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The Financial Cost of Using Special Drawing Rights:

Implications of Higher Interest Rates

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The Financial Cost of Using Special Drawing Rights: Implications of Higher Interest Rates

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ABSTRACT: Since the August 2021 SDR allocation, the SDR interest rate has risen about 390 basis points through end-June 2023. This paper analyzes the impact of higher SDR interest rates on IMF members with negative net SDR Department positions. To do so, it constructs SDR forward curves at different points in time, from which the expected cost of servicing SDR obligations can be compared. Results show that the expected path of the SDR interest rate has shifted significantly upward since the 2021 allocation. Expected costs of charges (interest) in net present value terms are estimated to have more than tripled, while the grant element of SDRs has fallen to just below the IMF's concessionality threshold. Despite this increase in cost, IMF members' capacity to service SDR obligations remains generally adequate in both baseline and stress scenarios, though a few countries will need to carefully manage the rise in interest costs. Decisions to convert SDRs should consider interest rate risks, among other country-specific factors.

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WORKING PAPERS

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Contents

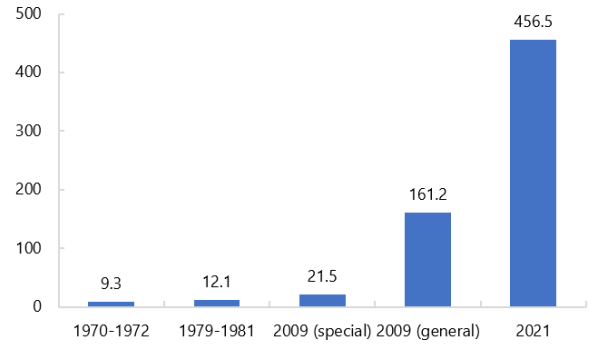
Glossary

BoE	–	Bank of England
DLP	–	IMF Debt Limits Policy
ECB	–	European Central Bank
ECF	–	Extended Credit Facility
EMDC	–	Emerging market developing countries
EUR	–	The euro
FIN	–	Finance Department of the IMF
FV	–	Face value
GAS	–	Global Assumptions Database
GBP	–	British pound sterling
IDA	–	International Development Association
IMF	–	International Monetary Fund
JPY	–	Japanese yen
LIC	–	Low-income countries
LIC-DSF	–	Debt Sustainability Framework for Low-Income Countries
NIR	–	Net international reserves
NPV	–	Net present value
NSS	–	Nelson-Siegel-Svensson
PRGT	–	Poverty Reduction and Growth Trust
PV	–	Present value
RMB	–	Chinese renminbi
SDR	–	Special Drawing Right
USD	–	U.S. dollar
VTAs	–	Voluntary Trading Arrangements
WEO	–	World Economic Outlook

Introduction

Special Drawing Rights (SDRs) are international reserve assets created by the IMF to supplement its member countries' official reserves. The IMF allocates SDRs to help meet a long-term global need to supplement existing reserves. Most recently, a general allocation of SDR 456.5 billion (equivalent to about US$650 billion) was implemented on August 23, 2021 (Figure 1).[1]

Figure 1. SDR Allocations
(Billions of SDRs)



Source: IMF Finance Department

In the SDR Department, IMF members receive interest on their cumulative SDR holdings and are assessed charges against their cumulative allocation of SDRs. Both interest and charges are assessed at the same rate (the SDR interest rate). When IMF members convert their SDR holdings to freely usable currencies or use them in Fund-related operations or in operations authorized by the Fund with other SDR Department participants or prescribed holders, a negative SDR Department position (where the member's SDR holdings are less than cumulative SDR allocations made to the member) may be generated. This negative net SDR Department position leads to a net interest expense ("charges," which constitute a financial obligation) to the SDR Department at the SDR interest rate.[2]

The SDR interest rate has risen significantly since the 2021 SDR allocation. It has climbed from 5 basis points in August 2021 to 395 basis points (Figure 2) as of end-June 2023, increasing the cost of having a negative SDR Department position. If sustained for an extended period, the current or higher interest rates may have implications for IMF members' capacity to service their financial obligations to the SDR Department, especially against the backdrop of rising debt vulnerabilities, tighter financing conditions, and lower availability of external

[1] For additional background on SDRs, see IMF (2021a) and IMF (2021b).

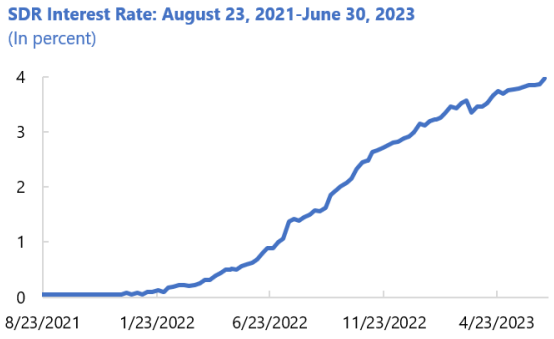
[2] This paper refers to members' decisions to convert SDR holdings to freely usable currencies as "SDR conversions." Note that this definition does not contemplate the potential different uses of proceeds from conversions from an economic perspective (e.g., increasing reserves, budget support, repayment of debt, etc.). All members with a net short position in the SDR Department—regardless of whether this short position followed from conversions of SDR holdings for freely usable currencies via the IMF's Voluntary Trading Arrangements (VTAs) or from other drawdowns in SDR holdings—are treated as "converters" for the purposes of this paper.

financing (including in aid budgets), particularly among low-income countries (LICs) and credit-constrained emerging markets and developing economies (EMDEs).[3]

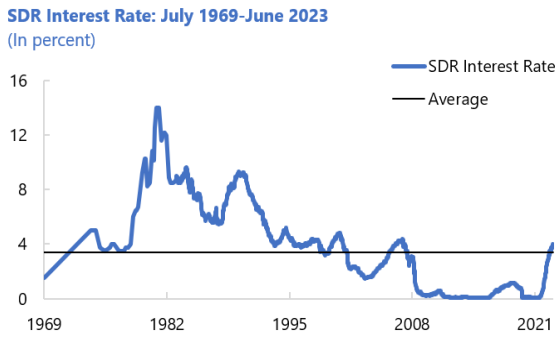
The purpose of this paper is twofold: 1) to estimate the expected cost of using SDRs for countries with negative SDR Department positions; and 2) to assess the implications of the results for IMF members' capacity to pay charges to the SDR Department. To this end, we project the forward path of SDR interest rates (i.e., forward curves) to estimate expected SDR Department payments. To construct SDR forward curves, we derive implied SDR forward rates from market-determined interest rates of SDR basket currencies. Forward curves are constructed at different points in time (i.e., at different "vintages"), from which an estimate of SDR Department financial obligations is computed. With these forward curve vintages, it is possible to then compare the expected cost of reducing SDR holdings over time. Based on these interest rate projections, the paper also assesses the financial and economic implications of the results for IMF members, including on the capacity to service financial obligations to the SDR Department.

Figure 2. SDR Interest Rate Since the 2021 General Allocation

The SDR interest rate has risen since the 2021 allocation…



…rising to just above its historical average.



Source: FIN's financial data query tool and authors' calculation.

This paper concludes that as SDR interest costs have increased, the grant element of SDRs as a financing instrument has declined and thus the financing terms of SDRs are just below the IMF's concessionality threshold of 35 percent.[4] Should SDRs be cancelled or the interest rate rise, then the grant element of SDRs would fall further. Moreover, IMF members' exposure to the SDR Department from the perspective of upcoming charges payable to the SDR Department is generally manageable under both baseline and stress scenarios, although for some members the increased financial cost can be material. These results hold for most of the emerging market (EM) and LIC members on both stock and flow measures.

[3] See IMF (2022b). See also IMF (2023c), especially Figure 3, on the evolution of the sources of financing for Sub-Saharan Africa since 2000.

[4] SDRs are international reserve assets that serve different purposes from instruments to which they are compared in this paper, such as concessional lending from the IMF's Poverty Reduction and Growth Trust. Still, SDRs are part of a pool of an IMF member's gross international reserves and as such can serve as a potential financing source. The concessionality of SDRs can be considered when assessing the suitability of using SDRs compared to other potential funding sources.

This paper contributes to the academic literature and adds to the operational understanding of the SDR as a financing instrument. To the authors' knowledge, it is the first attempt to derive forward curves for the SDR basket from market data.[5] Numerous authors have conducted a similar analysis for more traditional currencies or assets—such as, inter-alia, Hagan & West (2008), Deaves & Parlar (2000), and Ametrano & Bianchetti (2013). Several of these papers, similar to ours, rely on the regression-based methodology developed by Nelson & Siegel (1987) and Svensson (1994). Moreover, this paper provides a useful contribution to the literature on SDRs (see, for example, Truman (2022), Plant (2022), and Latindadd (2021)), as it highlights an element typically missing in other studies: the expected cost of SDR conversion, particularly in a higher interest rate environment. This paper also contributes to the literature on foreign reserve management, especially given the potential trade-offs between converting SDRs (and thus possibly reducing foreign exchange reserves) and preserving external sustainability. As put forth by Jeanne & Rancière (2011) and IMF (2016), identifying the optimal level of international reserves requires a cost-benefit analysis, for which this paper can be a useful input. This paper also supports the *ex-post* assessment of the 2021 SDR allocation.[6] Finally, it helps inform potential decisions on reducing SDR holdings for various purposes (e.g., external financing needs or fiscal support) compared to using other reserve assets or alternative financing sources.[7]

The rest of this paper proceeds as follows. Section II outlines the operational aspects of the SDR Department relevant for this study. Section III describes the methodology used to calculate the expected cost of SDR conversion, including its main assumptions. Section IV presents the results, discusses the implications of higher SDR interest rates for IMF members under baseline and stress scenarios, and examines a few extensions that follow from this analysis. Section V concludes. The Annex presents an additional robustness check for the paper's main results.

Operations of the SDR Department

Decisions to allocate SDRs are made by the IMF Board of Governors based on their assessment of long-term global reserve needs.[8] SDRs are allocated to IMF members participating in the SDR Department in proportion to their paid quota shares. They provide IMF members with unconditional liquidity.[9] Members can retain SDRs as their reserves or use SDRs: (i) in transactions to get freely usable currencies; or (ii) in Fund-related operations; or (iii) in operations approved by the IMF (e.g., payments of financial obligations, loans, pledges

[5] The debate on the forward SDR interest rate was historically interconnected to the valuation system, as both give rise to the "effective yield" on the asset. For more information, see Cutler & Gupta (1974).

[6] See IMF (2021b) and IMF (2023d).

