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POLICY CORNER

Great Dilution: The Global Impact of the US Inflation Shock on Sovereign Debt

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Abstract

Decades of low inflation led to widespread use of dollar-denominated financial instruments with fixed interest rates and long maturities. Unanticipated inflation dilutes the real value of these liabilities. We estimate this dilution to study the consequences of the recent US inflation shock on debt burdens. The US Treasury, the largest issuer of dollar-denominated liabilities, gained 6% of GDP from the inflation surprise of 2021 and 2022 (a third of which was paid by foreign creditors), a number that can escalate to 20% depending on how long it takes for inflation to return to the 2% target. For emerging markets the conventional wisdom holds that the increases in interest rates resulting from high inflation in the USA will have a negative impact because of the reversal of capital flows and higher financing costs. However, this view misses the fact that higher US inflation also diminishes the burden of nominal fixed-rate dollar-denominated sovereign debt issued by other countries. We find these gains to be substantial, which may help to explain why the current interest rate spike has not led to widespread sovereign debt crises.

JEL Classification E31 · E58 · F41 · H63

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1 Introduction

Rapid inflation has returned to the USA, suddenly and unexpectedly. In October 2019, the International Monetary Fund's *World Economic Outlook* (IMF-WEO) forecast that inflation in the USA would be 2.4% in 2021, 2.3% in 2022, and 2.3% in 2023, continuing a downward trend that began in the mid-1980s. However, inflation was 4.7% in 2021, closed at 8.1% in 2022, and is now expected to be 3.5% in 2023 (and may well be higher). In this paper, we measure the effect of this unforeseen inflation on the value of fixed-rate dollar-denominated debt around the world. Our central argument is that the US inflation shock has caused a "Great Dilution" in the real value of dollar-denominated sovereign liabilities, and sparked a vast redistribution of wealth in the process.

Our analysis encompasses sovereigns around the world. Policymakers are rightly concerned about the macroeconomic fate of emerging markets as interest rates rise in the USA and elsewhere, as previous episodes have led to macroeconomic and debt crises. For instance, Pazarbasioglu and Reinhart (2022) argue that:

> Tighter monetary policies in advanced economies are poised to push up international interest rates, which tends to put pressure on currencies and heighten the odds of default. ...Global financial conditions are set to deteriorate as central banks in advanced economies tighten policy to fight unexpectedly persistent inflation pressure.

Similarly, Acosta-Ormaechea et al. (2022) caution that:

> With public debt-to-GDP ratios above pre-pandemic levels and borrowing costs rising amid higher local and global interest rates, countries will need to ensure the sustainability of public finances to help preserve credibility and rebuild fiscal space.

While these concerns are certainly warranted, we suggest they should take into account the reason for tightening financial conditions: the increase in US inflation, which in some cases cushions the effect of rising rates by reducing the real value of dollar-denominated sovereign liabilities issued by other countries.

Although we estimate the gains (and losses) to be substantial and policy-relevant, we note at the outset that our analysis focuses on the direct effects of surprise inflation on the burden of sovereign debt. We do not model the general equilibrium consequences on the cost of future borrowing, financial system stability, and the like.

The worldwide issuance of dollar-denominated debt has grown significantly in the recent era of global financial integration. Years of low inflation catalyzed the growth of financial assets issued at fixed interest rates and with long maturities. According to the Bank for International Settlements (BIS),[1] international issues of sovereign debt securities at fixed rates and with maturities longer than one year

[1] Table C3: "Debt securities issues and amounts outstanding, in billions of US dollars." https://stats.bis.org/statx/srs/table/C3.

have represented more than 95% of all issues since 2013. Long-run fixed-rate dollar instruments are subject to larger valuation effects than if they had been issued at variable rates or issued at short maturities (as was the common practice prior to the "Great Moderation").

In order to illustrate the distributive effects of the US inflation shock we conduct a few exercises to estimate the gains to sovereigns arising from the dilution of the value of long-term fixed-rate debt instruments due to US inflation.[2] Our analysis focuses on sovereign dollar-denominated debt, both because of data constraints and because sovereigns are the focus of the policy concerns. The amount of dollar-denominated debt issued in international markets is immense, totaling $11.1 trillion globally by the end of 2020, according to the Bank for International Settlements (Eren and Malamud 2022), of which $1.3 trillion corresponds to non-US long-term fixed-rate sovereign securities.[3] In addition, by the end of 2020, $20.7 trillion worth of long-term fixed-rate securities had been issued by the US government.[4]

In order to estimate these effects we start with the USA, the biggest issuer of dollar-denominated debt. We first estimate the effect of surprise inflation on the $14.6 trillion worth of long-term treasury securities held by the public (including creditors abroad) and the Federal Reserve (Fed), to which we add the $2.1 trillion of cash notes. We show that the US government's gain from unexpected inflation in 2021 and 2022 amounts to $1.4 trillion or 6.8% of GDP. Adding the gain on debt held by government agencies in pension programs and the like the number climbs to $1.9 trillion (9.2% of GDP). However, adding the Fed to the baseline scenario lowers the gain to $1.3 trillion or 6.3% of GDP.

Because we have good information about the foreign holdings of dollar-denominated assets (including cash), we can study how much of the $1.4 trillion gain for the treasury is paid by US non-residents. High US inflation generates a transfer to the US government from non-residents of about $542 billion (for comparison in 2020 federal government spending on defense was $777 billion and on Medicaid was $447 billion). About one-third of these gains come from Japan and China, two of the biggest holders of US treasuries. In all, about one-third of the gains accruing to the US Treasury are paid by non-residents.

However, these numbers can increase substantially under alternative scenarios that account for the possibility that high inflation persists in 2023 and beyond. In order to estimate the resulting gains to the US Treasury, we draw on information about the maturity structure of fixed-rate debt, as the gain accrues only on the debt that is not rolled over (once debt is rolled over we assume it fully internalizes future inflation). In the most extreme case where inflation returns to the 2% level in 2030,

[2] Ideally, one would include both liabilities and assets of sovereigns. But data on sovereign asset holdings are not readily available, and while there is information on dollar assets in central bank reserves, these holdings are typically short term and thus shielded from the effects we discuss here.

[3] The difference between the two figures ($11.1 trillion and $1.3 trillion) corresponds to debt placed by other issuers, such as financial institutions, firms, central banks, and international institutions, as well to floating rate sovereign debt.

[4] See Treasury Bulletin https://www.fiscal.treasury.gov/files/reports-statements/treasury-bulletin/b2021-3.pdf.

the gain to the US Treasury is anywhere between 16% and 20% of GDP depending on whether the holdings of securities by the Fed and treasuries by government agencies are included or not.

Of course, these gains to the sovereign may produce a variety of potentially undesirable results such as higher debt servicing costs in the future, greater interest payments on bank reserves, reduced international use of the dollar, or financial system instability. These considerations, albeit no doubt important, are largely outside the scope of our paper, which focuses specifically on the inflation-debt channel.[5]

In the second part of the paper, we estimate the dilution of dollar-denominated long-term sovereign debt for other countries. This requires estimating how the GDP of other countries, measured in dollars, changes. We do this in two ways. First, we assume that US inflation transfers directly to local prices measured in dollars. If real exchange rates remain constant in the face of a US inflation shock, this relationship should be expected to occur. Moreover, we show this relationship is validated in the data. Second, we use *actual* observed increases in local prices in dollars to factor in the potential effect of recent US dollar appreciation and changes in the dollar real exchange rate.

Using the first method, we show that countries other than the US net a gain of over $104 billion from the unexpected US inflation shock of 2021–2022. Major winners in absolute dollar terms include middle-income countries like Turkey, Saudi Arabia, Argentina, Mexico, and Indonesia. Relative to the size of their economies, big winners include Oman and Qatar in the Middle East; Jamaica, Panama, and Uruguay in Latin America; as well as other countries such as Lebanon and Mongolia, all of which receive a one-time "transfer" larger than 2% of GDP. The second exercise does not modify the conclusions significantly. In fact, for the countries for which we have the data to perform this alternative computation, the gains actually increase from $100 billion for the years 2021 and 2022, to as much as $170 billion (because contrary to the widely held view, not all countries have experienced a real depreciation against the US dollar).

We then discuss how the inflation shock of 2021–2022 may carry over into the future and how this may compound the gains. As this exercise requires information about the maturity structure of fixed interest rate dollar-denominated debt, we conduct this exercise for a smaller group of countries. But the sample is quite representative of developed and emerging markets. Using the change in the IMF's inflation forecast as a measure of the inflation shock, the gains do not increase significantly when introducing a forward-looking analysis. This is because the IMF expects inflation to return to steady-state value in the order of 2% as soon as 2024. In the most pessimistic case of inflation returning to its target in 2030, the countries excluding the USA receive a bonus that doubles our initial computation. These large gains, we believe, help to explain why the abrupt increase in interest rates in the USA has not produced the turmoil in emerging market sovereign debt associated with previous

[5] Still it is notable that while yields on treasuries have increased, the increase in expected real interest rates is not substantial after taking into account higher inflation.

increases.[6] Here too, we note that the gains to these sovereigns could be balanced by various factors (for instance the short-run appreciation in the US dollar).

Our paper's principal contribution is to the literature on the currency denomination of sovereign debt (Calvo 1988; Eichengreen and Hausmann 1999, 2005; Alfaro and Kanczuk 2018; Ontonello and Perez 2019; Ballard-Rosa et al. 2021; Sosa and Sturzenegger 2023). Although debt denominated in local currency provides a better hedge against negative domestic and external shocks, governments face the temptation to generate inflation and depreciate their currency to reduce the real value of their debt. In a classic study Calvo (1988) argued that the solution to this time-inconsistency problem was for countries to rely on debt that is denominated in foreign currency that cannot be diluted by inflation (though others (Frankel 2014) have pointed out that a reliance on dollar-denominated debt has contributed to severe contractionary balance sheet effects in currency crises). However, most of the prior research did not contemplate the impact of high inflation in the USA, i.e., in the currency that was intended to solve the credibility problem. This paper highlights how unanticipated nominal shocks in developed countries shape the fortunes of emerging country sovereigns in unexpected ways.

Our results also provide further evidence for the argument made by Reinhart et al. (2015) that rich countries lean far more heavily on heterodox measures such as surprise inflation to reduce their debt ratios (and less on running primary surpluses and other orthodox strategies) than is typically believed. Rigorous analyses by Hilscher et al. (2022) had concluded that the probability that US inflation would lower the real value of the debt was very low, both because the private sector holds relatively short maturity debt and because high inflation was believed at the time to be extremely unlikely. We show that the large inflation shock that has come to pass means that the USA is indeed inflating away a substantial fraction of its debt, as anticipated by Aizenman and Marion (2011). A contemporaneous paper by Pallotti (2022) studies winners and losers across economic sectors in the USA and comes to a similar conclusion to ours with regards to the gain to the treasury. Our paper complements this body of work by systematically documenting the impact of unanticipated inflation not only for the USA, but also for countries around the world. As such, we hope our paper will serve as a springboard to more fine-grained theoretical and empirical work that extends beyond our focus on dollar-denominated sovereign assets and liabilities.

