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Commodity prices and the US Dollar

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Abstract

In the aftermath of the Covid pandemic rising commodity prices went hand-in-hand with a strengthening US dollar. This was a sharp contrast to the usual relationship between commodity prices and the dollar. This paper presents evidence that post-Covid correlation patterns could become more common in the future. This conclusion rests on two observations. First, the US dollar exhibits a close and stable relationship with the US terms of trade. Second, the United States' shift from being a net oil importer to a net oil exporter means that higher commodity prices now tend to raise the US terms of trade, rather than lowering them. Changes in the relationship between commodity prices and the US dollar will have implications for commodity exporters and importers alike.

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1 Introduction

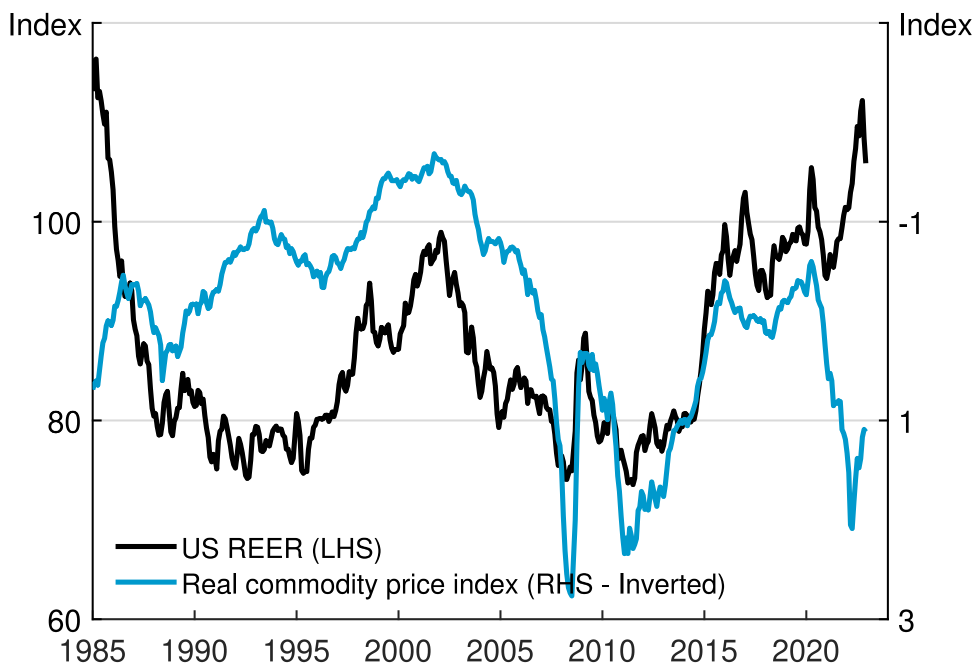
From at least the mid-1980s until the eve of the Covid pandemic, commodity prices moved predictably with the US dollar. In commodity price booms, the US dollar typically depreciated. And, when commodity prices fell, the value of the US dollar tended to rise.

As the global economy recovered from the Covid pandemic, this relationship broke down (Figure 1). From early 2021 to mid-2022, global food prices rose by around 30%, oil prices increased by around 150% and natural gas prices in some jurisdictions surged more than six-fold. But far from weakening, the US dollar appreciated against almost all major currencies.[1] Then, in late 2022, as commodity prices retraced some of their gains, the value of the US dollar declined.

The relationship between the US dollar and resource commodity prices matters for several reasons. For one, most commodity prices are denominated in US dollars. A negative correlation between commodity prices and US dollar strength provides non-US economies with a hedge. If the US dollar depreciates when US dollar commodity prices rise, the rise in commodity prices for non-US economies, *when measured in local currencies*, is smaller. Moreover, a depreciating US dollar is generally associated with looser global financial conditions (Hofmann et al. (2022b)). This eases the contractionary effects of higher commodity prices for commodity importers, although it can exacerbate the expansionary effects of such price rises for commodity exporters.

Will historical correlations between the US dollar and commodity prices re-assert themselves or will recent

Figure 1: US Dollar and Commodity Prices



Source: OECD, FRED, Authors' calculations.

[1]Notable exceptions included the Brazilian Real and the Mexican Peso.

patterns become the norm? The results of this paper point towards the latter.

This conclusion follows from three empirical exercises. The first documents historical correlations between the US dollar and the prices of individual commodities. This confirms both the generally negative correlation between the value of the US dollar and commodity prices indicated in Figure (1), and the historically unusual deviation from this relationship in recent times. The second exercise explores the relationship between commodity prices and the US terms of trade - i.e. the ratio of US export prices to US import prices. The sign of this relationship flipped in the early 2010s. Before then a rise in commodity prices was associated with a *deterioration* in the US terms of trade. Today, higher commodity prices are associated with an *improvement* in the US terms of trade. The shift in the commodity price - US terms of trade relationship coincided with the "shale oil boom" that saw the US move from being a net commodity importer to a net commodity exporter, almost entirely due to a change in the US net oil balance. The third exercise documents a long-run positive relationship between US dollar strength and the US terms of trade, which has held firm even as the relationship between commodity prices and the US terms of trade has shifted.

Taken together, these results point to a change in the relationship between the US dollar and commodity prices going forwards. In the past, higher commodity prices went hand-in-hand with a lower US terms of trade and a weaker dollar. Today, the opposite is more likely to be the case.

This paper is related to two main strands of literature.

The first documents a strong association between exchange rates and commodity prices (or the terms of trade) among commodity-exporting economies, including Australia, Canada, Norway and South Africa (see Blundell-Wignall et al. (1993), Amano and van Norden (1995), Chen and Rogoff (2003), Kohlscheen et al. (2017) among many others).[2] A novel contribution of this paper is to show that a similarly close relationship holds between the US terms of trade and the US dollar. In this respect at least, the US dollar behaves like a commodity currency.

The results of this paper also shed light on the source of the "commodity currency" relationship. In particular, it suggests that the positive correlation between exchange rate strength and terms of trade among commodity exporters is driven primarily by the positive co-movement of US dollar strength and the US terms of trade. Because the terms of trade of commodity exporters have historically moved inversely to the US terms of trade, their currencies have tended to appreciate when commodity prices rise and the US terms of trade decline. This also explains why the exchange rates of non-US commodity importing economies typically do not strengthen when their terms of trade improve. A corollary of these results is that, if the US remains a net commodity exporter (so that rising commodity price improve the US terms of trade), the link between exchange rate strength and terms of trade among "commodity currencies" could become less evident in the future.

The second strand of literature charts the outsized implications of US dollar movements for global economic

[2]Because of the high volatility in commodity prices relative to the prices of manufacturing and goods and services, and the large weight of commodities in their export baskets, commodity price movements tend to drive the terms of trade of economies with "commodity currencies", see e.g. Gillitzer and Kearns (2005).

and financial conditions. The consensus in this literature is the US dollar strength is contractionary for the global economy, coinciding with with tighter global financial conditions (Bruno and Shin (2015a), Bruno and Shin (2015b), Avdjiev et al. (2019)), less international trade (Goldberg and Tille (2008), Gopinath et al. (2020), Bruno and Shin (2023)) and weaker global growth (Rey (2013), Obstfeld and Zhou (2022)). Historically, these contractionary effects of US dollar strength have been partly mitigated by lower commodity prices.[3] The conclusions of this paper suggest, however, that the US dollar strength is likely to go hand-in-hand with *higher* commodity prices in the future. Other things equal, this means that US dollar strength will exert an even larger contractionary effect on the global economy.

The rest of the paper is organised as follows. Section 2 documents the historical relationship between the US dollar and commodity prices, demonstrating that the recent deviation from typical correlation patterns has been historically unusual. Section 3 explores the relationships between commodity prices and the US terms of trade on the one hand, and the US terms of trade and the US dollar on the other, concluding that changes in these relationships suggest that a return to pre-pandemic correlations is unlikely. Section 4 puts these results in a broader context, by examining the relationships between currency and terms of trade movements in other countries. Section 5 concludes with a discussion of the policy implications of these results and directions for future research.

2 A historical relationship breaks down

To illustrate the historical relationship between the US dollar and commodity prices, I estimate models of the form:

$$\Delta \log(RUSD_t) = \beta_0 + \beta_1 \Delta x_t + \beta_2 \Delta \log(RUSD_{t-1}) + \varepsilon_t \tag{1}$$

where $\Delta \log(RUSD_t)$ is the log change in the BIS "narrow" real US dollar index between month $t-1$ and month t and Δx_t is the change in a commodity price.[4] Throughout this paper, I express the exchange rate as the foreign currency price of a unit of domestic currency, so that an increase in the exchange rate represents an appreciation. The models are estimated using monthly data over the sample 1986:1 to 2022:12.

I first estimate the model using the commodity price index shown in Figure 1. I construct the index by taking the first principal component of a panel of 52 commodity prices.[5] I then estimate separate models using as explanatory variables the log change in the US dollar price of each of the 52 individual commodities used to construct the index.

Consistent with the visual impression conveyed by Figure 1, the estimation results indicate a negative association between commodity prices and US dollar strength (Table 1). The point estimate for the commodity price index (column (I)) implies that a one standard deviation rise in commodity prices, roughly

[3] See Lizardo and Mollick (2010) and Klitgaard et al. (2019).

[4] The BIS narrow US dollar index is a trade-weighted average of the bilateral real exchange rate between the US dollar and the exchange rates of 27 other economies, see Klau and Fung (2006).

[5] See Appendix A for data sources and details of the construction of the commodity price index.