[7] While the decision to convert SDRs should continue to be guided by country-specific factors and macroeconomic sustainability, such cost-benefit analysis should consider the interest expense associated with negative net SDR Department positions.

[8] The basis for considering a general allocation of SDRs is Article XVIII of the Fund's Articles of Agreement. Article XVIII, Section 1(a) provides that: "In all its decisions with respect to the allocation and cancellation of SDRs the Fund shall seek to meet the long-term global need, as and when it arises, to supplement existing reserve assets in such a manner as will promote the attainment of its purposes and will avoid economic stagnation and deflation as well as excess demand and inflation in the world." In addition, before making a proposal, the Managing Director is required under Article XVIII, Section 4(b) to "conduct such consultations as will enable [her] to ascertain that there is broad support among participants for the proposal." For more, see IMF (2020a).

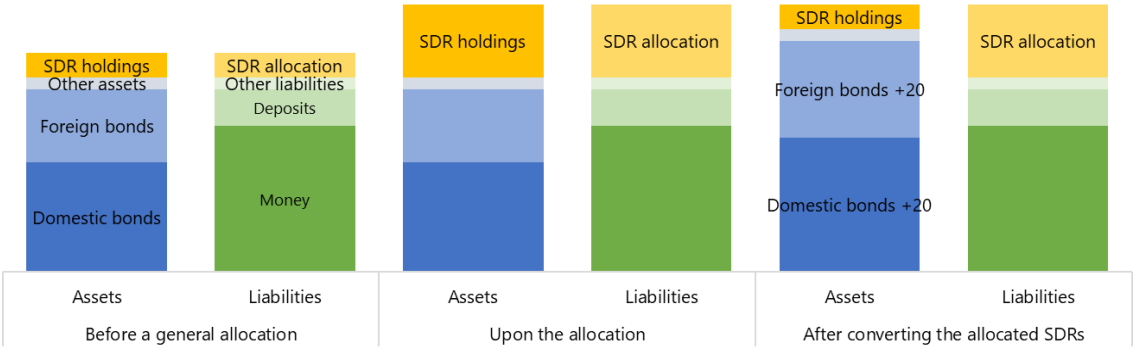
[9] IMF (2018).

donations, swaps, and forward transactions) with other SDR Department participants (i.e., all IMF members)[10] or prescribed holders.[11]

Under SDR allocations, IMF members receive an equal increase in their SDR holdings and allocation vis-à-vis the IMF's SDR Department. From the member's viewpoint, SDR allocations lead to the creation of both an asset (its SDR holdings, which can be used unconditionally for many purposes, including in transactions with the IMF) and a liability (its SDR allocation). Thus, there is no net transfer of wealth associated with an SDR allocation (Figure 3).

Members that have negative net SDR Department positions face an interest rate risk vis-à-vis the SDR Department. Members with SDR holdings less than their cumulative SDR allocations will pay more charges than they will receive interest on their holdings to the extent that they hold fewer SDRs than their allocation (as on the right-hand side of Figure 3). These charges are assessed at the SDR interest rate, which is determined weekly by a formula (i.e., a floating rate) that is based on the weighted average of the interest rates of short-term financial instruments of SDR basket currencies (the U.S. dollar, the Japanese yen, the euro, the U.K. pound sterling, and the Chinese renminbi), with a floor set at 5 basis points.[12]

Figure 3. Stylized Central Bank Balance Sheet[1]



[1] In this case, it assumed that the member (and more specifically, the monetary authority) receives a $40 SDR allocation. The allocation implies an increase in both gross assets and liabilities of the member (see middle panel). After the allocation, it is assumed that the member converts some of its freely usable currency to increase its holdings of domestic bonds worth $20 and increase its holdings of foreign bonds worth $20.

Source: Authors' stylized example.

[10] It is optional for IMF members to participate in the SDR Department. All IMF members, though, currently participate in the SDR Department.

[11] IMF (2021c). Prescribed holders are entities that, while not participants in the SDR Department, can nevertheless hold SDRs and use them for a range of financial operations. Prescribed holders do not receive allocations of SDRs. On February 8, 2023, the Executive Board approved the application of five new institutions to become prescribed holders of SDRs, bringing the total number of prescribed holders to 20, see IMF (2023b).

[12] See IMF (2022a) and (2021c).

The expected cost of SDR conversion

This paper studies the gross cost of net interest payments to the IMF's SDR Department due to having a negative SDR Department position. It does not analyze the *net benefit* of converting SDRs, as doing so would require an assessment of the specific use of SDR proceeds. Indeed, the decision to convert SDRs should consider the use of proceeds of exchanges of SDRs for freely usable currencies and country-specific circumstances, as SDR conversion may be compensated by the return on their proceeds.[13] Nevertheless, the results of this exercise can be an input into an overall cost-benefit analysis of using SDRs.

The expected cost of using SDRs is the present value (PV) of all future net interest payments and face value payments of SDRs for the projection period. The PV of interest payments in quarter *q* are determined by the prevailing SDR interest rate of the current quarter ($SDRi_q$), which is based on expected future SDR interest rates at that quarter at a given time ($E_t(SDRi_q)$), the difference between the member's SDR allocation and holdings in the same quarter ($SDRa_q - SDRh_q$), as well as the discount rate (r). The second term in the right-hand side of equation (1) represents the "face value" redemption of the member's net open position in the SDR Department (captured by the term ($SDRa_{q*} - SDRh_{q*}$), or the difference in the member's SDR allocation and its holdings at the quarter of redemption, discounted at the quarter of redemption (q^*). Note that one of the key inputs to compute the PVs is the assumed quarterly SDR interest rate for the projection period ($E_t(SDRi_q)$). This paper's main contribution is thus to estimate future expected SDR interest rates, which allows for comparisons in the expected cost of reducing SDR holdings in different interest rate environments.

$$(\mathbf{1})\ ExpectedCost_t = PV_t = \sum_{q=0}^{n} \frac{\left[\left(SDRa_q - SDRh_q\right) * E_t\left(SDRi_q\right)/4\right]}{(1+r)^{q/4}} + \frac{(SDRa_{q*} - SDRh_{q*})}{(1+r)^{q*/4}}$$

Additional assumptions include:

- For simplicity, it is assumed that the IMF's Board of Governors will not decide to cancel SDRs nor request member states to reconstitute them in the baseline scenario.[14]
- Basket weights of SDR basket currencies are fixed at the initial 2015 weights through July 2022, after which they follow the August–2022 basket weights for the rest of the projection period (see Table 1).
- SDR basket instruments are fixed for the projection period.

[13] For instance, the net (SDR) interest cost may be offset by the interest earned on the alternative use of these SDRs (e.g., returns on holding reserves assets in freely usable currencies, purchased with proceeds from the sale of SDRs or savings from paying off more expensive debt). Potential uses of the proceeds of reducing SDR holdings could include investing in assets that yield more income than the costs generated to the SDR Department or helping finance urgent spending, critical imports, and other high-multiplier investment. At the same time, reducing SDR holdings could adversely impact members' macroeconomic sustainability—for instance, a drawdown in SDR holdings for fiscal purposes would reduce members' net external buffers and potentially affect external sustainability, in turn increasing sovereign borrowing costs. See, for example, Bellas, Papaioannou, & Petrova (2010) who find that reserve coverage ratios (e.g., short-term debt to reserves, interest payments to reserves, and amortizations to reserves) contribute to lower emerging market sovereign bond spreads.

[14] Calculations can also be done without this assumption (i.e., by using a finite horizon), and results still broadly hold.

- SDR Department charges are assessed on a quarterly basis at a constant, imputed interest rate for that given quarter. Thus, the SDR interest rate used in this exercise can be thought of as the average value of the weekly SDR interest rate in the forecasted quarter.[15]
- The discount rate (r) is assumed to be 5 percent for all IMF members, in line with convention. This discount rate is also used in the Debt Sustainability Framework for Low-Income Countries (LIC-DSF) and in the IMF's Debt Limits Policy for calculating the grant element of a financing instrument.[16]

It is assumed that the member's SDR holdings are converted in period 0 and remain unchanged thereafter. Based on the assumption of no cancellation nor reconstitution, equation (2) simplifies further to equation (2.1). Given the lack of liquid bond yield data for all SDR basket currencies beyond thirty-years, SDR forward curves use market data for the first thirty years of the projection horizon (120 quarters).[17] Therefore, the stream of perpetual SDR Department obligations is separated into two summation operators in equation (3): the left-hand side summation operator uses market-implied interest rates from the exercise, while the right-hand side summation operator assumes that the expected SDR interest rate in quarter 120 is constant for quarters 121 into perpetuity.[18] In other words, the expected SDR interest rate in the 120th period is assumed to be the terminal SDR interest rate for the rest of the forecast horizon to ensure consistency of using market data across SDR basket currencies.[19] Equation (4) shows the specific form of the present value of the expected cost of reducing SDR holdings employed in this paper. The results are sensitive to the discount rate assumed in the analysis (5 percent). For ease of calculation, it is assumed that the member begins incurring interest expense in period 1 (q=1) into perpetuity.

$$(\mathbf{2})\ PV_t = (SDRa_0 - SDRh_0) * \sum_{q=1}^{q*} \frac{E_t(SDRi_q/4)}{(1+r)^{q/4}} + \frac{(SDRa_{q*} - SDRh_{q*})}{(1+r)^{q*/4}}$$

$$(\mathbf{2.1})\ PV_t = (SDRa_0 - SDRh_0) * \sum_{q=1}^{\infty} \frac{E_t(SDRi_q/4)}{(1+r)^{q/4}}$$

$$(\mathbf{3})\ PV_t = \left(\overline{SDRa_0 - SDRh_0}\right) * [\sum_{q=1}^{120} \frac{E_t(SDRi_q/4)}{(1+r)^{\frac{q}{4}}} + \sum_{q=121}^{\infty} \frac{E_t(SDRi_q/4)}{(1+r)^{\frac{q}{4}}}]$$

$$(\mathbf{4})\ PV_t = \left(\overline{SDRa_0 - SDRh_0}\right) * [\sum_{q=1}^{120} \frac{E_t(SDRi_q/4)}{(1+\overline{5\%})^{\frac{q}{4}}} + \sum_{q=121}^{\infty} \frac{E_t(\overline{SDRi_{120}}/4)}{(1+\overline{5\%})^{\frac{q}{4}}}]$$

[15] The SDR interest rate fluctuates weekly based on the basket instruments, see IMF (n.d.).

[16] For instance, IMF (2013) notes the unification of the discount rate of 5 percent for low-income country debt sustainability analyses. See also IMF (2021d).