2 The Impact on the US

Inflation in the USA reduces the real value of dollar-denominated government debt, generating a gain for the US Treasury. This effect is stronger when the debt has been issued at fixed rates and with long maturities. Even when there is some small

[6] Other factors, such as more conservative macroeconomic policies relative to previous eras, may also be important.

dilution to short-term debt, to be conservative we only deal with debt longer than one year which we (and the US government) define as long-term debt.

By the end of 2020, long-term fixed-rate US securities totaled $20.7 trillion. This includes notes, bonds, and nonmarketable debt held by the public of $14.6 trillion,[7] plus $6.1 trillion of nonmarketable debt held by government agencies which we assume is long-term debt.[8] The amount of cash notes at the end of 2020 added an additional $2.1 trillion.[9]

Because interest on debt compensates for *expected* inflation, it is the *unexpected* component of inflation that generates a transfer from creditors to debtors. Therefore, our starting point is an assumption about unexpected inflation. The October 2019 IMF-WEO (International Monetary Fund 2019) projected an inflation rate of 2.4% in 2021 and 2.3% in 2022 and 2.3% in 2024 for the USA (International Monetary Fund 2019, p.154), which we interpolate to an expected inflation rate of 2.3% for 2023. However, US inflation was 4.7% in 2021, 8% in 2022 and is currently projected to be 3.5% in 2023 according to the October 2022 IMF-WEO (International Monetary Fund 2022). The unanticipated inflation of 8% is simply equivalent to the sum of the actual inflation deviation from the forecast inflation over the two years (i.e., 4.7–2.4% + 8–2.3% = 8%).

We then apply this percentage of unexpected inflation (8%) to the total stock of long-term, fixed-rate dollar-denominated sovereign debt held by the public at the end of 2020 ($14.6 trillion). To this we add the full impact of inflation on US dollar cash notes. As prices in US dollars increase, the real value of these cash holdings diminishes. Unlike debt holders who receive interest, cash holders are not compensated for inflation and the government fully charges the "inflation tax" on them. Therefore we apply actual inflation in 2021 and 2022 (12.7%) to the stock of cash notes.

As might be expected, the gain for the USA is enormous. In dollar terms, the USA has shaved about $1.4 trillion in the purchasing power of its liabilities in 2021 and 2022. This is equivalent to a budget gain of 6.8% of GDP. Accounting for this "inflation tax" implies that the US government actually ran much smaller deficits over the years 2021 and 2022 than a straightforward examination of the nominal figures would suggest.

The inflation surprise may lead to higher interest rates on new debt issues in the future. Thus far, however, inflation projection-adjusted interest rates do not appear to have risen substantially in the USA (see appendix).

[7] See table FD2 in the Treasury Bulletin https://www.fiscal.treasury.gov/files/reports-statements/treasury-bulletin/b2021-3.pdf. To reach the $14.6 trillion, we subtract from the total held by the public the amount corresponding to bills, inflation-protected securities and floating rate notes. $14.6 trillion is the resulting amount as of December 2020.

[8] See Table FD1 in the Treasury Bulletin https://www.fiscal.treasury.gov/files/reports-statements/treasury-bulletin/b2021-3.pdf.

[9] See https://fred.stlouisfed.org/series/BOGMBASE.

A significant portion of US debt is held by other government entities and the Federal Reserve,[10] so there is a discussion to be had on whether these holdings should be added to our calculation. Government agents' $6.1 trillion holdings in short- and long-run treasuries could be added because most of these holdings are held in pension programs, social security trusts, and the like, whose beneficiaries, such as retirees, do not include the government.[11] Extending our baseline estimate to incorporate these government holdings, increases the gains to the US Treasury to $1.9 trillion or 9.2% of GDP. The evaluation of the Fed's holdings is more complex so we analyze it separately in the subsection below.

2.1 The Fed

The Fed holds a large balance sheet of nominal assets and liabilities and therefore is likely to be strongly affected by an inflation surge. Roughly speaking we can split the main components of the Fed's balance sheet as of December 2020 as in Table 1.

On the asset side the Fed experiences a loss on its holdings of long-term US treasuries (those that are not inflation-protected) and mortgage-backed securities. This has to be compared to the gains obtained on the liability side: notes (which we already computed above) and the eventual gains on reserves.

The losses by the Fed on treasuries is significant and wipes out part of the gains estimated for the treasury above. Mortgage-backed securities losses should be estimated exactly as that of treasuries because it is the unexpected inflation component which provides a reduction in the value of the debt.

The Federal Reserve holdings of mortgage-backed securities totaled $2.1 trillion in December 2020; unanticipated inflation causes losses in the real value of these securities. If we apply our factor of 8% to this $2.1 trillion, we find these losses to be $165 billion; these losses on the Fed portfolio in turn reduce its net income, which would otherwise have been passed on to the treasury.[12]

On the liability side cash notes should suffer the full effect of inflation, as discussed above. Reserves should incorporate the difference between inflation and the interest paid on reserves. The Federal Reserve began paying interest on these balances beginning in 2008; the rate was fixed at 0.15% till March 2022 and eventually rose to 4.40% in December 2022 (and 5.40% in July 2023).[13] Reserve balances totaled $3.14 trillion at the end of 2020.[14] Comparing

[10] See Table OFS1 in the Treasury Bulletin https://www.fiscal.treasury.gov/files/reports-statements/treasury-bulletin/b2021-3.pdf.

[11] See table FD-3 in the Treasury Bulletin.

[12] See Anderson et al. (2022b) and Anderson et al. (2022a) for a more detailed elaboration of the changing market value of the Fed's portfolio, including how interest rate changes affect the Fed's net income position. These authors estimate the losses in the value of the Fed's "System Open Market Account" (SOMA) to be in excess of $300 billion by mid-2022, though the value of the Fed portfolio fluctuates with market conditions.

[13] https://fred.stlouisfed.org/series/IORB.

[14] https://www.federalreserve.gov/releases/h41/20201231/.

cumulative inflation and the interest rate paid, the Fed gained $339 billion from reserve balances.[15]

If we consider the combined gain from cash and reserves less the combined loss from treasuries and mortgage-backed securities, the Fed nets a gain of $141 billion or 0.7% of GDP.

In the previous section, we did not consider the assets and liabilities of the Fed as a whole. Because 0.7% of GDP is smaller than the 1.3% gain on cash estimated in the previous section, if we consider the overall effect of the Fed, the US gain actually falls from $1.4 trillion to $1.3 (from 6.8% of GDP to 6.3%).

2.2 Foreign Transfers to the USA from US Inflation

How much of the gains to the US Treasury from unexpected inflation are paid by the rest of the world? It is possible to estimate this transfer to the treasury because unlike the case for other countries, data are available on the individual country holdings for the two categories of US liabilities that are most exposed to inflation: long-term US treasuries and cash.

At the end of 2020, $7 trillion worth of US treasuries were held by non-residents of the USA, of which $5 trillion had long-term maturities, according to the Treasury Information Capital (TIC) System.[16] Figure 1 shows the share of treasuries held by foreigners over recent years.

Approximately, $947 billion worth of dollar bills were held abroad at the end of 2020, according to the US Federal Reserve (Bertaut et al. 2019).[17] Current estimates of cash holdings by country are not available. We follow prior research (United States Department of the Treasury 2006) that computed country-wise cash holdings based on fieldwork and cash shipments to each destination in 2006. To reach an allocation by country in 2020, we proportionally increase the individual 2006 country estimates by the increase in the holdings of cash abroad from 2006 to 2020 as reported by the Federal Reserve. This allows us to assign 55% of the total to individual countries. Figure 4 shows the evolution of cash holdings in the last decades estimated by Judson (2017). Notice that most of the cash holdings abroad are in $100 bills, which suggests that individuals use them as a store of value rather than for liquidity services (Fig. 2).

With these data we can then compute the losses accruing to countries from their holdings of US liabilities from the unexpected inflation shock of 2021 and 2022. Figure 3a, b plot the unexpected inflation effect from the holdings of long-term treasuries both in dollar values and as a percentage of GDP. The overall losses add up to $422 billion. Of these losses, 38% is accounted by Japan and China, which are

[15] In the subsequent analysis, we assume no further gain or loss.

[16] See Table A7: https://ticdata.treasury.gov/resource-center/data-chart-center/tic/Documents/shla2020report.pdf.

[17] See line 38 in https://www.federalreserve.gov/releases/z1/20220310/html/l204.html and https://www.federalreserve.gov/econres/notes/feds-notes/the-international-role-of-the-u-s-dollar-20211006.html.

Table 1 Fed balance sheet Source: Federal Reserve Statistical Release. https://www.federalreserve.gov/releases/h41/20201231/

Assets		Liabilities	
Balance sheet			
Notes and bonds	3.695.169	Currency	2.071.600
Mortgage-backed securities	2.066.409	Reserves	3.135.000
	5.761.578		5.206.600
Balance sheet—effect of inflation shock			
Notes and bonds	(295.614)	Currency	263.093
Mortgage-backed securities	(165.313)	Reserves	338.580
	(460.927)		601.673

major holders of US treasuries. The largest losses as a share of GDP correspond to East Timor (34% of GDP) and Luxembourg (17% of GDP); Hong Kong, Ireland, and Bahamas are also major losers.

When considering both the effect on treasuries and cash in Fig. 3c, d, the gains for the US Treasury (at the expense of non-residents) rises to $542 billion. Thus, fully one-third of the "inflation tax" in 2021 and 2022 is levied on non-residents abroad.

Countries that are major holders of dollar currency (relative to their GDP), such as Argentina, Cambodia, and Russia, emerge as significant losers of unexpected inflation in the USA. Argentina and Cambodia suffer a loss that is larger than 2% of GDP. As a share of GDP, East Timor, Luxembourg, Cambodia, Hong Kong, Argentina, Taiwan, Belgium, Singapore, and Ireland suffer the largest losses. As can be seen, the costs spread across rich and poor countries alike.

2.3 The Effect of Future Inflation

Needless to say, our computation measures the reduction in the real value of liabilities arising from the inflation surprise in 2021 and 2022. But the real effect should consider additional inflation surprises beyond 2022. However, the estimate of the effect from future inflation depends on both how long we expect inflation to remain high and on the maturity structure of the debt.

Let us call θ_0 the intertemporal burden of debt at any time $t = 0$ for any country.[18] This intertemporal burden is defined by:

$$\theta_0 = \sum_t \frac{q_t b_t}{\epsilon_0 p_0 y_0}, \tag{1}$$

where q_t and b_t are price (in USD) and quantity of debt due in period t. ϵ_0, p_0 and y_0 are the exchange rate (for the USA equal to 1), local prices and real GDP at the time of the computation $t = 0$.

[18] We are grateful to an anonymous referee for feedback on this framework.

