DBS Focus
Currency fair values: What's cheap and what's DEER?

Strategy/FX/Global

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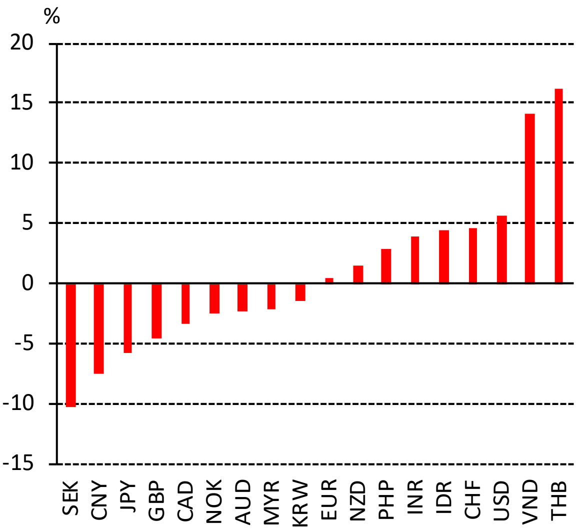
Chang Wei Liang
Macro Strategist (FX and Credit)

Please direct distribution queries to
Violet Lee +65 68785281 violetleeyh@dbs.com

- *An FX fair value framework can assist in a quantifiable comparison of currency valuations.*
- *We derive our DBS-EER (or DEER) methodology with three basic economic building blocks—relative PPP, productivity differentials, and terms of trade.*
- *Our DEER estimates show that within the G10 & Asia grouping, SEK, CNY and JPY are the cheapest while THB, VND and USD are the dearest beginning 2020.*

G10 and Asia: 2020 DEER valuations



Source: IMF, CEIC, DBS

FX fair values beyond the eyes of the beholder

What defines the fair value of a currency? Perceptions of value, cheap or dear, vary amongst individuals. To make any consistent comparison, we need quantifiable measures beyond just the eyes of the beholder.

One feature of currencies is that despite their volatility, they do not behave in a completely random fashion over time. This lack of randomness is because currencies must act as stabilizers, acting against untenable outcomes in international trade.

This naturally lends to a concept of trade-based equilibrium levels, around which currency prices fluctuate in the short-term. We delineate our FX fair value methodology in this article, which we name as **DEER (DBS equilibrium exchange rates)**.

The starting point for DEER is the set of exchange rates that simply equalize the price of goods across all countries. In short, no currency can buy more goods when converted into another—an outcome known as absolute Purchasing Power Parity (PPP).

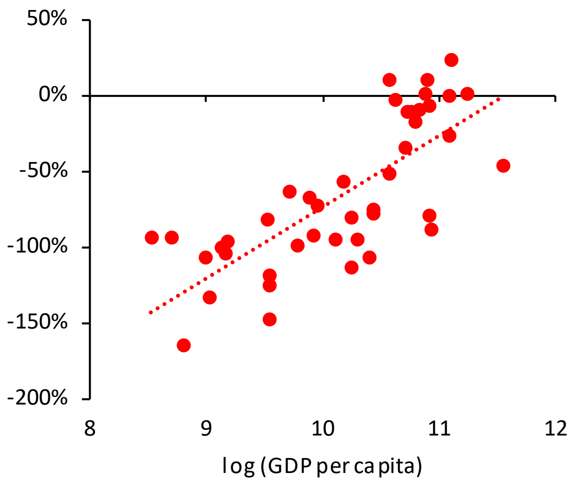
But, are international markets necessarily at equilibrium when currencies trade at PPP values? Suppose currencies deviate from PPP. Cheaper-priced goods in one country then face excessive demand relative to others, until its currency appreciates sufficiently to close the gap in relative prices and restore equilibrium. While this basic idea is well-founded, empirical support for absolute PPP is far from absolute.