[17] Of the SDR basket currencies, only the UK and China (about 19 percent of the SDR basket) offer bonds with a term greater than 30 years.

[18] It is worth noting that the thirty-year projection value of the SDR interest rate is roughly equal to the historical SDR interest rate since the SDR's inception (see Figure 2). This terminal value of the SDR interest rate could be upwardly biased if the long run average rate is no longer a sensible guide for the future average rate. That said, there are some benefits to using a conservative projection in assessing the financial cost of SDR use.

[19] This terminal rate assumption is changed in the stress scenario.

Once forecasts for the future values of three-month sovereign bonds rates for China, the euro area, Japan, the UK, and the US are derived, it is possible to build the SDR interest rate forward curve, as detailed in equation (5) below, with the currency amounts (ω_c) determined in the 2015 and 2022 SDR Valuation Reviews (see Table 1), and $e_{c,t+q|t}$, which is the expected exchange rate vis-à-vis the U.S. dollar. The basket is defined as a constant amount of the five currencies, so that weights evolve over time with exchange rate fluctuations. Note that for the purposes of this exercise, it is assumed that nominal exchange rates follow a random walk, and thus a flat line is the best possible projection for the exchange rate. However, short-term interest rates and exchange rates are closely related, and therefore the assumption of a flat line projection in exchange rates may not be realistic. Nonetheless, it is well-established in the literature that forecasting exchange rates from interest rate differentials is challenging, and thus this exercise is left for future analyses.[20] Additionally, as shown in IMF (2022a), Figure 2, the actual currency weights in the SDR basket have been broadly stable since 2016, which indicates that the fixed basket weights employed by this paper will not bias the results. Thus, the valuation review weights are fixed for the projection horizon as well (i.e., omitting an exchange rate variable).

$$(\mathbf{5})\ SDRi_{t+q|t} = \sum_{c\in\{CHN,EA,JPN,USA,GBR\}} i_{c,t+q|t}\frac{\omega_c e_{c,t+q|t}}{\sum_{c'}\omega_{c'}e_{c',t+q|t}}$$

Implied SDR forward curves are derived at multiple dates or "vintages" to study how the expected cost of using SDRs evolves over time. Dates chosen include August 23, 2021 (when the 2021 SDR allocation took place); January 1, 2022 (prior to the beginning of the Federal Reserve's rate tightening cycle); and end-June, 2023 (into the Federal Reserve's tightening cycle and amid the broad global inflationary shock and over a year after the start of Russia's war in Ukraine).

Table 1. Composition and Weights of the SDR Basket[1]

Currency		2015 Valuation Review Weights	Currency amounts fixed Oct. 2016–Jul. 2022	2022 Valuation Review Weights	Currency amounts fixed Aug. 2022–Jul. 2027
USD	US dollar	41.7%	0.58252	43.4%	0.57813
EUR	Euro	30.9%	0.38671	29.3%	0.37379
RMB	Chinese yuan	10.9%	1.0174	12.3%	1.0993
JPY	Japanese yen	8.3%	11.900	7.6%	13.452
GBP	Pound sterling	8.1%	0.085946	7.4%	0.080870

[1] SDR basket instruments include the three-month spot rate for euro area central government bonds with a rating of AA and above published by the European Central Bank; the three-month Japanese Treasury Discount bills; the three-month UK Treasury bills; and the three-month US Treasury bills.

Source: IMF (2015) and IMF (2022a).

[20] See, for example, Kilian & Taylor (2003) and Meese & Rogoff (1983).

Deriving forward rates using zero coupon curves

A two-step approach to derive forward curves for each SDR basket currency is used.[21] First, regression-based and interpolation-based techniques provide estimates of zero-coupon bond yield curves. Zero-coupon yield curve data are available from public sources, including the respective central bank websites for the US, EU, and UK, Bloomberg for Japan, and CEIC for China. However, these data contain yield curve information only for specific tenors, usually at a 6-month or 1-year interval, with intervals rising toward the longer-end of the curve. To derive three-month implied forward rates, zero coupon yield curve information is needed at a three-month interval. Therefore, regression-based and interpolation-based techniques are used to "re-fit" the yield curve such that information on the entire term structure can be obtained, as per the details outlined below:

Details on the derivation of zero-coupon curves differ slightly for each instrument, as follows:

- China, Japan, Euro Area, and United States: A common approach used to construct a zero-coupon yield curve is that proposed by Svensson (1994), which extends the work of Nelson & Siegel (1987) (hereafter referred to as the "Nelson-Siegel-Svensson" or "NSS" model). The NSS model provides a way to "best fit" the term structure of interest rates based on available data points of bond yields at different tenors. It further assumes that a zero-coupon bond yield curve is a function of six parameters based on the following functional form, where $y_t(n)$ is the continuously compounded yield of an *n*-year zero-coupon bond, and the parameters $\beta_0, \beta_1, \beta_2, \beta_3, \tau_1$ and τ_2 are estimated using non-linear regression.

$$(\mathbf{6})\ y_t(n) = \beta_0 + \beta_1 \frac{1-\exp\left(-\frac{n}{\tau_1}\right)}{\frac{n}{\tau_1}} + \beta_2\left[\frac{1-\exp\left(-\frac{n}{\tau_1}\right)}{\frac{n}{\tau_1}} - \exp\left(-\frac{n}{\tau_1}\right)\right] + \beta_3\left[\frac{1-\exp\left(-\frac{n}{\tau_2}\right)}{\frac{n}{\tau_2}} - \exp\left(-\frac{n}{\tau_2}\right)\right]$$

  For the *United States* and *Euro Area*, the Federal Reserve and the ECB provide information on the estimates of the NSS parameters. Zero-coupon yields can thereby be inferred for all tenors based on equation (6) using the parameters provided by the Federal Reserve and ECB. (see Table 2 for an example of the estimates provided).

  For *China* and *Japan*, such estimates are not available. Information on zero coupon yield curves is available on CEIC and Bloomberg for China and Japan, respectively, albeit only for specific tenors. As no additional information on how the data are computed is provided, the yield curves for China and Japan are "re-fit" to zero-coupon yields for the entire term structure using the NSS approach by estimating equation (6) (see Table 2 for an example of the estimated results).[22]

- United Kingdom: Information on zero-coupon yield curves is available on the Bank of England (BoE)'s website. Similar to the above cases, only speicifc tenors are available. Unlike the Fed and the ECB, however, the provided yield curves are from a spline-based method. Under a spline-based method,

[21] The current SDR basket instruments include the three-month benchmark yield for China Treasury bonds as published by China Central Depository and Clearing Co; the three-month spot rate for euro area central government bonds with a rating of AA and above published by the European Central Bank; the three-month Japanese Treasury Discount bills; the three-month UK Treasury bills; and the three-month US Treasury bills.

[22] The codes used for this econometric exercise are available upon request.

forward rates are modeled as a piecewise cubic polynomial, whereby the fitting is done for each segment of the yield curve rather than the entire yield curve at once (for more information, see Anderson & Sleath (2001)). While re-fitting the curves for the UK using the NSS approach was attempted, comparison of the data points with the fitted curve suggests that the NSS approach may not be flexible enough to fit the curves. This is likely due to the non-parametric nature of the original approach, which allows for greater flexibility for yield curve fitting. Therefore, linear interpolation is instead used to connect all the provided tenors—i.e., by using linear polynomials to construct new data points between each two adjacent tenors for which data are available. Given that the data provided by the BoE are at a relatively close interval (6-month), this approach should provide fairly reliable results.[23]

Based on the constructed continuously compounded zero-coupon yield curves, the second step involves deriving implied three-month forward rates for each SDR basket currency interest rates using no-arbitrage conditions. More specifically, to find a forward rate y_{t_1,t_2} for time period between t_1 and t_2—with t_1 and t_2 expressed in years, and given the yields of two zero-coupon bonds, y_{t_1} and y_{t_2}—a no-arbitrage condition is applied. That is, it is assumed that investing in the shorter-term bond for time period $(0, t_1)$ and re-investing the proceeds at rate y_{t_1,t_2} for time period (t_1, t_2) should give the same yield as investing in a longer term bond for time period $(0, t_2)$. For continuously compounded yields, this no-arbitrage condition corresponds to the following equation (7), where y_{t_1,t_2} can be readily solved for, given $y_{t_1}$and y_{t_2}. Using this condition and given the estimated or interpolated yields at t and $t + 0.25$ years horizons for $t \in \{0.25, 0.5, \dots, 120\}$ from Step 1, a forward curve at the same horizon for each of the five SDR basket currency interest rates is obtained.

$$(7)\ e^{y_{t_2}t_2} = e^{y_{t_1}t_1}e^{y_{t_1}t_2(t_2-t_1)}$$

After deriving these forward curves, an implied SDR interest rate forward curve can be computed by weighting the SDR basket currency forward rates at different tenors by their corresponding SDR basket weights (see equation (5) and Table 1).

The main advantage of this method is that it uses widely available market data. The use of market data allows for the direct extraction of market-based interest rate expectations by market participants. Additionally, the data used are widely available to market participants and thus can be replicated by interested parties. One potential drawback, however, is that in practice, yield curve information may not necessarily contain only information on interest rate expectations but could reflect other confounding elements such as term- and liquidity-premia. Moreover, markets can misprice the expected future path of interest rates, which could bias the results depending on whether actual rates undershoot or overshoot expectations. Given these limitations, the forward curves derived in this paper are complemented and assessed for robustness using WEO projections, which do not rely on market data (see Annex).

[23] The BOE does not provide zero coupon yield data for the 3-month tenor. To fill this missing data point, we estimate the NSS regression based on the provided tenors and use the estimates to obtain the implied rate for this tenor only.

Table 2. Illustrative Nelson-Siegel-Svensson Estimates for Zero-Coupon Yield Curves on August 23, 2021[1]

	USA[2]	Euro Area[2]	China[3]	Japan[3]
β_0	2.61	0.09	3.81	1.20
β_1	-2.49	-0.73	-2.12	-1.20
β_2	-2.49	13.29	29.25	-1.45
β_3	-2.19	-14.25	-29.95	-3.78
τ_1	1.31	5.19	2.31	0.51
τ_2	4.86	4.77	2.43	3.91

[1] Note that NSS estimates vary by day depending on the exact shape of the yield curve for that day, and thus an illustrative example of parameters for a discrete day (August 23, 2021, the date of the 2021 SDR allocation) was included.

[2] NSS estimates were obtained from the Fed and ECB websites. Additional details on the Fed's derivations are available in Gurkaynak, Sack, & Wright (2011).

