



Global macro matters

The U.S. dollar at a crossroads: Estimating fair value

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In the 12 months following July 2014, the U.S. dollar (USD) soared 20% amid falling oil prices and further monetary easing in Japan and Europe. As USD appreciation tightened global financial conditions, world industrial production growth declined over those 12 months by more than half, from 3.5% to 1.5%. This same dynamic is apparent with the latest cycle of deflation and slowdown (Figure 1). As the Federal Reserve has reduced interest rates while trade tensions are escalating and global growth signals are flashing amber, debate is intensifying about the USD's likely direction and its implications for the global economy and portfolios. Our analysis shows that the U.S. dollar is close to fair value based on economic fundamentals, poised to fluctuate around current levels absent a change in those fundamentals or an economic shock. A balanced, long-term approach will help investors weather the consequences of a stronger or weaker USD.

In this paper, we first provide a conceptual overview of currency valuation and the key drivers of currency prices. We then apply these concepts to calculate what economic fundamentals imply for current levels of Group of Ten (G10) currencies.¹ Finally, given the USD's unique contribution to global financial conditions, we analyze what USD fluctuations imply for asset-class returns.

Vanguard's approach to estimating fair value

Freely floating currencies are one of the primary means of adjustment that enable balanced trade in goods, services, and capital across borders. One building block for currency valuation and estimated fair value is the "law of one price," also known as purchasing power parity (PPP): The same product sold in two different countries should cost the same when expressed in a common currency. A smartphone in Japan, for example,

Figure 1. The USD is a key driver of global financial conditions and, in turn, the global industrial cycle



Note: Data cover July 2013 through May 2019.

Sources: Vanguard calculations, based on data from Thomson Reuters Datastream, the CPB Netherlands Bureau for Economic Policy Analysis, and the Federal Reserve.

¹ G10 currencies are the USD, Japanese yen, British pound, euro, Swedish krona, Norwegian krone, Swiss franc, Canadian dollar, Australian dollar, and New Zealand dollar.

should cost the same as one in the United States in USD terms; otherwise, an arbitrage opportunity might exist where someone could buy a good at a lower price in foreign markets.² Despite evidence that the law of one price holds over long periods, currencies can deviate from this theoretical equilibrium for years at a time. In addition, PPP does not reflect transaction costs or nontradable goods and services (such as haircuts). A broader measure of relative prices, such as consumer price indexes, is a better means for computing the real exchange rate (RER).³

Although PPP approaches assume a constant real exchange rate, other fair-value approaches assume that RERs evolve over time according to economic fundamentals. Estimating the fair value of a currency and its evolution over the medium to long term can be relevant for international investors, who might want to hedge their currency risk or take active positions, and for policymakers, who must assess the impact of significant misalignments on economic output (Cenedese and Stolper, 2012). Economists have proposed several approaches to estimating what the fair value of any currency pair should be at any point in time. These models fall into two main groups, based on whether the adjustment takes place assuming a constant RER or an evolving one (O'Neill et al., 2005).

These two approaches are clear when examining the equilibrium real exchange rate as a function of the nominal exchange rate and relative consumer price indexes:

$$RER_{i,t} = ER_{i,t} * \frac{CPI_{US,t}}{CPI_{i,t}}$$

In this equation, $RER_{i,t}$ represents the real exchange rate for currency i at time t and CPI is the consumer price index. Here, ER is the number of units of foreign currency that can be purchased with one U.S. dollar.

The first group of models assumes a constant real exchange rate and evolving relative prices. Over time, the real exchange rate remains centered on a constant rate, while relative prices and nominal exchange rates adjust to reach equilibrium as defined by PPP. One model in this group is simply a measure of deviation

from the long-term average of the real effective exchange rate (REER).⁴ As fair value is equivalent to this long-term average in these types of models, forecasts for a currency are based on reversion from deviations back to the average.

