CHAPTER 8. CROSS-BORDER VALUATION

Overseas investment decisions should generally be made like any other investment decision: *you discount an investment's incremental expected cash flows back to the present using a cost of capital that reflects the risk*. The investment's **net present value (NPV)** is the *present value of the expected cash flows minus the outlay necessary to undertake the investment*. If the NPV is positive, the investment should be accepted, because it will increase the intrinsic wealth of the firm's existing shareholders. *If the NPV is negative, the investment should be rejected*, because it would decrease the intrinsic wealth of the firm's existing shareholders.

In **overseas investment decisions**, there is often the question about whether to consider the entire cash flow or only the portion repatriated. Our answer is immediate: **consider the investment's entire cash flow**, not just the portion to be repatriated. The reason is that even the portion reinvested overseas affects the intrinsic wealth of the investor, because the reinvestment increases the value that the investment can be sold for, and thus needs to be included in the analysis. So we consider an overseas investment's entire cash flow, not just the portion repatriated.

A more involved issue in overseas investment decisions is the choice of *which of the two **currency perspectives** to use for the NPV analysis*.

One is the **home currency perspective**, where the analyst **converts the expected foreign currency cash flows into home currency equivalents**, and **then discounts them using a cost of capital denominated in the home currency**.

The other is the **foreign currency perspective**, where the analyst **uses the cash flows denominated in the foreign currency**, and **discounts them using a cost of capital denominated in the foreign currency**.

The typical advice tends to be that the choice of currency perspective is irrelevant in cross-border valuation, as long as we use consistent cash flow and cost of capital conversions across currencies. We'll show that a critical condition behind this advice is that *the best forecast of FX rate change is the **equilibrium rate***.

When managers' FX forecasts differ from equilibrium FX forecasts, the NPV analyses in the different currency perspectives lead to different results that may lead to different accept/reject decisions. This situation conflicts with the typical advice that the choice of currency perspective for the NPV analysis is irrelevant.

The best *forecast of future FX rate change may be different from the equilibrium forecast when the spot FX rate is misvalued*, because the best forecast may include a correction of the misvaluation.

When a currency is **overvalued**, the best forecast may be for the FX price of the currency to change at a rate lower than the equilibrium rate. When a currency is **undervalued**, the best forecast may be for the FX price of the currency to change at a rate higher than the equilibrium rate.

We'll use a simple valuation framework that assumes managers forecast a constant **perpetual rate** of change in the spot FX rate. This assumption allows us to use the **constant growth model for valuation** and to focus on some basic issues. With a spreadsheet, you could model the more realistic case where spot FX rates are forecasted to gradually converge to correct FX values.

This chapter contains examples of overseas investment decisions of **three types**.
   1. Potential acquisition of a foreign firm by a US multinational.
   2. Decision to relocate production capacity from one country to another.
   3. Expansion decision by an overseas subsidiary, is an end-of-chapter problem.

COST OF CAPITAL CONVERSION ACROSS CURRENCIES

Cost of capital may be viewed from the perspective of different currencies, so **you must be careful to specify which currency you are using to express a firm's (or**

a division's) cost of capital. If your analysis of a Swiss division is in US dollars, you use a cost of capital for the division from the US dollar perspective. If your analysis of the Swiss division is in Swiss francs, you use a cost of capital for the division from the Swiss franc perspective.

For example, a firm's COST OF EQUITY might be 10% expressed in US dollars and 8% expressed in Swiss francs. The different numbers expressed in different currencies are different ways to express the same cost of equity. Expressing a firm's cost of equity from different currency perspectives is no different from saying that a firm's equity has only one value, but it is a different number when expressed in different currencies.

Example: you can express a firm's equity value either as $100 or Sf 160 assuming a spot FX rate of 1.60 Sf/$. This is the same idea as a firm's cost of equity being 10% in US dollars or 8% in Swiss francs.

Financial managers often want to express a foreign asset's COST OF CAPITAL in the local overseas currency, given that the cost of capital is known in US $.

Example: a US multinational company may have an estimated US dollar *ECC* for a subsidiary that is based upon the subsidiary's enterprise beta, but it will want to supply the subsidiary's managers with a *consistent* cost of capital in their own local currency, so that they can have a "**hurdle rate**" for *making local, decentralized investment decisions*.

Example: Eurozone subsidiary AEM has **estimated enterprise beta** in US dollars of **1.25**.
Assume a risk-free rate in US dollars of 5% and a global risk premium in US dollars of 4%.

GLOBAL CAPM tells us that AEM's *ECC* in US dollars: **0.05 + 1.25(0.04) = 0.10, or 10%**. *US dollar ECC*: 10%, is the proper *capitalization rate* for AEM's expected operating cash flows, as measured in US dollars, if we want to find the subsidiary's *intrinsic enterprise value* in US dollars.

Since AEM's future *operating cash flow stream is in euros*, we also may think of AEM's *enterprise value in euros*. The question is **what discount rate should be used** to find the *intrinsic present value* in euros of the expected operating cash flow stream measured in euros. In other words, **what is AEM's *ECC* in euros, consistent with its 10% *ECC* in US dollars?**

Two ways to find an asset's COST OF CAPITAL in **ANOTHER CURRENCY**.
1. Use a conversion formula, based on a known cost of capital in US dollars.
2. Directly use a risk-return model (asset pricing model) from the foreign currency POV.

For technical reasons, it is difficult to use a risk-return model in a foreign currency consistent with a US dollar cost of capital estimated with the global CAPM, so we use the conversion approach in this chapter.