[3] NSS estimates for China and Japan were estimated according to equation 6, see Svensson (1994).

Results and sensitivity analysis

SDR forward curves for different vintages and expected costs for IMF members

SDR forward interest rates have increased significantly compared to those observed at the time of the 2021 allocation. Implied SDR forward curves indicate that the SDR forward rate curve over the 30-year horizon period has risen about 230 basis points on average from August 2021 to June 2023 (see Figure 4). Moreover, the June 2023 SDR forward curve is inverted in the 0–5-year time horizon, possibly reflecting the frontloaded monetary tightening in SDR basket currencies and anchored expectations of terminal benchmark interest rates.

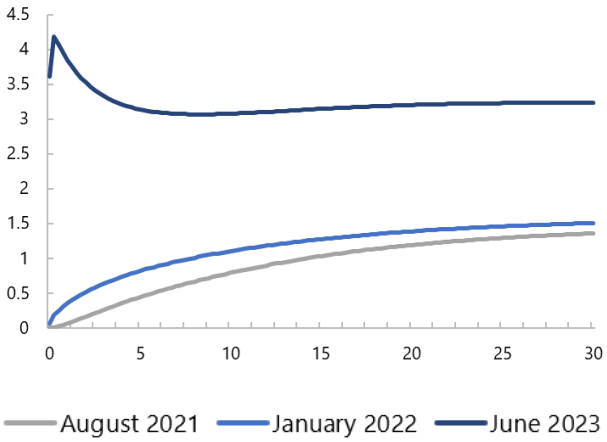
As a result of higher SDR interest rates, the expected cost of reducing SDR holdings has risen substantially since the August 2021 SDR allocation for the median country. Based on the market-implied forward curves, the median expected cost among IMF members with negative net SDR Department positions of converting SDRs based on the present value of SDR Department obligations has risen from $37 million in August 2021 to $134 million on June 2023—an increase of 262 percent (Figure 5). This increase is even more stark when considering the (median) expected one-year-ahead annual expected cost of servicing obligations to the SDR Department, which has risen from $0.1 million in August 2021 to $7.8 million in June 2023 (a nearly eighty-fold increase). For the top quartile country, the one-year-ahead and the PV cost measures are estimated at $19 million and $333 million, respectively; for the member with the largest negative SDR Department position in nominal terms, this cost is estimated at $259 million (one-year-ahead) and $4,471 million (PV), respectively.[24,25]

[24] Note that these maximum numbers are not reflected in the box plots of Figure 5 as the numbers exceed the standard interquartile range.

[25] This rise in nominal expected cost is examined in greater details in the context of capacity to pay in the following subsection.

Figure 4. Three-Month SDR Interest Rate Forward Curves Based on Market-Implied Estimates

(In percent; year)



Source: Central banks' websites, Bloomberg, CEIC, and authors' calculations. Full results available upon request.

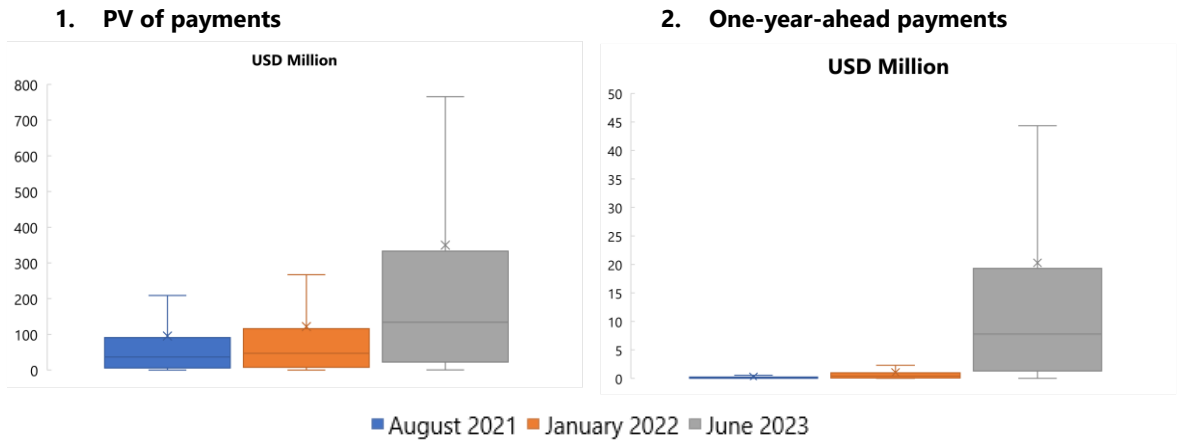
The higher SDR interest rate implies that the financing terms of SDRs have declined to just below the concessionality threshold. The concessionality—or degree of "grant element" of a financing instrument—can be assessed via discounting using the below equation (8), where FV is the face value of a member's negative net SDR Department position, and the PV is the discounted stream of SDR Department interest payments owed by the member at a given point in time. By convention, financing terms are considered concessional if the grant element is greater than 35 percent.[26] The grant element of SDRs has decreased significantly between the time of the 2021 SDR allocation and June 2023, from about 80 percent in August 2021 to 34 percent in end-June 2023—i.e., below the 35 percent concessionality threshold. Despite the rise in interest rates, the expected grant element of SDRs is still comparable to the IMF's Extended Credit Facility (ECF) under the Poverty Reduction and Growth Trust (PRGT) of roughly 36 percent and is lower than World Bank International Development Association loans (about 50 percent, see Figure 6).

$$(\mathbf{8})\ Grant\ element = \frac{FV - NPV|_{SDRi}}{FV}$$

[26] See IMF (2013) for the World Bank-IMF methodology of assessing the grant element of individual loans. SDR operations are not designed to provide concessional resources to IMF member countries.

Figure 5. PV of SDR Department Obligations and Expected 2023 Payments for IMF Members[1]

(By forward curve vintages, USD million)

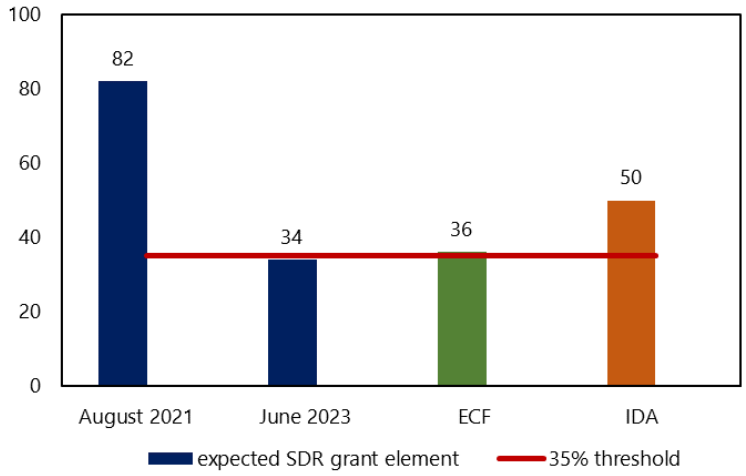


[1] The calculations are performed using SDR forward curves at a 5 percent discount rate, assuming no SDR cancellation. For all vintages, the calculations are performed using data on the net short positions in the SDR department (i.e., SDR holdings less SDR allocations) of all members with net short positions as of end-June 2023. This is done to allow for expected cost comparison at different vintages based on different interest rate expectations, rather than different amounts of SDR conversations across the dates. Outlier observations (with values exceeding 1.5 times the interquartile range) are not shown. These data points are, however, included in the histograms below when the manageability of SDR obligations is discussed on the individual countries' basis.

Source: Bloomberg, WEO, and authors' calculations

Figure 6: Expected Grant Element of SDRs and Other Facilities at Different SDR Forward Curve Vintages[1]

(percent, by SDR forward curve vintage and facility)



[1] The grant element numbers for SDRs are calculated based on expected interest rates at two vintages: August 2021 and June 2023. The numbers for IDA and the ECF are based on illustrative estimates discussed in International Monetary Fund (2023c) based on January 2023 interest rates.

Source: IMF (2023a) and authors' calculations

Assessing IMF members' capacity to service SDR Department obligations

Members' exposure to the SDR Department can be assessed and stress-tested relative to their capacity to service obligations. To assess the financial cost of higher SDR interest rates on IMF members, public information on IMF members with negative net open positions vis-à-vis the SDR Department was used. From these net open positions, it is possible to compute a variety of stock and flow measures of members' capacity to service obligations using different interest rate forward curve vintages (for the baseline) and a stress scenario SDR forward curve. Two forward curve vintages are considered for the results: August 2021 (at the time of the 2021 SDR allocation) and end-June 2023 (after the rise in SDR interest rates).

Results show that members' exposure to the SDR Department remains broadly manageable for most countries (see Figure 7)**.** Out of a sample of 59 LIC and 62 EM IMF members with negative net SDR Department positions, the expected cost of SDRs has risen over time. For instance, using the August 2021 SDR forward curve, only five countries had a PV of SDR Department payments greater than 1 percent of GDP greater. Using the June 2023 SDR forward curve vintage, this total rises to 36 (about 31 percent of all members). In August 2021, 14 countries had a ratio of PV of SDR Department payments greater than 5 percent of their gross foreign exchange reserves. By June 2023, this number had risen to 45 countries, with 9 having a ratio greater than 20 percent. Despite the higher expected cost on an NPV basis, capacity to service SDR obligations appears manageable based on several flow indicators. SDR Department payments as a percent of GDP are less than 0.1 percent for 90 percent of members with negative net SDR positions. Payments as a percentage of fiscal revenues are less than 0.5 percent for 90 percent the sample.

Some countries, however, exhibit weaker indicators of capacity to service their obligations to the SDR Department. On average, LICs show greater increases in expected cost of SDRs over time relative to EMs, especially on flow measures of capacity to service obligations (see Figure 7, panel on SDR Department payments to GDP and fiscal revenues). An assessment of members' exposure to the SDR Department relative to capacity to service obligations shows that a 5 EMs and 9 LICs have a PV of SDR Department obligations greater than 1 percent of GDP while having a reserve position less than 100 percent of the IMF's ARA metric (Figure 8). Among LICs with reserves less than 100 percent of the IMF's ARA metric, South Sudan and Zimbabwe stand out as having a PV of SDR Department obligations above 3 percent of GDP. Among EMs, only Jamaica has a PV of SDR Department obligations at about three percent of GDP and reserves less than 100 percent of the IMF's ARA metric.

