BIS

BIS Working Papers

No 1110

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by Ryan Banerjee, Valerie Boctor, Aaron Mehrotra and Fabrizio Zampolli

Monetary and Economic Department

July 2023

JEL classification: E31; E52; E62; E63.

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This paper was produced as part of the BIS Consultative Council for the Americas (CCA) research conference on "Structural changes in inflation and output dynamics after Covid and other shocks", held in Mexico City on 17–18 November 2022. BIS Working Papers are written by members of the Monetary and Economic Department of the Bank for International Settlements, and from time to time by other economists, and are published by the Bank. The papers are on subjects of topical interest and are technical in character. The views expressed in them are those of their authors and not necessarily the views of the BIS.

This publication is available on the BIS website (www.bis.org).

ISSN 1020-0959 (print)
ISSN 1682-7678 (online)

Fiscal sources of inflation risk in EMDEs: the role of the external channel*

Ryan Banerjee† Valerie Boctor‡ Aaron Mehrotra§ Fabrizio Zampolli¶

June 14, 2023

Abstract

We examine how changes in fiscal deficits affect near-term future inflation in a panel of emerging market and developing economies (EMDEs). Using a novel method for quantile panel regressions with fixed effects, we find that an increase in the fiscal deficit has highly non-linear effects on inflation - that is, a larger impact on upside tail risks than on average inflation. These effects are substantially larger in EMDEs than in advanced economies. We then show that an increase in the fiscal deficit raises the risk of future currency depreciation which magnifies the initial inflation response. This external channel is closely related to sovereign risk, being greater when the share of sovereign debt in foreign currency is large or when a sizeable share of sovereign debt is held by foreign residents. Finally, we find that the effects of fiscal deficits on future inflation are strongly attenuated in inflation targeting regimes and also influenced by constraints on monetary policy.

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*We are grateful to Agustin Carstens, Sandile Hlatshwayo (discussant), Enrique Martinez-Garcia (discussant), Luiz Pereira and Hyun Song Shin for comments, suggestions and discussions. We also thank seminar and conference participants at the BIS, Aix-Marseille School of Economics, Twelfth Annual BIS CCA Research Conference and CEBRA 2022 Annual Conference for comments and suggestions. Berenice Martinez provided excellent research assistance. The views expressed in the paper are those of the authors and do not necessarily reflect those of the Bank for International Settlements.

†Bank for International Settlements. E-mail address: ryan.banerjee@bis.org
‡University of California, Berkeley. E-mail address: valerieboctor@econ.berkeley.edu
§Bank for International Settlements. E-mail address: aaron.mehrotra@bis.org
¶Bank for International Settlements. E-mail address: fabrizio.zampolli@bis.org

1 Introduction

The Covid-19 pandemic has rekindled interest in the fiscal determinants of inflation. After the re-opening of the economy, inflation in many countries has reached levels not seen in the past two decades. While supply disruptions have played a role, so has strong demand. The latter has been fuelled not only by extremely expansionary monetary policies but also - in a large number of countries - by large fiscal stimuli. Indeed, there is a concern that fiscal policy may add fuel to fire, especially in countries with a troubled history of fiscal indiscipline and high inflation (see e.g. Esquivel et al. (2019) and World Bank (2021))[1].

Understanding the channels through which fiscal policy might impact on inflation has therefore gained greater prominence of late. A fiscal expansion contributes to increasing domestic aggregate demand. The ensuing smaller economic slack then leads to higher inflation through a standard Phillips curve. At the same time, however, other channels may also be relevant.

One works through the exchange rate. In textbook models, a fiscal expansion typically leads to a currency appreciation (e.g. Auerbach and Gorodnichenko (2016)), which then partly offsets the inflationary impact of smaller economic slack. However, if a fiscal expansion is expected to significantly worsen the fiscal accounts, it might lead to an erosion of investors' confidence and a currency depreciation, which then magnifies the initial inflation response (e.g. Ghosh et al. (2013)). This channel is likely to be more relevant in emerging market and developing economies (EMDEs) than in advanced economies (AEs).

In this paper, we examine how fiscal deficits affect inflation risks in EMDEs. In addition, we analyse to what extent exchange rates shift as deficits increase in light of the strong pass-through from exchange rates to inflation in EMDEs. Then, we explore how the composition of sovereign debt affects both the inflation and exchange rate responses to

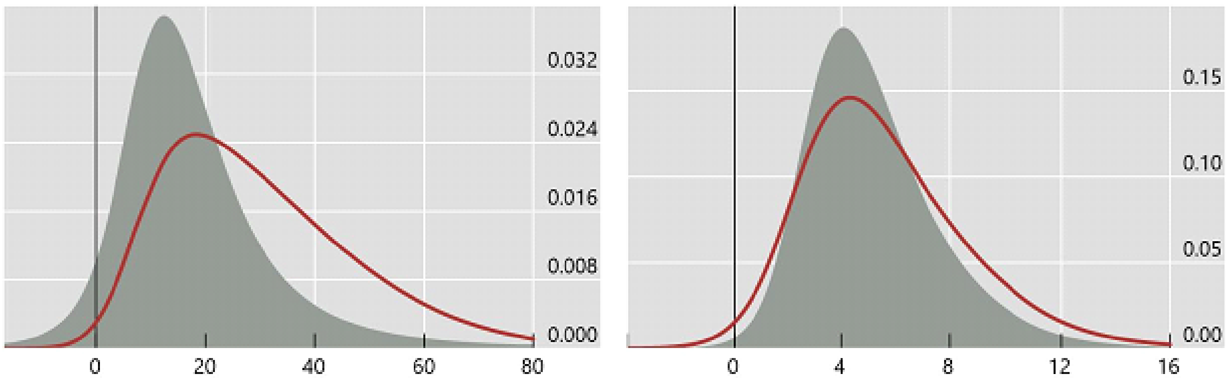
[1] For the recent debate regarding the inflationary consequences of fiscal stimulus in the United States, see Krugman (2021) and Summers (2021).

higher deficits. Importantly, in recent years, EMDE sovereigns have shifted from a reliance on foreign currency debt to greater foreign investor holdings of local currency debt, i.e. a shift from "original sin" (Eichengreen and Hausmann (1999) and Hausmann and Panizza (2003)) to "original sin redux" (Carstens and Shin (2019)). Finally, we examine to what extent inflation targeting regimes and the constraints on monetary policy faced by open economies affect the relationship between fiscal deficits and inflation.

To assess the deficit-inflation relationship, we use novel methods for quantile panel regressions with fixed effects (Machado and Santos Silva (2019)), which allow us to examine how higher deficits affect the entire forecast distribution of inflation. Indeed, central banks are typically interested not only in forecasting the average or modal effects of deficits on inflation outcomes, but also in assessing the risks surrounding those central forecasts. This allows them to take action to reduce the likelihood of very high (or very low) inflation outcomes (e.g. Greenspan (2004), Kilian and Manganelli (2008)).

Our paper has four main findings. Figure 1 illustrates our first main finding that increases in fiscal deficits in EMDEs have large and non-linear effects on inflation. Using data over six decades, the figure shows how a two standard deviation increase in the fiscal deficit shifts the one-year-ahead inflation forecast distribution - from grey to red - in EMDEs (left-hand panel). Our estimates show that an increase in the fiscal deficit has a strong effect on EMDE inflation. In addition, an increase in the deficit substantially increases upside tail risks to inflation in EMDEs - the right tail shifts visibly to the right. This stands in contrast to the influence of deficit increases in advanced economies (right-hand panel) where both the impact on the level and on the right tail are much weaker.

Second, the exchange rate channel is important, and also much stronger in EMDEs than in advanced economies. We show that the EMDE currencies depreciate, on average, as deficits rise, which magnifies the original inflation response to increases in the deficit. We further document non-linearities between fiscal deficits and exchange rates, with higher



(a) Emerging market and developing economies (b) Advanced economies

Figure 1: **The effects of higher deficits on the inflation forecast distribution are greater in EMDEs.** This figure shows the conditional forecast distribution of the inflation rate over the next year. The grey shaded density shows the conditional distribution evaluated at the sample means of all variables. The red density shows the conditional distribution evaluated at a two standard deviation increase in the change in the fiscal deficit, with other control variables at their means. The left-hand panel shows the conditional distributions of inflation estimated with the sample of emerging and developing economies. The right-hand panel shows the conditional distributions of inflation with the sample of advanced economies.

deficits increasing the risk of large EMDE currency depreciations. We also show that measures of sovereign risk deteriorate as deficits rise, which is consistent with the observed currency depreciations.

Third, in line with the mechanisms of "original sin" and "original sin redux", we find that higher deficits are followed by exchange rate depreciation and higher inflation when the share of sovereign debt in foreign currency is large or when a sizeable share of debt is held by foreign residents.

Fourth, we show that frameworks and constraints on monetary policy matter strongly for the deficit-inflation link and the associated non-linearities. We find that the effect of higher deficits on inflation is considerably weakened in inflation targeting regimes. We show that, under such regimes, the effects of rising deficits on the exchange rate are also attenuated, which weakens the external channel that we document for EMDEs. Interestingly, in inflation targeting EMDEs, we find the textbook effect of appreciating exchange rates in response to an increase in fiscal deficits. Moreover, monetary policy constraints faced by open economies have meaningful effects on the relationship between fiscal deficits and inflation. In particular, greater exchange rate stability and capital account openness are both associated with a weaker deficit-inflation link.

Our paper is related to various strands of literature. A number of papers have examined how fiscal deficits affect inflation (e.g. Catao and Terrones (2005); Lin and Chu (2013); Fischer et al. (2002); Bordo and Levy (2021)). One finding from this literature is that the effects of deficits are stronger in economies where inflation is high. We add to this literature by examining how monetary policy regimes in EMDEs and the structure of EMDE debt influence the effect of fiscal deficits on the entire forecast distribution of inflation.

We also add to the literature that analyses how changes in fiscal policy affect exchange rates. Some of the papers empirically examine the effects of fiscal policy on real exchange rates in advanced economies (e.g. Monacelli and Perotti (2010); Kim and Roubini (2008); Benetrix and Lane (2013)), while Ilzetzki et al. (2013) study the effects on real exchange rates in both advanced and developing economies. Alberola-Ila et al. (2021) show in a theoretical model that the effects of monetary and fiscal policies on exchange rates depend on whether the fiscal regime is Ricardian and present evidence for Brazil that support the model's predictions. We contribute to this research in two ways. First, we highlight important differences in the exchange rate effects between economies with different degrees of macro-financial vulnerabilities, such as foreign holdings of sovereign debt or the share of debt in foreign currency. Second, we examine the effects of fiscal deficits on the entire distribution of exchange rate changes, which has to our knowledge not been examined in previous literature.

Our paper is also related to studies that examine whether the monetary policy regime of inflation targeting influences inflation outcomes and expectations (e.g. Ball and Sheridan (2004); Lin and Ye (2007); Gürkaynak et al. (2010)). While the findings in the literature are notably mixed, some papers highlight important effects in emerging market economies

(Duncan et al. (2022); Banerjee et al. (2020)). We contribute to this literature by highlighting how inflation targeting in EMDEs helps mitigate both inflation and exchange rate risks stemming from higher fiscal deficits.

Finally, our paper adds to research that has highlighted non-linearities in the Phillips curve. A strand of literature shows how the effects of some factors vary across the conditional inflation forecast distribution (e.g. López-Salido and Loria (2020); Busetti et al. (2021); Banerjee et al. (2020)). We contribute to this literature by focusing on the non-linear effects of fiscal deficits on the inflation forecast distribution, and by examining how monetary policy frameworks interact with fiscal deficits to affect such non-linearities.

The rest of the paper is structured as follows. The next section describes the methodology and the data sources. Section 3 presents the baseline empirical results, followed by robustness tests in Section 4. Section 5 examines the importance of sovereign risk, the composition of sovereign debt and FX reserves. Section 6 investigates the importance of the monetary policy framework. Section 7 concludes.

2 Methodology and data

Our baseline specification to evaluate the effects of deficits on future inflation is as follows:

$$\pi_{it+1} = a_i + X'_{it}\beta + \epsilon_{it}, \tag{1}$$

where the dependent variable π_{it+1} is one-year-ahead inflation in country i. The vector of explanatory variables is:

$$X'_{it} = (\Delta def_{it}, \pi_{it}, \Delta y_{it}, \Delta exc_{it}, \Delta oil_{it}, SovereignCrisis_{it}), \tag{2}$$

where Δdef_{it} is the year-on-year change in headline fiscal deficit as a percentage of GDP;

π_{it} is the current level of headline inflation; Δy_{it} denotes the year-on-year change in real GDP; Δexc_{it} is the change in the bilateral exchange rate against the US dollar; Δoil_{it} denotes the change in oil prices denominated in local currency; and $SovereignCrisis_{it}$ is a dummy variable that captures the occurrence of sovereign debt crisis in year t. $\Delta y_{it}, \Delta exc_{it}$, and Δoil_{it} are changes in natural logarithm of the respective variables and are multiplied by 100.

