S&P Global
Ratings

Global Debt Leverage

Global Debt 2030

Can The World Afford A Multifaceted Transition?

Jan. 10, 2024

This report does not constitute a rating action

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Highlights

- Global leverage trending up and structurally higher interest rates will increase the financing bill for governments, corporates, and households.
- Additional investments will be necessary to address climate-related risks, the energy transition, digital transformation, and an aging population, with developing economies disproportionately affected.
- International collaboration and a combination of public and private capital will be required to make the transition affordable globally, but increasing geopolitical fragmentation will make this more difficult.

High interest rates are increasing the burden of servicing debt globally. We estimate global debt-to-GDP leverage will rise a moderate 3% to 238% by 2030, reaching a high of $336 trillion under a baseline scenario. However, factoring in a possible $37 trillion in additional transition investments due to climate mitigation and adaptation, digital transformation, and aging, we project leverage to rise 9% if financed exclusively through debt. The combination of higher interest rates and transition costs will be particularly onerous for developing economies given their more limited financial capacity.

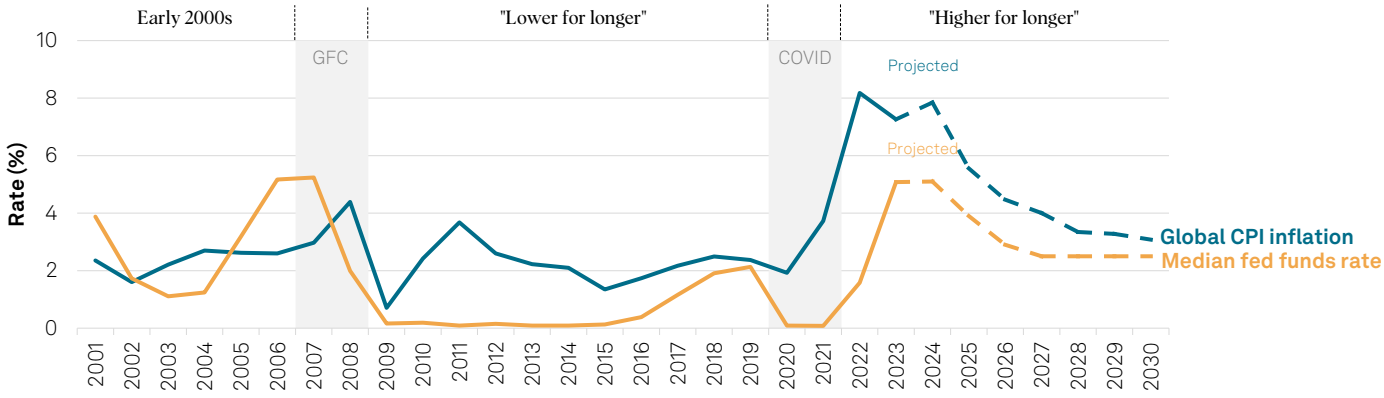
Higher real equilibrium rates

With the end of the Washington Consensus leading to more constrained trade and higher costs of doing business, and with the structural rise in investment needed to combat climate change, price pressures are likely to become structurally higher (see "End of the Washington Consensus" to learn more). Most major central banks are committed to achieving their inflation targets (e.g., 2% for the U.S. Federal Reserve) over the medium term. We assume they will do what is needed to achieve those objectives, which means central banks are likely to keep policy rates structurally higher. Put another way, the world's real equilibrium interest rate (r* (r-star)) has risen and is likely to stay higher through 2030 than in the post-Global Financial Crisis decade. Chart 1 shows global consumer price index inflation and federal funds rates for 2001–2022 and projected 2023–2030.

Chart 1

Interest rates to be kept high to control inflation

Global CPI inflation and U.S. fed funds rates (%), 2001-2030



Data compiled Dec. 1, 2023. CPI--Consumer Price Index. GFC--Global Financial Crisis. Source of CPI data: S&P Global Market Intelligence. Source of historical federal funds rate data: Federal Reserve Bank of St. Louis (FRED), retrieved Oct. 24, 2023. Source of projected fed funds rate: Federal Reserve Board, Summary of Economic Projections, Sep. 20, 2023. Source: S&P Global Ratings.

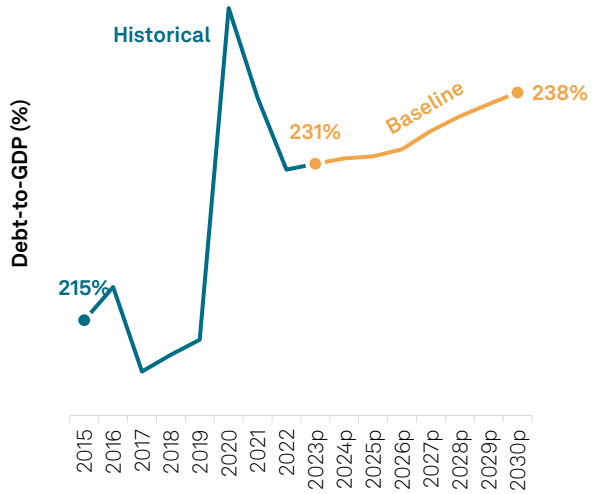
Nominal debt may surge to $336 trillion

We project debt-to-GDP leverage to grow 3%, to 238% from 231%, over 2023–2030 (see chart 2). This translates to a compound annual growth rate of 0.4% (see next subsection for details). Inflation will drive up both absolute debt and nominal GDP. We anticipate that absolute debt will rise by half, to $336 trillion, by 2030, from $225 trillion in 2023 (see chart 3). Removing the effects of inflation, absolute debt would have grown only 10%, to $247 trillion (in 2023 dollars; see chart 3). (Note: In this paper, global debt comprises the debt of nonfinancial corporate, government and household sectors, excluding the financial sector, to avoid possible double counting.)

Chart 2

Global debt-to-GDP leverage to rise 3% by 2030...

Global debt-to-GDP baseline scenario to 2030 (%)

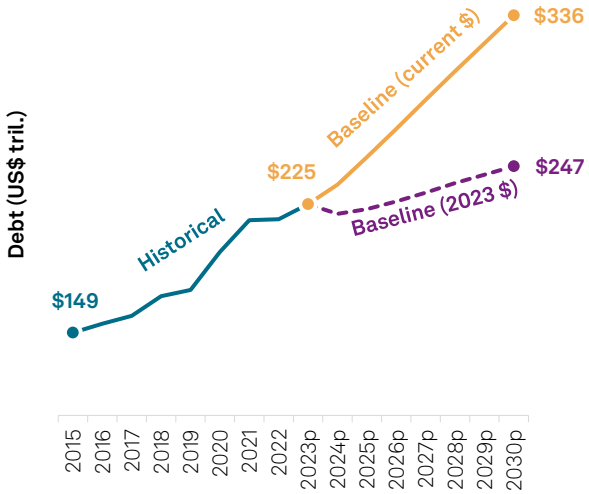


Data compiled Dec. 1, 2023. p--projected. Source: S&P Global Ratings.

Chart 3

...although inflation drives absolute debt up by half

Global debt baseline to 2030 (current and 2023 $)



Data compiled Dec. 1, 2023. p--projected. Source: S&P Global Ratings.