Table 1: US Dollar and Commodity Prices

		Energy		Industrial metals		Agricultural products	
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
	Com. index	Copper	Tin	Oil	Natural gas	Maize	Beef
Commodity price	-0.04^{***}	-0.08^{***}	-0.07^{***}	-0.03^{***}	-0.01^{**}	-0.00	-0.03
Lag exchange rate	0.28^{***}	0.30^{***}	0.33^{***}	0.33^{***}	0.36^{***}	0.36^{***}	0.36^{***}
Observations	444	444	444	444	444	444	444
Adj. R^2	0.19	0.22	0.20	0.16	0.13	0.12	0.13
Durbin-Watson	1.78	1.87	1.80	1.87	1.89	1.89	1.90

Notes: (i) *, ** and *** denote statistical significance at the 10, 5 and 1% levels. The regressions are estimated using OLS with White (1980) heteroskedasticity consistent standard errors. (ii) The dependent variable is the BIS real effective US dollar exchange rate. An increase in this variable represents an appreciation.

equivalent to that which occurred over 2021, is associated with a US dollar depreciation of about 4%.

A negative association with the US dollar is also evident for most individual commodity prices.[6] Industrial metals, such as copper and tin, generally exhibit the strongest relationships, both in terms of coefficient size and significance, as well as improvement in model fit (columns (II) - (III)). Energy commodities, such as oil and natural gas, also have a statistically significant negative relationship with the US dollar, but deliver only a marginal improvement in fit over a pure autoregressive model (columns (IV) - (V)). The prices of most agricultural and food products display a weaker relationship with the US dollar (columns (VI) - (VII)). The estimated coefficients on these commodity prices are generally negative, but rarely statistically significant.

Given these results, it is natural to ask whether the recent co-movement of the US dollar and commodity prices has been historically unusual. After all, while the models point to a statistically significant correlation between the US dollar and commodity prices, their fit is not particularly tight. Perhaps the post-Covid episode was just one of the many times over recent decades when the co-movement of commodity prices and the US dollar diverged from its typical pattern?

To address this question, I construct an historical simulation of the model.[7] That is, I calculate its fitted value in each month of the sample, using the previous month's fitted value as the lagged dependent variable. Relative to simply examining the model's residuals, the historical simulation isolates the predicted co-movement between commodity prices and the US dollar, independent of other persistent influences on the dollar's value that may work through the model's lagged dependent variable. Figure (2) presents the

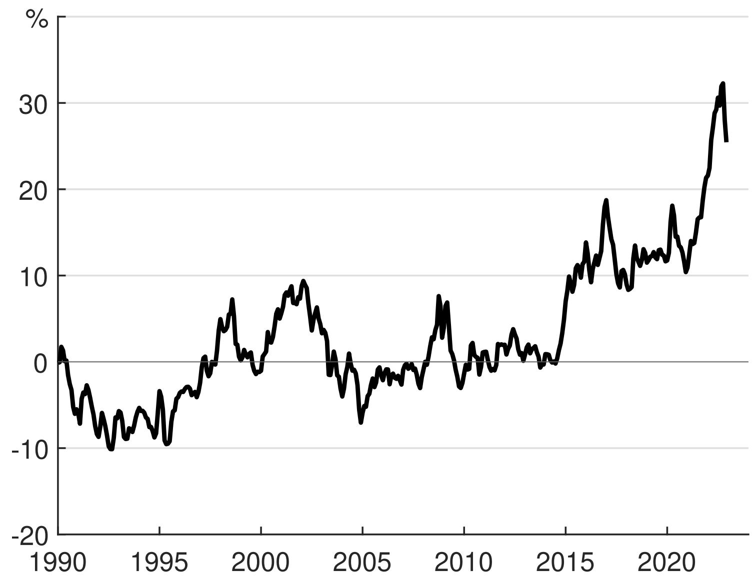
[6]Appendix B contains the full set of commodity-level results.

[7]For this exercise, I use the version of the model with the commodity price index as the explanatory variable.

resulting cumulative simulation error - i.e. it shows the deviation in the historical simulation's predicted *level* of the US dollar from its actual value.

This exercise reveals that the the post-pandemic divergence of US dollar and commodity price movements from their historical relationship was unprecedented. Given historical relationships, one would have expected the US dollar to depreciate by around 7% between late 2020 and September 2022. Instead, it appreciated by nearly 20%. At this time, the level of the US dollar was more than 30% stronger than that predicted by the dynamic simulation - the largest gap on record.

Figure 2: US Dollar Dynamic Simulation Error



Note: The Figure plots $100 \times (log(RUSD_t) - log(R\hat{USD}_t))$ where $R\hat{USD}_t$ is the predicted value of the real US dollar effective exchange rate from a dynamic simulation of the commodity price model described in Equation (1), using the coefficient values from Table (1).
Source: Authors' calculations.

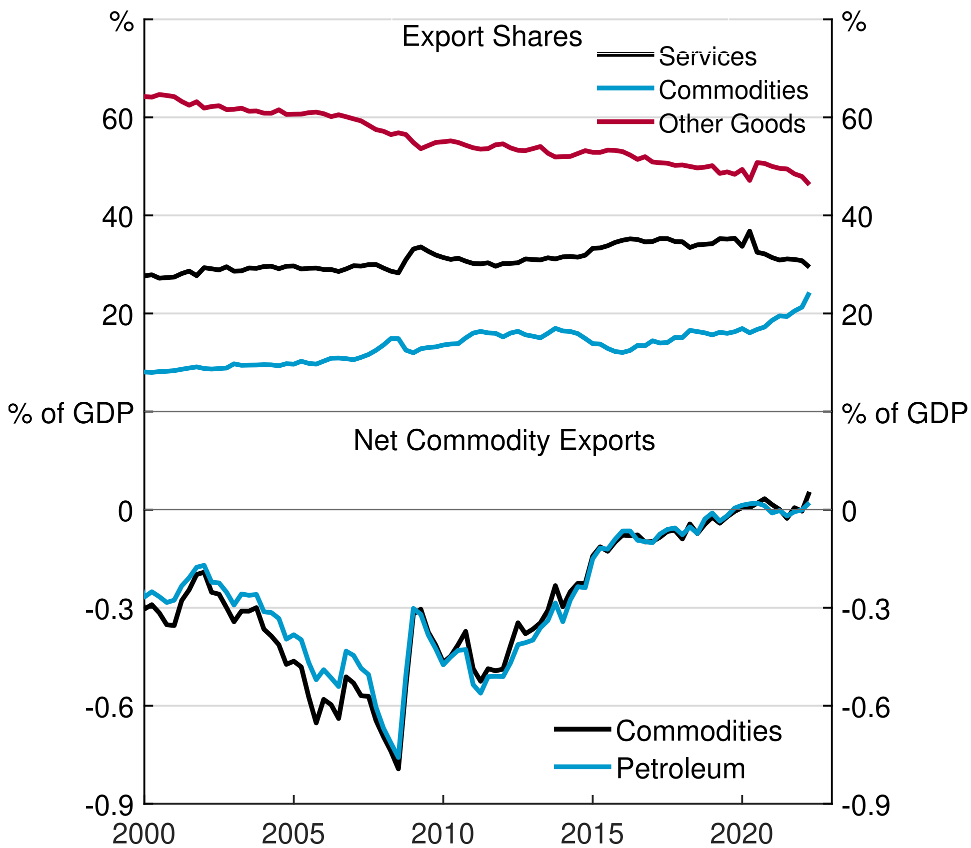
3 Will old correlations return?

Having reviewed the relationship between the US dollar and commodity prices in the past, this section asks whether historical correlations are likely to re-assert themselves in the future.

There are several reasons to expect a return to historical correlations. For one, the size and nature of the forces influencing commodity prices and exchange rates from 2020 onwards, including the Covid pandemic and Russia's invasion of Ukraine, were unusual and unlikely to be recurrent. As the effects of these shocks wane, one could reasonably expect any irregular correlations that they may have unleashed to fade.

Monetary policy could also matter. As global inflation surged in the aftermath of the Covid pandemic, monetary policy tightening started earlier, and advanced more rapidly, in the United States than in many other economies. Indeed, it is notable that countries that saw their currencies depreciate by less against the US dollar in 2022 – or even strengthened – such as the Brazilian Real and Mexican Peso, were those

Figure 3: US Trade Composition



Source: OECD, FRED, Authors' calculations.

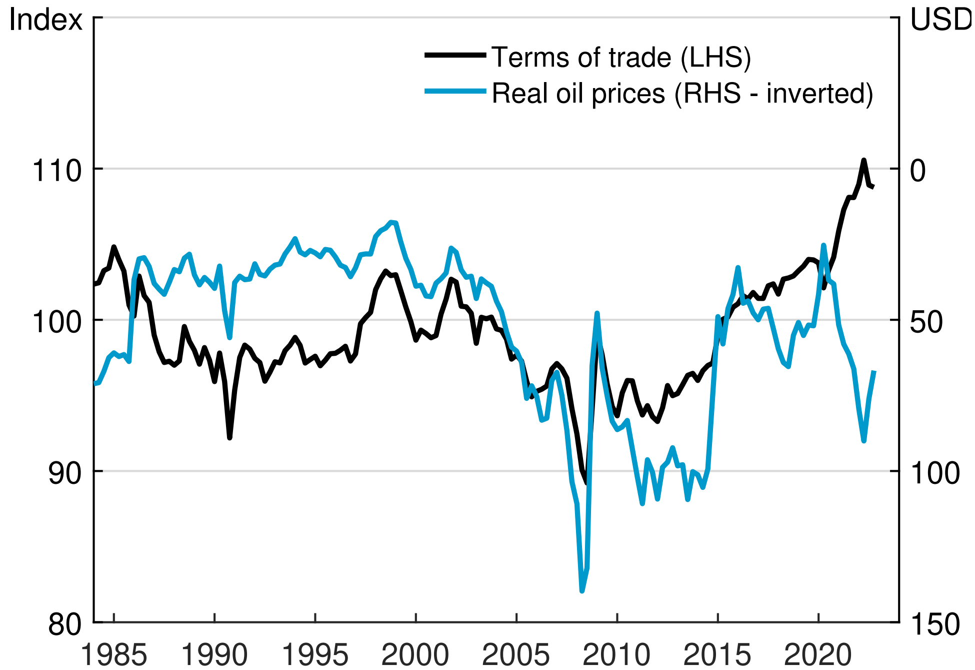
where central banks were quick to tighten monetary policy in the face of nascent inflationary pressures (Hofmann et al. (2022a)). This apparent disconnect between the monetary policy tightening phases in the United States and other economies is unlikely to persist indefinitely, however. If interest rate differentials did drive the breakdown in the standard relationship between the US dollar and commodity prices, the departure from standard correlations would likely be temporary.