In order to examine the possibility that changes in fiscal deficits lead to greater tail risks to inflation, we use novel methods for panel quantile regressions with fixed effects (see Machado and Santos Silva (2019)). We estimate the conditional quantiles of future headline inflation using a location-scale model, written as:

$$\pi_{it+1} = a_i + X'_{it}\beta + (\delta_i + X'_{it}\gamma)U_{it}, \tag{3}$$

where π_{it+1} and X'_{it} are defined as above. In this model, the size of the coefficients is allowed to vary according to the dependent variable's placement in the conditional inflation distribution. These non-linearities are driven by the scaling of the error term U, by a vector of constants γ. In Equation (3), the parameters $(\alpha_i, \delta_i), i = 1, \ldots, n$ denote the individual i fixed effects. From Equation (3), we have $\Pr[\delta_i + X'_{it}\gamma > 0] = 1$. We assume that the sequence $\{X_{it}\}$ is strictly exogenous, *i.i.d.* for any fixed i and independent across i.[2] U_{it} are unobserved random variables, *i.i.d.* across countries i and years t, orthogonal to X_{it} and normalised to satisfy $E[U] = 0$ and $E[|U|] = 1$. We obtain the conditional quantiles for one-year-ahead average inflation using:

$$Q_\pi(\tau|X_{it}) = (\alpha_i + \delta_i q(\tau)) + X'_{it}\beta + X'_{it}\gamma q(\tau). \tag{4}$$

[2]In Appendix B we conduct simulation exercises to assess the sensitivity of our estimates to deviations from these key assumptions. We find that such deviations lead our quantile estimates to underestimate the degree of non-linearities present in the data generating process.

In (4), the scalar $\alpha_i(\tau) = \alpha_i + \delta_i q(\tau)$ is the quantile-τ fixed effect for economy i. $\alpha_t(\tau)$ captures the time-invariant effect of individual country characteristics that potentially vary depending on where the country lies in the conditional inflation distribution. We estimate the coefficients for 5 quantiles: 5%, 25%, 50%, 75% and 95%. We estimate the confidence intervals by using a block bootstrap with 1,000 replications, clustering by country.

For a given country and year, each predicted quantile from Equation (4) represents a point in the CDF $F(\cdot)$ of the one-year-ahead inflation forecast. To address noise in our quantile estimates, following Adrian et al. (2019), we interpolate semiparametrically the predicted quantiles using the skewed $t-$distribution (see Azzalini and Capitanio (2003)). The distribution is described by the following function:

$$f(\pi;\mu,\sigma,\alpha,\nu) = \frac{2}{\sigma} t\Big(\frac{\pi-\mu}{\sigma;\nu}\Big) T\left(\alpha\frac{\mu-\pi}{\sigma}\sqrt{\frac{\nu+1}{\nu+\frac{(\pi-\mu)^2}{\sigma}}};\nu+1\right). \tag{5}$$

In Equation (5), $t(\cdot)$ and $T(\cdot)$ are the PDF and the CDF of the distribution, respectively. The distributional parameters μ (location), σ (scale), ν (kurtosis), and α (skewness) are estimated for each country-year pair by minimising the mean squared error between the five predicted quantiles and the distribution-implied values. In other words, we select parameter estimates that minimise the following objective function:

$$(\hat{\mu}_{it+h}, \hat{\sigma}_{it+h}, \hat{\alpha}_{it+h}, \hat{\nu}_{it+h}) = \text{argmin} \sum_{\tau} \big(\hat{Q}_{\pi_{t+h|x_t}}(\tau|x_t) - F^{-1}\big(\tau;\mu,\sigma,\alpha,\nu\big)\big)^2. \tag{6}$$

Beyond estimating the effect of changes in fiscal deficits on inflation, to investigate the transmission through the external channel we also use quantile regressions to investigate the effects of fiscal deficits on the exchange rate distribution. In this case we re-estimate Equation (1) but set the left-hand side variable to be the one-year-ahead change in the log exchange rate, Δexc_{it+1}, where an increase denotes a depreciation of the domestic currency against the US dollar. In these specifications, we include as additional explanatory variables the US Federal funds rate, i_{it}^{US}, and US equity return volatility as a proxy for global investor risk aversion, $EqVol_{it}^{US}$.

Finally, to shed light on the influence of deficits on sovereign risk, we also estimate linear models with fixed effects to analyse the effects of fiscal deficits on CDS spreads, $CDSspread_{it+1}$, and on the foreign currency long-term sovereign debt rating, $SovRating_{it+1}$. In addition we use linear models to assess how interactions between fiscal deficits and various macro-financial characteristics, such as the share of FX debt, affect the exchange rate.

Our dataset covers 26 emerging and developing economies from 1960 to 2019 at an annual frequency.[3] For many EMDEs, the time series are shorter due to data availability. In order to exclude extreme outliers, we omit country-year observations where current inflation and one-year-ahead inflation rates exceed 600%. We also winsorise the log change in the exchange rate at the 5% level.

Data for fiscal balances, interest payments and government debt are from Mauro et al. (2015) and have been extended forward to 2019 using data from IMF Fiscal Monitor. Real GDP and inflation are from national sources and the exchange rates are from the BIS. The oil price is that of West Texas Intermediate (WTI), transformed from US dollars into local currency. The years for sovereign debt crises are from Laeven and Valencia (2020).

Data on 5-year sovereign CDS spreads, the foreign currency long-term sovereign debt rating and general government debt held by non-residents, are from Kose et al. (2017). For government debt in foreign currency, we use BIS data on the share of total general

[3]The economies included are Bolivia, Brazil, Chile, China, Colombia, Dominican Republic, Ghana, Hong Kong SAR, Honduras, Haiti, Hungary, Indonesia, Israel, India, Korea, Mexico, Nicaragua, Peru, Philippines, Poland, Romania, Russia, Thailand, Turkey, Uruguay and South Africa. As a comparison group for some of the estimated models, we consider 22 advanced economies: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and the United States.

government debt securities that is denominated in foreign currency.[4] These indicators are generally available for much shorter time periods than the baseline series mentioned above.

3 Empirical evidence

3.1 Baseline model

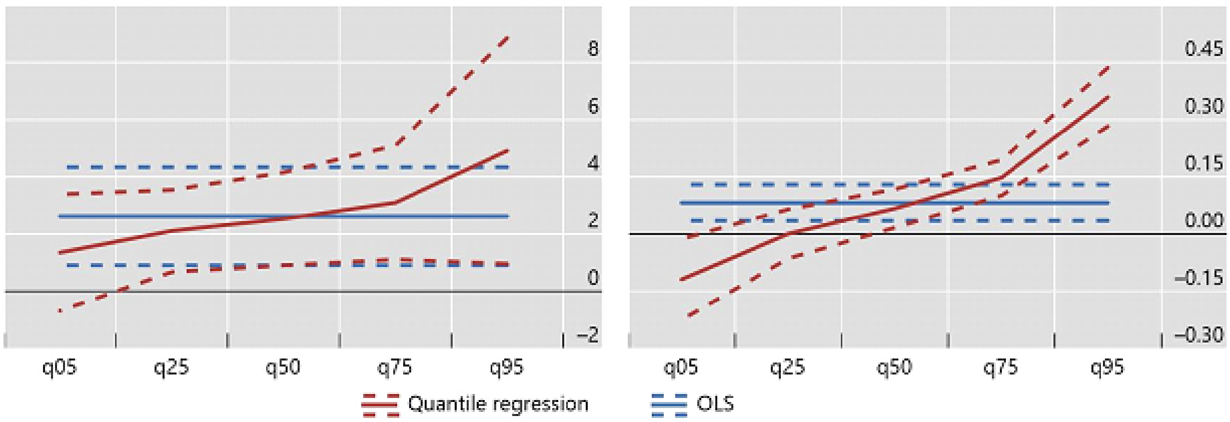
In this section, we show that fiscal deficits have strong effects on inflation in EMDEs. Using the "inflation at risk" framework of Banerjee et al. (2020), we highlight that these effects are highly non-linear and that they are much larger than those for advanced economies. We then analyse in detail how the exchange rate channel magnifies the initial effect on inflation in EMDEs.

Our baseline estimates of the effect of fiscal deficits on inflation in EMDEs, estimated with the quantile fixed effect model (Equation (4)), are shown in Table 1 and in the left-hand panel of Figure 2. On average, a one percentage point increase in the deficit is associated with a 2.5 percentage point rise in inflation one year down the road in EMDEs. The upward slope of the red line in Figure 2 shows that an increase in fiscal deficits has larger effects on the right tail of the inflation forecast distribution compared to the left tail. At the right tail, i.e. the 95th percentile, the effect is 4.9 percentage points. By contrast, at the left tail, i.e. the 5th percentile, the effect is not statistically significant at the 90% level.[5] Thus, an increase in fiscal deficits is associated with higher inflation and an especially large shift in the right-hand tail of the inflation forecast distribution, as shown in the left-hand panel of Figure 1. The underlying monetary policy is a key factor for the observed non-linearities, as we show later in Section 6.

To benchmark the EMDE fiscal-deficit inflation relationship, we present in the right-

[4] See https://www.bis.org/statistics/secstats.htm?m=6_33_615

[5] In the baseline sample, annual CPI inflation rates at the 5th, 25th, 50th, 75th and 95th percentiles are 0.8%, 3.6%, 6.7%, 14.6% and 63.4% respectively.



(a) Emerging market and developing economies

(b) Advanced economies

Figure 2: **Quantile regression estimates of fiscal deficits on inflation.** This figure shows the estimated coefficients in quantile regressions of inflation rate over the next year $t+1$ on changes in the fiscal deficit-to-GDP ratio in year t. Coefficients are shown by the q% quantile (x-axis); e.g. q50 denotes the 50% quantile. The left-hand panel shows coefficients estimated in the sample of emerging and developing economies while the right-hand panel shows the coefficients estimated in the sample of advanced economies. Quantile estimates are shown with 90% confidence bands using a block bootstrap clustered by country. OLS estimates are shown with 90% confidence bands clustered by country.

hand panel of Figure 2 the estimation results for advanced economies over the same sample period. A comparison of the two panels shows that the effects on inflation are considerably stronger in EMDEs than in advanced economies. For example, for EMDEs a one percentage point increase in the fiscal deficit is associated with a 2.5 percentage point increase in inflation one year later (at the median of the distribution), while for advanced economies, the same sized increase in the fiscal deficit only raises inflation by less than 0.1 percentage points (see also Appendix Table A.1). The non-linearity in the effect of fiscal deficits on inflation is also much stronger in EMDEs.

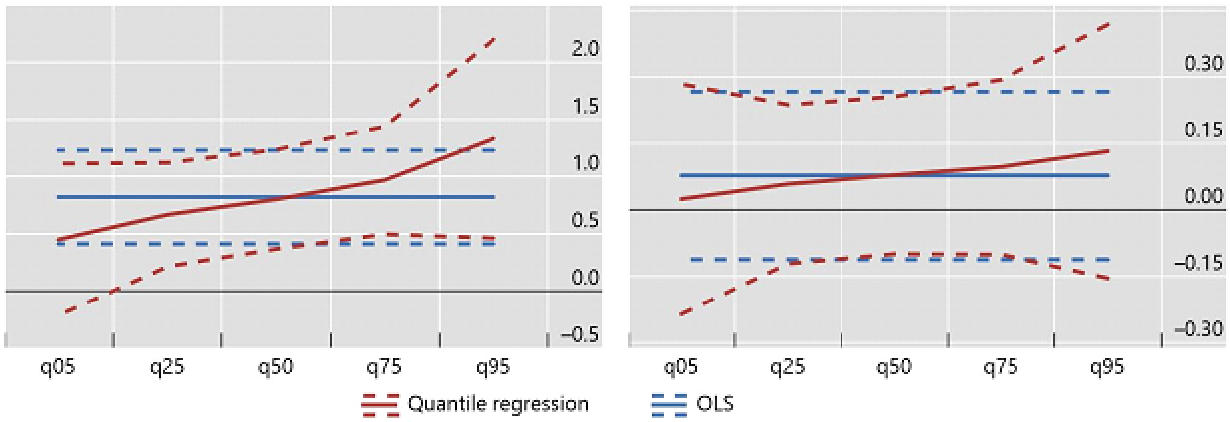
Beyond the influence of fiscal deficits, our results confirm the usual open economy Phillips curve relationships and show important non-linearities in the inflation forecast distribution (Table 1). Higher current inflation predicts higher future inflation. It especially increases the probability of high future inflation outcomes, as the coefficients are larger at the 75th and 95th percentiles of the inflation forecast distribution, compared with the 5th and 25th percentiles. Similarly, stronger real GDP growth is associated with higher subsequent inflation. Moreover, the effects of stronger growth are particularly large on the right tail of the inflation forecast distribution compared with the left tail. Although we do not find a statistically significant relationship between changes in oil prices and subsequent inflation, the coefficient on oil prices remains relatively constant across the inflation forecast distribution, suggesting that oil prices are not associated with strong non-linearities with respect to future inflation. The occurrence of a sovereign debt crisis raises subsequent inflation and has a larger effect on the right tail of the inflation forecast distribution.[6] Finally, the coefficient on the exchange rate is highly significant at the 25%, 50% and 75% quantiles, and economically large across the distribution; it is also larger in the higher quantiles. These results suggest an important role for the external channel in the EMDE fiscal deficit-inflation relationship which we explore next.[7]

	5%	25%	50%	75%	95%
Inflation forecast quantiles	π_{t+1}	π_{t+1}	π_{t+1}	π_{t+1}	π_{t+1}
Δdef_{it}	1.353	2.110**	2.531**	3.103**	4.911**
	(1.239)	(0.872)	(0.988)	(1.211)	(2.402)
π_{it}	0.0891	0.422***	0.606***	0.858***	1.652***
	(0.296)	(0.0986)	(0.0989)	(0.148)	(0.539)
Δy_{it}	0.142	0.688**	0.991***	1.405**	2.708
	(0.849)	(0.301)	(0.343)	(0.576)	(1.855)
Δexc_{it}	0.116	0.197**	0.242***	0.303**	0.497
	(0.214)	(0.0940)	(0.0906)	(0.139)	(0.438)
Δoil_{it}	0.0494	0.0468	0.0454	0.0435	0.0373
	(0.0416)	(0.0288)	(0.0282)	(0.0347)	(0.0729)
$SovereignCrisis_{it}$	10.23	14.61**	17.05***	20.37***	30.85*
	(9.298)	(6.216)	(6.279)	(7.674)	(16.78)
Observations	1,080	1,080	1,080	1,080	1,080

Table 1: **Quantile regression estimates of inflation risk in the sample of EMDEs.** This table shows the estimated coefficients in quantile regressions of the inflation rate over the next year π_{t+1}, on changes in the fiscal deficit-to-GDP ratio in year t, Δdef_{it}, annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, and log change in the local price of oil, Δoil_{it}. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

[6] The crisis date is the year of sovereign default to private creditors and/or restructuring.