Leverage to increase faster in emerging markets than in mature markets

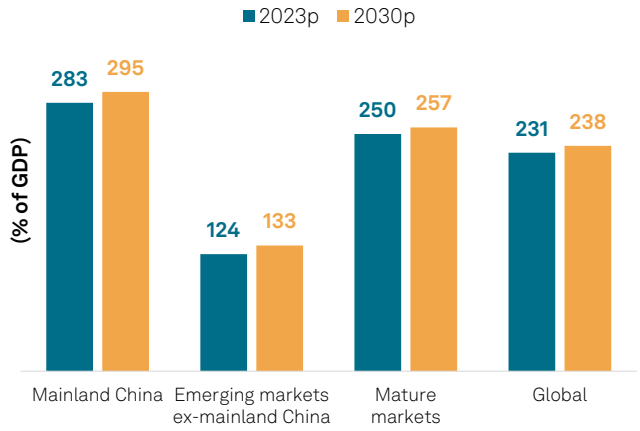
We expect emerging markets' leverage to grow twice as fast as that of mature markets. This isn't surprising given that as emerging economies develop, their degree of financialization (growth of its financial sector) tends to increase. Our baseline projection is for the leverage of emerging markets to grow 6%, to 211%, with emerging markets (excluding mainland China) up 7%, to 133%, and mature markets up 3%, to 257% (see chart 4). The U.S. and China—the two largest economies, accounting for almost half of global GDP—could see their debt-to-GDP increase to 269% and 295% in 2030, from 254% and 283% in 2023, respectively. Together, these countries could hold 53% of the world's debt in 2030.

We project corporate and government leverage to increase four times faster than household leverage. Our baseline projection is for the debt-to-GDP leverage of the global corporate sector to grow 4%, to 88%, the global government sector to climb 4%, to 87% and the global household sector to stay relatively flat at 62% (see chart 5). We see the household sector as more interest rate-sensitive, as the average household has less headroom to increase income over a short period.

Chart 4

Emerging markets excluding mainland China's leverage to be up 7%, twice the 3% of mature markets

Debt-to-GDP, 2023 and baseline 2030 (%)

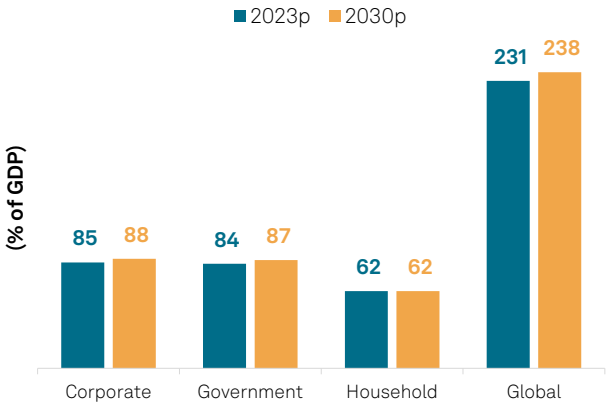


Data compiled Dec. 1, 2023. p--projected. Emerging markets--Argentina, Brazil, Chile, mainland China, Colombia, Czech Republic, Egypt, Ghana, Hungary, India, Indonesia, Kenya, Malaysia, Mexico, Nigeria, Pakistan, Peru, Philippines, Poland, Russia, Saudi Arabia, South Africa, Thailand, Turkey, Ukraine, United Arab Emirates, and Vietnam. Mature markets—Australia, Austria, Belgium, Canada, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong SAR, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, U.K., and U.S. Source: S&P Global Ratings.

Chart 5

Corporate and government sectors' leverage to rise 4%, while household to increase 1%

Debt-to-GDP, 2023 and baseline 2030 (%)



Data compiled Dec. 1, 2023. p--projected. Source: S&P Global Ratings.

We don't expect much incremental corporate borrowing over 2024–2025 because of the impact of high interest rates, subdued M&A activity, and more financial risk-aversion from corporate managers. From 2026-2030, we expect corporate debt-to-GDP to increase from a combination of more moderate borrowing costs and a return to risk-seeking behavior by investors.

We forecast government debt, mainly driven by fiscal dynamics in mature markets, to remain fairly high, at 87% of GDP by 2030, instead of retreating to lower levels, as would have been expected from the post-pandemic recovery. This is also assuming the cost of funding will be higher than before the pandemic. If we add to this other factors likely to increase pressure on government balance sheets, such as an aging population, climate mitigation and adaptation, and technological challenges, the need for governments to pick up momentum on fiscal consolidation will become imperative to maintain current levels of creditworthiness. Nonetheless, governments are likely to prioritize their spending as they are already doing so with the energy transition and aging-related issues.

While we expect global household debt leverage to remain relatively flat, there is a diverging trend between emerging and mature markets. We project emerging markets' household leverage to reach 51% in 2030, from 46% in 2023, driven by a rise in per capita income and population wealth, financial development, easier access to credit, and above-average GDP growth increasingly supported by greater consumption. On the other hand, we expect mature markets' household sector leverage to decline a few percentage points, to 70%, over the same period.

High climate, digital, and aging transition costs

$37 trillion needed to finance transition over 2024–2030

The cost of climate inaction is substantial. Lower- and lower-middle-income countries face up to 12% of GDP being at risk of physical hazard losses by 2050 under a slow transition scenario and absent adaptation (see "Investment in climate adaptation needs have high returns on growth" to learn more). Meanwhile, the challenge of energy security, affordability, and sustainability looks very different in developing economies than in Europe and the U.S., where per capita incomes are as much as 40 times higher (see "The multidimensional path to net-zero"). Concurrently, IT advances are continuing apace, e.g., generative AI (see "Can generative AI create a productivity boom?"), requiring governments and corporates to make further investment. On the societal front, many countries are facing an increasingly aging population, which could stymie further economic growth given the cost of caring for such populations (see "The challenges of aging: Fast and slow").

Besides the baseline scenario described above, we have developed a supplemental "cost of transition" scenario that assumes additional debt (over the baseline) is raised to fund climate mitigation and adaptation, digital transformation, and an aging population. We haven't compared results with other development pathways that countries might take, which could be more costly than this transition scenario (e.g., failure to act on climate change).

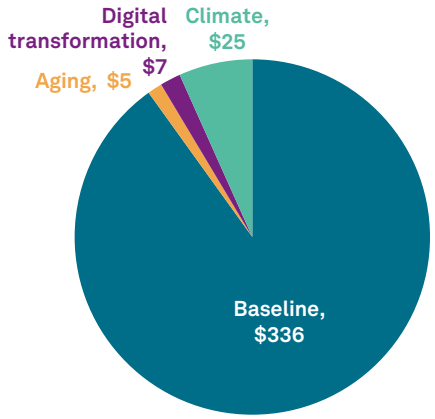
Climate financing takes up the largest share of debt for transition. We estimate that a cumulative $37 trillion of debt—$25 trillion for climate, $7 trillion for digital transformation, and $5 trillion for aging—may have to be raised between 2024 and 2030 (see chart 6). In arriving at these transition sums, we have used a variety of proprietary and external sources. For climate, we refer to the Intergovernmental Panel on Climate Change's "Sixth Assessment Report" and the UN Environment Program's "Adaptation Gap Report 2023." For digital, we refer to the Organization for Economic Co-operation and Development's "A Roadmap Toward A Common Framework For Measuring The Digital Economy." For aging, we drew on S&P Global Ratings' "Global Aging 2023" report. Our measure of climate-mitigation costs includes those for the energy transition, and digital-transformation costs are gross fixed capital investment in digital technology to transform nondigital processes and services into digital ones.

We acknowledge there is always a high degree of uncertainty in such estimates and variability in ranges of estimates for this financing gap. For example, we note more recent estimates around climate scenarios suggest higher financing needs or wider gaps. Also, other sources such as taxes, including a carbon tax, and equity financing could contribute to financing gaps. Nonetheless, the proposed transition scenario represents in our view a reasonable midrange estimate to support our discussion.

Chart 6

Additional debt needed for transition pushes absolute debt up 10% from baseline 2030...

Global debt, transition scenario, 2030 (US$ tril.)

