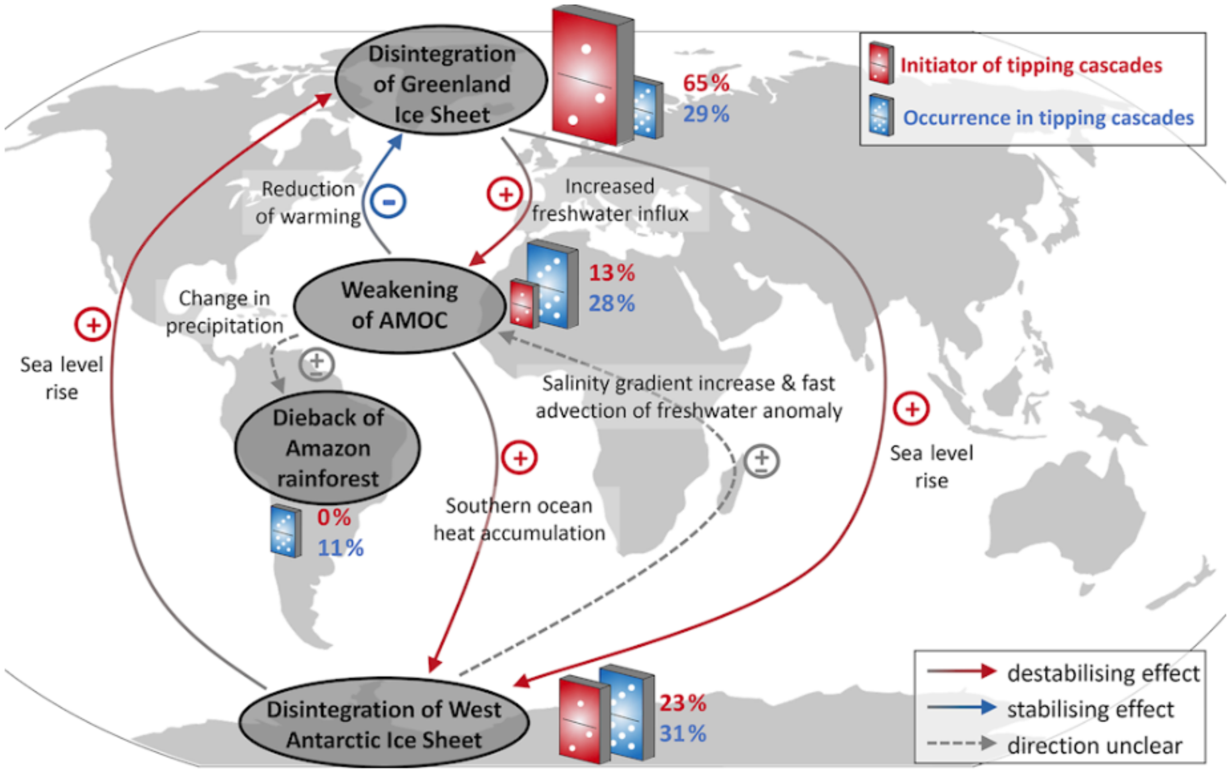
Timing implications:

- Upfront costs now → protect current capital stock.
- If delayed → larger costs arise in the future, in the form of rebuilding destroyed capital and wider socio-economic impacts (poverty, migration, conflict, etc.).

*We use upper bound of damage estimates since current methodologies omit and/or bias downward the impact of climate along several dimensions –See NGFS 2024: "Climate macroeconomic modelling handbook".

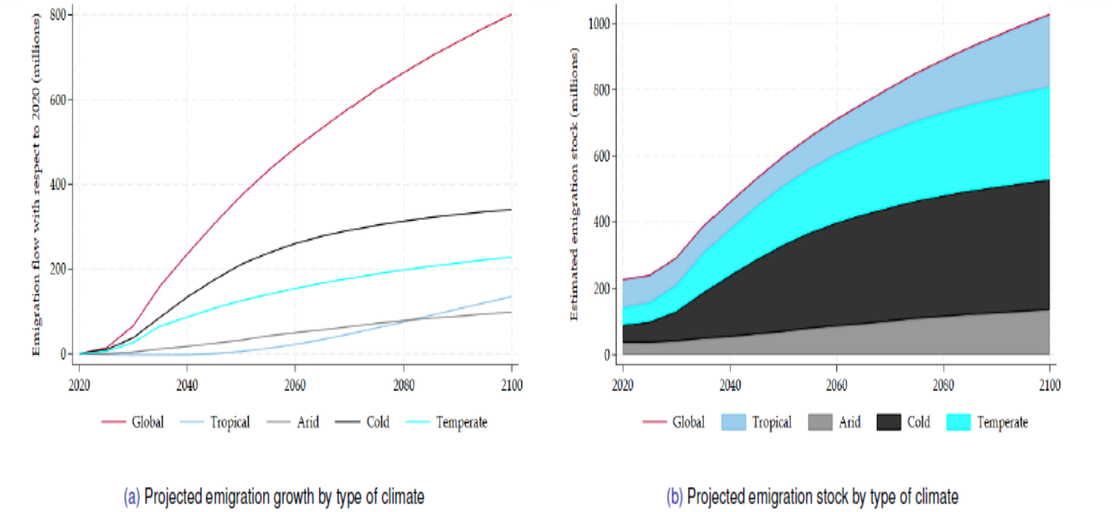
A collapse of the Atlantic Meridional Overturning Circulation (AMOC) would significantly increase temperature differentials between equatorial belt and North Atlantic. Severe damages to agriculture and extreme temperatures could trigger migration by the billions.

Interactions between climate tipping elements and their roles in tipping cascades



Note: Interactions between the Greenland Ice Sheet, the West Antarctic Ice Sheet, the Atlantic Meridional Overturning Circulation (AMOC) and the Amazon rainforest and their roles in tipping cascades. Destabilising links between the tipping elements are depicted as red arrows whereas stabilising interactions are depicted as blue arrows. Where the direction is unclear, the link is marked in grey. Where tipping cascades arise, the relative size of the dominoes illustrates how many ensemble members the respective climate component initiates tipping cascades in (red domino) or how many tipping cascades the respective climate component occurs in (blue domino).