At the same time, there are also reasons to think that positive co-movement between US dollar strength and commodity prices could become more common.

The changing patterns of US trade flows is a key one. Since the early 2000s, the composition of US exports has altered materially. Between 2000 and 2022, the share of commodities in total US exports increased by more than 10 percentage points, with a corresponding decline in the share of non-commodity goods (Figure 3, top panel). This shift was almost entirely due to a reversal in the balance of trade on petroleum products, including crude oil (bottom panel). As a result, the United States shifted from being a net importer of commodities to being a net exporter.

Changing trade patterns altered the drivers of the US terms of trade. Historically, the US terms of trade had moved inversely with commodity prices, particularly oil prices (Figure 4). For example, when oil and other commodity prices surged in the lead up to the Great Financial Crisis of 2008, the US terms of trade deteriorated. And when those prices subsequently fell, the US terms of trade improved.

Figure 4: US Terms of trade and real oil prices



Source: OECD, FRED, Authors' calculations.

When the US became a net commodity exporter, the correlation between the US terms of trade and commodity prices flipped. Less apparent during times when commodity prices were relatively stable, the change in this relationship became clear from late-2020, when sharp rises in oil and other commodity prices coincided with a marked improvement in the US terms of trade.

Formal econometric analysis confirms the visual messages of Figure (4). To illustrate this, I estimate the model:

$$\Delta \log(TOT_t) = \beta_0 + \beta_1 \Delta x_t + \varepsilon_t \tag{2}$$

where TOT_t is the US terms of trade - i.e. the ratio of the US export price deflator to the US import price deflator - evaluated at quarter t and Δx_t is either (i) the quarterly change in the commodity price index described above; or (ii) the quarterly log change in WTI oil prices. The estimation sample spans Q1 1986 to Q4 2022.[8] I use the Bai and Perron (1998) test for multiple structural breaks to identify potential shifts in the relationship, trimming the first and last 5% of the sample.

For both the commodity price index and oil prices, I find evidence of multiple breaks in the relationship with the US terms of trade. For the commodity price index, the estimated breaks occur in Q1 2010 and Q2 2019 (Table 2, (I)). Before the first break, a one standard deviation increase in commodity prices was associated with a roughly 3% deterioration in the US terms of trade. In the period between the first and the second break, there was no statistically significant relationship between commodity prices and the US

[8]Because the export and import deflators are sourced from the National Accounts, it is not possible to use monthly or higher frequency data for this exercise.

terms of trade. After the second break, a one standard deviation rise in commodity prices was associated with a roughly 3% *increase* in the US terms of trade, the inverse of the relationship in the first part of the sample.

Table 2: US Terms of trade and commodity prices

	(I) Commodity prices			(II) Oil prices		
	Pre break 1 1986Q1-2010Q1	Pre break 2 2010Q2-2019Q2	Post break 2 2019Q3-2022Q4	Pre break 1 1986Q1-2012Q2	Pre break 2 2012Q3-2019Q2	Post break 2 2019Q3-2022Q4
Commodity price	-0.03^{***}	-0.01	0.03^{***}	-0.07^{***}	-0.01	0.04^{***}
Intercept	0.00	0.00	0.00	0.00	0.00	0.00
Observations	97	37	14	106	23	18
Adj. R^2		0.27			0.53	
Durbin-Watson		1.94			1.90	

Notes: (i) *, ** and *** denote statistical significance at the 10, 5 and 1% levels. The regressions are estimated using OLS with White (1980) heteroskedasticity consistent standard errors.

The results for oil prices are qualitatively similar. The first break is estimated to occur slightly later than for the commodity price index, in Q2 2012. The second is estimated to occur in Q2 2019 (Table 2, (II)). Before the first break, a one per cent increase in oil prices is estimated to diminish the US terms of trade by 0.07%. In the second regime, oil prices have a negligible and statistically insignificant relationship with the US terms of trade. In the final regime, a 1% per cent increase in oil prices *improves* the US terms of trade by 0.04%. The relationships in both the first and third regimes are statistically significant.

The timing of the coefficient breaks, and resulting changes in the signs of the US terms of trade - commodity price relationship, are intuitive. The estimated breaks in the early 2010s coincide with the start of the shale oil boom in the United States. This saw a rapid increase in US oil production and the gradual evolution of the United States from being a net commodity importer to net exporter. Naturally, at this time higher commodity prices started to exert a smaller negative influence on the US terms of trade. The second break, around 2019, occurred around the time that the US became a net exporter of oil and other energy products. At this point, higher commodity prices started to boost the US terms of trade.

The changing relationship between commodity prices and the US terms of trade in turn has implications for the US dollar. In recent decades, the dollar and US terms of trade have displayed a remarkably stable and statistically robust relationship.[9] To illustrate this, I estimate models of the form:

$$\begin{aligned}\Delta \log(RUSD_t) =& \mu + \gamma \left[\log(RUSD_{t-1}) - \beta_1 \log(TOT_{t-1}) - \beta_2 GAP_{t-1}\right] \\ &+ \alpha_1 \Delta \log(TOT_t) + \alpha_2 \Delta(VIX_t) \\ &+ \alpha_3 \Delta \log(RUSD_{t-1}) + \alpha_4 \times TREND_t + \varepsilon_t \end{aligned} \tag{3}$$

where $RUSD_t$ is the real US dollar effective exchange rate, GAP_t is the gap between real policy interest rates in the US and those abroad, VIX_t is the VIX option implied volatility index and $TREND_t$ is a time trend.[10] The estimation sample is Q1 1986 to Q4 2022.

The model in Equation (3) is written in error-correction form. The term in square brackets represents the long-run relationship between the US dollar, the US terms of trade and the gap between US and overseas real interest rates.[11] The coefficients β_1 and β_2 govern the long-run elasticity of the US real exchange rate with respect to the US terms of trade and interest rate differentials. The coefficient γ represents the 'speed of adjustment' of the US dollar to its long-run fundamentals.[12] If this coefficient is negative then the real US dollar will tend to 'error correct' towards its long-run value.[13]

The remaining variables are included to capture 'short-run' drivers of the real US dollar. These include the contemporaneous growth rate of the terms of trade and a lag of the dependent variable.[14] The VIX is included to control for changes in risk aversion, which could affect the value of the US dollar as a 'safe haven' asset. The time trend controls for other persistent factors not explicitly included in the model.[15]

The appropriate measure of the interest rate gap to use in Equation (3) is open to debate. To illustrate the sensitivity to alternative choices, I estimate four versions of the model. The first omits the real interest rate gap altogether. The other three include the gap between the US real policy rate and those of (i) the euro area (Germany before 1999), (ii) the average of the euro area and Japan, and (iii) the average of the euro area, Japan and the United Kingdom. I calculate real policy rates by deflating nominal policy rates with an estimate of trend inflation extracted by applying a one-side HP filter with a smoothing parameter of 100,000 to year-on-year CPI inflation for each economy.[16]

The resulting estimates point to an economically and statistically significant long-run relationship between

[9] A positive relationship between exchange rates strength and terms of trade is a standard feature of theoretical models of open economies, for example Gali and Monacelli (2005).

[10] I use the VXO index before 1990.

[11] Note that because Equation (3) is linear, the estimates are identical if one instead considers the real interest rate gap to be part of the model's short-run dynamics.

[12] If one assumes that average growth rate of the US terms of trade and US dollar are zero, then the equilibrium value of the US dollar is given by: $\log(RUSD) = -\frac{1}{\gamma}\left[\mu - \beta_1 \log(TOT_t) - \beta_2 GAP_t + \alpha_4 \times t\right]$.

[13] Ignoring constants and time trends, if the real US dollar is above its equilibrium value, then the term in square brackets will be positive. Other things equal, a negative value of γ means that the US dollar will depreciate, i.e. move towards its long-run fundamental value.

[14] Preliminary analysis including the contemporaneous change in the real interest rate gap found that this term was always statistically insignificant.

[15] For example, the terms of trade variable is based on the export and import prices of the United States relative to all of its trading partners, while the exchange rate measure is based on bilateral exchange rates with only 27 other economies.

[16] The estimated relationship between the US dollar and the US terms of trade - the focus of this paper - is unchanged if I instead calculate real interest rates by deflating policy interest rates by contemporaneous year-on-year CPI inflation.

the US dollar and the US terms of trade (Table 3). The estimated speed of adjustment coefficient is around −0.17, implying a half-life of deviations of the US dollar from its fundamental value of about one year. The point estimates of the long-run elasticity of the US dollar to the US terms of trade lie between 1.69 and 1.83 and are highly significant, implying that a permanent 1% improvement in the US terms of trade leads to a US dollar appreciation of slightly more than 1.5%. The short run coefficient on the terms of trade suggests that around half of the effect of US terms of trade movements on the US dollar occur contemporaneously.