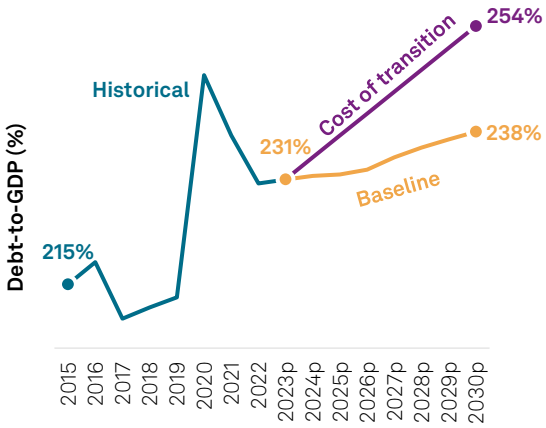


Data compiled Dec. 1, 2023. p--projected. Source: S&P Global Ratings.

Chart 7

...which translates to leverage rising a further 7% to 254%

Global debt-to-GDP scenarios to 2030



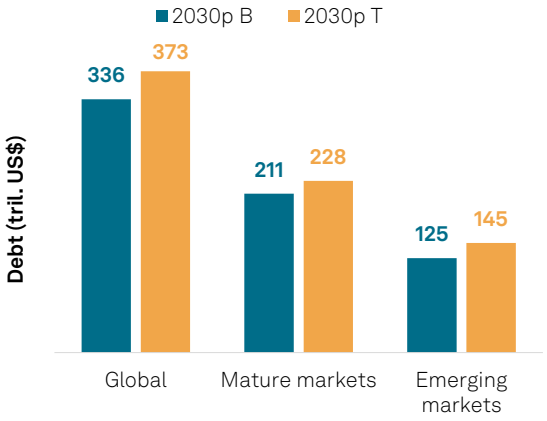
Data compiled Dec. 1, 2023. p--projected. Source: S&P Global Ratings.

Cost of transition could push leverage up another 7%. In our scenario, absolute debt could grow to $373 trillion from 2023-2030, 11% more than the baseline $336 trillion. This translates to the global debt-to-GDP ratio rising to 254%, 7% more than the baseline 238% (see chart 7). Because the weight of physical risk falls disproportionately on low- and low-middle-income countries (see "Investment in climate adaptation needs have high returns on growth" for more on climate adaptation costs), we see the absolute debt and, consequently, the debt-to-GDP leverage rising faster for emerging markets than for mature markets (see charts 8 and 9). The lower-income cohort of our emerging markets sample (classified as lower-middle-income economies by the World Bank) could fare even worse; they may see absolute debt increase 19% and debt-to-GDP jump 14% in the transition scenario compared with the baseline.

Chart 8

Transition scenario: emerging markets' debt growth of 16% will be double that of mature markets...

Global debt, transition scenario, 2030 (US$ tril.)

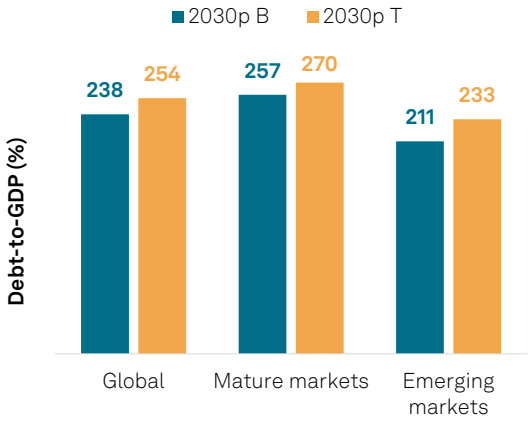


Data compiled Dec. 1, 2023. p--projected. B--Baseline scenario, T--Transition scenario. See chart 4 note for the emerging markets and mature markets sample coverage. Source: S&P Global Ratings.

Chart 9

...which translates to leverage for emerging markets rising 10%, twice as fast as mature markets

Global debt-to-GDP scenarios to 2030



Data compiled Dec. 1, 2023. p--projected. B--Baseline scenario, T--Transition scenario. See chart 4 note for the emerging markets and mature markets sample coverage. Source: S&P Global Ratings.

Higher debt-servicing costs

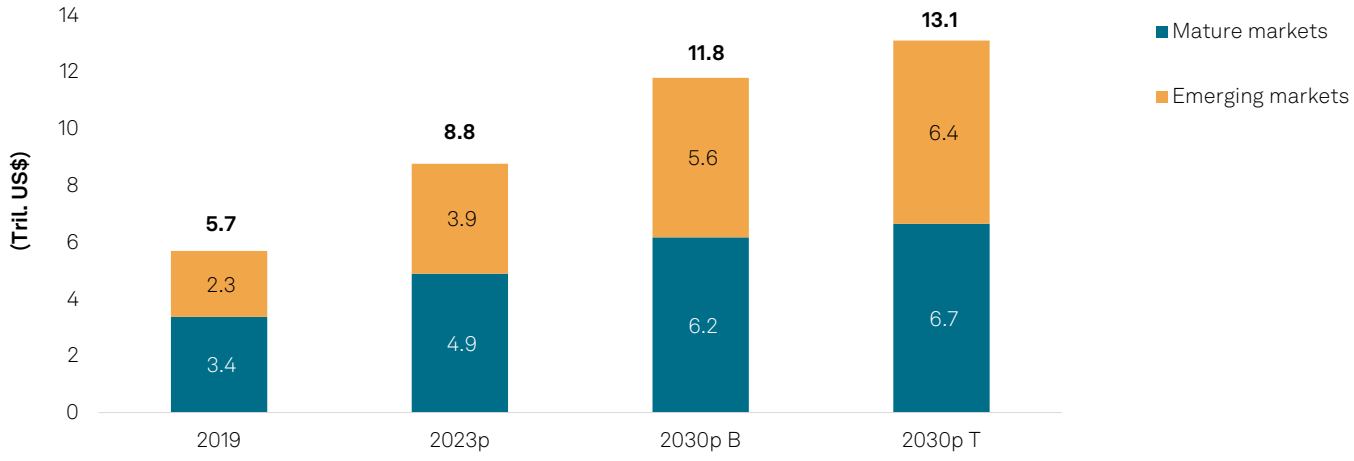
Interest expense will be higher than pre-COVID-19

We estimate that global borrowers are paying annual interest expenses of $9 trillion, 50% higher than 2019's $6 trillion (see chart 10). In our baseline, this rises to $12 trillion by 2030 given higher nominal debt. Our cost of transition scenario shows the amount climbing 8% against the baseline to $13 trillion. We estimated interest expense-to-revenue for corporates from the financial statement data of 50,000 entities, sourced from S&P Global Market Intelligence's Capital IQ database; for governments from S&P Global Ratings' "Sovereign Risk Indicators," published Oct. 9, 2023; and for households based on mortgage rates from national sources and disposable income data from S&P Global Market Intelligence's EconoSim database.

Chart 10

Interest expense is 50% higher than pre-COVID-19

Interest expense, 2019, 2023, and 2030 (US$ tril.)



Data compiled Dec. 1, 2023. p--projected, B--Baseline scenario, T--Transition scenario. See chart 4 note for the emerging markets and mature markets sample coverage. Source: S&P Global Ratings.

Governments to continue facing higher, albeit uneven, interest expense

Governments are likely to take the biggest hit. Despite an expected easing in interest rates, the global interest expense-to-revenue ratio is forecast to be 17% higher in 2030 than in pre-COVID 2019 (see chart 11). The household sector is projected to experience the least change in its interest expense-to-revenue ratio, partly due to an assumed 1% increase in debt-to-leverage ratios over the 2023–2030 period (see chart 12). The corporate sector is in the middle (see chart 13). We expect governments to bear most costs due to the climate transition, digital transformation, and aging, which leads to worse ratios in our cost of transition scenario (see chart 14).

