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November 2013

Dynamic Allocation
Strategies Team

Valuation Documentation in Brief – Currency

An important foundation of the Dynamic Allocation Strategies team's investment process is the determination of fundamental values for asset classes, market, sectors, and currencies. This document provides basic insight into the mechanics of our valuation model for exchange rates. The primary competitive advantage rests in the models' inputs and the application of outputs by seasoned investment professionals intimately knowledgeable about all aspects of currency valuation.

Fundamental values for exchange rates are determined by relative purchasing power with an adjustment for forward-looking relative real cash rates:

$$FV_{\$/f} = Equilibrium\ Exchange\ Rate + Carry$$

The valuation model requires historic and estimated forward-looking inflation, and estimates of real cash rates at future points in time.

Structure and Principles

Exchange rates are not assets. They do not generate cash flows (other than relative cash returns) and are not a claim on the wealth generation of an economy, or the relative wealth generation of two economies. Accordingly, they are not amenable to the discounted cash flow model of valuation that the DAS team uses for equities and bonds. Currency risk is not compensated over time, though active management of currency exposures can earn compensation for risk as exchange rates move toward fundamental value from levels that are different from fundamental value.

The equilibrating force that causes equity and bond prices to revert to fundamental values is a function of the gap between the price paid for an asset and the present value of the cash flows it is expected to generate. The larger this discrepancy, the greater the incentive for investors to buy or sell the asset at a price divergent from the present value of the expected cash flows. For exchange rates there is an analogous equilibrating force of relative purchasing power. If the quantity of internationally tradable goods and services a currency can purchase in its domestic market is significantly out of line with what it can purchase in an foreign market, there is similarly an incentive for economic agents and investors to buy or sell the domestic currency against the foreign currency in order to purchase goods and services at a more attractive price, or in anticipation of other agents doing the same thing. The greater the discrepancy from a stable relative level of purchasing power, the greater the equilibrating force acting to bring exchange rates back to fundamental value.

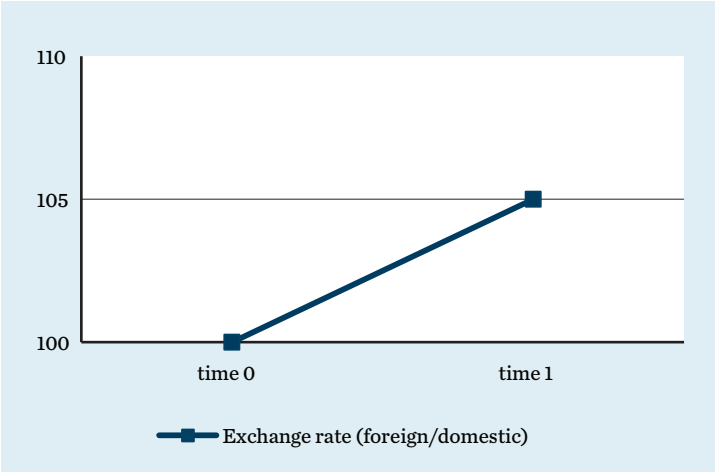
Relative or Absolute Purchasing Power Parity?

The theory that exchange rates revert to a constant level of purchasing power (domestic versus foreign) has two forms. One is absolute purchasing power parity (PPP), which holds that the fair level of the exchange rate is that at which a representative basket of goods and services has the same price expressed in foreign or domestic currency. The exchange rate is at absolute PPP when this holds true. The second form is relative PPP, which holds that the exchange rate need not revert to a level where the price of the basket is equal, but to a level where the ***ratio*** of prices of the basket of goods and services is stationary, or constant. In relative PPP, the constraint of "one price" for this representative basket, which holds true for absolute PPP, is relaxed. It is assumed that non-price factors (such as regulatory restrictions, quality differences, and domestic versus foreign income per capita) combine to prevent absolute PPP from holding. Relative PPP still holds that the influence of these factors, not all of which can be measured directly, is broadly constant over time[1].