The second group of models instead assumes constant relative prices and an evolving real exchange rate. The behavioral equilibrium exchange rate (BEER) is in this group. The model estimates the currency fair value using econometric techniques, relying on a set of macroeconomic variables that are meant to affect the real exchange rate over the medium to long term. These variables are normally chosen based on economic soundness and empirical results (Gkionakis and Vernazza, 2013). Our fair-value estimates by this approach use differentials in terms of trade, productivity, and long-term interest rates (Figure 2). We assembled a panel data set of these differentials and used a dynamic ordinary least squares regression to estimate a fair-value RER for each G10 currency pair from 2000 through the latest available data.⁵ Rather than simply assuming a mean reversion to a long-term average exchange rate (as with a REER approach), we estimated fair value based on how real exchange rates evolved with economic developments. Significant deviations from these fundamentals-based fair-value estimates can then be used to compute a forecast that assumes a reversion from current levels to fair value.

Figure 2. A change in economic fundamentals yields a significant change in fair value

Change in variable	Change in real exchange rate
1% increase in the terms of trade differential	0.69% increase
1% increase in the productivity differential	1.97% increase
10 basis point increase in the interest rate differential	0.95% increase

Note: A basis point is one-hundredth of a percentage point.

Sources: Vanguard calculations, based on data from Thomson Reuters Datastream.

² The Economist's "Big Mac Index" is one popular example of PPP being measured using identical goods in different markets.

³ Deviations from a real exchange rate consistent with the law of one price can be adjusted through two different channels: either changes in the ratio of consumer prices in the two countries (that is, changes in relative inflation rates), or changes in the two currencies' nominal exchange rate. A recent working paper by the European Central Bank found that nearly all the adjustment occurs through nominal exchange rates rather than relative consumer prices (Ca' Zorzi and Rubaszek, 2018). For example, after the USD's 2014 rally, relative consumer prices in Europe and the U.S. remained relatively constant, while the nominal exchange rate eventually reverted in favor of the euro.

⁴ More precisely, REER measures the value of a currency against a weighted average index of foreign currencies adjusted for inflation differentials. Note that *effective* denotes a currency index rather than a bilateral rate. As our analysis focuses on bilateral rates, we simply use real exchange rates rather than currency indexes.

⁵ One drawback is that this approach calculates equilibriums based on bilateral exchange rates, when it is conceptually more accurate to calculate an economy's equilibrium based on the exchange rate against a broad set of currencies. To mitigate this drawback, we calculate one cross-country equation using a panel data set, which improves the robustness of our estimates. See the Appendix for further technical details about our BEER model.

Developed-market currencies near fair value

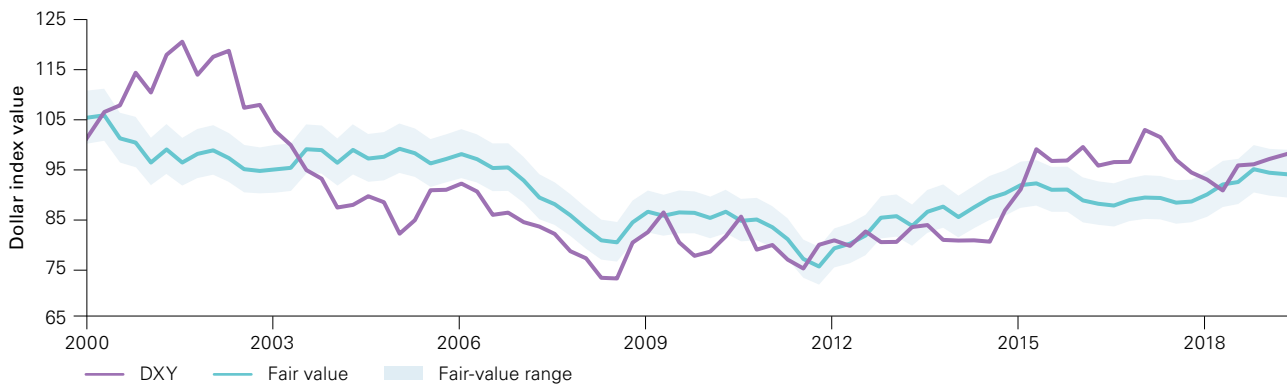
Our fair-value estimates of the USD using the BEER approach highlight the long-term deviations between nominal exchange rates and fair value based on economic fundamentals. The USD was overvalued entering the peak of the dot-com bubble and subsequent recession, only to be consistently undervalued as the U.S. current account deficit and global offshore dollar supply rapidly expanded. Since the European sovereign debt crisis began, the U.S. and its currency have broadly outperformed other developed economies. The latest data suggest that, although overvalued in the aftermath of the 2015 emerging markets slowdown, the USD as measured by the U.S. Dollar Currency Index (DXY) remains only marginally overvalued compared with select other G10 currencies (Figure 3). Given a small misalignment relative to estimated fair value, changes in the nominal exchange rate will be driven by developments in short-term factors and economic fundamentals rather than a reversion to fair value.