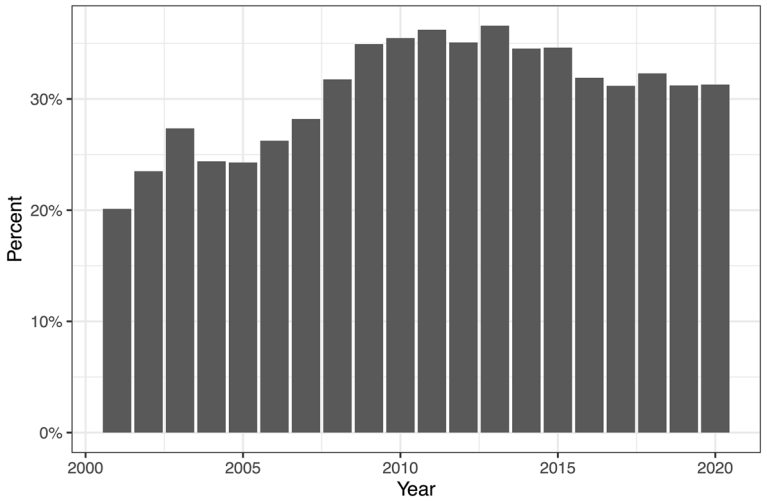


Fig. 1 Foreign holdings of long-term US securities. Source: Treasury Information Capital (TIC) System. The data correspond to foreign holdings of long-term US securities as fraction of the total long-term US securities

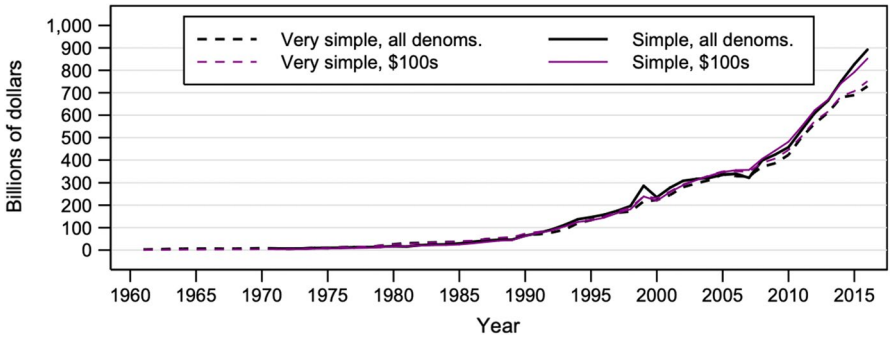


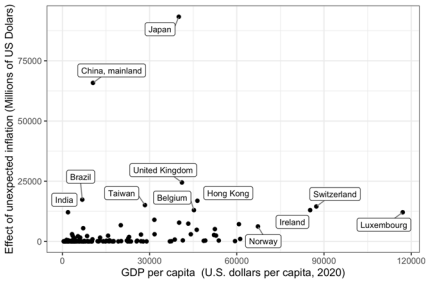
Fig. 2 Total amount of US currency abroad. Source: Judson (2017)

The price of one unit of debt due in period t is

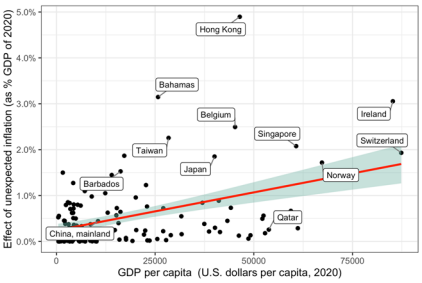
$$q_t = \frac{1}{(1 + r_t)E_0\Pi_t^{US}}, \tag{2}$$

where r_t and $E_0\Pi_t^{US}$ represent the cumulative real interest rate and cumulative US inflation expected at time 0 until time t.

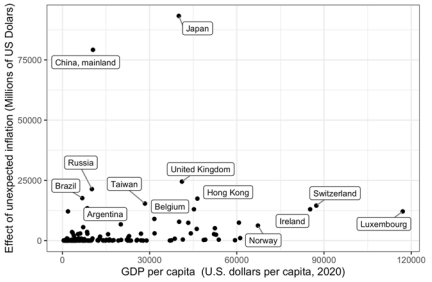
Given this definition it is easy to see that $\Delta\theta$, the change in the debt burden when only the expectation of US inflation changes equals



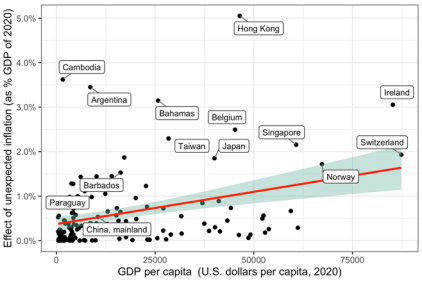
(a) Losses on long term Treasury holdings



(b) Losses on Treasury holdings as % of GDP



(c) Losses Treasury holdings and dollar cash holdings



(d) Losses on Treasury and dollar cash holding - % of GDP.

Fig. 3 Redistribution to USA from other countries' holdings of long-term US Treasury securities and cash. Sources: Treasury Information Capital System and Federal Reserve for Treasury holdings and Judson (2017), Bertaut et al. (2019) and US Federal Reserve for cash holdings. Panel b and d excludes two outliers: East Timor and Luxembourg

$$\Delta\theta_0 = \frac{\sum_t \frac{b_t}{(1+r_t)E_0^*\Pi_t^{US}}}{\epsilon_0 p_0 y_0} - \frac{\sum_t \frac{b_t}{(1+r_t)E_0\Pi_t^{US}}}{\epsilon_0 p_0 y_0}, \tag{3}$$

where $E_0^*\Pi_t^{US}$ is the new expected inflation rate for the USA. If we assume the real interest rate to be constant and equal to zero, the expression can be simplified to

$$\Delta\theta_0 = \frac{1}{\epsilon_0 p_0 y_0}\left[\sum_t b_t \left[\frac{E_0\Pi_t^{US}}{E_0^*\Pi_t^{US}} - 1\right]\right]. \tag{4}$$

In other words, the debt dilution corresponds to the effect of the higher inflation on the stock of nominal dollar debt, all expressed in terms of current GDP.

If we assume the structure of debt that is used typically in the sovereign debt literature (Hatchondo and Martinez 2009; Hatchondo et al. 2016) where debt is zero coupon and decays exponentially:

$$b_t = \left(\frac{1}{\eta}\right)^t d_0, \tag{5}$$

where the decay factor η is chosen to match the average maturity of the debt, we have a way of estimating (4). This is the equation we estimate.

In 2020, the average maturity of long-term debt (i.e., longer than one year maturity) in the USA was 8.3 years.[19] What remains for the computation is to obtain estimates of the change in inflation expectations, which we can take directly from the IMF World Economic Outlooks. In particular, we look at the change in expected US inflation between the October 2019 WEO and October 2022. The path for future inflation in both cases is presented in the first two rows of Table 2.[20]

Once we update our computation to include future periods with the inflation surprise of our Base Scenario (see first row of Panel B in Table 2), we find the gain for the USA is 7.2%. The results are impacted very little because the IMF expects inflation to return to steady state as soon as 2024, that is, that there will no further inflation surprises. (In fact, the increase comes from the persistent dilution on cash, as losses on bonds decrease due to the fact that we now allow debt to mature starting in 2021.)

This view, however, can be stressed by assuming that inflation declines to its steady-state value gradually over a longer period: 2026, 2028, and 2030. The second to fourth rows in panels A and B of Table 2 show these alternative disinflation hypotheses, and Table 3 shows the resulting gains to the USA. We assume in these computations that going forward higher interest rates fully compensate for inflation, including those for reserves, so that there are no further gains on debt that is rolled over, or on reserves. Still, if inflation takes longer time to decline, the gain for the USA scales up. They are 10.3% of GDP if inflation goes back to steady state in 2026, 13% if in 2028, and 15.7% if inflation goes back to steady state in 2030. By then, however, a third of the gain comes from the inflation tax on the money stock. The final rows show the estimates if we add holdings of treasuries by public agencies and, separately, the Fed's balance sheet.[21]

The discussion on the potential of US inflation to dilute US debt has been discussed in the literature. Aizenman and Marion (2011) suggested this would be a mechanism to reduce debt and argued that a steady-state 4% inflation rate would reduce the real value of debt by about 20%. This was a result in line with Reinhart et al. (2015), who argue that heterodox solutions have been used extensively by developed country governments to deal with debt spikes. Given the maturity structure of US debt (heavily tilted toward the short term) and the low future likelihood of the type of inflation we have witnessed, Hilscher et al. (2022) had forecast that substantial debt dilution was unlikely, and argued that a debt reduction of more than

[19] The average maturity is calculated as the weighted average of the number of years remaining until the maturity of the debt, taking into consideration only debt that matures in more than one year.

[20] The inflation trajectory is formulated in an exponential manner, resulting in a consistent percentage decline in the inflation rate across all years of the scenario.

[21] In doing this estimate, we assume the mortgage back securities and treasuries have the same maturity as the overall stock of treasuries.

Table 2 Excess inflation by scenario[20]

Scenario/year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Panel A: Inflation scenarios										
WEO Oct 2019	2.4	2.3	2.3	2.3	2.0	2.0	2.0	2.0	2.0	2.0
WEO Oct 2022	4.7	8.0	3.5	2.2	2.0	2.0	2.0	2.0	2.0	2.0
Scenario "2026"	4.7	8.0	5.7	4.0	2.8	2.0	2.0	2.0	2.0	2.0
Scenario "2028"	4.7	8.0	6.3	5.0	4.0	3.2	2.5	2.0	2.0	2.0
Scenario "2030"	4.7	8.0	6.7	5.7	4.8	4.0	3.4	2.8	2.4	2.0
Panel B: Excess inflation by scenario										
Base Scenario	2.3	5.7	1.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
Scenario "2026"	2.3	5.7	3.4	1.7	0.8	0.0	0.0	0.0	0.0	0.0
Scenario "2028"	2.3	5.7	4.0	2.7	2.0	1.2	0.5	0.0	0.0	0.0
Scenario "2030"	2.3	5.7	4.4	3.4	2.8	2.0	1.4	0.8	0.4	0.0

Table 3 Effect by inflation path scenarios (% GDP)

Country	Base scenario	Scen. "2024"	Scen. "2026"	Scen. "2028"	Scen. "2030"
Base scenario	6.8	7.19	10.31	13.00	15.68
Bonds	5.3	5.24	7.30	8.87	10.29
Currency	1.3	1.94	3.01	4.13	5.39
Base scenario plus public	9.2	9.38	13.35	16.71	19.98
Public Holdings	2.3	2.19	3.05	3.71	4.30
Base scenario plus Fed	6.3	8.97	12.13	14.86	17.57
Mortgage Fed	(0.8)	(0.74)	(1.03)	(1.26)	(1.46)
Fed treasuries	(1.4)	(1.33)	(1.85)	(2.25)	(2.61)
US Reserves	1.6	1.66	1.66	1.66	1.66

4% of GDP was all but impossible. The high inflation in the USA has led to a higher estimate (our 6.8% of GDP) in 2021 and 2022. However, if we allow inflation to persist at higher levels, our numbers approximate those of Aizenman and Marion (2011).

3 The Effect of US Inflation on Debt Burdens Around the Globe

We now turn to estimating the effect of US inflation on long-term dollar-denominated fixed-rate debt issued by *other* countries. As we show below, debt burdens will fall to the extent that US inflation increases the value of other countries' GDP when measured in dollars.

