Chapter 3
FOREIGN EXCHANGE (FX) MARKETS

Review, FX Rates & FX Market
Organization

• Class Structure

Given last semester experience, we will restrict each lecture to segments of 75'-80', 60'-70' & 45'-50', with a 10'-15' break in between segments.

PPT slides are already available on my homepage.

• Two Midterms

The midterms are open everything, computer included. Collaboration with others is not allowed.

If taken online, it will be through Canvas. You will have 2.5 hours to finish the exam.

• **Comments from previous classes**

- *"Class is somewhat technical"*

We will emphasize the numerical/mathematical aspects of international finance. We will use regressions, simulations, the CAPM, NPV formulas, Black-Scholes option pricing formulas, etc. We will review all topics in class.

- *"Class covers a lot of material"*

We cover FX rates and how to manage FX risk (first part of the class), International asset allocation, International Stock Markets, International Corporate Finance, Currency Swaps, International Bond Market and Eurocurrencies.

- *"Instructor (me) goes fast"*

Questions are a great way to slow me down. Ask questions. All questions and interruptions are greatly appreciated.

• **More comments from previous classes**

"It was difficult to keep awake in the class."

"Very technical course."

"Learned a lot. Good course. Enjoyed the exams. One of the good courses in the Finance."

"This course is <u>much</u> too quantitative."

"We covered too much info too fast."

"This is one of the few courses that I feel I've truly earned what I'm paying the university."

"I enjoyed the AMA at the beginning of each class."

"He fried my brain."

• International Finance

- Similar to (Domestic) Finance

We use same models and formulas: NPV, CAPM, option pricing, etc.

- What makes International Finance a different class

- Different currencies across the world (USD, EUR, JPY, MXN)
- Different countries, with different political and legal systems, regulations, social structures, institutions, etc.

These two features come with an associated a risk
      - FX or Currency risk
      - Country Risk

- Goal of the class

Learn how to minimize these risks in different markets.

• International Finance

- Questions to answer

- How are foreign exchange rates determined?
- When does a Central Bank intervene in the FX Market?
- Does arbitrage in FX Market work? More specific, does IRP hold?
- Which theory best explain the behavior of the exchange rate?
- What tools do companies have to protect against Currency Risk?
- How does a company protect a FC receivable from currency risk?
- How do companies compute the NPV of CFs in an foreign investment?
- How do companies compute the expected return of a foreign asset?
- What methods are used to establish the Country Risk of a country?
- What tools do companies have to protect against Country Risk?
- How does a MNC issue bonds in the World Bond Market?
- What are the advantages of using Eurobond debt over domestic debt?
- How do companies do financial engineering in international markets?

• **Today's class**

It will look more like an Economics class, than a Finance class. Next class, we will go over more Finance oriented topics.

- FX Market

  - Exchange Rate, S_t, & Determinants of Supply & Demand

  - FX Market: Organization, Activities, Players, & Segments

- FX Rate Determination

- Futures & Options

FX Market: Exchange Rates

• **Definition**

An exchange rate is a price: The relative price of two currencies.

Example: On June 3, 2024, the price of a euro (EUR) in terms of USD was USD 1.0903 per EUR $\Rightarrow$ EUR 1 = USD 1.09030

<u>Notation:</u> S_t = Exchange rate = 1.09030 USD/EUR.

• **Remark - Exchange Rate: Just a Price**

An exchange rate is just like any other price.

  $\Rightarrow$ Price of a gallon of milk: USD 3.50 (or 3.50 USD/milk).

Think of the currency in the denominator as the good you buy/sell.

Q: What is confusing in the FX Market?

A simple price, $S_t =$ **1.09030 USD/EUR** $\Rightarrow$ EUR 1 = USD 1.0630

But, a little bit different: Both, the numerator (USD) and the denominator (EUR), are easily exchanged for each other. We can also write:

$S_t = 0.9172$ EUR/USD $\Rightarrow$ USD 1 = (EUR 1/**1.09030**) = EUR 0.9172

In the case of the price of milk, only one good (USD) can be used to buy the other.

Q: What makes exchange rate quotes tricky?

A: Both traded goods (USD and EUR) can be exchanged for the other.