The COST OF CAPITAL CONVERSION APPROACH, equation (8.1):

$$k_i^{\text{€}} = k_i^{\$} - E^*(x^{\$/\text{€}}) + (1 - \xi_{i\text{€}}^{\$})\sigma_{\text{€}}^2 \qquad (8.1)$$

Asset i

Cost of Capital in euros, $k_i^{\text{€}}$

Asset's US dollar cost of capital, $k_i^{\$}$

Equilibrium Expected % change in the FX price of euro relative to the US dollar, $E^*(x^{\$/\text{€}})$

Covariance between the asset's returns in euros and $x^{\$/\text{€}}$, expressed as $(1 - \xi_{i\text{€}}^{\$})\sigma_{\text{€}}^2$

Asset's FX exposure to the euro, $\xi_{i\text{€}}^{\$}$

Volatility of the \$/€ spot FX rate measured as the standard deviation of annualized % changes in the spot FX price of the euro, $\sigma_{\text{€}}$

Asterisk (*****) denotes that the expected FX change is the **equilibrium** one (this is the expected rate of FX change consistent with simultaneous equilibrium in the global capital and FX markets).

To convert AEM's 10% US dollar cost of capital into its equivalent in euros using eq. (8.1):

First find the equilibrium expected percentage change in the FX price of the euro, $E^*(x^{\$/\text{€}})$. For this we can use a version of the uncovered interest rate parity (**UIRP**) condition.

Assume that the risk-free rate in US dollars is 6% and the risk-free rate in euros is 4%. Using the *linear approximation of the traditional UIRP condition*:

$$E^*(x^{\$/\text{€}}) = r_f^{\$} - r_f^{\text{€}} = 0.06 - 0.04 = 0.02, \text{ or 2% per year.}$$

Assume that AEM's FX exposure to the euro, $\xi_{i\text{€}}^{\$}$, is 0.75. This means when the FX price of the euro rises by 10%, the return on AEM, measured in US dollars, tends to be 7.5% higher.

Assume $\sigma_{\text{€}}$ is 0.10. The application of equation (8.1) yields…

AEM's estimated cost of capital from the euro perspective:

$$k_i^{\text{€}} = k_i^{\$} - E^*(x^{\$/\text{€}}) + (1 - \xi_{i\text{€}}^{\$})\sigma_{\text{€}}^2 = 0.10 - 0.02 + (1 - 0.75)0.10^2 = 8.25\%.$$

The result that AEM's estimated cost of capital expressed in euros is 8.25% is based on its estimated cost of capital in US dollars of 10% and given the other assumptions, including AEM's FX exposure to the euro of 0.75 from the US dollar perspective.

AEM really has only one basic cost of capital that compensates for risk: 10% and 8.25% are equivalent expressions of that cost of capital in two different currencies. While AEM's cost of capital in euros is a lower percentage than in US dollars, the two are equivalent in economic content.

Equation (8.1) reveals **TWO REASONS** why AEM's **cost of capital is different when represented in euros (8.25%) rather than US dollars (10%)**.

1. The first reason is the impact of the equilibrium expected percentage change in the FX price of the euro, based on the risk-free interest rate differential. That is, the risk-free rate in euros (4%) is lower than the risk-free rate in US dollars

(6%), so it is reasonable that an asset's cost of capital will be lower when expressed in euros than in US dollars. These capital market conditions are consistent with an **equilibrium expected appreciation** of the euro of 2% and a **currency beta** of the euro of zero.

2. The second reason is AEM's **FX EXPOSURE**. If AEM's returns in euros are related to FX changes, we need to **adjust for this interaction when we convert AEM's cost of capital across currencies**. Here, the assumed FX exposure to the euro of 0.75 (from the US dollar point of view) implies an FX exposure to the US dollar of 0.25 (from the euro point of view).

In the **special case** when **an asset's returns in euros are not correlated with spot FX rate changes**, i.e., the FX exposure to the US dollar, $\xi_{i\$}^{€}$, is zero, the returns in US dollars have only pure FX conversion exposure to the euro, $\xi_{i€}^{\$} = 1$.

Only in this special case is there no adjustment for the interaction between returns and FX changes, and equation (8.1) simplifies to $k_i^{€} = k_i^{\$} - E^*(x^{\$/€})$.

Figure 8.1 summarizes the process of converting a cost of capital from US dollars to euros.
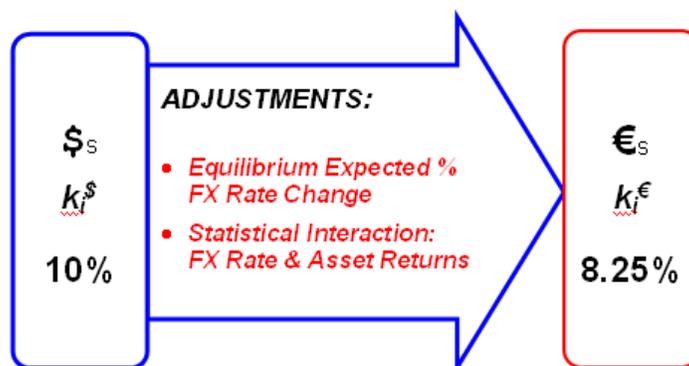

FIGURE 8.1: CROSS-BORDER COST OF CAPITAL CONVERSION

Japanese division of a US multinational:

FX operating exposure of 1.60 to the yen from the perspective of US dollars
ECC in US dollars estimated to be 9%
The US dollar risk-free rate is 5%
Yen risk-free rate is 2%
Volatility of the yen is 0.16

1. *What is the overseas division's estimated ECC expressed in yen?*

Estimate the equilibrium expected percentage change in the FX price of the yen:
$$E^*(x^{\$/¥}) = r_f^{\$} - r_f^{¥} = 0.05 - 0.02 = 0.03.$$

2. *Assume the linear approximation of the traditional UIRP condition holds in order to estimate the equilibrium expected rate of change in the FX price of*

the yen.