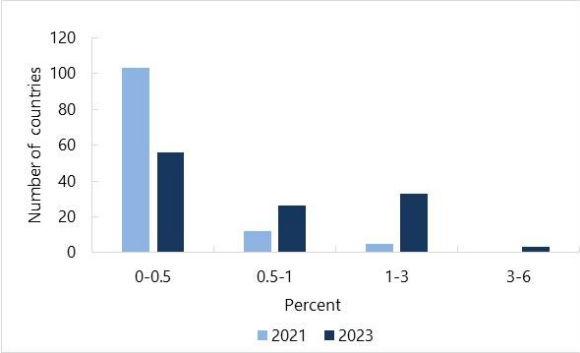
For a few EMs and LICs, capacity to service obligations could be weaker given existing vulnerabilities. Out of 62 of EMs, two countries (Jamaica and Suriname) have a PV of SDR Department obligations greater than 2 percent of GDP, while their total stock of public debt is greater than 60 percent of GDP; and three EMs with PV of SDR Department exposures greater than 2 percent of GDP also have external debt levels greater than 60 percent of GDP (Jamaica, Suriname, and Venezuela). Out of 59 LICs, six countries (Burundi, Central African Republic, South Sudan, São Tomé and Principe, Yemen, and Zimbabwe) have a PV of SDR Department obligations greater than 2 percent of GDP and a total stock of public debt greater than 40 percent of GDP (Figure 9); and three (São Tomé and Principe, Yemen, and Zimbabwe) have a PV of SDR obligations greater than 2 percent of GDP and external debt greater than 40 percent (Figure 8).[27] These countries will need to take

[27] For some of these countries, they also have large credit outstanding to the IMF's PRGT and General Resources Account that may also contribute to weakness in their capacity to service SDR Department obligations.

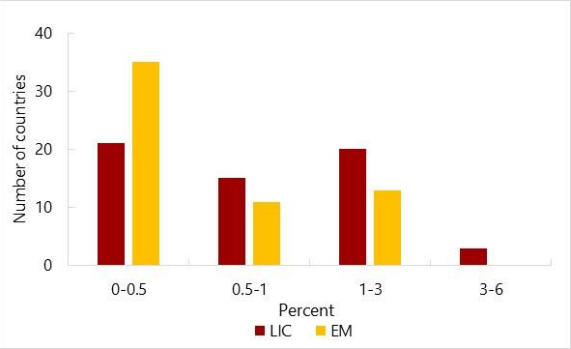
SDR Department obligations into account when determining their macroeconomic and financial policy settings to ensure an adequate capacity to service them over time. For IMF members with low levels of SDR holdings, early purchases of SDRs to meet payments of charges to the SDR Department and the GRA would be beneficial. This will help reduce the risk of incurring arrears to the IMF but may increase operational costs of the SDR Department by needing to arrange additional transactions. IMF staff can also assist IMF members through policy advice and technical assistance on broader external debt management issues.

Figure 7: Distribution of Expected Cost of SDRs Over Time and for LICs vs EMs[1]

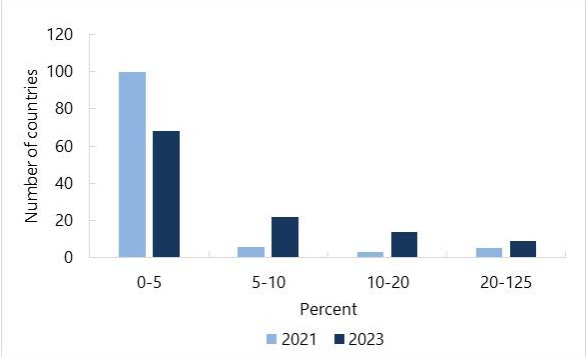
1. PV of SDR Department Obligations/GDP
(percent, all members, August 2021 vs. June 2023)



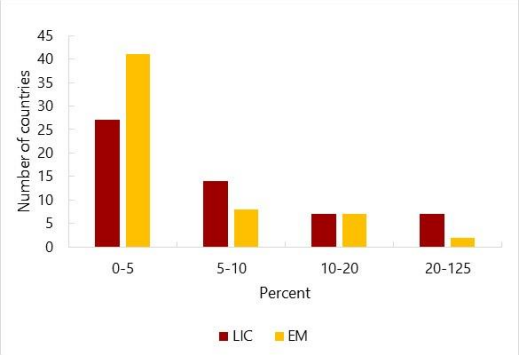
2. PV of SDR Department Obligations/GDP
(percent, LIC vs. EM, June 2023 vintage)



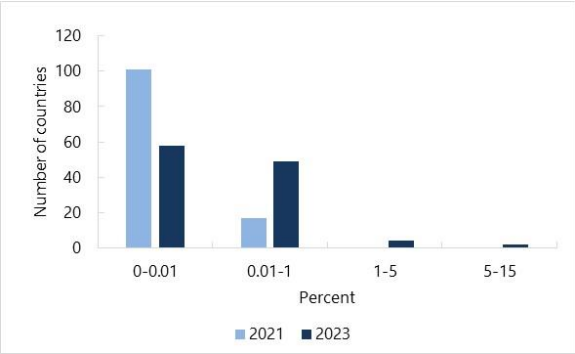
3. PV of SDR Department Obligations / Reserves
(percent, all members, August 2021 vs. June 2023)



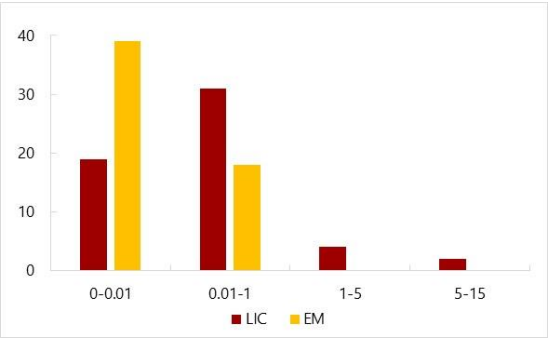
4. PV of SDR Department Obligations / Reserves
(percent, LIC vs. EM, June 2023 vintage)



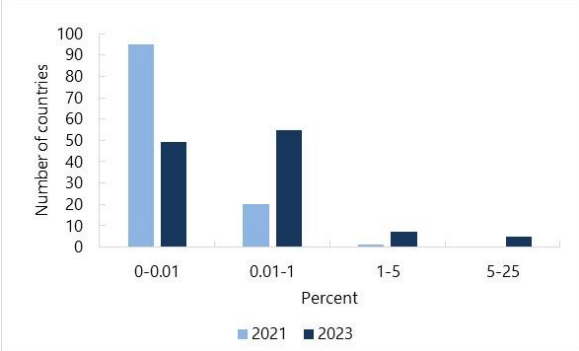
5. PV of SDR Department Obligations / Total debt *(percent, all members, using August 2021 and June 2023 vintages, respectively)*



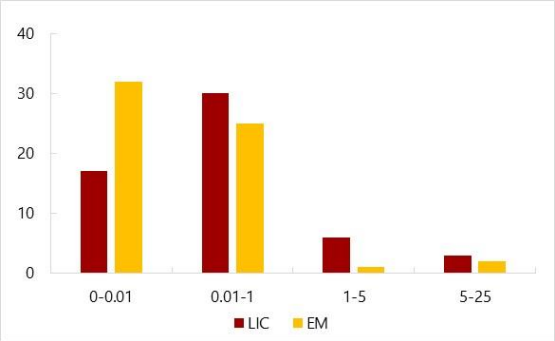
6. PV of SDR Department Obligations / Total debt (percent, LIC vs. EM, using June 2023 vintage)



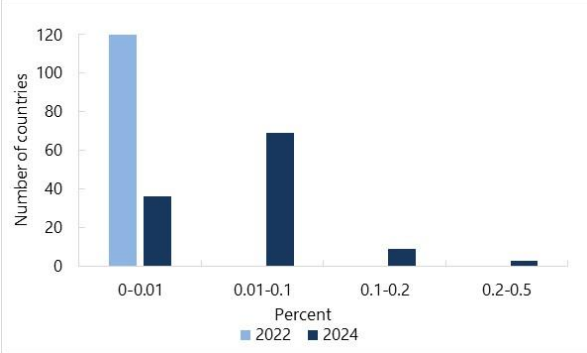
7. PV of SDR Department Obligations / Total External Debt *(percent, all members, using August 2021 and June 2023 vintages, respectively)*



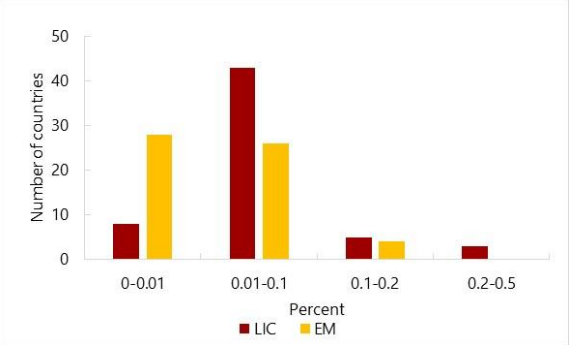
8. PV of SDR Department Obligations / Total External Debt *(percent, LIC vs. EM, using June) 2023 vintage)*



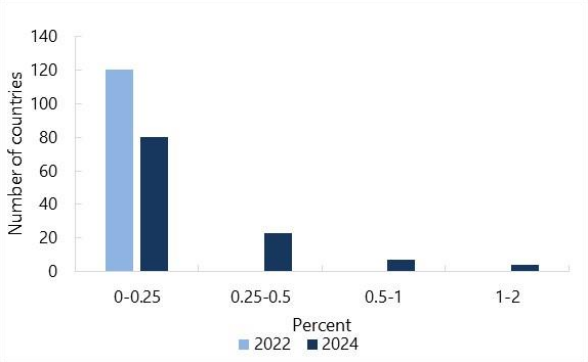
9. SDR Department Payments (est.) / GDP *(percent, all members, using August 2021 and June 2023 vintages and 2022 and 2024 GDP, respectively)*



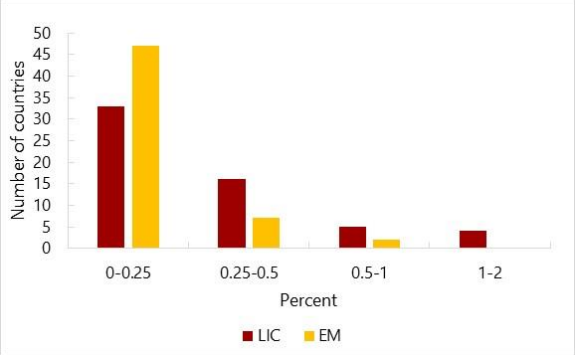
10. SDR Department Payments (est.) / GDP *(percent, LIC vs. EM, using June 2023 vintage and 2024 GDP)*