Emerging markets have disproportionate investment needs for the transition. We estimate transition needs (particularly for climate adaptation and aging) will be more pressing for emerging markets. For example, we expect potential GDP losses from physical risks by 2050 (under a slow transition scenario and absent adaptation) to be more than four times greater for less developed

countries than for their wealthier peers. Likewise, the increase in the old-age dependency ratio and age-related expenditures is far steeper for developing economies than for advanced economies, implying a greater scale of policy adjustment is required to offset rising aging pressures, although from a lower starting point. Emerging markets (excluding mainland China) governments could see their interest expense-to-revenue ratio rise by nearly half to 20.4% in the transition scenario in 2030, compared with 14.4% in 2019.

Chart 11

Global total interest expense-to-revenue is projected to be 17% higher than pre-COVID-19...

Total interest expense-to-revenue, 2019, 2023 and 2030 (%)

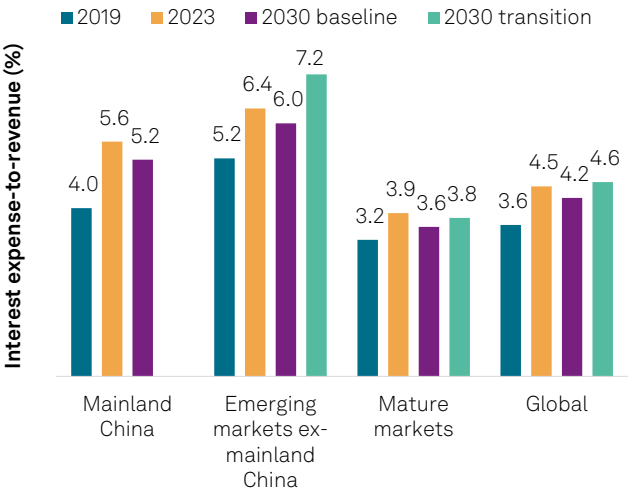


Chart 12

...although the change for global households is more muted...

Household interest expense-to-revenue, 2019, 2023 and 2030 (%)

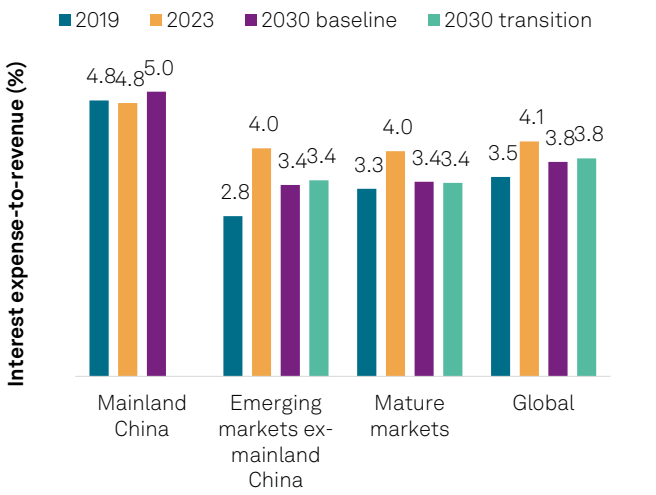


Chart 13

...with corporates in the middle...

Corporate interest expense-to-revenue, 2019, 2023 and 2030 (%)

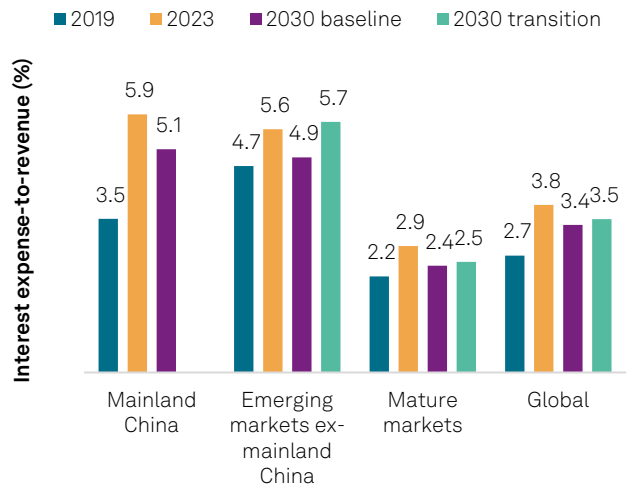
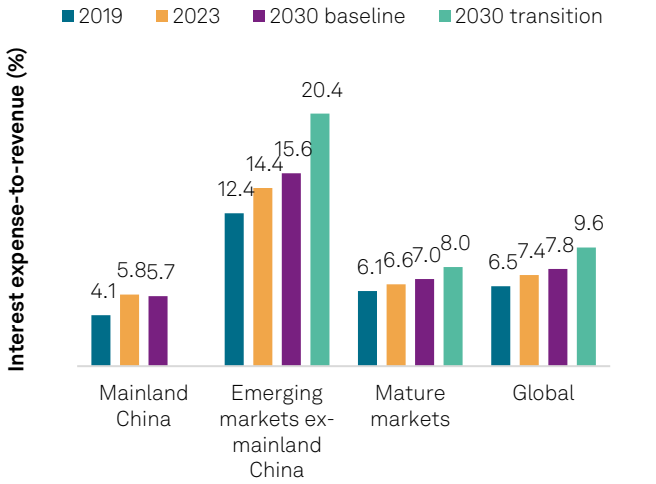


Chart 14

...but governments will still struggle with high interest expense-to-revenue ratios

Government interest expense-to-revenue, 2019, 2023 and 2030 (%)



Data compiled Dec. 1, 2023. 2023 and 2030 data are projections. Emerging markets--Argentina, Brazil, mainland China, India, Indonesia, Mexico, Poland, Saudi Arabia, Thailand, and Turkey. Mature markets--Australia, Belgium, Canada, France, Germany, Israel, Italy, Japan, Netherlands, South Korea, Spain, Switzerland, U.K., and U.S.
Source: S&P Global Ratings.

What if interest rates don't ease as much as expected?

We conducted a sensitivity analysis by adding a 50-basis-point (bp) increment to the anticipated 2030 interest rate for each geographic sector. Because of the continuing debt leverage buildup, albeit at a somewhat low compound annual growth rate, the government sector is most affected (see charts 15-18). In other words, government borrowers would suffer most if interest rates don't decline sufficiently over the next few years.

Chart 15

Higher debt base means +50bps interest rate worsens total interest expense-to-revenue...

Total interest expense-to-revenue, 2023 and 2030 (%)

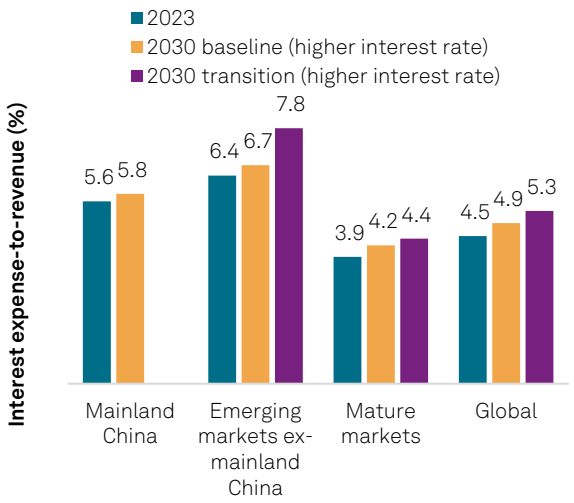


Chart 16

...although households suffer least...

