Foreign Exchange Swaps and Cross-Currency Swaps

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1 Introduction

A foreign exchange (FX) swap is a derivative contract between two parties which agree to exchange two currencies at a specific exchange rate, and then reverse this exchange at maturity, at a pre-agreed forward rate. As with most derivative contracts, FX swaps as a hedging and funding instrument render the market environment more complete and financial markets benefit from a more efficient allocation of resources and risk management.

In the first part of this chapter, we explain the FX swap contract and its pricing, emphasizing the importance of the valuation adjustment (XVA) approach. Then, we map the FX swap market in terms of currencies, parties, maturities, and how trading volumes evolve across time. The second part is devoted to the institutional framework of the FX swap market, specifically its over-the-counter (OTC) characteristics, recent trends in terms of technology, and policy actions. We conclude this chapter by pointing to future research directions to better understand the asset pricing and market functioning of FX swaps.

1.1 Definition and Usages of Foreign Exchange Swaps

An FX swap is an agreement for two reciprocal transfers of funds in two different currencies such that the transfer at maturity cancels out the initial exchange, which is usually conducted at spot.\textsuperscript{1} One party borrows one currency and simultaneously lends another with the same counterparty. The notional amounts in each currency are exchanged at the beginning and the end of the life of the swap. The exchanged notional amounts at the beginning act as collateral. The difference of the repayment obligation is fixed on the day of writing of the contract at the FX forward rate. At the time the contract is agreed, all transfers of funds are known. An FX swap can be seen as a low-risk, collateralized borrowing or lending facility for a foreign currency. It also can be viewed as combining a spot and a forward FX transaction into one instrument.

\textsuperscript{1}“Spot” is an FX naming convention referring to the fact that whereas the transaction terms (and economic substance) of a spot trade are instantaneous, delivery of the currency occurs two days later, a time frame referred to as spot.
Let’s take the example illustrated in Figure 1: bank A, in the Euro area, has x Euros in its books and needs USD for one year. We assume x equals 10 million Euros. On the spot market ($S_0$), bank A can buy 1.18979 USD for 1 Euro. At the same time, the ask one-year forward rate ($F_1$) is 1.2032 USD for Euro. The US-based bank B agrees to be the counterparty. Today at $t_0$, Bank A sends $x$ to bank B, corresponding to 10’000’000 Euros in the example. Bank B sends $x \times S_0$ USD to bank A, corresponding to 11’897’900 USD. One year later at maturity, bank B sends x Euros to bank A, 10’000’000 Euros, and bank A sends $F_1 \times x$, 12’032’000 USD in the example, to bank B.

Figure 1: Payments of a EUR/USD FX swap

A cross-currency swap resembles an FX swap but with two main differences. First, both parties of the cross-currency swap periodically exchange interest payments throughout the life of the contract. Second, the final rate at which the last payment is exchanged is the same FX spot rate as at the start of the contract. So a cross-currency swap is an agreement for two reciprocal transfers of funds at initiation and maturity, plus the recurring exchanges of floating rates during the life of the contract. The notional amounts in each currency are usually exchanged at the beginning and the end of the life of the swap. The repayment obligations of both parties and margins act as collateral. The rate of exchange of the floating payments during the contract term is specified when writing the contract. The specified rate is usually based on interbank offered rates, most prominently the Libor.² For example, the

²The Libor (London Inter-bank Offered Rate) is an average of estimates provided by the leading banks
USD Libor could be exchanged against the EUR Libor for floating payments throughout the life of the contract. At the moment of writing, the swap market faces enormous challenges as Libor rates will cease to be published at the end of 2021. Most likely, the Libor transition will have its most pronounced effects on the five Libor currencies: US dollar, pound sterling, Euro, Japanese yen and Swiss franc. While the way forward is not entirely clear at the moment, regulators, central banks, and industry actors are working on best-practice guidelines and calling for market participants to switch to alternative reference rates. It seems that no single rate will replace Libor, but rather that Libor rates across jurisdictions will be replaced with national or jurisdictional risk-free rates. For example in case of the USD, the US Commodity Futures Trading Commission called for interdealer brokers to replace trading of Libor cross-currency swaps with SOFR starting in September 2021, the so-called “SOFR first initiative” (CFTC, 2021). The ECB made a similar announcement in June 2021; the most-used European risk free rate is the ESTR (Euro short-term rate) (ECB, 2021). The UK is transitioning to the risk free rate SONIA (sterling overnight index average) and Switzerland to SARON (Swiss average rate overnight).

Let’s take a close look at a cross-currency swap as illustrated in Figure 2: bank C, in Switzerland, has x Swiss francs in its books and needs Euros for three years. We assume x equals 10 million CHF. On the spot market, bank C can buy 1.1068 CHF for 1 EUR (S₀). The German bank D agrees to be the counterparty. Banks C and D also exchange SARON + 0.3% against EONIA on a yearly basis. At the moment the swap goes live (t₀), bank C sends x = 10 million CHF to bank D. Bank D sends x/S₀ = 11’068’000 EUR to bank

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for which interest rate they would be willing to borrow and lend from and to other banks. It is a non-traded interest rate.