Emigration projections based on AMOC collapse scenario



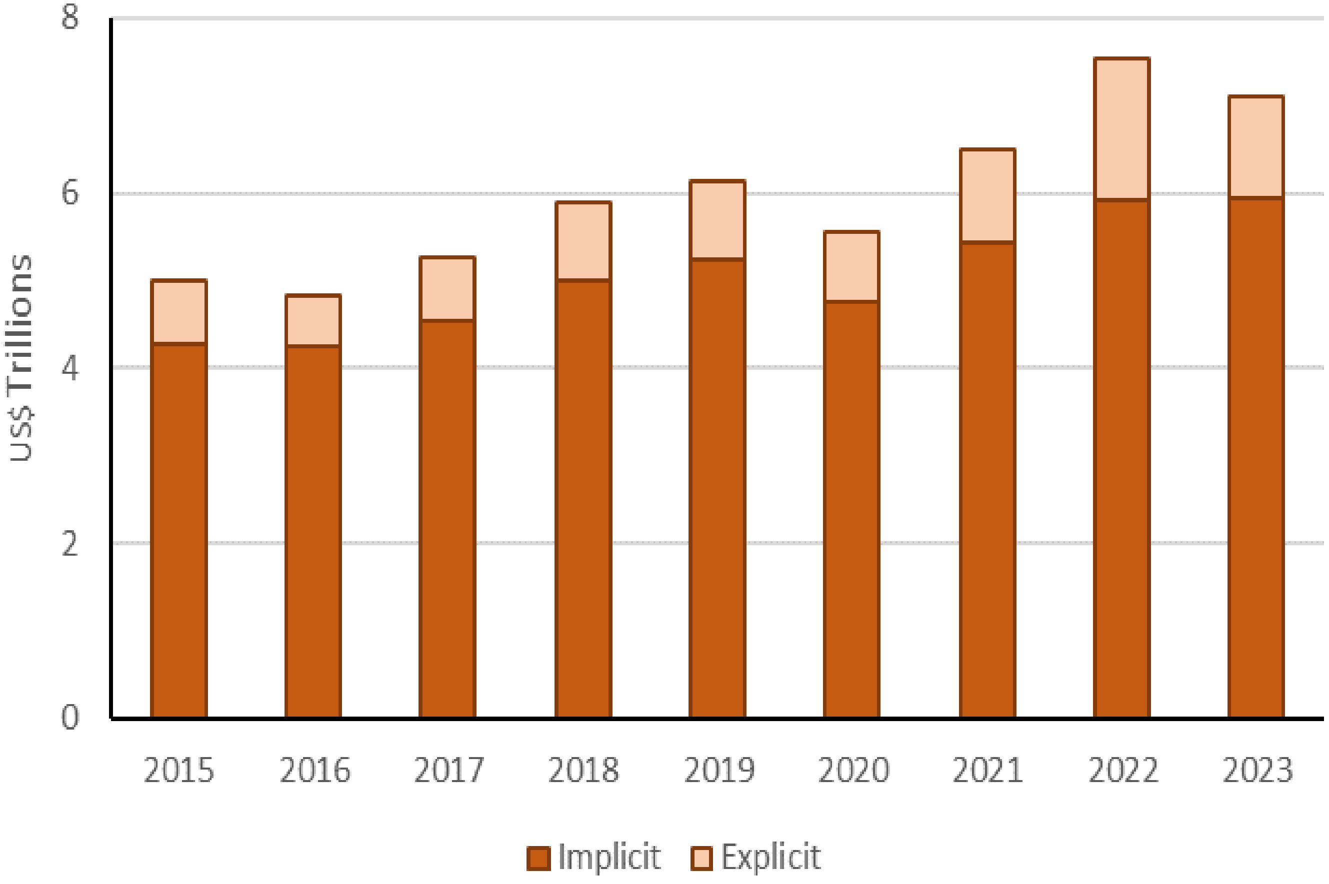
- Tropical countries become warmer and northern countries colder, translating into an increasing outward migration for both groups.
- Total outward migration stock is projected to increase from 200 million to more than 1 billion under AMOC scenario.

Source: Albagli et al 2024; Wunderling et al., 2021[4]), OECD, 2021, Kriegler et al, 2009; Cai, Lenton and Lontzek, 2016; Wunderling et al 2021

Other policies: the bulk of climate expenses could be netted out by removing direct and indirect fossil fuels subsidies.

Implicit and explicit fossil fuels*

2021 US$ Trillions



* Explicit subsidies result from underpricing, where costs exceed user prices. Implicit subsidies arise from the gap between costs and socially efficient prices, considering negative externalities and lost tax revenue, excluding explicit subsidies. Source: IEA 2024.

4. Other factors and link with policy rates

Other elements that may affect long-term interest rates have been highlighted both in the academic literature and in policy discussions: ambiguous and/or of smaller magnitude.

- **Demographic trends**: Ambiguous effect
  - Along the transition, an aging population in EMEs and AEs increases savings and puts downward pressure on long-term interest rates.
  - Once in the new SS, higher consumption levels from non-productive individuals decreases savings, pushing interest rates up. (Goodhart & Pradhan, 2020).
- **Savings glut in EMEs:** Ambiguous effect, likely positive on interest rates
  - EMEs accumulated large stocks of foreign-exchange reserves to counteract potential sudden-stops and capital outflows in case of financial crises. The higher global savings was one of the factors pushing interest rates down in the last decades (Bernanke, 2005). Scarcity of safe assets was a reinforcing factor (Caballero *et al.* 2016).
  - Demand for safe assets is likely to continue diminishing due to: lower commodity prices (notably oil), lower current account surpluses and a more consumption-driven aggregate demand of EMEs.
  - If EMEs start decumulating safe assets, effect on interest rates would be positive.
- **Risk aversion:**
  - The increase in the variance of income needed to counteract these investment through higher savings (risk aversion) is unrealistically large.

Still, the mapping from higher cost of capital $\widehat{R}$ to the risk-free, short-term rate R^* (neutral MPR) is not straightforward (e.g., Ricardo´s Keynote address).

- Going from $\hat{R}$ *to* R^* requires discounting different layers of risk and term premia.

- $\widehat{R}$ to yield curve, need to consider
  - Relative contributions of public vs. private financing of new investment needs.
  - Corporate risk premia and liquidity premia.
  - Factors affecting the preference for govt. bonds vs. other assets.

- From long-term risk-free rates to R^* (MP neutral rates), need to consider term premia.

  - Thus, movements in R^* are unlikely to track $\hat{R}$ one-to-one.

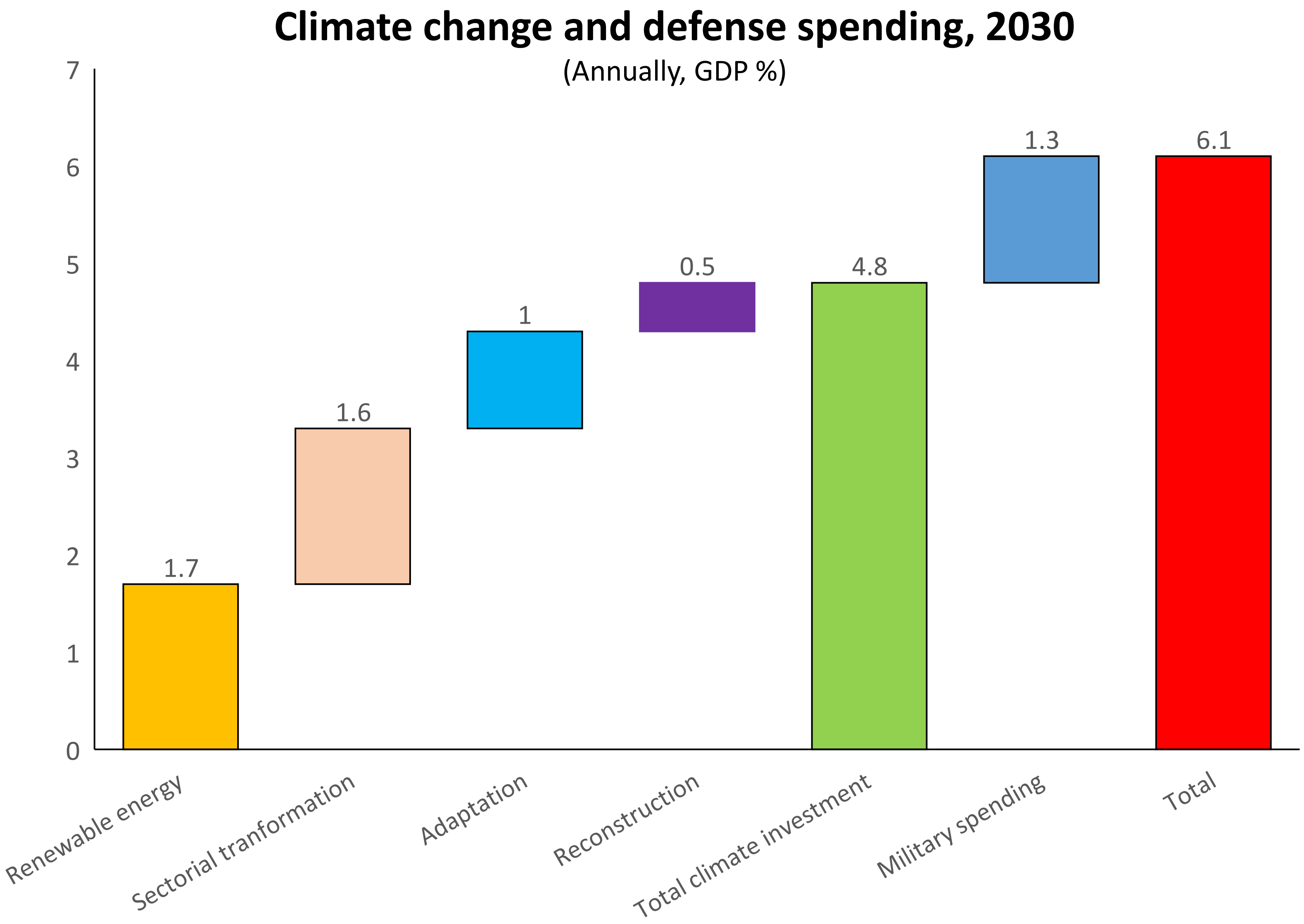
- The implications of these trends for R^* need to be carefully evaluated.

