Currency Exchange Rates

Abstract

Keywords
Keyword1 — Keyword2 — Keyword3

Contents

12a	Calculate and interpret price, income and cross-price elasticities of demand and describe factors that affect each measure
12b	Compare substitution and income effects
12c	Distinguish between normal goods and inferior goods
12d	Describe the phenomenon of diminishing marginal returns
12e	Determine and interpret breakeven and shutdown points of production
12f	Describe how economies of scale and diseconomies of scale affect costs

1. Foreign Exchange Market

Three-Letter Currency Code

Individual currencies are often referred by a standardized 3 letter codes that the market agreed upon though the International Organization for Standardization (ISO).

Three-Letter Currency Code	Currency
USD	US dollar
EUR	Euro
JPY	Japanese yen
GBP	British pound
CHF	Swiss franc
CAD	Canadian dollar
AUD	Australian dollar
NZD	New Zealand dollar
ZAR	South African rand
SEK	Swedish krona
NOK	Norwegian krone
BRL	Brazilian real
SGD	Singapore dollar
MXN	Mexican peso
CNY	Chinese yuan
HKD	Hong Kong dollar
INR	Indian rupee
KRW	South Korean won
RUB	Russian ruble

Figure 1. Standard Currency Codes

Terminology
Individual currency

Exchange rate

Price currency

Base currency

Appreciation

Depreciation

Nominal exchange rates

Real exchange rates

Spot transactions

Future contracts (futures)

FX options

Forward contracts (forwards)

FX swaps

Direct exchange rate

Indirect exchange rate

Ask price/Bid price/Spread

pips

Forward premium/Forward discount

Forward points/swap points

Foreign risk hedging

1.1 Nominal and Real exchange rates
Nominal exchange rates are expressed by just considering the plain exchange rate for one currency for another. Real exchange rates, however, are economical constructs which incorporate the relative purchasing power of one unit compared to another. In practice, the difference between nominal and real exchange rates appeals to this question: *Why would you pay more domestically for a widget if you could import an identical widget from overseas at a cheaper price?*

This is the basic concept between **purchasing power parity** (PPP) which describes the long term equilibrium of nominal exchange rates such that identical baskets of goods will have the same price in different markets. However, that does not happen because there are a lot of frictions: goods and services are not identical between countries, many goods are not trade internationally, there are trade barriers from import taxes to shipping costs and transaction costs (transaction fees). Therefore, the market exchange rate differs from the PPP exchange rate.

1.1.1 Law of one price
The law of one price states that if transaction costs and trade barriers are absent, then the price of one good should be the same in every location.

Why does that affect exchange rates? Because if this holds true, exchange rates can be inferred from price level differences. If a computer costs 500 US in NY and 2000 HK dollars in HK, then the exchange rate should be 4 HK dollars for 1 dollar.

A simple example of PPP comparison between countries is the *Big Mac* index produced by the *Economist*. The Big Mac index shows how hamburger prices can vary internationally . The same way PPP differences show changes in exchange rates, changes in real exchange rates provide meaningful information about changes in relative purchasing power among countries.

The real purchasing power depends on the exchange rates (whether the spot exchange rate for the foreign currency appreciated or depreciated) or if the foreign price level appreciated or depreciated.

1.1.2 Real exchange rate
The main difference between the nominal and real exchange rates is that the real exchange rate represents the relative price levels in the domestic and foreign countries.

$$Real = S_{d/f} \frac{P_f}{P_d} \tag{1}$$

where $S_{d/f}$ is the spot exchange rate, P_f is the foreign price level and P_d is the domestic price level.

Considering the example of the GBP/EUR real exchange rate, considering GBP the price currency and EUR the base currency:

$$Rate_{\frac{GBP}{EUR}} = S_{\frac{GBP}{EUR}} \frac{CPI_{EU}}{CPI_{UK}} \qquad (2)$$

1.2 Market Functions

FX markets facilitate international trade in goods and services where companies and individuals need to make transactions in foreign currencies. It allows the mobility of capital with minimum delay, risk and costs for multiple purposes and serving very distinct clienteles.