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A survey conducted by Duff and Phelps (2021) shows that half of the firms surveyed do not have a transition plan in place in early 2021. However, concrete changes are taking place. For instance, interdealer trading conventions for cross-currency swaps between USD, JPY, GBP and CHF LIBOR have moved to each currency’s risk-free rate (i.e., “RFR First”) as of September 21, 2021, and the share of transaction references in RFR has increased sharply starting in the summer of 2021.

SOFR stands for Secured Overnight Financing Rate. It is a secured interbank overnight interest rate and uses actual transaction costs of the overnight US repo market.

SARON (Swiss Average Rate Overnight) represents the overnight interest rate of the secured funding market for the Swiss franc (CHF).
C. After one year \((t_1)\), bank C sends \((\text{SARON} + 0.3\%) \times 10\text{ mio. CHF}\) to bank D and D sends EONIA\(\times x/S_1\) to C. The same payment is repeated in year two. After three years, the contract has matured, and the banks exchange the final interest payments due, as well as the notional amounts at the same FX spot rate as at the start of the contract \((S_0)\). That is, bank C sends \((\text{SARON} + 0.3\%) \times 10\text{ mio. CHF}\) to D and D sends EONIA\(\times x/S_3\) to C. Bank C also sends \(x/S_0\) EUR to bank D and bank D sends 10 million CHF to Bank C.

Figure 2: Payments of an EUR/USD cross-currency swap

Two further aspects distinguish the FX swap and cross-currency contracts from each other. First, the former is a pure FX instrument referencing only the spot and the forward rate and is quoted in forward points (or swap points). By no-arbitrage conditions, the forward premium (discount) remains closely tied to the differential of key interest rates in the two currencies establishing an indirect link to money market rates. By contrast, cross-currency swaps pricing is directly determined by the interest rates referenced in the contract. This renders the cross-currency swap similar to a an interest rate swap, but with one collateral leg in a different currency, hence actually requiring an exchange of collateral at the prevailing spot rate. Second, these two contracts are used differently. For instance, FX swaps are predominantly used by banks for managing (short-term) funding liquidity across currencies or for hedging FX risk on a rolling basis. By contrast, cross-currency swaps are by design term instruments, used to implement long-term hedges and are particularly suitable for hedging
corporate bond issuances. Although the topics discussed below also apply to cross-currency swaps, for the sake of simplicity we will focus on FX swaps from here onwards.

In addition to making the market more complete, the utility of FX swaps is multi-faceted and depends on the initial situation of the two parties. In the following, we focus on three issues. First, international agents can achieve a comparative advantage by entering into an FX swap contract. Second, FX swaps allow firms to adjust their assets and liabilities and the currency composition thereof, thus altering their balance sheet positions. Third, they allow for the hedging of foreign currency exposure and cash flows.

For the FX market, comparative advantage occurs when two parties have different borrowing costs and/or different creditworthiness. For example, a US company would like to borrow in Euro, while a European bank needs USD. Both can borrow relatively cheaply in their home currency in comparison to the respective foreign currency. A swap contract is able to facilitate the exploitation of the gains from trade and leads to a Pareto improvement. If the US company additionally provides a higher credit rating, then it might have lower costs of borrowing for both currencies in comparison to the European bank. Table (1) illustrates this example. For both parties, borrowing in USD is cheaper than in Euro, but each has a comparative advantage in borrowing in its respective home currency. Possible additional sources of comparative advantages are different tax treatments of company earnings related to the place of taxation, or regulatory requirements of FX risk exposures.

Table 1: Hypothetical interest rates as a basis for FX swaps

<table>
<thead>
<tr>
<th></th>
<th>USD</th>
<th>EUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>US company</td>
<td>3.20%</td>
<td>5.60%</td>
</tr>
<tr>
<td>European bank</td>
<td>5.00%</td>
<td>6.00%</td>
</tr>
</tbody>
</table>

The balance sheets of international firms show multi-currency assets and liabilities. They can be modified by FX swap contracts as shown in Figures (1) and (2). Imagine a multina-

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7For example, European corporate issuers of reverse yankee bonds would typically also ask the underwriting bank to provide the hedge in the form of a cross-currency swap matching the maturity of their newly issued Euro-denominated bond.
tional US company holds a USD-denominated bond with an interest rate of 2.5%. With a cross-currency swap, all incoming payments of the bond can be transformed into, for example, the corresponding payments of a Euro bond with an interest of 3%. Depending on the regulatory framework, changing the nature of a balance sheet position from a foreign into a home currency or vice versa can free up or retain capital.