Wrinkles in absolute PPP are systematic

It turns out that various economic factors cause systematic deviations (or biases) for exchange rates against PPP**. As these biases do not diminish over time, any "equilibrium" fair value must account for them.**

One of the most cited factors in the literature is **the Balassa-Samuelson effect—real prices and real exchange rates should be systematically higher in countries with higher real productivity**. Empirically, one finds that countries with higher GDP per capita typically have stronger currencies than prescribed by PPP, and vice-versa.

FX deviation from PPP vs productivity (FY19)



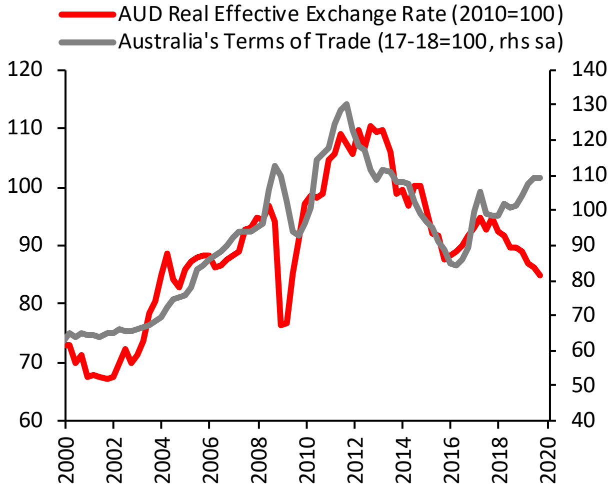
Source: IMF, CEIC, DBS Bank

Note: FX-PPP deviations equals the percentage difference between 43 countries' average market exchange rates for 2019 and their IMF PPP exchange rates (both in USD terms). Real GDP per capita (at PPP exchange rates) is used as a proxy of TFP productivity. Balassa-Samuelson is predicated on productivity differentials, but since US productivity is the same across all 43 crosses, we can plot the FX deviations against GDP per capita directly.

Apart from real productivity differentials, countries' production of goods is non-uniform, depending on resource endowments. The imperfect substitutability of traded goods can lead to **significant divergences in countries' nominal terms of trade** (i.e. relative prices of exports vs imports), which **impact equilibrium exchange rates via wealth effects**.

Historically, commodity price booms have been accompanied by currency strength for their exporting countries. The term "Dutch disease" was coined to describe impaired trade competitiveness from overt currency strength accompanying a boom in commodity exports. This effect is evident from the AUD real effective exchange rate's high co-movement to its terms of trade from 2004 to 2016, driven by an iron ore boom-bust cycle.

Australia: Real exchange rate vs terms of trade

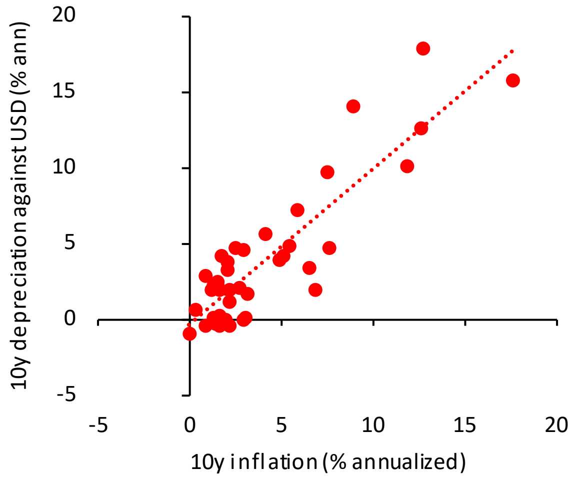


Source: IMF, CEIC, DBS Bank

PPP power is relative, not absolute

Despite absolute PPP's shortfalls, relaxed assumptions that link exchange rates to price changes instead of price levels (i.e. relative PPP) sees strong empirical support. Our plot of 43 USD crosses against their respective inflation for a ten-year period shows a positive, almost one-to-one, relationship between changes in exchange rates and changes in prices. **Clearly, relative price changes are still an extremely powerful driver of FX over time.**