3.1 Why US Inflation Matters Elsewhere

A helpful starting point to show how US inflation translates into dollar-denominated GDP of other countries is the simple purchasing power parity (PPP) relationship:

$$P_t = EP_t^*, \tag{6}$$

where P_t is the price level in a specific country, and P_t^* is the price level in the USA. E is the exchange rate defined as the number of units of currency of that specific country per dollar.

This equation assumes all goods are tradable, or, alternatively, that there are no changes in the real exchange rate. Our relevant shock is an inflation shock in the USA, which should not change the real exchange rate.

PPP provides a simple exchange rate equation:

$$E = P_t/P_t^*, \tag{7}$$

which states that the exchange rate will move according to the inflation differential. If the local country has higher inflation, its exchange rate will depreciate. But if the US inflation is higher the local country's, then the currency will appreciate relative to the dollar. Now, if

$$GDP_t = P_t Q_t, \tag{8}$$

where GDP_t is local currency nominal *GDP*, and Q_t is real *GDP,* then

$$\frac{GDP_t}{E_t} = GDP_t^{USD} = \frac{P_t}{E_t} Q_t = P_t^* Q_t, \tag{9}$$

which shows that the local *GDP measured in US dollars* grows at the rate of US inflation.

The bottom line is that US inflation will increase the value of GDP in all countries, when measured in dollars, at the tune of the US inflation.[22] When payments are fixed in (nominal) US dollars, the real burden of these payments falls with US inflation.

Real exchange rates need not remain fixed. In the specific case of the inflation shock of 2021–2022, the sharp increase in interest rates in the USA led to a large real exchange rate appreciation of the US dollar (though this appreciation later reversed somewhat). A strong dollar appreciation may therefore lead to an increase in the debt burden in spite of higher US inflation.

[22] When there is equal inflation in both countries, exchange rates remain unchanged but nominal GDP in dollars would still grow at the US inflation and there would be a decline in the real value of nominal US dollar-denominated debt.

Table 4 Regression results

Dependent variable:	Local US inflation	
Model:	(1)	(2)
	1-year interval	5-year interval
US inflation	1.252***	1.028***
	(0.0751)	(0.0625)
Fixed-effects		
Country	Yes	Yes
Fit statistics		
Observations	9654	1914
R^2	0.06233	0.21351
Within R^2	0.04755	0.17391

Clustered (country) standard errors in parentheses

*Signif. Codes: ***0.01, **0.05, *0.1*

What does the evidence have to say about how US inflation transfers to other countries? Using data from 1960 to the present, we can compute the dollar inflation in each country (we do this by dividing nominal GDP in dollars by real GDP, estimating a dollar deflator) and explore its relationship with US inflation for each country.[23] The results of this computation are shown in Table 4. Column 1 shows the relationship between yearly dollar inflation in each country and US inflation. The regression includes country fixed effects to control for country-specific drivers of the local real exchange rates. The coefficient is highly significant and larger than one. This indicates that an increase in US inflation is associated with a real dollar depreciation.

Column 2 in Table 4 shows the same exercise with data collected in 5-year interval. Now, the coefficient reduces to 1. This means that US inflation will (sooner or later) imply a higher local price level in nominal dollars. Ceteris paribus, given trends in the real exchange rate US inflation translates to domestic dollar inflation basically one to one.

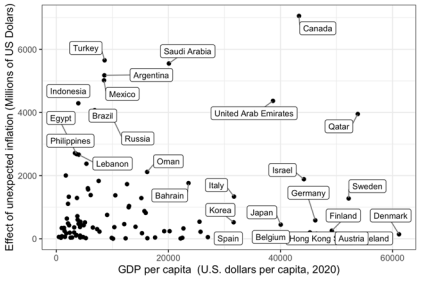
Of course, at least for 2020 and 2021 data, we can use *actual* dollar GDP numbers which are available. This should factor in the effect of the US appreciation, if any. We show below that our results hold regardless of which methodology we use.

3.2 The Effect of the 2021–2022 Inflation Shock

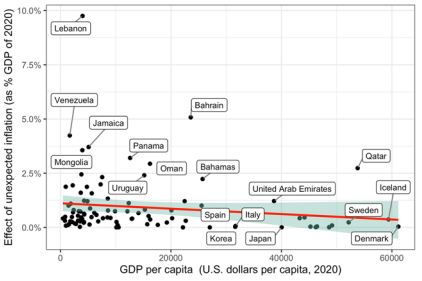
In estimating the effects of the inflation shock, we perform the analysis in two ways, first assuming constant real exchange rates, and second using actual real exchange rates.

[23] To do the computation with the longest data we use World Bank data from https://data.worldbank.org/indicator/NY.GDP.MKTP.CD.

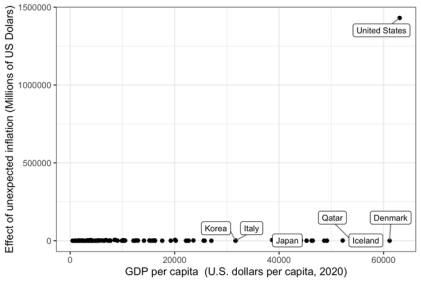
Fig. 4 Share of long-term fixed-rate securities in total Sovereign International Issues. Source: BIS. The share is computed as the total long-term fixed-rate securities over the total securities (denominated in all currencies). All data refer to the outstanding issued in the fourth quarter of every year



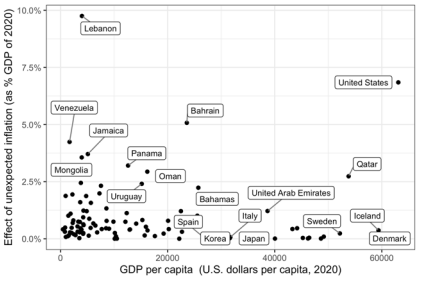
(a) Effect in nominal terms, excl. USA.



(b) Effect as % of GDP, excl. USA.



(c) Effect in nominal terms, incl. USA.



(d) Effect as % of GDP, incl. USA.

Fig. 5 Effect of unexpected inflation on value of Sovereign Liabilities. Source: BIS Table C3 "Debt securities issues and amounts outstanding, in billions of US dollars" and IMF-WEO (for forecast and actual inflation). The effect of unexpected inflation corresponds to the product between the stock of long-term fixed-rate securities denominated in US dollars and the 8% unexpected inflation. Figures for the USA include treasury securities and monetary base

Table 5 Revised effect, selected cases

Country	Year	Nominal GDP growth (%)	Real GDP growth (%)	GDP deflator growth (%)	GDP deflator growth (adj.) (%)
Canada	2021	20.8	4.5	15.6	13.2
Canada	2022	10.7	3.3	7.1	4.8
China. People's Republic of	2021	19.4	8.1	10.4	8.0
China. People's Republic of	2022	3.2	3.2	0.0	−2.3

3.2.1 Assuming Constant Real Exchange Rates

When real exchange rates are constant, dollar inflation in other countries equals that of the USA. This implies that we can apply the same methodology that we use for the US debt to estimate the (real) gain for the issuing sovereigns and the equivalent loss for the holders of that debt. In short, we can multiply the stock of long-term, fixed-rate dollar-denominated debt by the extent of unexpected US inflation to estimate the resulting gains to other countries.

Our data on the size, composition, and maturity of dollar-denominated sovereign debt comes from the BIS Debt Securities Statistics.[24] As can be seen in Fig. 4, almost all international sovereign debt is issued at fixed rates and with long maturities.[25]

Although the amount of domestic currency debt issues has increased in recent decades,[26] the amount of total long-term fixed-rate dollar-denominated debt issued by countries other than the USA still totaled $1.3 trillion at the end of 2020.

As before, we apply the unexpected inflation (8%) to the total stock of long-term, fixed-rate dollar-denominated sovereign debt at the end of 2020. Figure 5a, b show our estimate of transfers to sovereigns. Figure 5a shows the absolute value in dollar terms, while Fig. 5b shows the values as a share of GDP for all countries except the USA (which is included in the bottom panel of Fig. 5). Data for each country is reported in Appendix.

Although the issuance of dollar debt was originally thought to be a mechanism for tying the hands of sovereigns that otherwise faced the temptation to use inflation to reduce their debt obligations, US inflation now provides a means of debt dilution through, as it were, the back door. Argentina, Brazil, Indonesia, Mexico, Turkey, Saudi Arabia, the United Arab Emirates, Qatar, and Canada are some of the

[24] See: https://www.bis.org/statistics/secstats.html and https://www.bis.org/statistics/debt_sec/overviewDebtSec.pdf for an overview table. Table C3 "Debt securities issues and amounts outstanding, in billions of US dollars" is the primary source for dollar-denominated government debt. The data were accessed at https://stats.bis.org/statx/srs/table/C3.

[25] International issues are issues in foreign jurisdictions. These numbers, then, basically exclude issues by the USA which are domestic issues even when held by foreigners. We will return to this issue later.

[26] See BIS Table C4 "Central and general government debt securities markets; Long-term, all markets, amounts outstanding in billions of US dollars at end-2021." https://www.bis.org/statistics/c4.pdf.

biggest beneficiaries of this debt dilution by absolute dollar value, with each country securing a windfall that exceeds $4 billion. Excluding the USA, the gains across all countries amounts to $104 billion, a number on the scale of total annual foreign aid flows.

If we focus on the impact as a percentage of GDP (in 2020), which provides a more appropriate measure of the effects, we see that the effect is larger for poorer countries. As share of GDP, the biggest beneficiary is Lebanon (9.8% of GDP, which is even higher than for the US!). Other major winners are countries such as Venezuela, Jamaica, Panama, Oman, Bahrain, and Qatar.

Real exchange rates may change as a result of interest rate hikes. In this first-cut analysis, by assuming PPP, i.e., that inflation differentials are exactly reflected in exchange rate changes, we abstracted from such realignments. However, in the short run, PPP may not hold. For example, recent interest rate hikes have led to significant short-run appreciation of the dollar, which actually decreases the US dollar-denominated GDP of other countries. This change is short run and likely to be transitory (as we showed above, also see (Taylor and Taylor 2004)). We can therefore interpret our results in this section as the eventual effect of unanticipated US inflation even if it does not reveal itself in the short run. Regardless, in the next subsection, way allow real exchange rates to vary.

3.2.2 Allowing Real Exchange Rates to Vary

The above estimation assumed real exchange rates to be constant. What if they are not? One way to relax the assumption is to compute the rate of price increases in dollars in each country and then compare this to the expected inflation rate. We do not need to speculate about this number, as it is readily and publicly available, at least for 2021 and 2022.

The exercise is to compute a country-wise dollar deflator, which can be computed by dividing nominal dollar-denominated GDP for each country by real GDP. We then subtract this number from the expected US inflation in 2019. To illustrate the methodology, Table 5 shows the nature of the exercise for two cases.

Note that dollar prices in Canada and China increased faster than in the USA in 2021 but slower in 2022 (when the dollar appreciated). The last column shows the local dollar price inflation surprise, but subtracting US inflation. We extend this computation for all countries.

We should expect to see that countries for which the real exchange rate appreciates have higher price level increases when measured in dollars. Figure 6 shows that this is the case in our computation. As can be seen, a significant number of countries in our sample saw their currencies *appreciate* viz. the dollar.