FX swap contracts also allow agents to hedge currency mismatches in cash flows. In predominantly (but not exclusively) emerging markets, firms and institutions often receive a majority of cash flows denominated in a currency other than the entity’s functional currency. This foreign currency dominance can lead to a mismatch in cash flows and is a source of risk that can be hedged through swaps.

1.2 Further Swap Pricing Considerations

In introductory textbooks, FX swap pricing begins as either the difference of two bonds or as a portfolio of forward contracts. In an idealized setting, it is assumed that no “frictions” such as credit risk and funding spreads exist, and that forward exchange rates are realized. In such a frictionless environment, the Covered Interest Rate Parity (CIP) condition is satisfied; that is, borrowing in one currency to lend in another over a given period, while hedging exchange rate risk, makes no profit. The financial crisis of 2008 has proven that these assumptions no longer hold and that the CIP condition is systematically violated, as will be discussed later. Nowadays, swap pricing takes into account market frictions and other practical considerations such as funding costs and regulatory issues related to margins, credit risk, and capital costs. Banks must consider applying valuation adjustments to address theses issues, a practice termed XVA (“X-value adjustments”).

XVA can be understood as the application of an adjustment(s) to a base value, which is the theoretical market price of a perfectly collateralized FX swap in such an idealized setting. XVA adds or subtracts from this base value margins which depend on several factors, such as which side of the contract the counterparty is on, the underlying risks, and the shadow costs.

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8See Hull (2017) for a detailed discussion of classical pricing methods.
of regulation. The main types of XVA are the credit (CVA), debit (DVA), funding (FVA), margin (MVA), and capital (KVA) valuation adjustments. Since the XVA quantification is computationally intensive and depends on what kind of model and inputs are used, the XVA estimation for the same trade can significantly differ across financial firms.\(^9\)

While an in-depth discussion of XVA swap pricing is outside the scope of this chapter,\(^{10}\) we illustrate the main idea behind the XVA adjustment for counterparty risk, i.e. CVA and DVA, which are two sides of the same coin. Derivative contracts are always a zero-sum game and therefore whether a party deals with CVA or DVA depends on which side of an eventual default it is on. If the counterparty default occurs and the swap has a positive (negative) value to the company and a negative (positive) value to the counterparty, the company will be an unsecured creditor (debtor) in the outstanding amount. The adjustment is then called a CVA (DVA).

A pricing adjustment due to counterparty default is the base value of a swap minus the probability-weighted value if the counterparty defaults, plus the probability-weighted value if the adjusting company defaults. For this, it is assumed that a base value of the swap \(V_{ND}\) exists. The expected cost if the counterparty defaults (CVA) depends on the intervals the contract is active \(N\), the present value of the expected loss given default \(ELGD\) in period \(i\), and the probability of default \(p\) in period \(i\).

\[
CVA = \sum_{i=1}^{N} p_i (ELGD_i)
\]  

(1)

However, the value adjusting company itself, not just the counterparty, may (also) default. This may lead to a loss for the counterparty, but a gain to the company itself. Similar to the CVA, the DVA follows:

\[
DVA = \sum_{i=1}^{N} p_i^H (ELGD_i^H)
\]  

(2)

\(^9\)While large dealers have specific desks computing XVA exposures, it is more difficult to compute XVA for small banks that might ignore them or rely on optimization vendors.

\(^{10}\)See Green (2015) and Gregory (2015) for a comprehensive discussion of XVA.
where $p_i^H$ reflects the probability of default in period $i$ of the company itself and $ELGD_i^H$ the expected gain given default.

Taking both value adjustments into account, the value of the portfolio ($PF$) of swap contracts becomes:

$$PF = V_{ND} - CVA + DVA$$  \hspace{1cm} (3)

Depending on the ELGD, CVA and DVA can be positive or negative. This implies that the XVA adjustment can lead to a price greater or smaller than the base value. It is important to emphasize that XVAs are usually calculated for the entire portfolio. If two companies have various derivative exposures with each other, the net exposure matters while the derivative-specific position is irrelevant.

In general, the XVA approach tends to generate heterogeneity in (FX) derivative pricing given that the price resulting from its application varies according to the characteristics of the contract, counterparties, and regulatory framework (as will be discussed later). Therefore, CVA (FVA) can play a more pronounced role for long (short) term contracts such as FX cross currency swaps (FX swaps) while more tightly regulated financial firms such as global systemically important banks (G-SIBs) are more receptive to regulatory issues such as KVA.

### 1.3 Mapping the FX Swap Market

Although it is the largest financial market in the world, the global FX market, both spot and derivatives, is quite opaque and decentralized. This is one of the main reasons why the market is not easy to map accurately and at a regular frequency. BIS central bank survey is by far the most comprehensive source of global FX spot and OTC FX derivatives trading activity, although it is infrequent (triennial) and provides a snapshot of activity taking place only in the month of April\(^{11}\). As of recently, Continuous Linked Settlement (CLS) provides aggregate high-frequency data of FX prices and volumes. CLS plays an important role in

\(^{11}\)April is chosen because historically it tends to be one of the calmer months in financial markets, as it does not fall on a fiscal quarter- or year-end and is not known for historical periods of global financial turbulence. FX dealer trading volume for the month are then converted into a daily average in the published results.
reducing settlement risk and its data is representative of global FX trading as shown in Figure 3.