Table 3: Baseline USD real exchange rate model

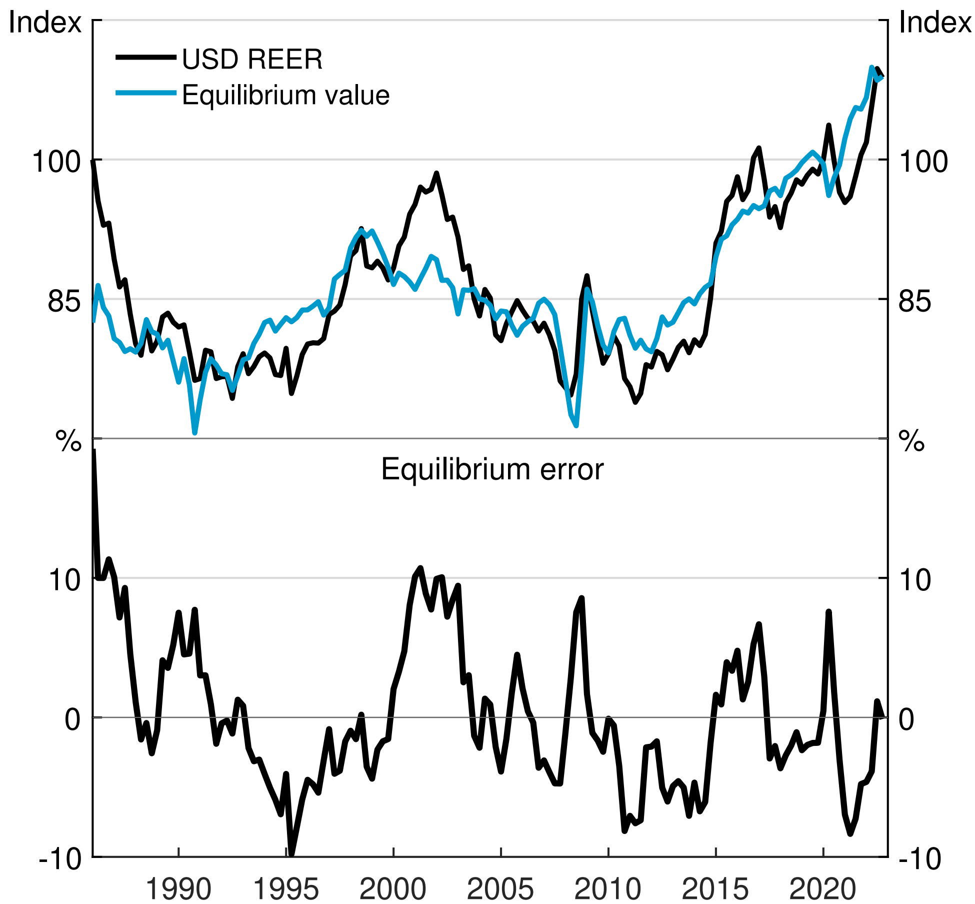
		Interest rate gap relative to:		
	(I)	(II)	(III)	(IV)
	No rate gap	Euro area	Euro area + Japan	Euro area + Japan + UK
Constant (μ)	−0.66**	−0.59*	−0.56*	−0.58*
Speed of adjustment (γ)	−0.16***	−0.17***	−0.17***	−0.17***
Equilibrium relationships				
Terms of trade (β_1)	1.83***	1.70***	1.64***	1.69***
Interest rate gap (β_2)		0.76	1.10*	1.05
Short-run relationships				
Δ terms of trade (α_1)	0.87***	0.88***	0.89***	0.88***
ΔVIX(α_2)	0.09*	0.09*	0.08*	0.09*
Lagged Δ exchange rate (α_3)	0.13*	0.13*	0.12	0.13*
Time trend (α_4)	0.01***	0.01***	0.02***	0.01**
Observations	147	147	147	147
Adj. R^2	0.29	0.29	0.30	0.29
Durbin-Watson	1.95	1.96	1.96	1.95

Notes: (i) *, ** and *** denote statistical significance at the 10, 5 and 1% levels. (ii) The regressions are estimated using OLS with White (1980) heteroskedasticity consistent standard errors. (iii) Coefficients on the time trend multiplied by 100.

The model's other coefficients are of the expected sign, although generally less significant. The coefficient on the interest rate gap is positive but statistically significant at the 10% level only in the model using the average of the euro area and Japanese policy rates. An increase in the VIX is estimated to coincide with an appreciation of the US dollar, consistent with its status as a 'safe haven' currency.

The estimated model accounts for most of the low-frequency variation in the real US dollar over recent

Figure 5: US Real Exchange Rate



Source: OECD, FRED, Authors' calculations.

decades. For example, the model's estimated equilibrium real US dollar effective exchange rate tracks the actual exchange rate closely (Figure 5, top panel).[17] Although the US dollar departed from its estimated equilibrium value by as much as 10% on some occassions, these deviations were in most cases rapidly reversed (bottom panel). One such deviation occurred early in the Covid pandemic. But, by the end of 2022, the model estimates suggest that the US dollar was about where one would have expected it to be, given the level of the US terms of trade and US and overseas real interest rates.[18]

4 Commodity Currencies Revisited

The previous section documented a robust long-run relationship between the US dollar and the US terms of trade. In this respect, the US dollar resembles the "commodity currencies" of large commodity exporters. In contrast, the exchange rates of commodity importing economies display quite different dynamics.

[17]Although Figure 5 plots the estimated equilibrium US dollar from model (IV) in Table 3, the estimates from other models were very similar.

[18]The estimates from model (I) in Table 3, which does not include a real interest rate gap, were very similar, confirming that this results reflects terms of trade-related developments rather than diverging monetary policy settings.

To illustrate this, I first estimate variants of the model in Equation (3) for eight commodity exporters: Australia, Brazil, Canada, Columbia, Mexico, New Zealand, Norway and South Africa.[19] For the interest rate gap, I use the difference between country-specific real policy rates and the average real policy interest rates of the United States, euro area and Japan.[20] I then estimate the same model for a selection of commodity-importing economies: Belgium, Denmark, Finland, France, Germany, Italy, Japan, Korea, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the euro area.[21]

In line with past literature, I find a strong positive relationship between the terms of trade and real exchange rates of commodity exporters. For each country in the sample, the long-run coefficient on the terms of trade is positive (and generally statistically significant), while the speed of adjustment coefficient is negative, indicating that their exchange rates appreciate as commodity prices rise (Table 4). For these countries, the coefficients on the interest rate gap were generally positive, although never significant. One point of difference from the US model is that the coefficient on the VIX is negative and significant for the commodity exporters and, for the emerging markets and Australia, much larger in absolute value than in the US dollar model.

The currencies of non-commodity exporters behave differently (Table 5). For these countries, the coefficient on the level of the terms of trade is always insignificant (with the marginal exception of Spain), and in many cases negative. In other words, it is hard to pinpoint a stable long-run relationship between the real exchange rate and terms of trade for these economies. Admittedly, in around half of the countries examined, the coefficient on contemporaneous terms of trade growth is still positive and statistically significant.[22] But even with that caveat, the results for commodity importers are very different from those for the United States or the commodity-exporting economies.

Real exchange rates and terms of trade are relative prices. How can it be that for one group of countries exchange rate strength and terms of trade display a positive and significant relationship, but not in the other group?

To answer this question, it helps to consider the patterns of correlations across countries for both terms of trade and real exchange rates.

Consider first the terms of trade. For this variable, countries divide into two distinct blocs. The terms of trade of commodity exporters are positively correlated with each other and negatively with the terms of trade of non-commodity exporters (Figure 6). Similarly, the terms of trade of non-commodity exporters

[19]The country selection was dictated by data availability. The categorisation of Mexico as a commodity exporter is debatable. Although oil accounted for a significant share of Mexico's exports in the early years of the data sample, its share of total exports had fallen to around 5% by the late 2010s. Nonetheless, in the next section I present evidence that, on average over the data sample considered in this paper, Mexico's terms of trade has been more closely correlated with those of commodity exporting economies than those of commodity importers.

[20]Results using the gap with the US real policy rate were very similar.

[21]The country selection is driven by data availability. For the models featuring Japan and euro area economies I use the United Kingdom real interest rate, rather than the domestic real interest rate, to calculate the foreign real interest rate in used to calculate the interest rate gap variable.

[22]Another key difference between the results for non-commodity exporters is that the coefficient on the VIX is often insignificant, with the exception of Japan and Switzerland, where it is positive and significant.

Table 4: Real exchange rate models: Commodity exporters

	Australia	Brazil	Canada	Colombia	Mexico	New Zealand	Norway	South Africa
Constant (μ)	0.20**	−0.38	−0.19	0.88***	0.12	0.13	0.60***	0.33
Speed of adjustment (γ)	−0.12***	−0.13**	−0.07***	−0.28***	−0.17***	−0.12**	−0.15***	−0.19***
Equilibrium relationship								
Terms of trade (β_1)	0.67***	1.63***	1.72***	0.67***	1.02*	0.74	0.24***	0.99*
Interest rate gap (β_2)	0.40	0.51	−1.74	1.14	2.07	0.24	0.19	0.70
Short-run relationships								
Δ terms of trade (α_1)	0.26**	−0.02	0.43***	0.13*	0.15	0.15*	0.10***	0.07
VIX (α_2)	−0.36***	−0.47***	−0.14***	−0.24***	−0.32***	−0.13**	−0.10**	−0.40***
Lagged Δ exchange rate (α_3)	0.16*	0.37***	0.17*	0.24**	0.24**	0.24**	0.10	0.32***
Trend (α_3)	−0.01	−0.02	−0.03**	−0.17***	−0.06**	0.01	−0.03**	−0.13**
Observations	145	105	145	69	94	137	145	112
Adj. R^2	0.38	0.22	0.35	0.30	0.32	0.15	0.18	0.27
Durbin-Watson	2.14	2.05	2.04	2.01	2.31	2.11	1.95	2.10

Notes: (i) *, ** and *** denote statistical significance at the 10, 5 and 1% levels. The regressions are estimated using OLS with White (1980) heteroskedasticity consistent standard errors.