This marginal overvaluation is consistent when expressing valuation in bilateral terms rather than as an

index. Like the index, the USD can be over- or undervalued for years at a time against individual other currencies; however, substantial deviations outside the fair-value range imply that an exchange rate will revert to fair value over time. In our analysis, an exchange rate reverts about 40% of the deviation within four quarters. The most undervalued currency at the time of this writing was the Swedish krona, at a 12% deviation from fair value, whereas most other currencies were within 4% of fair value.

Given that the U.S. dollar is within its fair-value range, it is reasonable to assume it can deviate in either direction from this equilibrium. In a bearish scenario for the USD, additional Federal Reserve interest rate cuts might ease global financial conditions and catalyze a rebound in global trade that causes the USD to depreciate based on narrower interest rate differentials and less favorable productivity differentials. In a bullish scenario, further weakness in global growth could spur other central banks to resume easing, leaving the U.S. with a stable yield differential despite a reduced U.S. policy rate. Figure 4 outlines these two potential scenarios for the USD in terms of fair value.

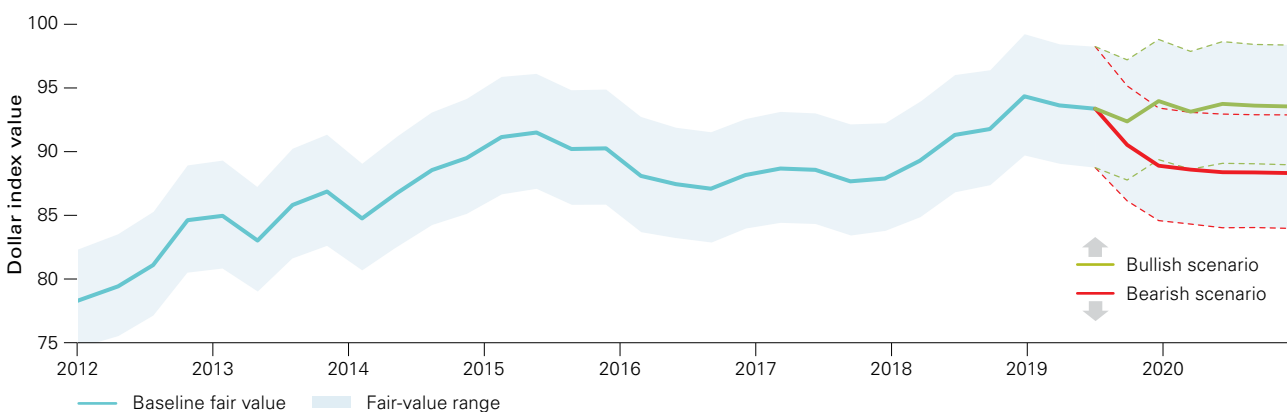
Figure 3. The DXY has had persistent deviations from fair value, but today it's in line with fundamentals



Note: Data cover January 1, 2000, through July 31, 2019.

Sources: Vanguard calculations, based on data from Thomson Reuters Datastream, the CPB Netherlands Bureau for Economic Policy Analysis, and the Federal Reserve.