Again, we will think of the currency in the denominator as the good we buy/sell, the FC. (**direct quote**.) Easy to translate FC prices to DC:

      Multiply a foreign price (in FC) by direct quote = price in DC

• Direct & Indirect quotes with spreads

i. **indirect quote** or "*European*" quote

      S_t(*indirect*) = units of FC that one domestic unit will buy.

ii. **direct quote** or "*American*" quote.

      S_t(*direct*) = units of DC that one foreign unit will buy.

Remark: indirect quotation = reciprocal of the direct quotation.

Example: A U.S. tourist wishes to buy JPY at LAX.

(A) Indirect quotation (JPY/USD).

A quote of JPY **108.04** – **113.90** means:

Dealer buys one USD for JPY **108.04** (*bid*)

      sells one USD for JPY **113.90** (*ask*).

For each round-trip USD transaction, she makes a profit of JPY 5.86.

(B) Direct quotation (USD/JPY).

If the dealer at LAX uses direct quotations, the bid-ask quote will be 0.008780 – .009256 USD/JPY. ¶

<u>Calculation</u>: S(*direct*)$_{bid}$ = 1/S(*indirect*)$_{ask}$ = 1/**113.90** = 0.008780 USD/JPY

Note: $S_t(direct)_{bid} = 1/S_t(indirect)_{ask}$,
$\quad\quad\quad S_t(direct)_{ask} = 1/S_t(indirect)_{bid}$.

Remark: In class, we will use **_direct_** quotations. Think of the currency in the denominator as the currency you buy, the FC.

Example: Quotes:

S_t = 1.03 **CHF**/USD $\Rightarrow$ You are in **Switzerland**

S_t = 1.09 **USD**/EUR $\Rightarrow$ You are in the **U.S.**

• **FX Rates: Cross-quotes**
Most currencies are quotes against the USD. *Cross-rates* are rates calculated from USD quotations. (Think of liquidity!)

Rule for cross-rates with 3 currencies: X (CHF), Y (EUR), and Z (common currency, usually, **USD**):
$$\Rightarrow S_{X/Y,t} = \frac{S_{X/Z,t}}{S_{Y/Z,t}} \quad\quad\quad \text{(common currency Z cancels out!)}$$

Example: Calculate the CHF/EUR cross rate, based on the following quotes:
S_t = 0.89 CHF/USD
S_t = 0.91 EUR/USD

Common currency (Z) = **USD**

$$S_{CHF/EUR,t} = \frac{0.89 \; CHF/USD}{0.91 \; EUR/USD} = 0.9780 \text{ CHF/EUR. } \P$$

• **Just a Price, but an Important One**

S_t plays a very important role in the economy. It influences the current account (CA = X (exports) – M (imports)), cross-border investments, the domestic price level, P_d, and real wages.

Examples: Suppose the EUR appreciates vs the USD –i.e., EUR is more expensive in terms of USD. Using direct quote, $S_t \uparrow$.

- When $S_t \uparrow$, imports become more expensive in USD $\Rightarrow$ M $\downarrow$ & $P_d \uparrow$

$\Rightarrow$ Real wages $\downarrow$ (through a reduction in purchasing power).

- Also, when $S_t \uparrow$, USD-denominated goods and assets are more affordable to foreigners.

$\Rightarrow$ Foreigners buy more goods and assets in the U.S. (X, bonds, real estate, companies, etc.).

Note: Under normal circumstances, CA $\uparrow$ ("improves"). ¶

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• **Supply & Demand in the FX Market**

Like any other price, S_t is determined by supply and demand.
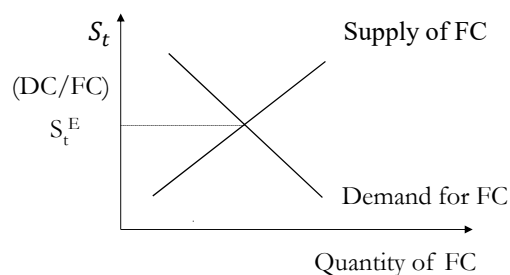
• Standard Demand and Supply graph:

- Price, S_t (=units of DC per unit of FC), on the vertical axis.

- Quantity (of FC) on the horizontal axis.

• **Similar to Supply & Demand in other Markets**

Milk Market determines the price of milk, P_t (= Units of DC per gallon).