The DAS team's valuation model assumes that relative PPP holds true over time. This amounts to assuming that the real exchange rate of two currencies—the nominal exchange rate absent the effect of domestic and foreign inflation —has a constant level to which it reverts. This constant level is termed *equilibrium*, which is distinct from *fundamental value* itself, as detailed below.

The relationship between a nominal exchange rate, relative prices, and a real exchange rate is shown in a hypothetical example below. The exchange rate is expressed as units of foreign currency per one unit of domestic currency. During the hypothetical period, the domestic currency appreciates in nominal terms, from a rate of 100 foreign currency units to 105—a nominal appreciation of 5%. However, prices in the foreign economy rise by 2% during the period, and prices in the domestic economy rise by 1%. It follows that the purchasing power of the domestic currency relative to the foreign currency—its real exchange rate—has risen by less than +5%. The change in the real exchange rate is lower, at approximately +4%. If prices had risen by the same amount in the foreign and domestic economies, the real exchange rate would have risen by 5%, the same as the nominal exchange rate. Conversely, had the nominal exchange rate appreciated by close to 1% instead of 5%, its real exchange rate and relative purchasing power would be unchanged.

Real Exchange Rate Example



Source: William Blair

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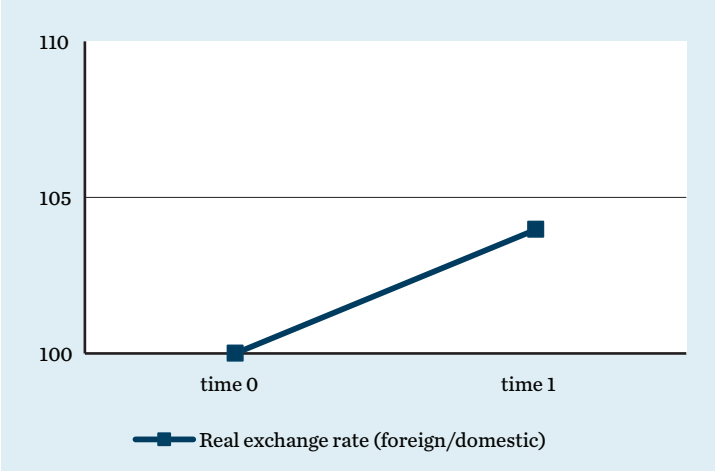


Source: William Blair

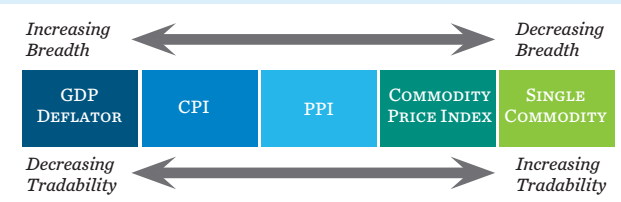
[1] This need not be assumed for income per capita, which is taken into account in the case of many emerging economies, as detailed in the last section referencing productivity.

Which Inflation Measure?

To calculate a real exchange rate over time from a nominal exchange rate, inflation in the domestic currency and the foreign currency must be known. This raises the question of which measure of inflation is most appropriate.

In one sense, to properly measure the purchasing power of a currency in its domestic market and a foreign market, the measures of inflation in each economy should be as broad as possible. But conversely, in another sense, because many goods and services are not viably tradable across international borders (such as haircuts or domestic legal services), inclusion of these items in the inflation measure would be distortionary—it would not signify a difference in relative purchasing power upon which there was a viable equilibrating force to produce reversion. Hence, the optimum inflation measure should be as broad a range of goods and services as possible while still being an internationally tradable basket of the same[2].

Ranking of Inflation Measures



The choice of inflation measure that represents the optimum balance of breadth and tradability is the producer price index (PPI), which is the one used to obtain (historical) real exchange rates in the DAS team's exchange rate valuation approach. The historical real exchange rate is, in turn, used to estimate the equilibrium exchange rate—the constant level to which an exchange rate reverts.