Use equation (8.1: $k_i^{€} = k_i^{\$} - E^*(x^{\$/€}) + (1 - \xi_{i€}^{\$})\sigma_€^2$) to find the division's ECC in Yen:
ECC = 0.09 – 0.03 + (1 – 1.60)0.16^2 = 0.0446, or 4.46%.

Note that we convert an asset's cost of capital not using the managers' FX forecast, but rather using the *equilibrium* expected rate of FX change, even if it is different from the managers' FX forecast. The reason is that the cost of capital is a compensation for risk, regardless of the currency perspective of the cost of capital. We take the view that there is a single relationship between risk and *required* return for globally traded assets, even though specific assets might be mispriced at any time in one or more currencies.

Only the equilibrium expected rate of change in the FX price of the euro preserves a consistent risk and required return relationship across different currencies for globally traded assets.

RISK-ADJUSTED UIRP

We can use the CAPM and equation (8.1) to improve the traditional UIRP condition by adding a risk premium for systematic FX risk. The result is called the *RISK-ADJUSTED UIRP CONDITION*.

First, we note that FX rates have betas relative to the global market portfolio. Since corporate financial results are sensitive to changes in FX rates, it makes sense that a statistical relation exists between FX rates and the global equity market index.

CURRENCY BETA:the statistical relation between percentage changes in a spot FX rate and returns on the equity market index.

$\beta_€^{\$}$: the currency beta of the euro. Thus the beta of the percentage changes in the spot FX price of the euro versus the (global) equity market index, where the US dollar is the pricing currency of both the euro and the index.

Some currency beta estimates are shown in Exhibit 8.1. The estimates for the developed country currencies in Panel A were made with the simple regression approach in Interactive Exercise 8.1. The estimates for the emerging Latin American country currencies in Panel B are in the published literature.

Generally, the currency betas for the emerging country currencies tend to be larger, possibly because global stock markets tend to fall when there is "flight to safety".

"FLIGHT TO SAFETY" episodes tend to be correlated with capital flight from emerging markets, creating a positive correlation between the FX price of the local currency and world equity returns.

The "flight to safety" idea would also explain the negative currency beta of the Swiss franc in the earlier time period. Investors tend to increase deposits in Switzerland during times of increased worry about risk.

As you can see in Exhibit 8.1, estimates of currency betas with actual FX data tend to change over time. The changes occur for statistical reasons as well as

because of changes in the economic structure of a particular country compared to the rest of the world and other changes in market conditions. Except for Mexico (whose beta has been cyclical) and Peru (whose FX rate does not seem to float), currency betas for the Latin American currencies in Panel B have increased, corresponding to the trend toward lower intervention and increased floating.

We can use currency beta estimates and the global CAPM to **estimate the required rate of return** in US dollars **on assets that are risk-free in their own currencies**.

Since the only uncertainty in the US dollar return on a risk-free euro asset is uncertainty about the \$/€ spot FX rate, **a risk-free euro asset has a beta in US dollars that is equal to the currency beta of the euro, $\beta_\epsilon^\$$**.

$k_{\epsilon f}^\$$: the **US dollar required rate of return on a risk-free euro asset** is the **compensation for the (global) systematic risk** of the euro. Using the global CAPM:

$$k_{\epsilon f}^\$ = r_f^\$ + \beta_\epsilon^\$(GRP^\$)$$

Example: assume $r_f^\$ = 6\%$, $GRP^\$ = 4\%$, and $\beta_\epsilon^\$ = 0.20$. The US dollar *required* rate of return on a risk-free euro asset would be:

$$0.06 + 0.20(0.04) = 0.068, \text{ or } 6.80\%.$$

The risk-free euro asset's required rate of return in US dollars is 6.80%, **in equilibrium**.

The foreign asset's **==EQUILIBRIUM EXPECTED RATE OF RETURN==** in US dollars must plot on the risk-return line of the global CAPM in Figure 7.1, (like all assets in the integrated financial market).

So the **required rate of return in US dollars on a risk-free euro bond** must be consistent with the **asset's systematic risk in US dollars**, i.e., the **currency beta of the euro**.

Currency Beta of the Swiss franc is –0.10
US dollar risk-free rate of 5.60%
Global Risk Premium of 4% in US dollars
What is the required rate of return in US dollars on a risk-free Swiss franc bond?

Answer: $k_{\text{€}f}^{\$} = r_f^{\$} + \beta_{\text{€}}^{\$}(GRP^{\$}) = 0.056 - 0.10(0.04) = 0.052$, or 5.2%.

To get the RISK-ADJUSTED UIRP CONDITION, we use the fact that ==we also know the rate of interest on a risk-free euro bond in euros, denoted== $r_f^{\text{€}}$.

The risk-free euro bond's returns in euros are certain, and thus have zero FX exposure to the US dollar. Thus from a US dollar perspective, the bond's returns have an FX exposure to the euro of 1.