P_t
(USD/milk)

$P_0 = 3.50$

$P_1 = 3.30$

A

B

S_0

S_1

D_0

Quantity of milk (in gallons)
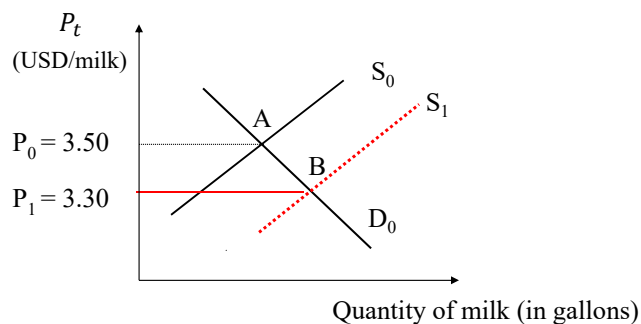
- New technology increases milk production (Supply ↑)

• P_t moves from A to B

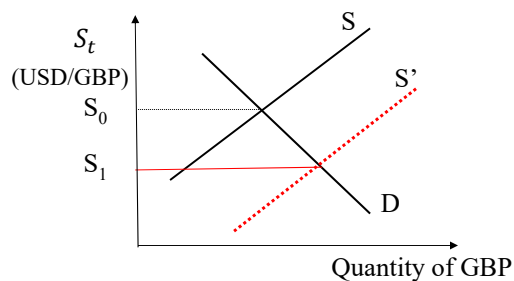⇒ Milk becomes less expensive in terms of USD.

Supply & Demand in the FX Market

• **Who supplies GBP in the (U.S.) FX market?**

- UK investors, investing in the U.S.
- US exporters, exporting to the U.K.
- UK tourism

Remark: More UK investments, US exports, or UK tourism:

⇒ Higher supply of GBP in the FX USD/GBP market.

S_t
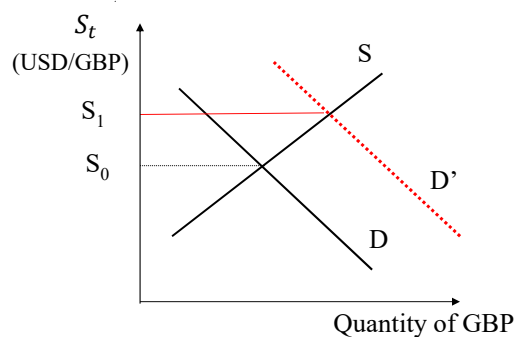(USD/GBP)

S_0

S_1

S

S'

D

Quantity of GBP

• **Who demands GBP in the (U.S.) FX market?**

- US investors, investing in the U.K.
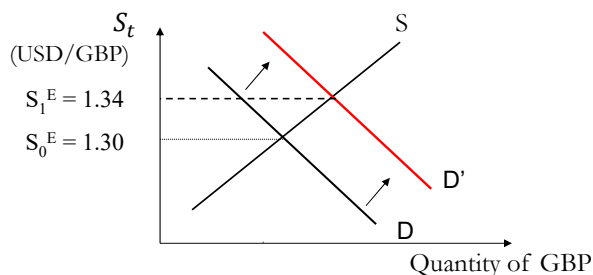
- US importers, importing from the U.K.

- US tourism

Remark: More US investments, US imports, or US tourism:

$\Rightarrow$ Higher demand for GBP in the FX USD/GBP market.

S_t
(USD/GBP)

S_1

S_0

S

D'

D

Quantity of GBP

• **Effect of a Change in Demand**

Suppose that there is a craze for British goods.

S_t
(USD/GBP)

$S_1^E = 1.34$

$S_0^E = 1.30$

S

D'

D

Quantity of GBP

Demand for GBP ↑ (D moves up to D').

$\Rightarrow$ Value of the GBP increases (more USD needed to buy GBP 1): S_t ↑

Terminology: We say the USD *depreciates* against the GPB (or the GBP *appreciates* against the USD).

• **What moves Supply & Demand?**

– International Investing

– International Trade

– International Tourism

– Other factors (Central Banks needs, international transfers, etc.)

All these activities are reflected in the Balance of Payments (BOP).

• **Balance of Payments**

BOP = Current Account (CA) + Capital Account (KA)

CA = Net Exports of goods and services (main component) + Net Investment Income + Net Transfers

KA = Financial capital inflows – Financial capital outflows

The BOP = 0 ⇒ The CA is financed by the KA.