We then replicate our estimation of the reduction in debt burdens using actual dollar inflation. The country-by-country results are presented in Table 11 of Appendix. The exercise, somewhat surprisingly, shows that once the actual dollar GDP number is computed, the total gains to sovereigns are higher, though results differ by

Table 6 Effect by inflation path scenarios (% GDP)

Country	Avg. maturity	Base scenario	Scen. "2024"	Scen. "2026"	Scen. "2028"	Scen. "2030"
Argentina	6.66	1.33	1.22	1.66	1.99	2.28
Belgium	10.36	0.04	0.04	0.05	0.06	0.07
Brazil	3.39	0.28	0.22	0.28	0.32	0.34
Colombia	7.81	0.88	0.82	1.14	1.38	1.59
Germany	6.80	0.01	0.01	0.02	0.02	0.03
Hong Kong SAR	0.57	0.05	0.01	0.01	0.01	0.01
Hungary	4.50	0.53	0.45	0.59	0.68	0.76
Indonesia	8.17	0.41	0.38	0.53	0.64	0.74
Israel	15.60	0.46	0.46	0.66	0.82	0.98
Korea	10.50	0.03	0.03	0.04	0.05	0.06
Malaysia	8.00	0.11	0.10	0.14	0.17	0.20
Mexico	7.80	0.46	0.43	0.60	0.72	0.83
Peru	10.87	0.67	0.65	0.92	1.13	1.33
Philippines	5.50	0.75	0.67	0.89	1.05	1.19
Poland	4.20	0.15	0.12	0.16	0.18	0.20
Russia	6.64	0.26	0.23	0.32	0.38	0.44
Saudi Arabia	9.03	0.79	0.75	1.05	1.28	1.49
South Africa	14.80	0.48	0.47	0.67	0.84	1.00
Spain	7.50	0.00	0.00	0.01	0.01	0.01
Turkey	2.80	0.79	0.58	0.71	0.78	0.84
USA	8.30	6.80	7.19	10.31	13.00	15.68
Weighted average		6.56	6.93	9.94	12.53	15.11
Weighted average (w.o. USA)		0.62	0.55	0.75	0.90	1.03

country. The results of this new inflation measure implies gains that are 1.7 times as large (from $100 billion for the countries with available data in 2021 and 2022, vs. $170 billion in the new formulation.) Figure 7 compares both methodologies. The correlation is positive.[27]

In short, correcting for changes in the real exchange rate strengthens our central finding: the current inflation spike has led to a substantial reduction in debt burdens for a significant number of countries.

3.2.3 Inflation Beyond 2023

The computations above measure the reduction in the real value of liabilities arising from the inflation surprise in the 2021–2022 period. Again, the real effects should

[27] We have not included Venezuela because of its reported official exchange rate is not meaningful.

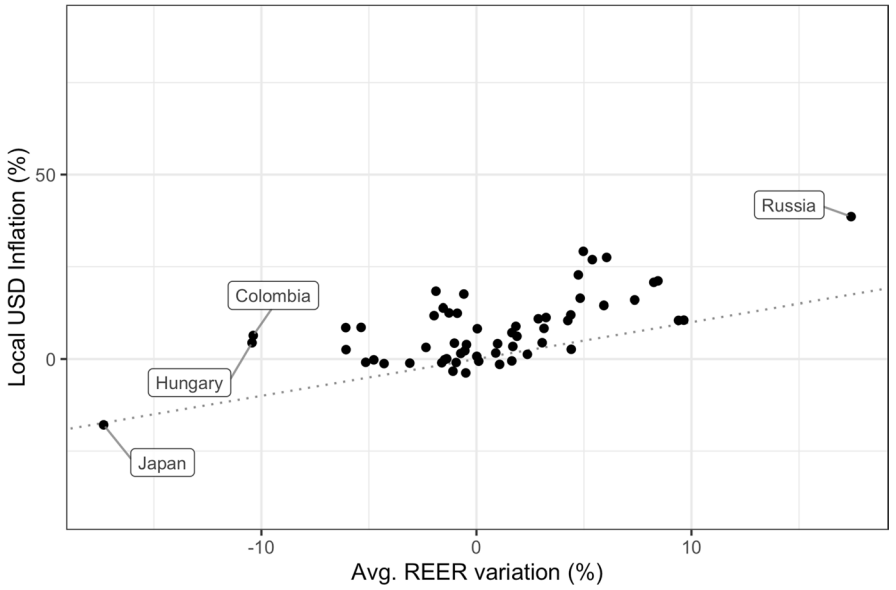


Fig. 6 Local US GDP deflator vs REER

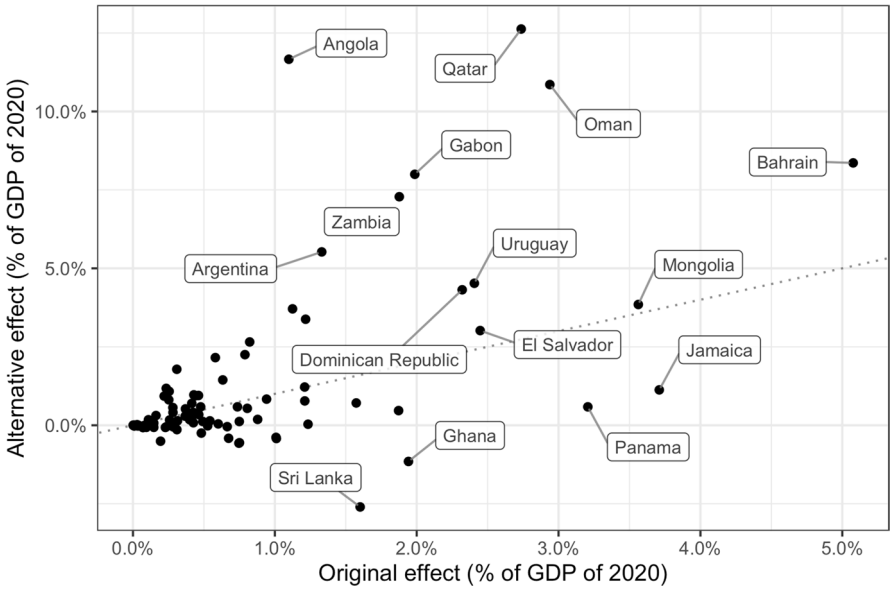


Fig. 7 Original vs. alternative effect (% of GDP of 2020)

consider the expected inflation increase in 2023 and beyond. As with the USA, the estimate depends on both the duration of the inflation shock and on the maturity structure of the debt.

To do this computation, we can use equation (4). While not as easily available, the average maturity of countries' debt is available for a number of countries. Column 1 in Table 6 shows these maturities for selected countries for which maturity data is available. Maturities vary across countries.

What remains for the computation is to obtain estimates of the dollar inflation in each country. But from our analysis above, we can use US inflation, so again we use the change in expected US inflation, obtained from the WEO, as well as in alternative scenarios that we already showed in Table 2.

The gains to other countries increase if the inflation shock persists. A more persistent inflation shock could mean, on average, the doubling of benefits to countries.

3.3 Caveats

Our results assume that there is inflation only in the USA, though inflation has risen in other parts of the world. Sovereigns that have issued debt in their own currencies will therefore gain from the reduction in the real value of their outstanding liabilities. Our estimates should be thought of as applying to the specific impact of US inflation rather than the consequences of global inflation in general. However, they bring attention to the declining value of sovereign debt stocks, an issue that has received insufficient attention.

In our computation, we have ignored holdings of US dollar-denominated assets by central banks. These holdings may imply a loss to sovereigns, thereby reducing the computed gains. We have ignored these holdings because it is difficult to find data on both the maturities and currency denomination of those assets. However, central banks frequently hold their assets as short-term instruments, so the omission may not be significant for our results (and indeed there is some evidence that holdings of dollar assets may be declining).

Our computations do not consider debts issued by multilateral financial institutions like the World Bank and IMF. The reason for this is that most multilateral debt is at variable rates (with a very small fraction of concessional loans at fixed rates).

We have focused on transfers arising from sovereign debt. However, governments account for only about one-quarter of the $4.2 trillion of dollar-denominated debt issued in emerging markets. The distributive impact of US inflation is thus more far-reaching than what we have estimated here. We leave it to future work to arrive at estimates of the scope of gains and losses for private creditors and debtors.

Finally, the large short-term gains to sovereigns may come with longer-term costs, such as higher interest rates on future debt issues and economic contractions associated with central banks' efforts to curb inflation. However, at least for the USA, real interest rates on treasuries so far have not increased significantly (see appendix).

4 Conclusion

We have considered the distributive consequences of unanticipated inflation in the USA. The overall impact on the real value of sovereign liabilities is substantial and the largest beneficiary is the US Treasury. One-third of the inflation tax is levied abroad, particularly on large holders of US Treasury securities, including Japan and China, and countries whose residents hold significant stocks of dollar cash, such as Russia and Argentina. Only in 2021 and 2022, the USA has thus effectively received a transfer from the rest of the world of over $500 billion. But sovereigns other than the USA also secure substantial windfalls from the dilution of their dollar-denominated debt. The decline in the real value of non-US sovereign debt arising from unexpected inflation in 2021 and 2022 amounts to $104 billion, with a number of poor countries experiencing significant gains relative to their GDP. These gains come at the expense of private creditors and other sovereigns.

A key implication of our findings is that the widely anticipated turmoil in emerging market sovereign debt may be mitigated by the inflation windfall accruing to other countries. In addition, nominal US interest rates thus far have not risen as much as US inflation, so real interest rates remain negative. This distinguishes current policy from the 1980s, when real interest rates rose substantially, thereby precipitating the international debt crisis.[28] Seen from the perspective of sovereign debt issuers, the current international environment is therefore more benign than in the past. It is well-known that unanticipated inflation benefits debtors at the expense of creditors, but our work highlights the surprising set of winners and losers and the sheer size of the ongoing gains to sovereigns.

Appendix A: Unexpected Inflation Effect by Country

See Table 7.

[28] We thank Jeffrey Frankel for alerting us to this point.

