FX Exposure

2. Measuring Exposure

Economic Exposure

Economic exposure (EE): Risk associated with a change in the NPV of a firm's expected cash flows, due to an *unexpected* change in S_t .

<u>Note</u>: S_t is very difficult to forecast. Actual change in S_t can be considered "unexpected."

• General definition: It can be applied to any firm (domestic, MNC, exporting, importing, purely domestic, etc.).

• The degree of EE depends on:

- Type & structure of the firm

- Industry structure in which the firm operates.

• In general:

- **Importing & exporting** firms face higher EE than purely domestic firms - **Monopolistic** firms face lower EE than firms that operate in competitive markets.

Example: A U.S. firm face almost no competition in domestic market. Then, it can transfer to prices almost any increase of its costs due to changes in S_t . Thus, this firm faces no/low EE. ¶

• The degree of EE for a firm is an empirical question.

• Economic exposure is difficult to measure.

• We can use *accounting data* (EAT changes) or *financial/economic data* (returns) to measure EE. Economists like economic-based measures.

A Measure Based on Accounting Data

We use cash flows to estimate FX exposure. For example, we simulate a firm's **CFs** (EBT, Operating Income, etc.) **under several FX scenarios**.

Example: IBM HK provides the following info: Sales and cost of goods are dependent on S_t :

$S_t = 7 \text{ HKD/USD}$ $S_t = 7.70 \text{ HKD/USD}$

Sales (in HKD)	300M	400M
Cost of goods (in HKD)	<u>150M</u>	<u>200M</u>
Gross profits (in HKD)	150M	200M
Interest expense (in HKD)	<u>20M</u>	<u>20M</u>
EBT (in HKD)	130M	180M

Example (continuation):

A 10% depreciation of the HKD increases HKD CFs from HKD 130M (=USD 18.57M) to HKD 180M (=USD 23.38M): A 25.92% change in CFs measured in USD.

Q: Is EE significant?

A: We can calculate the elasticity of CF to changes in S_t :

CF elasticity =
$$\frac{\% \text{ change in EBT}}{\% \text{ change in } s_t} = \frac{.2592}{.10} = 2.59$$

<u>Interpretation</u>: We say, a 1% depreciation of the HKD produces a change of **2.59%** in EBT. Quite significant. But the change in exposure is **USD 4.81M**. This amount may not be significant for IBM (*Judgment call* needed.)

IBM HK behaves like a net exporter: Weaker DC, Higher CFs. ¶

Note: Firms will simulate many scenarios & produce an expected value.

We can use historical accounting cash flows to calculate economic exposure.

Example: Kellogg's cash flow elasticity in 2020-2019.

From 2019 to 2020 (end-of-year to end-of-year), K's operating income increased 2.6%. The USD depreciated against basket of major currencies by 3.58%. Then,

$$CF elasticity = \frac{.026}{.0358} = 0.73$$

<u>Interpretation</u>: We say, a 1% depreciation of the USD produces a positive change of 0.73% in operating income. K's behaves like a **net exporter**. ¶

A Regression based Measure and a Test CF elasticity gives us a measure, but it is not a test of EE. A judgment call is needed. It is easy to test regression coefficients (t-tests or F-tests). • Simple steps: (1) Get data: $CF_t \otimes S_t$ (available from the firm's past) (2) Estimate regression: $\Delta CF_t = \alpha + \beta \Delta S_t + \varepsilon_t,$ $\Rightarrow \beta$: Sensitivity of ΔCF_t to ΔS_t . \Rightarrow The higher β , the greater the impact of ΔS_t on CF_t . (3) Test for EE $\Rightarrow H_0$ (no EE): $\beta = 0$ H_1 (EE): $\beta \neq 0$ (4) Evaluation of this regression: t-statistic of β and R². <u>Rule</u>: $|t_{\beta} = \beta/SE(\beta)| > 1.96 \Rightarrow \beta$ is significant at the 5% level.

A Regression based Measure and a Test

In general, regression is done in terms of % changes:

$$cf_t = \alpha + \beta \, \boldsymbol{e_{f.t}} + \boldsymbol{\xi}_t,$$

 cf_t : % change in CF from t-1 to t.

Interpretation of β : A 1% change in S_t changes the CF_t by β %.

• Expected Signs

We estimate the regression from a Domestic (say, U.S.) firm's point of view: CF measured in DC (say, USD & S_t is USD/FC). Then, from the regression, we can derive the Expected sign (β):

Type of company	Expected sign for β
U.S. Importer	Negative
U.S. Exporter	Positive
Purely Domestic	Depends on industry

• Other variables also affect CFs: Investments, acquisitions, growth of the economy, etc.