The **REQUIRED RATE OF RETURN** in US dollars on a **RISK-FREE EURO BOND**, $k_{\text{€}f}^{\$}$, is equal to the euro risk-free rate, $r_f^{\text{€}}$, plus the equilibrium expected rate of FX change, $E^*(x^{\$/\text{€}})$.
Apply equation (8.1) to get another expression for $k_{\text{€}f}^{\$}$:

$$k_{\text{€}f}^{\$} = r_f^{\text{€}} + E^*(x^{\$/\text{€}})$$

Equate risk-free euro bond's required US dollar return from the global CAPM:

$$r_f^{\$} + \beta_{\text{€}}^{\$}(GRP^{\$})$$

with the equilibrium expected US dollar return on the risk-free euro asset (eq 8.1):

$$r_f^{\text{€}} + E^*(x^{\$}/\text{€})$$

The result is the **RISK-ADJUSTED UIRP** relationship in linear approximation % form:

*Risk-Adjusted UIRP Condition (*RUIRP*)*
Percentage Form—Linear Approximation

$$E^*(x^{\$/\text{€}}) = r_f^{\$} - r_f^{\text{€}} + \beta_{\text{€}}^{\$}(GRP^{\$}) \qquad \textbf{(8.2)}$$

The LINEAR PERCENTAGE FORM OF THE TRADITIONAL UIRP, called the TUIRP condition
from (eq. 5.2): $E^*(x^{\$/\text{€}}) = r_f^{\$} - r_f^{\text{€}}.$

The RUIRP condition adds the risk premium $\beta_{\text{€}}^{\$}(GRP^{\$})$ to the TUIRP condition. The

$\beta_\epsilon^{\$}(GRP^{\$})$ term lets us adjust the TUIRP condition for the systematic risk of the spot FX rate. **Using the TUIRP condition implies that we are assuming the currency beta is 0.**

Example: assume $r_f^{\$}$ = 6%, $GRP^{\$}$ = 4%, $\beta_\epsilon^{\$}$ = 0.20,   and r_f^{ϵ} = 3%.
The **US dollar** *required* **rate of return on a risk-free euro asset**:
$$0.06 + 0.20(0.04) = 0.068, \text{ or } 6.80\%.$$

The **RUIRP** condition (eq, 8.2) says that the equilibrium expected percentage change in the spot FX price of the euro, $E^*(x^{\$/\epsilon})$, is 0.06 – 0.03 + 0.20(0.04) = 0.038, or 3.80%.

That is, if the spot FX rate is currently correctly valued according to the **RUIRP condition**, the annualized expected rate of change in the spot FX price of the euro would be **3.8% per year**. The **TUIRP condition** would say that: $E^*(x^{\$/\epsilon}) = r_f^{\$} - r_f^{\epsilon} =$ 0.06 – 0.03 = 0.03, or **3%.**

Assume the currency beta for yen is $\beta_¥^{\$}$ = 0.25.
Assume the yen risk-free interest rate is $r_f^{¥}$ = 0.02
The US dollar risk-free rate is $r_f^{\$}$ = 0.055.

 A) Find the required rate of return in US dollars on risk-free yen debt using the global CAPM.

*Using the global CAPM, the required rate of return in US dollar on yen risk-free debt is 0.055 + 0.25(0.04) = 0.065, or **6.5%**.*

B) Find the equilibrium expected percentage change in the spot FX price of the yen, given the global CAPM, where the global risk premium is 4%.

*Using the RUIRP condition in equation (8.2), $E^*(x^{\$/¥}) = r_f^{\$} - r_f^{¥} + \beta_¥^{\$}(GRP^{\$})$ = 0.055 – 0.02 + 0.25(0.04) = 0.045, or **4.5%**.*

*Since the required rate of return in US dollars on the yen risk-free debt (**6.50%**) is **equal to** the **yen risk-free rate (2%) plus $E^*(x^{\$/¥})$**, we can reconcile that **6.50%** = 2% + 4.50%.*

As our examples show, adjusting for systematic FX risk in the UIRP condition results in a modest difference in estimates of the equilibrium expected rate of change in spot FX prices for developed country currencies. And, given the market's consensus expected future spot FX rate, the risk adjustment will usually result in a modest difference in the equilibrium expected rate of FX change. **Even though the TUIRP condition does not have a risk adjustment, and suffers from the Siegel's paradox problem, the correction for these issues is often so small that it is not worth the extra effort to deal with them, at least for many major developed country currencies**. That is, **the TUIRP condition is often good enough when we are dealing with major developed market currencies**.

For **currencies of emerging market countries, adjusting for FX risk in the UIRP condition is more significant**, because the currency betas tend to be larger. (See Exhibit 8.1.)

Note that we specify the RUIRP in equation (8.2) only in the direction of the US dollar as the pricing currency, which is expressed in terms of the expected change in the value of the non-US dollar currency.

> Equation (8.2) **_CANNOT_** be rotated into European terms to find the equilibrium expected change in the spot FX price of the US dollar (relative to the foreign currency), the way we can turn around the TUIRP condition. (The reason has to do with the risk-adjustment factor.)

CROSS-BORDER VALUATION WITH EQUILIBRIUM FX FORECAST

Assume the US multinational ABC is considering acquiring VPC, a company that produces and sells widgets in the Eurozone. VPC's revenues are generated in euros, and all production costs are stable in euros. VPC's current annual revenues are €600; operating costs are €400; and so the expected operating cash flow is €200.

VPC's revenues in euros are not subject to economic exposure to FX changes in the sense that output and selling price do not depend on FX rates. That is, from the euro perspective, VPC's FX revenue exposure to changes in the FX price of the US dollar (relative to the euro) is 0. Since its operating costs are stable in euros, VPC's operating cash flow has no FX operating exposure to the US dollar. Thus from the US dollar perspective, VPC's FX operating exposure to the euro, $\xi_{O\text{€}}^{\$}$, is 1.