Household interest expense-to-revenue, 2023 and 2030 (%)

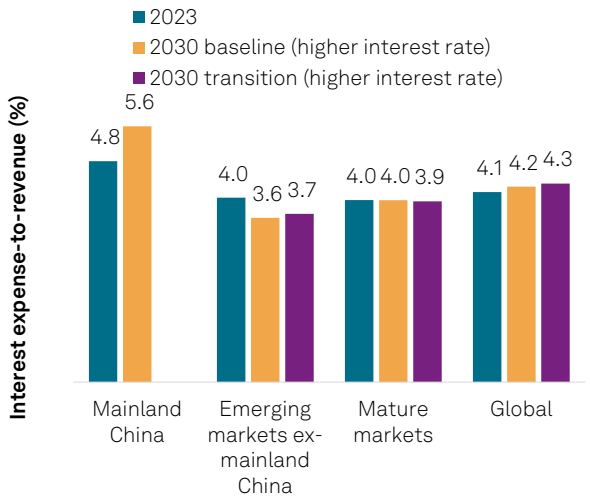


Chart 17

...with corporates still in the middle...

Corporate interest expense-to-revenue, 2023 and 2030 (%)

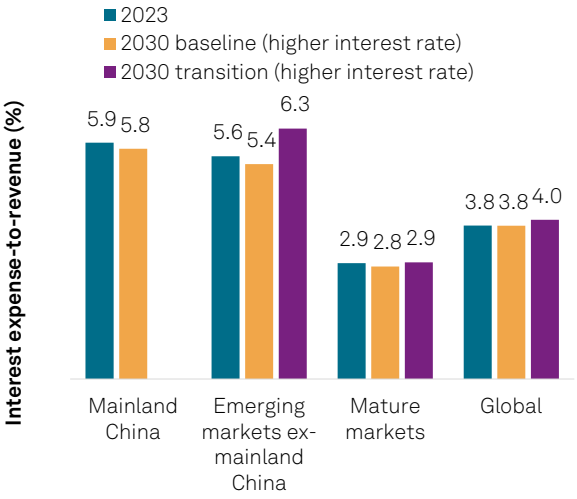
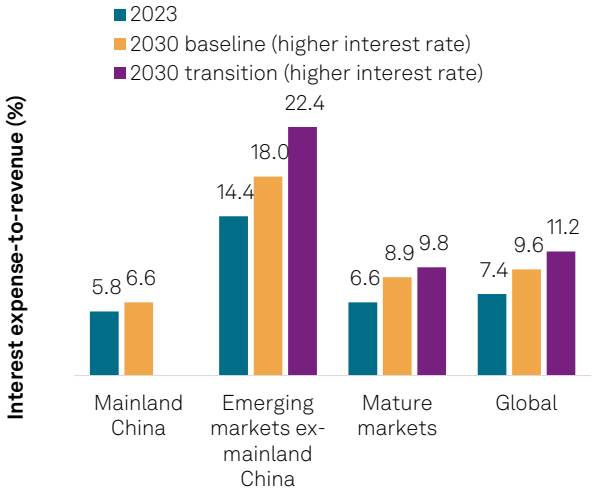


Chart 18

...and governments suffering worst

Government interest expense-to-revenue, 2023 and 2030 (%)



Data compiled Dec.1, 2023. 2023 and 2030 data are projections. Emerging markets--Argentina, Brazil, mainland China, India, Indonesia, Mexico, Poland, Saudi Arabia, Thailand, and Turkey. Mature markets--Australia, Belgium, Canada, France, Germany, Israel, Italy, Japan, Netherlands, South Korea, Spain, Switzerland, U.K., and U.S.
Source: S&P Global Ratings.

A world of higher debt and rates

After a step-up during the COVID-19 years, it is likely that debt may have to be raised beyond what is already planned to cover climate, digitalization and aging transition costs. Coupled with this is the high likelihood that interest rates will settle at equilibrium levels higher than those pre-COVID-19. Policymakers will have to address the necessary trade-off between short- and longer-term costs to their economies and population, as the cost of inaction could become greater over time. Given the global nature of climate change and the disproportionate exposure of emerging markets, including lower-income countries, to physical and transition risks, a higher degree of international collaboration to support capital flows, as well as a combination of public and private capital, is needed to make the transition affordable for all. This collaboration could be constrained by an increasingly fragmented geopolitical environment (see our Q&A with Senior Vice President for Geopolitics and International Affairs Carlos Pascual to learn more).

Related research

- Look Forward: Funding the Future, Jan. 10, 2024
- Global Debt Leverage: A 1% Financing Contraction Could Push Cashflow Negative Corporates To 13%, Oct. 16, 2023
- Global Aging 2023: The Clock Ticks, Jan. 18, 2023
- Global Debt Leverage: Is a Great Reset Coming?, Jan. 13, 2023
- Green Spending Or Carbon Taxes (Or Both): How To Reach Climate Targets, And Grow Too, By 2030?, Nov. 4, 2021

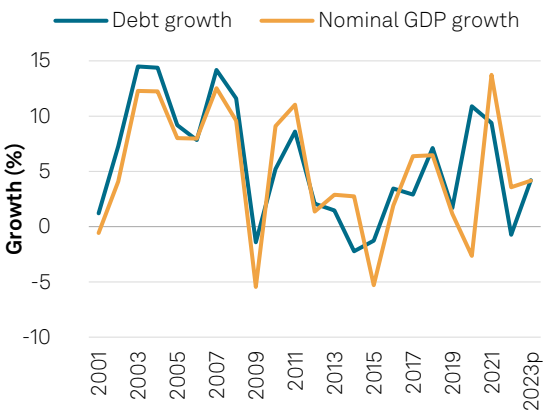
Appendix 1: Higher real equilibrium rates

Historical global leverage growth. Global debt grew slightly faster than nominal GDP from 2001-2007, but, since the Global Financial Crisis, they have tended to grow together, albeit with leads and lags (see chart A1-1). For example, the COVID debt surge in 2020 preceded the nominal GDP surge in 2021. Over the past two decades, gross debt-to-GDP leverage annual growth (excluding the financial sector) has trended toward near-zero (see chart A1-2). With higher (than pre-COVID) inflation and interest rates, our baseline projection is for debt-to-GDP leverage to grow 0.4% compound annual growth rate (CAGR) from 2024-2030. Global debt is projected to have hit $225 trillion by year-end 2023 (see chart 5). In nominal terms, absolute debt is projected to grow 50%, to $336 trillion, by 2030. But it would have grown only 10%, to $247 trillion, in 2023 dollar terms. In respect of leverage, with nominal GDP also growing, debt-to-GDP leverage only grows 3%, to 238%, in 2030, from 231% in 2023 (see chart 2).

Chart A1-1

Nominal GDP growth and debt growth move in tandem albeit with leads and lags...

Global debt and nominal GDP growth rates (%), 2001 to 2023

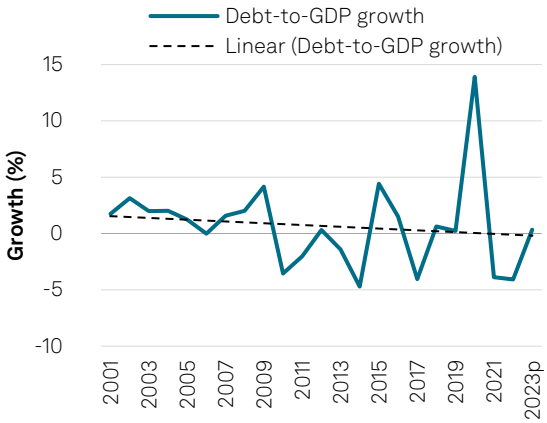


Data compiled Dec.1, 2023. p--projected. Source of historical debt and debt-to-GDP data: Institute of International Finance. Source: S&P Global Ratings.

Chart A1-2

...with global debt-to-GDP leverage growth tending toward zero over the past two decades

Global debt-to-GDP growth rates (%), 2001 to 2023



Data compiled Dec.1, 2023. p--projected. Source: S&P Global Ratings.

