

FOREIGN EXCHANGE AND CROSS-BORDER VALUATION

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Abstract

Should a corporate financial manager analyze a cross-border capital budgeting proposal from the perspective of the foreign currency or the home currency? This issue is explored when the manager's foreign exchange (FX) forecast differs from the forecast implicit in uncovered interest rate parity. Scenarios include the valuation of a foreign business entity, a proposal to expand overseas production, and a decision to relocate production to a different country. Two secondary issues in cross-border valuation are also addressed, cash flow components with different FX exposures and the gradual correction of a misvalued FX rate.

FOREIGN EXCHANGE AND CROSS-BORDER VALUATION

For the analysis of a cross-border capital budgeting proposal, Brealey and Myers (2000) emphasize the irrelevance of both the currency perspective and the level of the foreign exchange (FX) rate. They convert the cost of capital across currencies using the uncovered interest rate parity (UIRP) condition and use forward FX rates as the forecasted rates. Thus, Brealey and Myers get the irrelevance results by assuming FX forecasts that are implicit in the cost of capital conversion.

In my exploration of the issue, I consider a company that develops an FX forecast different from the implicit forward FX forecast, and I constrain the company's ability or willingness to directly speculate in the FX and financial markets. In this setting, the currency perspective of the company's capital budgeting analysis does become an issue.¹ My presentation is consistent with an imperfect FX market, where an undervalued (overvalued) currency is forecasted to appreciate (depreciate) at a faster rate than the equilibrium expected rate. I discuss the related problem of incorporating non-equilibrium FX forecasts into the cost of capital conversion across currencies.

I also address the secondary issue of cash flow components that are stable in different currencies. For example, since an exporter's revenues are likely to be generated in a foreign currency, while operating costs are incurred in the home currency, FX changes

¹ I have learned that Zenner and Akaydin (2002) take a similar perspective in a short section of a practitioner paper.

imply that the cash flow components are likely to change over time at different rates in either given currency.²

I provide numerical illustrations of three types of international investment decisions: the valuation and sale of a foreign entity, the expansion of overseas production, and the relocation of production to a different country. Other things equal, companies may invest more in projects that generate cash flows in an undervalued currency to take advantage of a forecasted above-equilibrium FX appreciation. Thus the level of FX rates influences foreign direct investment (FDI) decisions, supporting empirical findings of a connection between the level of FDI and changes in FX rates. See Caves (1989), Froot and Stein (1991), Klein and Rosengren (1994), Dewenter (1995), and Blonigen (1997).³

The main analysis assumes that FX rates are forecasted to change at a constant perpetual rate. This simplification allows the use of the constant growth model and thus permits a clearer focus on the primary issue. An appendix addresses cross-border valuation when FX rates are forecasted to change at a non-constant rate as they converge

² A good discussion of valuation of cash flow components is in Ariel (1998).

³ A related empirical finding is the relationship between the acquisition premium paid for a foreign target and the weakening of the foreign currency. See Harris and Ravenscraft (1991), Servaes and Zenner (1994), and Swenson (1994). There are also other possible explanations for the empirical findings that are not related to FX misvaluation and the forecasted correction. One is the imperfect capital market argument of Froot and Stein (1991), that internal financing is less costly than external financing. If the currency of an acquisition target depreciates, a foreign acquirer will be relatively better off (in terms of internal funds) than a local acquirer. Thus, FDI is more likely to occur when the target's currency depreciates, consistent with the empirical evidence.

Another explanation is that of Blonigen (1997), who assumes imperfect good markets. In the Blonigen model, the target firm owns a valuable firm-specific innovation, perhaps the result of the target's research and development. A foreign acquirer would like to export the innovation to its home operation, while the local acquirer does not operate in the foreign acquirer's home market. When the target's currency depreciates, the cost of the innovation declines to the foreign acquirer but not to the local acquirer. Thus, other things equal, FDI is more likely to occur when the target's currency depreciates, consistent with the empirical evidence.

toward a long-run rate, creating a non-constant growth rate in expected foreign currency cash flows from the perspective of the home currency.

I. FRAMEWORK FOR ILLUSTRATIONS

The illustrations use a hypothetical corporate entity, Euro Pipe Fitters (EPF), which produces aluminum pipefittings in Ireland and sells them in Germany, and is a wholly owned subsidiary of the US multinational ABC Corporation. EPF's revenues are generated in euros, and all production costs are stable in euros except for the cost of aluminum, which is stable in US dollars. By assumption, EPF's sales volume is expected to grow perpetually by 5% per year; sales volume is not subject to economic exposure to FX changes in the sense that optimal output and selling price do not depend on FX rates. Thus EPF's euro cash flows and depreciation are projected to grow at the rate of 5% per year *in euros*, and the aluminum costs are projected to grow at the rate of 5% per year *in US dollars*.⁴

The current spot FX rate is assumed to be 1 \$/€. Currently, EPF's annual revenues are €600K; non-aluminum production costs are €235K; aluminum costs are \$125K; and depreciation is €40K. At an assumed tax rate of 20%, EPF's current annual after-tax operating cash flow may be viewed as either €200K or \$200K. Exhibit 1 shows how a 20% depreciation of the euro would affect cash flows in euros and in US dollars.