Table 5: Real exchange rate models: Non-commodity exporters

	Belgium	Denmark	Finland	France	Germany	Italy	Japan
Constant (μ)	0.27	0.48	0.49**	0.45	0.09	0.40	0.51
Speed of adjustment (γ)	−0.08**	−0.08*	−0.06*	−0.08**	−0.07*	−0.05	−0.12**
Equilibrium relationship							
Terms of trade (β_1)	0.20	−0.44	−0.75	−0.14	0.75	−0.63	0.32
Interest rate gap (β_2)	1.47	2.26	−0.75	0.51	2.23	2.12	4.63
Short-run relationships							
Δ terms of trade (α_1)	−0.07	0.03	0.10	−0.14	0.31**	0.19***	0.58***
ΔVIX(α_2)	−0.01	0.00	0.01	0.00	−0.02	−0.02	0.27***
Lagged Δ exchange rate (α_3)	0.27**	0.14	0.33**	0.35***	0.18**	0.21*	0.22**
Trend (α_4)	0.01***	0.01	−0.02**	−0.01**	0.00	0.00	−0.06**
Observations	109	109	129	146	125	105	114
Adj. R^2	0.11	0.02	0.35	0.12	0.13	0.21	0.26
Durbin-Watson	2.02	1.96	1.92	1.94	1.92	2.08	1.79

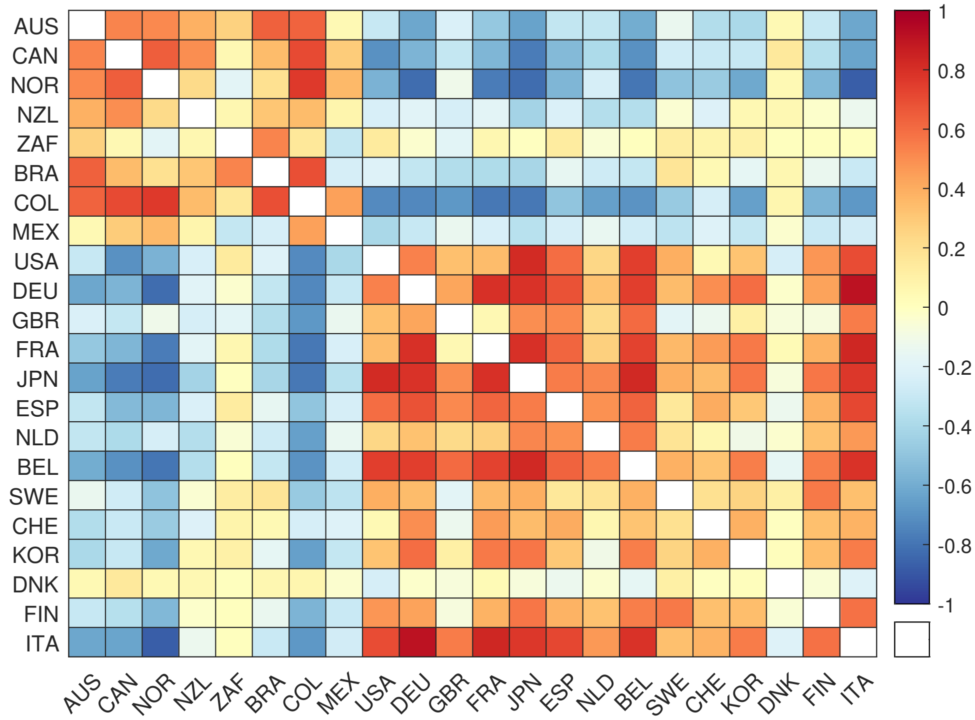
Notes: (i) *, ** and *** denote statistical significance at the 10, 5 and 1% levels. The regressions are estimated using OLS with White (1980) heteroskedasticity consistent standard errors.

Table 5: Real exchange rate models: Non-commodity exporters (Continued)

	Dependent variable: Natural logarithm of REER						
	Korea	Netherlands	Spain	Sweden	Switzerland	United Kingdom	Euro area
Constant (μ)	0.17	−0.34	−0.08	0.47	0.26	0.26	0.44
Speed of adjustment (γ)	−0.06	−0.09***	−0.05**	−0.13***	−0.06*	−0.12***	−0.06
Equilibrium relationship							
Terms of trade (β_1)	0.06	1.77	1.35*	0.32	0.01	0.62	−0.79
Interest rate gap (β_2)	−31.51	1.77	1.36	0.32	9.11	2.04	−0.14
Short-run relationships							
Δ terms of trade (α_1)	0.16	0.15	0.02	0.69**	0.72***	0.58***	0.81***
ΔVIX(α_2)	−0.26**	0.01	−0.02**	−0.15**	0.10***	−0.02	−0.07**
Lagged Δ exchange rate (α_3)	0.21**	0.19**	0.20	0.24**	0.14	0.32***	0.28***
Trend (α_4)	0.03*	0.00*	0.00	−0.02	0.00	−0.02	0.00
Observations	92	146	110	117	145	146	109
Adj. R^2	0.32	0.10	0.06	0.20	0.23	0.15	0.13
Durbin-Watson	2.17	1.99	1.81	2.07	2.12	1.95	2.05

Notes: (i) *, ** and *** denote statistical significance at the 10, 5 and 1% levels. The regressions are estimated using OLS with White (1980) heteroskedasticity consistent standard errors.

Figure 6: Terms of trade correlations



Note: Each square in the graph shows the correlation between year-on-year terms of trade growth in a given country-pair. Sample periods vary between country pairs depending on data availability, with a maximum sample of Q1 1986 - Q4 2022.
Source: OECD, FRED, Authors' calculations.

are positively correlated with each other and negatively correlated with those of commodity exporters.[23]

Exchange rate correlations are different. In the case of trade-weighted exchange rates, the existence of two country blocks is much less clear. Admittedly, the trade-weighted exchange rates of commodity exporters typically move together (Figure 7). But their correlation with those of non-commodity exporters is often close to zero, and at times also positive. Among commodity importers, exchange rate correlations are high among members of the euro area, but not particularly strong elsewhere.[24] The US dollar is an outlier, as its exchange rate is negatively correlated with almost every other currency in the sample.

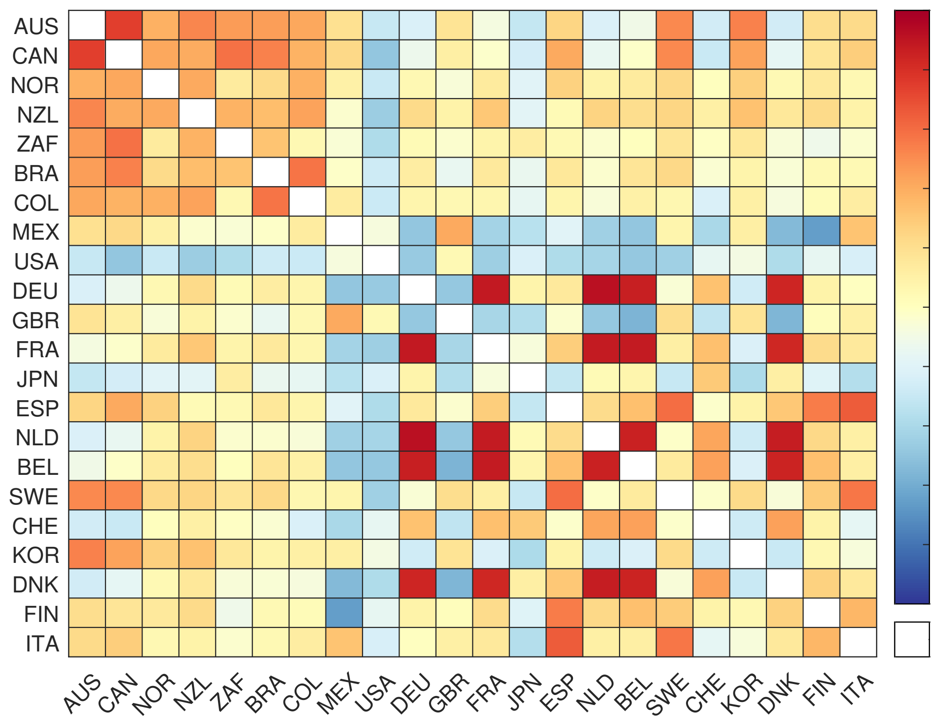
The picture is even more stark when one considers the correlations of bilateral US dollar real exchange rates. Relative to the US dollar, the real exchange rates of almost all of the countries in the sample are positively correlated, with the exception of Mexico (Figure 8).

Taken together, the results of Figures (6 - 8) help to rationalise the absence of a strong positive relationship between the terms of trade and exchange rate strength among commodity importers. Shifts in a country's terms of trade reflect the composition of its export base. Those of commodity exporters typically move

[23]Note that because these calculations are based on terms of trade movements over the entire data sample, the US terms of trade is positively correlated with those of the non-commodity exporting countries.

[24]The correlation between the trade-weighted exchange rates of euro are members are not one because of differences in trade weights, in the domestic price indices used to calculate real exchange rates and because the sample used to calculate the correlations includes periods in which these countries had seperate national currencies.

Figure 7: Real trade weighted exchange rate correlations



Note: Each square in the graph shows the correlation between year-on-year log change in the real effective exchange rates of a given country-pair. Sample periods vary between country pairs depending on data availability, with a maximum sample of Q1 1986 - Q4 2022.
Source: OECD, FRED, Authors' calculations.

together, and inversely to those of commodity importers. But, relative to the US dollar, all other exchange rates by and large move together, regardless of export composition. The positive relationship between the US dollar and US terms of trade translates into negative, or at most negligible, co-movement between the exchange rates and terms of trade of those countries with a similar export base to the US. Historically, that has meant commodity importers. In the future it will be commodity exporters.