• **Balance of Payments**

BOP = Current Account (CA) + Capital Account (KA)

• We model:

- CA as influenced by prices: P_d, P_f, S_t

- KA as influenced by expected rates of returns. In the short term, interest rates (i_d & i_f) dominate.

- Y (income) influences both CA & KA.

- Factors that affect prices, expected rates of returns, & income, such as taxes, tariffs, tech, uncertainty, etc., also have an influence on the BOP.
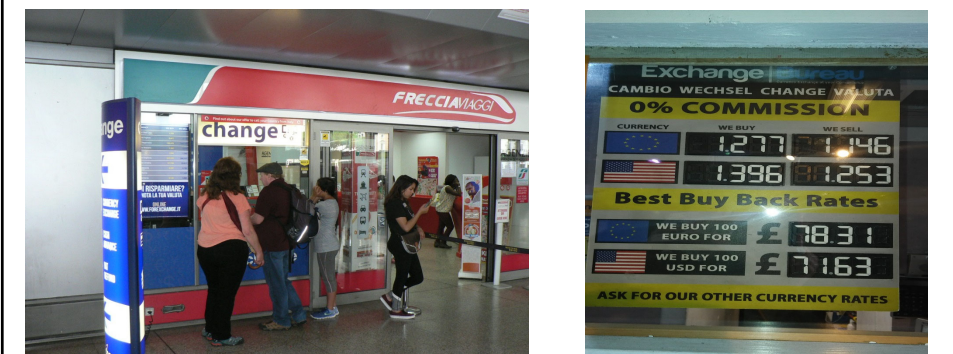
FX Markets: Organization

Q: How is the FX market organized?
A: Organized in two tiers:

      i. *Retail tier*
      ii. *Wholesale tier* (the "market")

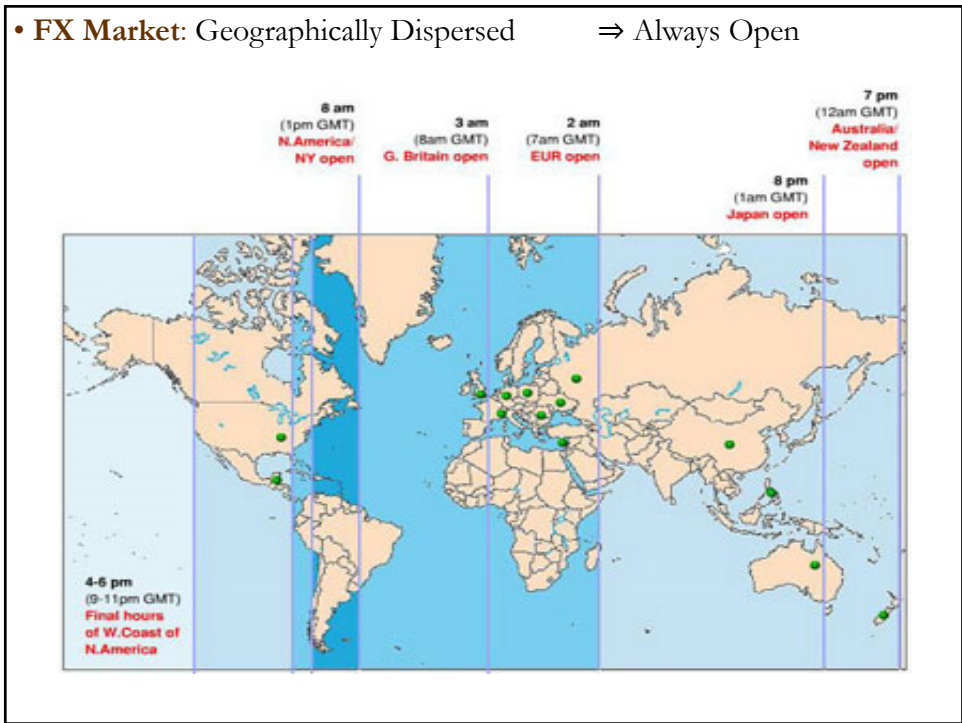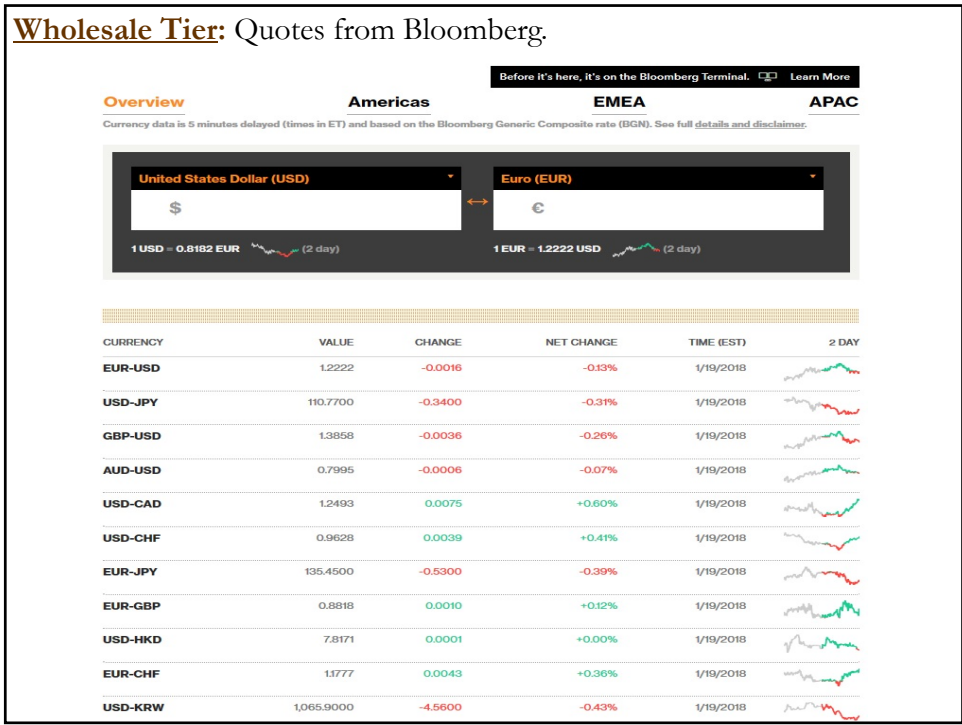Retail Tier: Where small agents buy and sell FX.