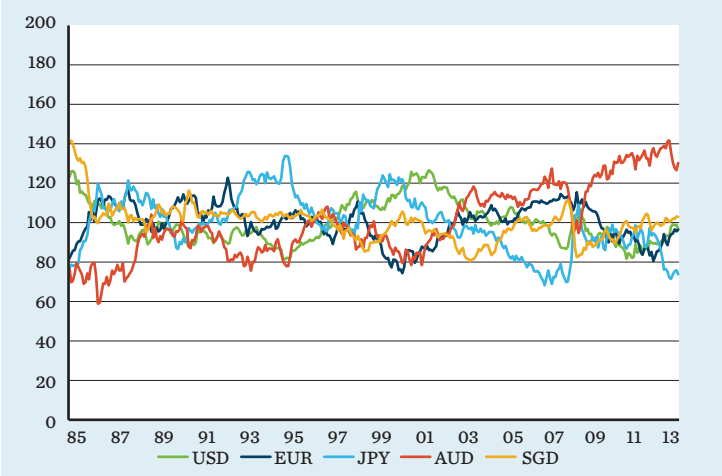
Estimation of Equilibrium Exchange Rate

As noted above, the equilibrium exchange rate represents the level of relative purchasing power to which an exchange rate reverts. In real (inflation-adjusted) terms this equilibrium is stationary, or constant. In nominal terms the equilibrium exchange rate is not stationary, but rather follows a path that is determined entirely by the ratio of domestic to foreign prices. An important exception to the foregoing statements arises in the case of several emerging currencies, where sustained differences in productivity growth and income-per-capita growth imply, as briefly mentioned above, that relative PPP may not hold and should be adjusted over time. This is covered in the last section as a special case where an emerging currency equilibrium exchange rate is first estimated in accordance with the theory that it is constant in real terms, and then given a trend consistent with the assumed (sustainable) difference in productivity growth (domestic versus foreign).

Historical real exchange rates are extracted from nominal history by backing out domestic and foreign PPI inflation. This can be accomplished by considering each currency in the investment universe relative to a single base currency (such as the U.S. dollar). It does not need to be undertaken for every pair of currencies in the investment universe, since cross-rates (in real and nominal terms) must be internally consistent with each other. The team uses the U.S. dollar as base currency for this estimation.

Historical real exchange rates are not constant in actuality, but are observed to oscillate around a constant central tendency. Deviations from this central tendency, or equilibrium, can be large and sustained, but overall permanent trends in real exchange rates are the exception, with reversion to a stationary level being the norm. This is exhibited in the charts for selected developed currencies (each currency is reflected against a basket of the others on the chart) and for a selection of emerging currencies (the latter currencies being ones for which there is no material productivity adjustment).

Real Exchange Rates: Selected Developed Currencies

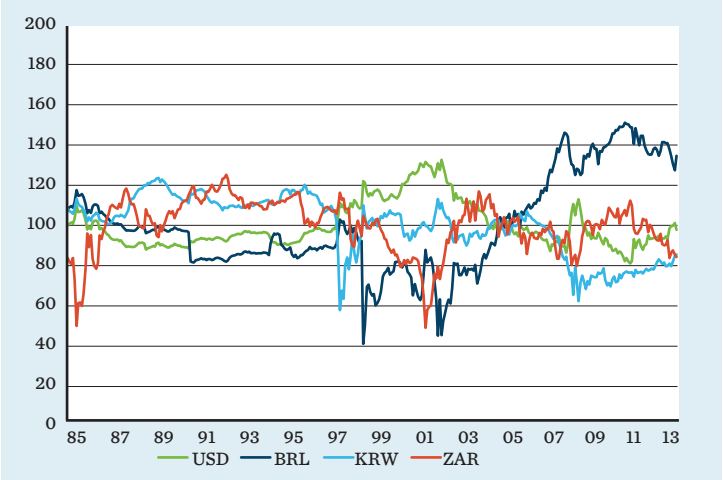


Source: William Blair

The equilibrium exchange rate is inferred statistically from these histories, and then transformed back into a nominal series.