Since a portion of EPF's cash flow is stable in euros, and the rest is stable in US dollars, it is useful to re-express the cash flow components on an after-tax basis. EPF's

⁴ This hypothetical scenario is adapted from the Eurotech example in Godfrey and Espinosa (1998). Although it is an unnecessary complexity in terms of the primary issue, the assumption that the cash flow components are stable in different currencies remains true to the Godfrey-Espinosa scenario, and provides the motivation for the secondary issue of valuation of the cash flow components.

after-tax euro cash flow, including the depreciation tax savings, is currently (€600K – €235K)(1 – 0.20) + 0.20(€40K) = €300K (or \$300K). EPF’s after-tax aluminum cost is currently \$125K(1 – 0.20) = \$100K (or €100K). Again, at the current spot FX rate of 1 \$/€, EPF’s current annual after-tax operating cash flow may be viewed as either €200K or \$200K.

Exhibit 1. EPF Cash Flows--Production in Ireland		
<u>€000s</u>	<u>1.00 \$/€</u>	<u>0.80 \$/€</u>
Revenues	€600	€600
Production Expense	235	235
Aluminum	125 (\$125 @ 1 \$/€)	156 (\$125 @ 0.80 \$/€)
Depreciation	<u>40</u>	<u>40</u>
EBIT	€200	€169
Taxes (20% x EBIT)	<u>40</u>	<u>34</u>
EBIAT	€160	€135
+ Depreciation	<u>40</u>	<u>40</u>
After-Tax Op Cash Flow	€200	€175
<u>\$000s</u>		
Revenues	\$600	\$480
Production Expense	235	188
Aluminum	125	125
Depreciation	<u>40</u>	<u>32</u>
EBIT	\$200	\$135
Taxes (20% x EBIT)	<u>40</u>	<u>27</u>
EBIAT	\$160	\$108
+ Depreciation	<u>40</u>	<u>32</u>
After-Tax Op Cash Flow	\$200	\$140

A. Cost of Capital Conversion Across Currencies

Assume that the US parent firm ABC has determined that the cost of capital for EPF in US dollars is $k^{\$} = 10\%$. EPF’s cost of capital in euros, $k^{\text{€}}$, consistent with its cost of capital in US dollars, is found using Equation (1):

$$k^{\text{€}} = k^{\text{\$}} - E(x^{*\text{\$/€}}) + (1 - B_{\text{€}}^{\text{\$}})\sigma_{\text{€}}^2 \quad (1)$$

Equation (1) shows that $k^{\text{€}}$ is found by first subtracting from $k^{\text{\$}}$ the *equilibrium* expected rate of change in the FX value of the euro, denoted $E^*(x^{\text{\$/€}})$, where the asterisk denotes equilibrium. The last term in Equation (1), $(1 - B_{\text{€}}^{\text{\$}})\sigma_{\text{€}}^2$, is an adjustment for the covariance between the asset's returns and percentage changes in the FX rate, where $B_{\text{€}}^{\text{\$}}$ is the sensitivity of asset's returns in US dollars to changes in the $\text{\$/€}$ FX rate, and $\sigma_{\text{€}}$ is the volatility of the $\text{\$/€}$ FX rate.⁵

As is common (e.g., Brealey and Myers), we rely on the uncovered interest rate parity (UIRP) condition to estimate $E^*(x^{\text{\$/€}})$ using the interest rate differential, $r^{\text{\$}} - r^{\text{€}}$, the risk-free interest rate in US dollars minus the risk-free interest rate in euros. We assume that the interest rate in US dollars is 4.00% and the interest rate in euros is 5.50%. Thus the equilibrium expected rate of change in the FX value of the euro is $0.040 - 0.055 = -0.015$, or -1.50% . Just as the interest rate in euros (5.50%) is found by subtracting $E^*(x^{\text{\$/€}})$ from the interest rate in US dollars, EPF's estimated cost of capital in euros involves subtracting $E^*(x^{\text{\$/€}})$ from the cost of capital in US dollars.⁶

The adjustment in Equation (1) for the covariance between the asset's returns and percentage changes in the FX rate, $(1 - B_{\text{€}}^{\text{\$}})\sigma_{\text{€}}^2$, is simplified by the assumption that EPF has no economic FX exposure, so that the covariance between EPF's euro cash flows and FX changes is zero. Thus in US dollars, the sensitivity ($B_{\text{€}}^{\text{\$}}$) of EPF's euro cash flows to percentage changes in the $\text{\$/€}$ FX rate is 1 (conversion exposure), while the

⁵ This adjustment is based on Ito's Lemma. See Sercu and Uppal (1995), p. 601, footnote 13. Equation (1) is also used by O'Brien (1999).

⁶ The impact of systematic risk in the FX rate is ignored here for simplicity.

sensitivity of the aluminum costs is 0. Let us assume that σ_{ϵ}^2 is 0.015 (an FX volatility of about 0.122). Given that the US dollar cost of capital of 10.0% pertains to both cash flow components, the cost of capital in euros for EPF's euro cash flows is $0.10 - (-0.015) + (1 - 1)0.015 = 0.115$, or 11.5%, and the cost of capital in euros for EPF's aluminum costs is $0.10 - (-0.015) + (1 - 0)0.015 = 0.130$, or 13.0%.