TABLE II.6 NEUTRAL MONETARY POLICY RATE ESTIMATES
(percent)

Method	Real NMPR
1. Stochastic Trend - BCP10	1.0
2. Stochastic trend - Convenience Yield	0.9
3. Term premium correction	0.6
4. Taylor Rule	1.2
5. Taylor Rule - Expectations	0.6
6. Interest rate parity (dots)	1.5
7. Interest rate parity (U.S. models)	2.3
8. Consumption model with habits	0.0
9. Common stochastic trend model	1.1
10. Reduced-form model (dots)	1.1
11. Reduced-form model (U.S. models)	1.4
Median	**1.1**
Range (*)	**0.6 – 1.5**

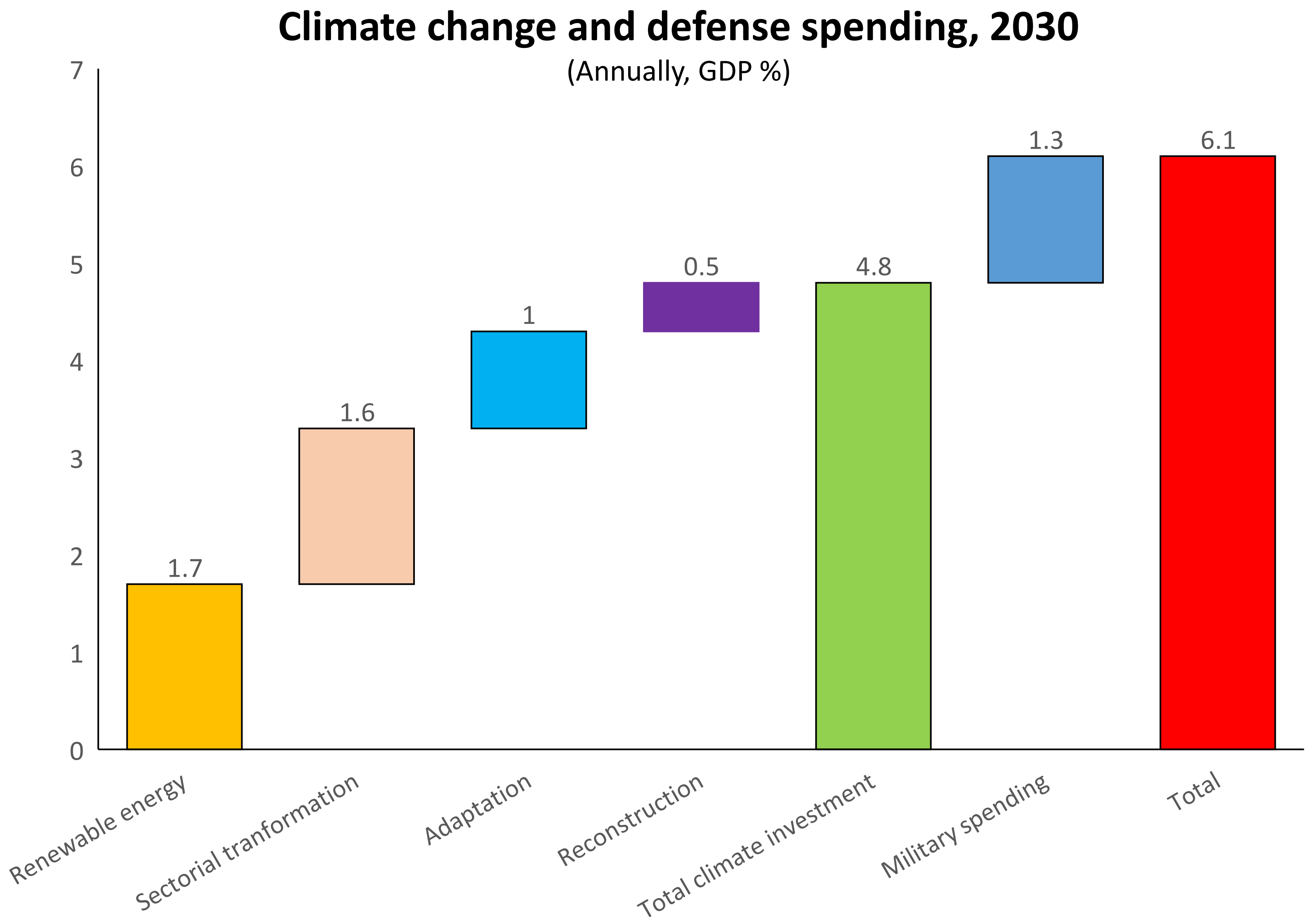
(*) Excludes lowest (0.0) and highest (2.3) estimates.
Source: Arias et al. (2023).

Conclusions



- The climate transition and the likely ramp up of defense spending worldwide imply huge investments in the coming decades: 6%-8% higher spending/GDP annually around 2030.
- These expenses are too large –about 30% of current investment--, and thus likely to be kicked down the road (especially climate). This mainly postpones costs, changing their inherent nature (from protecting, to rebuilding capital stocks) and significantly increasing their magnitude and scope, to include broader socio-economic effect.
- One single policy could net out the bulk of these expenditures –removing fossil fuel subsidies. Its political feasibility is also highly unlikely.

Conclusions



- Other elements can also affect aggregate savings-investment equilibrium, but they are either ambiguous and/or of smaller orders of magnitude (e.g., precautionary savings).
- Large part of this spending is likely to be financed by public debt. Given already deteriorated public finances, this would probably push "risk-free" yield curves upward.
- Whether this increase in long-run interest rates will translate into higher MP neutral rates (R*) depends on many factors, and in any case, probably lie beyond current monetary policy horizons.

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Appendix: climate change

CPI (2023): key findings on climate finance landscape.

1. The climate finance gap is huge: 10-fold
2. Energy, transport & infrastructure explain bulk of current investment. AFOLU receives virtually no investment, despite largest CO2 emissions reduction potential towards (IPCC 2022)
3. Adaptation investment is tiny, representing a core vulnerability to climate damages, particularly in EMEs.
4. Most climate finance is raised and spent domestically (80%).
5. The core of climate finance is in the form of public debt, most at market rates.