Figure 3: Daily FX swap volume provided by CLS and BIS

The pie charts in Figure 3 show the average daily FX swap volume by currency as provided by CLS and BIS. Three points are visible: first, for the major currencies, CLS figures match BIS data almost perfectly. Both data sets exhibit the same order as well as the same size of the shares. Second, the FX market is dominated by the USD, followed by the Euro. Almost half of all FX trades (by volume) include the USD, and almost 20% the Euro. This holds true for CLS and BIS. Third, the major difference in the data sets is that the Russian ruble (RUB), the Chinese Renminbi (CNY), and some other emerging market currencies are missing from the CLS figures because they are not part of the CLS system.
Figure 4: Daily FX swap volume settled by CLS

The time series in Figure 4 shows the smoothed daily FX swap volume settled by CLS converted in USD terms. Total daily volume increased from a level of around 800 billion USD in 2016 to levels of around 1'000 billion USD in 2020. This corresponds to around one-sixth of total daily FX volume (BIS, 2019). The yearly volume corresponds to almost 3 times global 2019 GDP. The most traded currency pair is EURUSD with around 40% of volume, followed by USDJPY with around 18%.
Figure 5 shows in l.h.s. left pie chart the total FX swap volume from 2016 - 2021 grouped by the respective trading parties. The r.h.s. pie chart shows the volume by its maturity. Only around 1% of the volume has a maturity longer than one year. Source: CLS group.

The l.h.s. pie chart in Figure 5 shows the total FX swap volume by the two trading parties involved in a swap contract. CLS data allows us to differentiate between banks, corporates, funds, and non-bank financial institutions. The main component (93%) is driven by bank-to-bank transactions. This includes clients’ order placement funneled through the bank as well as banks’ order placements. Another 6% are transactions between funds and banks. The remaining 1% are transactions between banks and non-bank financial institutions or corporates (a bank must virtually always be one of the counterparties in the CLS network).

The r.h.s. pie chart in Figure 5 shows the total FX swap volume by its maturity. Overnight swaps account for almost half of total volume and around 80% of the volume is within a one-month maturity.
Figure 6: Intraday FX swap volume

CLS data allows us to uncover two recurring temporal behaviors of the FX swap market, namely how it evolves during the day and through the quarter. First, the *intraday time series* in Figure 6 documents the hourly average intraday FX swap volume for EURUSD and USDJPY. The orange shaded area reflects London trading hours (from 7 am to 5 pm local time) and the bluish shaded area the Tokyo hours, which are eight hours ahead of London. The average USDJPY swap volume is above the EURUSD swap volume for the Tokyo hours (0 –6am) but both peak in the overlapping opening hours in London (7 – 9 am), which is part of the CLS settlement window. These patterns are consistent with the common perception that FX markets are active 24 hours a day but also that dealers significantly reduce their inventory exposures, or are unwilling to take risk, outside of the most liquid trading hours.
Figure 7 shows the FX CLS swap volume for EURUSD and USDJPY from 2016 - 2021. The x-axis represents the days before and after the IMM date, i.e. the third Wednesdays of March, June, September, and December when many FX swaps and other FX derivative contracts expire. It is calibrated in a way that day zero is the IMM day. The IMM day is represented by the blue bar. The quarter-end days are represented by the green bar. Source: CLS group.

Second, the time series in Figure 7 is centered around the International Monetary Market (IMM) dates. The IMM dates are the third Wednesday of March, June, September, and December and are therefore located closely to the quarter-end.\textsuperscript{12} The regularly occurring IMM dates are of particular importance for FX markets as many FX swaps and other FX derivative contracts expire. In the days leading up to the maturity date, FX derivatives are frequently rolled to maintain the position. Figure 7 reveals the change of CLS FX swap volumes in billion USD a month before and after the IMM date. In Figure 7, the blue-shaded bar represents the IMM day and the green shaded bar the quarter-end days. FX swap volumes show strong seasonalities: they decline on the IMM date and again around the quarter-end.

\textsuperscript{12}Due to weekends, holidays, and alternating month length, the days between IMM date and quarter-end vary.
Figure 7 highlights the seasonality for the EURUSD and USDJPY, but the pattern holds for all prominent currency pairs.

2 Institutional Framework

Here we discuss three aspects of the FX swaps market and its institutional framework: the OTC setting, recent technological changes, and the policy context.

2.1 OTC Market

The FX swap market is an over-the-counter (OTC) market in which each transaction is executed between two parties away from regulated exchanges. The ISDA Master Agreement is the standard document used to govern FX swap transactions. However, the party and counterparty bilaterally bargain and eventually agree upon a specific contract that can be customized in various aspects including price, notional amounts in either currency, and date of the near and far legs.