Figure 4. Narrowing interest rate differentials are likely to weigh on the USD



Note: Data cover January 1, 2012, through June 30, 2019, with projections through December 31, 2020.

Sources: Vanguard calculations, based on data from Thomson Reuters Datastream.

The future consequences of a weaker (or stronger) dollar

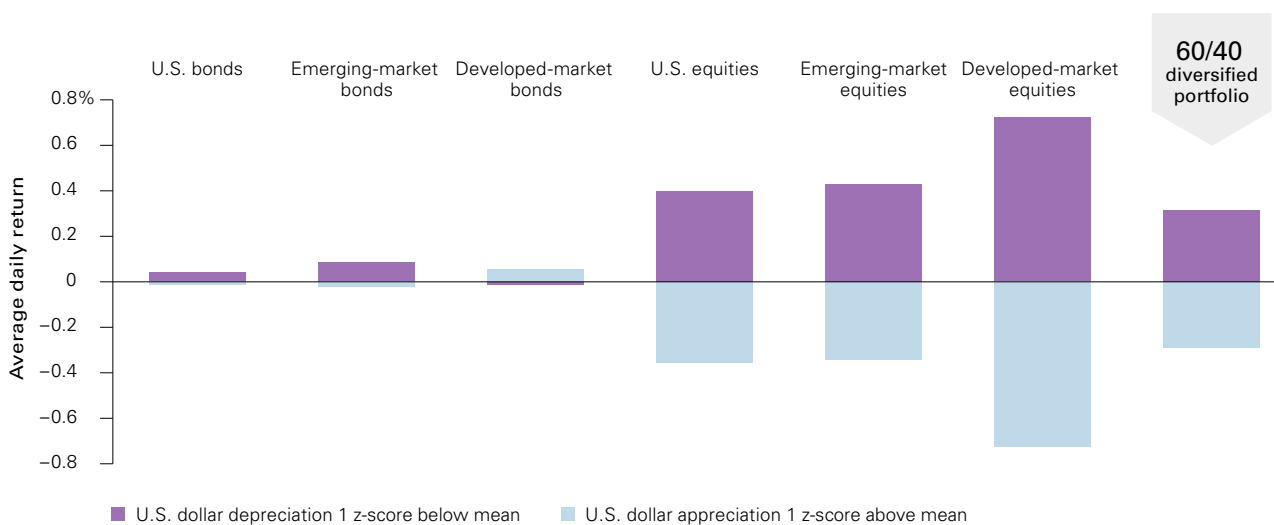
Whether the USD appreciates or depreciates moving forward, its movement will have important implications for different asset-class returns. In most cases, movement in the USD and other asset classes is triggered by the same shock. In other cases, the USD itself can amplify shocks and affect economic fundamentals through financial conditions and the balance sheets of international borrowers and lenders (Avdjiev et al., 2017). A weaker U.S. dollar coincides with stronger global trade growth and outperformance by the rest of the world relative to the U.S.—an environment beneficial to trade-dependent economies that rely on rising commodity prices and cross-border USD financing.

On the other hand, a stronger U.S. dollar coincides with the opposite circumstances of slowing global trade growth and tightening global financial conditions. To assess this relationship in more detail, we examine daily returns on days of strong USD appreciation and depreciation from the perspective of a USD-based investor.⁶

As expected, safer assets such as bonds have low sensitivity to USD movements, with emerging-market bonds the most sensitive within fixed income. When the dollar depreciates, most emerging-market currencies appreciate against it, translating into more USD per emerging-market currency in coupon payments. For developed-market bonds, however, USD movements have the opposite effect. Developed-market bond returns are positive when the USD is appreciating. This is because such periods are linked with risk-off behavior, when cash globally is flowing to safer assets such as developed-market bonds.

On the other hand, equity asset returns are more sensitive to periods of USD appreciation or depreciation. When the dollar is appreciating, the impact on equity returns also reflects investors' risk-off behavior. Directionally, emerging- and developed-market equities behave the same way: USD appreciation coincides with negative returns and USD depreciation with positive returns. Compared with standalone equity returns, a balanced, globally diversified portfolio offers a middle path during periods of dollar appreciation or depreciation by being relatively shielded against USD movements.