[2] The inflation measure should not be so narrow such that it contains only items that are perfectly internationally tradable, as such narrowing will yield the increasingly un-useful observation that the real exchange rate never actually departs from a stable equilibrium. For example, if the "inflation measure" was restricted to a single item such as the price of crude oil, then backing out the crude oil price in domestic and foreign currency would lead to a "real" exchange rate that was always fixed in actuality.

Real Exchange Rates: Selected Emerging Currencies



Source: William Blair

The equilibrium exchange rate can then be projected forward in time, in nominal terms, by applying the forward-looking inflation assumptions for the domestic and foreign economies that are a part of the DAS team's valuation model inputs. If the inflation assumptions are the same in each economy then the forward-projection of equilibrium exchange rate (in nominal terms) will be constant. If the inflation assumptions are different then the projected equilibrium exchange rate will have a slope equal to the difference in inflation rates. (In either case, in real terms the forward projection of equilibrium exchange rate will be constant).

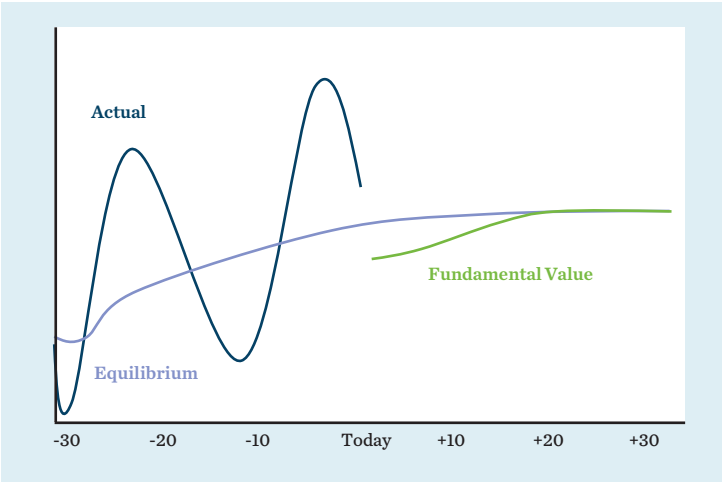
Fundamental Value: Impact of Forward-Looking Real Cash Rates

Although an equilibrium exchange rate is consistent with the level of relative PPP to which an actual exchange rate should revert, there is an important reason why fundamental value for an exchange rate may be different from equilibrium. This is the expectation of different real cash rates in the foreign economy and the domestic economy. Forward-looking real cash rate assumptions are part of the DAS team's valuation model inputs. If expected real cash rates in the domestic economy and the foreign economy are the same, then there is no differential real cash rate to impact fundamental value and the fundamental value exchange rate will be the same as the equilibrium exchange rate. If foreign and domestic forward-looking real cash rates are different, then the fundamental value exchange rate should be higher or lower than the equilibrium exchange rate by an amount equal to the total forward-looking difference in real cash returns.

The theory behind this assumption is known as uncovered interest rate parity (UIP). The rationale is that a risk-neutral investor will be indifferent between the available interest rate in one[3] currency and another currency provided that the exchange rate is anticipated to adjust to exactly offset the observed or anticipated difference in available interest rates. Accordingly, if interest rates are expected to be higher in one currency relative to another, the fair exchange rate of the first currency against the other should be stronger than the exchange rate that satisfies relative PPP, because over a forward-looking horizon it will be expected to depreciate to the relative PPP level by an equal but opposite amount to the interest rate advantage, offsetting what would otherwise be an arbitrageable gain. Since relative PPP is a property of real exchange rates, rather than nominal, it is the relative real interest rates that are of relevance here.

In the DAS team's valuation model, real cash rates are typically unequal in the first stages of the model[4] but converge to equal levels by the fourth stage. It follows that the total forward-looking difference in the relative real cash return between two currencies is bounded and finite. The summation of relative forward-looking real cash returns in the valuation model gives the magnitude and direction of the difference between equilibrium exchange rate and fundamental value exchange rate.