Spot transactions involve the immediate change of currencies with immediate delivery. For most currencies it is the "T+2" delivery, meaning that the exchange of currencies is settled within 2 business days after the trade is agreed. This is the exchange rate quoted in financial press or news.

Forward contracts are contracts to deliver foreign exchange at a future data at an exchange rate agreed upon today. Forward contracts exist so that multinational companies avoid the risks of floating exchange rates by creating present contracts with fixed maturity and exchange rate.
Dealers usually quote the forward rates for a variety of standard forward settlements such as 1 week, 1 month, 1 quarter but traders can also arrange forward settlements at any future date at OTC markets.
The liquidity in forward markets declines with maturity and trade size.

Future contracts differ from forward contracts because they are only available on exchanges rather than OTC; they are only available for fixed contract amounts and fixed settlement dates; the exchanges demand collateral to be posted against the trade, with counter-parties asked to post further collateral if their positions generate losses. Future contracts are somewhat less flexible than forward contracts.
Currency futures contracts can be found on the International Monetary Market (IMM) of the Chicago Mercantile Exchange (CME).

FX swap exist because forward contracts eventually expire and need to be extended. This involves (1) a spot transaction to settle the expiring forward contract and (2) a new forward contract to be set at a more distant settlement date.
The combination of an offsetting spot transaction and a new forward contract is referred to as FX swap. It is necessary to understand (1) an FX swap consists of spot + forward transactions, (2) these swaps can extend (roll) an existing forward position.
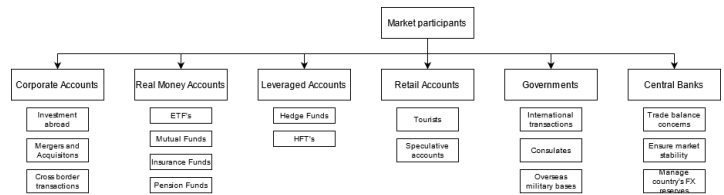
1.3 Market participants

Figure 2. Market participants (*buy side*)

Buy side
Corporate accounts corporate account of varying sizes undertake FX transactions during cross-border purchases and sales of goods and services. Many of their transactions can also be related with cross-country investment flows such as Mergers and Acquisitions, investment in foreign assets, etc

Real money accounts are managed by insurance companies, mutual funds, pension funds, exchange traded funds (ETF's), etc. They are referred as real money because of their limited use of leverage.

Leveraged accounts are the professional trading community such as hedge funds high frequency traders, etc which manages FX risk for profits.

Retail accounts are mainly divided in the typical tourist exchanging currency at an airport kiosk and speculative retail accounts which trade for profit.

Governments public entities also engage in FX trade to make transactional flows such as maintaining consulates abroad, maintain large military bases overseas, issue debt in international currencies.

Central banks intervene in FX markets in order to influence either the trend or the structure of the market. This often occurs when central banks judge their currencies too weak or too strong (trade balance concerns), when the exchange rates do not reflect the underlying economical conditions (because of speculative forces) or to provide liquidity when markets become dysfunctional hurting corporations and FX players.
Another important role of central banks is to manage their country's FX reser

Sovereign wealth funds (SWF) are government entities with investment purposes rather than public policy ones. As such, they can be treated as real money accounts. SWF's are particularly tied to countries with huge current account surplus.

Sell side
Bank Behemoths such as the Deutsche Bank, Citigroup, UBS, HSBC, among others. FX is an industry which requires huge fixed-cost investment in electronic and communications technologies in order to connect the markets in real time across the world. As a result, only the largest banks are able to compete successfully in the broad range of FX products. The banks are know as *tier 1 banks*.

Second and third tier banks are regional or local banks with well developed business relationships but lacking economies of scale and capital to compete in FX markets. So these banks outsource FX services to larger tier 1 banks.

1.4 Market Size and Composition
FX Turnover by Instrument

Exhibit 3	FX Turnover by Instrument
Spot	33%
Outright forwards	14
Swaps[a]	49

Figure 3

Exhibit 3	(Continued)
FX options	5
Total	100%

[a] Includes both FX and currency swaps.