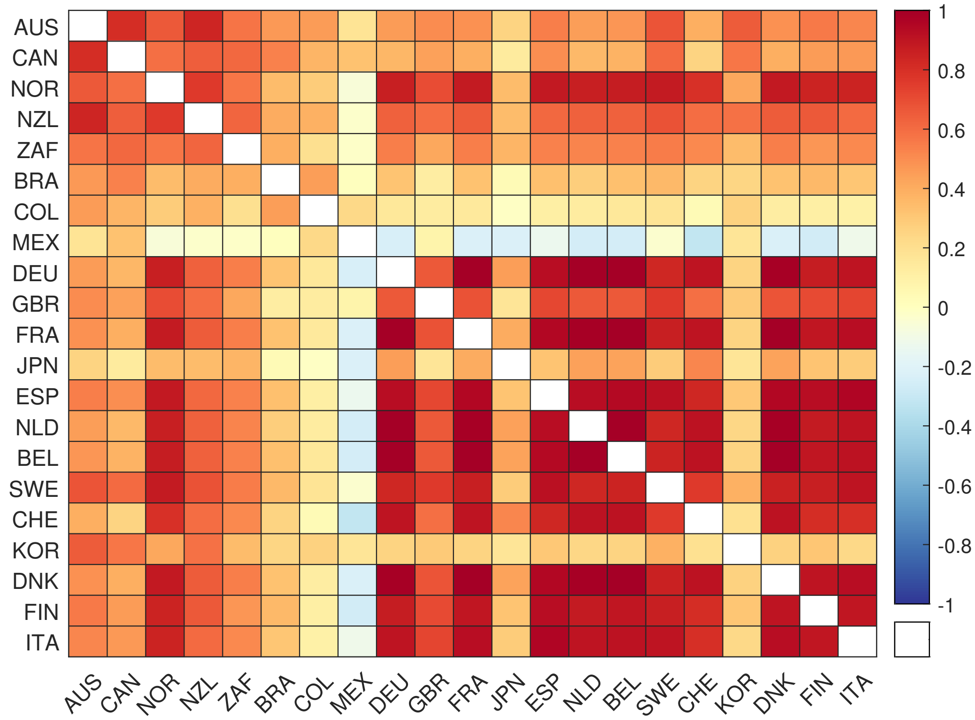
5 Conclusion

Several questions arise from the above results. How will exchange rate behaviour change going forward if the US remains a net oil exporter and the historical correlation between the US dollar and US terms of trade persists? And what will that mean for commodity importers and commodity exporters?

Starting with exchange rates, the results of this paper suggests that US dollar appreciation is more likely to go hand-in-hand with higher commodity prices than in the past.

An immediate implication of this is that non-US economies could face greater volatility in commodity prices, when measured in their own currencies. To give a concrete example, if US dollar oil prices rise by 10%, but the US dollar depreciates by 10% against all other currencies, oil prices measured in non-US

Figure 8: Real US Dollar correlations



Note: Each square in the graph shows the correlation between year-on-year log change in the real bilateral US dollar rates of a given country-pair. Sample periods vary between country pairs depending on data availability, with a maximum sample of Q1 1986 - Q4 2022.
Source: OECD, FRED, Authors' calculations.

currencies are unchanged. But if oil prices rise by 10% *and* the US dollar appreciates by 10% against all other currencies, non-US economies will see oil prices measured in their currencies rise by 20%.

Admittedly, the effects of a shift in US dollar - commodity price correlations may not be so mechanical. Commodity prices are endogenous. A positive correlation between US dollar strength and higher commodity prices could make global demand more responsive to changes in US dollar commodity prices. This, in turn, could diminish the required response of US dollar commodity prices to any given economic shock. As a result, US consumers and firms could face less commodity price volatility.

A shift in the relationship between commodity prices and the US dollar could also weaken the "commodity currency" relationship between the exchange rates and terms of trade of commodity exporters. The results of the previous section suggest that this relationship reflects (i) a negative relationship between the terms of trade of commodity exporting and those of the United States, and (ii) a negative exchange rate correlation with the US dollar that is common to all countries, regardless of export composition. If exchange rate correlations remain stable, but the US terms of trade co-moves positively with commodity prices then it follows that the exchange rates of other commodity exporting economies will strengthen by less when commodity prices rise.

The effects of an increased correlation between US dollar strength and commodity prices are likely to be felt most acutely in commodity importing economies. For these countries, rises in US dollar commodity prices will become more inflationary, with the contractionary effects on output exacerbated by the tighter global financial conditions induced by US dollar appreciation (possibly offset by increased international competitiveness *vis-a-vis* the United States).[25]

But commodity exporters will also be affected. If their exchange rates appreciate by less against the US dollar during commodity booms, and depreciate by less during busts, exchange rate movements may provide a less effective 'shock absorber' for these countries than in the past.[26] As a result, more active macroeconomic stabilisation policies may be needed to manage the economic consequences of commodity price movements.

[25] See Hofmann et al. (2023)

[26] See Manalo et al. (2015).

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Appendix (For Publication)

A Data Sources

Commodity prices:

Individual commodity price series are sourced from the World Bank's "Pink Sheet" database.

The commodity price index is constructed using data from all commodities in the Pink Sheet database with complete monthly data from 1982 - 2022. This leaves 52 commodities: aluminum, bananas, beef, coal, cocoa, coconut oil, coffee (Arabica), coffee (Robusta), copper, cotton, crude oil (Brent), crude oil (WTI), DAP, fish meal, gold, groundnut oil, groundnuts, iron ore, lead, liquified natural gas, logs (Cameroon), logs (Malaysian), maize, chicken, natural gas (Europe), natural gas (US), nickel, oranges, palm oil, phosphate rock, platinum, plywood, potassium chloride, rice (Thai), rubber, sawnwood, shrimps, silver, soybean meal, soybean oil, soybeans, sugar (EU), sugar (US), tea (Colombo), tea (Kolkata), tea (Mombasa), tin, tobacco, TSP, urea, wheat, zinc.

To construct the commodity price index, I first deflate all series by the US CPI. I normalise the resulting series to have a mean of zero and standard deviation of one over the sample 1982-2022. I then extract the first principal component of the resulting data panel. Finally, to ease the interpretation of the regression results I normalise the resulting principal components series to have a standard deviation of one.

Terms of trade:

The terms of trade for each country is constructed as the ratio of the export price deflator to the import price deflator from the national accounts. The source for the deflators is the OECD.

Real exchange rates:

Nominal and real effective exchange rates are sourced from the BIS. For all countries except Brazil, Columbia and Mexico I use "narrow" exchange rate series, which are calculated based on a smaller number of bilateral exchange rates than the "broad" series (27 versus 64), but have a longer time series available. Because "narrow" measures are not available for Brazil, Columbia and Mexico, I use "broad" series, which are available from 1994.

Policy interest rates:

Where available, policy interest rates are sourced from the BIS. Where BIS data is unavailable, I use short term interest rate series from the OECD.

B Additional results

B.1 USD and commodity prices

Table B.1: US Dollar and Commodity Prices

	Aluminum	Bananas	Chicken	Coal	Cocoa	Coconut oil	Coffee: Arabica
Com. price	-0.06^{***}	-0.00	0.01	-0.01	-0.04^{***}	-0.03^{***}	-0.01
Lag exchange rate	0.31^{***}	0.36^{***}	0.36^{***}	0.35^{***}	0.34^{***}	0.34^{***}	0.36^{***}
Intercept	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations	444	444	444	444	444	444	444
Adj. R^2	0.18	0.12	0.12	0.13	0.15	0.15	0.13
Durbin-Watson	1.86	1.89	1.89	1.89	1.87	1.88	1.89

	Coffee: Robusta	Corn	Cotton	DAP	Fish meal	Gold	Groundnut oil
Com. price	-0.03^{**}	-0.01^{***}	-0.03^{**}	-0.00	-0.02	-0.14^{***}	0.00
Lag exchange rate	0.35^{***}	0.29^{***}	0.35^{***}	0.36^{***}	0.35^{***}	0.32^{***}	0.36^{***}
Intercept	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations	442	442	444	444	444	444	444
Adj. R^2	0.15	0.21	0.14	0.13	0.13	0.23	0.12
Durbin-Watson	1.89	1.82	1.88	1.89	1.89	1.87	1.90

	Groundnuts	Iron Ore	Lead	LNG	Logs: CMR	Logs: MYS	Natural Gas
Com. price	-0.01	-0.03^{**}	-0.05^{***}	0.02	-0.23^{***}	-0.09^{***}	0.00
Lag exchange rate	0.35^{***}	0.32^{***}	0.32^{***}	0.36^{***}	0.24^{***}	0.37^{***}	0.36^{***}
Intercept	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations	442	442	444	444	444	444	444
Adj. R^2	0.13	0.15	0.18	0.13	0.37	0.21	0.12
Durbin-Watson	1.89	1.88	1.88	1.90	1.82	1.87	1.90

	Nickel	Oranges	Palm oil	Phosphate	Platinum	Plywood	Potassium
Com. price	-0.04^{***}	-0.01^{**}	-0.04^{***}	0.02^{*}	-0.08^{***}	-0.12^{***}	0.01
Lag exchange rate	0.32^{***}	0.37^{***}	0.33^{***}	0.36^{***}	0.30^{***}	0.35^{***}	0.36^{***}
Intercept	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations	442	442	444	444	444	444	444
Adj. R^2	0.18	0.13	0.16	0.14	0.21	0.22	0.13
Durbin-Watson	1.83	1.90	1.86	1.91	1.90	1.86	1.90

Notes: (i) *, ** and *** denote statistical significance at the 10, 5 and 1% levels. The regressions are estimated using OLS with White (1980) heteroskedasticity consistent standard errors. (ii) The dependent variable is the BIS real effective US dollar exchange rate. An increase in this variable represents an appreciation.

