

Week 7: Foreign Exchange (FX) Exposure

FINA3020

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Today, we will discuss the three types of FX exposure and how firms hedge against them:

- Transaction exposure
- Economic exposure
- Translation exposure

Key concept: Exchange rates are volatile, directly affect the profits of multinational corporations (MNCs), so MNCs hedge FX risk more than domestic-only firms

Example Consolidated Net Cash Flow Statement by Currency

Currency	Inflow	Outflow	Net	USD per	Net USD
GBP (£)	£8M	£6M	+£2M	\$1.35	+\$2.7M
EUR (€)	€5M	€1M	+€4M	\$1.15	+\$4.6M
CHF	CHF 1M	CHF 3M	CHF -2M	\$1.25	-\$2.5M
MXN	MXN 20M	MXN 70M	MXN -50M	\$0.05	-\$2.5M

Exposure depends on net flow:

- When a US firm has positive net cash flows from abroad, it benefits from USD depreciation relative to host countries, as you saw in Week 6 and the practice midterm exam
- Total exposure is increasing in transaction volume and volatility. If MXN were much more volatile vs USD as the other currencies vs USD, then it would be more important to hedge against MXN

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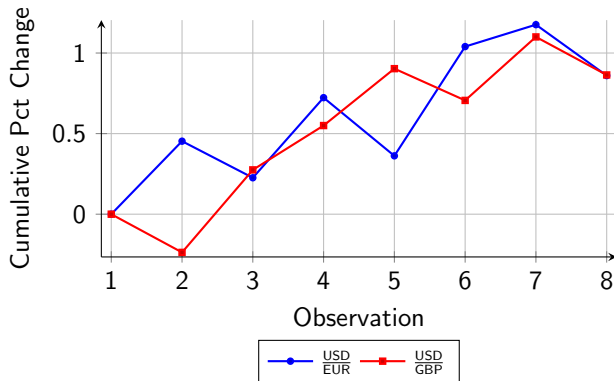
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Two FX Time Series in US Direct Quotation

USD per other currency, along with date-by-date percent returns (prefixed "r")

EUR	GBP	rEUR	rGBP
1.1050	1.2720		
1.1100	1.2690	0.452	-0.236
1.1075	1.2755	-0.225	0.512
1.1130	1.2790	0.495	0.274
1.1090	1.2835	-0.359	0.351
1.1165	1.2810	0.671	-0.195
1.1180	1.2860	0.134	0.389
1.1145	1.2830	-0.314	-0.233

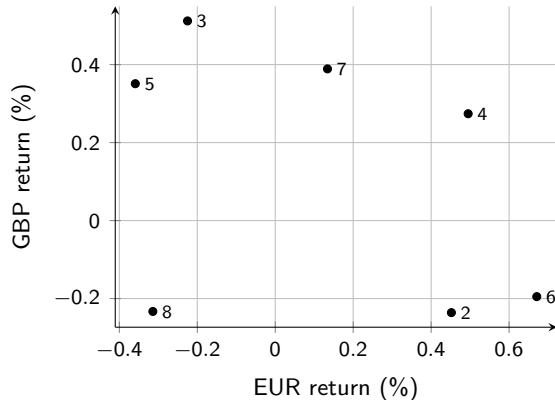
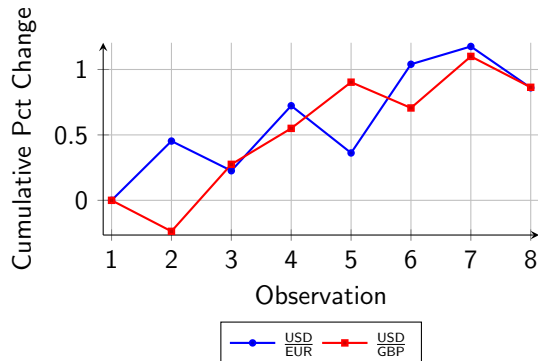


Given spot rates for EUR and GBP vs USD (left two columns), we compute returns (below and right two columns)

$$\text{Return}_{t-1,t} = \frac{\text{Spot value}_t - \text{Spot value}_{t-1}}{\text{Spot value}_{t-1}}$$