Figure 4

Flows by market player

Exhibit 4	FX Flows by Counterparty
Interbank	42%
Financial clients	51
Non-financial clients	8

Figure 5

Flows by currency pair

Exhibit 5	FX Turnover by Currency Pair
Currency Pair	% of Market
USD/EUR	23.1%
JPY/USD	17.8%
USD/GBP	9.3%
USD/AUD	5.2%
CAD/USD	4.3%

Figure 6

The largest portion of the global FX trading occurs in London, followed by New York. and Tokyo.

2. Currency Exchange Rate Calculations

2.1 Exchange Rate Quotations
The **direct currency quotation** takes the domestic country as the price currency and the foreign country as the base currency. In the quoting convention, A/B represents the number of units of A which correspond to one unit of currency B.

The **indirect quote** has the domestic currency as the base currency. A/B represents the units of B which correspond to one unit of A.

The indirect and direct quotations are the inverse of each other.

2.2 6 letter quoting convention
The 6 letter quoting convention says that there is a code for the exchange pairs which mentions the base currency first and then the price currency, in the opposite order of the actual ratio. So, the code of "Sterling-yen" is GBPJPY and the actual ratio is JPY/GBP.

FX Rate Quote Convention	Name Convention	Actual Ratio (Price currency/Base currency)
EURJPY	Euro–yen	JPY/EUR
EURGBP	Euro–sterling	GBP/EUR
EURCHF	Euro–Swiss	CHF/EUR
GBPJPY	Sterling–yen	JPY/GBP
EURCAD	Euro–Canada	CAD/EUR
CADJPY	Canada–yen	JPY/CAD

Figure 7. Example of the 6 letter quotation and actual ratio

Another aspect involving the quoting system in FX markets is that price is *two sided*. That means when a client asks a bank for an exchange rate quote, the bank will provide a *bid* (the price at which the bank is willing to buy) and the *offer* (the price the bank is willing to sell). The difference between the ask and offer price is called *spread*.

2.3 Cross-Rate Calculations
The cross-rate calculations involves an exchange between two currencies involving a third currency as common denominator. As an example, the cross-rate betwen CAD/EUR is given by two exchange rates: USD/EUR and (CAD/USD).

$$\frac{CAD}{USD}\frac{USD}{EUR} = \frac{CAD}{EUR} \tag{3}$$

Cross-rate exchanges allows for triangular arbitrage. However, both human traders and automatic trading algorithms are constantly on alert for these pricing inefficiencies so they never occur.

2.4 Forward calculations
The forward exchange rates are expressed in terms of **pips** (*percentage in points*). The points measure the difference between the forward exchange rate quote and the spot exchange rate quote. When the forward rate is higher than the spot trade, the base currency is said to be trading at a *forward premium*.

Conversely, if the forward rate is less than the spot rate, the base currency is said to be trading at *forward discount*.
The *forward points* (or swap points) express the difference between the spot exchange rate and the forward rate at different maturities. It's also called swap points because FX swaps involves spot and forward transactions.

Maturity	Spot Rate or Forward Points
Spot	1.15885
One week	+5.6
One month	+27.1
Three months	+80.9
Six months	+175.6
Twelve months	+364.7

Figure 8. Forward points and spot exchange rate

2.4.1 Relationship between spot rates, forward rates and interest rates

The absolute number of points generally increases with maturity. This is because the number of points is proportional to the yield differential between two countries, scaled by the term in maturity.

Forward rates essentially express an arbitrage relationship between two alternative but equivalent investments - either hold currency A and invest at interest i_A or hold currency B and invest at interest i_B. So one alternative is to invest for one period at the domestic risk-free rate (i_d); at the end of the period one has $(1 + i_d)$.

An alternative investment is to convert the unit of domestic currency to foreign currency using the spot rate $S_{f/d}$. This foreign currency can be invested at the foreign risk-free rate of i_f; at the end of the period the investor has $(1 + i_f)$. These funds need to be converted to the domestic currency at the end of the period. If the exchange rate was pre contracted at the start of the period using a forward rate with maturity of one period, it would eliminate the foreign exchange risk.