High public debt limits further scaling-up of climate investment, urging policies that align investment incentives in mitigation, adaptation, and nature

Figure 8: Uses of climate finance with private-public splits

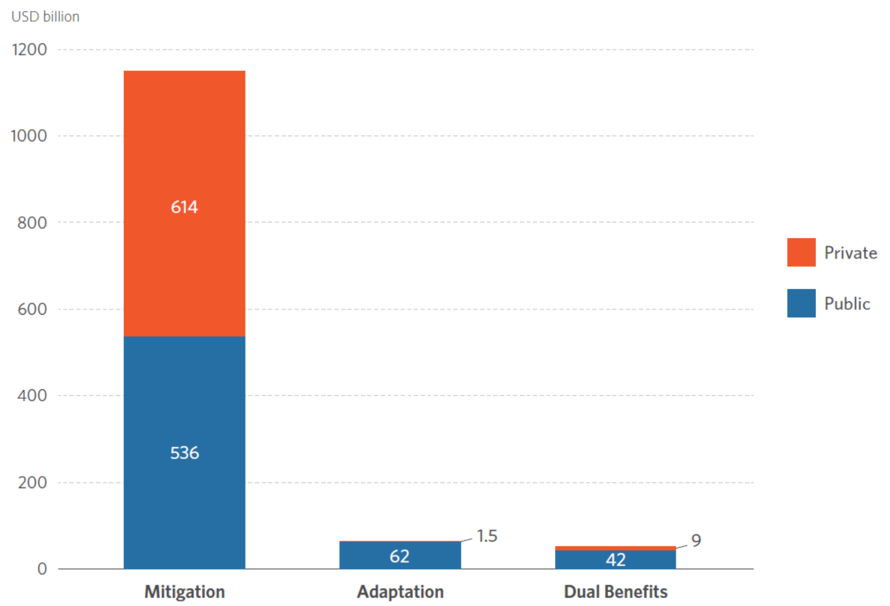
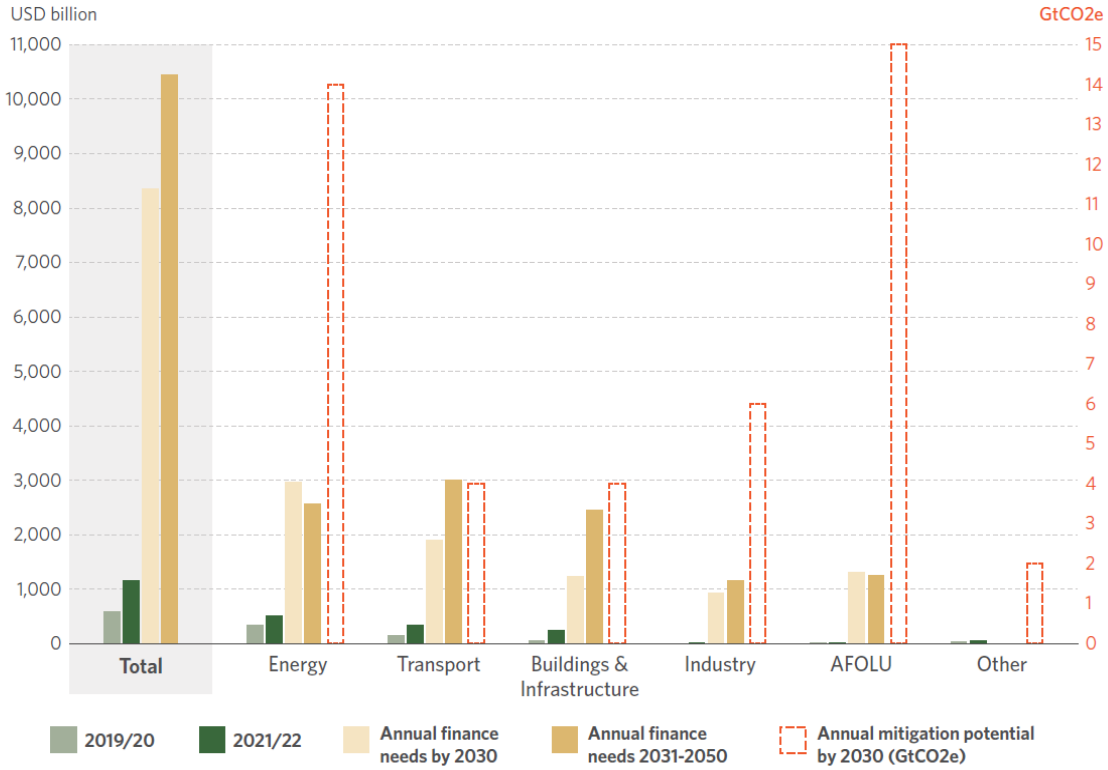


Figure 9: Climate finance flows in key mitigation sectors, finance needs and mitigation potential



Mitigation investments: Renewable power, grids and storage.

Renewable Power

- Solar energy: Investment in photovoltaic (PV) solar farms and rooftop solar installation
- Development of solar concentrating power technologies.
- Construction of onshore and offshore wind farms.
- Investments in advanced turbine technologies to improve efficiency and capacity
- Investments in biomass conversion technologies for energy generation.

Investments in Energy grids

- Implementation of smart meters, sensors, and communication technologies to enhance grid management and efficiency.
- Upgrading existing grid infrastructure improvements to withstand extreme weather events and other disruptions.
- Development of microgrids to enhance energy security and local resilience
- Interconnection projects, investments in cross-border power lines to facilitates the sharing of renewable energy across regions and countries.

Battery Storage

- Development of large-scale battery systems to support grid stability and integrate variable renewable energy sources (e.g., solar and wind)
- Investments in lithium-ion and emerging technologies (like solid-state batteries)to enhance battery storage
- Residential and commercial energy storage systems, allowing consumers to store excess renewable energy for later use

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Source: IEA (2023, 2022), IRENA (2023) WEF (2022) BloombergNEF (2023)

Mitigation investments: buildings, transport and industry

Industry

- Energy efficiency improvements: Implementing advance manufacturing process and technology to reduce energy consumption, such as high-efficiency motors and waste heat recovery systems
- Carbon capture and storage (CCS): Investing in technologies to capture and store carbon emissions from industrial processes, particularly in heavy industries such as steel, cement, and chemicals
- Switching to low-carbon fuels: Transforming from fossil fuels to low-carbon energy sources such as biomass, hydrogen, and electricity from renewables
- Circular economy practices: Enhancing recycling, reusing materials, reducing waste in manufacturing processes to lower emissions associated with production and disposal

Buildings

- Energy –efficient retrofits: Upgrading insulation, windows, lighting, and heating, ventilation, and air conditioning (HVAC) systems to reduce energy demand in existing buildings.
- Renewable energy integration and green design: Using sustainable material like wood, maximizing natural light and installing solar panels.
- IA smart energy systems: Utilizing smart technologies, energy management, and sensors to optimize energy use and reduce consumption.

Transport

- Electrification: Accelerating the adoption of electric vehicles (EV) by investing in charging infrastructure, providing incentives to EV purchases, and supporting public transportation electrification.
- Fuel efficiency standards: Implementing stricter fuel economy standards for vehicles to reduce fuel consumption and emissions.
- Public transit and non-motorized transport: Expanding and improving public transit systems, and promoting cycling and walking infrastructure to reduce reliance on personal vehicles

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Source: Global CCS institute (2020), IEA (2020, 2021), ICCT (2020), U.S. Department of Energy (2019), EPA (2018), APTA (2017),European Comission (2015),

Cost of inaction on climate change: literature review.

	Economic Cost			Social Cost					
Escenario	Eimpacts on productivity	Damage to asset and capital	Global flow of currency	Health and well-being	Loss of nature and biodiversity	Conflict and Migration	Global and local inequalities	Looses and Damages	Source
1.6 -2.6 C by 2060 2.5 - 4.4 C by 2100								1-3% yearly GDP loss by 2060 2-10% yearly GDP loss by 2100	The economic consequences of Climate Change, OECD 2015
Deley policy action								Additional US$ 12 Trillions cost	Stranded Assets and Renewables, IRENA 2017
1.5 C by 2100 (RCP 2.6)								US$ 2.7 Trillions	Working on a warmer planet: The impact of heat stress on labor productivity and decent work, ILO 2019
Actual warming 2011								US$ 11.4 - 23.4 Trillions annually	Biodiversity: Finance and the Economic and Business Case for Action, OECD 2019
2-3 C (RCP 4.5)								US$ 90 - 225 Billions	The economic case for nature, World Bank 2021
BAU until 2020								EU$ 450 - 520 Billion	Briefing Economic looses and fatalities from weather and climate related events in Europe, EEA 2022
3C by 2100 (current policies)								Up to 20% GDP looses	Scenarios for Central Banks and Supervisors, NGFS 2022

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Source: CPI 2023

Appendix: wars

Towards a two-polar world: the consolidating alliances in the "West" vs. "East".