Given this OTC setting, the FX swap market is fragmented. Although electronification is increasingly spreading, there is no centralized exchange system relying on facilities such as an electronic limit order book facilitating a uniform price formation process. In this respect, FX spot and swap markets differ, since the interdealer segment of the former relies on some central electronic limit order book platforms such as the Electronic Broking Services (EBS), Refinitiv FX Matching or CboeFX FX ECN.

The network of FX swap trading is a two-tier market that encompasses different types of market participants, amongst which dealers have a central role. In the outer tier, dealers make the market for customers which may be banks, large multi-national corporations, hedge funds, pension funds, insurance companies, mutual funds, other institutional investors, and retail clients as well as central banks. In the dealer-to-customer segment, dealers act as market makers and liquidity providers for a global market which operates more or less around the clock (see Figure 6). It should be stressed that this dealership is concentrated on about 50
financial institutions, of which a handful of the largest global banks represents the lion’s share of the FX swap market. In the inner tier, dealers trade among themselves. In addition to supporting the price formation process, the inter-dealer segment facilitates the adjustment of inventory imbalances and hedging positions. However, a clear separating line between the inter-dealer and the dealer-customer market is no longer discernible for at least two reasons. First, financial institutions outside the core inter-dealer market are taking over brokerage and market-making functions. As an example of this new permeation, prime brokerage is the situation where FX (spot) dealers facilitate direct client to established counterparty trading. Second, the emergence of electronic trading venues blurs the separating line between inter-dealer and dealer-customer markets.

That being said, the FX swap market nevertheless remains a fundamentally two-tier, global, dealer-centric network dealing with a highly diverse client base. Its OTC nature implies that the market is fragmented, information is highly dispersed and there is heterogeneity in terms of prices and bargaining power.

2.2 Technological Changes

Since the first swap contracts were written in the early 1980s, many technological and institutional improvements have occurred. Here we will discuss just two that have especially marked the last decade: electronification and settlement issues.

Electronification, i.e. the advent of electronic and automated trading, has especially developed in FX spot trading. Structural impediments such as multiple pricing factors, less standard contracts, and regulatory issues combined with a general preference for voice trading on the part of market participants have prevented greater electronification in FX derivatives markets. In recent years, however, electronification in the outer tier has caught up with the swaps and forwards market before moving on to non-deliverable forwards.

13 The biggest players include (custodian) banks such as JP Morgan, Deutsche Bank, UBS, XTX Markets, Citi, HSBC, Jump Trading, Goldman Sachs, State Street, and Bank of America (Euromoney (2020)).

14 Large volumes processed in a relatively small number of trades also discourage investment in automation and electronification (Wooldridge, 2019).

15 A survey ran in 2021 by fx-markets.com indicates that electronic trading in OTC FX options is between
The dealer-to-dealer segment is approximately evenly split into voice and electronic trading, with the latter being fragmented across many different trading venues (Schrimpf and Sushko, 2019). In the dealer-to-customer segment, trades have traditionally been negotiated by phone. However, trading has become increasingly electronic on the following types of venue: electronic communication network (ECN), bank-based, or platforms. Electronic venues generally enable clients to solicit quotes from multiple dealers simultaneously by indicating the desired currency pair, tenor, amount, and trade direction (if possible). Of course, this creates competitive pressures on dealers who can respond either with a static quote or with a quote stream that updates in real time as market conditions evolve. These trading facilities are not anonymous as dealers can observe the client’s identity and possibly tailor their quotes accordingly. At least on electronic trading platforms for FX spot rates (but not for FX swaps), dealers can also observe whether other dealers provide (streamed) quotes and often retain a “last look” on whether the trade is executed after a client accepts a quote, rendering the dealer’s offer non-binding.

Settlement is another area of FX infrastructure which has witnessed considerable progress. Settlement or “Herstatt” risk, i.e. the danger that the a buyer (seller) may not receive delivery (payment) of the bought (sold) currency by the settlement date, has been significantly reduced over the last two decades. In this respect, CLS plays a crucial role. It operates the world’s largest multi-currency cash settlement system, handling 40% of global spot, swap, and forward FX transaction volumes or more depending on estimates. After agreeing on a

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66-90% but only between 10-40% of total traded volume.

16 For FX swaps, ECN includes 24 Exchange, 360T, BGC, Bloomberg, CME/NEX Group, Currenex, FXSpotStream, ICAP, Integral, MOEX, and Refinitiv. Bank venues are rather addressed to active clients looking for faster execution, and might provide additional features such as access to execution algorithms. Bank venues include BAML, Barclays, BNP, Citi, Commerzbank, Credit Suisse, Deutsche Bank, HSBC, JP Morgan, Lloyds, Morgan Stanley, Nordea, RBC, SEB, Société Générale, Standard Chartered, State Street, and UBS. FlexTrade is a trading platform and Virtu Financial is a non-bank venue. Additional information can be find on https://www.marketfactory.com/venues/

17 The failure of Bankhaus Herstatt in 1974 showed settlement risk to its full extent and complexity. Subsequently, the Committee on Payment and Settlement Systems (CPSS) called on banks to develop multi-currency settlement and netting arrangements to reduce settlement risk with the support of central banks. From this initiative, the first steps were taken to create CLS (originally Continuous Linked Settlement) which became operational in 2002.