[7] Table A.1 in the Appendix shows corresponding evidence for advanced economies. In addition to the weaker effect of deficits on inflation, the coefficients on output growth and the exchange rate are also much smaller than in EMDEs.



(a) Emerging market and developing economies

(b) Advanced economies

Figure 3: **Exchange rate channel: quantile regression coefficients of one-year-ahead change in the exchange rate regressed on changes in the fiscal deficit.** This figure shows the estimated coefficients in quantile regressions of the log change in the exchange rate between year t and $t+1$ on changes in the fiscal deficit-to-GDP ratio in year t. Coefficients are shown by the qth percentile (x-axis); e.g. q50 denotes the 50th percentile. The left-hand panel shows coefficients estimated in the sample of emerging and developing economies while the right-hand panel shows the coefficients estimated in the sample of advanced economies. Quantile estimates are shown with 90% confidence bands using a block bootstrap clustered by country. OLS estimates are shown with 90% confidence bands clustered by country.

3.2 The exchange rate channel

Above we showed that exchange rate depreciations in EMDEs feed through into higher inflation. We now examine the effect that fiscal deficits have on exchange rates in these economies which then magnifies the initial inflation response.

To do so we consider a model of "exchange rate at risk". Figure 3 shows the coefficient on the change in deficits from a quantile regression where the dependent variable is the one-year-ahead change in the bilateral exchange rate against the US dollar (and where higher positive values imply a larger exchange rate depreciation).

The left-hand panel of Figure 3 shows that in EMDEs, a one percentage point increase in the fiscal deficit is associated with a 0.8% exchange rate depreciation on average (OLS and 50th percentile estimates).

Moreover, and similarly to the non-linearity associated with inflation, an increase in fiscal deficits is found to have larger effects at the right tail of the EMDE exchange rate

Exchange rate forecast quantiles	5% Δexc_{it+1}	25% Δexc_{it+1}	50% Δexc_{it+1}	75% Δexc_{it+1}	95% Δexc_{it+1}
Δdef_{it}	0.450	0.668**	0.801***	0.969***	1.331**
	(0.409)	(0.280)	(0.256)	(0.291)	(0.521)
π_{it}	0.113*	0.113***	0.113***	0.113***	0.114**
	(0.0604)	(0.0423)	(0.0330)	(0.0293)	(0.0453)
Δexc_{it}	0.115	0.270***	0.365***	0.484***	0.742***
	(0.0830)	(0.0567)	(0.0512)	(0.0564)	(0.102)
Δy_{it}	0.514**	0.294*	0.160	-0.00921	-0.375
	(0.256)	(0.177)	(0.179)	(0.237)	(0.433)
Δoil_{it}	0.00404	0.00157	6.76e-05	-0.00183	-0.00592
	(0.0201)	(0.0124)	(0.0117)	(0.0167)	(0.0329)
$SovereignCrisis_{it}$	9.861	6.142	3.877	1.019	-5.158
	(6.480)	(4.579)	(4.404)	(5.586)	(10.44)
i_t^{US}	0.353*	0.605***	0.759***	0.953***	1.372***
	(0.188)	(0.134)	(0.147)	(0.192)	(0.354)
$EqVol_t^{US}$	-1.496	-0.250	0.508	1.466**	3.535**
	(0.934)	(0.454)	(0.383)	(0.700)	(1.712)
Observations	1,079	1,079	1,079	1,079	1,079

Table 2: **Quantile regression estimates of exchange rate risk in the sample of EMDEs.** This table shows the estimated coefficients in quantile regressions of log changes in the exchange rate between year t and $t+1$, on changes in the fiscal deficit-to-GDP ratio in year t, Δdef_{it}, annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, and log change in the local price of oil, Δoil_{it} and a dummy variable taking the value of one in sovereign crisis years. We also include the level of interest rates in the United States i_t^{US} and realised equity volatility of the S&P 500 $EqVol_t^{US}$ to control for the influence of global financial conditions. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

distribution (Figure 3, red line in the left panel). In other words, higher deficits raise the risk of larger exchange rate depreciations. An increase in fiscal deficits by one percentage point is associated with a 1.3% depreciation at the right tail of the distribution. At the left tail the estimated effect is around 0.45% and it is statistically insignificant.

By contrast, higher deficits in AEs are not associated with subsequent exchange rate depreciations (Figure 3, right-hand panel). In addition to being statistically insignificant, the point estimates are also economically small. Further, in AEs, non-linearity between deficits and the exchange rate across the forecast distribution is almost non-existent.

For EMDEs, non-linearities in the forecast distribution of exchange rates are also present in a number of other explanatory variables (see Table 2). A larger exchange rate depreciation in the current year raises the probability of greater future exchange rate depreciations. Moreover, an increase in the Fed funds rate increases the likelihood of larger EMDE exchange rate depreciations, with a 100 basis points increase associated with a 1.4% depreciation at the 95% quantile. The effect of US interest rates on EMDE exchange rate distributions appears to be much stronger than for AE currencies (see Table A.2 in the Appendix).[8] In summary, our results show that in EMDEs, currencies depreciate strongly in response to increases in fiscal deficits. Given the significant coefficient on exchange rates in the inflation-at-risk model (Table 1), this external channel is likely to magnify the inflation response to higher deficits.

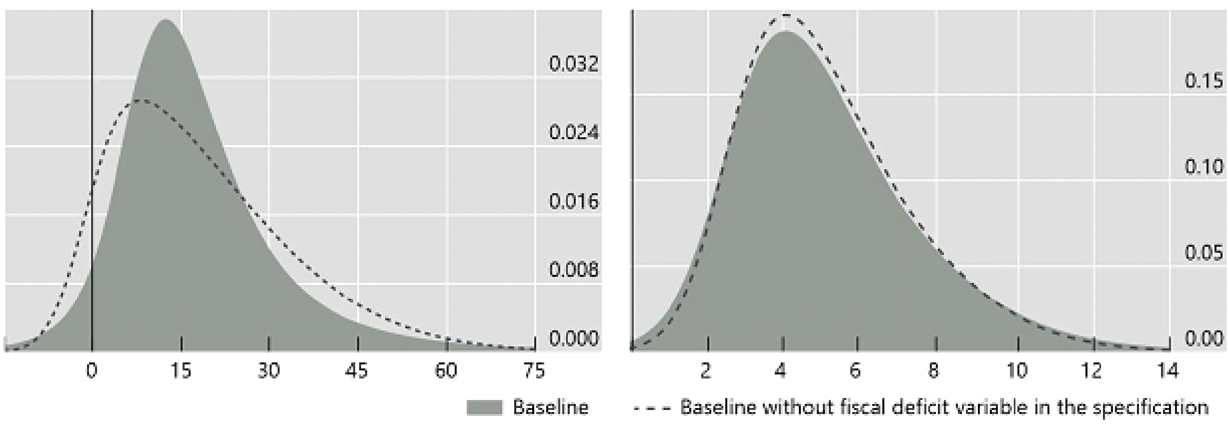
4 Robustness

In this section, we consider a number of robustness tests with respect to our baseline specification. We make changes to the model specification, highlighting the importance of including fiscal deficits when considering EMDE inflation risks. We also analyse if fiscal deficits affect inflation risks at longer horizons. Furthermore, we test if our results are sensitive to using fiscal shocks instead of changes to the fiscal deficit when estimating the effects of fiscal policy on inflation. Finally, we analyse differences across countries by income level and by region, and based on whether countries are commodity importers or exporters.

[8] Alternatively, the interest rate differential between US and domestic monetary policy rates could be included in the regression. However, in our sample of EMDEs, domestic policy rates are not available for a large part of the early sample. Using a shorter sample with available data - excluding close to 30% of country-year observations - yields a statistically insignificant coefficient on the interest rate differential that is close to zero at all quantiles of the exchange rate distribution.

4.1 Model specification

We examine the effects of some changes to the model specification. First, we estimate the baseline model without fiscal deficit and examine the resulting density functions. Not surprisingly, the differences are greater in the case of emerging market and developing economies than for AEs (see Figure 4). For EMDEs, excluding fiscal deficits from the model results in more downside inflation risk, with the density function covering more deflationary outcomes. For AEs, the differences are minor.



(a) Emerging market and developing economies

(b) Advanced economies

Figure 4: **Inflation forecast density functions with and without fiscal deficit controls.** This figure shows the conditional forecast distribution of the inflation rate over the next year. The grey shaded density shows the conditional distribution evaluated at the sample means of all variables in our baseline specification including changes in the fiscal deficit. The blue dotted density shows the conditional distribution derived from a model which excludes fiscal deficits. The left-hand panel shows the conditional distributions of inflation estimated with the sample of emerging market and developing economies. The right-hand panel shows the conditional distributions of inflation with the sample of advanced economies.

4.2 Inflation horizon

While the baseline results suggest that deficits raise future inflation and upside inflation risks in the near term, a question arises as to what extent medium-term inflation risks are affected. To investigate this, we estimate the inflation risk model with the annualised inflation rate over the next three years as the dependent variable. This better captures the inflationary effects of deficits over a longer horizon.

The results, reported in Appendix Table A.3, show that the relationship between fiscal deficits and EMDE inflation is statistically and economically significant even when average inflation over the next three years is considered. However, there is now less nonlinearity between deficits and future inflation, and the coefficient estimates tend to be lower across the forecast distribution. This is probably not surprising, given that policy has more time to respond to medium-term inflation risks resulting from higher deficits. Importantly, the exchange rate pass-through remains economically sizeable and highly statistically significant when inflation over the next three years is considered, in all quantiles except the 5% quantile. This finding confirms the relevance of the exchange rate channel for inflation.

4.3 Fiscal shocks

Next, in the model we replace the change in fiscal deficit with a measure of fiscal shocks. As deficits could be correlated with and be partly endogenous to some other explanatory variables, in particular GDP growth, we replace fiscal deficits by a more exogenous measure. To do so, we first estimate a fiscal rule that links primary deficits to lagged primary deficits, the lagged level of government debt and the output gap in our panel of EMDEs. We then use the residual from this regression as an exogenous measure of fiscal expansion. This approach follows that of Corsetti et al. (2012) who identify fiscal shocks as residuals from an estimated spending rule.

Inflation forecast quantiles	5% π_{t+1}	25% π_{t+1}	50% π_{t+1}	75% π_{t+1}	95% π_{t+1}
$FiscalShock_{it}$	-0.959	1.025	1.726**	2.723***	7.113**
	(2.189)	(0.654)	(0.730)	(0.965)	(3.176)
π_{it}	-0.252	0.383***	0.608***	0.928***	2.335***
	(0.442)	(0.113)	(0.123)	(0.199)	(0.778)
Δy_{it}	-0.562	0.522	0.905**	1.449**	3.848*
	(1.274)	(0.347)	(0.387)	(0.599)	(2.077)
Δexc_{it}	0.262	0.247**	0.241**	0.234**	0.201
	(0.340)	(0.120)	(0.0943)	(0.119)	(0.503)
Δoil_{it}	0.0321	0.0465	0.0516*	0.0589*	0.0909
	(0.0532)	(0.0293)	(0.0281)	(0.0345)	(0.0817)
$SovereignCrisis_{it}$	4.298	13.62*	16.91***	21.59***	42.21**
	(14.13)	(7.091)	(6.138)	(6.168)	(16.39)
Observations	1,057	1,057	1,057	1,057	1,057

Table 3: **Quantile regression estimates of inflation risk with fiscal shocks.** This table shows the estimated coefficients in quantile regressions of the inflation rate over the next year π_{t+1}, on fiscal shocks $FiscalShock_{it}$, annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, and log change in the local price of oil, Δoil_{it}. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

The results with a measure of fiscal shocks are highly similar to the baseline model (Table 3). Fiscal shocks display identical non-linearities with respect to future inflation as fiscal deficits, with much larger effects at the right tail of the inflation forecast distribution. The same non-linearity is also observed for current inflation and real GDP growth, respectively. One difference from the baseline results is that the coefficient on fiscal shocks at the left tail is negative (although it is not statistically different from zero).

4.4 Country composition

We then consider various changes to the country composition of the panel. As the first test, we investigate whether the results are robust to the exclusion of lower income economies from the sample. Such economies may face more volatility, including in inflation, as well as more persistent shocks. Using the GDP per capita (USD) in 2019 from the IMF WEO, we exclude economies in the lowest quantile of the income distribution: Haiti, Nicaragua, Ghana, Honduras, India and Bolivia. Appendix Table A.4 shows that our results do not hinge on the inclusion of the lower income countries in the sample. By contrast, the coefficient estimates are highly comparable (and even somewhat higher) in the smaller sample that excludes these economies.