B. Conversion of Forecasted Growth Rates Across Currencies

The projected growth rate of EPF's cash flows, when measured in US dollars, $g^{\$}$, depends on the projected growth rate of the cash flows in euros, g^{ϵ} , and the *forecasted* rate of change in the FX value of the euro, denoted $E(x^{\$/\epsilon})$. Lack of an asterisk indicates the forecasted FX rate of change can be different from the expected equilibrium rate. We also make an adjustment for covariance between percentage changes in the cash flow and the FX rate. Equation (2) shows the relationship:

$$g^{\$} = g^{\epsilon} + E(x^{\$/\epsilon}) - (1 - B_{\epsilon}^{\$})\sigma_{\epsilon}^2 \quad (2)$$

Because EPF has revenues and some production costs that are stable in euros, but aluminum costs that are stable in US dollars, EPF's cash flow components are projected to grow at different rates from the viewpoint of either given currency.

II. FX FORECASTS AND CROSS-BORDER VALUATION

In this section, I first demonstrate the Brealey-Myers (2000) irrelevance result under the assumption that the forecasted rate of FX change is equal to the equilibrium expected rate. After this baseline case, I show an example where the forecasted rate is not equal to the equilibrium expected rate.

A. FX Forecasts Equal to Equilibrium Expectations

Assume that the forecasted rate of change in the spot FX value of the euro, $E(x^{\$/\epsilon})$, is equal to the equilibrium expected rate, -1.50% per year. By Equation (2), the projected growth rate of EPF's euro cash flows (assumed to be 5.00% when viewed in euros), is 3.50% when viewed in *US dollars* ($0.05 - 0.015 + (1 - 1)0.015 = 0.035$). Using Equation (2) rearranged, the projected growth rate in EPF's aluminum costs (assumed to be 5% when viewed in *US dollars*) is 8% when viewed in euros ($0.05 - (-0.015) + (1 - 0)0.015 = 0.08$).

Let us now reconcile EPF's value across currencies with the cost of capital, 10% in US dollars and component costs of capital of 11.5% and 13.0% in euros, in a discounted cash flow (DCF) analysis under constant perpetual growth. EPF's value in euros is the capitalized value of the expected after-tax cash flow stream, viewed in euros, at the euro cost of capital. We find EPF's value in euros by components, i.e., as the difference between the present value of the future after-tax euro cash flows and the present value of the future after-tax aluminum costs.

EPF's after-tax euro cash flow, currently $\text{€}300\text{K}$, is projected to grow at 5% , and the cost of aluminum is projected to grow in euros at 8% . Thus, the intrinsic value of EPF in euros is equal to $\text{€}300\text{K}/(0.115 - 0.05) - \text{€}100\text{K}/(0.13 - 0.08) = \text{€}4.62\text{M} - \text{€}2\text{M} = \text{€}2.62\text{M}$.

Next we find EPF's value in US dollars as the difference between the present value of the future after-tax euro cash flows and the present value of its future after-tax aluminum costs. When viewed in US dollars, EPF's after-tax euro cash flow, currently $\text{\$}300\text{K}$, is projected to grow at 3.50% , and the cost of aluminum is projected to grow at

5.00%. Since the cost of capital in US dollars is 10%, EPF's intrinsic value in US dollars is $\$300K/(0.10 - 0.035) - \$100K/(0.10 - 0.05) = \$4.62M - \$2M = \$2.62M$.

This illustration reconciles EPF's value across the two currencies when the FX rate is forecasted to change at the *equilibrium* expected rate. In this case, we see that EPF's intrinsic value to the investor in US dollars, \$2.62M, is indeed equivalent to the intrinsic value in euros, €2.62M, given the current spot FX rate of 1 \$/€, and $E(x^{\$/\epsilon}) = E^*(x^{\$/\epsilon}) = -1.50\%$.

B. FX Forecasts NOT Equal to Equilibrium Expectations

What if instead one forecasts an annual rate of change in the FX value of the euro that is different from the equilibrium expected rate? For now, assume that the FX value of the euro is forecasted to appreciate at the constant rate of $E(x^{\$/\epsilon}) = 1.00\%$ per year, even though the equilibrium expected rate of change is -1.50% per year; in reality, the forecasted rate is apt to gradually converge to a long-run rate (the implication of this for valuation is addressed in the appendix).

With a forecast that the euro will appreciate at 1.00% per year, Equation (2) tells us that EPF's expected euro cash flows, measured in US dollars, are forecasted to grow at the constant rate of $0.05 + 0.01 - (1 - 1)0.015 = 0.06$, or 6.00% per year, instead of 3.50%. Thus, the intrinsic value of EPF, to a US dollar investor who forecasts a perpetual euro appreciation of 1% per year, is $\$300K/(0.10 - 0.06) - \$100K/(0.10 - 0.05) = \$7.50M - 2M = \$5.50M$. And EPF's aluminum costs, when viewed in euros, are forecasted to grow only at the rate of 5.50% per year, instead of 8.00%. Thus, the investor's intrinsic value of EPF in euros is $\text{€}300K/(0.115 - 0.05) - \text{€}100K/(0.13 - 0.055) = \text{€}4.615M - \text{€}1.333M = \text{€}3.28M$.

To an investor with a 1.00% per year euro appreciation forecast, EPF's intrinsic value in US dollars, \$5.50M, is higher than \$2.62M, because the forecasted growth rate in US dollar cash flows is higher than with the – 1.50% FX forecast rate. And EPF's intrinsic value in euros, €3.28M, is higher than €2.62M because the cost of aluminum, when measured in euros, is projected to grow more slowly than with the – 1.50% FX forecast rate.