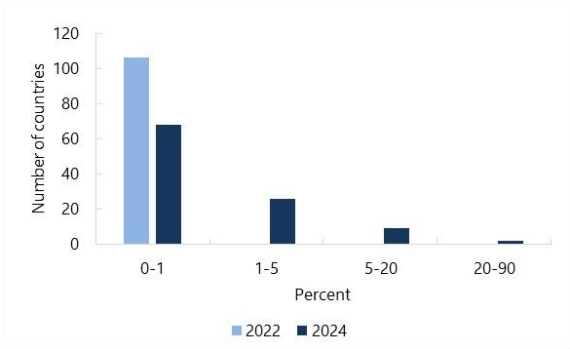
11. SDR Department Payments (est.) / Fiscal Revenues *(percent, all members, using August 2021 and June 2023 vintages and 2022 and 2024 fiscal revenues, respectively)*



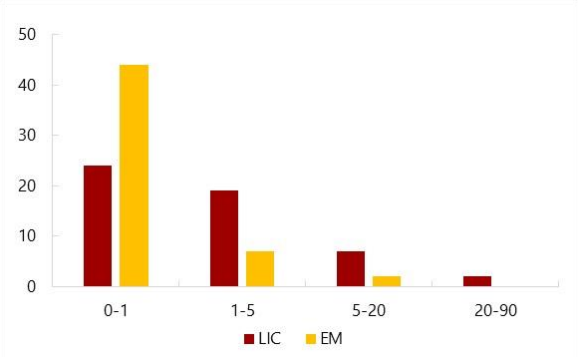
12. SDR Department Payments (est.) / Fiscal Revenues *(percent, LIC vs. EM, using June 2023 vintage and 2024 fiscal revenues)*



13. SDR Department Payments (est.) / External Debt Service *(percent, all members, using August 2021 and June 2023 vintages and 2022 and 2024 external debt service, respectively)*



14. SDR Department Payments (est.) / External Debt Service *(percent, LIC vs. EM, using June 2023 vintage and 2024 external debt service)*

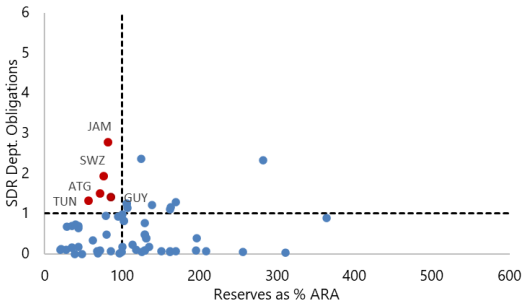


[1] For LIC and EM categories for right-hand side charts, this paper uses the emerging markets and developing countries designation as per the IMF's quota classification. EMDCs are further divided into low-income countries (LICs), which are eligible for PRGT financing, while emerging markets (EMs) include the rest of the sample. Only countries with negative net SDR Department positions are considered.

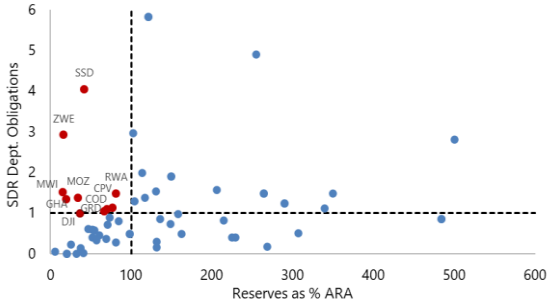
Source: World Economic Outlook, authors' calculations

Figure 8. Members' Capacity to Service SDR Department Obligations—Reserves

1. PV of SDR Department Obligations and Reserves
(percent of GDP and ARA, EMs, June 2023 vintage)



2. PV of SDR Department Obligations and Reserves
(percent of GDP and ARA, LICs, June 2023 vintage)

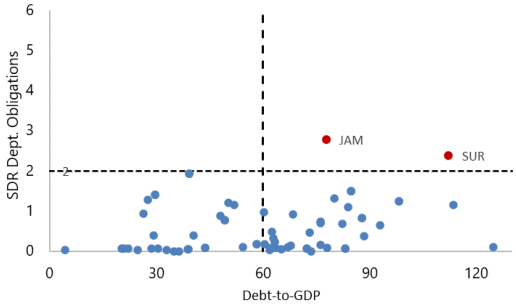


Source: World Economic Outlook and authors' calculations

Figure 9. Members' Capacity to Service SDR Department Obligations—Debt

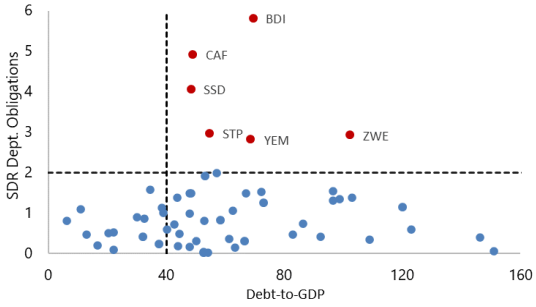
1. PV of SDR Department Obligations vs. Total Debt

(percent of GDP, EMs, June 2023 vintage)



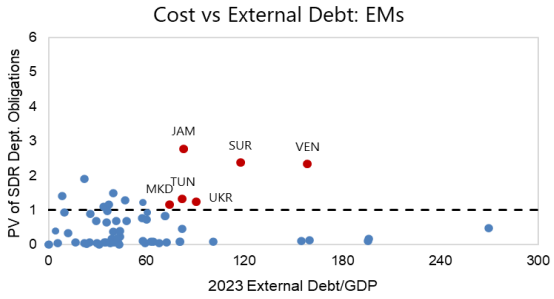
2. PV of SDR Department Obligations vs. Total Debt

(percent of GDP, LICs, June 2023 vintage)



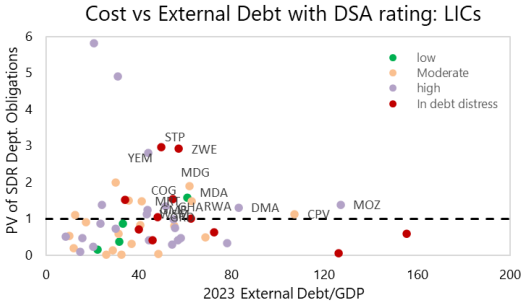
3. PV of SDR Department Obligations vs. External Debt

(percent of GDP, EMs, June 2023 vintage)



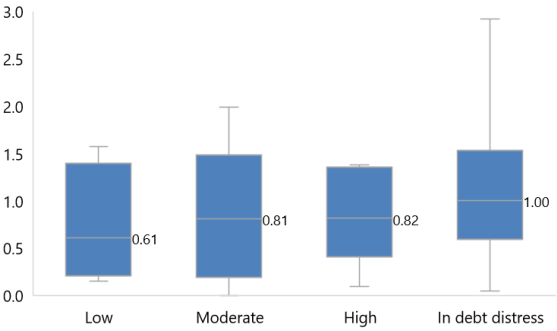
4. PV of SDR Department Obligations vs. External Debt

(percent of GDP, LICs, June 2023 vintage



5. PV of SDR Department Obligations vs. Debt Ratings[1]

(percent of GDP, LICs, June 2023 vintage)



Source: World Economic Outlook, LIC-DSF database (latest rating available), and authors' calculations

[1] For the "High" category of the risk of debt distress, three countries had values greater than the standard box plot threshold of 1.5 times the interquartile range and were thus not included. They had values between 3 and 6 percent of GDP: Burundi (5.8 percent of GDP); Central African Republic (4.9 percent); and South Sudan (4.0).

Stress test scenario and sensitivity analysis

To assess the sensitivity of the baseline results on the capacity to service SDR Department obligations and the concessionality of SDRs, a stress test is conducted under a more extreme scenario**.** In the stress scenario, a higher steady state (or terminal) long-term SDR interest rate than that projected under the baseline scenario is assumed. More specifically, the forward rates at year 30 onward are assumed to be higher than the baseline rates by one standard deviation of the historical value of the SDR interest rate (2.9 percentage points). From years 0 to 30, the SDR forward rates are assumed to rise linearly from the baseline projection in quarter 0 (that is, zero increase in the baseline projection at quarter 0) to the new higher steady state interest rate in year 30 onward to indicate a "higher-for-longer" SDR interest rate scenario.

Stress results show that although capacity to service SDR Department indicators generally weaken, financial obligations to the SDR Department remain manageable for most countries. In the stress scenario, the projected cost of SDRs rises significantly, with the median converter's cost increasing from $134 million to $196 million based on the present value of the expected payments. Most members' expected debt service metrics appear serviceable, with an average PV of SDR Department obligations of 1.60 and 0.89 percent of GDP for all LICs and EMs, respectively. Given this increase, a number of countries—many of which are LICs or fragile— exhibit greater vulnerability in their capacity to service obligations, based on GDP- and reserves-based measures (Figure 10). For instance, in the stress scenario, 21 members have a PV of SDR Department obligations greater than 2 percent of GDP compared to 9 members in the baseline. Seventeen countries have a PV of SDR Department obligations greater than 20 percent of reserves compared to 9 in the baseline.[28] Still, no country is expected not to be able to service SDR Department obligations currently.

Concessionality falls considerably in the stress scenario**.** As shown in Table 3, the stress scenario reduces the grant element of the SDR as a financing instrument by 31 percentage points—from about thirty-four percent to about three percent—under the assumptions of no cancellation and a 5 percent discount rate. This result suggests that the grant element of SDRs would fall precipitously should interest rates rise considerably higher than that envisaged under the baseline.

Cancellation of SDRs, although it has not happened so far, can affect the grant element of SDRs**.** Should the IMF decide to cancel SDRs, members with negative SDR balances (cumulative SDR allocations greater than holdings) would need to repay this balance "promptly." SDR cancellation could be incorporated into the analysis by including a final face value payment of the member's negative SDR position at a specified horizon (see right-hand side of equation (1)). Results suggest that SDR cancellation at twenty years would reduce the grant element of SDRs from 34 to 21 percent for the June 2023 forward curve vintage (see Table 3).

Higher discount rates increase the grant element of SDRs. As noted previously, it is assumed that a discount rate of 5 percent is uniformly applied to all countries for the analysis, in line with convention.[29] In some applications, country-specific discount rates can be chosen to reflect appropriately the opportunity cost of

[28] The stress scenario aims to capture a more extreme scenario in which the SDR interest rate curve shifts further up relative to that currently implied by market data. Given the nature of this experiment, the results for the one-year ahead measure are not materially different from those under the baseline scenario.