Wholesale Tier: Informal network of about **2,000 banks** and currency brokerage firms that deal with each other and with large corporations.

The wholesale tier is where FX rates are determined (**97% of volume**). These FX rates usually reported on financial websites and newspapers.
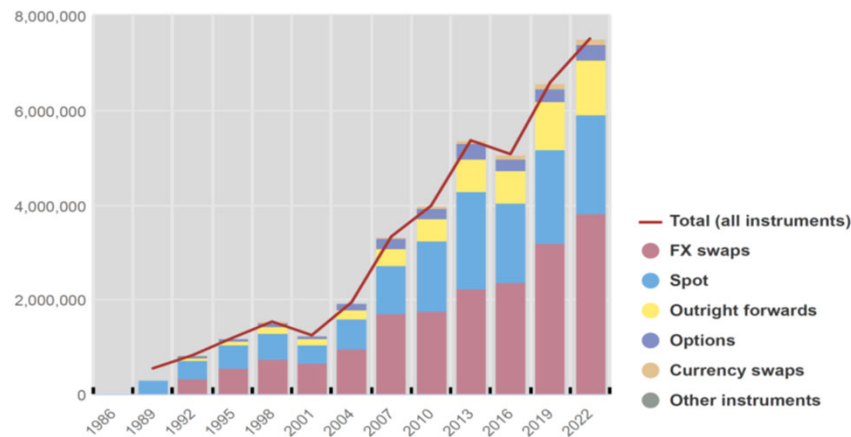
It is an Over-the-counter (**OTC**) market. There is no central exchange or clearinghouse.

Bloomberg FX Quotes

Wholesale Tier: Quotes from Bloomberg.