If EPF were an independent company, with stock traded in euros at an actual market value, say, of €4M, then in the absence of arbitrage, the stock would also have to be priced at \$4M in US dollars, e.g., as an ADR, given the assumed current spot FX rate of 1 \$/€. Thus a US dollar investor forecasts a 1% euro appreciation would view EPF's ADRs as undervalued (priced below intrinsic value, \$5.50M) at a market cap of \$4M. Similarly, a euro investor forecasting a 1% euro appreciation per year would view EPF's stock as overvalued, with a market value of €4M, above the intrinsic value of €3.28M.

III. INTERNATIONAL CORPORATE INVESTMENT DECISIONS

The three types of corporate investment decisions considered are the valuation and sale of a foreign entity; the expansion of overseas production; and the relocation of production to a different country.

A. Valuation and Sale of an Entity

What if the parent ABC is offered €4M (= \$4M) for its wholly owned entity EPF, when ABC is forecasting a 1% per year appreciation of the euro and when the spot FX rate is 1 \$/€?⁷ The offer of €4M exceeds ABC's estimate of EPF's intrinsic value in euros,

⁷ Whether to sell an overseas entity at a given price is the decision featured in Godfrey-Espinosa (1998).

€3.28M, although it is lower than EPF's intrinsic value in US dollars, \$5.50M, given the spot FX rate of 1 \$/€. Should ABC accept the offer?

By selling EPF, ABC would give up the opportunity to generate cash flows that would benefit from the forecasted appreciation of the euro at an above-equilibrium rate. In US dollar terms, ABC would be forgoing \$1.50M of intrinsic value by selling EPF for \$4M. *In theory*, ABC would be better off accepting the offer and investing the \$4M in a long-term risk-free euro deposit, to exploit its view on euro appreciation, rather than continue to operate EPF. The intrinsic value in US dollars of investing \$4M in a risk-free euro deposit, given the forecast of a 1% per year appreciation of FX value of the euro, would be \$7.33M, higher than the \$5.50M of intrinsic value of continuing to operate EPF.⁸

ABC's decision rests on whether this alternative use of the \$4M is realistic. ABC may or may not view a position in a long-term risk-free euro deposit as a realistic business alternative to operating EPF. If ABC cannot realistically directly speculate in the euro deposit, then continuing to operate EPF is a better alternative to selling, because it remains a way to exploit the currency forecast.

B. Expansion of Overseas Production

Next consider an investment proposal to expand EPF's production capacity in Euroland. Assume that the production expansion would require an investment outlay of €1M and would increase EPF's output by 25%. Given the current spot FX rate of 1 \$/€,

⁸ To see this, recall that the euro risk-free rate is assumed to be 5.50%. Thus a €1M investment will earn annual interest of $(0.055)(€1M) = €55K$. In US dollars, the cost of capital for a risk-free euro asset is $r_f^€ + E^*(x^{S/€}) = 0.055 - 0.015 = 0.04$. From Equation (2), the asset's cash flows are projected to grow at the forecasted rate of euro appreciation of 1%, since there is no growth in the euro cash flows and no covariance between the asset's euro cash flows and the FX rate. Thus the intrinsic value in US dollars of investing \$1M in the risk-free euro deposit is $\$55K / (0.04 - 0.01) = \$1.83M$, and the NPV is \$833K. The intrinsic value of a \$4M investment in the risk-free euro deposit is thus \$7.33M.

EPF would thus generate an additional €75K in current after-tax euro cash flow and incur an additional \$25K in current (after-tax) aluminum costs. (The growth rates would be the same as assumed above.)

The NPV of the expansion proposal *in euros* is thus $€75K/(0.115 - 0.05) - €25K/(0.13 - 0.055) - €1M = €1154K - €333K - €1M = -€179K$. The proposal's NPV *in US dollars* is $\$75K/(0.10 - 0.06) - \$25K/(0.10 - 0.05) - \$1M = \$1875K - \$500K - \$1M = \$375K$.

The proposal's NPV is negative in euros and is positive in US dollars. Should EPF accept or reject the expansion proposal? If euro investors owned EPF, the answer would be "reject." Given that EPF is owned by the US firm ABC, the positive NPV in US dollars suggests that the expansion proposal should be accepted. But ABC should again consider the alternative of investing the \$1M outlay in a long-term risk-free euro deposit, which has a zero NPV in euros and an \$833K intrinsic NPV in US dollars, given the forecasted appreciation of the euro of 1% per year. This \$833K of intrinsic NPV, due entirely to the forecasted change in the FX value of the euro at an above-equilibrium expected rate, is higher than the NPV in US dollars of EPF's proposed expansion of production, \$375K.

The question for ABC is again whether a speculative position in the euro deposit is a realistic option. If not, then the expansion decision makes sense as a means for ABC to exploit its FX forecast.

In theory, a pure financial strategy can *always* be found that dominates a capital investment proposal when the FX rate is forecasted to change at a different rate from the equilibrium expected rate. For example, assume that the investment outlay for the

expansion is only \$400K (instead of \$1M), so that the proposal has a positive NPV in *both* euros (€421K) and US dollars (\$975K). The alternative of investing the \$400K in a long-term risk-free euro deposit will generate an intrinsic NPV in US dollars of only \$333K. Nevertheless, there is always a way to obtain a higher NPV in the FX/financial markets by *levering* the \$400K with borrowed long-term US dollars to invest in a large long-term risk-free euro deposit; lever the \$400K with \$1.60M of borrowed long-term US dollars, and invest the \$2M into a long-term risk-free euro deposit, for example, for an intrinsic NPV of \$1.667M.