Therefore, because we have two alternative investments - both risk-free because both are invested at the risk-free interest rates and because foreign exchange risk was eliminated (hedged) through forward contracts, they must yield the same return.
This equality can be expressed as:

$$(1 + i_d) = S_{f/d}(1 + i_f)(\frac{1}{F_{f/d}}) \tag{4}$$

This is the arbitrary condition between two alternative investments (different interest rates) but with equal risk (riskless) and hence, similar returns. The difference between the spot and forward rates is:

$$F_{f/d} = S_{f/d}(\frac{1 + i_f}{1 + i_d}) \tag{5}$$

As result, the currency with higher interest rate will always trade at discount and the currency with lower interest rate will always trade at a premium in the forward market.

3. Exchange Rate Regimes

The exchange rate regime is the policy framework adopted by central banks when it comes to exchange rates.

3.1 The Ideal Currency Regime

The ideal currency regime has 3 properties: (i) *the exchange rates between currencies would be fixed*, eliminating foreign currency denominated investment risks, (ii) *all currencies would be fully convertible* (currencies would be freely exchanged at any amount, time and purpose) to ensure unrestricted capital flows and (iii) *countries would maintain fully monetary independent monetary policies* to pursue domestic objectives, such as growth and inflation.

3.2 Historical Perspective of Currency Regimes

3.2.1 Gold standard

Throughout most of 19th century and early 20th century until the start of WWI, both US dollar and UK pound sterling operated on the *classical gold standard*. The price of each currency was fixed in terms of gold- Gold was the *numeraire* for each currency, that is, it was the official unit of account and the official value of each currency was expressed in ounces of gold (thus indirectly it was the numeraire for all the economy). Other countries would fixed their value on the sterling or dollar and were therefore implicitly operating in the gold standard as well.

In this system, national currencies were backed by gold. The countries could only print as much money as its gold reserve warranted by the amounts dictated by the fixed parity. The system was self adjusted by the limited amount of gold and inspired confidence. The *price-specie-flow mechanism* affected gold balances trough trade imbalances: a trade surplus and consequently accumulation of gold allowed the domestic supply of money to increase (prices rose and exports fell); a trade deficit and consequently outflow of gold constrained the domestic supply of money (prices lowered and exports increased).

During the 1930's during the Great Recession the world dropped the gold standard.

3.2.2 Bretton Woods System

The Bretton Woods system was established in 1944 in the end of WWII and established a system of fixed parities for exchange rates between currencies. When parities deviated from the balancing supply and demand, there would be a realignment toward the fixed parity values of currencies, with some appreciating others depreciating.

These periodic alignments were part of the standard monetary policies. However, because these periodic alignments spurred opportunities for speculators, large speculative profit opportunities would appear when realignments were imminent. These traders could force monetary policy authorities with their actions to distort the data.

3.2.3 Smithsonian Agreements

The Smithsonian Agreeements marked the drop of the Bretton Woods System in favor of a flexible exchange rate system. It was predicted that flexible exchange rates would remove the volatility caused by poor domestic monetary policy and trade barriers in fixed systems as the flexible rates would adjust accordingly to the relative performance of countries and currencies.

However, there was an unpredictable high volatility which was the manifestation of a highly liquid forward market. This forward market mattered much more in setting the spot exchange rate.

3.2.4 European Exchange Rate Mechanism (ERM)

The ERM was established in 1979 as a system for European currencies to fluctuate within a narrow band called *the snake*. The ERM lasted only about 3 years as speculative attacks and the differential between yields in different currencies disrupted markets.

3.2.5 European Currency

In 1999, it was created a common currency for most of western european countries called the Euro. Each country lost the ability to engange in independent monetary policy but it facilitated efficient allocation of capital and enhanced market competition among other consequences.

3.3 Taxonomy of Currency Regimes

While there are no real clearly distinguished exchange regimes framework, there are a few classifications described in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions 2014.

The categories are:

- Dollarized (No separate legal tender)

- Monetary Union

- Currency Board

- Fixed Parity

- Target Zone

- Crawling Peg

- Crawling Band

- Managed Float

- Independent Float

3.3.1 No separate legal tender

There are considered two types of no separate legal tender: (i) the dollarization and (ii) monetary unions.

The first, a country adopts a currency as its official unit of account and legal tender. That is, there is a full or partial currency substitution. A partial substitution or *de facto* currency substitution is an unofficial currency substitution which

occurs when residents of a country choose to hold a significant wealth of their financial assets in foreign currency, even though the foreign currency is not legal tender.

