

CURRENCY CHOICES IN VALUATION
AND THE INTEREST PARITY AND PURCHASING POWER PARITY THEORIES

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TO VALUE THE INVESTMENT IN THE DOMESTIC OR FOREIGN CURRENCY?

- Valuing an investment or an acquisition in a foreign or an emerging market: what currency should be used and how it affects the inputs?
- Often the senior management is required to express expected cash flows in a strong currency, usually dollars

We are going to demonstrate the equivalence independent of the currency used in the valuation, using an arbitrage-free pricing model to obtain the fair value of the business.

TO VALUE THE INVESTMENT IN THE DOMESTIC OR FOREIGN CURRENCY?

Two alternative methods can be used to obtain a fair value:

- Forecast both cash flows and cost of capital in dollars, estimating the Discounted Cash Flow (DCF) value in dollars.
- Forecast both cash flows and cost of capital in domestic currency, estimating the DCF value in domestic currency.

For the first case, since the business generate sales, expenses, and cash flows in domestic currency, it is necessary to forecast the exchange rate for the investment horizon.

In the second, we have to make some adjustments in the cost of capital and long-term growth rate used to estimate the terminal value of forecasted cash flow.

If the exchange rate and inflation rate are forecasted consistently, both methodologies yield identical values.

TO VALUE THE INVESTMENT IN THE DOMESTIC OR FOREIGN CURRENCY?

- Establishing the correct assumptions and selecting the economic theories that provide rationale is required since the choice of currency affects the inputs.
- The equivalence can be demonstrated using a DCF model which assumes the simultaneous fulfillment of Interest Rate Parity theory (IRP) and Purchasing Power Parity theory (PPP).
- *Cash flows and the cost of capital have to be estimated consistently in the same currency.*

INTEREST RATE PARITY THEORY

IRP states a relationship between the interest rates and the currency exchange rates. In the absence of arbitrage opportunities, the interest rate differential is equivalent to the differential between the spot and forward exchange rates, so the IRP must hold for every period of t in equilibrium:

$$\frac{F_t^{D/USD}}{S^{D/USD}} = \frac{1 + i_t^D}{1 + i_t^{USD}} \leftarrow \text{Interest rate differential}$$

i_t^D = one period forward domestic interest rate,

i_t^{USD} = one period forward dollar interest rate,

$F_t^{D/USD}$ = forward exchange rate for one period forward.

Therefore, the forward exchange rate can be expressed as:

$$F_t^{D/USD} = S^{D/USD} \frac{1 + i_t^D}{1 + i_t^{USD}}$$

PURCHASING POWER PARITY THEORY

PPP requires that the inflation rate differential between two countries be equal to the change in the foreign exchange rate.

$$\frac{F_t^{D/USD}}{S^{D/USD}} = \frac{1 + \pi_t^D}{1 + \pi_t^*}$$

← Inflation rate differential

Therefore, the forward exchange rate for one period forward is:

$$F_t^{D/USD} = S^{D/USD} \frac{1 + \pi_t^D}{1 + \pi_t^*}$$

VALUING IN FOREIGN AND DOMESTIC CURRENCY

Valuation in foreign currency (i.e. dollars):

$$V^{USD} = \sum_{t=1}^{\infty} \frac{FCF_t^{USD}}{(1 + WACC_t^{USD})^t}$$

Valuation in domestic currency (i.e. pesos):

$$V^D = \sum_{t=1}^{\infty} \frac{FCF_t^D}{(1 + WACC_t^D)^t}$$

For valuing the company in domestic currency, we have to perform two adjustments first, one in the cost of capital and the other in the nominal long-term growth rate...

EXPECTED (IMPLICIT) DOMESTIC INFLATION RATE

IRP, coupled with PPP and the expectations theory of forward exchange rates, implies the international Fisher effect. To be consistent, both theories should be predicting the same forward exchange rate:

$$F_t^{D/USD} = S^{D/USD} \frac{1 + i_t^D}{1 + i_t^{USD}} = S^{D/USD} \frac{1 + \pi_t^D}{1 + \pi_t^*}$$

Since the inflation rate in developed countries is around 2%, we can assume it will remain constant along the forecast period.