Does the *theoretical* possibility of such a dominating financial strategy mean that EPF's proposed expansion should be rejected if the outlay is \$400K? The answer depends on whether ABC regards the financial strategy as a *realistic* alternative use of the \$400K, which is often not the case for an operating enterprise.

C. Production Relocation to a Different Country

Now consider a production relocation decision. Suppose that in light of the forecasted appreciation of the euro of 1% per year, higher than the equilibrium expected rate, EPF is considering relocating its production into the United States as a means to reduce future production costs. Assume there is no production cost savings or cash flow change as long as the FX rate stays at 1 \$/€, so that EPF's current after-tax cash flow would still be €200K or \$200K, depending on the currency viewpoint. Assume the all-in direct investment outlay necessary to close the plant in Ireland and open one in the United States is \$800K, or equivalently €800K.⁹ Exhibit 2 shows pro forma cash flow figures.

⁹ The relocation of production to the United States would increase the FX operating exposure to the euro. This change does not affect EPF's cost of capital (assume to remain at 10%) as long as the FX rate has no systematic risk. If the FX rate has systematic risk, then the cost of capital for the cash flow components

Exhibit 2. EPF Pro Forma Cash Flow--Production in U.S.

<u>\$000s</u>	<u>1.00 \$/€</u>	<u>0.80 \$/€</u>
Revenues	\$600 (€600 @ 1 \$/€)	\$480 (€600 @ 0.80 \$/€)
Production Expense	235	235
Aluminum	125	125
Depreciation	<u>40</u>	<u>40</u>
EBIT	\$200	\$80
Taxes (20% x EBIT)	<u>40</u>	<u>16</u>
EBIAT	\$160	\$64
+ Depreciation	<u>40</u>	<u>40</u>
After-Tax Op Cash Flow	\$200	\$104

Since EPF's revenues are still expected to grow at 5% per year in euros, the revenues are still forecasted to grow at 6% per year in US dollars, given the forecasted 1% euro appreciation. But with the relocation of production to the United States, *all* of EPF's costs are now assumed to be stable in US dollars and thus projected to grow at the rate of 5% in US dollars and 5.50% in euros. In after-tax terms, EPF's current revenues are €480K (or \$480K) and current costs are \$280K (or €280K).

The new intrinsic value of EPF *in euros* would thus be $\text{€}480\text{K}/(0.115 - 0.05) - \text{€}280\text{K}/(0.13 - 0.055) = \text{€}7.385\text{M} - \text{€}3.733\text{M} = \text{€}3.65\text{M}$. The relocation of production would thus raise EPF's intrinsic value in euros by €370K, from €3.28M to €3.65M, due to the lower projected future production costs associated with the forecasted 1% per year euro appreciation. If the NPV analysis is conducted in euros, the decision would be to reject the relocation proposal, because the outlay of €800K exceeds the incremental intrinsic value, €370K.

would be different (in both currencies), and the production relocation would alter EPF's overall cost of capital as the relative mix of the cash flow components would change. (Shipping costs are ignored here for simplicity.)

EPF's new intrinsic value, viewed in US dollars, would be $\$480K/(0.10 - 0.06) - \$280K/(0.10 - 0.05) = \$12M - \$5.60M = \$6.40M$. Thus, the intrinsic value of EPF in US dollars would rise by \$900K, from \$5.50M to \$6.40M, and the NPV of the relocation decision from the US dollar point of view is $\$900K - \$800K = \$100K$. The economic benefit in US dollars of the forecasted appreciation of the euro at an above-equilibrium expected rate has made the intrinsic NPV positive from the US dollar point of view in this case, even though the NPV is negative from the euro point of view.

Should the proposed relocation of production be implemented? If EPF were an independent European company, the answer would be no. But as a wholly owned subsidiary of the US firm, the answer is yes, unless ABC finds it realistic to exploit its FX forecast directly by investing the \$800K in a levered position in a long-term euro deposit.

IV. CONVERTING THE COST OF CAPITAL WITH FX FORECASTS?

It is sometimes suggested that FX forecasts should be incorporated into the cost of capital conversion. This approach will reestablish the Brealey-Myers (2000) irrelevance result on currency perspective, but may be very misleading.

For example, if the forecasted appreciation of the euro of 1.00% is incorporated into EPF's cost of capital in euros, instead of the equilibrium expected rate of – 1.50% implicit in the interest rate differential, ABC would have an *ad hoc* estimate of EPF's euro cost of capital of 250 basis points lower, 9.0% instead of 11.5% for the euro cash flows and 10.5% instead of 13.0% for the aluminum costs. The expansion analysis earlier, with a €1M outlay, would show an NPV in euros of $\text{€}75K/(0.09 - 0.05) - \text{€}25K/(0.105 - 0.055) - 1M = \text{€}1875K - 500K - 1M = \text{€}375K$. Given the spot FX rate of 1 \$/€, this NPV is equivalent to the NPV found in US dollars, \$375K.

It should be stressed that this €375K is the NPV in euros *to a US dollar investor* (like ABC) with a 1% euro appreciation forecast, *not* to a euro investor with a 1% euro appreciation forecast. If euro investors owned EPF, they would base the valuation on the 11.5%/13.0% equilibrium component costs of capital, which is the basic compensation for risk regardless of the FX forecast. And as I have shown, the NPV of the expansion proposal would be – €179K, given the forecasted 1% euro appreciation.