CURRENCY	VALUE	CHANGE	NET CHANGE	TIME (EST)	2 DAY
EUR-USD	1.2222	-0.0016	-0.13%	1/19/2018	
USD-JPY	110.7700	-0.3400	-0.31%	1/19/2018	
GBP-USD	1.3858	-0.0036	-0.26%	1/19/2018	
AUD-USD	0.7995	-0.0006	-0.07%	1/19/2018	
USD-CAD	1.2493	0.0075	+0.60%	1/19/2018	
USD-CHF	0.9628	0.0039	+0.41%	1/19/2018	
EUR-JPY	135.4500	-0.5300	-0.39%	1/19/2018	
EUR-GBP	0.8818	0.0010	+0.12%	1/19/2018	
USD-HKD	7.8171	0.0001	+0.00%	1/19/2018	
EUR-CHF	1.1777	0.0043	+0.36%	1/19/2018	
USD-KRW	1,065.9000	-4.5600	-0.43%	1/19/2018	

• **FX Market**: Geographically Dispersed ⇒ Always Open

• **FX Market**: Huge daily turnover: **USD 7.5 T** ⇒ Largest Financial Mkt

USD 7.5 trillion = 40 times daily volume of international CA flows.
                 = 85 times the U.S. daily GDP.
                 = 40% of total official foreign exchange reserves.
                 = 50 times daily volume on NYSE.

• **Characteristics of the FX market** (continuation)

- Geographically dispersed, but volume concentrated in a few markets: Tokyo (4% of volume), HK (7%), Singapore (**9%**), Zurich (5%), **London** (largest market, **38%**), **NY** (**19%**).

- Open 24 hours a day, 365 days a year.

- Organization:
    ◊ OTC market, where brokers and dealers negotiate directly.
    ◊ Typical transaction in USD: About 1 million ("one dollar").
    ◊ Typical minimum trading size is 100K units (a standard "lot").

- Currencies are noted by a three-letter code, the ISO 4217: USD, EUR, JPY, GBP, CHF, AUD, CAD, SEK, HKD, MXN.

- USD, EUR, and JPY are the major currencies.

- USD involved in **88%** of transactions (EUR **31%**, JPY **17%**).

- USD/EUR most traded currency pair (**23%** of turnover).

• Characteristics of the FX market (continuation)
- Very small *bid-ask* spreads for actively traded pairs, usually no more than 3 *pips* –i.e., 0.0003.

Example: A bid/ask quote of USD/EUR: 1.2397/1.2398 (spread: one *pip* or 0.008%). See screenshot from electronic trading platform EBS below:

• **Characteristics of the FX market** (continuation)

Example: A bid/ask quote of USD/GBP: 1.8218/1.8221 (spread: three *pips*). As a percentage (relative to the ask quote):
$$\text{bid-ask spread (\%)} = .0003/1.8221 = \mathbf{0.0165\%}$$

Compare this spread to the retail one (see below, from Edinburg, U.K.):
$$\text{bid-ask spread (\%)} = .143/1.396 = \mathbf{10.24\%}$$

• **Players**: Big Corporations, Speculators, Banks, Central Banks
  ⇒ Financial institutions are involved in **93%** of transactions:
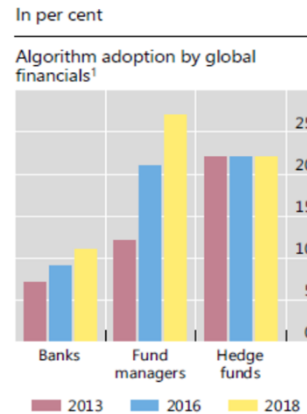 **42%** Reporting dealers ("interbank")
  51% Other financial institutions (hedge funds 8%)

- A large bank trades billions of dollars daily. Largest dealer bank (2016): Citi (12.9%). The top 5 include JP Morgan (8.8%), Deutsche Bank (7.9%), UBS (8.8%), BOFA/ML (6.4%).

- The interbank market gets the majority of commercial turnover.
- Banks trade on behalf of customers and for themselves.
- HFT (high frequency trading) accounts for 35% of volume (and growing over time).