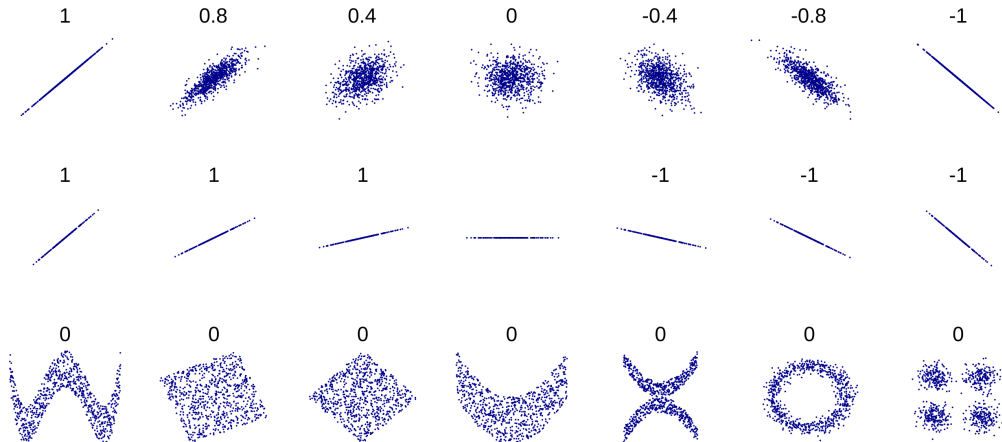
plot the cumulative changes (right), then create the scatterplots (next slide)

From Time Series (vs USD) to Scatterplot

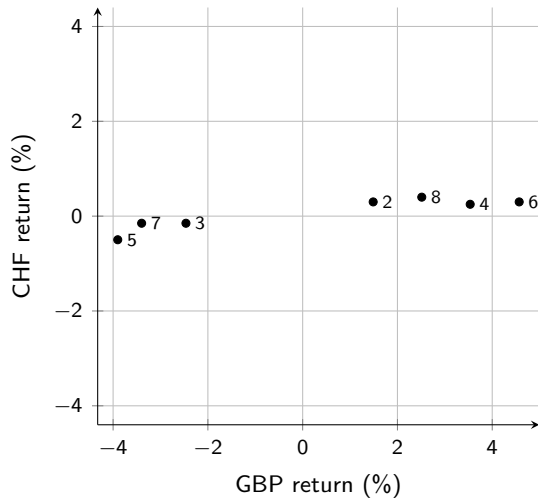
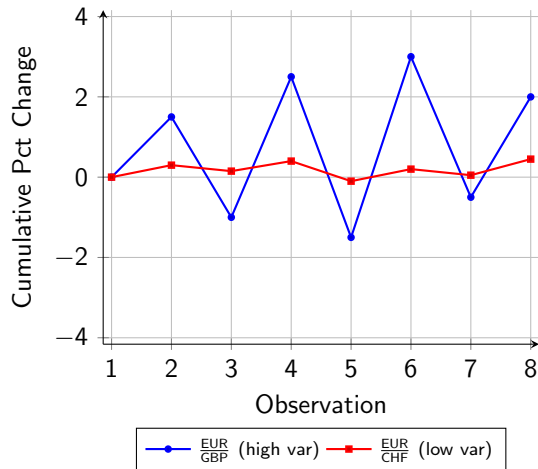


Each point on the right represents one day's EUR and GBP returns (in percentage points) against the same USD benchmark. If the two currencies were pegged against each other, then their fluctuations against the USD would look identical, and the points on the right would follow the 45-degree line through the origin.

What do correlations represent?



Comparing Variances: GBP and CHF against EUR



How Do We Measure Volatility?

For a two-currency portfolio p , the standard deviation (SD) of portfolio FX risk is

$$\sigma_p = \sqrt{W_X^2 \sigma_X^2 + W_Y^2 \sigma_Y^2 + 2W_X W_Y \sigma_X \sigma_Y \rho_{XY}}$$

where W_X and W_Y are the weights (proportion of portfolio value in each currency),

$$\sigma_X^2 = \frac{1}{T-1} \sum_{t=1}^T \left(\underbrace{\text{PctChange}_{X,t}}_{R_{X,t}} - \underbrace{\text{AvgPctChange}_X}_{\bar{R}_X} \right)^2$$

is the variance (measure of FX volatility) in percentage points of currency X over T time periods. Define similarly for σ_Y^2 for currency Y. The correlation coefficient is

$$\text{Sample covariance: } \text{Cov}(X, Y) = \frac{1}{T-1} \sum_{t=1}^T (R_{X,t} - \bar{R}_X)(R_{Y,t} - \bar{R}_Y)$$