Thus, the idea of converting the cost of capital using the FX forecast may be misleading in terms of finding an asset's intrinsic value from a foreign currency perspective.

V. CONCLUSION

It is frequently asserted that an asset's value will be the same in one currency as in another, given the spot FX rate, and that it is irrelevant whether an investment's NPV analysis is performed in the home currency or foreign currency, as long as we use consistent cost of capital parameters in the analyses. In fact, as has been shown, if one's actual *forecast* for the FX rate differs from the *equilibrium* expectation, the currency perspective is an important issue in the assessment of an investment's intrinsic value.

APPENDIX

NON-CONSTANT FOREIGN EXCHANGE FORECAST RATES

The text assumes a constant perpetual projected rate of change in the foreign exchange rate as a simplification for reasons of exposition. A more realistic assumption is a non-constant projected rate of change as FX misalignment is forecasted to gradually correct itself over time. A review of purchasing power parity (PPP) may be helpful before we discuss asset valuation under that assumption.

A. Purchasing Power Parity and FX Forecasts

The absolute purchasing power parity (APPP) condition represents a measure of intrinsic FX value based on the parity of trade goods prices in different currencies. Empirical research has indicated that actual FX rates do not obey APPP, but do tend to gravitate gradually toward the APPP value (Rogoff, 1996). The fact that the APPP condition does *not* fit actual FX rates provides the FX forecasting power, because it gives an indication of how FX rates will tend to move in the future in order to correct the misalignment.¹⁰

The relative purchasing power parity (RPPP) condition predicts FX movement based on inflation rate differentials. Although empirical research has reported that the RPPP condition has not been a particularly good fit with short-run data (Rogoff, 1996),

¹⁰ An interesting study of violations of the law of one price for some internationally distributed retail goods (of the IKEA Company) is Haskel and Wolf (2001). This article also has a good bibliography, including references to empirical results on correction of APPP violations.

anticipated inflation rate differentials are often a useful component of FX rate forecasts. The inflation differential is generally a more useful FX forecasting factor when a country is subject to a high-inflation country than when neither country has serious inflation.

Thus, the theory of PPP provides two factors that are useful in forecasts of future FX rates. One factor is the magnitude of the deviation of the current spot FX rate from the theoretical FX rate of the APPP condition. The notion is that a misvalued FX rate will tend to gradually correct itself.¹¹ The second factor is the forecasted inflation rate differential, where the higher-inflation currency should tend to depreciate, all else equal.

For example, assume that the inflation forecast in the US, $E(\pi^{\$})$, is 3%, and in Euroland, $E(\pi^{\text{€}})$, is 2%. The RPPP forecasted FX change due to the forecasted inflation differential is $E(x^{\$/\text{€}}) = E(\pi^{\$}) - E(\pi^{\text{€}}) = 3\% - 2\% = 1\%$. That is, the anticipated change in the nominal value of the euro because of the inflation differential is 1% per year. If the current spot FX rate is correctly valued according to APPP, we would be done; the euro would be forecasted to appreciate by 1% per year.

Suppose instead that the current actual spot FX rate is 1 $\$/\text{€}$, while the current APPP-FX value of the euro is 1.25 $\$/\text{€}$, so the euro is currently undervalued (in terms of the US dollar) by 20% in the spot FX market. What is the best forecast of next year's spot FX rate from this information? The answer depends on the rate at which the APPP violation is forecasted to correct itself.

¹¹ Some FX forecasting models also use the expected rate of FX change from the uncovered interest rate parity (UIRP) condition as a third factor to improve the FX forecasts. By itself, the UIRP condition has a poor track record in FX forecasting, but it may be useful in multifactor FX forecasting models. Other forecasters have advocated also using economic measures like productivity, employment, and so forth; still others have maintained that such economic measures do not add much to the two PPP factors and the interest rate differential factor of UIRP. Note that the UIRP theoretical relationship is a useful theory, even though there is a controversy about its fit with empirical data, as the interest rate differential (the UIRP relationship) is useful in converting an asset's cost of capital across currencies in a consistent manner.

Let us first consider the (unrealistic) assumption that the APPP misvaluation will be immediately corrected. In this case, the forecasted spot FX rate for a year from now would be the same as the FX rate forecasted by the inflation differential (RPPP) if the current spot FX rate were the APPP-FX value of 1.25 \$/€. Thus, the forecasted FX rate for the next year would be $1.25 \text{ \$/€}(1.01) = 1.2625 \text{ \$/€}$. The forecasted FX rate for the following year would be $1.2625 \text{ \$/€}(1.01) = 1.275 \text{ \$/€}$, and so forth.

The reality, however, is that actual FX rates do not tend to correct misvaluations immediately. Let us think rather of a gradual process, in which $c\%$ of the *prior year's* misvaluation will be corrected each year, so that $100\% - c\%$ of the prior year's misvaluation will remain uncorrected. Thus since the euro is undervalued at the present time by 20%, and if $c\% = 10\%$, we forecast the euro to be undervalued a year from now by only 90% of 20%, or 18%. By the same token, we forecast the euro to be undervalued by only 90% of 18%, or 16.2%, two years from now, and so forth.