Once the forward exchange rate was obtained using the IRP and we know the spot exchange rate and the international inflation rate, we can obtain the *implied* domestic inflation rate:

$$\frac{F_t^{D/USD}}{S^{D/USD}} (1 + \pi_t^*) - 1 = \pi_t^D$$

ADJUSTMENT 1: COST OF CAPITAL IN DOMESTIC CURRENCY

The inflation rate observed in emerging countries is higher compared to the inflation rate observed in developed countries...

$$(1 + WACC_t^D) = (1 + WACC_t^{USD}) \left(\frac{(1 + \pi_t^D)}{(1 + \pi_t^*)} \right) \leftarrow \text{Inflation rate differential}$$

π_t^D = t -period domestic inflation rate

π_t^* = t -period international inflation rate

EXERCISES

IRP states that the change in the exchange rate is equal to the differential between theexchange rate and theexchange rate.

Equivalently, it implies that the forward exchange rate is equal to the.....exchange rate multiplied by the interest rate.....

PPP states that the change in the exchange rate is equal to the differential between theinflation rate and theinflation rate.

Equivalently, it implies that the forward exchange rate is equal to the.....exchange rate multiplied by the rate.....

More important, if the forward exchange rate was estimated using the IRP, then the domestic inflation rate must be equal to therate differential multiplied by $(1+...)^{-1}$

EXERCISES

Using the following data, calculate the company value assuming perpetuities. Estimate first the value in dollars and then in domestic currency (pesos).

FCF^D	100
ER_0	10
ER_1	10,19
$WACC^{USD}$	10%
Yield emerg. Bond ^D	7%
Yield emerg. Bond ^{USD}	5%
Internac. Inflation rate	2%

STEP 1: VALUING IN FOREIGN CURRENCY

Step 1: once the forward Exchange rate was forecasted, the cash flow is expressed in dollars and the company value is calculated discounting it with the WACC expressed in dollars:

	A	B	C	D	E	F
1						
2	FCF ^D	100		FCF ^{USD}	9,8	--> +B2/B4
3	ER ₀	10		V ^{USD}	98,1308	--> +E2/B5
4	ER ₁	10,19	--> =+B3*(1+B6)/(1+B7)			
5	WACC ^{USD}	10%				
6	Yield emerg. Bond ^D	7%				
7	Yield emerg. Bond ^{USD}	5%				

STEP 2: VALUING IN DOMESTIC CURRENCY

For valuing in domestic currency we need to express the WACC in domestic currency.

It will be equal to the WACC in dollars adjusted by the inflation rate differential.

To obtain the inflation rate differential, we need to estimate the domestic inflation rate (the inflation rate in the emerging country). We will use the PPP theory to perform this estimation.

STEP 2: VALUING IN DOMESTIC CURRENCY

Once the forward Exchange rate was obtained using the IRP, we can extract the domestic (implicit) inflation rate in the emerging country so both theory hold (notice that we assumed an international inflation rate of 2%)

$$\frac{10,19}{10} = \frac{(1 + \pi_{EMERG})}{(1 + 0,02)}$$

$$\pi_{EMERG} = 3,94\%$$

STEP 2: VALUING IN DOMESTIC CURRENCY

Then the WACC in dollars is adjusted by the inflation rate differential to obtain the WACC in domestic currency. Finally, the FCD is discounted with the WACC D to obtain the company value in domestic currency.

We have demonstrated that $V^D/ER^0 = V^{USD}$

	A	B	C	D	E	F
1						
2	FCF ^D	100		FCF ^{USD}	9,8	--> +B2/B4
3	ER ₀	10		V ^{USD}	98,1308	--> +E2/B5
4	ER ₁	10,19	--> =+B3*(1+B6)/(1+B7)			
5	WACC ^{USD}	10%				
6	Yield emerg. Bond ^D	7%				
7	Yield emerg. Bond ^{USD}	5%				
8	Internac. Inflation rate	2%				
9	Domestic inflation rate	3,94%	--> +(B4/B3)*(1+B8)-1			
10	WACC ^D	10,19%	--> +B5*(1+B9)/(1+B8)	Working with perpetuities, the WACC		
11	V ^D	981,31	--> +B2/B10	is adjusted without compounding rates		
12						
13	V ^D /ER ₀	98,13	--> +B11/B3			

ADJUSTMENT 2: LONG-TERM GROWTH RATE IN DOMESTIC CURRENCY

The same adjustment have to be performed in the domestic long-term growth rate g^D , in order to calculate the terminal value for a company that operates in an emerging or foreign market.