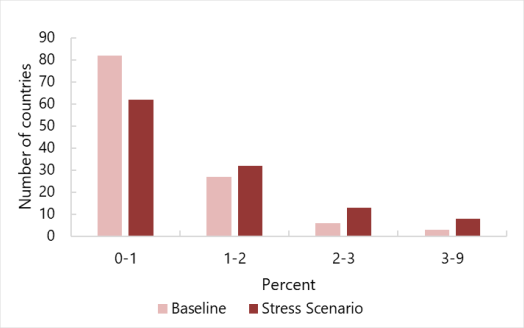
[29] See IMF (2013) and IMF (2021d).

capital of a specific issuer, with riskier debtors having a higher discount rate.[30] As shown in Tables 3 and 4, higher discount rates increase the grant element of SDR use: assuming no cancellation, an increase in the discount rate from 5 percent to 8 percent increases the grant element from 34 percent (i.e., just below the concessionality threshold) to 58 percent using the end-June 2023 SDR forward curve. An 8 percent discount rate also implies that SDRs are concessional even in the stress scenario—specifically, the grant element of SDRs is 44 percent in the stress scenario using an 8 percent discount rate compared to three percent using the 5 percent discount rate.

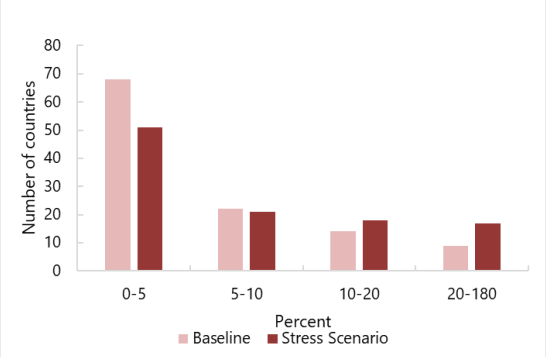
[30] As argued by Kozack (2005), part of the motivation to use a country-specific discount rate, rather than a uniform rate for all debtors, is to reflect the fact that different countries have different levels of sovereign risk and therefore, discount rates should reflect individual country risk in addition to overall market risk premia.

Figure 10. Stress Rest Results[1]

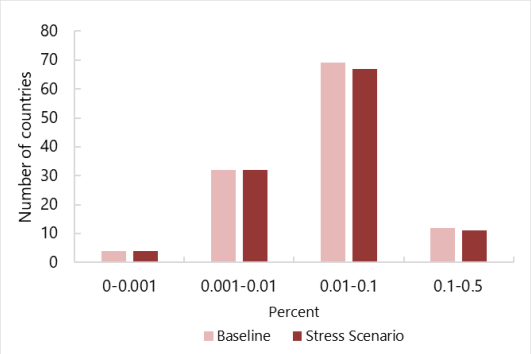
1. PV of SDR Department Obligations / GDP
(percent, baseline vs stress scenario, all countries, based on 2023 vintage)



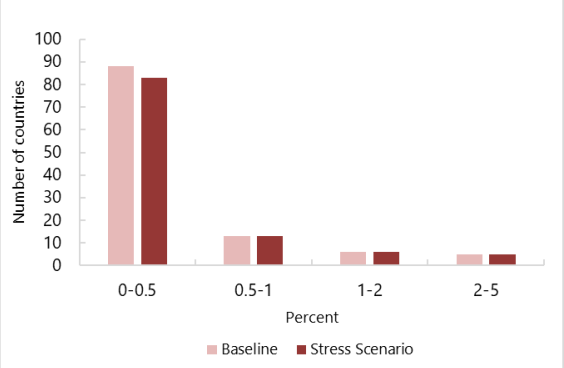
2. PV of SDR Department Obligation / Reserves
(percent, baseline vs stress scenario, all countries, based on 2023 vintage)



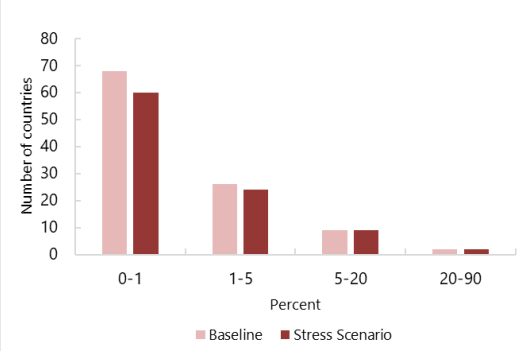
3. SDR Department Payments (est.) / GDP
(percent, baseline vs stress scenario, all countries, based on 2023 vintage and 2024 GDP)



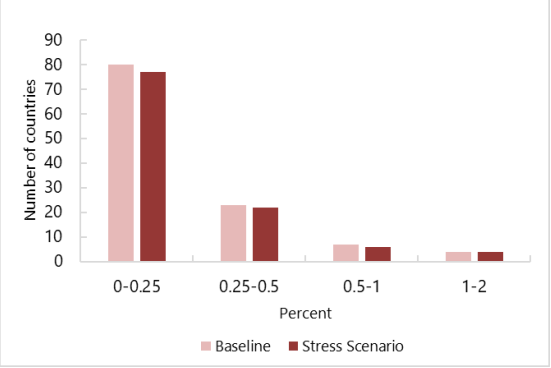
4. SDR Department Payments (est.) / Reserves
(percent, baseline vs stress scenario, all countries, based on 2023 vintage and 2024 reserves)



5. SDR Department Payments (est.) / External Debt Service *(percent, baseline vs stress scenario, all countries, based on 2023 vintage and 2024 external debt service)*



6. SDR Department Payments (est.) / Fiscal Revenues *(percent, baseline vs stress scenario, all countries, based on 2023 vintage and 2024 fiscal revenues)*



[1] Authors' calculations based on a stress scenario, whereby the SDR interest rate is assumed to further increase by one standard deviation of its historical value for the next 30 years. The period used for the computation of the standard deviation is between July 1969 and June 2023.

Source: World Economic Outlook, authors' calculations

Table 3. Grant Element of SDRs with Cancellation and with Variable Discount Rates *(Baseline and Stress Scenarios)*

June 2023 SDR forward curve[1]

	Cancellation horizon						
Discount rate	**1Y**	**2Y**	**5Y**	**10Y**	**20Y**	**30Y**	**None**
1%	-3%	-6%	-12%	-22%	-40%	-58%	-225%
3%	-1%	-2%	-3%	-3%	-4%	-5%	-9%
5%	1%	2%	6%	12%	21%	26%	34%
8%	4%	7%	17%	30%	45%	52%	58%
10%	5%	10%	24%	40%	56%	62%	66%

Stress test concessionality[1]

	Cancellation horizon						
Discount rate	**1Y**	**2Y**	**5Y**	**10Y**	**20Y**	**30Y**	**None**
1%	-3%	-6%	-13%	-26%	-57%	-93%	-474%
3%	-1%	-2%	-4%	-7%	-17%	-29%	-73%
5%	1%	2%	5%	9%	11%	9%	3%
8%	4%	7%	16%	28%	38%	41%	44%
10%	5%	10%	23%	37%	50%	54%	56%

Change in grant element due to stress test (June 2023 vintage, baseline vs stress scenario)[2]

	Cancellation horizon						
Discount rate	**1Y**	**2Y**	**5Y**	**10Y**	**20Y**	**30Y**	**None**
1%	0%	0%	-1%	-4%	-17%	-35%	-249%
3%	0%	0%	-1%	-4%	-13%	-24%	-64%
5%	0%	0%	-1%	-3%	-10%	-17%	-31%
8%	0%	0%	-1%	-3%	-7%	-11%	-14%
10%	0%	0%	-1%	-2%	-6%	-8%	-10%

[1] Green shaded cells for indicate the grant element is greater than 35%, which is the conventional threshold for loan concessionality. The blue border (i.e., the right column) indicates the baseline assumptions of no cancellation. Stress test concessionality based on June 2023 SDRi forward curve vintage stress scenario.

[2] Heatmap indicates extent of decline in concessionality from June 2023 baseline to stress scenario.

Source: Authors' calculations.

Concluding remarks

Since the August 2021 general allocation, the SDR interest rate has risen by over 390 basis points. Over the same period, the expected path of SDR interest rates has shifted upward by about 230 basis points on average across the forward curve.

As a result, the financing terms of SDRs are substantially higher and now slightly below the IMF's concessionality threshold. For the median country, the expected cost based on the present value of net SDR Department payments has increased almost threefold. The grant element of SDRs is 34 percent, or below the IMF's concessionality threshold of 35 percent. The grant element of SDR use would decline further if interest rates were to increase further, if a discount rate lower than 5 percent is used, or if the SDR allocation were to be cancelled after 30 years or sooner.

Most IMF members' capacity to service SDR Department obligations remains broadly adequate, though there are some exceptions. For several IMF members, SDR Department obligations are a significant part of their external debt stock. Some IMF members have significant SDR Department obligations in the context of lower reserves coverage or higher debt levels.

SDR obligations would remain relatively manageable in a stress scenario for most members. While capacity to service indicators generally deteriorate in a stress scenario, most IMF members' expected debt service metrics appear serviceable, with an average PV of SDR Department obligations less than 2 percent of GDP for 82 percent of countries. For members where SDR Department obligations are sizeable, these obligations will need to be considered when determining their macroeconomic and financial policy settings to ensure an adequate capacity to service them over time.

This paper offers several future avenues of research and operational applications. Additional interest rate projection methodologies, such as surveys, can be used. More granular projections, including by incorporating potential changes to the foreign exchange composition and currency weights of the SDR basket can be forecast as well. Different types of stress tests could be conducted as well, including a more attenuated and near-term shock to the SDR interest rate. Sensitivity analysis related to reconstitution of SDRs could also be considered. Operationally, SDR forward curves constructed in this exercise can be used in an input in other IMF staff tools, such as in debt sustainability analyses or in assessing how the flows of charges of aggregate negative SDR Department balances among all IMF members have evolved. This paper's results and methodology could also be used to assess capacity to service SDR Department obligations in countries with large credit outstanding to the IMF. This paper's findings can also be a useful input for IMF members' decisions to convert SDR holdings, which should consider interest rate risks, among other factors. The forward curve methodology can also be used by foreign exchange reserve managers to forecast the expected cost of having a negative net SDR Department position.

Annex. SDR interest rate forward curves

This Annex consists of two parts. The first part presents the results of a robustness check based on forward curves derived using WEO data. Overall, results of the robustness check are consistent with the results derived from zero-coupon curves of SDR basket currencies. The second part reports the full results on the estimated forward curves based on the market-implied (primary) method.