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Matrix Form (No Need to Remember)

Two-currency case:

$$\sigma_p^2 = W_X^2 \sigma_X^2 + W_Y^2 \sigma_Y^2 + 2W_X W_Y \sigma_X \sigma_Y \rho_{XY}$$

With weight vector $\mathbf{w} = \begin{bmatrix} W_X \\ W_Y \end{bmatrix}$ and covariance matrix $\Sigma = \begin{bmatrix} \sigma_X^2 & \sigma_X \sigma_Y \rho_{XY} \\ \sigma_X \sigma_Y \rho_{XY} & \sigma_Y^2 \end{bmatrix}$,

$$\sigma_p^2 = \mathbf{w}^\top \Sigma \mathbf{w}.$$

This generalizes to any number of assets in the portfolio

FX Correlations

Correlations	EUR	GBP	AUD	NZD	JPY	CNY	CHF	CAD	MXN	INR	BRL	RUB	KRW	USD
EUR		.65	.82	-.03	-.45	.70	.97	.36	.87	-.64	.80	-.02	.29	.95
GBP	.65		.65	.47	.08	.57	.57	.63	.53	-.11	.52	.34	.70	.79
AUD	.82	.65		.01	-.48	.86	.80	.28	.87	-.60	.83	-.08	.39	.79
NZD	-.03	.47	.01		.63	-.21	-.07	.81	-.25	.65	-.31	.57	.63	.20
JPY	-.45	.08	-.48	.63		-.61	-.46	.31	-.72	.76	-.65	.16	.15	-.18
CNY	.70	.57	.86	-.21	-.61		.67	.14	.87	-.68	.85	-.02	.44	.63
CHF	.97	.57	.80	-.07	-.46	.67		.31	.84	-.63	.73	-.06	.24	.91
CAD	.36	.63	.28	.81	.31	.14	.31		.16	.31	.05	.65	.75	.53
MXN	.87	.53	.87	-.25	-.72	.87	.84	.16		-.78	.92	-.03	.27	.75
INR	-.64	-.11	-.60	.65	.76	-.68	-.63	.31	-.78		-.80	.43	.15	-.45
BRL	.80	.52	.83	-.31	-.65	.85	.73	.05	.92	-.80		-.17	.20	.69
RUB	-.02	.34	-.08	.57	.16	-.02	-.06	.65	-.03	.43	-.17		.64	.07
KRW	.29	.70	.39	.63	.15	.44	.24	.75	.27	.15	.20	.64		.43
USD	.95	.79	.79	.20	-.18	.63	.91	.53	.75	-.45	.69	.07	.43	

Value at Risk (VaR): Basic Idea

VaR estimates the maximum expected loss from exchange rate changes over a given time and confidence level.

Definition: Maximum possible loss on a foreign-currency position, assuming normal conditions and a chosen confidence level.

Formula: $\text{Max 1-day loss} = \text{Expected Change} - (z \times \sigma)$ context: $z = 1.65$ one-tailed at 95%

Example: Selling in Mexico

- MXN 10M due tomorrow, $\sigma = 1.0\%$, expected change = 0%
- $\text{Max 1-day loss} = 0\% - (1.65 \times 1.0\%) = -1.65\%$
- $\text{Spot} = \$0.09 \implies \text{min rate} = \$0.09(1-0.0165) = \$0.0885$
- $\text{Peso value tomorrow} = \text{MXN } 10,000,000 \times \$0.0885 = \$885,000$
- $\text{Current (expected) value} = \text{MXN } 10,000,000 \times \$0.09 = \$900,000$
- **Dollar loss** = $\$900,000 - \$885,000 = \$15,000$

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VaR for a Currency Portfolio

Portfolio VaR accounts for correlations among currencies.