Table 7 Long-term, fixed-rate dollar-denominated international debt securities outstanding (IDS), issued by the general government and unexpected inflation effect by country

	Long-term fixed-rate dollar IDS	Unexpected inflation effect	Unexpected inflation effect (%GDP)
Albania	259.00	20.72	0.14
Angola	8000.00	640.00	1.10
Argentina	64,714.00	5177.12	1.33
Armenia	1000.00	80.00	0.63
Aruba	378.00	30.24	1.21
Austria	600.00	48.00	0.01
Azerbaijan	1250.00	100.00	0.23
Bahamas	2769.00	221.52	2.24
Bahrain	22,035.00	1762.80	5.08
Barbados	215.00	17.20	0.37
Belarus	4450.00	356.00	0.58
Belgium	2500.00	200.00	0.04
Bermuda	3860.00	308.80	
Bolivia	2500.00	200.00	0.54
Brazil	50,881.00	4070.48	0.28
Bulgaria	38.00	3.04	0.00
Cameroon	750.00	60.00	0.15
Canada	88,225.00	7058.00	0.43
Chile	12,977.00	1038.16	0.41
China	17,200.00	1376.00	0.01
Colombia	29,705.00	2376.40	0.88
Costa Rica	5800.00	464.00	0.75
Cote d'Ivoire	5332.00	426.56	0.69
Croatia	4750.00	380.00	0.66
Denmark	1777.00	142.16	0.04
Dominican Republic	22,895.00	1831.60	2.32
Ecuador	19,533.00	1562.64	1.57
Egypt	33,510.00	2680.80	0.74
El Salvador	7538.00	603.04	2.45
Ethiopia	1000.00	80.00	0.08
Finland	3191.00	255.28	0.09
Gabon	3809.00	304.72	1.99
Georgia	500.00	40.00	0.25
Germany	7300.00	584.00	0.02
Ghana	16,627.00	1330.16	1.94
Guatemala	5830.00	466.40	0.60
Honduras	2400.00	192.00	0.81
Hong Kong SAR	2000.00	160.00	0.05
Hungary	10,250.00	820.00	0.53
Iceland	1000.00	80.00	0.37

Table 7 (continued)

	Long-term fixed-rate dollar IDS	Unexpected inflation effect	Unexpected inflation effect (%GDP)
Indonesia	53,650.00	4292.00	0.40
Iraq	4659.00	372.72	0.22
Israel	23,589.00	1887.12	0.46
Italy	16,700.00	1336.00	0.07
Jamaica	6477.00	518.16	3.71
Japan	5594.00	447.52	0.01
Jordan	6750.00	540.00	1.23
Kazakhstan	9447.00	755.76	0.44
Kenya	6100.00	488.00	0.48
Korea	6525.00	522.00	0.03
Kuwait	4092.00	327.36	0.31
Laos	450.00	36.00	0.19
Latvia	500.00	40.00	0.12
Lebanon	33,304.00	2664.32	9.75
Lithuania	3000.00	240.00	0.42
Malaysia	4600.00	368.00	0.11
Maldives	350.00	28.00	0.75
Mexico	62,747.00	5019.76	0.46
Mongolia	5928.00	474.24	3.56
Morocco	4500.00	360.00	0.31
Mozambique	727.00	58.16	0.41
Namibia	1250.00	100.00	0.94
Nigeria	13,846.00	1107.68	0.26
Oman	26,468.00	2117.44	2.94
Pakistan	4300.00	344.00	0.11
Panama	21,633.00	1730.64	3.21
Papua New Guinea	500.00	40.00	0.16
Paraguay	5360.00	428.80	1.21
Peru	17,296.00	1383.68	0.67
Philippines	33,923.00	2713.84	0.75
Poland	10,950.00	876.00	0.15
Portugal	108.00	8.64	0.00
Qatar	49,400.00	3952.00	2.74
Romania	12,468.00	997.44	0.40
Russia	47,287.00	3782.96	0.26
Rwanda	400.00	32.00	0.31
Saudi Arabia	69,394.00	5551.52	0.79
Senegal	3100.00	248.00	1.01
Serbia	2838.00	227.04	0.43
Seychelles	169.00	13.52	1.12
Slovakia	3000.00	240.00	0.23

Table 7 (continued)

	Long-term fixed-rate dollar IDS	Unexpected inflation effect	Unexpected inflation effect (%GDP)
Slovenia	6750.00	540.00	1.01
South Africa	20,000.00	1600.00	0.48
Spain	640.00	51.20	0.00
Sri Lanka	16,150.00	1292.00	1.60
Suriname	675.00	54.00	1.87
Sweden	15,963.00	1277.04	0.24
Tajikistan	500.00	40.00	0.49
Trinidad and Tobago	2200.00	176.00	0.82
Tunisia	1500.00	120.00	0.28
Turkey	70,660.00	5652.80	0.79
Ukraine	8950.00	716.00	0.46
United Arab Emirates	54,590.00	4367.20	1.22
USA	1,6663,865[29]	1,430,474	6.8
Uruguay	16,111.00	1288.88	2.41
Uzbekistan	2110.00	168.80	0.28
Venezuela	25,050.00	2004.00	4.24
Vietnam	1253.00	100.24	0.03
Zambia	4250.00	340.00	1.88

Sources: BIS, IMF-WEO and US Federal Reserve. Long-term, fixed-rate dollar-denominated international debt securities outstanding (IDS), issued by the general government. Data on long-term fixed-rate securities come from the Bank for International Securities Table C3: "Debt securities issues and amounts outstanding, in billions of US dollars."(https://stats.bis.org/statx/srs/table/C3). Forecast and actual inflation is taken from the IMF-WEO 2019 and 2022. Data on the USA come from the treasury (ttps://www.fiscal.treasury.gov/files/reports-statements/treasury-bulletin/b2021-3.pdf.) and Federal Reserve (https://fred.stlouisfed.org/series/BOGMBASE). The effect of the unexpected inflation over the outstanding long-term fixed-rate debt is the product between 8% and the total outstanding, except USA (explained in the main text). Unexpected inflation effect (% GDP): ratio of the unexpected inflation effect and the nominal GDP for 2020. Empty rows correspond to missing information for nominal GDP. Table continues on next page.

See explanatory note on previous page

Appendix B: Foreign Holdings of US Currency/Cash

See Table 8.

Table 8 US currency held by foreigners

Country	Currency holdings 2006	Currency holdings 2020 (Estimated)	Inflation surprise	Inflation surprise (%GDP)
Argentina	50,000	105,222.22	13,363.22	3.43
Belarus	3000	6313.33	801.79	1.31
Brazil	1000	2104.44	267.26	0.02
Bulgaria	1000	2104.44	267.26	0.38
Cambodia	2000	4208.89	534.53	2.12
Chile	250	526.11	66.82	0.03
China	50,000	105,222.22	13363.22	0.09
Colombia	2000	4208.89	534.53	0.2
Dominican Republic	1500	3156.67	400.9	0.51
Ecuador	1000	2104.44	267.26	0.27
Egypt	1000	2104.44	267.26	0.07
El Salvador	1000	2104.44	267.26	1.08
Hong Kong	2000	4208.89	534.53	0.15
Indonesia	2000	4208.89	534.53	0.05
Korea	15,000	31,566.67	4008.97	0.24
Latvia	500	1052.22	133.63	0.4
Lithuania	500	1052.22	133.63	0.24
Mexico	5000	10,522.22	1336.32	0.12
Panama	2000	4208.89	534.53	0.99
Peru	5000	10,522.22	1336.32	0.65
Paraguay	100	210.44	26.73	0.08
Philippines	2000	4208.89	534.53	0.15
Poland	1000	2104.44	267.26	0.04
Romania	2000	4208.89	534.53	0.21
Russia	80000	168,355.56	21,381.16	1.44
Singapore	1000	2104.44	267.26	0.08
South Africa	2000	4208.89	534.53	0.16
Taiwan	1000	2104.44	267.26	0.04
Thailand	250	526.11	66.82	0.01
Turkey	10,000	21,044.44	2672.64	0.37
Vietnam	3000	6313.33	801.79	0.23
Others	201,900	424,887.33	53,960.69	

Sources: Judson (2017), Bertaut et al. (2019) and US Federal Reserve. The currency holding is expressed in millions of US dollars estimated in 2006. The currency holdings in 2020 results from using the aggregate growth rate of foreign currency holdings between 2006 and 2020 to update the 2006 information (see main text for additional information). The unexpected inflation effect is the product between the sum of US inflation in 2021 and 2022 (from IMF-WEO) and the currency holdings in 2021.

Appendix C: Holdings of US Treasuries and Unexpected Inflation Effect by Country

See Table 9.

Table 9 Impact of unexpected inflation on value of treasury security holdings by country

Country	Long-term fixed-rate treasuries holdings	Unexpected inflation effect	Unexpected inflation effect (%GDP)
Afghanistan	1400	112	0.56
Albania	475	38	0.25
Algeria	0	0	0
Andorra	304	24.32	0.84
Angola	1359	108.72	0.19
Anguilla	85	6.8	
Antigua and Barbuda	248	19.84	1.45
Argentina	758	60.64	0.02
Armenia	803	64.24	0.51
Aruba	74	5.92	0.24
Australia	30518	2441.44	0.18
Austria	3293	263.44	0.06
Azerbaijan	6797	543.76	1.27
Bahamas	3898	311.84	3.15
Bahrain	82	6.56	0.02
Bangladesh	0	0	0
Barbados	893	71.44	1.53
Belarus	126	10.08	0.02
Belgium	162,539	13,003.12	2.49
Belize	24	1.92	0.12
Bermuda	36,816	2945.28	
Bhutan	5	0.4	0.02
Bolivia	97	7.76	0.02
Botswana	623	49.84	0.33
Brazil	217,006	17360.48	1.2
British Indian Ocean Territory	0	0	
British Virgin Islands	26,860	2148.8	
Brunei	1086	86.88	0.72
Bulgaria	67	5.36	0.01
Burma	161	12.88	
Cambodia	4723	377.84	1.5
Canada	92,384	7390.72	0.45
Cape Verde	80	6.4	0.37
Cayman Islands	69,849	5587.92	

Table 9 (continued)

Country	Long-term fixed-rate treasuries holdings	Unexpected inflation effect	Unexpected inflation effect (%GDP)
Chile	19774	1581.92	0.63
China, mainland	822,937	65,834.96	0.44
Colombia	27,039	2163.12	0.8
Cook Islands	4	0.32	
Costa Rica	1354	108.32	0.17
Croatia	1468	117.44	0.21
Curacao	364	29.12	
Cyprus	89	7.12	0.03
Czech Republic	23,323	1865.84	0.76
Denmark	12,810	1024.8	0.29
Dominica	89	7.12	1.31
Dominican Republic	2681	214.48	0.27
East Timor	8043	643.44	33.83
Ecuador	151	12.08	0.01
Egypt	2235	178.8	0.05
El Salvador	607	48.56	0.2
Estonia	86	6.88	0.02
Federated States of Micronesia	32	2.56	0.62
Finland	4553	364.24	0.13
France	97,625	7810	0.3
Gabon	1	0.08	0
Gambia	0	0	0
Germany	60,481	4838.48	0.13
Ghana	3287	262.96	0.38
Gibraltar	14	1.12	
Greece	1788	143.04	0.08
Grenada	164	13.12	1.26
Guatemala	6971	557.68	0.72
Guernsey	5407	432.56	
Guyana	7	0.56	0.01
Haiti	202	16.16	0.11
Holy See (Vatican)	12	0.96	
Honduras	2368	189.44	0.8
Hong Kong	211,055	16,884.4	4.9
Hungary	769	61.52	0.04
Iceland	1799	143.92	0.67
India	151,402	12,112.16	0.45
Indonesia	20,052	1604.16	0.15
Iraq	13,221	1057.68	0.62
Ireland	162,506	13,000.48	3.05
Isle of Man	847	67.76	

Table 9 (continued)