ABC's managers believe that VPC's expected operating cash flows in euros will grow at the rate of 4.5% indefinitely, i.e., $g^{\text{€}} = 0.045$. ABC's managers estimate the *ECC* for VPC in US dollars of 11%, i.e., $k_V^{\$} = 0.11$. VPC's owners are asking €5800 for the enterprise. Given an assumed current spot FX rate of 1 $/€ today, ABC's investment outlay in US dollars would be $5800. Should ABC acquire VPC?

(this stuff picks up on next page)

Here is a case where the acquirer has estimated the target's cost of capital in US dollars but has measured the expected operating cash flow stream in euros.

Let's first convert the cost of capital for VPC from US dollars to euros, using equation (8.1).

Let's use the linear approximation of the traditional uncovered interest rate parity (TUIRP) condition to estimate the equilibrium expected rate of change in the FX price of the euro, i.e., with the risk-free interest rate differential, $r^{\$} - r^{\text{€}}$.

Risk-free interest rate in US dollars is 6%
Risk-free interest rate in euros is 4%.
Thus the equilibrium expected rate of change in the FX price of the euro is
$E^*(x^{\$/\euro}) = 0.02 = 2\%$.

Further assume that $\sigma_\euro^2$ is 0.015 (an FX volatility of the euro of about 0.122,

Example: a case where the acquirer has estimated the target's cost of capital in US dollars but has measured the expected operating cash flow stream in euros.

ABC's <mark>investment outlay in US dollars</mark> would be $**5800**.

First convert the cost of capital for VPC from US dollars to euros, using equation (8.1).

Use the linear approximation of the traditional uncovered interest rate parity (TUIRP) condition to estimate the equilibrium expected rate of change in the FX price of the euro, i.e., with the risk-free interest rate differential, $r^\$ - r^{€}$.

Risk-free interest rate in US dollars is 6%

Risk-free interest rate in euros is 4%.

Thus the equilibrium expected rate of change in the FX price of the euro is 2%, i.e., $E^*(x^{\$/€}) = r^\$ - r^{€} = 0.02$.

Further assume that $\sigma_{€}^2$ is 0.015 (an FX volatility of the euro of about 0.122, or 12.2%).

Assuming that VPC's US dollar *ECC* is 11%, eq. 8.1 tells us that VPC's *ECC* in euros is:

$$k_V^{€} = k_V^\$ - E^*(x^{\$/€}) + (1 - \xi_{O€}^\$)\sigma_{€}^2 = 0.11 - 0.02 + (1 - 1)0.015 = 9\%.$$

Now we apply the constant growth valuation equation (eq. 7.1) in the euro denomination to find the intrinsic enterprise value for VPC in euros.

Growth rate of VPC's operating cash flows in euros is the constant perpetual rate of 4.5%:

$$\boxed{V^{€}} = E(O^{€})/(k_V^{€} - g^{€}) = €200/(0.09 - 0.045) = \boxed{€4444}.$$

We use $V_i^{€}$ to denote asset *i*'s intrinsic value in euros. In this case, we know that asset *i* is the enterprise VPC, so we suppress the *i* subscript when specifically referring to VPC.

Looking at the proposal from the euro point of view, the **NPV** of the investment would be:

$$\boxed{NPV^{€}} = V^{€} - I^{€} = €4444 - 5800 = \boxed{-€1356}.$$

From **EURO PERSPECTIVE** the acquisition has a negative NPV and should be <mark>**REJECTED**</mark>.

Now let us next look at **ABC's valuation of VPC from the perspective of US dollars**.

While ABC's managers expect a growth rate in VPC's euro operating cash flows of 4.5%, the projected growth rate of VPC's cash flows when measured in US dollars depends on the forecasted rate of change in the spot FX price of the euro, denoted $E(x^{\$/€})$, with no asterisk.

In this section, we cover the case where the **forecasted rate of change in the FX price of the euro, $E(x^{\$/€})$, is equal to the equilibrium expected rate, $E^*(x^{\$/€})$.**
$V_i^{*\$}$: denote asset i's **intrinsic value** in US dollars consistent with **equilibrium** in the **FX market**.

INTRINSIC VALUE **of an asset in US dollars consistent with equilibrium in the FX market** is equal to the **asset's intrinsic value in the foreign currency, adjusted for the spot FX rate:**

$$V_i^{*\$} = X_0^{\$/€}(V_i^{€}) \qquad \text{(8.3)}$$

We want to find VPC's intrinsic enterprise value in US dollars consistent with equilibrium in the FX market, $V^{*\$}$. Given the assumed current spot FX rate of 1 $/€ today and the intrinsic enterprise value of VPC in euros of $V^{€} = €4444$, equation (8.3) tells us that VPC's enterprise value in US dollars is: $V^{*\$} = (1 \ \$/€)(€4444) = \$4444$.

Example: verify this result using the direct approach to finding an asset's value in US dollars.

Convert the asset's expected cash flow growth rate in **euros** into an expected cash flow growth rate in US **dollars** using a formula similar to equation (8.1):

$$g_i^{\$} = g_i^{€} - E(x^{\$/€}) + (1 - \xi_{i€}^{\$})\sigma_{€}^2$$

$g_i^{\$}$ is the expected growth rate of asset i's operating cash flows when viewed in US dollars,
$g_i^{€}$ is the expected growth rate of asset i's operating cash flows in euros.
$(1 - \xi_{i€}^{\$})\sigma_{€}^2$ measures the statistical interaction between asset's cash flows and FX rate changes.