In per cent

Algorithm adoption by global financials[1]

	Banks	Fund managers	Hedge funds
2013			
2016			
2018			

• **Dealers**:

— *Market-makers*	(Hold inventories to provide liquidity. Give a two-way quote: *bid* and *ask*)
— *Traders*	(Buy and sell on their own accounts)
— *Brokers*	(Finds the best price for another player)

Until recently, FX brokers did large amounts of business for small fees.
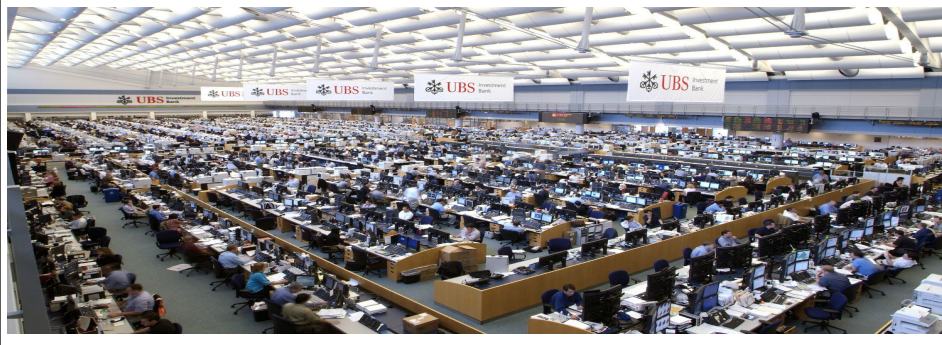
• **Electronic Trading (from the early 2000s):**

Today, much of the trading has moved to electronic platforms like EBS (Electronic Broking System), Reuters Dealing 3000 Matching (D2), and Bloomberg Tradebook.

The major trading banks (Barclays, UBS) have their own electronic platforms (*single-bank trading systems*).

There are also *multi-bank trading platforms* (FXall, Currenex, Hotspot).

Big market with a lot of competition.

• **Typical Trading Day (from the early 90s):**

For a DEM trader (DEM: German Mark):
  Executed about **270 transactions** a day (one every 67″).
  Average daily volume traded **USD 1.2 billion**.
  For large transactions brokers were used.
  Median spread: **DEM .0003** (.02% of the spot rate).

• Speculation and Trading

A market participant that holds an open FX position at the end of the day is classified as a *speculator*.

An FX trader will attempt to be *square* or *flat* by the end of the day. That is, a trader is square when she has no exposure (or risk) on the FX market.

Terminology: Squaring up is when you have an open position and you are going to close. So if you have sold a currency, you are 'squaring up' when you are buying the currency and 'going flat' when you have bought a currency and you are now selling it.

• **Segments of the FX Mkt**

1. The Spot Market

The spot market is the FX market for payment and delivery today. In practice, "today" means today only in the retailer tier. Usually, it means 2 business days.

The Spot Market represents **28%** of total daily turnover.

Example: Bank of America (BOFA) buys **GBP 1M** in the spot market at S_t **= 1.28 USD/GBP**.

In 2 business days, BOFA will receive a GBP 1M deposit and will transfer to the counterparty a USD 1.28M deposit. ¶

• Settlement of FX transactions
At the wholesale tier, no real money changes hands:
⇒ Electronic transactions. Banks involved transfer bank deposits.

Example:
– Parties: Argentine Bank: Banco de Galicia (GGAL)
             Malayan Bank: Malayan Banking Berhard (MBB)

– Transaction: GGAL sells BRL (Brazilian real) to MBB for JPY.

– Settlement: A transfer of two bank deposits:
        (1) GGAL turns over to MBB a **BRL deposit** at a bank in Brazil,
        (2) MBB turns over to GGAL a **JPY deposit** at a bank in Japan. ¶

2. The Forward Market

A forward transaction is generally the same as a spot transaction:
        ⇒ but settlement is *deferred* much further into the future.

"Further into the future" = Maturity = T: 7-day, 15-day, 1-, 2-, 3- and 12-month settlements (& up to 10 years).

Notation:
$F_{t,T}$: Today's (time t) forward price of a forward contract with maturity T.

Characteristics:
        - Transactions are tailor-made.
        - Contracts allow firms and investors to transfer risk.
        - Forward transactions are classified into two classes:
            - *Outright*
            - *FX swap*

Outright & *FX swap*
◊ The (outright) Forward Market represents **15%** of total daily turnover.
⇒ Outright forward transaction: *Uncovered* speculative position in a currency.
    - **40%** of outright forwards have duration of **less than 7 days**.

◊ The FX Swap combines a forward transaction with a spot transaction.

Example: Outright forward.
BOFA *sells* **GBP 1M forward** using a 7-day GBP forward contract at $F_{t,7-day}$ = **1.2855 USD/GBP**.