18 Currently, CLS settles more than USD 5 trillion on behalf of its clients. CLS’s membership comprises over 70 of the world’s largest financial institutions, and CLS is member-owned. Over 25,000 third parties, primarily
transaction, CLS members send the payment instructions to CLS to be matched, confirmed, and stored until value date. At the beginning and end of every normal business day, each settlement member’s multicurrency account has a zero balance. The funding and pay-out of multilateral net positions is conducted using a daily and pre-defined schedule. In this framework, settlement members pay and receive funds “irrevocably” through CLS’s central bank account in each currency via their own accounts or nostro bank accounts.\textsuperscript{19} Along with settlement risk reduction, the multilateral netting approach has improved operational efficiency and reduced funding requirements. Efficiency in terms of collateral allocation and use has been particularly important in recent years given the scarcity of (high-quality and liquid) collateral assets induced by various factors such as regulation and large asset purchase (quantitative easing) programs.

2.3 Policy Actions

Since the Global Financial Crisis, there have been two major policy actions on which we will focus: the post-crisis financial regulatory reform and the introduction of standing central bank FX swap lines.

Before the Global Financial Crisis erupted in 2007-08, the existing legislative framework was quite loose and uneven across jurisdictions. In 2009, the Group of Twenty (G20) leaders agreed on strengthening and harmonizing it. This policy agenda has given rise to various international and national legislations whose exhaustive treatment is beyond the scope of this chapter. Here we focus on a few important aspects of Basel III legislation which are arguably having significant and heterogeneous consequences for FX swap contracts and counterparty

\textsuperscript{19}In addition to CLS Settlement, CLS provides (i) CLSClearedFX for OTC cleared FX products; (ii) CLSnow for intraday currency settlement; (iii) Cross currency swaps; and (iv) OTC credit derivatives.
ties. Specifically, we discuss the regulation of derivative contracts and banking, which of course have also been incorporated in part into important legislative frameworks such as the Dodd-Frank Act and the European Financial Market Infrastructure Regulation (EMIR). These legislations have been joined by other guidelines such as the FX Global Code published in May 2017 and updated in July 2021.

One of the central parts of the political agenda affecting FX swaps has been the reform of over-the-counter (OTC) derivatives. Despite attempts to coordinate policy initiatives, regulatory requirements vary across jurisdictions and depend on whether the counterparties are regulated entities (a bank, securities dealer, insurance company, fund management company, or asset manager) and the size of the outstanding notional of OTC derivatives. In general, trading in FX derivatives might be subject to obligations aiming to improve post-trading transparency (reporting, trade confirmation, and reconciliation/dispute resolution) or decrease ex-ante uncertainty (risk mitigation, valuation, as well as initial and variation margins).

What has certainly increased is the data collection promoted by market regulators, whose analysis should improve internal risk assessment, peer monitoring, and financial stability policy conducted by market authorities and central banks. Other measures are designed to decrease and manage financial risks. For instance, the portfolio compression obligation is intended to net out OTC transactions and only applies if counterparties have many open OTC derivatives that have not been centrally cleared. Importantly, FX derivatives not delivered payment-vs-payment are generally subject to margin requirements in the form of initial or variation margin, unless one of the counterparties is a small non-financial counterparty. While variation margin obligation is generally applied by everyone, the initial margin requirement applies only to entities if the aggregated month-end average gross position of OTC derivatives not cleared through a central counterparty exceeds a given size.

It should be noted that FX swaps are generally less regulated than other derivatives such as

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20 Basel III refers to a new regulatory framework on bank capitalization, stress testing, and liquidity risk announced by the Basel Committee on Banking Supervision in July 2010.

21 The Global Code provides a set of global principles of good practice in the foreign exchange market.
as interest-rate swaps (IRS). For instance, contrary to IRS, it is not mandatory that an FX swap be cleared by a central counterparty (CCP). Similarly, FX swaps are not subjected to platform trading obligations such as swap-execution-facilities ("SEF") in the United States. Even if less regulated than other derivatives, it is reasonable to assume that the new legislative apparatus has created direct or "shadow" costs that heterogeneously affects FX swaps depending on which categories market participants formally belong to, their characteristics (e.g. balance sheet composition and size, business models, etc.), and how they act in the markets.