What if ABC's managers forecast the spot FX price of the euro to appreciate at the equilibrium expected rate of 2% per year? That is, what if $E(x^{\$/€}) = E^*(x^{\$/€})$?
In this example $g_i^{€} = 0.045$,
$E(x^{\$/€}) = 0.02$, and $\xi_{O€}^{\$} = 1$,
The managers expect VPC's operating cash flows, measured in US dollars, to grow at the rate of

$$g^{\$} = 0.045 + 0.02 - (1 - 1)0.015 = 0.065, \text{ or } 6.5\%.$$

Assume that the forecasted rate of change in the spot FX price of the euro of 2% is a constant, perpetual rate. Thus, since ABC's managers expect VPC's operating cash flows to grow perpetually at 4.5% in euros, they expect VPC's operating cash flows to grow perpetually at 6.5% when measured in US dollars.

Recall that the enterprise cost of capital for VPC in US dollars is 11%.
The intrinsic enterprise value of VPC consistent with equilibrium in the FX market is:

$$V^{*\$} = \$200/(0.11 - 0.065) = \$4444$$

as we found using the easy method in equation (8.3).

As we can see, **if ABC's managers forecast the spot FX price of the euro to change at the equilibrium rate, it really makes no difference which currency ABC chooses to evaluate the NPV of the acquisition proposal, US dollars or euros**.

In our VPC example, since the outlay is of €5800 is equivalent to $5800 at the assumed spot FX rate of 1 $/€, the NPV in US dollars is:

$$\text{NPV in US dollars} = \$4444 - 5800 = -\$1356$$

which we know is equal to the spot FX rate times the NPV in euros.

In this case where the managers' forecasted FX change is equal to the equilibrium expected FX change, the two currency perspectives will indeed lead to the same decision outcome, as long as the inputs to the analysis in the home currency are consistent with the inputs to the analysis in the foreign currency. **In this case**, it in principle does not matter which currency is chosen for the NPV analysis, because the same decision is reached either way. That is, if the spot FX forecast is the equilibrium forecast, the same accept/reject decision is reached by conducting the NPV analysis in euros with euro cash flows and a euro cost of capital, or in US dollars, applying the US dollar cost of capital after converting the expected stream of euro cash flows into an expected stream of US dollar cash flows.

There is one idiosyncrasy in the cross-border valuation process that is different than what you may remember from other finance courses:

> **the initial operating cash flow in the numerator in the constant growth valuation model needs to be thought of more as a time-0 concept than a time-1 concept. As such, the initial operating cash flow is converted from one currency to the other at today's spot FX rate.**

Given an assumed current spot FX rate of 1 $/€ today, VPC's initial euro operating cash flow of €200 converts to $200, which is $E(O^\$)$.

The reason we do this is because of the **continuous compounding perspective** inherent in the **linearization of the cost of capital conversion** and **growth rate conversions** across currencies.

Consider the Eurozone firm DYA
expected euro operating cash flow stream is €1 million for the current yr
projected to ==grow at the rate of 4% per year into perpetuity.==
 When its financial results are viewed in US dollars,
          DYA has an ==FX operating exposure to the euro of 0.80.==
ECC for DYA in US dollars is assumed to be 8.50%.

 XYZ Company, a US firm, is considering the acquisition of DYA.
 DYA's owners are asking € 13 million for the enterprise.
 Assume the risk-free rate in US dollars is 3%,
 risk-free rate in euros is 5%,
the FX volatility of the euro is 10%,
 current spot FX rate is 1.50 $/€.
 Assume the linear approximation of the TUIRP condition for the equilibrium
expected rate of change in the FX price of the euro.
XYZ's managers believe that the spot FX price of the euro is correctly valued
and will change at the equilibrium rate into perpetuity.

A) What is the intrinsic value of XYZ's proposed acquisition of DYA in euros?

The equilibrium expected rate of change in the FX price of the euro is 3% – 5% = – 2%.

Using equation (8.1), the ECC for DYA in euros is:
$k_V^€ = k_V^\$ - E^*(x^{\$/€}) + (1 - \xi_{O€}^\$)\sigma_€^2 = 0.085 - (-0.02) + (1 - 0.80)0.10^2 = 0.107$, *or 10.70%.*

The intrinsic enterprise value of DYA in euros is €1 million/(0.107 – 0.04) = €14.92 million.

B) What is the NPV in euros?

The NPV of the acquisition in euros is €14.92 million – 13 million = €1.92 million.

C) What is the intrinsic value of XYZ's proposed acquisition of DYA in US dollars?

Since the forecasted rate of change for the euro is the equilibrium rate, equation (8.2) tells us that the intrinsic value of DYA in US dollars is (1.50 $/€)(€14.92 million) = $22.38 million.

D) What is the NPV in US dollars?

The investment outlay in US dollars is (1.50 $/€)(€13 million) = $19.50 million.

The NPV in US dollars is $22.38 million – $19.50 million = $2.88 million.

Note: the NPV in euros of €1.92 million is equivalent to $2.88 million at the current spot FX rate of 1.50 $/€.

CROSS-BORDER VALUATION WITH DISEQUILIBRIUM FX FORECASTS

What if the managers forecast the **spot FX price of euro will change at a rate different from the equilibrium rate**, say because of a misvalued spot FX price of the euro?