Country	Long-term fixed-rate treasuries holdings	Unexpected inflation effect	Unexpected inflation effect (%GDP)
Israel	37,327	2986.16	0.73
Italy	37,468	2997.44	0.16
Jamaica	602	48.16	0.34
Japan	1,165,857	93,268.56	1.85
Jersey	1314	105.12	
Jordan	744	59.52	0.14
Kazakhstan	81	6.48	0
Kenya	5677	454.16	0.45
Korea, South	112,373	8989.84	0.55
Kuwait	16,267	1301.36	1.23
Kyrgyzstan	5	0.4	0.01
Latvia	169	13.52	0.04
Lebanon	2	0.16	0
Lesotho	44	3.52	0.17
Liberia	58	4.64	0.15
Libya	2050	164	0.85
Liechtenstein	197	15.76	
Lithuania	1750	140	0.25
Luxembourg	151,290	12,103.2	16.51
Macau	1222	97.76	0.38
Macedonia	0	0	0
Madagascar	858	68.64	0.53
Malawi	49	3.92	0.03
Malaysia	11,092	887.36	0.26
Maldives	2	0.16	0
Malta	255	20.4	0.14
Marshall Islands	11	0.88	0.36
Mauritania	197	15.76	0.19
Mauritius	515	41.2	0.38
Mexico	28,166	2253.28	0.21
Moldova	1162	92.96	0.81
Monaco	320	25.6	
Mongolia	279	22.32	0.17
Montserrat	27	2.16	
Morocco	4181	334.48	0.29
Mozambique	354	28.32	0.2
Namibia	41	3.28	0.03
Nepal	151	12.08	0.04
Netherlands	64,122	5129.76	0.56
New Zealand	5398	431.84	0.2
Nicaragua	26	2.08	0.02

Table 9 (continued)

Country	Long-term fixed-rate treasuries holdings	Unexpected inflation effect	Unexpected inflation effect (%GDP)
Nigeria	3907	312.56	0.07
Norway	77798	6223.84	1.72
Oman	5802	464.16	0.64
Pakistan	436	34.88	0.01
Palau	8	0.64	0.25
Panama	1488	119.04	0.22
Papua New Guinea	41	3.28	0.01
Paraguay	2213	177.04	0.5
Peru	20,038	1603.04	0.78
Philippines	37,787	3022.96	0.84
Poland	29,853	2388.24	0.4
Portugal	4254	340.32	0.15
Qatar	4644	371.52	0.26
Romania	4895	391.6	0.16
Russia	17	1.36	0
Rwanda	316	25.28	0.24
Saint Kitts and Nevis	229	18.32	1.87
Saint Lucia	198	15.84	0.98
Saint Vincent and the Grenadines	126	10.08	1.16
Saudi Arabia	84225	6738	0.96
Serbia and Montenegro	1688	135.04	
Seychelles	158	12.64	1.05
Sierra Leone	0	0	0
Singapore	89,663	7173.04	2.08
Sint Maarten	7	0.56	
Slovakia	146	11.68	0.01
Slovenia	358	28.64	0.05
Solomon Islands	5	0.4	0.03
South Africa	4929	394.32	0.12
Spain	35,709	2856.72	0.22
Sri Lanka	2505	200.4	0.25
Sudan	0	0	0
Suriname	22	1.76	0.06
Swaziland	47	3.76	
Sweden	33,524	2681.92	0.5
Switzerland	181,496	14,519.68	1.93
Taiwan	188,726	15,098.08	2.26
Tajikistan	52	4.16	0.05
Tanzania	1842	147.36	0.23
Thailand	68,672	5493.76	1.1
Trinidad and Tobago	1944	155.52	0.73

Table 9 (continued)

Country	Long-term fixed-rate treasuries holdings	Unexpected inflation effect	Unexpected inflation effect (%GDP)
Tunisia	300	24	0.06
Turkey	2067	165.36	0.02
Turks and Caicos Islands	89	7.12	
Uganda	474	37.92	0.1
Ukraine	5664	453.12	0.29
United Arab Emirates	9701	776.08	0.22
United Kingdom	306,011	24,480.88	0.89
Uruguay	3809	304.72	0.57
Vanuatu	7	0.56	0.06
Venezuela	67	5.36	0.01
Vietnam	30335	2426.8	0.71
Zambia	137	10.96	0.06

Sources: Federal Reserve and IMF-WEO. All expressed in millions of dollars. The effect of the unexpected inflation is the product between 8% and the total long-term fixed-rate treasuries holdings. Unexpected inflation effect (% GDP): Ratio of the unexpected inflation effect and the nominal GDP for 2020. Empty rows correspond to missing information for nominal GDP

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Appendix D: Long-Term Fixed-Rate Share of Outstanding Securities Issued in International Markets

See Table 10.

Table 10 Share of fixed-rate long-term securities in total outstanding securities

	Total securities outstanding	Fixed-rate long-term outstanding	% of the total
1990-Q4	242,534	217,340	89.61
1991-Q4	249,998	225,884	90.35
1992-Q4	290,710	264,800	91.09
1993-Q4	429,835	392,009	91.2
1994-Q4	576,787	528,301	91.59
1995-Q4	588,932	536,938	91.17
1996-Q4	629,517	566,117	89.93
1997-Q4	684,019	619,252	90.53
1998-Q4	701,393	635,739	90.64
1999-Q4	722,708	669,497	92.64
2000-Q4	799,535	752,896	94.17
2001-Q4	798,639	770,053	96.42
2002-Q4	838,606	815,916	97.29
2003-Q4	867,508	845,992	97.52
2004-Q4	923,944	894,862	96.85
2005-Q4	933,602	904,704	96.9
2006-Q4	928,609	895,373	96.42
2007-Q4	921,584	893,268	96.93
2008-Q4	945,492	923,492	97.67
2009-Q4	1,085,720	1,060,532	97.68
2010-Q4	1,205,697	1,180,957	97.95
2011-Q4	1,309,323	1,286,819	98.28
2012-Q4	1,461,578	1,443,820	98.79
2013-Q4	1,558,730	1,538,992	98.73
2014-Q4	1,688,254	1,667,368	98.76
2015-Q4	1,672,330	1,651,482	98.75
2016-Q4	1,857,450	1,834,662	98.77
2017-Q4	2,076,828	2,043,242	98.38
2018-Q4	2,190,702	2,165,718	98.86
2019-Q4	2,309,988	2,292,504	99.24
2020-Q4	2,668,666	2,656,282	99.54
2021-Q4	2,846,174	2,840,936	99.82

Source: BIS Debt Securities Statistics. Securities issued in international markets, denominated in US dollars. Total securitiesoutstanding includes all terms and all rate type

Appendix E: Unexpected Inflation Effect by Country (Local USD GDP deflator)

See Table 11.

Table 11 Unexpected inflation effect by country (Local USD GDP deflator)

Issuer residence	Original effect (2021 and 2022)	Alternative effect (2021 and 2022)
Albania	0.14	0.04
Angola	1.10	11.66
Argentina	1.33	5.52
Armenia	0.63	1.44
Aruba	1.21	0.78
Austria	0.01	−0.01
Azerbaijan	0.23	1.18
Bahamas	2.24	0.50
Bahrain	5.08	8.36
Barbados	0.37	0.29
Belarus	0.58	2.16
Belgium	0.04	−0.00
Bolivia	0.54	0.14
Brazil	0.28	0.56
Bulgaria	0.00	0.00
Cameroon	0.15	−0.07
Canada	0.43	0.97
Chile	0.41	0.20
China	0.01	0.01
Colombia	0.88	0.19
Costa Rica	0.75	−0.57
Cote d'Ivoire	0.69	−0.46
Croatia	0.66	−0.04
Denmark	0.04	−0.02
Dominican Republic	2.32	4.32
Ecuador	1.57	0.71
Egypt	0.74	0.59
El Salvador	2.45	3.02
Ethiopia	0.08	−0.00
Finland	0.09	−0.07
Gabon	1.99	8.00
Georgia	0.25	0.81
Germany	0.02	−0.01
Ghana	1.94	−1.15
Guatemala	0.60	0.04
Honduras	0.81	0.54
Hong Kong SAR	0.05	−0.02

Table 11 (continued)

Issuer residence	Original effect (2021 and 2022)	Alternative effect (2021 and 2022)
Hungary	0.53	−0.02
Iceland	0.37	0.52
Indonesia	0.40	0.32
Iraq	0.22	0.93
Israel	0.46	0.34
Italy	0.07	−0.07
Jamaica	3.71	1.13
Japan	0.01	−0.03
Jordan	1.23	0.03
Kazakhstan	0.44	0.94
Kenya	0.48	−0.25
Korea	0.03	−0.02
Kuwait	0.31	1.78
Laos	0.19	−0.51
Latvia	0.12	0.12
Lithuania	0.42	0.41
Malaysia	0.11	0.18
Maldives	0.75	0.12
Mexico	0.46	0.95
Mongolia	3.56	3.85
Morocco	0.31	0.14
Mozambique	0.41	0.70
Namibia	0.94	0.83
Nigeria	0.26	0.17
Oman	2.94	10.86
Pakistan	0.11	0.10
Panama	3.21	0.59
Papua New Guinea	0.16	0.31
Paraguay	1.21	1.22
Peru	0.67	−0.41
Philippines	0.75	−0.56
Poland	0.15	0.07
Portugal	0.00	−0.00
Qatar	2.74	12.63
Romania	0.40	0.18
Russia	0.26	1.08
Rwanda	0.31	−0.14
Saudi Arabia	0.79	2.25
Senegal	1.01	−0.42
Serbia	0.43	0.08
Seychelles	1.12	3.71
Slovakia	0.23	−0.07

Table 11 (continued)

Issuer residence	Original effect (2021 and 2022)	Alternative effect (2021 and 2022)
Slovenia	1.01	−0.39
South Africa	0.48	0.59
Spain	0.00	−0.00
Sri Lanka	1.60	−2.60
Suriname	1.87	0.47
Sweden	0.24	−0.05
Tajikistan	0.49	0.12
Trinidad and Tobago	0.82	2.65
Tunisia	0.28	−0.05
Turkey	0.79	−0.33
United Arab Emirates	1.22	3.38
USA	6.8	6.8
Uruguay	2.41	4.52
Uzbekistan	0.28	0.41
Venezuela	4.24	30.35
Vietnam	0.03	0.02
Zambia	1.88	7.28

Appendix F: Inflation Expectations and Yields on US Treasury Issues

In this appendix section, we first graphically present (forward-looking) inflation expectations from FRED at various intervals ranging from 1 year to 30 years, along with actual inflation (marked in black). Subsequently, we present interest rates on treasury debt issues, along with corresponding "inflation-adjusted" rates that simply subtract the expected inflation rate from (from FRED) the nominal interest rates for debt issues at various maturities (Figs. 8, 9, 10, 11, 12, 13, 14, 15).