FX change vs inflation (2008-2018, annualized)



Source: IMF, CEIC, DBS Bank

Approximate real FX stability in the long run

$$\frac{ER_{i,t}}{ER_{i,0}} \approx K \frac{P_{i,t}/P_{us,t}}{P_{i,0}/P_{us,0}} \Rightarrow \frac{RER_{i,t}}{RER_{i,0}} \approx K$$

$ER_{i,t}$: country's *i* exchange rate per USD at time *t*

$P_{i,t}$: country's *i* price index at time *t*

$P_{us,t}$: US price index at time *t*

$RER_{i,t}$: country's *i* real exchange rate per USD at time *t*

K : a constant that differs with country pairs

The relative PPP equation above **implies that real exchange rates are stable,** even without absolute PPP**.** This means that countries with inflation rates significantly above US norms are expected to face nominal FX depreciation over time against the USD.

Consider Turkey and India, two high inflation economies. The TRY (Turkish Lira) and INR (Indian Rupee) have both shown substantive depreciation against the USD in the last decade, in accordance with relative PPP.

Nevertheless, relative PPP is incomplete, and a full model must account for the twin factors of real productivity and terms of trade.

Model, model on the wall…

With relative PPP, we can model the real exchange rate as a constant over time, adding on variations due to changes in relative productivity and terms of trade. All are related by a function *f*:

$$\text{RER} \approx f(const, pdty, tot)$$

Should real exchange rates be denominated in USD, EUR or CNY? Global trade is uneven because of geographical distances, so different countries have different dominant trading partners. The crux is to note that real exchange rate relationships are more stable with countries where bilateral trade is larger.

Thus, **the best estimates are those estimated against a trade-weighted basket of currencies,** which means changing numeraires for all variables to the trade-weighted form in our model.

For *f*, we expect real exchange rates to have a constant, proportional relationship with the twin factors (i.e. loglinear). This accords well with the data sourced from the IMF, with productivity proxied by GDP per capita in PPP terms.

One problem is inherently limited observations for each currency, resulting in imprecise estimates when estimated individually. To remedy this, we pool data across all currencies to obtain more precise coefficient estimates, using a technique known as fixed effects panel regression.

Another concern is whether EM currencies that are less market-determined and subject to more capital controls could behave differently from the freely traded G10 currencies. Fortunately, our statistical Wald test shows little difference in the two, and thus no harm in combining all currencies into a single panel.

Wald test of coefficients for G10 and non-G10 FX

We estimate an unrestricted model with two sets of coefficients for relative productivity and terms of trade for the set of G10 and non-G10 FX. The Wald test statistic is derived by adding two restrictions:

1. Productivity effect (G10) = Productivity effect (non-G10)
2. Terms of trade effect (G10) = Terms of trade effect (non-G10)

Our result: We cannot reject these restrictions at the 10% significance level i.e. the effects are very likely to be equal across both sets of currencies.

Fixed effects panel regression

We run a fixed effects panel regression of the 31 REERs at a monthly frequency between March 2000 and June 2019. The explanatory variables are:

1. Productivity (GDP per capita) differentials
2. Terms of trade differentials
3. Lead/lag of changes in the two regressors

Fixed effects are necessary since individual REERs have different constants K. The lead and lag of changes in the two main regressors can be viewed as nuisance parameters to obtain more accurate estimates—a technique known as dynamic OLS.

Panel fixed effects DOLS regression results

Factors	Estimate	Std. Error	t-value	p-value	Signif
Productivity	0.39	0.02	17.73	0.00	***
Terms of trade	1.09	0.07	15.24	0.00	***

Our model results yield **the expected positive effects for both the productivity and terms of trade differentials,** at the 1% significance level. The weight of relative PPP is implicitly set to 1, while the weights of the terms of trade and productivity differentials are estimated to be 1.09 and 0.39 respectively. The fitted model explains 35% of variations across the 31 REERs.