Table B.1: US Dollar and Commodity Prices (Continued)

	Rice	Rubber	Sawnwood	Shrimps	Silver	Soy meal	Soy oil
Com. price	-0.00	-0.03^{**}	-0.09^{***}	0.00	-0.06^{***}	-0.03^{**}	-0.04^{***}
Lag exchange rate	0.36^{***}	0.33^{***}	0.35^{***}	0.36^{***}	0.33^{***}	0.34^{***}	0.34^{***}
Intercept	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations	444	444	444	444	444	444	444
Adj. R^2	0.12	0.15	0.16	0.12	0.20	0.14	0.15
Durbin-Watson	1.89	1.86	1.90	1.89	1.87	1.88	1.87

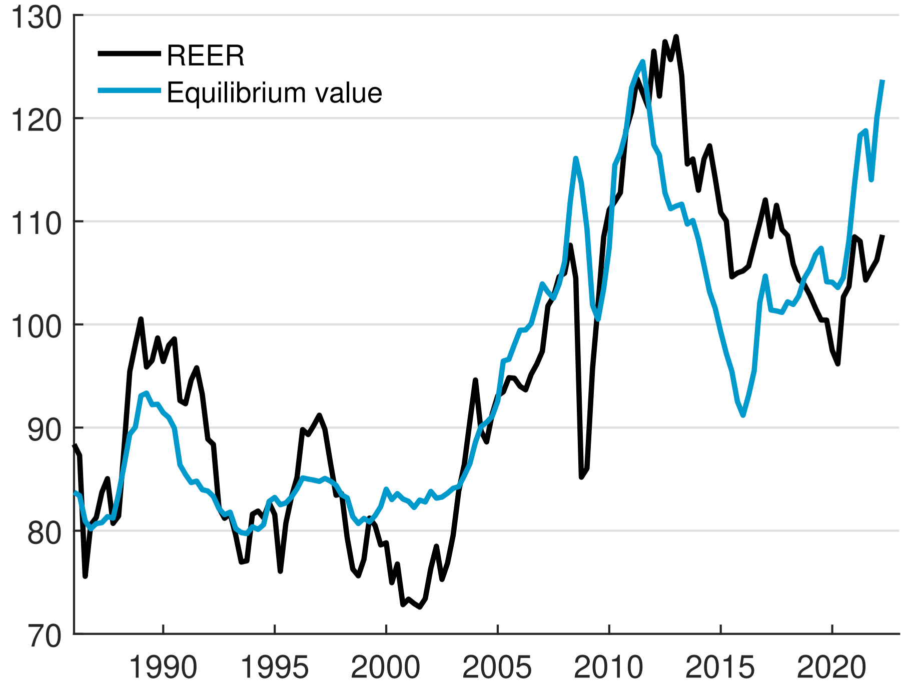
	Soybeans	Sugar: EU	Sugar: US	Tea: Col.	Tea: Kol.	Tea: Mom.	Tobacco
Com. price	-0.05^{***}	-0.31^{***}	-0.02	0.00	-0.01	-0.00	0.05
Lag exchange rate	0.33^{***}	0.21^{***}	0.36^{***}	0.36^{***}	0.36^{***}	0.36^{***}	0.35^{***}
Intercept	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations	444	444	444	444	444	444	444
Adj. R^2	0.15	0.48	0.13	0.13	0.13	0.12	0.13
Durbin-Watson	1.87	1.86	1.89	1.89	1.88	1.89	1.90

	TSP	Urea	Wheat	Zinc
Com. price	-0.00	0.01	-0.03^{**}	-0.06^{***}
Lag exchange rate	0.36^{***}	0.37^{***}	0.35^{***}	0.33^{***}
Intercept	0.00	0.00	0.00	0.00
Observations	444	444	444	444
Adj. R^2	0.12	0.13	0.14	0.19
Durbin-Watson	1.89	1.90	1.90	1.83

Notes: (i) *, ** and *** denote statistical significance at the 10, 5 and 1% levels. The regressions are estimated using OLS with White (1980) heteroskedasticity consistent standard errors. (ii) The dependent variable is the BIS real effective US dollar exchange rate. An increase in this variable represents an appreciation.

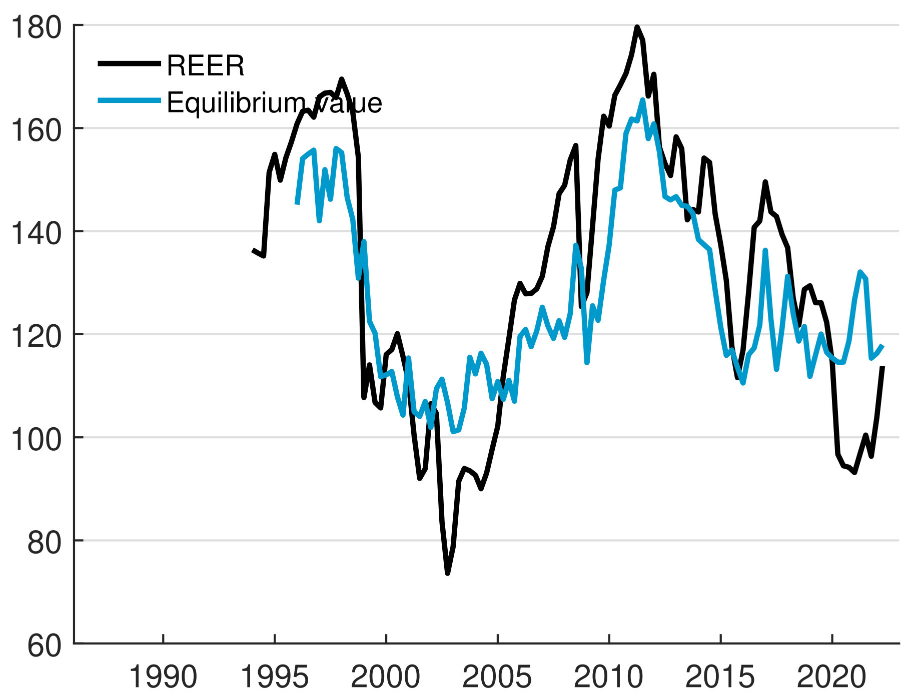
B.2 Real and Equilibrium Exchange Rates for Commodity Exporting Economies

Figure B.1: Australia



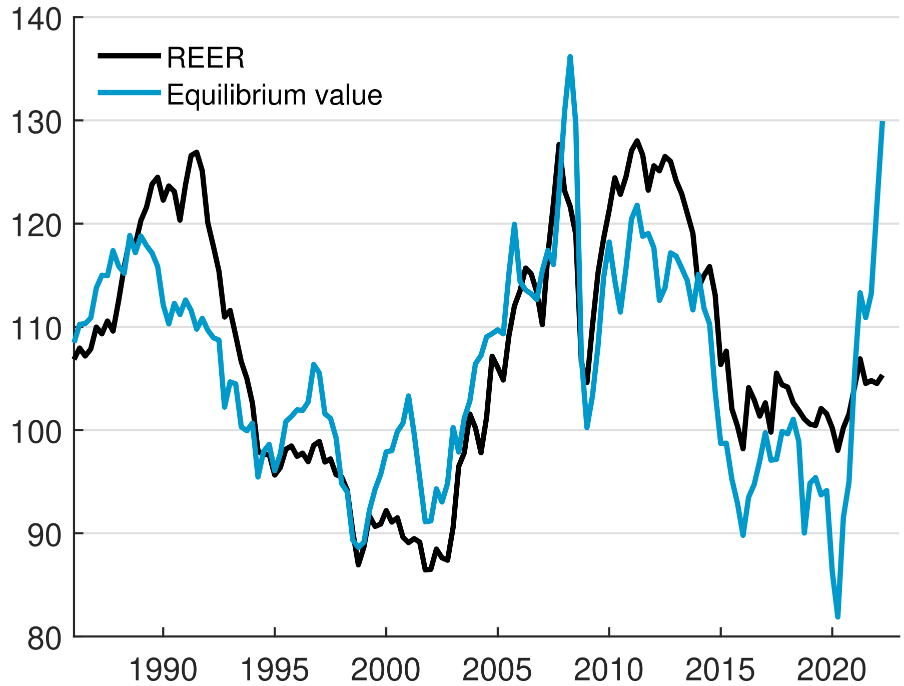
Source: BIS, Authors' calculations.