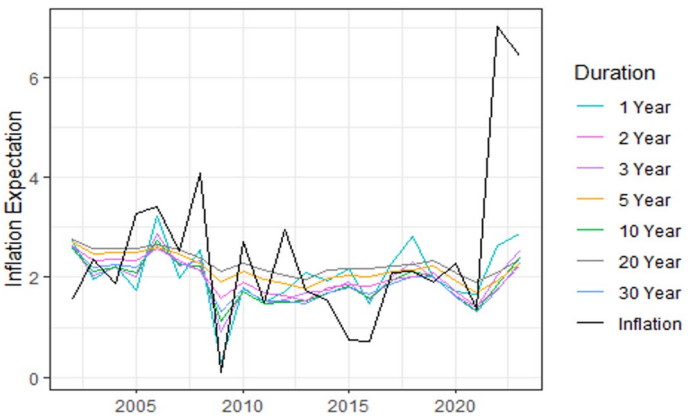

Fig. 8 Inflation expectations and actual inflation rate for USA (Source: FRED)

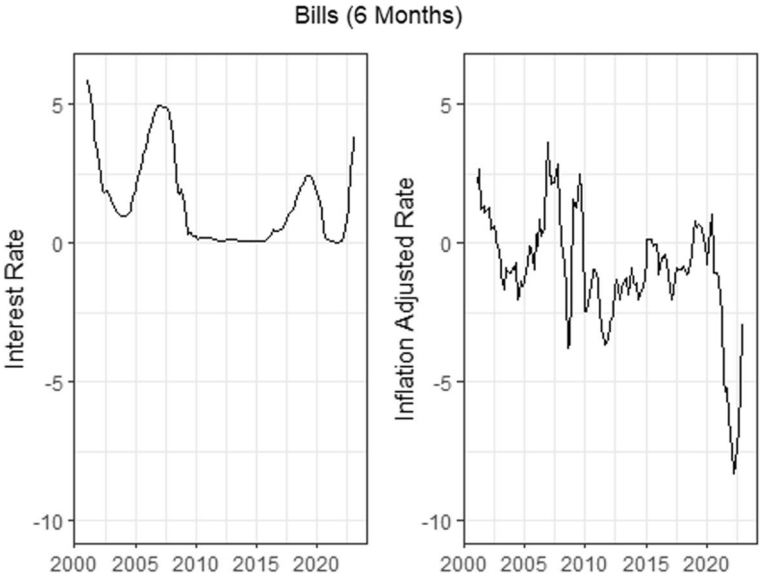

Fig. 9 Yields on US Treasury debt (6 Month)

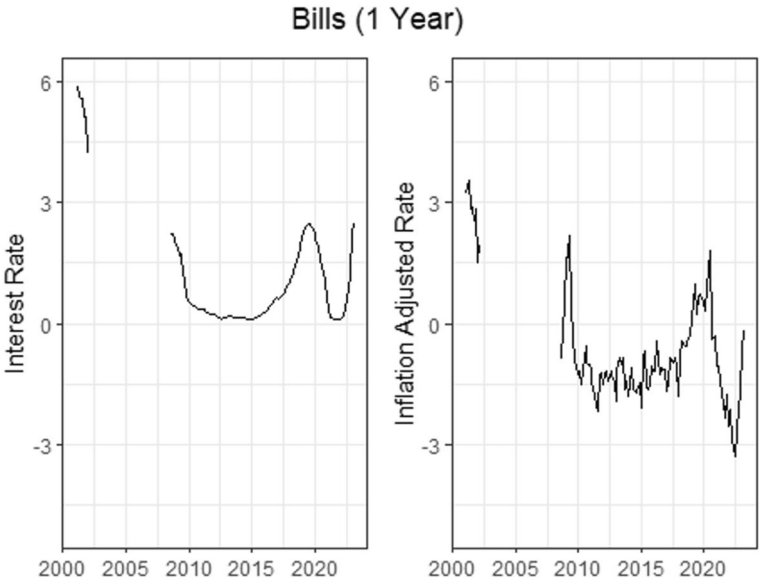

Fig. 10 Yields on US Treasury debt (1 Year)

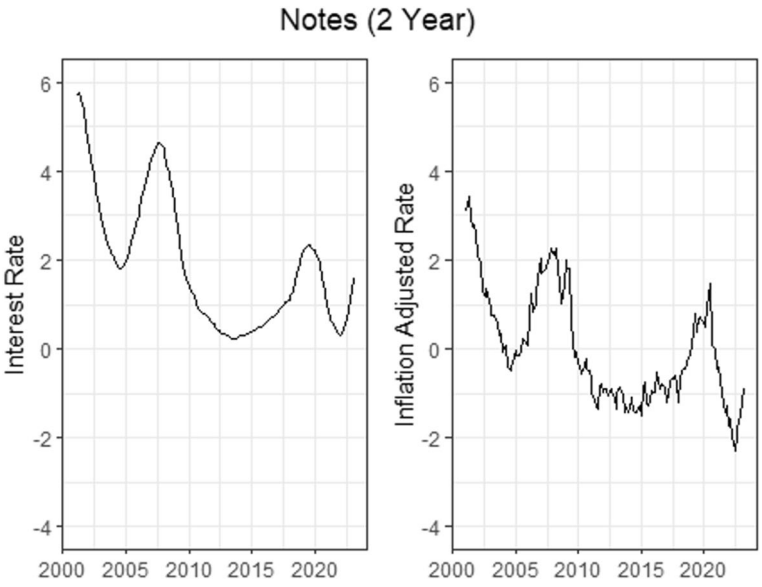

Fig. 11 Yields on US Treasury debt (2 Year)

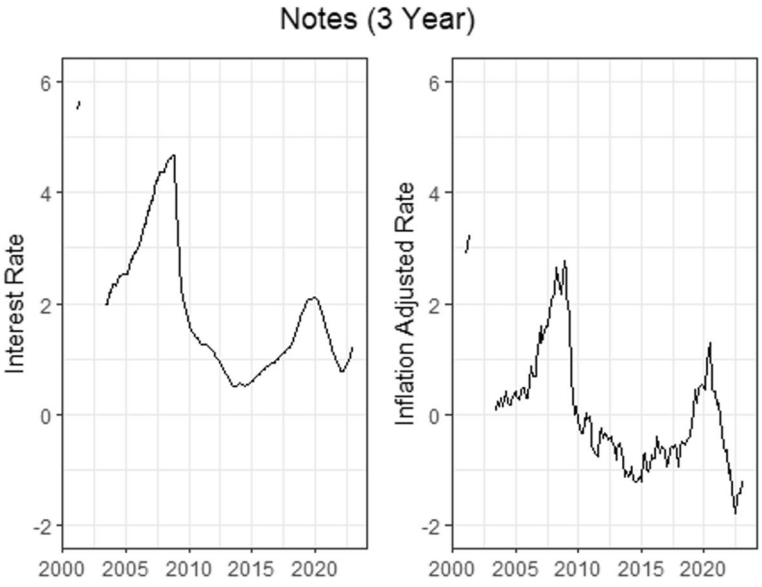

Fig. 12 Yields on US Treasury debt (3 Year)

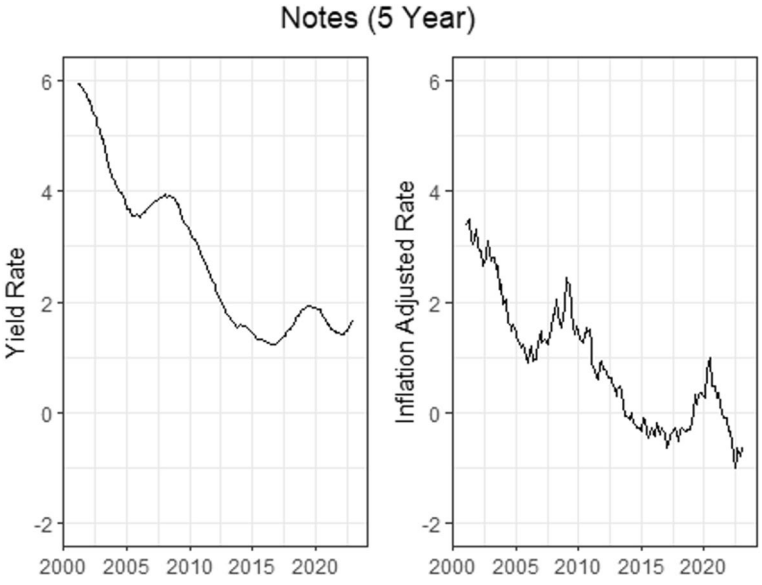

Fig. 13 Yields on US Treasury debt (5 Year)

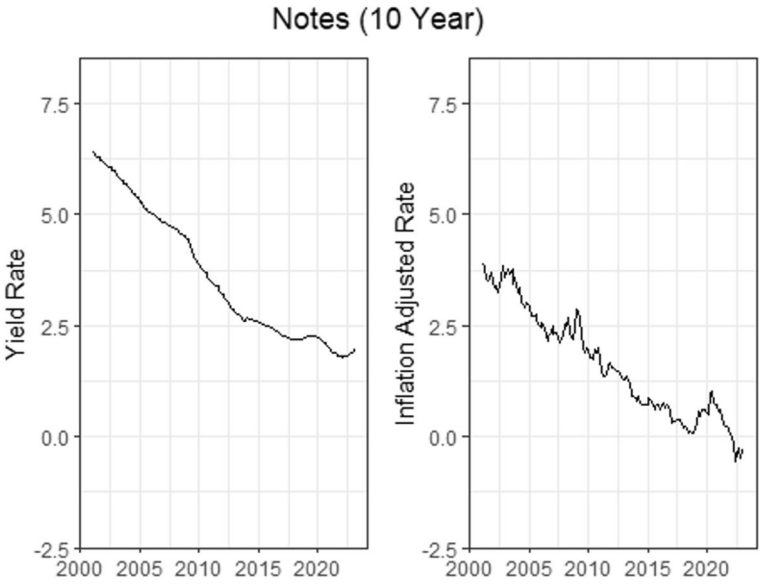

Fig. 14 Yields on US Treasury debt (10 Year)

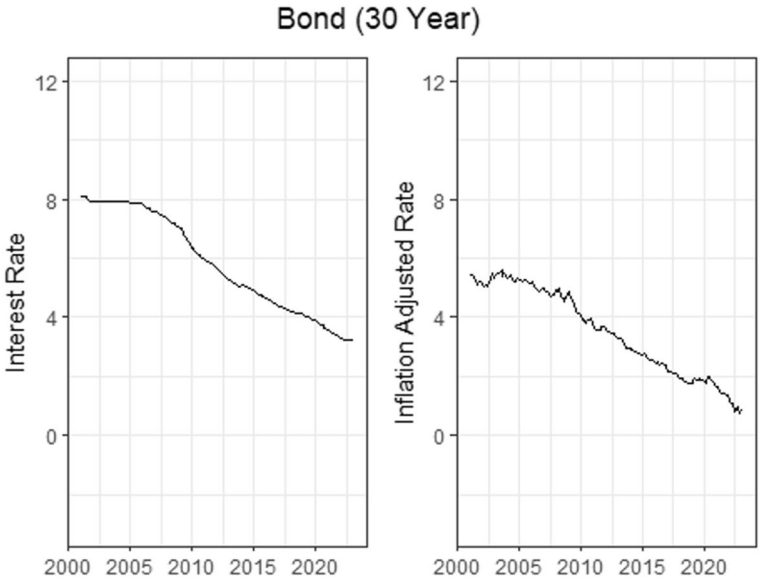

Fig. 15 Yields on US Treasury debt (30 Year)

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1057/s41308-023-00220-z.

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