However, these results all amount to naught if we cannot show a fundamental point—that our model's fitted values are anchors that exchange rates drift to over time (i.e. cointegrated). Only then can they be labelled as currency fair values.

We conduct a battery of statistical tests which verify that **real exchange rates turn from being unanchored to well-anchored, once we account for the effects of productivity and terms of trade.** *(Technical readers are welcome to refer to the appendix for details.)*

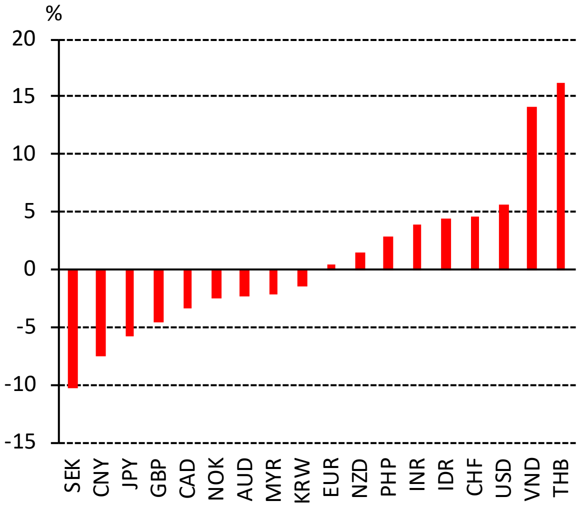
The upshot is that any exchange rate deviation from the anchor derived from our DEER model should revert over time. **How currencies stand relative to their equilibrium DEER values—which they drift towards over time—now gives a quantifiable measure of value.**

At this point, we qualify that numerous other factors also affect currency markets, especially in the short term. The US-China trade is just one prominent example. We also note that clustered capital flows are a recurring feature in emerging countries. These often drive currencies to significantly under-shoot their equilibrium fair values. History has shown that cheap currencies can become cheaper, and vice-versa. As such, our fair value model should be viewed from a long-run perspective of value.

… which is the DEERest of them all?

Our previous discussion has answered what's DEER, but readers will want to jump to the more pertinent question of what's cheap. In other words, which currency's price is the lowest relative to its DEER fair value?

G10 and Asia: 2020 DEER valuations



Source: IMF, CEIC, DBS

SEK, CNY and JPY have the cheapest valuations within the G10 and Asian group, based on market prices as of 7 Jan 2020.

The SEK and JPY are perennially cheap, and for good reasons with their central banks keeping policy extremely accommodative to bolster inflation. Perhaps the SEK's extremely cheap valuation has afforded space for the Riksbank to hike rates in Dec, marking the first departure from negative rates amongst global central banks.

Of greater interest is the CNY tumbling to levels that imply it being as cheap as the JPY. Concerns of a Chinese growth slowdown, lingering trade tensions with the US and ongoing credit issues all suggest that the direction of Chinese policy is headed towards easing. As such, the CNY's cheap valuations are justifiable, while offering the benefit of a cushion to exporters facing trade uncertainty.

At the other end, **THB, VND and the USD rank as having the highest valuations.**

Whether the THB's expensive valuation is justified is worth a debate. THB strength does not look that excessive once we account for Thailand's very substantive current account surplus at 7% of GDP. Still, the BoT has become increasingly concerned with a strong THB, to the extent that it has relaxed regulations in late 2019 to encourage outflows and stem inflows.

VND's lofty valuation reflects numerous issues. For one, the country has become more export-oriented over the last ten years, while also growing more important within regional supply chains. The US-China trade war has also increased its attractiveness as a manufacturing base for diversifying production from China.

As for the USD, its valuation has stayed high given US growth outperformance relative to other major economies, and its yield advantage over G10 peers. However, such a valuation could now imply a more muted USD performance in 2020.