Example: say the managers forecast that the euro will actually rise at the rate of 3% per year when the equilibrium expected rate of change is 2%. In this case, we'd think that an asset generating cash flows in euros would have a higher intrinsic value in US dollars than if the forecast was the equilibrium expected rate of FX change.

Plug $\quad E(x^{\$/€}) = 3\%\quad$ into $\quad g_i^{\$} = g_i^{€} - E(x^{\$/€}) + (1 - \xi_{i€}^{\$})\sigma_€^2$

and find that the operating cash flows will be expected to grow at the rate of 7.5%, when viewed in US dollars, instead of the expected growth rate of 6.5% consistent with an equilibrium FX forecast.

Unfortunately, we cannot simply plug the **growth rate** of 0.075 into the constant growth formula to find VPC's **intrinsic enterprise value** in US dollars.

Think in terms of two components of the cash flow in US dollars.
1. the cash flow from the business operation plus the equilibrium FX change.
2. the "extra" cash flow from the projection that the FX rate will change at a different rate than the equilibrium rate.

If we combine both components and discount them at the corporate *ECC*, we'd be using VPC's corporate *ECC* to discount the expected windfall "extra" cash flow component that is expected because of FX forecast is different from the equilibrium forecast. This is incorrect because **the risk in the windfall FX component is not corporate business risk**, **it's FX risk, which has a different beta than the enterprise**.

We need to think of a foreign asset's intrinsic value in US dollars, $V_i^{\$}$, as having two components:
1. $V_i^{*\$}$, the value **consistent with the equilibrium rate** of FX change.
2. $V_{iX}^{\$}$, the **intrinsic value in US dollars created (or destroyed) due to an FX forecast that differs from the equilibrium FX forecast**: $V_i^{\$} = V_i^{*\$} + V_{iX}^{\$}$.

There is a direct way to find $V_i^{\$}$ without finding $V_{iX}^{\$}$ first, simply find the present value of investing a face value of $V_i^{*\$}$ into a perpetual risk-free euro-denominated bond. If the currency is expected to change at a different rate than the equilibrium rate, then **that difference will be reflected in the difference between the bond's intrinsic value and its face value**. Equation 8.4 builds in a **disequilibrium FX forecast and can be used to find the intrinsic value of a foreign asset**:

$$V_i^{\$} \;=\; \frac{V_i^{*\$}\left(r^{€}\right)}{[k_{€_f}^{\$} - E\left(x^{\$/€}\right)]} \qquad\qquad \textbf{(8.4)}$$

Equation (8.4) is a constant growth valuation formula. The **numerator** is the **US**

dollar equivalent of the initial cash-flow. In this case, the cash flow is from a risk-free euro-denominated bond, with a face value equal to the asset's equilibrium intrinsic value in euros. The **denominator** is the **asset's required rate of return** in US dollars minus the **expected cash flow growth rate** in US dollars:

$k_{€f}^{\$}$ is the cost of capital in US dollars for the risk-free euro bond,

$E(x^{\$/€})$, the forecasted rate of change in the FX price of the euro, assumed constant in perpetuity.

The bond's cash flow in euros has a zero growth rate and has no FX exposure to the US dollar.

The bond's cash flows in US dollars are forecasted to grow at the rate of $E(x^{\$/€})$.

In the VPC example, the cost of capital in US $ for a risk-free euro asset, is:

$$k_{€f}^{\$} = r_f^{€} + E^*(x^{\$/€}) = 0.04 + 0.02 = 0.06$$

(The **TUIRP** condition **assumes the currency beta is zero**, so that a risk-free euro bond is "zero-beta" in US dollars.) Thus the risk-free rate in US dollars, 6%, is the proper required rate of return in US dollars for the expected cash flows of a risk-free euro bond.

VPC has $V^{*\$}$ = $4444.
Since $r^{€}$ = 0.04, the initial cash flow from the bond in US dollars is $4444(0.04) = $178.
To see this note that $4444 converts to €4444 because the spot FX rate is 1 $/€.
A €4444 investment in a euro-denominated risk-free bond earns annual interest 0.04(€4444) = €178. Because the spot FX rate is 1 $/€, the first bond's cash flow to a US dollar investor is $178.

Viewed in US dollars the bond's cash flows are forecasted to grow at the rate of 3%. Thus $V^{\$}$ = $178/(0.06 – 0.03) = $5933 is the **intrinsic value** in US dollars of investing $4444 in the risk-free euro bond. This is the **intrinsic enterprise value** of VPC in US dollars when we **forecast the euro to appreciate** at 3% while the **equilibrium rate** is 2%.

The NPV in US dollars of investing $4444 in a risk-free euro asset is $5933 – 4444 = $1489.
Note that this NPV is due solely to the fact that the **forecasted rate of change** in the euro is 3% whereas the **equilibrium expected rate of change** is 2%. The bond's NPV of $1489 is the $V_x^{\$}$ component for VPC, **the intrinsic value in US dollars created (or destroyed) due to an FX forecast that differs from the equilibrium FX forecast**.

So now let's take another look at the proposal to acquire VPC from the US dollar perspective. Ignoring the benefit of a forecasted appreciation of the euro at an above-equilibrium rate, we know already that the **NPV of the project would be $4444 – 5800 = –$1356**. But considering the managers' windfall currency appreciation forecast, **the NPV of the acquisition is $5933 – 5800 = $133**.