Fundamental Value Illustration



Source: William Blair. For illustrative purposes only.

[3] The reference to "foreign" and "domestic" is omitted from this explanation as it is not appropriate. A domestic investor is not indifferent to domestic interest rates (earned on cash deposits) and foreign interest rates (earned by buying foreign currency out of domestic currency and placing that on deposit). This is because a domestic investor faces no currency risk with a domestic cash deposit but does experience exchange rate risk with a foreign currency deposit. However the no-arbitrage condition of UIP still holds because the situation is symmetric: foreign investors are equally but oppositely not indifferent between foreign cash deposits and domestic cash deposits. The "fair" exchange rate should, therefore, still be at a level that is different from the relative PPP rate by an amount equal to the expected difference in cash returns between the two currencies.

[4] See "Valuation Documentation in Brief (Assets)". William Blair.

The preceding diagram illustrates the foregoing aspects of exchange rate valuation in a stylized context. The chart is shown in nominal (not inflation-adjusted) terms. The vertical axis is in exchange rate units—units of foreign currency per unit of domestic currency.

The dark blue line represents the path of the actual exchange rate during the prior three decades. The lighter blue line is the equilibrium (relative PPP) exchange rate shown over the same historical period (estimated from historic real exchange rate data as above), and also projected forward from today. For the prior three-decade period, as described above, the equilibrium exchange rate (which is constant in real terms) follows a path described solely by relative inflation in the foreign and domestic economy. Since the light blue line is sloping upwards, the equilibrium exchange rate of the domestic currency has gradually appreciated over the past, in nominal terms. This implies that foreign inflation has been higher than domestic inflation during this period—such that a constant real exchange rate (foreign currency units per unit of domestic currency) translates to a rising nominal exchange rate (more units of foreign currency per unit of domestic currency are "needed" over time to compensate for more rapid inflation in the foreign economy).

Looking forward from today, the equilibrium exchange rate path is determined by the relative inflation assumptions in the DAS team's valuation model. In the diagram the equilibrium exchange rate continues to appreciate (in nominal terms) into the future but then becomes stationary. This implies that the inflation assumptions show continued higher inflation in the foreign economy for a period, but that the two inflation rates subsequently converge to the same rate.

The green line that starts from today and projects forward is the fundamental value exchange rate. As described above, this is displaced above or below the equilibrium exchange rate by an amount equal to the total forward-looking assumed difference in real cash returns (domestic less foreign). Since the fundamental value exchange rate is lower than the equilibrium exchange rate—the domestic currency's fundamental value is lower than its relative PPP level—this implies that the assumed real cash return from domestic currency deposits is lower than the real return on foreign cash deposits (both of these measures are local currency returns). Because domestic real cash rates are assumed to be lower, the fundamental value of the domestic currency is weaker, as it should be anticipated to appreciate over the forward-looking horizon to compensate for the real cash rate disadvantage. The green line approaches the light blue line over time because at each point in the future, the remaining total difference in real cash rates (looking forward from that future point) decays as real cash rates ultimately converge in the fourth stage of the valuation model, which happens twenty years into the future. At that point—where real cash returns are equal—the assumed forward-looking difference in real cash return is zero, and the fundamental value exchange rate and equilibrium exchange rate are the same.

The value/price discrepancy for the exchange rate is the vertical gap between the actual exchange rate (dark blue) and the fundamental value exchange rate (green) at the time marked "Today". In the diagram, value is below price, meaning the value/price discrepancy is negative, and the domestic currency is overvalued—it buys more units of foreign currency in the market today than it would if it was at fundamental value.