Understanding how the leverage ratio rule in the Basel III regulation impacts FX swaps is difficult. The leverage ratio is a non-risk weighted capital requirement according to which a bank has to hold a minimum level of high-quality loss-absorbing (Tier 1) capital in proportion to "on-balance sheet" instruments, such as loans, securities, or repurchase agreements. Conversely, FX swaps fall in the category of the so-called "off-balance sheet" instruments that marginally contribute to leverage ratio computation.\footnote{Being an off-balance sheet instrument, FX swaps' contribution to exposure under the leverage ratio goes through what is known as an "add-on factor" for potential future exposure (PFE). For FX and gold derivatives of maturities less than or equal to one year, the PFE factor is 1\% (BIS, 2014). There may be indirect effects, though. For instance, an (arbitrage) trade might need additional funding that might increase the LR exposure by 100\% depending on the balance sheet structure of the institution performing it.}

On the other hand, by weighting all exposures equally the leverage ratio rule triggers an increase of intermediation costs of those assets which are characterized by a low margin and high volume such as FX swaps. As discussed in the section on XVA, these regulatory costs become even more relevant when banks have a limited capacity to net out derivatives exposure that offset each other across different counterparties and when counterparties entail higher credit risk exposure.

Basel III has also created higher capital requirements from the perspective of risk-weighted capital,\footnote{For example, for US G-SIBs, the Tier 1 capital ratio increased from 4\% pre-crisis to the 9.5\% to 13\% range under Basel III, and the total capital ratio increased from 8\% to the 11.5\% to 15\% range.} liquidity requirements such as the liquidity coverage ratio (LCR), and the net stable funding ratio (NSFR), which requires banks to hold High Quality Liquidity Assets (HQLA) against potential net cash outflows during a short and longer stress period, respectively. Furthermore, some nations apply additional or countercyclical requirements. To sum up, the
regulatory impact of Basel III reforms on FX swap trading is complex as it heterogeneously affects FX swaps across regulations, entities, and time.

Since FX dealers are typically large global banks, it should be noted that the gradual phasing-in of the G-SIB framework since the Global Financial Crisis has also added upward pressure to the regulatory cost of trading FX swaps. For a bank that is classified as a G-SIB (globally systematically important bank), FX swap exposures add to its overall G-SIB score and can lead to an additional capital surcharge. Depending on banks’ business model, FX swap exposures can contribute to several indicator categories all at once.\textsuperscript{24} However, assessing the exact mechanism of how the G-SIB framework ultimately affects the incentives to trade FX swaps is again a complex task and is likely to depend on on each bank individually. A variety of different factors can interplay simultaneously, including the relative regulatory cost of trading FX swaps in comparison to alternatives, as well as the fact that, for the G-SIB capital surcharge, it is the relative score vis-a-vis other large banks, not the absolute numbers, that ultimately matter.

Let us now move to another policy action that has proven to be very effective in times of global stress: central bank swap lines. Their rationale is to equip central banks with an effective tool to counteract the adverse effects coming from disruptions in the modern financial system, which is highly interconnected and global. Central bank swap lines, an international arrangement, complement the more traditional role of central bank as the lender of last resort (LOLR) to its own economy. By applying a plain vanilla FX swap, two central banks agree on the exchange of the equivalent amount with an agreed-upon future date of re-sale. Both payments are at the spot exchange rate of the initial exchange. The initiating borrowing central bank lends (requiring collateral) the exchanged currency from the swap to eligible banks in its jurisdictions at the same cost as charged by the counterparty central bank. By doing so, the borrowing central bank bears the default risk of the local banks but facilitates their access to the international money market.

\textsuperscript{24}FX swaps contribute most to the G-SIB score through the so called complexity component as it considers the total notional amount of OTC derivatives (BIS, 2013). Other components can also be affected depending on the exact nature of FX swap exposures.
Figure 8: Fed lending through its swap lines in Billion USD

Although central banks utilize FX swaps since at least the 1980s, standing central bank swap lines are recent policy tools introduced in December 2007 as a response to global USD shortages. They were initially arranged between the Fed and five major national and central banks (see Figure 8). Then, they were reintroduced in May 2010 and turned into a permanent monetary policy tool in October 2013. As illustrated by Figure 8, the reliance on this measure increases substantially during global financial crises.

FX swap lines have become reciprocal standing arrangements not only with the Fed but as a network of advanced central banks. In the wake of the Covid-19 pandemic, the utilization as well as the network of swap lines has been augmented to a branched network of around 170 bilateral swap lines (Bahaj and Reis (2021)).

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25The first network consisted of the Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank, and the Swiss National Bank. In the fourth quarter of 2008, the Fed’s FX swap lines alone added up to 553 billion USD, corresponding to 4% of 2008 US GDP.