Next, we analyse differences across two major EME regions, Asia and Latin America. Whereas previous literature has highlighted the contribution of fiscal and monetary policies to elevated inflation in Latin America (see e.g. Kehoe and Nicolini (2021)), inflation has generally been lower in emerging Asia. Such differences are also highlighted in our data. The median fiscal deficit over the sample period has been 75% higher and the median increase in fiscal deficits some 40% higher in Latin America than in emerging Asia. But perhaps even more important differences are found for the effects of fiscal deficits on inflation. As shown in Tables A.5 and A.6 in the Appendix, the effects for Latin American countries are similar to the ones obtained for the entire sample, whereas those for emerging Asia are economically very small and not statistically different from zero.

4.5 Commodity importers vs exporters

In addition to varying by regions, the dynamics between the variables could be different for commodity exporters and importers. We examine whether the effect of oil prices on future inflation risks differs between commodity export-dependent economies and other countries in the sample, using the classification in UNCTAD (2021). In the latter, a country is classified as commodity-export dependent when more than 60% of its merchandise exports are comprised of commodities. We further require the economy to be classified as commodity-export dependent in both 2008-9 and 2018-9, and then interact the commodity-export dependent/not-dependent dummy variable with the oil price change. While the statistical significance of the oil price change remains weak in these estimations, similarly to the baseline regression, the higher positive coefficient for countries that do not rely on commodity exports is consistent with the evidence in Alekhina and Yoshino (2018) (see Table A.7 in the Appendix). Thus, higher oil prices increase future inflation especially in countries that are not major exporters of commodities.

5 The sovereign risk channel

In this section, we examine the role of the sovereign risk channel in magnifying the initial inflation response to higher deficits. In textbook models, a fiscal expansion is generally expected to lead to exchange rate appreciation (e.g. Auerbach and Gorodnichenko (2016)). However, and perhaps more prominently in EMDEs, fiscal expansion could lead to a loss of confidence by economic agents and a rise in country risk, depreciating the exchange rate, especially if a country is perceived to have little or no fiscal space (e.g. Ghosh et al. (2013)).

The first column of Table 4 shows that, on average in our EMDE sample, an increase in fiscal deficits is associated with an exchange rate depreciation, confirming the results in Section 3.2. The point estimate suggests a 0.8% depreciation, after one year, in response to a one percentage point increase in fiscal deficits. This corresponds to a 1.7% depreciation associated with a one standard deviation increase in deficits (2.1 percentage points).

Furthermore, the second column in Table 4 shows that as fiscal deficits increase, EMDE sovereign risk as measured by the sovereign CDS spread, rises. A one percentage point increase in fiscal deficits is associated with around 25 basis points increase in the 5-year sovereign CDS spread, although the relationship is only statistically significant at the 10% level.

Moreover, the rating of the country's sovereign foreign currency debt deteriorates as fiscal deficits rise (third column), with the effect being significant at the 5% level. In the regression, the sovereign rating is converted to a numeric scale where higher values indicate lower ratings, with a one-notch deterioration corresponding to an increase in the index by around 0.05 units. Thus, the coefficient estimate suggests that a one percentage point increase in deficits is associated with a deterioration in the country's sovereign foreign currency debt rating by around 1.5 notches.

Regarding the coefficients on the other control variables, we note that higher policy rates in the United States result in EME exchange rate depreciations (Column 1) and higher CDS spreads (Column 2), with both effects statistically significant at the 5% level.

5.1 Sovereign debt structure

Given the importance of the exchange rate channel coupled with the high exchange rate pass-through to inflation in EMDEs (e.g. Ha et al. (2019)), this section further analyses the relationship between fiscal deficits and exchange rates. It examines how the structure of sovereign debt - an important factor in determining sovereign risk - affects the fiscal deficit-exchange rate-inflation link.

Table 5 shows the outcomes from linear fixed effect regressions where deficits are interacted with a dummy variable, D_{it}, based on different dimensions of sovereign debt vulnerabilities. As an example, in the first column, D_{it} obtains a value of one if the share of foreign currency denominated debt in total sovereign debt securities is above the sample median; the second column does the same for the share of foreign holdings of sovereign debt, and so on. An important caveat in these exercises is that the sample size is significantly smaller than in the baseline models due to more limited data availability.

The first column of Table 5 shows that an increase in fiscal deficits leads to an EMDE currency depreciation when the share of sovereign debt securities denominated in foreign currency is above the sample median (17.3%). In this case, a one percentage point increase in deficits is associated with a 1.1% exchange rate depreciation. Notably, when FX debt is below the sample median, an increase in deficits has no statistically significant effect on

VARIABLES	(1) Exc rate$_{t+1}$	(2) CDS spread$_{t+1}$	(3) Sov rating$_{t+1}$
Δdef_{it}	0.821***	24.48*	0.0752**
	(0.248)	(12.75)	(0.0296)
π_{it}	0.113***	-28.35	-0.00892
	(0.0291)	(19.81)	(0.00909)
$\Delta CDSspread_{it}$		0.107	
		(0.0963)	
Δy_{it}	0.140	-7.369	-0.0446
	(0.190)	(6.959)	(0.0284)
Δexc_{it}	0.379***	-3.499**	0.00979
	(0.0479)	(1.439)	(0.0111)
Δoil_{it}	-0.000157	0.379	0.000634
	(0.0129)	(0.338)	(0.00179)
$SovereignCrisis_{it}$	3.539	479.9*	6.418***
	(4.369)	(254.7)	(1.962)
i_t^{US}	0.782***	35.27**	0.00722
	(0.148)	(12.45)	(0.0140)
$EqVol_t^{US}$	0.622	35.05	-0.101
	(0.402)	(45.71)	(0.0761)
$\Delta SovRating_{it}$			0.0359
			(0.0458)
Observations	1,079	337	599
R-squared	0.442	0.449	0.302
Number of countryid	26	20	25

Table 4: **Increases in fiscal deficits result in weaker exchange rates and increase country risk.** This table shows the estimated coefficients from OLS regressions of the log change in the nominal exchange rate (column (1)), the sovereign CDS spread (column (2)) and the sovereign rating (column (3)) in $t+1$ regressed on changes in the fiscal deficit-to-GDP ratio in year t, Δdef_{it}, annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, log change in the local price of oil, Δoil_{it}, a dummy variable taking on the value 1 in sovereign crisis years $SovereignCrisis_{it}$, change in the sovereign CDS spread $\Delta CDSspread_{it}$, and the change in the sovereign rating $\Delta SovRating_{it}$. The sovereign rating is converted to a numeric scale where higher values indicate lower ratings. For the external variables we also include the level of interest rates in the United States i_t^{US} and realised equity volatility of the S&P 500 $EqVol_t^{US}$ to control for the influence of global financial conditions. Estimated regressions include country fixed effects. Robust standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

the exchange rate.

Similar results obtain for foreign holdings of EMDE sovereign debt, shown in the second column of Table 5. In this case, when the share of sovereign debt held by foreign residents is above the sample median (35.7%), a one percentage point increase in deficits leads to around 0.4% exchange rate depreciation (-0.77%+1.16%*1=0.39%). By contrast, with a below-median share of foreign holdings, an increase in deficits is met with exchange rate appreciation in the following year, in line with a textbook model.

By contrast, the size of the overall government debt stock as share of GDP (regardless of currency) appears to play little role. In particular, as shown in the third column, there is no statistically significant interaction between total public debt and the change in deficit.[9]

When we split the sample instead by the ratio of interest payments to GDP[10], we find evidence that an increase in deficits is associated with future depreciations in countries with higher interest burdens. In particular, a one percentage point increase in deficits is associated with a 1.1% depreciation (Column 4).

One interpretation of the results in Table 5 is that greater concern about the fiscal health of the sovereign is more likely to lead to exchange rate depreciation when a larger share of debt is denominated in foreign currency, and when a larger share of debt is held by non-residents.

The fact that both the share of FX debt and the share of foreign holdings matter for the exchange rate effects of deficits raises the question of whether and to what extent they also matter for the inflation outcomes. To investigate the issue, we estimate the original inflation-at-risk model with the interaction variables for FX debt and non-resident holdings, respectively. The results are shown in Tables 6 and 7.

We find that in economies with above-median FX share of government debt (Table 6),

[9]This finding is robust to an alternative construction of the dummy variable, splitting the sample based on the median level of public debt for each year. This approach takes into account the gradual increase in EMDE debt ratios over time.

[10]Defined as the difference between the primary balance and the headline balance.

	FX share	Nonres holding	Total govt debt	Int pay to GDP
	Δexc_{it+1}	Δexc_{it+1}	Δexc_{it+1}	Δexc_{it+1}
Δdef_{it}	-0.317	-0.771**	0.235	0.214
	(0.255)	(0.353)	(0.424)	(0.320)
$\Delta def_{it} * D_{it}$	1.104***	1.164**	0.951	1.137**
	(0.331)	(0.501)	(0.645)	(0.459)
D_{it}	0.699	-2.140	-1.159	-0.173
	(1.034)	(1.926)	(1.011)	(0.977)
π_{it}	-0.0870	0.0461	0.113***	0.118***
	(0.248)	(0.262)	(0.0280)	(0.0277)
Δexc_{it}	0.237***	0.307***	0.381***	0.374***
	(0.0506)	(0.0537)	(0.0453)	(0.0451)
Δy_{it}	0.165	-0.0684	0.104	0.129
	(0.140)	(0.116)	(0.192)	(0.196)
Δoil_{it}	0.0516**	0.0685***	-0.000634	-0.00109
	(0.0202)	(0.0217)	(0.0129)	(0.0129)
i_t^{US}	0.241	-0.759***	0.765***	0.779***
	(0.283)	(0.230)	(0.152)	(0.151)
$Eqvol_t^{US}$	1.316	1.600*	0.617	0.575
	(1.107)	(0.919)	(0.421)	(0.433)
$SovereignCrisis_{it}$			3.299	2.709
			(4.420)	(4.215)
Observations	335	334	1,079	1,066
R-squared	0.089	0.151	0.447	0.448
Number of countryid	19	21	26	26

Table 5: **Macro-financial characteristics and EMDE exchange rate effects.** This table shows the estimated coefficients in OLS regressions of changes in the log exchange rate between year t and $t+1$. The control variables are the change in the fiscal deficit Δdef_{it}, a dummy variable taking the value of one if the variable listed at the topic of the column in period t is above the sample average D_{it} as well as the interaction of the dummy variable and the change in the deficit. In column (1) the dummy variable takes the value of one if the foreign currency share of government debt securities is above the sample median, column (2) if the share of non-resident holding of government debt are above the sample median, column (3) if the total government debt-to-GDP ratio is above the sample mean, column (4) if the interest expenses on government debt are above the median. We also control for the annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, log change in the local price of oil, Δoil_{it} and a dummy variable taking the value of one in sovereign crisis years. We also include the level of interest rates in the United States i_t^{US} and realised equity volatility of the S&P 500 $EqVol_t^{US}$ to control for the influence of global financial conditions. Estimated regressions include country fixed effects. Robust standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Inflation forecast quantities	5% π_{t+1}	25% π_{t+1}	50% π_{t+1}	75% π_{t+1}	95% π_{t+1}
Δdef_{it}	-0.0315	-0.0207	-0.0113	-0.00185	0.0185
	(0.126)	(0.119)	(0.106)	(0.126)	(0.180)
$\Delta def_{it} * D_{it}$	0.187	0.222	0.253*	0.284**	0.350**
	(0.228)	(0.184)	(0.140)	(0.129)	(0.156)
D_{it}	-0.184	-0.138	-0.0984	-0.0586	0.0272
	(0.692)	(0.486)	(0.537)	(0.722)	(1.314)
π_{it}	0.220*	0.354***	0.471***	0.589***	0.841***
	(0.115)	(0.117)	(0.109)	(0.112)	(0.131)
Δy_{it}	0.286***	0.264***	0.244***	0.225***	0.183
	(0.110)	(0.0798)	(0.0668)	(0.0799)	(0.147)
Δexc_{it}	0.0277	0.0372**	0.0455**	0.0539***	0.0719***
	(0.0219)	(0.0185)	(0.0184)	(0.0191)	(0.0267)
Δoil_{it}	0.0125*	0.0103	0.00837	0.00644	0.00228
	(0.00705)	(0.00683)	(0.00688)	(0.00872)	(0.0133)
Observations	335	335	335	335	335

Table 6: **Inflation-at-risk, share of FX debt.** This table shows the estimated coefficients in quantile regressions of the inflation rate over the next year π_{t+1}, on changes in the fiscal deficit-to-GDP ratio in year t, Δdef_{it}, a dummy variable taking the value of one if the country is classified as having above median foreign currency government debt D_{it} as well as the interaction of the dummy variable and the change in the deficit. We also control for annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, and log change in the local price of oil, Δoil_{it}. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Inflation forecast quantiles	5% π_{t+1}	25% π_{t+1}	50% π_{t+1}	75% π_{t+1}	95% π_{t+1}
Δdef_{it}	-0.176	-0.0948	-0.0318	0.0305	0.156
	(0.218)	(0.162)	(0.135)	(0.134)	(0.174)
$\Delta def_{it} * D_{it}$	0.404*	0.303*	0.226	0.149	-0.00551
	(0.234)	(0.175)	(0.146)	(0.156)	(0.235)
D_{it}	0.0548	0.0305	0.0117	-0.00688	-0.0444
	(0.701)	(0.441)	(0.275)	(0.270)	(0.600)
π_{it}	0.419***	0.505***	0.570***	0.636***	0.767***
	(0.131)	(0.125)	(0.116)	(0.115)	(0.121)
Δy_{it}	0.199**	0.215***	0.227***	0.240***	0.264**
	(0.0811)	(0.0702)	(0.0667)	(0.0804)	(0.109)
Δexc_{it}	0.00326	0.0171	0.0279**	0.0385**	0.0599**
	(0.0224)	(0.0162)	(0.0138)	(0.0150)	(0.0253)
Δoil_{it}	-0.000375	-1.19e-05	0.000268	0.000545	0.00110
	(0.00442)	(0.00496)	(0.00654)	(0.00789)	(0.0124)
Observations	334	334	334	334	334

Table 7: **Inflation-at-risk, share of foreign holdings.** This table shows the estimated coefficients in quantile regressions of the inflation rate over the next year π_{t+1}, on changes in the fiscal deficit-to-GDP ratio in year t, Δdef_{it}, a dummy variable taking the value of one if the country is classified has having above median foreign ownership of government debt D_{it} as well as the interaction of the dummy variable and the change in the deficit. We also control for annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, and log change in the local price of oil, Δoil_{it}. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

higher deficits are followed by higher inflation. The effect is non-linear, being higher in the right tail of the inflation forecast distribution. By contrast, in economies with above-median foreign holdings (Table 7), the non-linearity is different: the effect is larger at the left tail of the forecast distribution, but it is only weakly statistically significant. In this sense, the implications of high shares of FX debt for inflation differ from those of high foreign holdings of sovereign debt.