Example: Exports to Southeast Asia

- IDR 600K, THB 400K
- Weights: $W_{IDR} = 0.6$, $W_{THB} = 0.4$
- $\sigma_{IDR} = 7\%$, $\sigma_{THB} = 8\%$
- $\rho_{IDR,THB} = 0.5$

Portfolio Standard Deviation

$$\sigma_p = \sqrt{W_I^2 \sigma_I^2 + W_T^2 \sigma_T^2 + 2W_I W_T \sigma_I \sigma_T \rho_{IT}}$$
$$= \sqrt{0.001764 + 0.001024 + 0.001344} = 6.43\%$$

Maximum 1-Month Loss:

$$0\% - (1.65 \times 6.43\%) = -10.6\%$$

Smaller magnitude than single-currency VaR: IDR -11.6%, THB -13.2%

Diversification: Portfolio risk (10.6%) is lower in magnitude than individual currency risks.

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Applications

- Assess if losses are acceptable
- Guide hedging and capital allocation
- Compare risk-adjusted performance

Limitations

- Assumes normal returns
- Volatility may change
- Ignores extreme tail losses
- Correlations rise in crises

Complementary Tools

- Scenario analysis (hypotheticals)
- Stress testing (historical shocks)
- Sensitivity analysis (vary inputs)
- Expected Shortfall (avg. tail loss)

Takeaway: VaR measures risk exposure; it does not manage risk. Use it to inform judgment.

What is Transaction Exposure?

Transaction exposure arises when a firm has contractual cash flows (known receivables or payables) denominated in a foreign currency.

Exchange rate changes can affect the home-currency value of these flows.

- Example: A U.S. exporter sells products to Mexico for MXN 10 million, payable in one month.
 - If the peso depreciates 10%, the dollar value of the receivable falls by 10%.
- Example: An importer owes 1M EUR due in a month. Local costs rise if the euro appreciates over the next month.

Firms hedge transaction exposure to reduce uncertainty and stabilize future cash flows.

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Firms differ in how aggressively they hedge:

- **Full:** Some MNCs hedge most exposures to stabilize cash flows (e.g., DuPont, Merck).
- **Selective:** Others hedge selectively, based on transaction size, duration, and market outlook.

Example corporate statements:

- *"We do not comprehensively hedge exposure to currency rate risk, although we may selectively hedge."* — ConocoPhillips
- *"Decisions to hedge are made case-by-case, considering exposure, volatility, and trends."* — DuPont

Techniques to Hedge Payables

A firm owing a foreign currency may hedge against appreciation of that currency.

- ① *Forward or futures hedge*: Lock in a future exchange rate.
- ② *Money market hedge*: Borrow home currency, convert, and invest foreign currency to cover the future payment.
 - Equivalent to forward/future under CIP
- ③ *Currency option*: Buy the right (not obligation) to purchase (call) or sell (put) the foreign currency at a fixed price.

Hedging Payables Example

Coleman Co. (U.S.) owes €100,000 in one year.

$$\text{Forward rate} = 1.20 \Rightarrow \text{Dollar cost} = 100,000 \times 1.20 = \$120,000$$

Coleman Co. can alternatively create a money market hedge.

$$\text{Deposit required in euros} = \frac{100,000}{1 + 0.05} = 95,238 \text{ euros}$$

$$\text{Dollars needed today} = 95,238 \times 1.18 = \$112,381$$

$$\text{Repayment in 1 year (8\% rate)} = 112,381 \times 1.08 = \$121,371$$

Firms choose based on transaction costs and convenience.

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Call Option Hedging Payables Example

Coleman can hedge by buying call options on €100,000:

- Exercise price = \$1.20
- Premium = \$0.03
- Maturity = 1 year

If spot rate $< 1.20 \Rightarrow$ option expires, cost = spot + 0.03

If spot rate $\geq 1.20 \Rightarrow$ exercise option, cost = $1.20 + 0.03 = 1.23$

Expected cost based on forecasted probabilities:

$$E(\text{Cost}) = 0.2(119,000) + 0.8(123,000) = 122,200$$

Forward hedge (\$120,000) is cheaper on average, but operating exposure may motivate the option (several slides from now)

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For receivables, the logic is reversed.

- ① *Forward hedge*: Lock in a rate to sell foreign currency.
- ② *Money market hedge*: Borrow foreign currency now, convert to domestic currency, and use receivables to repay later.
- ③ *Put option hedge*: Buy the right to sell the foreign currency at a fixed rate, protecting against depreciation.