Corporate leverage to grow just over 4%. Global nonfinancial corporate debt spiked more rapidly than other asset classes during the initial stages of the pandemic. Although corporate leverage moderated thereafter, as we enter 2024 leverage remains structurally higher than at any point during the previous decade, at 85% of GDP (see chart 5). On one hand, some large highly rated corporates have reduced their indebtedness to adjust to the new reality of sharply higher debt costs. However, lower-rated borrowers lack such flexibility to adjust their balance sheets, and most remain saddled with high debt burdens with increasing carrying costs.

In next few years, we expect refinancing activity to increase as debt maturities move ever closer. But we don't expect much incremental borrowing because of the impact of higher for longer rates, subdued M&A activity, and generally more financial risk-aversion among corporate managers in the next few years. From 2026-2030, we expect corporate debt-to-GDP to increase again as a result of the combination of easing central bank policy rates leading to gradually lower borrowing costs and a return to risk-seeking behavior by investors. Under our baseline projections, debt-to GDP for corporates would reach 88% by the end of this decade, gradually approaching the all-time high set during the onset of the pandemic.

Government leverage to grow just under 4%. Global government debt leverage has been increasing since the end of the GFC. This was further exacerbated by the pandemic, during which governments took the large share of cost, with overall general government debt leverage reaching 91% of GDP in 2020. Subsequently, economic activity rebounded sharply, inflation surged, and global debt levels improved to 84% of GDP by 2022 (see chart 5). As the world confronted another set of economic setbacks--the war in Ukraine, persistent inflationary pressures, and record high borrowing costs--governments haven't been able to consolidate their fiscal positions to regain debt levels before the pandemic (76% of GDP in 2019).

As we look ahead to 2030, we expect government debt, mainly driven by fiscal dynamics in mature markets, to remain fairly high at an expected 87% of GDP by 2030 in the context where the cost of funding will most likely be higher than before the pandemic. If we add other pressures that are likely to increase on government balance sheets, like aging population, energy transition, and climate adaptation, as well as technological challenges, we think the need for governments to pick up the momentum on fiscal consolidation will become imperative to maintain current levels of creditworthiness.

Household leverage to remain flat. Global household debt leverage remained relatively stable in 2022-2023, at about 62% of GDP (see chart 5), after decreasing in 2021. The latter was largely due to the sharp economic rebound and savings accumulated during the pandemic, against a backdrop of price increases in financial and real estate assets. Overall, we expect global household debt leverage to remain relatively flat until 2030. This stability masks a diverging trend between emerging and mature markets. Indeed, we project the household leverage in emerging markets (including China) to reach 51% of GDP in 2030, from 46% at the end of 2023. Factors supporting this trend are the rise in income per capita and wealth of populations, financial development and easier access to credit, and above-average GDP growth increasingly supported by greater consumption. As a consequence, the share of household debt from emerging markets to total household debt should continue rising (from 29% in 2023 to 35% in 2030).

On the other hand, we expect leverage for the household sector in mature markets to reduce by a few percentage points of GDP over the same time (down to 70% in 2030). This expected trend reflects the already high level of household debt in several countries (e.g., Switzerland, Canada, Australia, South Korea) and higher-for-longer interest rates. It is important to note that understanding households' creditworthiness and resiliency to potential economic shocks requires considering the assets they have available (to assess the net leverage). For instance, the way pension systems work in various countries is a key element explaining the significant difference in household gross leverage among mature markets.

The U.S., China, and Japan lead in absolute debt. Chart A1-3 illustrates the relative size of absolute debt projected for 2030 among 24 large economies. In the top quartile are the U.S. (US$95 tril.), China (US$85 tril.), Japan (US$25 tril.), India (US$13 tril.), Germany (US$12 tril.), and the U.K. (US$12 tril.). This is to be expected as these six are also the world's largest economies. The U.S. and China alone could still account for half the world's debt by 2030.

Japan, Switzerland, and China lead in debt-to-GDP leverage. When we factor in the size of GDP, the ranking changes. Japan rises to the top spot in debt-to-GDP leverage (see chart A1-4) (third place in absolute debt). Switzerland is second (15th in absolute debt) followed by China, South Korea, the U.S., and Canada. Digging further, the driver of leverage could vary by country, suggesting different risks. For example, Japan is among the world's largest external creditors, and its fiscal deficits will likely remain higher than pre-pandemic levels given increased spending to offset cost-of-living pressures, higher defense spending, and social spending on an aging population (see "Japan," published Nov. 7, 2023). On the other hand, Switzerland has one of the highest levels of gross private-sector debt among its peers, as the Swiss tax system gives

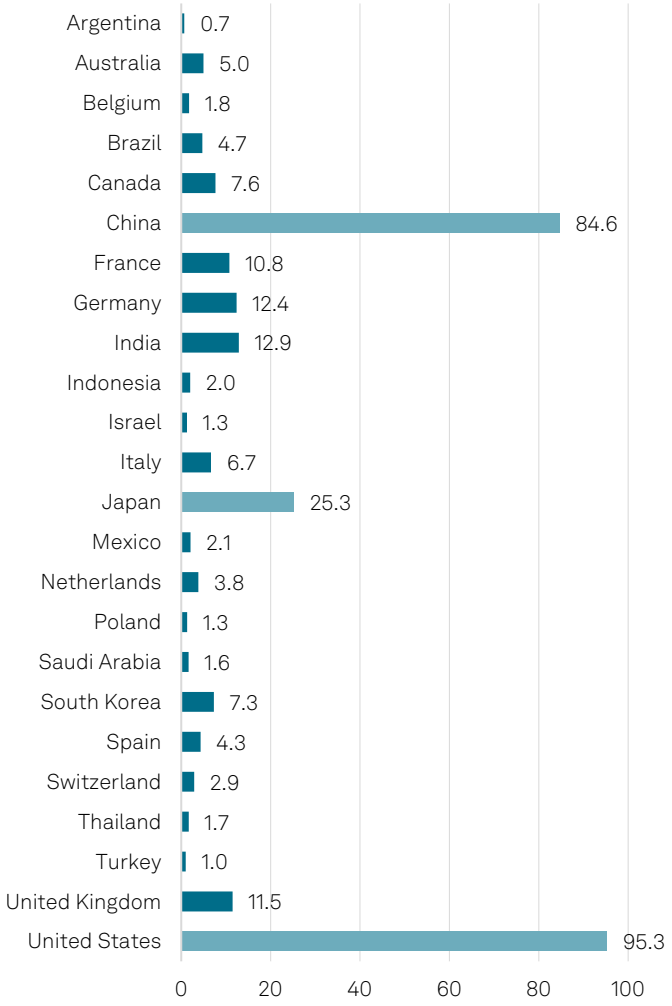
households incentives to carry large credit levels (see "Banking Industry Country Risk Assessment: Switzerland," published May 30, 2022). In China, corporate debt-to-GDP accounts for more than half of the country's total leverage, mainly due to heavy credit-funded infrastructure investment (see "Banking Industry Country Risk Assessment: China," published Aug. 15, 2023).

We emphasize that government or total country leverage risk isn't the same as sovereign risk. Weighing a sovereign's creditworthiness requires assessing that government's institutions, economy, external, fiscal and monetary profiles (see "Sovereign Rating Methodology," published Dec. 18, 2017). For example, assessment of the debt burden involves analysis of general government interest expenditures as a percentage of general government revenues, and net general government debt as a percentage of GDP. Net debt is gross debt less the most liquid financial assets. In short, merely looking at gross debt leverage is a partial assessment.

Chart A1-3

The U.S., China, and Japan to remain the top three in absolute debt...