We "*control*" for the other variables that affect CFs with a multivariate regression, say with k other variables:

 $cf_t = \alpha + \beta \ \boldsymbol{e_{f.t}} + \delta_1 X_{1,t} + \delta_2 X_{2,t} + \dots + \delta_k X_{k,t} + \boldsymbol{\varepsilon_t},$ where X_{k,t} represent one of the k^{th} other variables that affects CFs.

<u>Note</u>: Sometimes the impact of ΔS_t is not felt immediately.

 \Rightarrow contracts and short-run costs matter.

Example: For an exporting U.S. company a sudden appreciation of the USD increases CF in the short term. Solution: use a modified regression:

$$cf_t = \alpha + \beta_0 \mathbf{e}_{f,t} + \beta_1 \mathbf{e}_{f,t-1} + \beta_2 \mathbf{e}_{f,t-2} + \dots + \beta_q \mathbf{e}_{f,t-q} + \delta_1 \mathbf{X}_{1,t} + \dots + \varepsilon_t.$$

Sum of **B**'s: Total sensitivity of cf_t to $e_{f,t}$ (= $\beta_0 + \beta_1 + \beta_2 + \beta_3 + ...$)

A Measure Based on Financial Data

Accounting data can be manipulated. Moreover, international comparisons are difficult. Instead, use financial data: Stock prices!

We can easily measure how returns and ΔS_t move together: *correlation*.

Example: Kellogg's and IBM's EE.

Using monthly stock returns for Kellogg's ($r_{K,t}$) and monthly changes in S_t (USD/EUR) from **33 years** (**1988:Jan** – **2022:Jan**), we estimate $\rho_{K,s}$ (correlation between $r_{K,t} \& e_{f,t}$) = **0.150**. It looks small.

We do the same exercise for IBM, measuring the correlation between $r_{IBM,t}$ & $e_{f,t}$, obtaining $\rho_{IBM,s} = 0.089$, small and, likely, close to zero.

But, if we use USD/TWC, based on the major currencies, things change a bit: $\rho_{K,s} = 0.1263$ (similar to USD/EUR) & $\rho_{IBM,s} = 0.1795$ (different).

An Easy Measure of EE Based on Financial Data
Better measure: A regression-based measure that can be used as a test.
Steps:

Regress, r_t, returns against (unexpected) ΔS_t.
r_t = α + β e_{f,t} + ε_t

2) Check statistical significance of regression coefficient for s_t:

H₀ (No EE): β = 0.
H₁ (EE): β ≠ 0.
A simple t-test can be used to test H₀.

Interpretation: A 1% change in S_t changes the Value of the firm by β%.

Example: Kellogg's EE. Using 1988-2022 data (see previous example), we run the regression: $r_{K,t} = \alpha + \beta \, \boldsymbol{e_{f,t}}(\text{USD/TWC}) + \varepsilon_t$ $R^2 = 0.01596$ Standard Error = 5.56447Observations = 409 Coefficients Standard Error P-value t-stat Intercept (α) 0.38592 0.27515 1.4026 0.1615 0.43775 0.17041 2.5688 0.0106 *e_{f,t}* (β) <u>Analysis</u>: Reject H_0 , $|t_\beta = 2.57| > 1.96$ (significantly $\neq 0$) \Rightarrow EE! $\beta > 0$, K behaves likes an exporter. <u>Interpretation of β </u>: A 1% increase in exchange rates, increases K's returns by **0.44%**. Note: R² is very low! ¶

Example: IBN	∕I's EE.			
Now, using the	e IBM data (1 9	988-2022), we run	n the regress	ion:
	$r_{IBM,t} = \alpha$	+ $\beta e_{f,t}$ (USD/T	WC)+ ε_t	
$R^2 = 0.03221$				
Standard Error	= 7.4465			
Observations =	409			
	Coefficients	Standard Error	t-stat	P-value
Intercept (a)	0.38896	0.36821	1.0563	0.2914
<i>e_{f,t}</i> (β)	0.83941	0.22805	3.6809	0.0003
<u>Analysis</u> : Reje β >	ct H_0 , $ t_\beta = 3$, 0, DIS behave	. <mark>68</mark> > 1.96 (sign es likes an export	ificantly $\neq 0$ er.	$) \implies \text{EE!}$
Interpretation returns by 0	<u>of β</u> : Α 1% .84% .	increase in ex	change rates	s, increases DIS's
Again, the R ² i	s low! ¶			