What explains the previous findings, in particular the weaker statistical significance in the case of foreign holdings? The effect through exchange rate pass-through is one potential factor. In particular, the exchange rate depreciation in the case of above-median FX debt is stronger than in the case of foreign holdings, which could then contribute to differences in the eventual inflation outcome.

5.2 FX reserves

EMDEs have accumulated larger FX reserves, especially since the early 2000s. These serve as buffers against the risk of sudden stops in capital flows and exchange rate depreciations. To what extent do these FX reserves mitigate the exchange rate effects of higher fiscal deficits? We estimate the model of "exchange rate-at-risk", with an interaction variable that obtains the value of one for periods where FX reserves - measured as ratio to GDP - are above the sample median. The results in Table 8 show that FX reserves do provide meaningful insulation against exchange rate depreciations (those at the 50%, 75% and 95% quantiles of exchange rate changes). Notably, non-linearities associated with the deficit-exchange rate relationship are much weaker when FX reserve buffers are larger.

The fact that FX reserves mitigate the influence of fiscal deficits on exchange rates effects raises the question of whether they also matter for the inflation outcomes. To investigate the issue, we estimate the original inflation-at-risk specification with an interaction variable capturing above median FX reserves to GDP. Overall, we find that qualitatively, high FX reserves are associated with lower upside inflation risks following an increase in the deficit. However, this effect is not statistically significant (Appendix Table A.8).

Exchange rate forecast quantiles	5% Δexc_{it+1}	25% Δexc_{it+1}	50% Δexc_{it+1}	75% Δexc_{it+1}	95% Δexc_{it+1}
Δdef_{it}	1.096	1.482***	1.710***	2.008***	2.592**
	(0.735)	(0.563)	(0.571)	(0.651)	(1.052)
$\Delta def_{it} * D_{it}$	-0.848	-1.242*	-1.475**	-1.780***	-2.377**
	(0.954)	(0.700)	(0.656)	(0.672)	(0.992)
D_{it}	-1.493	-2.393*	-2.925**	-3.621**	-4.986*
	(1.782)	(1.381)	(1.369)	(1.613)	(2.730)
π_{it}	0.0972*	0.105***	0.109***	0.115***	0.126***
	(0.0564)	(0.0388)	(0.0327)	(0.0264)	(0.0390)
Δexc_{it}	0.130*	0.279***	0.367***	0.482***	0.708***
	(0.0770)	(0.0566)	(0.0507)	(0.0576)	(0.0920)
Δy_{it}	0.435*	0.244	0.131	-0.0169	-0.307
	(0.259)	(0.177)	(0.188)	(0.245)	(0.439)
Δoil_{it}	0.00893	0.00307	-0.000403	-0.00494	-0.0138
	(0.0221)	(0.0133)	(0.0134)	(0.0175)	(0.0352)
$SovereignCrisis_{it}$	9.368	5.678	3.495	0.640	-4.957
	(6.522)	(4.593)	(4.497)	(5.068)	(9.294)
i_{it}^{US}	0.274	0.455***	0.561***	0.701***	0.975**
	(0.226)	(0.156)	(0.153)	(0.210)	(0.398)
$EqVol_{it}^{US}$	-0.721	0.439	1.125**	2.022***	3.782**
	(0.982)	(0.579)	(0.545)	(0.726)	(1.520)
Observations	1,078	1,078	1,078	1,078	1,078

Table 8: **Fiscal deficits, FX reserves and exchange rates.** This table shows the estimated coefficients in quantile regressions of log changes in the exchange rate between year t and $t+1$, on changes in the fiscal deficit-to-GDP ratio in year t, Δdef_{it}, a dummy variable taking the value of one if the country has above median exchange rate reserves D_{it} as well as the interaction between the high reserves dummy variable and the change in the deficit. We also control for the annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, and log change in the local price of oil, Δoil_{it} and a dummy variable taking the value of one in sovereign crisis years. We also include the level of interest rates in the United States i_t^{US} and realised equity volatility of the S&P 500 $EqVol_t^{US}$ to control for the influence of global financial conditions. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

6 Monetary policy

In this section, we first examine how the adoption of inflation targeting has affected the strength of the deficit-inflation relationship. We then examine how constraints on monetary policy in open economies, elaborated in the trilemma between monetary policy independence, financial openness and exchange rate stability (eg Aizenman et al. (2010)), influence the extent to which higher deficits feed through into inflation.

6.1 Importance of inflation targeting

To what extent do the effects of higher deficits on inflation hinge on the prevailing monetary policy regime? The monetary policy response could potentially play a key role. If the central bank raises interest rates to counteract the inflationary effects of higher deficits, fiscal deficits may not lead to higher inflation, at least beyond a short horizon. If monetary policy is focused on stabilising inflation over the medium term, as in an inflation targeting (IT) regime, any correlation between fiscal deficits and future inflation is likely to be weaker. To investigate the issue, we re-estimate the inflation-at-risk model, interacting fiscal deficits with a dummy variable that obtains a value of one for the years when a central bank was targeting inflation, and zero during other periods.[11]

Table 9 confirms that the inflationary effects of higher deficits are considerably weaker in IT regimes. Moreover, the attenuating effect of the monetary policy regime holds across the inflation forecast distribution. At the median of the distribution, a one percentage point increase is associated with a 3.0 percentage point increase in inflation when a central bank is not pursuing inflation targeting but only 0.3 percentage points in the IT regime (3.04%-2.72%*1=0.32%). At the right tail, i.e. at the 95% quantile, the effect is 6.1 percentage points for non-inflation targeters but only 0.6 points for those in an IT regime (6.10%-5.52%*1=0.58%). Therefore, the non-linearity in the relationship between fiscal deficits and inflation is also notably attenuated in IT regimes, suggesting that the policy regime plays an important role in accounting for the observed degree of non-linearity.

[11] The inflation targeting adoption dates are from Jahan (2017).

Inflation forecast quantiles	5% π_{t+1}	25% π_{t+1}	50% π_{t+1}	75% π_{t+1}	95% π_{t+1}
Δdef_{it}	1.470	2.474**	3.037**	3.855***	6.104**
	(1.573)	(1.088)	(1.195)	(1.451)	(2.974)
$\Delta def_{it} * D_{it}$	-1.290	-2.208**	-2.722**	-3.469***	-5.524**
	(1.352)	(1.044)	(1.118)	(1.310)	(2.422)
D_{it}	-1.530	-2.652	-3.281*	-4.195**	-6.708*
	(2.854)	(1.933)	(1.740)	(1.725)	(3.621)
π_{it}	0.0986	0.430***	0.616***	0.886***	1.629***
	(0.277)	(0.100)	(0.0999)	(0.151)	(0.531)
Δy_{it}	0.0659	0.602**	0.902**	1.338**	2.538
	(0.844)	(0.305)	(0.351)	(0.603)	(1.897)
Δexc_{it}	0.102	0.182*	0.227**	0.292*	0.471
	(0.209)	(0.0938)	(0.0935)	(0.151)	(0.456)
Δoil_{it}	0.0463	0.0375	0.0325	0.0254	0.00559
	(0.0388)	(0.0261)	(0.0251)	(0.0322)	(0.0727)
$SovereignCrisis_{it}$	9.087	13.57**	16.07**	19.72**	29.75*
	(9.433)	(6.309)	(6.423)	(8.118)	(17.18)
Observations	1,080	1,080	1,080	1,080	1,080

Table 9: **Fiscal deficits, inflation-at-risk and inflation targeting regimes.** This table shows the estimated coefficients in quantile regressions of the inflation rate over the next year π_{t+1}, on changes in the fiscal deficit-to-GDP ratio in year t Δdef_{it}, a dummy variable taking the value of one if the country is in an inflation targeting regime D_{it} as well as the interaction of the inflation targeting dummy variable and the change in the deficit. We also control for annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, log change in the local price of oil, Δoil_{it} and a dummy variable taking the value of one in sovereign crisis years. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

We also note that inflation targeting is associated with lower future inflation across the inflation forecast distribution, as indicated by the coefficient on the dummy variable on its own. For example, at the median of the distribution, inflation rates are 3.3 percentage points lower in IT than in non-IT regimes. At the 95% quantile, the difference rises to 6.7 percentage points. Taken together, these results suggest that inflation targeting strongly counteracts the inflationary effects of higher deficits. They are consistent with the findings in Duncan et al. (2022) on the significant improvement in inflation performance in EMDEs after adopting an inflation targeting regime.

Exchange rate forecast quantiles	5% Δexc_{it+1}	25% Δexc_{it+1}	50% Δexc_{it+1}	75% Δexc_{it+1}	95% Δexc_{it+1}
Δdef_{it}	0.694	0.934***	1.074***	1.262***	1.622***
	(0.503)	(0.340)	(0.318)	(0.349)	(0.622)
$\Delta def_{it} * D_{it}$	-1.258**	-1.427***	-1.525***	-1.658***	-1.911***
	(0.636)	(0.419)	(0.346)	(0.386)	(0.734)
D_{it}	-1.027	-1.805	-2.254**	-2.863**	-4.025*
	(1.855)	(1.190)	(1.051)	(1.239)	(2.301)
π_{it}	0.119**	0.116***	0.114***	0.112***	0.107**
	(0.0571)	(0.0400)	(0.0333)	(0.0285)	(0.0455)
Δexc_{it}	0.108	0.265***	0.355***	0.479***	0.713***
	(0.0803)	(0.0548)	(0.0529)	(0.0584)	(0.0997)
Δy_{it}	0.466*	0.247	0.120	-0.0526	-0.381
	(0.264)	(0.176)	(0.191)	(0.244)	(0.438)
Δoil_{it}	-0.00141	-0.00304	-0.00399	-0.00527	-0.00772
	(0.0211)	(0.0133)	(0.0138)	(0.0176)	(0.0345)
$SovereignCrisis_{it}$	9.478	5.798	3.669	0.786	-4.715
	(6.303)	(4.549)	(4.642)	(5.763)	(10.40)
i_t^{US}	0.296*	0.490***	0.601***	0.753***	1.042***
	(0.177)	(0.133)	(0.149)	(0.216)	(0.386)
$EqVol_t^{US}$	-0.523	0.495	1.084**	1.881**	3.403**
	(0.947)	(0.509)	(0.509)	(0.772)	(1.637)
Observations	1,079	1,079	1,079	1,079	1,079

Table 10: **Fiscal deficits, exchange rate and inflation targeting regimes.** This table shows the estimated coefficients in quantile regressions of log changes in the exchange rate between year t and $t+1$, on changes in the fiscal deficit-to-GDP ratio in year t, Δdef_{it}, a dummy variable taking the value of one if the country is in an inflation targeting regime D_{it} as well as the interaction of the inflation targeting dummy variable and the change in the deficit. We also control for the annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, and log change in the local price of oil, Δoil_{it} and a dummy variable taking the value of one in sovereign crisis years. We also include the level of interest rates in the United States i_t^{US} and realised equity volatility of the S&P 500 $EqVol_t^{US}$ to control for the influence of global financial conditions. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

The transmission of higher deficits through exchange rates to inflation is also different in inflation targeting regimes. Notably, higher deficits are associated with exchange rate appreciation, as in the textbook model, in inflation targeting regimes (see Table 10). This is shown by the coefficient on the interaction variable, which is negative and higher in absolute value than the coefficient on fiscal deficits, across the exchange rate distribution. At the median of the distribution, a one percentage point increase in fiscal deficits is associated with a 1.1% depreciation in non-IT regimes but a 0.5% appreciation in inflation targeting regimes (1.07%-1.53%*1=-0.46%). This small exchange rate appreciation in IT regimes partly accounts for the muted inflation impact in this regime.

We also note that inflation targeters generally see a smaller risk of large exchange rate depreciations over time (see the coefficients on D_{it} which become more strongly negative when moving to the higher quantiles). Indeed, the lower inflation effects of higher deficits in IT regimes is consistent with the behaviour of inflation expectations. In particular, using Consensus expectations for the next calendar year, we find that these expectations rise by around 20 basis points in non-IT economies in the year when deficits increase, but they remain broadly unchanged in inflation targeters.