This is equal to the nominal long-term growth rate observed in developed countries adjusted by the inflation rate differential:

$$TV^{USD} = \frac{FCF_T^{USD} (1 + g^*)}{WACC_T^{USD} - g^*}$$

$$g^D = g^* \left(\frac{1 + \pi_T^D}{1 + \pi_T^*} \right)$$

Inflation rate differential

$$TV^D = \frac{FCF_T^D (1 + g^D)}{WACC_T^D - g^D}$$

g^* = nominal long-term growth rate in the developed country,

g^D = nominal long-term growth rate in the emerging country,

π_T^D = last forecast period domestic inflation rate,

π_T^* = last forecast period international inflation rate.

EXERCISE

You have to demonstrate the equivalence of valuing in foreign and domestic currency of *Drunk Country Corp* using the following data:

<u>Data</u>		<u>Data cost of capital</u>	
Spot exchange rate	10	rf	3%
Yield ^D	7%	MRP	6%
Yield ^{USD}	4%	Beta	1,20
Internac. Infl. Rate	2%	kd	9%
LT growth rate g*	4,00%	D/V	25%
		t	35%
		CRP	1%

Company value in US\$

	Yr 0	Yr 1	Yr 2	Yr 3
FCF D		15	17	18
Forward exchange rate				
FCF ^{USD}				
Terminal value				
FCF ^{USD} + TV				

SOLUTION

	A	B	C	D	E	F	G	H	I	J	K	L	
1	<u>Data</u>			<u>Data cost of capital</u>			<u>Calculations</u>						
2	Spot exchange rate	10		rf	3%								
3	Yield ^D	7%		MRP	6%		g^{emerg}	7,00%	--> $=(1+H2)*(1+H4)/(1+B5)-1$				
4	Yield ^{USD}	4%		Beta	1,20		Domestic inflation rate	4,94%	--> $+C14/B2*(1+B5)-1$				
5	Internac. Infl. Rate	2%		kd	9%		ke	11,2%					
6	LT growth rate g*	4,00%		D/V	25%								
7				t	35%								
8				CRP	1%								
9													
10		<u>Company value in US\$</u>					<u>Company value in domestic currency</u>						
11													
12		Yr 0	Yr 1	Yr 2	Yr 3		Yr 0	Yr 1	Yr 2	Yr 3			
13	FCF ^D		15	17	18		FCF ^D	15	17	18			
14	Forward exchange rate		10,29	10,59	10,89		Terminal value				319		
15	FCF ^{USD}		1,46	1,61	1,65		FCF ^D + TV	15	17	337			
16	Terminal value				29,32								
17	FCF ^{USD} + TV		1,46	1,61	30,97								
18													
19							<u>Equivalence proof</u>						
20													
21	WACC ^{USD}	9,86%	--> $=E6*E5*(1-E7)+H7*(1-E6)$					WACC ^D	13,03%	--> $=(1+B21)*(1+H4)/(1+B5)-1$			
22	V ^{USD}	\$ 26,02						V ^D	\$ 260,16				
23								V ^{USD}	26,02	--> $=+I22/B2$			

FORECASTING THE EXCHANGE RATE WITH THE YIELD CURVES

Previous examples assumed a flat yield curve. A yield curve is transitional; the most common form is upward sloping.