Given that the forecasted APPP-FX value next year is 1.2625 \$/€, the forecasted *actual* FX rate for next year is $1.2625 \text{ \$/€}(1 - 0.18) = 1.035 \text{ \$/€}$. Given that the forecasted APPP-FX value for the following year is 1.275 \$/€, the forecasted *actual* FX rate is $1.275 \text{ \$/€}(1 - 0.162) = 1.068 \text{ \$/€}$, since the euro is forecasted to be undervalued at that time by 16.2%. The rate at which an FX misvaluation is expected to correct is denoted $c^{\text{\$/€}}$; in this example, $c^{\text{\$/€}} = 0.10$.¹²

Note that while the spot FX rate is projected to change at a non-constant rate, the *difference* between the APPP-FX rate and the forecasted FX rate diminishes at a

¹² A gradual correction of an FX misvaluation by 10% per year is consistent with the consensus of empirical researchers that the half-life of convergence to parity is three to five years. This consensus is discussed in Rogoff (1996).

constant rate. The difference starts at $1.25 \text{ \$/€} - 1 \text{ \$/€} = 0.25 \text{ \$/€}$, then declines to $1.2625 \text{ \$/€} - 1.035 \text{ \$/€} = 0.2275 \text{ \$/€}$, then declines to $1.275 \text{ \$/€} - 1.068 \text{ \$/€} = 0.207 \text{ \$/€}$, and so on. The *difference* changes at the constant rate of -9.1% per year. This rate of change is equal to $1.01(1 - 0.10) - 1$, where 0.01 represents the forecasted 1% change in the APPP-FX value of the euro, and 0.10 is $c^{\text{\$/€}}$, the 1% projected rate of correction of the current APPP misvaluation.¹³

B. Asset Value and Gradual Correction of FX Misvaluation

When an FX misvaluation is projected to correct itself at a constant rate per year, $c^{\text{\$/€}}$, and thus when the forecasted rate of FX change is non-constant, the growth rate in the overall cash flow in US dollars is not constant. Thus we assess an asset's intrinsic value (in US dollars), $V^{\text{\$}}$, as the difference between two components, as shown in Equation (3):

$$V^{\text{\$}} = V^{*\text{\$}} - V_D^{\text{\$}} \quad (3)$$

The first component in Equation (3), $V^{*\text{\$}}$, is the hypothetical value that the asset would have if the FX misvaluation were to correct itself immediately. The second, $V_D^{\text{\$}}$, is the intrinsic present value of the *difference* between the immediate-correction forecasted cash flow stream and the actual forecasted cash flow stream, given that the FX correction is instead forecasted to occur at the constant gradual rate, $c^{\text{\$/€}}$.

¹³ According to the Fisher theory, the inflation rate differential is exactly equal to the interest rate differential, which has been the basis of our view of equilibrium expected FX changes. The reason for the equality is Fisher's assumptions that the real rate of return on assets is the same across all countries and that FX rates are correctly valued in the sense of APPP. When these assumptions are violated, the inflation rate differential will not necessarily be equal to the interest rate differential. In that case, we may think of the interest rate differential as the equilibrium expected rate of FX change, and the forecasted inflation rate differential as a long-run forecasted rate of FX rate change.

The projected growth rate in the cash flow *difference*, $g_D^{\$}$, is determined by a combination of the long-run cash flow growth rate, $g^{\$}$, and the rate of convergence of the FX rate toward parity, $c^{\$/\epsilon}$, as given by Equation (4):

$$g_D^{\$} = (1 + g^{\$})(1 - c^{\$/\epsilon}) - 1 \quad (4)$$

In general, if the foreign currency is currently *undervalued*, the asset's value if the FX rate were to correct immediately would be higher than the asset's true value, $V^{\$}$, and the *difference* between the immediate correction cash flow and the actual forecasted cash flow (in the home currency) is positive. Thus the economic value of an asset is found by subtracting the present value of the cash flow differences, $V_D^{\$}$, from $V^{\$}$, as represented in Equation (3).

If the foreign currency is currently *overvalued*, the asset's value if the FX rate were to correct immediately would be lower than the asset's actual value, $V^{\$}$, and the *difference* between the immediate-correction cash flow in US dollars and the actual cash flow in US dollars is negative. Thus Equation (3) applies, since the present value of the cash flow differences, $V_D^{\$}$, is negative, and substitution of this result implies a higher value of $V^{\$}$.

C. Long-Term Forecast of 1% Euro Appreciation Per Year

Let us now show how this valuation approach works with numbers from the initial EPF scenario, where production is in Ireland. We extend the scenario by assuming that at the current spot FX rate of 1 $\$/\epsilon$, the euro is currently undervalued by 20% (relative to the US dollar), using the APPP condition as the standard of FX valuation. Thus we assume that the APPP-FX rate is currently 1.25 $\$/\epsilon$.

We first assume that the forecasted rate of FX change would be equal to an assumed long-run forecasted rate of change of 1% per year, if it were not for the APPP violation. Because of the current undervaluation of the euro, the forecasted rate of FX change is *higher* than 1%, but expected to converge gradually to the long-run forecasted rate of 1% per year. We assume that the FX valuation correction is expected to take place at the constant rate of $c^{\$/\epsilon} = 10\%$ per year. We want to build the gradual correction of the current FX misvaluation into ABC's assessment of EPF's intrinsic value in US dollars.