A full substitution occurs when a country adopts a foreign currency as its sole legal tender and ceases to issue the domestic currency. This type of substitution is called *de jure* currency substitution. The full substitution is also called *dollarization* because of the importance of the dollar in international trades, however some countries choose to adopt other currencies such as the Euro, Swiss franc, etc.

The European Economic and Monetary Union (EMU) is the most prominent example of the second type of example. Each member uses the Euro as common currency.

With this type of arrangements, countries lose their ability to conduct its own monetary policy. However, it can facilitate growth and international trade and capital flows because it enhances transparency and financial stability.

3.3.2 Currency Board System

The Currency Board System (CBS) is defined as ”*a monetary regime based on an explicit legislative commitment to exchange domestic currency for a specified foreign currency at a fixed exchange rate, combined with restrictions on the issuing authority to ensure fulfillment of its legal obligation. This implies that domestic currency will be issued only against foreign exchange and it remains fully backed by foreign assets*”.

Hong Kong SAR is an example of a currency board. They held US dollar reserves to cover at a fixed parity its entire monetary base of HKD. As result, Hong Kong Monetary Authority (HKMA) does not function as a traditional central bank because they are obliged to maintain 100% foreign currency reserves against the monetary base, which limits its lending abilities - it can only lend HKD against a foreign currency collateral.

A CBS works like the classical gold standard with expansion and contraction of domestic currency based on the trade and capital flows. A trade surplus leads to an increase in USD reserves which expands the HKD monetary base at fixed parity while a trade deficit declines the USD reserves and monetary base.

Seigniorage derives from the french ”*right of the lord to mint money*”. In medieval ages, it was the difference between the cost of producing and distributing money and the creation of money. The first example of seigniorage was the production of silver and gold coins, for which it was worth its weight in silver but it was composed by 95-92% silver and the rest of a base metal - this difference between the monetary value of a coin (1 ounce of silver) and its real value (0.95 ounce of silver) was the seigniorage.

In a CBS the monetary authority trades a HKD for USD, selling its monetary base in exchange for foreign assets. In turn, it invests the foreign assets at market rate gaining an interest. When it was to trade USD for HSK it has pocket the interest rate as USD.

3.3.3 Fixed Parity

A fixed parity differs from CBS because: (a) there is no legislative commitment to maintain a specific parity, (b) the target level of foreign exchange rates is discretionary (can change targets). That means (a) that market participants never know if the country may choose to abandon the parity rather than make adjustments and (b) the level of parity is hardly predictable.

3.3.4 Target Zone

A target zone is a regime of fixed parity where the intervention bands are wider to somewhat -+2% around the parity level.

3.3.5 Active and passive crawling pegs

Crawling pegs for exchange rate occurs by having the domestic currency pegged to one foreign currency where it is allowed to fluctuate within a band of rates. The par value of the currency is adjusted depending on the volatility of exchange rates.

Passive crawling pegs were used in Brazil in periods of high inflation to prevent the devaluation of Brazilian currency. The exchange rates were adjusted frequently (weekly or daily).

Active crawling pegs were used in Argentina were the exchange rate was pre announced before taking place (weeks before) to manipulate market expectations and thus price level.

3.3.6 Fixed Parity with Crawling Bands

A system which starts with a fixed central parity with crawling bands. Initially the country fixes its rates to a foreign currency to anchor expectations about future inflation but there gradually allows for widening bands. This allows more flexibility and a gradul exit strategy from fixed parity.

3.3.7 Managed Float

Managed float is when countries follow specific exchange rate policies in order to achieve internal or external targets - intervening to achieve trade balance, price stability or employment objectives. Such policy is also called *dirty floating* because independent governments pursue egoistic goals which potentially affects the worlds market stability and its trading partners. An example of it was the consistent depreciation of german and japanese currencies in the 1970/1980's in order to export more.

3.3.8 Independently Floating Rates

In this scenario, the exchange rate is left to market determination.

4. Exchange rates, International Trade and Capital Flows

- Trade deficit implies an offsetting capital account surplus

- Trade surplus implies an offsetting capital account deficit

That is, the effect of exchange rates on the trade balance (current account) must be followed by a reverse impact on capital flows.