In the case where the managers' forecasted FX change is *not* equal to the equilibrium expected FX change, the two currency perspectives may not lead to the same decision outcome. **The NPV of the VPC decision is negative when the analysis is conducted in euros and is positive when the analysis is conducted in US dollars.**

Consider the US firm XYZ and its target Eurozone firm DYA in the previous example. ==Assume this time that XYZ's managers forecast the FX price of the euro will change by –3.5% per year into perpetuity.== This forecast is for a faster depreciation of the euro than at the equilibrium rate of –2%, possibly reflecting the view that the spot FX price of the euro is overvalued.

A) What is the NPV of XYZ's proposed acquisition of DYA in euros?

The NPV in euros of the acquisition is the same as before, ***€1.92 million***.

B) What is the NPV of XYZ's proposed acquisition of DYA in US dollars?

The intrinsic enterprise value of DYA in euros of €14.92 million converts to $22.38 million at the current spot FX rate of 1.50 $/€.

To find $V^\$$, we use equation (8.3). Recall that the euro risk-free rate is assumed to be 5%. So investing $22.38 million into a perpetual risk-free euro-denominated bond means that the bond's initial cash flow from the US dollar perspective is $22.38(0.05) = $1.119 million.

In US dollars, the **cost of capital** for a risk-free euro asset is $r_f^\text{€} + E^*(x^{\$/\text{€}})$ = 0.05 – 0.02 = 0.03, given our assumption that the linear approximation of **traditional UIRP condition holds**.

So the intrinsic value in US dollars of DYA is $1.19 million/(0.03 – (–0.035)) = ***$17.22 million***.

The **NPV** of the proposed acquisition in US dollars is ***$17.22 million*** – 19.50 million = ***–$2.28 million***.

Note that the NPV of the acquisition is positive with the equilibrium FX forecast **(€1.92 million(1.50 $/€) = $2.88 million)**, but is **negative here because of the forecasted the disequilibrium depreciation of the euro**.

WHICH NPV?

If ABC's managers forecast the **disequilibrium 3% rate of change in the FX price of the euro**, the **NPV** of the VPC acquisition is $133 when the analysis is conducted in US dollars.

If ABC's managers forecast **rate of change in the FX price of the euro is the equilibrium rate** of 2%, the NPV of the VPC acquisition is –$1356.

Regardless of the FX forecast, the result is an NPV of –€1356, when the analysis is conducted in euros. **Which of these NPVs should be the basis of ABC's investment decision? Should ABC acquire VPC or not?**

There are **two schools of thought** on whether managers should base foreign asset decisions on the asset's intrinsic value consistent with equilibrium, or on the asset's intrinsic value that includes the windfall gain/loss based on the disequilibrium FX forecast.

1) NPV BASED ON THE EQUILIBRIUM FX FORECAST: proponents make several arguments. One is that managers should not be using FX forecasts that deviate from the equilibrium forecast. This argument is based on the efficient market notion that the financial market's information (like the UIRP model) contains the **best information**. Managers should **stick to managing their company instead of trying to forecast FX rates** better than the financial market.

2) DISEQUILIBRIUM APPROACH : proponents counterargue that a **forecasted disequilibrium correction of misvalued spot FX rates should influence overseas investment decisions**. Reports of FX misvaluation are common and easily observed, as we saw in Chapters 4 and 5. So **why should managers ignore this information** when making investment decisions? Researchers have found that the level of overseas investment is related to the level of spot FX rates, consistent with the use of the **disequilibrium approach**. They have also found that the level of the acquisition premium is related to the spot FX rate in cross-border mergers and acquisitions.

A second argument by the proponents of the equilibrium approach is that even if managers have an FX forecast that differs from the equilibrium one, they are better able to exploit that forecast using a financial market transaction instead of an investment like a foreign company acquisition. That is, in principle, ABC is better off to invest the $5800 in a long-term risk-free euro-**denominated bond instead of acquiring VPC. The NPV would be would be higher than $133**. **According to this viewpoint, the acquisition of VPC should be rejected in favor of an investment in the euro-denominated bond.**

Disequilibrium Approach: proponents counterargue that a financial market transaction like buying a euro-denominated bond is not a realistic alternative to a business investment decision. For one thing, **investing in a euro-denominated bond is not consistent with ABC's business**, while **acquiring VPC is**. For another, there are **accounting implications** for reported current earnings of the mark-to-market (MTM) changes in a financial transaction like the euro-denominated bond. See Chapter 11. ABC's managers are likely to want to avoid the volatility this position would create in reported earnings.

From ABC's home currency perspective, acquiring VPC adds less intrinsic value than investing in a euro-denominated bond, given the FX forecast of a euro appreciation at an above-equilibrium rate. But the acquisition of VPC may still be a more practical way for ABC's managers to add intrinsic value **in light of their view that the euro is currently undervalued**.

Note that if you think a managers' FX forecast should be incorporated into the analysis, it is not a good idea to try to do this in the cost of capital conversion across the currencies.

Example, say the forecasted appreciation of the euro of 3% is incorporated into VPC's cost of capital conversion from US dollars into euros, instead of the equilibrium expected rate of 2%. So ABC would estimate VPC's euro cost of capital to be 100 basis points lower, 8% instead of 9%.

The NPV analysis in euros, with a **€5800 outlay**, would show an NPV in euros of:

$$€200/(0.08 - 0.045) - \textbf{5800} = -€86.$$

Given the spot FX rate of 1 \$/€, the NPV found in euros is equivalent to an NPV in US dollars of –\$86.

As we see, this analysis would imply a reject decision for an acquisition that we've already shown should be accepted. The problem is the risk of the forecasted FX change is being incorrectly built into the enterprise cost of capital, which is supposed to reflect the basic risk of the business.