Value/Price Discrepancy and Expected Holding Period Return

From the illustration above, it is sometimes thought that the return from holding foreign currency against domestic currency will vary dependent on the assumed time horizon over which price is anticipated to converge to fundamental value. This supposition is incorrect, but it comes from the observation that the fundamental value exchange rate in the future is typically different from fundamental value today. Although that observation is correct, the return from holding long foreign currency exposure against short domestic currency exposure is composed of both the expected change in exchange rate (as it converges to fundamental value) and the difference in cash rates that is accumulated over the holding period. As mentioned in the example, foreign real cash rates are higher than domestic real cash rates, therefore the investor holding a long foreign/short domestic currency exposure earns a positive relative real cash rate over time.

By construction, the change in the fundamental value exchange rate over any holding period (which appears as a shrinking V/P discrepancy) is exactly offset by the interest rate differential that is earned over the same period (which is a positive value). Accordingly, the total return experienced by the exchange rate reverting to fundamental value is constant no matter which time horizon is considered. (The rate of return varies for different assumed horizons, but not the total holding period return).

Expected Return: Exchange Rate Change and Carry

The expected return from a long/short currency exposure, assuming an exchange rate converges to fundamental value over an assumed period, can thus be decomposed into an exchange rate change component, and an earned relative interest rate (carry) component. In general, the larger the gap between fundamental value and equilibrium at the point marked "Today" in the diagram above, the larger the carry component. It is sometimes thought that a significant carry component of expected return from convergence to value is more certain and thus more valuable than an expected exchange rate change. However, this line of thought it also erroneous because although the expected return can be decomposed in this way, the two components of return are not separately investable—it is impossible to gain exposure to the carry without exposure to the exchange rate change, and vice versa. Thus, while such decomposition may be informative, it is incorrect to attach greater weight to expected carry than to expected exchange rate change.

By way of explanation, consider exchange rate misvaluations, V1/P1 and V2/P2 in two distinct currency pairs (four currencies in total). Suppose that the expected return from a long/short exposure to each currency pair is +5% per annum over the assumed convergence horizon. Next, suppose that the expected return consists entirely of carry for the first pair and entirely of exchange rate change for the second pair. Finally, suppose that the exchange rate volatility is the same for both exchange rates and the cash rate volatility is the same for all four currencies. It would not be correct to regard the expected return from the first currency pair to be more valuable, in other words less risky, than the second pair, because in each case an investor accepts exactly the same total currency risk for exactly the same expected return. Although the exchange rate change in the case of the first pair is assumed to be zero (and +5% per annum in the case of the second pair), the uncertainty around both expectations is the same. It is the magnitude of the combined components of expected return that is the only relevant return consideration, and the uncertainty of the combination of exchange rate and interest rate exposure that is the only relevant uncertainty consideration.

Productivity and Non-Stationarity of Equilibrium Exchange Rate

An important exception to the prior statement concerning an equilibrium exchange rate being constant in real terms arises in the case of several emerging currencies, where sustained differences in productivity growth and income-per-capita growth imply that relative PPP may not hold, and should be adjusted over time. This is the Balassa-Samuelson Effect, and it holds that sustained excess growth in productivity in a foreign economy, relative to the domestic economy, should result in the real exchange rate of the foreign currency appreciating versus the domestic currency over time without this impairing its relative purchasing power. In such special cases, the valuation methodology described above is relaxed from the condition that the equilibrium exchange rate should be constant in real terms, and it is given a trend consistent with the relative rates of historical and prospective productivity growth.

In these cases the equilibrium exchange rate is first estimated in accordance with the theory that it is constant in real terms, and then given a trend consistent with the assumed (sustained) difference in productivity growth (domestic versus foreign). Past productivity growth differentials are measured using GDP per capita data as a proxy, and forward-looking productivity growth is estimated using Jorgensen and Vu (2009) projections[5]. The team identifies a productivity case for such adjustment of the equilibrium exchange rate (away from stationarity) in some emerging economies and adjusts the equilibrium estimate higher (to a stronger level for the emerging currency). Thereafter, the estimation of fundamental value is the same as described above.

[5] Please go to: http://link.springer.com/article/10.1007%2Fs12626-009-0007-9.

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