6.1.1 Further evidence on the relevance of the monetary policy regime

Inflation targeting regimes were adopted towards the end of the sample when inflation rates were lower. Then, a question arises as to what extent the results regarding smaller inflation effects of deficits reflect the monetary policy regime or simply a time effect of overall lower inflation.

We deal with this issue in two ways. First, we estimate the model with the inflation targeting dummy for the post-1985 sample. As the first EMDEs in our sample adopted inflation targeting in the 1990s, a sample starting in 1986 yields a sufficient number of non-inflation targeting years even for the early adopters, while excluding the prominent high inflation decades of the 1960s and 1970s for all economies. Second, instead of using inflation targeting to identify the monetary policy regime, we use a measure of cyclicality of monetary policy, following Vegh and Vuletin (2013). We estimate correlations between the cyclical components of policy interest rates and real GDP, using the HP filter with a smoothing parameter of 100 to isolate the cyclical component of the two series. A positive correlation between the series is taken to indicate countercyclical monetary policy (such that there are higher interest rates during good times). The dummy variable then obtains of value of one during periods of countercyclical monetary policy and zero otherwise. For this measure, compared to formal inflation targeting, there is more variation both within and across economies over the entire sample period.[12]

The results confirm the relevance of monetary policy. Inflation targeting retains its importance also in the post-1985 sample (see Table 11). And, the countercyclicality of monetary policy has qualitatively similar effects to inflation targeting. The effects are somewhat less statistically significant (see Table A.9 in the Annex), but the interaction dummy for countercyclical monetary policy and fiscal deficits obtains statistically significant negative coefficients at the 5% level at the 75% and 95% quantiles. Therefore, monetary policy again appears to be an important factor for the observed non-linearities between fiscal deficits and inflation.

To what extent are changes in fiscal policy and the behaviour of deficits behind the different dynamics observed during IT and non-IT periods? Sims (2004), and more recently Cochrane (2023), discuss how monetary policy centred on inflation control requires an appropriate fiscal backing. However, identifying the fiscal regime for EMDEs is not a straightforward task. For example, Mauro et al. (2015) who classify periods of fiscal prudence and profligacy for 55 economies over multiple decades, identify notably fewer periods of fiscal prudence/profligacy for EMDEs than for their advanced economy counterparts. Still, simple statistical evidence regarding the behaviour of deficits may provide some clues. For example, using the test by Levene (1960) to compare the variance of deficits over IT and non-IT periods, we find that the null hypothesis that the variance of deficits over those periods is the same is rejected (p-value below 0.01). Moreover, the persistence of deficits is somewhat lower in IT compared with non-IT periods.[13] Taking the evidence together,

[12] To capture time variation in the cyclicality of monetary policy within economies, we use moving correlations over three-year rolling windows. As discussed earlier, due to lack of data on interest rates in the early part of the EMDE sample, the sample size is reduced by close to 30% in these estimates.

[13] To obtain this result, we estimate an AR(1) model of fiscal deficits, additionally including an inter-

it seems plausible that changes in fiscal policy have accounted for some of the observed changes in the deficit-inflation relationship, but that monetary policy has also played an important role.[14]

Inflation forecast quantiles	5% π_{t+1}	25% π_{t+1}	50% π_{t+1}	75% π_{t+1}	95% π_{t+1}
Δdef_{it}	0.841	1.853***	2.254***	2.939**	4.955
	(2.509)	(0.680)	(0.806)	(1.239)	(4.027)
$\Delta def_{it} * D_{it}$	-1.014	-1.574***	-1.795***	-2.174***	-3.288
	(1.734)	(0.567)	(0.596)	(0.834)	(2.771)
D_{it}	-4.185	-4.254*	-4.282*	-4.329	-4.468
	(4.859)	(2.408)	(2.502)	(3.117)	(7.948)
π_{it}	-0.353	0.328	0.598***	1.059***	2.416*
	(0.880)	(0.201)	(0.207)	(0.320)	(1.359)
Δy_{it}	0.381	0.950**	1.175**	1.560**	2.693
	(1.556)	(0.386)	(0.468)	(0.728)	(2.404)
Δexc_{it}	0.338	0.227*	0.183	0.108	-0.112
	(0.402)	(0.138)	(0.143)	(0.215)	(0.741)
Δoil_{it}	-0.00232	0.0250	0.0358	0.0543	0.109
	(0.0537)	(0.0200)	(0.0249)	(0.0366)	(0.106)
$SovereignCrisis_{it}$	-0.478	6.144	8.761	13.25	26.43
	(36.93)	(12.44)	(10.42)	(11.81)	(44.69)
Observations	792	792	792	792	792

Table 11: **Fiscal deficits, inflation-at-risk and inflation targeting regimes, post-1985.** This table shows the estimated coefficients in quantile regressions of the inflation rate over the next year π_{t+1}, on changes in the fiscal deficit-to-GDP ratio in year t Δdef_{it}, a dummy variable taking the value of one if the country is in an inflation targeting regime D_{it} as well as the interaction of the inflation targeting dummy variable and the change in the deficit. We also control for annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, log change in the local price of oil, Δoil_{it} and a dummy variable taking the value of one in sovereign crisis years estimated in the post-1985 sample of EMDEs. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

action variable of an inflation targeting dummy variable with lagged fiscal deficits. In this estimation, the interaction variable obtains a negative, though economically small coefficient, which is statistically significant at the 10% level.

[14]Episodes of "monetary financing" could also be a factor resulting in different inflationary dynamics in non-IT vs. IT periods. Monetary financing has been a prominent contributor to high inflation in EMDEs in the past (see e.g. the discussion in World Bank (2021), Chapter 4). The presence of monetary financing episodes in our sample is reduced as we exclude country-year observations with inflation exceeding 600%. Nevertheless, some years of monetary financing, such as those for Bolivia, Peru and Turkey, as identified in World Bank (2021), Annex 4.4, fall into our sample periods. Therefore, they could partly account for the strong relationship between fiscal deficits and inflation observed at the right tail of the inflation forecast distribution.

6.2 Constraints on monetary policy in open economies

Another question is to what extent constraints on monetary policy in open economies could affect the relationship between fiscal deficits and inflation. EMDEs have typically become more financially integrated over time, and exchange rates have become more flexible. These dimensions could have implications, inter alia, for the extent central banks can stabilise inflation following an increase in fiscal deficits. We use data on the trilemma indices proposed in Aizenman et al. (2010) and Aizenman et al. (2013) that capture the degree of financial openness, monetary independence and exchange rate stability.[15] We construct dummy variables for each of the dimensions that take the value of one if the indicator is above the sample median and zero otherwise. The results are shown in Table 12.

The results suggest that constraints faced by open economies have meaningful effects on the relationship between fiscal deficits and inflation. For economies with greater financial openness, the relationship between deficits and future inflation is notably weaker, with statistically significant coefficients on the interaction variable at the 25%, 50% and the 75% quantiles (upper panel in Table 12). The result is consistent with the negative relationship between financial integration and inflation documented in Gupta (2008). The latter study argues that the result could stem from a disciplinary effect of financial integration on monetary policy, or because the private sector believes that monetary policy will be more disciplined. Another explanation could be the role of capital account openness in increasing fiscal discipline. Similar results are obtained for exchange rate stability, whereby more stable exchange rates are associated with a weaker deficit-inflation relationship (lower panel in Table 12). They are consistent with earlier literature showing a relationship between

[15] In these papers, financial openness is defined as the first principal component of measures of exchange rate restrictions (i.e. the presence of multiple exchange rates, restrictions on current account transactions, on capital account transactions, and the requirement of the surrender of export proceeds). Monetary independence is defined by the correlation between domestic interest rates and interest rates in the base country to which monetary policy in the domestic economy is most closely linked. Exchange rate stability is defined by the standard deviation of the monthly bilateral exchange rate vis-à-vis the most closely linked major economy.

fixed exchange rates and low and stable inflation, stemming both from favourable effects on policy discipline and confidence (see e.g. Ghosh et al. (1997)). By contrast, the results regarding the importance of monetary independence for the deficit-inflation link are not statistically significant.

Financial openness	5% π_{t+1}	25% π_{t+1}	50% π_{t+1}	75% π_{t+1}	95% π_{t+1}
Δdef_{it}	2.256	3.729**	4.494***	5.604***	9.544*
	(3.925)	(1.666)	(1.641)	(1.861)	(5.739)
$\Delta def_{it} * D_{it}$	-2.492	-3.002**	-3.267***	-3.652**	-5.017
	(4.009)	(1.426)	(1.228)	(1.586)	(5.907)
D_{it}	3.468	-0.0517	-1.880	-4.531	-13.95
	(5.620)	(1.763)	(1.996)	(3.665)	(11.95)
Monetary independence	5% π_{t+1}	25% π_{t+1}	50% π_{t+1}	75% π_{t+1}	95% π_{t+1}
Δdef_{it}	0.756	2.338	3.201*	4.531**	8.695**
	(2.202)	(1.704)	(1.854)	(2.237)	(4.367)
$\Delta def_{it} * D_{it}$	1.097	-0.406	-1.225	-2.488	-6.441
	(2.438)	(1.729)	(1.866)	(2.269)	(4.584)
D_{it}	1.332	-0.671	-1.763	-3.448	-8.721
	(3.746)	(1.109)	(1.202)	(2.577)	(9.236)
Exchange rate stability	5% π_{t+1}	25% π_{t+1}	50% π_{t+1}	75% π_{t+1}	95% π_{t+1}
Δdef_{it}	1.794	3.057**	3.601**	4.465***	7.489**
	(2.305)	(1.357)	(1.451)	(1.691)	(3.350)
$\Delta def_{it} * D_{it}$	-1.272	-2.314*	-2.763**	-3.476**	-5.972*
	(2.187)	(1.311)	(1.404)	(1.642)	(3.217)
D_{it}	8.470	1.811	-1.053	-5.606	-21.55
	(8.309)	(1.283)	(1.488)	(3.724)	(14.21)
Observations	1,080	1,080	1,080	1,080	1,080

Table 12: **Quantile regression estimates of inflation risk with three components of the trilemma index.** This table shows the estimated coefficients in quantile regressions of the inflation rate over the next year π_{t+1}, on changes in the fiscal deficit-to-GDP ratio in year t Δdef_{it}, a dummy variable D_{it} taking the value of one if the component of the trilemma index is above the sample mean and zero otherwise, as well as the interaction of the dummy variable and the change in the deficit. We also control for annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, log change in the local price of oil, Δoil_{it} and a dummy variable taking the value of one in sovereign crisis years (coefficients not shown). Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

7 Conclusions

In this paper, we have highlighted the effects of higher deficits on inflation and exchange rates in a panel of emerging market and developing economies. We showed that the effects of higher deficits on inflation and exchange rates are non-linear, and are larger in the right tails of the inflation and exchange rate distributions. We also documented that the structure of sovereign debt has implications for the effects of higher deficits on EMDE exchange rates and their pass-through into higher inflation. In particular, higher deficits lead to exchange rate depreciations especially when the share of foreign currency-denominated debt is sizeable and when foreign holdings of sovereign debt are high. Finally, we show that the effects of deficits on both inflation and exchange rates are smaller when an economy is pursuing a policy of inflation targeting. Importantly, we show that the monetary policy regime is a key factor behind the observed non-linearities between fiscal deficits and inflation. Overall, the results suggest that fiscal deficits have important implications for both inflation and exchange rate dynamics in EMDEs and that there is important heterogeneity in the effects between countries with different macro-financial vulnerabilities and institutional characteristics.