A. Forward Curves from WEO-estimated Method (Robustness Check)

The robustness check relies on explicit official forecasts, rather than market-implied estimates. Four times a year, with two full-fledged publications in the Fall and in the Spring and two interim updates in Winter and Summer, the IMF WEO provides projections for China, the EU, Japan, the UK, and the US economies (among others). These forecasts rely on short-term interest rate assumptions. While the WEO's forecast methodology is not public, they usually reflect best estimates and projections of market expectations based on discussions with country authorities.

The main advantage of this robustness check is its consistency and stability. The robustness check relies on data that are less subject to market volatility, unlike the method employed in this paper. It is more agnostic as to whether markets can price future interest rates correctly and rationally, and to whether they tend to overreact to news. It can also be easily replicated by country authorities and IMF country teams when trying to optimize the use of the SDR allocation or other instruments. Another benefit of employing this method is that policymakers do not necessarily infer futures from market data using complex inference techniques. Rather, they might use easily available, internationally reputable forecasts for the various interest rates that compose the SDR basket—i.e., the IMF's projections. On the other hand, this method may incorporate less information than market-based data, which is why both methods are useful in assessing the potential forward path of SDR interest rates.

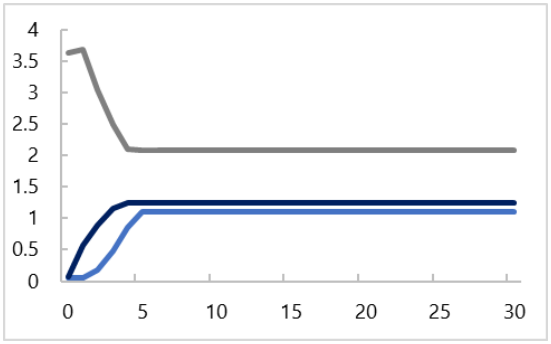
There are some gaps in available WEO data. For instance, there is no January 2020 nor March 2020 short-term deposit rate information available for China. To compensate for this lack of data, gaps were filled by assuming that the rates are the same as the December 2020 vintage. Additionally, WEO projection periods are only five years, after which it is assumed that the final year value is the terminal rate associated with the relevant basket currency.

A few differences in the primary method and robustness check can yield different results in the forward curves. The method employed in the paper is based on market-determined data, while the robustness check relies on official forecasts. The former has the benefit of representing the market's "best guess" of future interest rates, while the latter represents a more granular assessment, less driven by noise, especially during periods of volatility. Both methods face limitations in dealing with out-year projections. For the market-implied method, out-year projections could reflect not only market expectations of the risk-free rates, but also other components of bond yields related to risk- and term-premia. In the robustness check, there are no specific out-year projections, and thus data gaps are filled by assuming the final year value is the terminal rate. As a result, the robustness check forward curve results could be flatter in outer years than compared to the primary method given that short-term interest rate projections for the robustness check extend for five years for a given vintage.

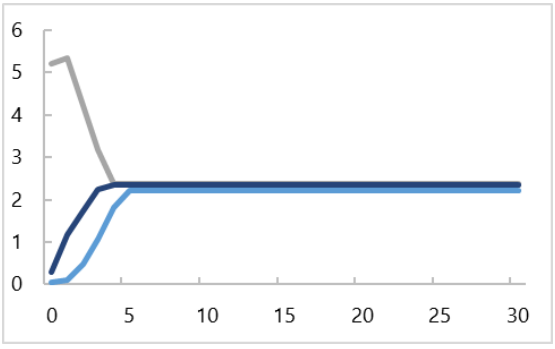
Annex Figure 1: WEO-Estimated 3-month Forward Curves (Robustness check)

(In percent; year)

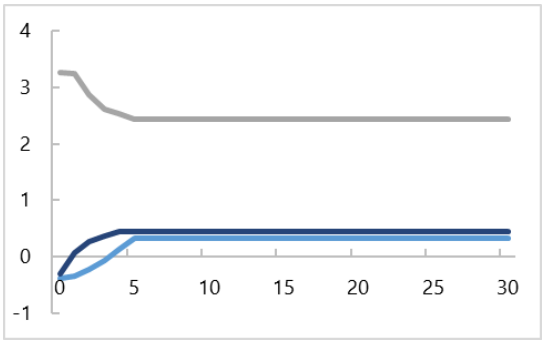
SDR



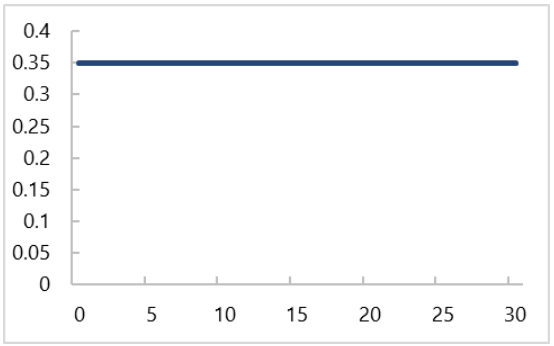
U.S. dollar



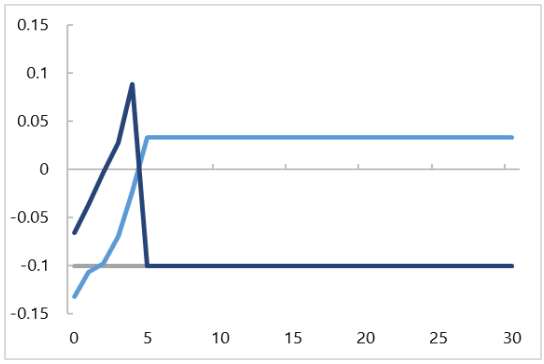
Euro



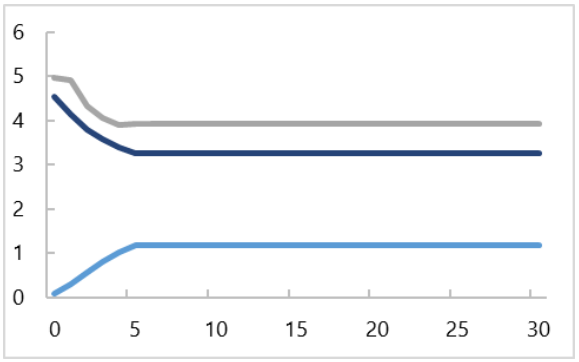
Chinese renminbi



Japanese yen



British pound sterling



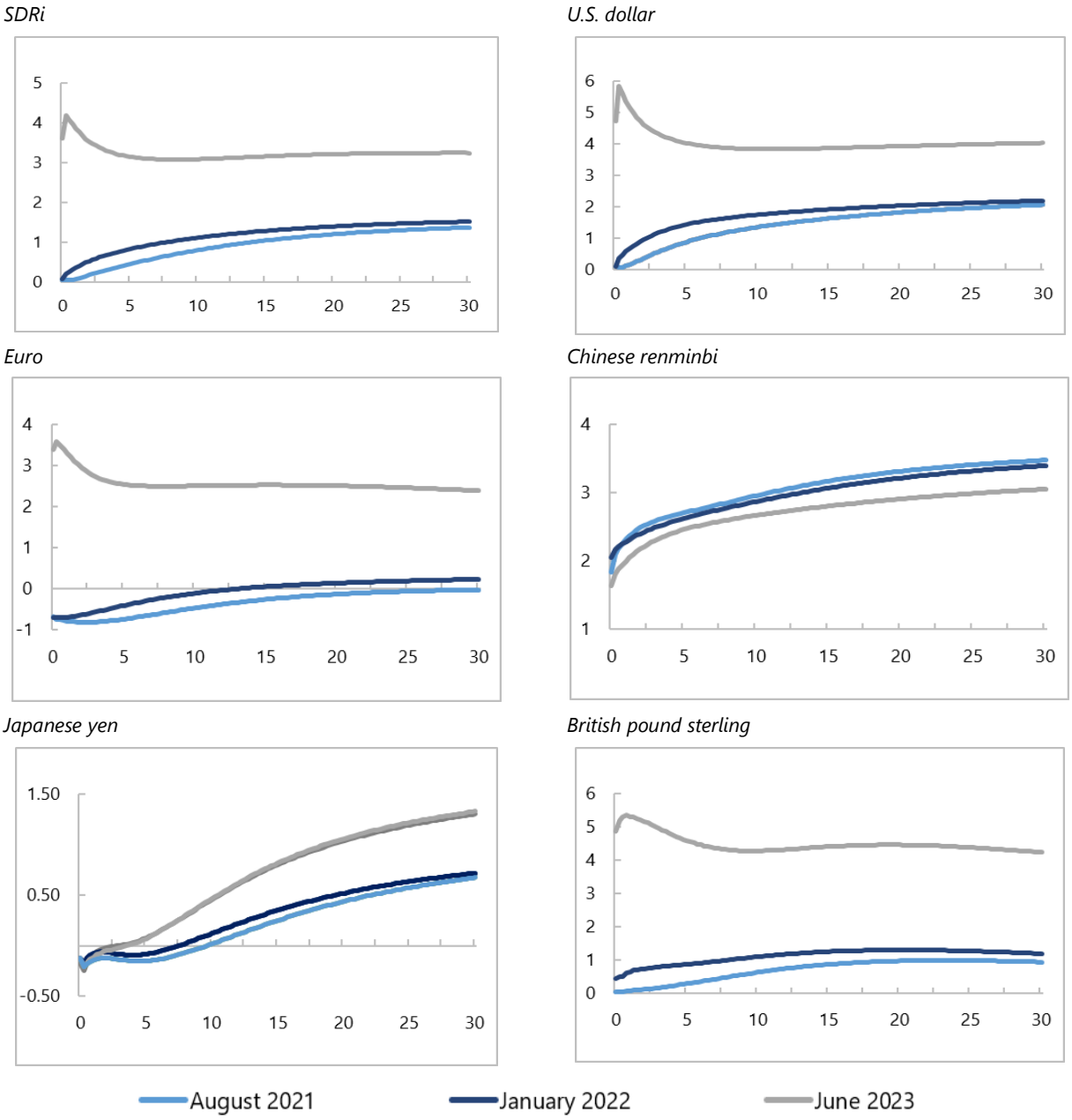
August 2021 January 2022 June 2023

Source: WEO and authors' calculations. Full results available upon request.

B. Forward Curves Based on the Primary Method

Annex Figure 2: three-Month Forward Curves Based on Market-Implied Estimates

(In percent; year)



Source: Central banks' websites, Bloomberg, CEIC, and authors' calculations. Full results available upon request.

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