China, Russia, Iran, and North Korea are significantly increasing their strategic, economic and military cooperation.

- Just before invasion of Ukraine **Beijing** announced its "*no limits* relationship" with **Russia** (bilateral trade increased 26% in 2023).
- Ali Khamenei about Russia invasion of Ukraine: "*it's a defensive act in the face of an imperialistic West".*
- Many large **China-Russia** joint military exercises including naval patrol near Alaska and flying bombers around Japan during a President Biden's visit in 2022.
- **China and Iran** signed a *Strategic Partnership Plan* in 2021 (Chinese investment plan in exchange for cheap oil): but little progress so far.
- Nearly 100% of **North Korea** external trade is with **China**.
- **NK and Russia** signed a treaty for *comprehensive strategic partnership* in June 2024. **In October Iran sent troops to Ukraine.**
- **Russia-Iran** relations improved since 2015 support to Bashar al-Assad. In 2021 signed agreement for sharing intelligence about U.S. cyber operations.
- **Iranian** Foreign Ministry Spokesperson: "*We congratulate the people and government of **Venezuela** for the successful holding of the presidential elections…"*

China is expanding its sphere of influence far beyond the East axis.

- As of 2022, at least 147 countries had signed BRI cooperation documents, up from 125 in 2019.
- Between 2013 and 2022 China spent $679 billion in global infrastructure projects (average 70bn per year), the US $76 bn.
- Instability in the Sahel region (*aka "the coup belt"*) is another anti-western pole (supported by Russia), but also may affect Chinese economic interests.

China-Tawian conflict has the potential of direct US-China confrontation.

- **President Xi** (Jan-2024): **China will surely be reunified with Taiwan**, setting 2049 as a target date for achieving the Chinese dream.
- Chinese Military drills around Taiwan have increased significantly, a way of "*strong punishment for separatist acts*".
- Lin et.al (2024): *"Chinese military planners have long considered a blockade to be one of the main campaigns for which the PLA needs to prepare"…*
- President Biden (Sept 2022): **The US would defend Taiwan militarily**—breaking the strategic ambiguity policy.
- Pentagon Report Oct.24: "*China is undergoing the most rapid expansion and ambitious modernization of its nuclear forces in history*".

Six "global swing states" will be particularly important (Kendal and Fontaine, 2024).

- Brazil, India, Indonesia, Saudi Arabia, South Africa, and Turkey are all middle powers with enough collective geopolitical to sway direction of the international order.
- Oct. 24: Brazil eyes China's Belt and Road Initiative. US says to reconsider

Russia-Ukraine conflict overview

Historical Background

go back

- **Soviet Dissolution & Independence (1991)**: Ukraine's independence followed the USSR's collapse, but its strategic importance remained crucial for Russia (**House of Commons Library**).
- **Euromaidan & Crimea Annexation (2013-2014)**: Protests led to the ousting of Ukraine's president; Russia annexed Crimea and supported separatists (CFR Ukraine Overview, CFR 2023).

Full-Scale Invasion (2022)

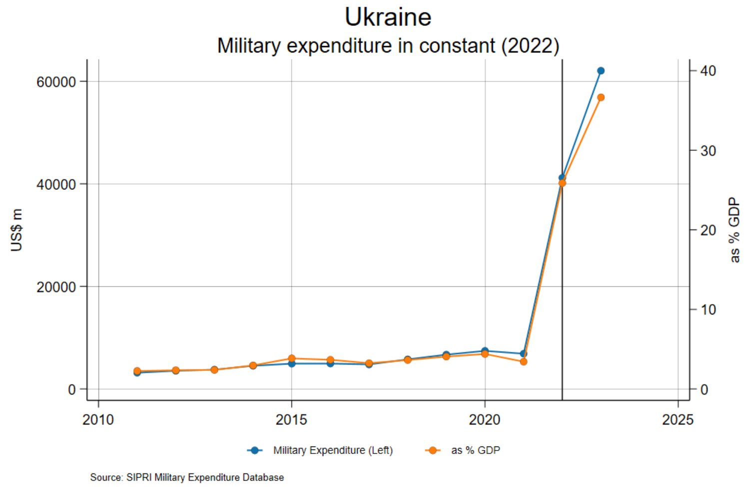
- Aimed at overthrowing the Ukrainian government; condemned by NATO and the EU (CFR).

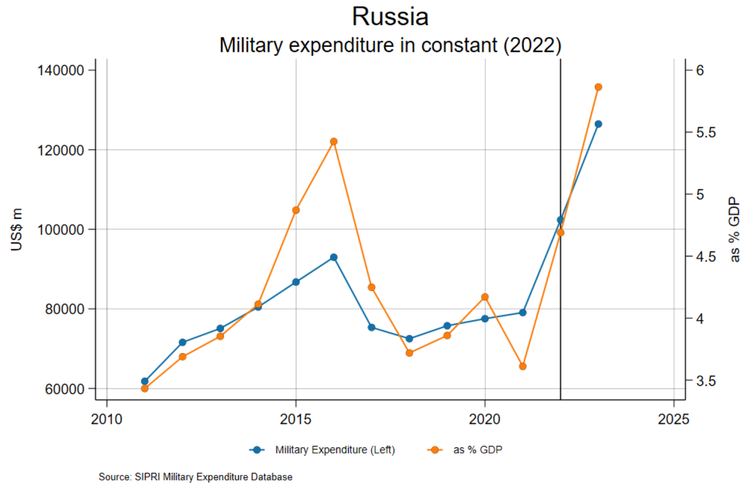
Recent Developments

- **Military Momentum (2024)**: Russia is regaining momentum, Ukraine facing aid delays (IISS).
- **International Support**: NATO allies' support remains vital for Ukraine's defense (IISS).

Military Spending

- **Russia**: Defense budget increased by 24% to $109b in 2023, to 116b in 2024, and to 145b in 2025 (Military Benefits Hub).
- **Ukraine**: U.S. has committed $176bn in aid for fiscal years 2022-24 (CFR; U.S. Department of Defense).
- **Poland**: Defense spending at 4% of GDP, a 46% increase in 2023 (Chatham House).
- **China & Iran**: Supplying arms and technology to Russia (Defense News).





Israel-Hamas, Hezbollah and Iran Conflict Overview

Escalation and Iran's Role

- Since October 2023, after Hamas's surprise attack, Iran has increased its involvement, including missile and drone attacks on Israel (April 2024).
- The conflict marks a significant escalation in the Israel-Iran proxy war, pushing both countries toward direct conflict.

Hezbollah's Role

- Hezbollah opened a **second front** along the **Lebanese border**, launching rockets and drones into northern Israel. Despite losses, Hezbollah remains a key threat due to its **Iranian-backed arsenal**.