Other cases of interest include those instances where currency valuations are opposing cyclical adjustment, rather than helping it. Surprisingly, the INR still trades above its equilibrium fair value, even as the economy remains mired in a prolonged slowdown. That could explain the RBI's decision to build up its FX reserves in recent months; the INR could be vulnerable if short-term portfolio flows ease.

One perception of Asian currencies is that they belong to a bloc that trade in sync. While there is a small grain of truth given the interconnected supply chains in Asia, it is striking to see some stark divergences within our valuation framework.

Notably, **currency valuations for the perceived trade war "winners"—Vietnam and Thailand—are the highest in our G10-Asia grouping**. On the flip side, with China bearing the largest negative impact from the trade war, the RMB has also seen its valuation tumble towards a historical low.

While these FX outcomes are not necessarily desirable for the relevant policymakers, it demonstrates how currency markets are highly responsive to changing conditions. **Our DEER valuations can thus serve as an analytical framework to distil such insights, besides illuminating long-term value.**

Appendix

There exist two major arcs in the equilibrium exchange rate literature, which are namely the 1/ Fundamental Equilibrium Exchange Rate (FEER) and 2/ Behavioural Equilibrium Exchange Rate (BEER) approaches.

FEER[1] is based on the notion of a REER level that promotes internal and external balance of an economy. This requires normative judgement of what are the balanced current account and full employment levels for all relevant economies in the model. BEER[2] focuses instead on examining how real exchange rates behave with respect to fundamental determinants, being a reduced form model. It does not assume full employment, as in the case of FEER.

Essentially, FEER assesses fair value from a balanced macroeconomic perspective, while BEER seeks convergence to a fair value in the empirical sense, based on quantifiable factors.

Thus, our data-driven DEER methodology is grounded in the BEER approach. We choose to model 31 real effective exchange rates (REER) from the period between March 2000 and June 2019. In order to ensure data consistency and the reproducibility of our findings, we sourced all data from the excellent IMF databases. Effective exchange rates and trade weights are from the IFS database. Real productivity is proxied by using GDP per capita at PPP exchange rates from the WEO database. Terms of trade data is obtained from a new IMF commodity database[3]. The sample period was selected to eliminate possible breaks arising from currency crises of the 1990s, the introduction of the Euro and China's meteoric rise in global trade since 1999.

We note that relative PPP alone implies stationary real exchange rates, with no unit root. None of the augmented Dickey-Fuller tests for individual REERs was able to reject the null hypothesis of a unit root. Perhaps the power of Dickey-Fuller tests is too low? The likelihood of a Type II error, where the presence of a unit root is falsely unrejected, may be high.

We increase the statistical power by running a panel unit root test for all 31 REERs. Two tests were selected: (1) Levin-Lin-Chu (2002) test[4],

[1] Williamson, J. (1994). Estimating Equilibrium Exchange Rates

[2] MacDonald, R. (1997). What Determines Real Exchange Rate? The Long and Short of It

[3] Gruss, B., & Kebhaj, S. (2019). Commodity Terms of Trade: A New Database

[4] Levin, A., Lin, C.F., & Chu, C. (2002). Unit Root Testing in Panel Data: Asymptotic and Finite-Sample Properties

and (2) Maddala-Wu (1999) chi-squared test[5]. The difference between the two is that Levin-Lin-Chu restricts the autoregressive coefficients to be equal across all REERs and sets the alternative hypothesis as all series being stationary. Maddala-Wu relaxes these restrictions, allowing different AR coefficients and setting the alternative hypothesis to be that one or more REERs are stationary.

Again, both test statistics fail to reject the null that all REERs have unit roots at the 10% significance level. The inadequacy of relative PPP alone is made clear.

After determining that all REERs are non-stationary, we explore the possibility of a cointegrating vector between REERs and their respective productivity and terms of trade differentials.