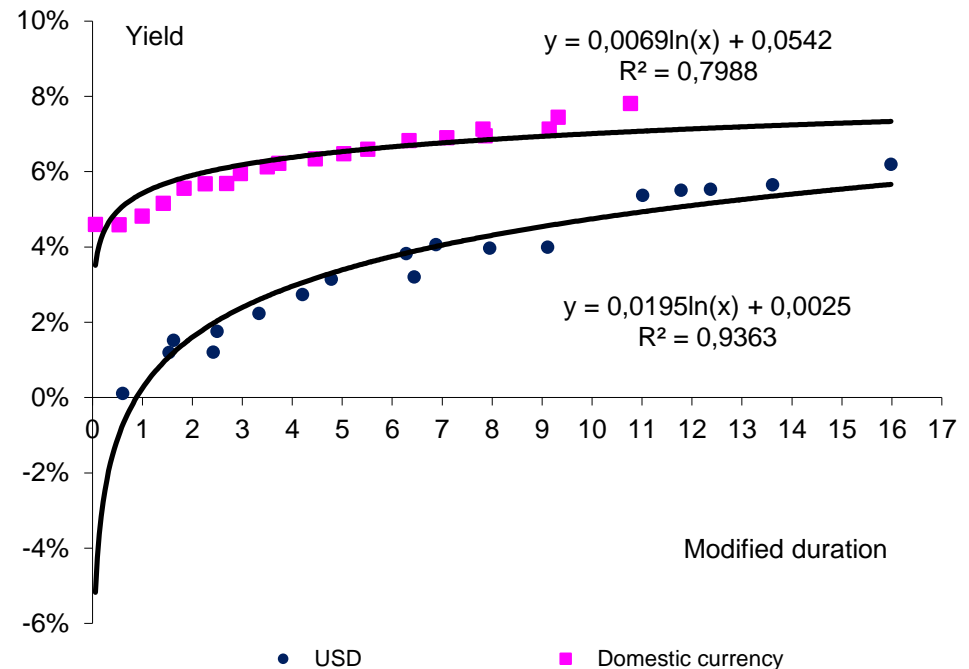
One way to forecast the Exchange rate is through the yield curves for bonds issued by the same issuer expressed in domestic and foreign currency.

A HYPOTHETICAL EXAMPLE

- “Foreign investor” is a company that has operations in several countries and is considering an acquisition in México.
- The senior management is required to create a consistent set of macroeconomic assumptions regarding the exchange rate, the domestic inflation rate, the interest rates, and the GDP growth.
- The target acquisition’s FCF is expected to grow at a rate of 3% per year plus the domestic inflation rate. Beyond this period, FCF is expected to grow at a rate of 2% per year plus the domestic inflation rate.
- A Terminal Value in foreign and domestic currency is estimated using Equations 10 and 11, the WACC expressed in dollars is estimated to be 15%, and the spot exchange rate is $S^{D/USD}=11.72$.

FORECASTING THE EXCHANGE RATE USING MARKET BONDS YIELDS

- In emerging markets, the forward exchange rates are not liquid or are not available beyond 12/18 months. To obtain the company fair value in dollars, analysts need to forecast the forward exchange rate for a longer horizon.
- To fill the gap, we can use the data of market bond yields in an emerging country and assuming the IRP holds, forecast the forward exchange rate for the explicit forecast period.



Emerging market bonds issued in local currency generally pay a premium in comparison to bonds issued in dollars. Since the issuer and the jurisdiction are the same and differ solely in the currency, the yield spread reflects the market's opinion about the forward exchange rate.

FORECASTING THE EXCHANGE RATE USING MARKET BONDS YIELDS

Since the market requires a currency premium for the devaluation risk, the yield spread reflects the market's opinion about the expected exchange rate. Analysts can easily obtain the required returns for a specific year using the yield curve equations. For example, to calculate the required return in domestic currency and dollars for one year from now:

$$i_1^D = 0,0542 + 0,0069 \ln(1) = 5,42\%$$

$$i_1^{USD} = 0,0025 + 0,0195 \ln(1) = 0,25\%$$

To obtain the expected yields for subsequent years, analysts only have to change the year number in the equation:

$$i_1^D = 0,0542 + 0,0069 \ln(3) = 6,18\%$$

$$i_1^{USD} = 0,0025 + 0,0195 \ln(3) = 2,39\%$$

FORECASTING THE EXCHANGE RATE USING MARKET BONDS YIELDS

To forecast the forward exchange rate for a specific year, analysts can extrapolate what some market participants refer to as the market's consensus of forward interest rates. Given the two-year spot rate, there could be a rate on a one-year instrument one year from now that will make the investor indifferent between two alternatives:

$$f_1^{USD} = \frac{(1 + i_2^{USD})^2}{(1 + i_1^{USD})} - 1$$

For example, to forecast the expected exchange rate for two years from now:

$$F_2^{D/USD} = S^{D/USD} \frac{(1 + i_1^{USD})(1 + f_1^{USD})}{(1 + i_1^D)(1 + f_1^D)}$$

The forward exchange rate is estimated using IRP rather than PPP. This is because one can observe forward interest rates in the market, but one cannot directly observe the expected inflation rates.