Recent Developments

- In **October 2024**, **Iran launched its largest-ever missile attack** on Israel, further escalating tensions and raising the risk of a broader war.
- **Iran** continues to use **proxy forces** like Hezbollah and Hamas to challenge Israel. The conflict seems to be shifting toward **direct confrontation**.
- Both **Israel** and **Iran** have surged defense spending, with Israel focused on bolstering its **Iron Dome** and Iran investing in **missiles and drones.**

U.S. Involvement and Two-Front Dilemma

- The U.S. faces the challenge of supporting **Israel** and **Ukraine** simultaneously, putting pressure on defense budgets and **diplomatic efforts.** These dual conflicts risk escalating tensions with adversaries like **Russia** and **Iran**, challenging U.S. global dominance.
- As of **October 2024**, the U.S. has provided **$17.9 billion** in military aid to Israel, including **Iron Dome systems** and munitions. Israel also secured an additional **$8.7 billion** to support its military campaigns.

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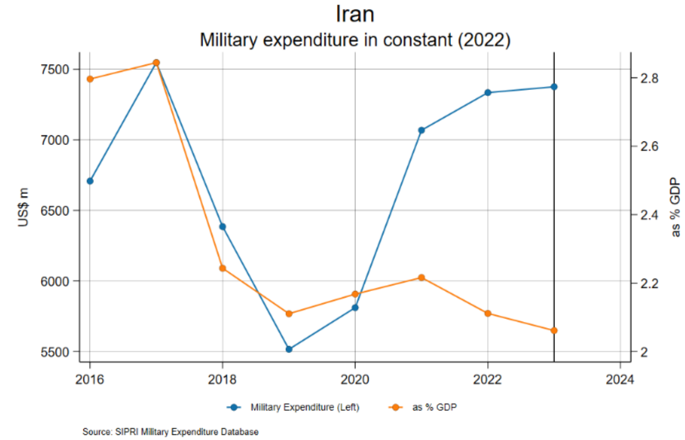
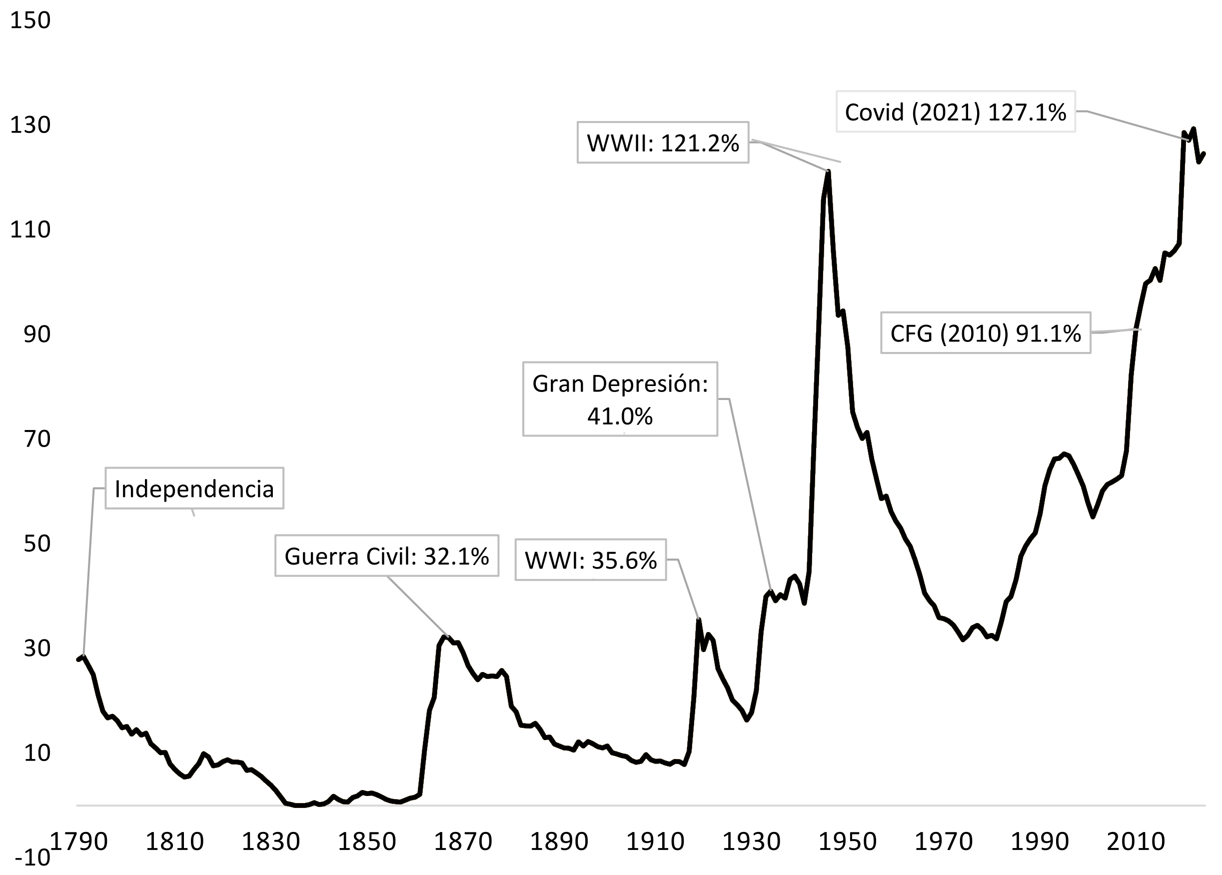


Sources: CSIS, The Times of Israel (a, b), USAFacts, CFR.

Public debt: the starting point looks bad. Soaring spending, a ballooning fiscal deficit, high debt levels, rising interest rates, and record-high central bank balance sheets are severely restricting the ability to significantly boost spending in the years ahead, especially in the US.

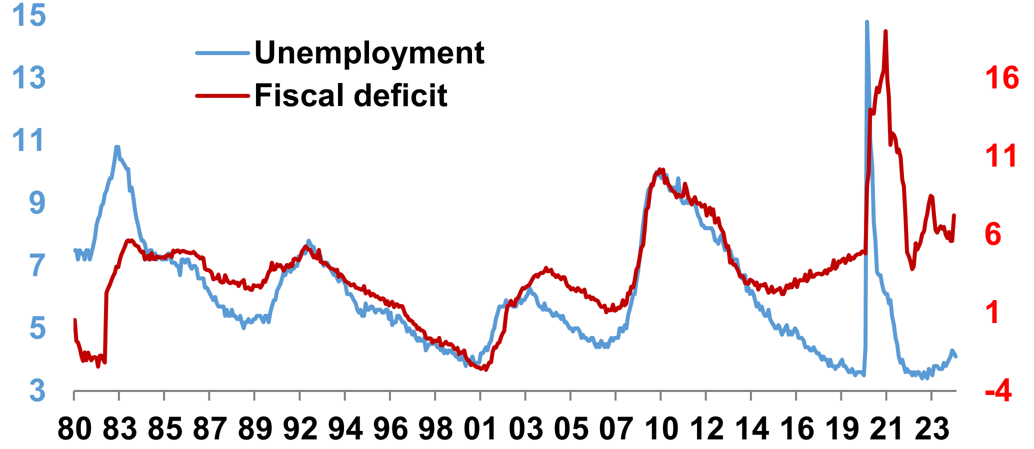
US Historical Debt Outstanding

(GDP, %)



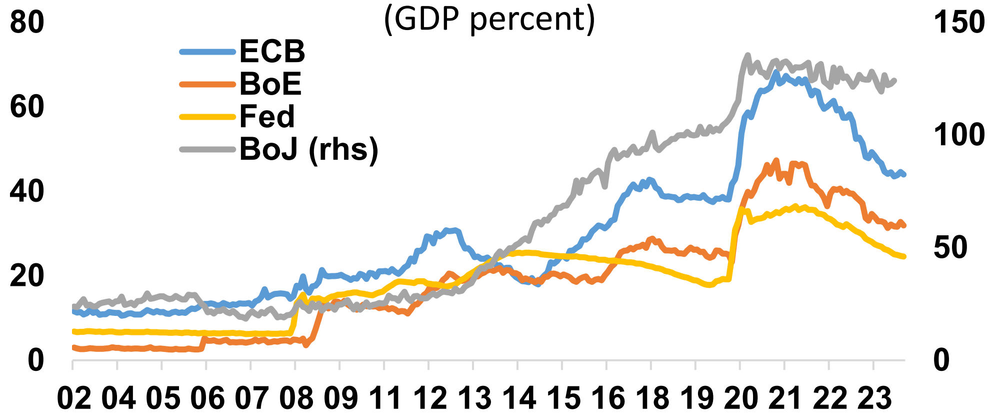
US unemployment and fiscal deficit

(lhs: % ; rhs: GDP percent)