Returns are not only influenced *e_{f,t}*. In investments, it is common to use the 3 factors from the Fama-French models to model stocks returns:
Market ([r_M - r_f])
SMB (size)
HML (value).
In Kellogg's case:
 r_{K,t} = α + γ₁ (r_M - r_f)_t + γ₂ SMB_t + γ₃ HML_t + ε_t

A momentum can be added to accommodate Carhart's (1997) model.
<u>Note</u>: In general, we find γ₁ & γ₃ significant. R² is not very high.
Now, we test if Kellogg's faces EE, *conditioning* on the other drivers of K's returns. That is, we do a t-test on β on the following regression:

 $r_{K,t} = \alpha + \gamma_1 \left(\mathbf{r}_{Mar} - \mathbf{r}_{f} \right)_t + \gamma_2 SMB_t + \gamma_3 HML_t + \beta \, \boldsymbol{e_{f,t}} + \boldsymbol{\varepsilon_t}$

Example (continuation) : Kellogg's EE (with 3 FF factors):					
		Coefficients	Std Error	t-stat	
	Intercept	0.0798	0.2691	0.2967	
	Market (R _m -R _f)	0.3893	0.0647	6.0204	
	Size (SMB)	-0.1144	0.0898	-1.2738	
	B-M (HML)	0.1546	0.0851	1.8157	
	$e_{f,t}(\beta)$	0.2601	0.1664	1.5633	
$R^2 = 0.0995$ (a higher value driven mainly by the market factor). Now, t-stat = 1.56 (<i>p</i> -value = .119). We say:					
"After controlling for other factors that affect Kellogg's excess returns, we do not find					
evidence of EE at the 5% significance level."					
\Rightarrow <u>Usual interpretation</u> : No EE for K.					

We also see a lower sensitivity, β : 0.2601.

		Coefficients	Std Error	t-stat		
	Intercept	-0.2894	0.3180	-0.9102		
	$e_{f,t}(\beta)$	0.3963	0.1966	2.0157		
	Market (R _m – R _f)	0.9506	0.0764	12.4363		
	Size (SMB)	-0.2557	0.1062	-2.4085		
B-M (HML) -0.1154 0.1006 -1.1471						
$R^{2} = 0.3092.$ The t-stat = 2.01 (<i>p-value</i> = .045). \Rightarrow <u>Usual interpretation</u> : IBM faces EE.						
	Again, we see a big reduction in lower sensitivity, β : 0.3963.					

EE: Evidence

The above regression (for K) has been done for firms around the world.

Results from work by Ivanova (2014):

- Mean $\beta = 0.57$ (a 1% USD depreciation increases returns by 0.57%).
- But, only 40% of the EE are statistically significant at the 5% level.
- For large firms (MNCs), EE is small –average $\beta = 0.063$ & not significant at the 5% level.
- 52% of the EEs come from U.S. firms that have <u>no international</u> <u>transactions</u> (a higher S_t "*protects*" these domestic firms).

<u>Summary</u>:

- On average, large companies (MNCs, Fortune 500) face no EE.
- EE is a problem of small and medium, undiversified firms.

	E: Evidence						
• Check Ivanova's results for big firms, using the S&P 100 .							
We aga	We regress SP100 returns from past 38 years (1984:Apr – 2022:Jan) against $e_{f,t}$ (USD/TWC) & the 3 FF factors:						
R ² =	$R^2 = 0.9664$						
Star	ndard Error = 0.8136						
Obs	servations = 454						
		Coefficients	Std Error	t_stat	D voluo		
		Councients	Stu LIIOI	t-stat	I -value		
	Intercept	-0.0247	0.0389	-0.6357	0.5253		
	Intercept <i>e</i> _{<i>f</i>,<i>t</i>}	-0.0247 - 0.0225	0.0389 0.0231	-0.6357 - 0.9756	0.5253 0.3298		
	Intercept <i>e_{f,t}</i> Market - r _f	-0.0247 -0.0225 0.9988	0.0389 0.0231 0.0090	-0.6357 - 0.9756 110.5233	0.5253 0.3298 >.00001		
	Intercept <i>e_{f,t}</i> Market - r _f SMB	-0.0247 -0.0225 0.9988 -0.2459	0.0389 0.0231 0.0090 0.0133	-0.6357 -0.9756 110.5233 -18.4659	0.5253 0.3298 >.00001 >.00001		
	Intercept e _{f,t} Market - r _f SMB HML	-0.0247 -0.0225 0.9988 -0.2459 0.0068	0.0389 0.0231 0.0090 0.0133 0.0126	-0.6357 -0.9756 110.5233 -18.4659 0.5381	0.5253 0.3298 >.00001 >.00001 0.5907		