Cointegration is important to establish for two reasons: 1/ validating a long-term relationship between the real exchange rate and its determinants, which implies convergence over time, and 2/ showing that the statistical relationship with the determinants is not spurious.

The model is specified as a dynamic OLS (DOLS)[6] fixed effects panel regression of the following form:

$$REER_{it} = \alpha_i + \beta_1 PDT_{it} + \beta_2 TOT_{it} + \sum_{j=-1}^{1} c_{i,j}\, \Delta PDT_{it+j} + \sum_{j=-1}^{1} d_{i,j}\, \Delta TOT_{it+j}$$

Note that the addition of lead(s) and lag(s) of first differences of the OLS regressors is a characteristic of DOLS. While OLS is a consistent estimator, Kao and Chiang (2000)[7] found that it suffers from non-negligible finite-sample bias in heterogenous panels and they recommend DOLS given its considerably reduced bias.

To correct for serial correlation and heteroskedasticity within the residuals, we utilize Newey-West (HAC) standard errors for inference.

Results

Panel fixed effects DOLS regression results

Factors	Estimate	Std. Error	t-value	p-value	Signif
Productivity	0.39	0.02	17.73	0.00	***
Terms of trade	1.09	0.07	15.24	0.00	***

Our DOLS coefficient estimates were all significant at the 1% level. More importantly, **Dickey-Fuller tests show 30 out of 31 residual series rejecting the presence of a unit root at the 10% significance level, demonstrating cointegration.** Both our panel unit root tests also gave the same conclusion.

Unit root test results

	Augmented Dickey-Fuller (lags by BIC)	Levin-Lin-Chu	Maddala-Wu
REER alone	Does not reject unit roots for all series	Does not reject null	Does not reject null
REER with PDT & TOT	Reject unit roots for all series (but SGD)	Rejects null at 1%	Rejects null at 1%

SGD is the only currency that we cannot reject the unit root, perhaps due to structural breaks in the economy. As such, we have no fair value estimates for the SGD, which is almost wholly determined by MAS policy anyway.

[5] Maddala, G. S., & Wu, S. (1999). A Comparative Study of Unit Root Tests with Panel and a New Simple Test

[6] Stock, J., & Watson, M. (1993). A Simple Estimator of Cointegrating Vectors in Higher Integrated Systems

[7] Kao, C., & Chiang, M.H. (2000). On the estimation and inference of a cointegrated regression in panel data

Group Research

Economics & Macro Strategy

Taimur Baig, Ph.D.
Chief Economist - G3 & Asia
+65 6878-9548 taimurbaig@dbs.com

Chang Wei Liang
Strategist
+65 6878-2072 weiliangchang@dbs.com

Ma Tieying, CFA
Economist - Japan, South Korea, & Taiwan
+65 6878-2408 matieying@dbs.com

Nathan Chow
Strategist - China & Hong Kong
+852 3668-5693 nathanchow@dbs.com

Radhika Rao
Economist – Eurozone, India, & Thailand
+65 6878-5282 radhikarao@dbs.com

Masyita Crystallin, Ph.D.
Economist – Indonesia & Philippines
+62 21-2988-4003 masyita@dbs.com

Irvin Seah
Economist - Singapore, Malaysia, & Vietnam
+65 6878-6727 irvinseah@dbs.com

Eugene Leow
Rates Strategist - G3 & Asia
+65 6878-2842 eugeneleow@dbs.com

Samuel Tse
Economist - China & Hong Kong
+852 3668-5694 samueltse@dbs.com

Chris Leung
Economist - China & Hong Kong
+852 3668-5694 chrisleung@dbs.com

Duncan Tan
FX and Rates Strategist - Asean
+65 6878-2140 duncantan@dbs.com

Philip Wee
FX Strategist - G3 & Asia
+65 6878-4033 philipwee@dbs.com

Sources: Data for all charts and tables are from CEIC, Bloomberg and DBS Group Research (forecasts and transformations).