Figure B.2: Brazil



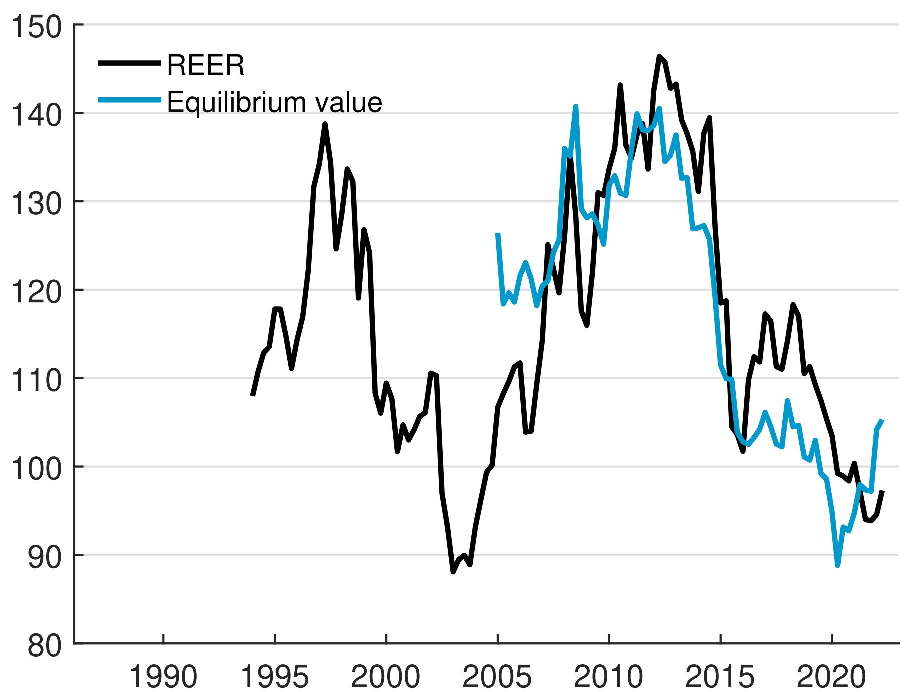
Source: BIS, Authors' calculations.

Figure B.3: Canada



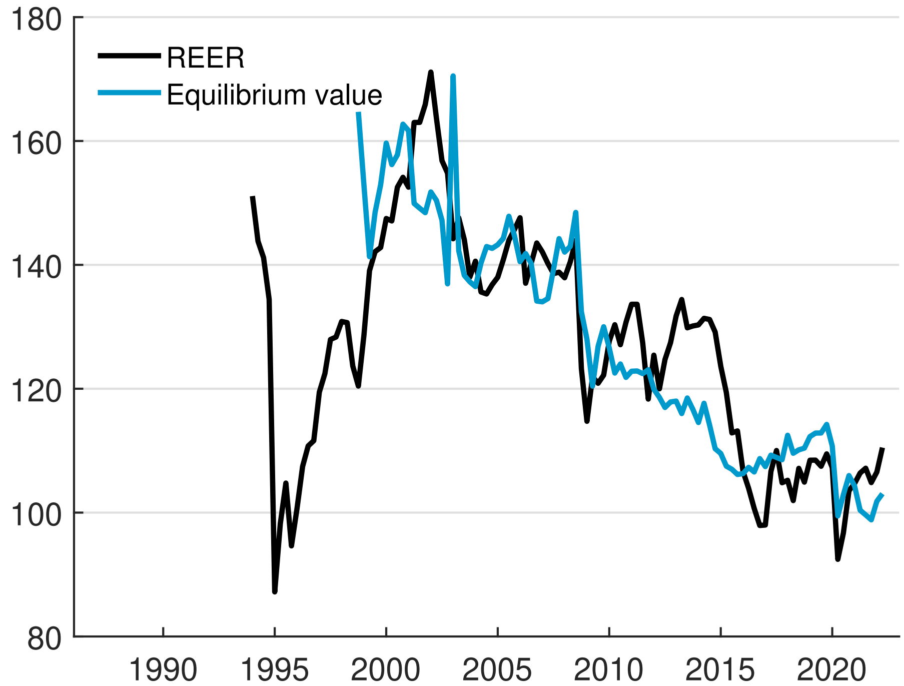
Source: BIS, Authors' calculations.

Figure B.4: Columbia



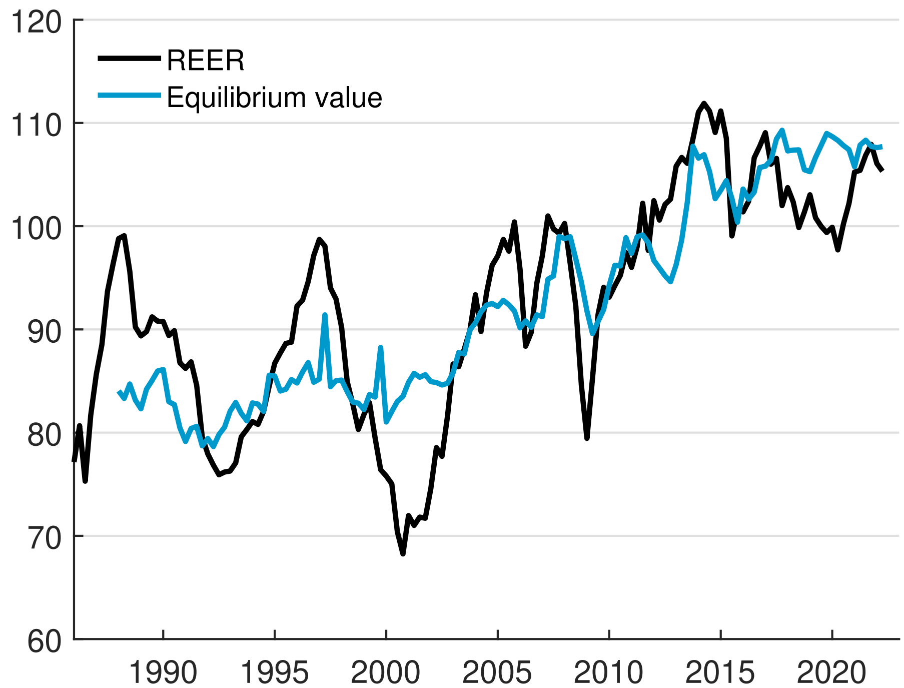
Source: BIS, Authors' calculations.

Figure B.5: Mexico



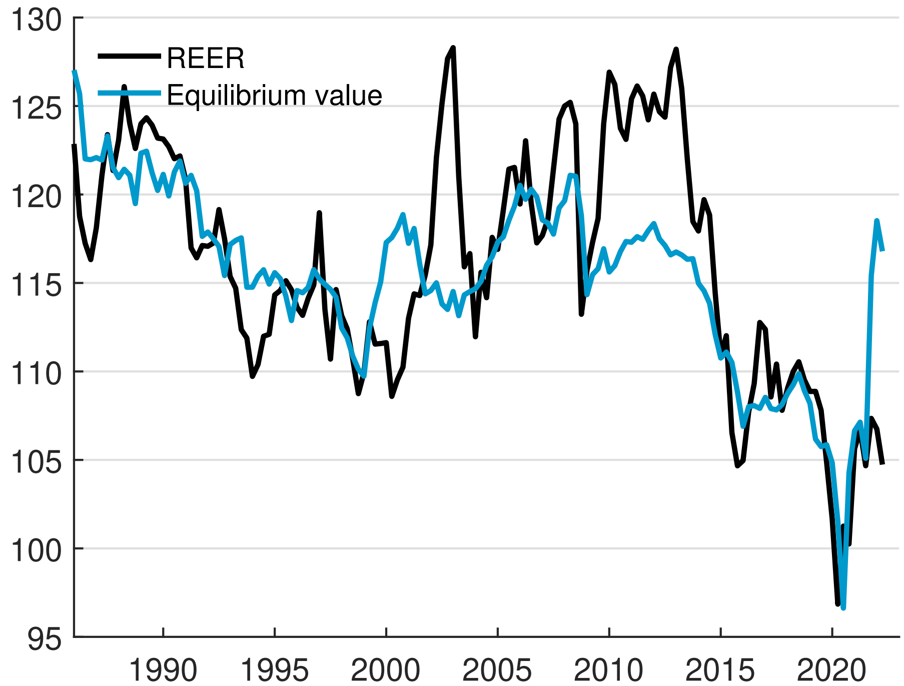
Source: BIS, Authors' calculations.

Figure B.6: New Zealand



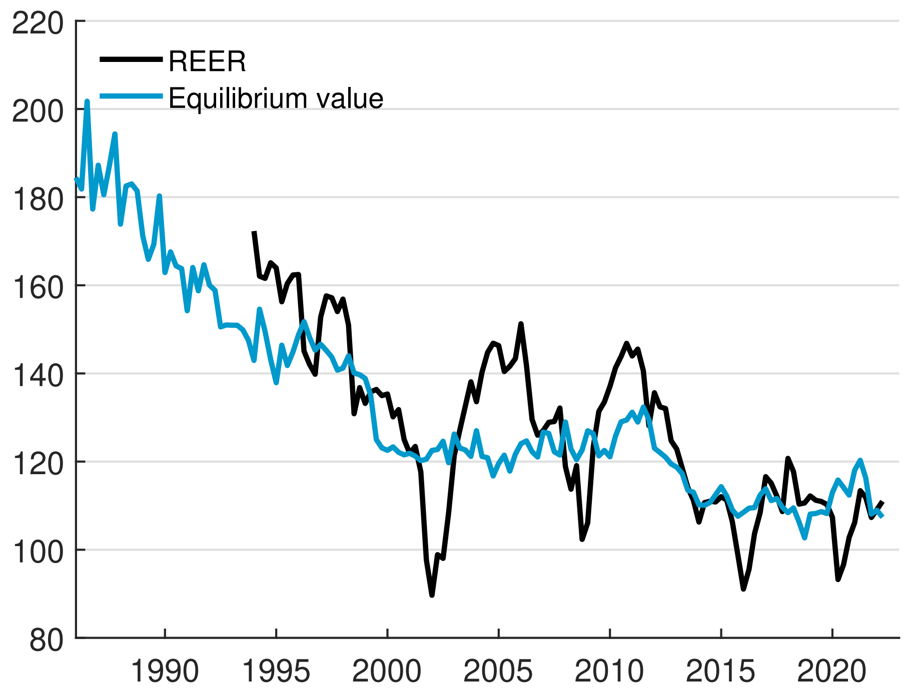
Source: BIS, Authors' calculations.

Figure B.7: Norway



Source: BIS, Authors' calculations.

Figure B.8: South Africa



Source: BIS, Authors' calculations.

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