If 100% of the FX misvaluation were to correct itself immediately, then EPF's first euro cash flow (€300K) would be converted into US dollars at the current APPP-FX rate of 1.25 \$/€, to get \$375K. We know from before that the *long-run* growth forecasted rate in EPF's euro cash flows, viewed in US dollars, is $g^{\$} = 6\%$. Thus the hypothetical immediate-correction value of EPF in US dollars would be $V^{*\$} = \$375K/(0.10 - 0.06) - \$100K/(0.10 - 0.05) = \$9.38M - 2M = \$7.38M$.

In US dollars, the difference between EPF's €300K initial euro cash flow at the current APPP-FX rate (1.25 \$/€) and at the current actual spot FX rate (1 \$/€), is $\$375K - 300K = \$75K$. If the misvaluation is never corrected at all, the cash flow difference would grow at the long-run forecasted growth rate, $g^{\$} = 6\%$, but we have instead assumed that the rate of change in the difference also entails a 10% reduction per year as the FX misvaluation gradually corrects itself. That is, on top of the long-run growth rate of 6%, the difference (in US dollars) between the immediate-correction cash flow and the actual cash flow is reduced by 10% each year, as the forecasted FX rate of change converges to the assumed long-run projected rate.

Thus using Equation (4), the difference between the APPP-FX rate cash flow and the actual forecasted cash flow (in US dollars) is projected to change at the constant rate of $g_D^{\$} = (1.06)(1 - 0.10) - 1 = -0.046$, or -4.6% per year. Therefore, the present value of the cash flow difference is $V_D^{\$} = \$75K/[0.10 - (-0.046)] = \$514K$.

Thus the intrinsic value of EPF in US dollars, using Equation (3), is $V^{\$} = V^{*\$} - V_D^{\$} = \$7.375M - 514K = \$6.86M$, less than the value if the FX misvaluation corrects itself immediately, to reflect the lower expected cash flows due to the fact that the FX correction is only gradual.

Exhibit A1 may help clarify the forecasted patterns of the FX rate and the cash flows. Note that the growth rate in the actual forecasted cash flow drops from 8.65% between years 1 and 2 to 8.32% between years 2 and 3, and continues to decline thereafter toward 6.00%.

Exhibit A1. EPF Pro Forma Euro Cash Flows in US Dollars (\$000s)				
Long-Term FX Forecast: Euro Value Change = 1% per year				
Year	1	2	3	
APPP \$/€ FX Values	1.25 \$/€	1.2625 \$/€	1.275 \$/€	
Forecasted \$/€ FX Rates	1.00 \$/€	1.035 \$/€	1.068 \$/€	
Immediate-Correction Cash Flow (6% growth)	\$375	\$397.50	\$421.35	
Cash Flow Difference (- 4.6% growth)	\$75	\$71.55	\$68.26	
Actual Forecasted Cash Flow	\$300	\$325.95	\$353.09	

D. Long-Term Equilibrium Forecast of – 1.5% Euro Change Per Year

Instead of a long-run forecast for FX changes based on inflation rate forecasts, one may prefer to regard the implicit (equilibrium) FX projection in the UIRP condition as the long-run forecast. Assume that the long-run forecast is that the correctly valued euro will change by the equilibrium expected rate of – 1.50% per year. Thus, the long-run growth rate in EPF's euro cash flows, viewed in US dollars, is $g^{\$} = 3.5\%$. Continue to assume that the current spot FX rate of 1 $\$/\epsilon$ represents an undervaluation of the euro by 20%, and that the misvaluation is anticipated to gradually correct itself by 10% per year. Due to the current undervaluation of the euro, the forecasted rate of change is *higher* than – 1.50%, but is expected to decline gradually toward – 1.50% per year.

If 100% of the FX misvaluation were to correct itself immediately, EPF's first euro cash flow (€300K) would be converted into US dollars at the current APPP-FX rate of 1.25 $\$/\epsilon$, to get \$375K. Thus the hypothetical immediate correction value of EPF in US dollars would be $V^{*\$} = \$375K/(0.10 - 0.035) - \$100K/(0.10 - 0.05) = \$5.77M - 2M = \$3.77M$. Using Equation (4), the difference between the APPP-FX rate cash flow and the actual forecasted cash flow (in US dollars) is projected to change at the constant rate of the $(1.035)(1 - 0.10) - 1 = -0.0685$, or – 6.85% per year. Therefore, the present value of the cash flow difference is $V_D^{\$} = \$75K/[0.10 - (-0.0685)] = \$445K$.

The value of EPF in US dollars, using Equation (3), is $V^{\$} = V^{*\$} - V_D^{\$} = \$3.769M - 445K = \$3.32M$, less than the value if the FX misvaluation corrected immediately, to reflect the lower expected cash flows due to fact that the FX correction is only gradual. Exhibit A2 clarifies the forecasted FX rate and cash flow patterns for this scenario.

Exhibit A2: EPF Pro Forma Euro Cash Flows in US Dollars (\$000s)

Long-Term FX Forecast: Euro Value Change = - 1.5% per year

Year	1	2	3
AAPP \$/€ FX Values	1.25 \$/€	1.23125 \$/€	1.2128 \$/€
Forecasted \$/€ FX Rates	1.00 \$/€	1.0096 \$/€	1.0163 \$/€
Immediate-Correction Cash Flow (3.5% growth)	\$375	\$388.13	\$401.71
Cash Flow Difference (- 6.85% growth)	\$75	\$69.86	\$65.08
Actual Forecasted Cash Flow	\$300	\$318.27	\$336.63

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