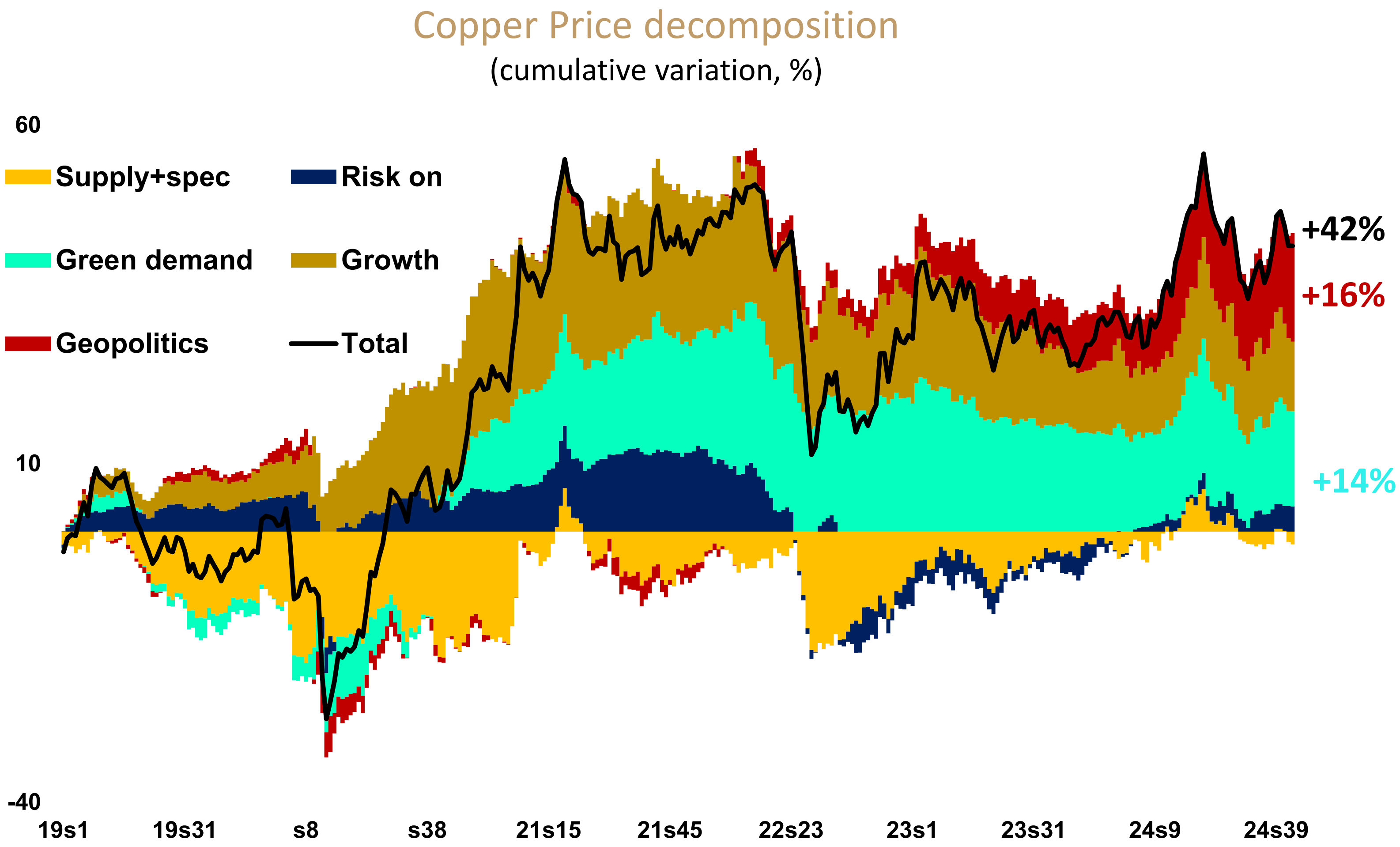
Central Banks Balance sheets

(GDP percent)



(1) Consider all wars between states since 1830 until 2007 and represent from the first and last year of wars. (2) WWII is not considered in the case of Russia. Sources: SIPRI, Correlates of War, Fed, ECB, BoE, BoJ, Fred, Gabriel-Zucman.eu, [Historical Debt Outstanding | U.S. Treasury Fiscal Data](#).

The geopolitical landscape and the green transition are also being key drivers of metal prices. They have driven a 30-percentage-point increase in copper prices since 2019, accounting for 75% of the total rise.



Source: Zelppo et.al (2024).

Copper Price decomposition.

go back

Var Bayesiano con restricción de Signo

- With 4 lags at a weekly frequency from the first week of 2010 to the 22nd week of 2024:

$$D_0 y_t = D_1 y_{t-1} + D_2 y_{t-2} + D_3 y_{t-3} + D_4 y_{t-4} + \epsilon_t \,, \epsilon_t \sim N(0, \Sigma)$$

- With y_t = [Green ETF, copper price, ratio of copper price to gold price, ratio of copper price to aluminum price, ratio of copper price to the S&P 500, and 10-year US Treasury yield]

- Matrix D_0 is identified based on the sign restriction specified in the tables on the right, which provide similar results

Sign restrictions (versión 1)

	Green demand	**Supply +spec**	**Growth**	**Geopolitics**	**Risk on-** Common	**Risk on-** *Hedge*
Green ETF	+	-	+		-	-
Copper	+	+	+	+	-	-
Copper / gold	+	+	0	-		-
Copper / Alum		+	0			
Copper / SP500	+	+	+		+	
10y rate			+	+	+	-

Sign restrictions (versión 2)

	Green demand	**Supply +spec**	**Growth**	**Geopolitics**	**Risk on-** Common	**Risk on-** *Hedge*
Green ETF	+	-				-
Copper	+	+	+	+	-	
Copper / gold	+	+	0	-		-
Copper / Alum		+	0			
Copper / SP500	+	+	+		+	
10y rate				+		-

Fuente: Elaboración propia en base a datos de Bloomberg

Methodology.