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Appendix A

Inflation forecast quantiles	5% π_{t+1}	25% π_{t+1}	50% π_{t+1}	75% π_{t+1}	95% π_{t+1}
Δdef_{it}	-0.122*	0.000522	0.0672**	0.148***	0.359***
	(0.0673)	(0.0387)	(0.0290)	(0.0266)	(0.0465)
π_{it}	0.433***	0.693***	0.834***	1.006***	1.455***
	(0.139)	(0.0551)	(0.0245)	(0.0166)	(0.126)
Δy_{it}	0.204***	0.275***	0.313***	0.360***	0.482***
	(0.0408)	(0.0285)	(0.0271)	(0.0289)	(0.0573)
Δexc_{it}	-0.0267	-0.0220	-0.0194**	-0.0163*	-0.00816
	(0.0294)	(0.0144)	(0.00835)	(0.00891)	(0.0288)
Δoil_{it}	0.0160	0.00919	0.00547	0.000973	-0.0108
	(0.0109)	(0.00635)	(0.00443)	(0.00348)	(0.00681)
$SovereignCrisis_{it}$	1.122**	0.713**	0.490*	0.221	-0.486
	(0.530)	(0.336)	(0.261)	(0.306)	(0.580)
Observations	1,258	1,258	1,258	1,258	1,258

Table A.1: **Baseline model in the sample of advanced economies.** This table shows the estimated coefficients in quantile regressions of the inflation rate over the next year π_{t+1}, on changes in the fiscal deficit-to-GDP ratio in year t, Δdef_{it}, annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, and log change in the local price of oil, Δoil_{it} estimated on the sample of advanced economies. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Exchange rate forecast quantiles	5% Δexc_{it+1}	25% Δexc_{it+1}	50% Δexc_{it+1}	75% Δexc_{it+1}	95% Δexc_{it+1}
Δdef_{it}	0.0442	0.0697	0.0867	0.103	0.132
	(0.150)	(0.117)	(0.114)	(0.130)	(0.192)
π_{it}	-0.0336	0.0916	0.175**	0.253**	0.398**
	(0.0497)	(0.0652)	(0.0850)	(0.114)	(0.168)
Δexc_{it}	0.258***	0.262***	0.264***	0.266***	0.271***
	(0.0352)	(0.0193)	(0.0151)	(0.0248)	(0.0462)
Δy_{it}	0.238*	-0.0800	-0.292***	-0.490***	-0.858***
	(0.127)	(0.0845)	(0.0807)	(0.0938)	(0.144)
Δoil_{it}	-0.000208	0.0270***	0.0450***	0.0619***	0.0934***
	(0.0125)	(0.00766)	(0.00783)	(0.00998)	(0.0156)
$SovereignCrisis_{it}$	5.743***	-2.775**	-8.450***	-13.75***	-23.63***
	(1.588)	(1.399)	(1.380)	(1.489)	(1.948)
i_{it}^{US}	0.136	0.206***	0.252***	0.296***	0.377***
	(0.0876)	(0.0608)	(0.0568)	(0.0677)	(0.105)
$EqVol_{it}^{US}$	0.680	0.982	1.183***	1.371***	1.722***
	(0.919)	(0.600)	(0.436)	(0.380)	(0.605)
Observations	1,258	1,258	1,258	1,258	1,258

Table A.2: **Quantile regression estimates of exchange rate risk in the sample of AEs.** This table shows the estimated coefficients in quantile regressions of log changes in the exchange rate between year t and $t+1$, on changes in the fiscal deficit-to-GDP ratio in year t, Δdef_{it}, annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, and log change in the local price of oil, Δoil_{it} and a dummy variable taking the value of one in sovereign crisis years. We also include the level of interest rates in the United States i_t^{US} and realised equity volatility of the S&P 500 $EqVol_t^{US}$ to control for the influence of global financial conditions estimated on the sample of advanced economies. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Inflation forecast quantiles	5% $\overline{\pi}_{t+1,t+2,t+3}$	25% $\overline{\pi}_{t+1,t+2,t+3}$	50% $\overline{\pi}_{t+1,t+2,t+3}$	75% $\overline{\pi}_{t+1,t+2,t+3}$	95% $\overline{\pi}_{t+1,t+2,t+3}$
Δdef_{it}	1.767**	1.631***	1.559***	1.448***	1.061
	(0.880)	(0.572)	(0.462)	(0.390)	(0.768)
π_{it}	-0.0348	0.230**	0.369***	0.586***	1.339***
	(0.148)	(0.0962)	(0.136)	(0.208)	(0.422)
Δy_{it}	0.398	0.803***	1.016***	1.346***	2.497***
	(0.532)	(0.291)	(0.318)	(0.401)	(0.966)
Δexc_{it}	-0.0318	0.271***	0.431***	0.678**	1.540**
	(0.396)	(0.0875)	(0.150)	(0.276)	(0.739)
Δoil_{it}	0.0557**	0.0375	0.0279	0.0130	-0.0388
	(0.0270)	(0.0244)	(0.0241)	(0.0279)	(0.0465)
$SovereignCrisis_{it}$	17.36**	15.64**	14.74**	13.33	8.438
	(8.445)	(6.099)	(7.303)	(9.872)	(21.65)
Observations	1,076	1,076	1,076	1,076	1,076

Table A.3: **Distribution of average three-year-ahead inflation, EMEs.** This table shows the estimated coefficients in quantile regressions of the average inflation rate over the next three years $\pi_{t+1,t+2,t+3}$, on changes in the fiscal deficit-to-GDP ratio in year t, Δdef_{it}, annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, and log change in the local price of oil, Δoil_{it}. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Inflation forecast quantiles	5% π_{t+1}	25% π_{t+1}	50% π_{t+1}	75% π_{t+1}	95% π_{t+1}
Δdef_{it}	1.292	2.183**	2.657**	3.454***	5.989**
	(1.599)	(1.041)	(1.139)	(1.310)	(2.685)
π_{it}	0.204	0.505***	0.666***	0.936***	1.794***
	(0.292)	(0.0632)	(0.0808)	(0.157)	(0.568)
Δy_{it}	0.0371	0.726**	1.092***	1.708***	3.668*
	(1.097)	(0.308)	(0.346)	(0.630)	(2.112)
Δexc_{it}	0.0905	0.175*	0.220**	0.295*	0.534
	(0.247)	(0.0949)	(0.100)	(0.164)	(0.508)
Δoil_{it}	0.0463	0.0436	0.0421	0.0396	0.0318
	(0.0546)	(0.0309)	(0.0303)	(0.0375)	(0.0989)
$SovereignCrisis_{it}$	11.98	16.10**	18.29***	21.98***	33.70*
	(10.83)	(6.909)	(6.381)	(8.067)	(18.54)
Observations	862	862	862	862	862

Table A.4: **Quantile regression estimates of inflation risk excluding lower income countries.** This table shows the estimated coefficients in quantile regressions of inflation rate over the next year π_{t+1}, on changes in the fiscal deficit-to-GDP ratio in year t, Δdef_{it}, annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, and log change in the local price of oil, Δoil_{it} estimated on the sample of EMDEs but excluding low income countries. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Inflation forecast quantiles	5% π_{t+1}	25% π_{t+1}	50% π_{t+1}	75% π_{t+1}	95% π_{t+1}
Δdef_{it}	-0.0814	-0.0157	0.0170	0.0606	0.0606
	(0.191)	(0.134)	(0.200)	(0.348)	(0.348)
π_{it}	0.181**	0.343***	0.423***	0.531***	0.531***
	(0.0730)	(0.0488)	(0.0606)	(0.0865)	(0.0865)
Δy_{it}	0.390***	0.417***	0.431**	0.450	0.450
	(0.111)	(0.152)	(0.208)	(0.316)	(0.316)
Δexc_{it}	0.0761	0.0792	0.0807	0.0827	0.0827
	(0.0574)	(0.0565)	(0.0654)	(0.0901)	(0.0901)
Δoil_{it}	-0.0111	-0.00606	-0.00357	-0.000237	-0.000237
	(0.0100)	(0.00738)	(0.00742)	(0.00916)	(0.00916)
$SovereignCrisis_{it}$	-20.33	-0.253	9.726	23.04	23.04
	(26.70)	(21.04)	(20.11)	(21.29)	(21.29)
Observations	339	339	339	339	339

Table A.5: **Inflation-at-risk, Asian EMDEs.** This table shows the estimated coefficients in quantile regressions of the inflation rate over the next year π_{t+1}, on changes in the fiscal deficit-to-GDP ratio in year t, Δdef_{it}, annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, and log change in the local price of oil, Δoil_{it} estimated on the sample of Asian EMDEs. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Inflation forecast quantiles	5% π_{t+1}	25% π_{t+1}	50% π_{t+1}	75% π_{t+1}	95% π_{t+1}
Δdef_{it}	-1.921	1.954**	2.659**	3.658**	7.741
	(3.851)	(0.994)	(1.104)	(1.729)	(7.373)
π_{it}	-0.413	0.496***	0.662***	0.896***	1.855*
	(0.792)	(0.0973)	(0.157)	(0.300)	(1.114)
Δy_{it}	-3.050	0.707	1.391**	2.359**	6.320
	(2.337)	(0.487)	(0.606)	(1.051)	(4.601)
Δexc_{it}	0.215	0.285***	0.297*	0.315	0.389
	(0.731)	(0.0997)	(0.169)	(0.344)	(1.224)
Δoil_{it}	0.229*	0.0748**	0.0467	0.00689	-0.156
	(0.120)	(0.0373)	(0.0315)	(0.0491)	(0.183)
$SovereignCrisis_{it}$	-2.483	18.37	22.17*	27.54*	49.52
	(26.99)	(11.58)	(11.76)	(14.26)	(36.42)
Observations	284	284	284	284	284

Table A.6: **Inflation-at-risk, Latin American EMDEs.** This table shows the estimated coefficients in quantile regressions of the inflation rate over the next year π_{t+1}, on changes in the fiscal deficit-to-GDP ratio in year t, Δdef_{it}, annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, and log change in the local price of oil, Δoil_{it} estimated on the sample of Latin American EMDEs. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Inflation forecast quantiles	5% π_{t+1}	25% π_{t+1}	50% π_{t+1}	75% π_{t+1}	95% π_{t+1}
Δdef_{it}	1.475	2.115**	2.503**	3.035**	4.881*
	(1.183)	(0.923)	(1.008)	(1.212)	(2.528)
π_{it}	0.133	0.431***	0.612***	0.860***	1.719***
	(0.251)	(0.102)	(0.0985)	(0.149)	(0.515)
Δy_{it}	0.213	0.698**	0.991***	1.393**	2.789
	(0.794)	(0.304)	(0.355)	(0.577)	(1.857)
Δexc_{it}	0.121	0.198**	0.245***	0.309**	0.531
	(0.209)	(0.0977)	(0.0944)	(0.144)	(0.427)
$\Delta oil_{it} * commexp$	0.0667	0.0317	0.0105	-0.0186	-0.119
	(0.113)	(0.0713)	(0.0706)	(0.0906)	(0.252)
$\Delta oil_{it} * non-commexp$	0.0441	0.0535	0.0592	0.0671	0.0942
	(0.0653)	(0.0382)	(0.0391)	(0.0531)	(0.131)
$SovereignCrisis_{it}$	11.30	14.97**	17.20***	20.26***	30.86*
	(10.14)	(6.796)	(6.207)	(7.460)	(16.83)
Observations	1,080	1,080	1,080	1,080	1,080

Table A.7: **Inflation-at-risk, commodity exporters vs importers.** This table shows the estimated coefficients in quantile regressions of the inflation rate over the next year π_{t+1}, on changes in the fiscal deficit-to-GDP ratio in year t, Δdef_{it}, annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, and log change in the local price of oil, Δoil_{it}. We also include interaction variables between the change in the oil price and a dummy variable for commodity exporters and importers, respectively: $\Delta oil_{it} * commexp$ and $\Delta oil_{it} * non-commexp$. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Inflation forecast quantiles	5% π_{t+1}	25% π_{t+1}	50% π_{t+1}	75% π_{t+1}	95% π_{t+1}
Δdef_{it}	1.400	2.540**	3.194***	4.135***	7.035
	(2.739)	(1.028)	(1.061)	(1.537)	(5.090)
$\Delta def_{it} * D_{it}$	0.104	-0.628	-1.048	-1.653	-3.515
	(2.653)	(1.648)	(1.710)	(2.142)	(5.179)
D_{it}	-0.0504	-2.059	-3.212**	-4.870	-9.980
	(5.799)	(1.254)	(1.582)	(3.598)	(12.11)
π_{it}	0.0806	0.420***	0.614***	0.894***	1.757***
	(0.291)	(0.102)	(0.101)	(0.149)	(0.546)
Δy_{it}	0.0252	0.610*	0.946***	1.430**	2.918
	(1.004)	(0.315)	(0.353)	(0.596)	(2.016)
Δexc_{it}	0.128	0.195**	0.234**	0.289**	0.460
	(0.252)	(0.0976)	(0.0956)	(0.144)	(0.455)
Δoil_{it}	0.0548	0.0462*	0.0413	0.0342	0.0124
	(0.0420)	(0.0268)	(0.0287)	(0.0344)	(0.0786)
sov_crisis	9.941	13.99**	16.32***	19.67**	29.98
	(10.14)	(6.022)	(6.195)	(7.677)	(18.48)
Observations	1,079	1,079	1,079	1,079	1,079

Table A.8: **Fiscal deficits, FX reserves and inflation.** This table shows the estimated coefficients in quantile regressions of the inflation rate over the next year, π_{t+1}, on changes in the fiscal deficit-to-GDP ratio in year t, Δdef_{it}, a dummy variable taking the value of one if the country has above median exchange rate reserves D_{it} as well as the interaction between the high reserves dummy variable and the change in the deficit. We also control for the annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, and log change in the local price of oil. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Inflation forecast quantiles	5% π_{t+1}	25% π_{t+1}	50% π_{t+1}	75% π_{t+1}	95% π_{t+1}
Δdef_{it}	-1.696	4.007	5.276*	7.152**	15.51**
	(4.997)	(2.545)	(2.769)	(3.053)	(6.202)
$\Delta def_{it} * D_{it}$	1.380	-3.821	-4.978*	-6.688**	-14.31**
	(4.683)	(2.680)	(2.871)	(3.085)	(5.674)
D_{it}	19.74**	3.531**	-0.0750	-5.406**	-29.16**
	(9.992)	(1.672)	(0.799)	(2.515)	(12.35)
π_{it}	-0.0805	0.546***	0.685***	0.891***	1.809***
	(0.459)	(0.0557)	(0.0888)	(0.179)	(0.678)
Δy_{it}	-1.060	0.707*	1.100**	1.681***	4.271*
	(1.689)	(0.425)	(0.454)	(0.640)	(2.208)
Δexc_{it}	-0.183	0.0876	0.148	0.237	0.634
	(0.362)	(0.0940)	(0.104)	(0.173)	(0.581)
Δoil_{it}	0.0106	0.0272	0.0309	0.0363	0.0607
	(0.0816)	(0.0360)	(0.0324)	(0.0375)	(0.105)
$SovereignCrisis_{it}$	-12.78	13.51	19.36*	28.00**	66.53*
	(21.27)	(9.736)	(9.896)	(12.56)	(34.67)
Observations	770	770	770	770	770

Table A.9: **Fiscal deficits, inflation-at-risk and countercyclical monetary policy.** This table shows the estimated coefficients in quantile regressions of inflation rate over the next year π_{t+1}, on changes in the fiscal deficit-to-GDP ratio in year t, Δdef_{it}, a dummy variable taking the value of one if the country is classified has having countercyclical monetary policy D_{it} as well as the interaction of the dummy variable and the change in the deficit. We also control for annual inflation rate π_{it}, GDP growth, Δy_{it}, log change in the bilateral USD exchange rate Δexc_{it}, and log change in the local price of oil, Δoil_{it}. Estimated regressions include quantile-τ fixed effects for economy i. Block bootstrap standard errors clustered by country shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix B: Robustness of estimation techniques

The quantiles via moments estimation procedure of Machado and Santos Silva (2019) solves a number of challenges in extending quantile regression methods to panel data, but the asymptotic proofs require certain assumptions about the data generating process (DGP) that may not hold in our data. In this appendix, we examine the sensitivity of estimates to deviations from the key assumption that the sequence $\{X_{it}\}$ of regressors is assumed to be strictly exogenous and *i.i.d.* for any country i and independent across i. Two factors are likely to lead to deviations from this assumption. First, inflation persistence leads to serial correlation in the errors. As is well known from time-series econometrics, this can lead to a bias in small samples. In addition, in a panel setting with fixed effects, this can lead to an additional source of bias (Nickell (1981)).[16] Second, interconnections across countries through factors such as oil price shocks would violate the assumption of independent regressors across countries.