24 large economies' debt (US$ tril.), baseline 2030p

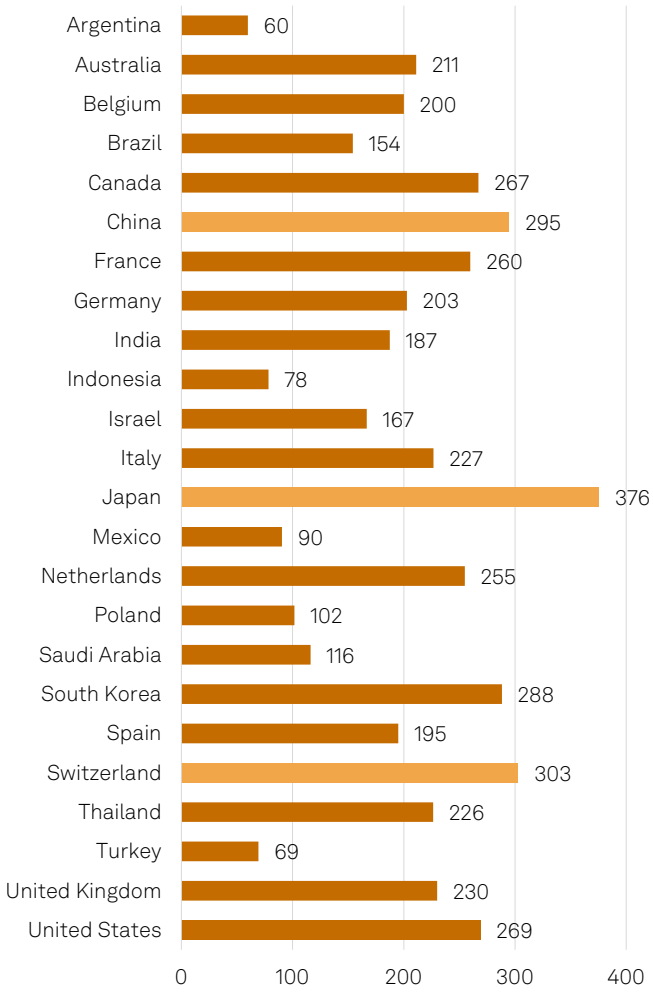


Data compiled Dec. 1, 2023. p--projected. Source: S&P Global Ratings.

Chart A1-4

...while Japan, Switzerland, and China to remain the top three in debt-to-GDP leverage

24 large economies' debt-to-GDP (%), baseline 2030p



Data compiled Dec. 1, 2023. p--projected. Source: S&P Global Ratings.

Appendix 2: High climate, digital, and aging transition costs

Our assumptions for estimating debt for additional climate, digital transformation and aging costs is given in table A2.

Table A2

More funding needs to be raised for climate, digital transformation, and aging

Our assumptions for estimating debt for additional climate, digital transformation, and aging costs

Additional cost	Assumptions

Climate mitigation and adaptation	• **Total additional investment**
	  • Climate mitigation: We refer to the Intergovernmental Panel on Climate Change's range estimations on global average financing levels and needs from their Sixth Assessment Report (2022). (Here, climate mitigation cost includes those for energy transition).
	  • Climate adaptation: We refer to the UN's Environment Program's estimation on annual adaptation needs for this decade and the annual adaptation finance gap per year, as outlined in their "*Adaptation Gap Report 2023*".
	• **Debt**:
	  • Climate mitigation: We presume that such investment is financed entirely through debt, and is borne 50% by government, 40% by corporates, and 10% by households (who have to retain more debt because of higher bills). For calculation of aggregate interest expense associated with such debt, we assume geographies will take on the debt according to their greenhouse gas emissions within their mature markets or emerging markets cohorts.
	  • Climate adaptation: We presume that such investment is financed entirely through debt, and is borne fully by government.
	• **Contribution to GDP**: We add the investment each year to nominal GDP.

Digital transformation	• **Total additional investment**: We assume annual technology gross fixed capital formation investment to be about 2.3% of GDP annually. The ratio comes from the OECD's "*A Roadmap Toward A Common Framework For Measuring The Digital Economy*," published 2020. • **Debt**: We presume that in mature markets such investment is borne 60% by corporates and 40% by government, and in emerging markets, vice versa. For corporates, roughly half of the financing is through debt. For government, all of the financing is through debt. • **Contribution to GDP**: We add the investment each year and a notional 6% return on investment (ROI, source: EY-Parthenon, *How can your digital investment strategy reach higher returns?,* 2022) to nominal GDP.
Aging	• **Total additional investment**: We draw on our "Global Aging 2023: The Clock Ticks," published Jan. 18, 2023, for estimated costs. • **Debt:** We presume that 100% of such investment will be borne by government, and all is funded through debt. Geography-level data is directly assumed based on the approach. • **Contribution to GDP:** We add the investment each year to nominal GDP.
Total	**$37 trillion**

Source: S&P Global Ratings.

Appendix 3: Higher debt-servicing costs

Ranking more highly leveraged geographic sectors. Table A3-1 shows the debt-to-GDP ratios for the corporate, government, and household sectors for the global, mature markets, emerging markets, and China cohorts for projected 2023, baseline 2030 and cost-of-transition 2030.

Table A3-1

Debt-to-GDP projections for sectors by cohort, 2023, baseline and cost-of-transition 2030 (%)

	Gross debt-to-GDP (%)												Debt (US$ tril.)		
	Corporate			Government			Household			Total			Total		
		2030p			2030p			2030p			2030p			2030p	
Geography	2023p	B	T	2023p	B	T	2023p	B	T	2023p	B	T	2023p	B	T
Global	85	88	92	84	87	101	62	62	61	231	238	254	225	336	373
Mature markets	78	80	83	100	107	118	72	70	69	250	257	270	150	211	228
Emerging markets	95	99	104	59	60	79	46	51	51	199	211	233	75	125	145
China	153	162	N.A.	61	59	N.A.	70	74	N.A.	283	295	N.A.	50	85	N.A.

p--projected, B--Baseline, T--Transition scenario. N.A.--Not available. See chart 4 note for the emerging markets and mature markets sample coverage. Source: S&P Global Ratings.

Global interest expense. In this exercise, we made some broad and simplifying assumptions owing to data limitations (see tables A3-2 and A3-3).

Table A3-2

Our assumptions in applying interest rates

Variable or Sector	Baseline scenario - interest rates	Sensitivity analysis - interest rates
Fed funds rate	We adopt the median values of the "dot plot" in the Federal Reserve's "*Summary of Economic Projections*", published Sept. 20, 2023, for years 2024-2026 and "longer run" for 2027 onwards.	Not applicable.
Corporate	We draw on the interest expense-to-debt data of a global sample of 50,000 nonfinancial corporates from S&P Capital IQ database and the U.S. corporate effective yields from the St. Louis Fed's economic database (FRED) to compute the assumed corporate interest rate for each geography for 2023. • To project corporate interest rates for 2030, we apply the differential between 2030 projected fed funds rate and its 2019 median, onto 2019 corporate interest rates.	**2023:** Keep the same as the baseline interest rates **2030:** Add 50 bps on top of the baseline interest rates for each geographic sector
Government	We draw on our "Sovereign Risk Indicators," published Oct. 9, 2023, to arrive at government interest rates for each geography.	
Household	We take mortgage rates as a proxy for household interest rates as home mortgages tend be the largest borrowing of households. We recognize that the interest rates on other borrowings such as auto and credit card loans could be higher. We extract 2023 mortgage rates for the geographies from various national sources. • To project household interest rates for 2030, we apply the differential between 2030 projected fed funds rate and its 2019 median, onto 2019 household interest rates.	

Source: S&P Global Ratings.