Volver

Sign restriction matrix

	Growth	**Monetary**	**Hedge**	**Common risk**	**War**
US Treasury yield 2y	+	+	+	+	NaN
US Treasury yield 10y	+	+	+	+	NaN
S&P 500 ex defense	+	-	+	-	-
Oil prices	+	-	+	-	+
Defense stocks/Industrial stocks	NaN	NaN	NaN	NaN	+

Restrictions between variables:

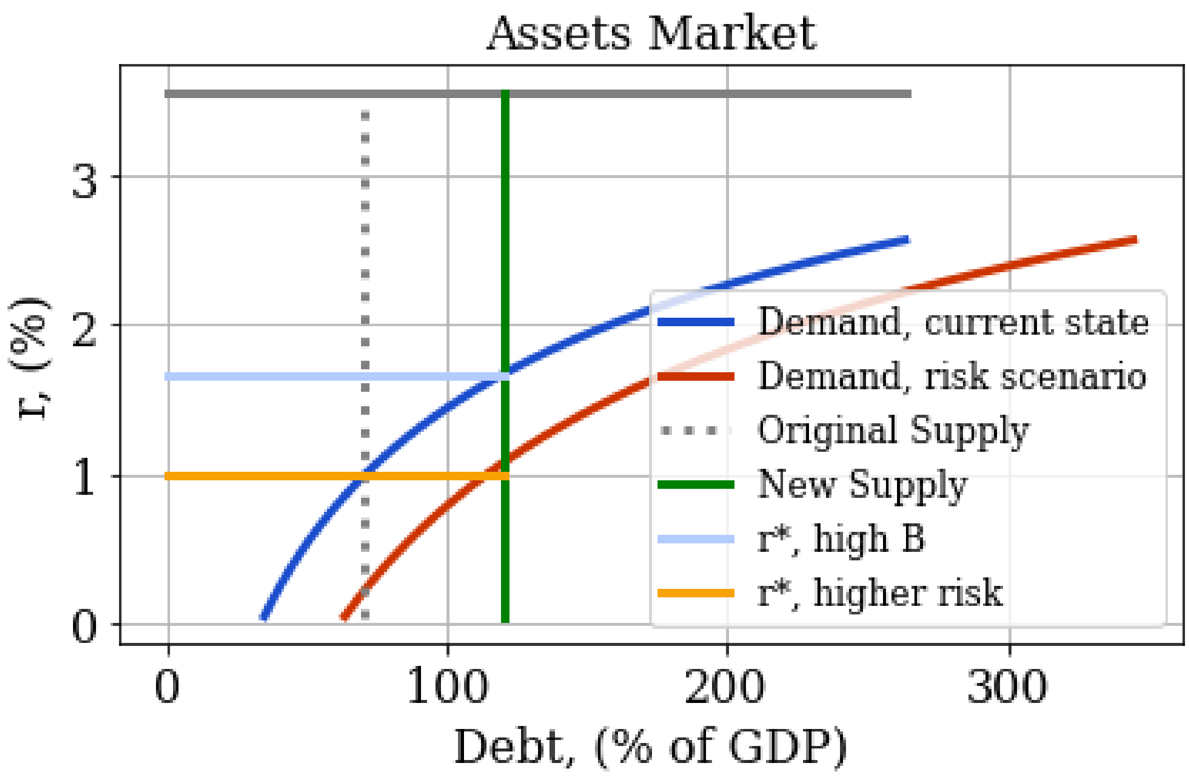
1. Growth: 2y> 10y
2. Monetary: 2y>10y
3. Hedge: 10y>2y
4. Common: 10y> 2y
5. war: tasa 10y>tasa 2y

Restrictions within variables:

1. 2y: |growth|+|monetary|>|hedge|+|common|+|war|
2. 10y: |growth|+|monetary|<|hedge|+|common|
3. Oil: |war|+|common|+|rowth|>|hedge|+|monetary|

Quantitative effects of increased income risk.

Supply-demand of public debt



- A Huggett model parameterized for the US (Campos *et al.* 2024) yields a steady state annual r = 1% for a level of Debt/GDP = 70%.
- For a level of Debt/DGP = 120% (50pp increase), r = 1.68% (68% increase).
- To counteract this increase in r, the variance of the temporary idiosyncratic log wage shock would need to increase around 55%.
- **This is almost twice the difference between the variances of the US and Sweden (Floden & Lindé, 2001).**

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There is increasing agreement that fiscal concerns are being relevant drivers of long rates. Since a large part of climate and rearmament investments would come from public debt, they are likely to increase "risk-free" yield curves.

- Recent studies suggest that fiscal policies in many developed nations are on an unsustainable path. (CBO Oct. 2024; IMF Fiscal Monitor Oct. 2024)

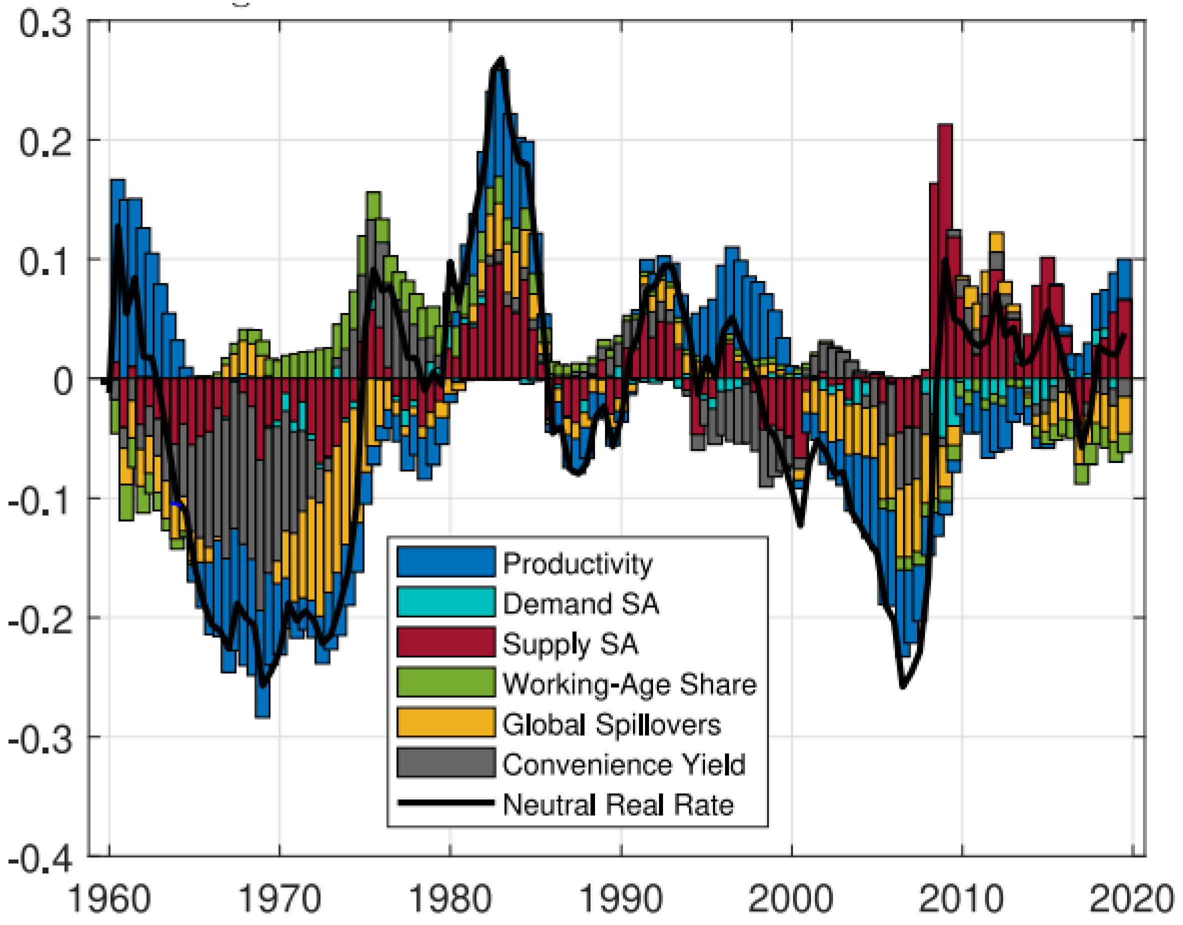
- Common view: increased spending will lead just to to higher debt but growing evidence that interest rates will also rise (e.g., UK case FT Oct 8, 2024).

- Ferreira and Shousha (2023, JIE): increased supply of safe assets (public debt) in the US has been a significant factor in driving up interest rates since the GFC (though limited foresight might moderate the effect, Gust & Skaperdas, 2024).

  → **If US debt had remained at 2007 levels, long-term real interest rates would be around 150 bps lower today.**

Change in US real neutral rate from Ferreira & Shousha (2023, JIE)

(percentage points)



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