ADJUSTMENT 3: COST OF CAPITAL AND THE SLOPE OF THE YIELD CURVE

Equations 5 and 6 assume a *flat yield curve*. In a valuation, it is common that practitioners consider a constant cost of capital along the investment horizon. However, the common yield curve is upward sloping (the inverted yield curve generally means the expectations of a downturn and the flat yield curve is transitional).

If the interest rates change with maturity, *the cost of capital must be calculated for each period*. The WACC expressed in dollars for the t -period will be equal to the WACC expressed in dollars for the $t-1$ period *plus the change in the interest rate*:

$$WACC_t^{USD} = WACC_{t-1}^{USD} + (i_t^{USD} - i_{t-1}^{USD})$$

VALUING IN DOMESTIC OF FOREIGN CURRENCY: THE EQUIVALENCE

	Yr 0	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
FCF ^D		100,00	109,50	119,30	129,50	140,19	151,42	163,23	175,69	188,82	202,67
Terminal Value ^D											1.565,42
FCF ^D		100,00	109,50	119,30	129,50	140,19	151,42	163,23	175,69	188,82	1.768,09
FCF ^{USD}		8,11	8,52	8,96	9,41	9,89	10,39	10,91	11,46	12,04	12,65
Terminal Value ^{USD}											97,73
FCF ^{USD}		8,11	8,52	8,96	9,41	9,89	10,39	10,91	11,46	12,04	110,38
F ^{D/USD}	11,72	12,32	12,85	13,32	13,76	14,18	14,58	14,96	15,33	15,68	16,02
i ^D		5,42%	5,90%	6,18%	6,38%	6,53%	6,66%	6,76%	6,85%	6,94%	7,01%
i ^{USD}		0,25%	1,60%	2,39%	2,95%	3,39%	3,74%	4,04%	4,30%	4,53%	4,74%
π ^D		7,26%	6,31%	5,77%	5,39%	5,10%	4,86%	4,66%	4,49%	4,34%	4,21%
π*		2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%
Disc. factor ^{USD}		0,87	0,75	0,65	0,56	0,48	0,42	0,36	0,32	0,27	0,24
PV Cash Flow ^{USD}	70,73	7,06	6,37	5,78	5,26	4,78	4,36	3,97	3,62	3,30	26,24
Disc. factor ^D		0,83	0,68	0,57	0,48	0,40	0,34	0,28	0,24	0,20	0,17
PV Cash Flow ^D	828,95	82,69	74,67	67,75	61,59	56,06	51,05	46,52	42,40	38,66	307,57
Real exchange rate	11,72	11,72	11,72	11,72	11,72	11,72	11,72	11,72	11,72	11,72	11,72

$$V^{USD} = \frac{828,95}{11,72} = 70,73$$

REAL EXCHANGE RATE

If the PPP holds and both theories predict the same exchange rate, it implies that the RER remains constant along the projection. To illustrate for one single year:

$$RER_0^{D/USD} = F_t^{D/USD} \frac{1 + \pi_t^*}{1 + \pi_t^D}$$

For practitioners, the estimated value of the RER is extremely important at the moment to decide an investment, in order to avoid an undervaluation or an overvaluation...

CONCLUSIONS

- Valuation in foreign currency or in domestic currency yields identical values when the simultaneous fulfillment of both IRP and PPP is assumed.
- A simple fact: an asset cannot be sold for more than one price in the market.
- One way to forecast the expected exchange rate is to adjust the spot rate by the yield spread observed in market sovereign bonds for different currencies.
- While our approach is essentially a suggestion for valuation in emerging markets, it can also be used by multinationals which have businesses in developed countries.