4.1 Marshall-Lerner condition

The elasticity analysis of the effect of devaluation (fixed regimes) or depreciation (flexible regimes) in the trade balance is called the *Marshal-Lerner condition*.

The idea behind the Marshall-Lerner condition is that demand for imports and exports should be sufficiently price sensitive so that the increase in relative price of imports increase the difference between exports and import expenditure.

The generalized equation is:

$$W_i \varepsilon_i + W_e(\varepsilon_e - 1) > 0 \qquad (6)$$

where W_i and W_e are the percentage share of imports and exports, respectively, in total trade and ε_i and ε_e are the price elasticity of imports and exports respectively.

Note that $(W_i + W_e) = 1$, the condition that the total trade is comprised by the import and export factors and $W_e > W_i$, which means there is a trade deficit.

The condition is satisfied if the absolute sum of a country's export and import demand elasticities is greater than 1. If that is true, then the trade balance will improve as the overall effect on the trade balance is price responsive: $\varepsilon_i > 1$ means that demand is elastic, so if the cost of imports increases, the amount of imports decreases; $\varepsilon_e > 1$ means that if the price of exports decreases, demand for them will increase.

4.1.1 Further considerations

The elasticity of demand depends on at least 4 factors: (i) the existence of close substitutes, (ii) the structure of the market for the product, (iii) the share in peoples budgets, (iv) the nature of the product and its role in the economy.

That being said, the trade balance adjustments are more effective if the country imports (i) goods for which there are close substitutes, (ii) goods that trade in competitive markets, (iii) luxury goods rather than necessary goods and (iv) goods that represent a large portion of consumer expenditure or large input costs for producers.

4.1.2 J-Curve

When the Marshall-Lerner conditions are satisfied and the devaluation/depreciation happens, it will make the trade balance worse before making it better. This effect is called **J-Curve effect**.
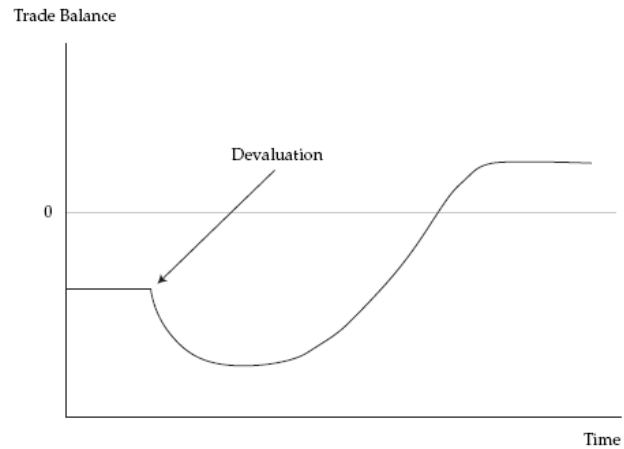

Figure 9. J-Curve effect

The J-Curve effect is due to the order-delivery lag in the very short run. When orders or contracts in foreign denominated assets take place before the devaluation, when the payment is due the cost has suddenly increased in terms of the domestic currency because the foreign currency appreciated. However, in the medium run producers and consumers start to cut off or consume less foreign products because they are more expensive.

J-Curve pattern may also arise if the short-term and long-term elasticities do not match, meaning that the consumption patterns often take time to fully adapt to the new price level.

4.2 Absorption Approach

The macroeconomic approach states that the trade balance is equal to the country's savings plus government surplus or deficit minus investment. Thus, in order to shift the trade balance towards surplus, the devaluation/depreciation of the domestic currency must decrease expenditure or increase savings.

If there is excess capacity in the economy, by switching demand towards domestic markets, the depreciation of the currency can increase output and income. If the economy is at full capacity (full employment), then the trade balance will put upward pressure on domestic products, leading to a general increase in prices to match its original level relative to imports.

The currency depreciation reduces overall consumer expenditure. Why? The devaluation of a currency reduces the purchasing power of domestic currency and thus it makes households less likely to afford imports. Households respond to a decrease in wealth by reducing expenditure and increasing saving in order to rebuild their wealth- *wealth effect*.

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