In 7 days, BOFA will receive a **USD 1,285,500** deposit and will transfer to the counterparty a **GBP 1M** deposit. ¶

Terminology: FX premium
• A FC is a *premium* (*discount*) currency if its forward rate is higher (lower) than the spot rate.
    $F_{t,T} > S_t$ for a premium currency.
    $F_{t,T} < S_t$ for a discount currency.

Example: From previous examples
S_t = **1.28 USD/GBP**
$F_{t,7-day}$ = **1.2855 USD/GBP**
$F_{t,7-day} > S_t$ ⇒ *"GBP trades at a premium in the forward market."* ¶

Premium & discount are expressed as an annualized percentage deviation from S_t.

The forward premium, p, is calculated as follows:
$$p = \frac{F_{t,T} - S_t}{S_t} * \frac{360}{T}$$

<u>Note</u>: p could be a premium (if $p > 0$), or a discount (if $p < 0$).

The forward premium, p, is calculated as follows:

$$p = \frac{F_{t,T} - S_t}{S_t} * \frac{360}{T}$$

Example: The 7-day USD/GBP forward premium is:

$$p = \frac{1.2855 - 1.28}{1.28} * \frac{360}{7} = .22098 \ (\text{or } 22.10\%.)$$

The GBP is trading at an annualized **22.10%** premium for delivery in 7 days. ¶

Remark: Think of p as the annualized return of:
- Selling forward the FC for T days
- Buying the FC spot today.

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3. The FX Swap

FX swap involves 2 transactions:
- A spot & a forward with opposite signs (a sale & a purchase).
- With approximately an equal amount of FC.
- Executed together (*simultaneous*).

FX swap: Simultaneous sale (or purchase) of spot foreign exchange against a forward purchase (or sale) of approximately an equal amount of the foreign currency.

Rationale of an FX Swap: A position taken to reduce the exposure in a forward trade.

— The FX Swap Market represents **51%** of total daily turnover.

— The majority of FX Swaps (≈70%) are **short-term** (**≥ 7 days**).

Example: A U.S. trader wants to invest in a **GBP 1M** bond position for a 7-day period.

Simultaneously, the U.S. trader
        (1) Buys **GBP 1M** spot at S_t = **1.28 USD/GBP**
        (2) *Buys* the short-term **GBP 1M** bond position, and
        (3) *Sells* **GBP 1M** forward at $F_{t,7-day}$ = **1.2855 USD/GBP**.

Selling **GBP 1M** forward protects ("covers") against an appreciation of the USD.

Return of FX Swap = (**1.2855** – **1.28**)/**1.28** = **0.004296** (≈ **0.43%** in 7 days)
        ⇒ Annualized ≈ **0.004196** * 360/7 = **0.2210** (= p). ¶

The FX swap market is the segment of the FX market with the highest daily volume.

Q: How is the daily volume distributed among the segments?
This USD 7.5 trillion in global FX market turnover is broken down as:

        - USD 2.10 trillion in spot transactions (**28%**)
        - USD 1.16 trillion in outright forwards (**15%**)
        - USD 3.81 trillion in FX swaps (**51%**)
        - USD 428 billion estimated gaps in options, currency swaps, etc

Foreign exchange market turnover by instrument[1]

Net-net basis, daily averages in April   Graph 1
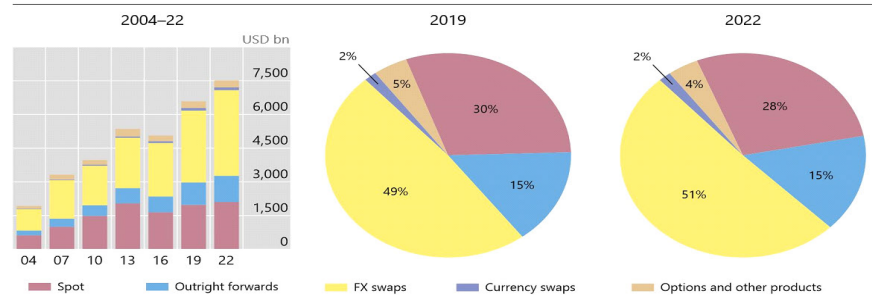
[1] Adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis.

Source: BIS Triennial Central Bank Survey. For additional data by instrument, see Table 1.

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