Table A3-3

Our assumptions in computing interest expense to revenue

Component	Sector	Approach
Interest expense	All sectors	We apply the interest rates (see approach detailed in table A3-2) on the debt amount of the corresponding geographic sector to arrive at the interest expense.
Revenue	Corporate	**2023:** Using the same global sample of nonfinancial corporates (per table A3-2), we refer to their fiscal year 2022 revenue by geography. The sample amounts to US$82 trillion of debt (or 92% of global corporate debt per Institute of International Finance at end-2022). We presume the sample revenue reflects that of the population. **2030:** We assume a 1-to-1 relationship between corporate revenue growth and nominal GDP growth. We apply the 2023-2030 growth rate of nominal GDP (US$) for each geography (sources: "Sovereign Risk Indicators," published Oct. 9, 2023, and S&P Global Market Intelligence) onto its 2023 revenue data, to project its 2030 revenue.
	Government	**2023:** We refer to the 2023 general government revenue by geography from "Sovereign Risk Indicators," published Oct. 9, 2023.
	Household	**2023/2030:** We refer to the "personal disposable income" data for each geography (source: SPGMI's EconoSim).

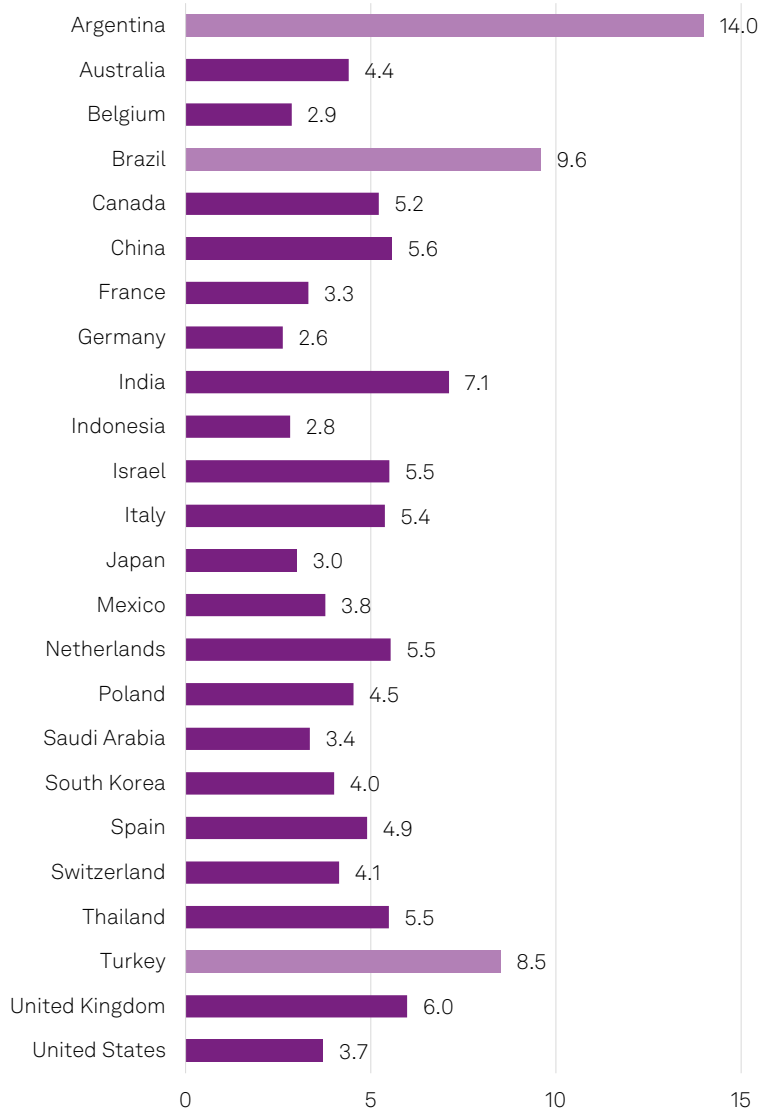
Source: S&P Global Ratings.

Moderating interest rates should provide some relief. The emerging markets of Argentina, Brazil, and Turkey are the top three in interest expense to revenue among our sample of 24 large economies (see chart A3-1). Expected lower interest rates in the medium to long term should provide relief to most geographic sectors with high debt-servicing costs as measured against income or revenue. However, there are exceptions—notably the **governments of India, Brazil, Italy, and the U.S.**—which continue to maintain or grow leverage in the baseline scenario.

Chart A3-1

Argentina, Brazil, and Turkey are the top three in interest expense to revenue

24 large economies' trisector interest expense to revenues (%), 2023p



Data compiled Dec. 1, 2023. p--projected. Source: S&P Global Ratings.

Emerging markets have disproportionate investment needs for the transition. In table A3-4, because of the imprecision of allocating by geographic sector for cost-of-transition, we haven't shown individual geographic results. However, the high-level outcomes reflect our view that the cost of transition will be primarily borne by governments and, arguably, disproportionately by emerging markets—many of them face more expensive debt financing amid lower GDP, have higher exposure to climate physical risks, and are in earlier stage of energy transition, compared to their mature market peers.

Governments have higher interest expense-to-revenues. Table A3-4 also shows that the government sector tends to have larger interest expense-to-revenue ratios. This isn't surprising given that governments generally provide public goods and services that are meant to be shared among the population at usually below-market pricing. As previously discussed, we expect governments to bear most of the cost of climate, digital transformation, and aging, which would worsen their ratios in our cost-of-transition scenario. As mentioned, we also conducted a sensitivity analysis by adding 50 bps to the anticipated 2030 interest rate across the geographic sectors. Table A3-5 shows the scenario outcomes if interest rates don't ease as anticipated.

Table A3-4

Lower interest rates should provide relief to most, but not all, geographic sectors

Interest expense-to-revenue projections for sectors by cohort, 2023, baseline and cost-of-transition 2030 (%)

	Interest expense-to-revenue (%)											
	Corporate			Government			Household			Total trisector		
		2030p			2030p			2030p			2030p	
Geography	2023p	B	T	2023p	B	T	2023p	B	T	2023p	B	T
Global	3.8	3.4	3.5	7.4	7.8	9.6	4.1	3.8	3.8	4.5	4.2	4.6
Mature markets	2.9	2.4	2.5	6.6	7.0	8.0	4.0	3.4	3.4	3.9	3.6	3.8
Emerging markets ex-mainland China	5.6	4.9	5.7	14.4	15.6	20.4	4.0	3.4	3.4	6.4	6.0	7.2
Mainland China	5.9	5.1	N.A.	5.8	5.7	N.A.	4.8	5.0	N.A.	5.6	5.2	N.A.

p--projected, B--Baseline, T--Transition scenario. N.A.--Not available. See chart 11 note for the emerging markets and mature markets sample coverage. Source: S&P Global Ratings.

Table A3-5

In a higher interest rate scenario, government borrowers would suffer most

Interest expense-to-revenue projections under higher interest rates, for sectors by cohort, 2023, baseline and cost-of-transition 2030 (%)

	Interest expense-to-revenue (%)											
	Corporate			Government			Household			Total trisector		
		2030p			2030p			2030p			2030p	
Geography	2023p	B	T	2023p	B	T	2023p	B	T	2023p	B	T
Global	3.8	3.8	4.0	7.4	9.6	11.2	4.1	4.2	4.3	4.5	4.9	5.3
Mature markets	2.9	2.8	2.9	6.6	8.9	9.8	4.0	4.0	3.9	3.9	4.2	4.4
Emerging markets ex-mainland China	5.6	5.4	6.3	14.4	18.0	22.4	4.0	3.6	3.7	6.4	6.7	7.8
Mainland China	5.9	5.8	N.A.	5.8	6.6	N.A.	4.8	5.6	N.A.	5.6	5.8	N.A.

p--projected, B--Baseline, T--Transition scenario. N.A.--Not available. See chart 11 note for the emerging markets and mature markets sample coverage. Source: S&P Global Ratings.

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