B.1 Monte Carlo simulation

In the main results of this paper, we document significant non-linearities in the effects of fiscal deficits across the inflation distribution. We verify the robustness of our estimation technique using a Monte Carlo simulation, in which we explore a few departures of our data from the assumptions used to derive the location-scale model in Machado and Santos Silva (2019). In particular, using a simulated data set, we show that through the effect of noise due to persistence and cross-correlation in the regressors, the quantile regression estimation appears to understate the true degree of non-linearities in the simulated data. In the context of our real-world data, the simulation exercise suggests that the non-linearities in the effects of fiscal deficits may be even larger than our reported estimates.

[16] Machado and Santos Silva (2019) investigate potential bias arising from fixed effects in quantile regressions. They find that the bias is not too large for $n/T < 10$. In our case $n = 26$ and $T = 66$.

We describe the simulation technique and results in further detail below.

For the Monte Carlo exercise we restrict the number of countries and time periods to match our baseline sample of $n = 26$ and $T = 66$. We then simulate time series for our dependent variable inflation and the regressors. We characterize the DGP as follows:

- Each country is assigned two fixed effects, as in Machado and Santos Silva (2019). The first fixed effect, α_i, corresponds to the country-specific time-invariant average inflation. For each country, this fixed effect is drawn randomly from a normal distribution with mean 5 and standard deviation 2.[17] The second fixed effect, δ_i, describes the countries' time-invariant average level of scaling applied to the error term. Intuitively, the second fixed effect allows inflation in some countries to respond more or less strongly to random shocks relative to other countries in the sample. For each country, the second fixed effect is randomly drawn from the standard normal distribution.

- $\pi_{i,t} \sim AR(1), \epsilon_{i,t} \sim \mathcal{N}(\mu_\pi, \sigma_\pi^2)$

- $\Delta def_{i,t} \sim \mathcal{N}(\mu_{\Delta def}, \sigma_{\Delta def}^2)$

- $\Delta y_{i,t} \sim \mathcal{N}(\mu_{\Delta y}, \sigma_{\Delta y}^2)$

- $\Delta exc_{i,t} \sim \mathcal{N}(\mu_{\Delta exc}, \sigma_{\Delta exc}^2)$

We assume that inflation $\pi_{i,t}$ is an AR(1) process, while fiscal deficits $\Delta def_{i,t}$, output growth $\Delta y_{i,t}$, and exchange rate shocks $\Delta exc_{i,t}$ are assumed to be *i.i.d.* with the means and variances taken from the unconditional moments of our data. In addition, we allow for cross-correlation across countries in our simulated oil price, i.e. for all t, we assume $\Delta oil_{i,t} = \Delta oil_t \sim \mathcal{N}(\mu_{\Delta oil}, \sigma_{\Delta oil}^2)$.[18] With these assumptions about the variables, our

[17] These moments were selected based on an approximation of the average inflation distribution across EMDEs. The estimation results are relatively insensitive to the choice of moments.

[18] In principle, other variables could also be correlated across countries, but we set this aside for simplicity to examine the potential bias stemming from one variable.

simulated data is generated with the following location-scale model:

$$\overline{\pi}_{i,t+1} = a_i + X'_{it}\beta + (\delta_i + X'_{it}\gamma)U_{it}, \quad U_{it} \sim \mathcal{N}(0,1) \tag{B1}$$

$$X'_{i,t} = (\Delta def_{i,t}, \pi_{i,t}, \Delta y_{i,t}, \Delta exc_{i,t}, \Delta oil_t). \tag{B2}$$

As before, conditional quantiles are then given by:

$$Q_\pi(\tau|X_{it}) = (\alpha_i + \delta_i q(\tau)) + X'_{it}\beta + X'_{it}\gamma q(\tau). \tag{B3}$$

Since $U|X \sim \mathcal{N}(0,1)$, the conditional quantile of U is obtained using properties of the standard normal distribution. In particular,

$$Q_\pi(\tau|X_{it}) = (\alpha_i + \delta_i q(\tau)) + X'_{it}\beta + X'_{it}\gamma\Phi^{-1}(\tau) \tag{B4}$$

where $\Phi^{-1}(\cdot)$ denotes the inverse CDF of $U \sim N(0,1)$. We estimate the average effects of the regressors using ordinary least squares (OLS), and subsequently the quantile effects using the method of Machado and Santos Silva (2019).

In our simulation exercise, we are primarily concerned with the degree of bias on parameter estimates of $\Delta def_{i,t}$ as well as biases on $\pi_{i,t}$ due to inflation persistence and on $\Delta oil_{i,t}$ in the presence of correlated shocks. Results from the Monte Carlo simulation are shown in Table B.1. The results demonstrate that both the OLS and quantile regression estimates recover the β^*s with reasonable accuracy (see also Figure B.1). Furthermore, we show that the noise resulting from inflation persistence and cross-correlation in the regressors lead to attenuation towards the average effects. In other words, the noise leads to an underestimation of the true degree of non-linearities in the effect of deficits and lagged inflation on one-period-ahead inflation. Applying these results to our main findings suggests that our estimates likely underestimate the true extent of non-linearities in the real-world inflation distribution. This is particularly noteworthy for observations with above-median inflation, since it suggests that the risk of further inflation due to fiscal deficits may be even higher than estimated.

	Quantile (τ)	5%	25%	50%	75%	90%	OLS	$\beta^*(\tau)$
100 Reps	$\overline{\beta}_{\Delta def}$	1.595 (-0.532,3.722)	2.286 (1.258,3.314)	2.583 (1.860,3.305)	2.878 (2.182,3.573)	3.245 (2.218,4.272)	2.583 (2.588,2.577)	$2.578 + 0.900\Phi^{-1}(\tau)$
	$\overline{\beta}_{\pi}$	0.408 (-1.481,2.296)	0.548 (-0.370,1.466)	0.609 (-0.037,1.254)	0.669 (0.049,1.289)	0.743 (-0.171,1.658)	0.609 (0.613,0.604)	$0.617 + 0.200\Phi^{-1}(\tau)$
	$\overline{\beta}_{\Delta oil}$	0.059 (-0.106,0.225)	0.054 (-0.026,0.135)	0.052 (-0.005,0.109)	0.050 (-0.005,0.104)	0.047 (-0.033,0.127)	0.052 (0.052,0.052)	$0.052 + -0.004\Phi^{-1}(\tau)$
10000 Reps	$\overline{\beta}_{\Delta def}$	1.600 (0.466,2.734)	2.298 (1.792,2.805)	2.577 (2.159,2.995)	2.856 (2.347,3.366)	3.224 (2.442,4.006)	2.577 (2.582,2.572)	$2.578 + 0.900\Phi^{-1}(\tau)$
	$\overline{\beta}_{\pi}$	0.391 (-0.934,1.717)	0.553 (-0.047,1.153)	0.618 (0.122,1.114)	0.683 (0.080,1.286)	0.768 (-0.156,1.693)	0.618 (0.624,0.612)	$0.617 + 0.200\Phi^{-1}(\tau)$
	$\overline{\beta}_{\Delta oil}$	0.054 (-0.016,0.123)	0.052 (0.021,0.084)	0.052 (0.026,0.078)	0.051 (0.020,0.083)	0.050 (0.002,0.099)	0.052 (0.052,0.052)	$0.052 + -0.004\Phi^{-1}(\tau)$
		N =840 (T = 40)						

Table B.1: **Monte Carlo simulation results.** In each column, we report average estimates of $\beta(\tau) = \beta + \gamma Q_{\overline{\pi}}(\tau|X)$ for simulations with 100 and 10,000 repetitions, respectively. The 90% confidence intervals, shown in parentheses, are computed using the average point estimate and average standard error from the repetitions in each simulation. The simulated results show that OLS estimates are robust to inflation persistence and cross-correlation in the regressors. Non-linearities are also reflected in the simulation.

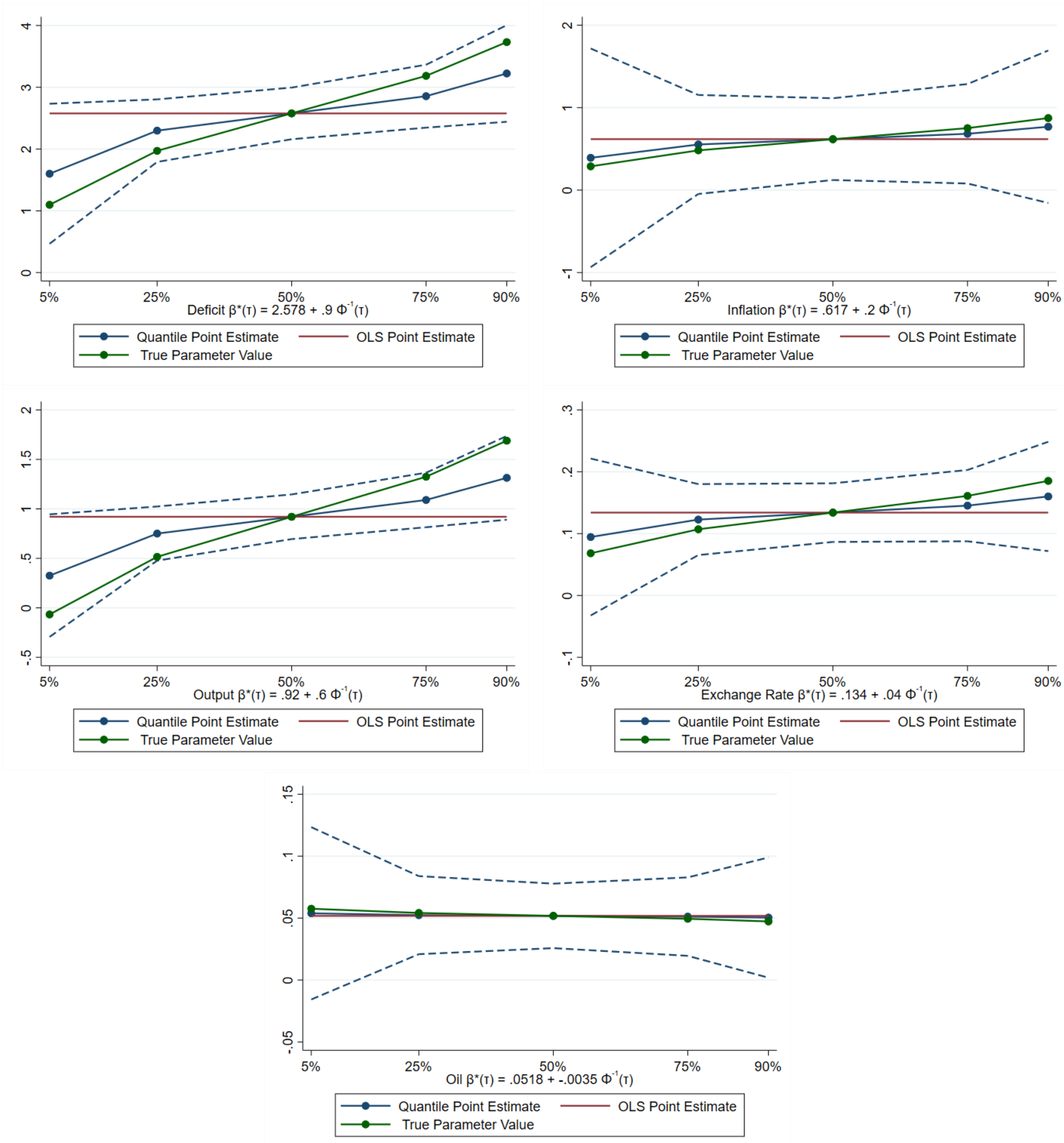

Figure B.1: **Estimated vs. "true" parameter values.** We plot the estimated parameter values against what would be the true parameter values across quantiles based on the DGP described above. The plots suggest that the effects are overstated below the median quantile and understated above it, so the real-world non-linearities are likely understated due to noise in the sample. Importantly, the right tail inflation risk from fiscal deficits may be larger than it seems, based on our simulated results.

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