Figure 5. Even hedged assets can respond significantly to extreme movements in the USD



Notes: Data cover June 2011 through June 2018. A z-score is a measure that standardizes data in terms of the number of deviations a particular data point is from the average of that series. U.S. bonds are represented by the Bloomberg Barclays U.S. Aggregate Bond Index, emerging-market bonds by the Bloomberg Barclays USD Emerging Markets Government RIC Capped Index, developed-market bonds by the Bloomberg Barclays Global Aggregate ex USD Float Adjusted Index Hedged, U.S. equities by the CRSP U.S. Total Market Index, emerging-market equities by the FTSE Emerging Markets All Cap China A Inclusion Index, and developed-market equities by the FTSE Global All Cap ex US Index. The 60/40 diversified portfolio is constructed by using the CRSP U.S. Total Market Index for the 60% equity allocation and the Bloomberg Barclays U.S. Aggregate Bond Index for the 40% bond allocation.

Sources: Vanguard calculations, based on data from Thomson Reuters Datastream.

⁶ We use daily asset-return data in USD terms and the DXY index from June 2011 through June 2019. We use dummy variables to indicate days of dollar appreciation or depreciation and run an ordinary least squares regression on the dummy variable against daily asset returns. We measure periods of appreciation or depreciation as ones characterized by the movement of USD by 1 z-score above or below the mean.

Conclusion

Exchange rates are notoriously difficult to predict, but economic fundamentals provide some rationale for what levels exchange rates revert to over time. The USD remains marginally overvalued against a basket of developed-market currencies based on differences in terms of trade, productivity, and interest rates. So any substantial movement in the USD and other currencies will be driven by short-term developments, such as risk sentiment and changes in Fed policy. In turn, these USD fluctuations may affect global financial conditions, making it an important indicator for investors to monitor.

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Appendix

Our BEER model is similar to that of Clark and MacDonald (1998) and uses an unbalanced panel fixed-effects model estimated by dynamic ordinary least squares as specified by Stock and Watson (1993):

$$\ln(RER_{i,t}) = \alpha_i + \beta X_{i,t} + \sum_{k=-L}^{k=+L} \gamma_k \Delta X_{i,t+k} + \varepsilon_{i,t}$$

In the above equation, α_i refers to the country-specific constant and $X_{i,t}$ is the vector of macroeconomic variables explaining real exchange rate in the long run. The Stock and Watson approach with leads (+L) and lags (-L) is preferred for obtaining unbiased estimates of the coefficients of the equilibrium relationship. In our analysis, we determine leads and lags using the Schwarz criterion. The fair-value nominal exchange rate for any currency pair i can then be computed as:

$$ER_{i,t}^* = \frac{CPI_{i,t}}{CPI_{US,t}} e^{\hat{\alpha}_i + \hat{\beta} X_{i,t}}$$

We verify that our BEER model is economically and statistically meaningful by specifying an error correction model and test for the speed of adjustment to be negative and statistically significant:

$$\Delta \ln(RER_{i,t}) = \theta (\ln(RER_{i,t-1}) - \hat{\alpha}_{i,t} - \hat{\beta} X_{i,t-1}) + \varphi \Delta X_{i,t} + \varepsilon_{i,t}$$

In this equation, θ is the speed of adjustment and φ describes the short-term relationship. The speed of adjustment tells us how fast the currency pair is expected to revert to its equilibrium level. The speed of adjustment can ultimately be used to compute the reversion percentage to develop forecasts for q quarters ahead as:

$$\text{Reversion \%} = 1 - \exp(q\theta)$$

Notes on risk

All investing is subject to risk, including possible loss of principal. Past performance is no guarantee of future results. Investments in bonds are subject to interest rate, credit, and inflation risk. Investments in stocks or bonds issued by non-U.S. companies are subject to risks including country/regional risk and currency risk. The performance of an index is not an exact representation of any particular investment, as you cannot invest directly in an index.

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