Put Option Hedge Example

You expect to receive money, so you buy a put option on AUD 200,000:

- Exercise price = \$0.72
- Premium = \$0.02

Possible outcomes for USD per AUD

Spot Rate	Action	Cash/Unit	Total Cash
0.71	Exercise	$0.72 - 0.02 = 0.70$	\$140,000
0.74	Expire	$0.74 - 0.02 = 0.72$	\$144,000
0.76	Expire	$0.76 - 0.02 = 0.74$	\$148,000

Expected value = \$144,000. Compared with forward hedge (\$142,000), the option provides higher expected value and upside potential.

Limitations of Hedging

- Uncertain transactions: Overhedging can occur if the actual amount differs from forecasted exposure.
- Short-term horizon: Repeated short hedges cannot protect long-term exposures.
- Cost: Options require premiums; forwards and money market hedges may have implicit financing costs.

Example: A U.S. importer repeatedly hedging annual yen payments still faces higher dollar costs over time if the yen steadily appreciates.

Long-term forward contracts or parallel loans may better stabilize costs.

When perfect hedges are unavailable or costly, firms can reduce exposure by:

- *Leading and lagging*: Adjust payment timing based on expected currency movements.
- *Cross-hedging*: Hedge with a correlated currency when direct hedging is not available.
- *Currency diversification*: Hold inflows and outflows in several currencies to offset movements.

Example: If a Polish subsidiary cannot hedge the zloty, it might hedge using the euro if the two currencies move together.

Economic Exposure: Cash Flow Sensitivity to Exchange Rates

Concept: Economic exposure measures how a firm's *future cash flows* (not just contracts) are affected by exchange rate movements.

Key Idea: Even if all transactions are invoiced in the home currency, a firm may still lose competitiveness when the exchange rate changes.

Example: Retailer prices all goods in USD, same prices worldwide. No transaction exposure, but when EUR depreciates against USD, European consumers face higher local price and buy less

Takeaway: Economic exposure captures the *real operating impact* of exchange rates on competitiveness, prices, and demand — not just the accounting impact.

Types of Economic Exposure Situations

Situation	Effect if Foreign Currency Depreciates
Export contract in foreign currency	Export revenue falls in home currency
Import contract in foreign currency	Import costs fall
Exports priced in home currency vs foreign competitors	Lose price competitiveness
Purely domestic firm with foreign competitors	Local customers shift to cheaper imports

Even firms that sell only at home can face economic exposure if exchange rates change relative competitiveness.

Impact of Local Currency Movements

When the local currency strengthens:

- Exports become more expensive to foreigners
- Foreign competitors become cheaper domestically
- Inflows fall, outflows (for imports) improve

When the local currency weakens:

- Exports rise, foreign competition declines
- Imported inputs cost more

Net Effect: Depends on the firm's structure:

- Exporter using domestic inputs benefits from depreciation
- Local seller importing materials is hurt by depreciation

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translated to the parent's currency for reporting. Example:

- U.K. subsidiary accounts for half of total earnings.
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- Stock price and executive pay fall — even though operations are unchanged.

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Hedging Translation Exposure

Objective:

Stabilize reported earnings by offsetting translation effects.

Forward Hedge

- If subsidiary expects £20M earnings, parent sells £20M forward.
- If pound depreciates, translation loss is offset by gain on the forward contract.

Limitations:

- Forecasted earnings may be inaccurate.
- Forwards unavailable for some currencies.
- Accounting mismatch between average and closing rates.
- May create real (cash) transaction losses to offset paper (accounting) gains.

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Transaction exposure affects the home-currency value of contractual cash flows.

- Firms use forward, money market, and option hedges to manage risk.
- Option hedges provide flexibility but tend to cost more.
- Alternative approaches include timing strategies, proxy hedges, and diversification.

Economic Exposure affects a firm's operating cash flows and competitiveness.

- Harder to hedge, measured by the sensitivity of cash flows to FX
- Can be reduced through operational restructuring, e.g. matching currency inflows and outflows, sourcing, or financing.

Translation Exposure affects consolidated financial statements.

- Changes in exchange rates alter reported earnings and equity.
- Important for investor perception and managerial incentives, even if no real cash flow changes occur.

Next 2 weeks: international banking system, exchanges, and capital markets