26The New York Fed, authorized by the FOMC, entered into temporary U.S. dollar liquidity arrangements (swap lines) with the Reserve Bank of Australia, the Banco Central do Brasil, the Danmarks Nationalbank (Denmark), the Bank of Korea, the Banco de Mexico, the Norges Bank (Norway), the Reserve Bank of New Zealand, the Monetary Authority of Singapore, and the Sveriges Riksbank (Sweden) (FRBNY (2020)).
3 Research

Despite its importance, the FX swap market has not been studied in-depth as many aspects of its functioning and pricing are still obscure. This is very likely due to the over-the-counter nature of this market and the consequent lack of comprehensive and granular data. However, some new data sources give hope that we will soon improve our knowledge of this market. Among them, it is worth noting two sources: First, repository and supervisory data offering information at transaction and identity (ID) levels; second, aggregate high-frequency data from CLS representative of global trading volume.

There are at least three areas of future research to highlight, first of which is the market design of FX swaps. Some frictions of OTC markets such as search costs and bargaining have been studied theoretically (e.g., Duffie, Garleanu, and Pedersen, 2005, 2007; Colliard, Foucault, and Hoffmann, 2018). But the discussion above has shown that many more important factors determine FX swap pricing and the behavior of participants in these markets including their network structure.27 It would be helpful to have a general theoretical framework that more closely matches with the characteristics of the FX swap market to better understand the real macroeconomic implications of its frictions and policyrelevant instruments involving or affecting FX swaps such as central bank FX swap lines,28 conventional and unconventional monetary policies,29 or the regulatory issues discussed above.30

The second research area deserving more work is asset pricing. Some of the key overarching questions that arise there are as follows: What are the systematic factors that drive FX swap pricing? Which pricing factors explain the cross-sectional and time-series variation of FX swap rates? Much research has been done in the past to shed light on the determination of spot foreign exchange rate, but much less attention has been paid to FX swaps. In addi-

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27 For instance, Hasbrouck and Levich (forthcoming) show that traders who hold a more central position in the FX spot market network benefit from a centrality premium and bargaining power.

28 See e.g. Bahaj and Reis (2021).

29 For example, Brazil is an interesting case as its central bank has used FX swaps to conduct (sterilized) FX interventions (Chamon, Garcia, and Souza, 2017).

30 Comparing IRS that are centrally and bilaterally cleared IRS, Cenedese, Ranaldo, and Vasios (2020) show that the latter bear an OTC premium consistent with the regulatory cost.
tion, the CIP condition, the cornerstone of currency forward and swap pricing, has attracted significant attention in recent years. The CIP arbitrage condition used to hold well until the Global Financial Crisis, but it has been systematically violated ever since. The initial reasons were credit risk and funding constraints, but CIP deviations have remained despite the easing of these constraints. The most recent research has sought to shed light on the role of financial intermediation. Recent studies provide evidence that post-crisis regulations have played an important role in the increase of CIP deviations (Du, Tepper, and Verdelhan, 2018; Cenedese, Della Corte, and Wang, forthcoming; Abbassi and Bräuning, 2021).

Yet, as previously discussed, it is often quite challenging to pinpoint the exact way of whether, how, and which parts of the new regulations lead to changes in FX swap pricing and arbitrage conditions. One promising way to hone in on these mechanisms is to take the intermediary’s point of view and, in particular, the way how FX dealers apply XVA. In addition to the supply side (represented by FX dealers), future research should also shed light on the demand side, i.e. dealers’ customers and their primary reasons for demanding swaps: hedging and funding. For instance, do firms’ characteristics such as international trade, trade credits, and natural hedging affect their demand for FX swaps? To what extent and how are FX swaps used as a funding instrument? How do alternative funding sources such as money market

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31 Akram, Rime, and Sarno (2008) provide evidence that the CIP held before the Global Financial Crisis while Baba, Packer, and Nagano (2008) and Mancini-Griffoli and Ranaldo (2011) relate CIP deviations to credit risk and (dollar) funding liquidity constraints.

32 Comparing the CIP basis coming from a forward position expiring before and after the quarter-end, Du, Tepper, and Verdelhan (2018) show that the latter is significantly larger, pointing to a causal effect of the leverage ratio requirement on asset prices. By conducting a dealer-level analysis that exploits the exogenous variation introduced by the UK leverage ratio framework, Cenedese, Della Corte, and Wang (forthcoming) show that dealers mostly affected by the regulatory shock charge an additional premium to their customers. Abbassi and Bräuning (2021) provide evidence that banks with large dollar funding needs have a strong incentive to sell dollars forward before the quarter ends.

33 For instance, dealers intermediating IRS appear to be charging regulatory costs and risk premiums to their customers consistent with XVA (Cenedese, Ranaldo, and Vasilis, 2020) including Funding Valuation Adjustments (Andersen, Duffie, and Song, 2019).

instruments affect FX swaps pricing and why?\textsuperscript{35}

The third research area calling for more work is market microstructure. It is important to better understand how price formation occurs and factors that determine it. This area of research should include contractual issues such as the “LIBOR transition”. In many markets, including the FX spot market, it has been argued that order flow leads the price discovery process. Early work on FX swaps in this direction is promising.\textsuperscript{36} Future research should highlight the price formation process and the information content of order flows in various market segments such as in the (mostly electronic) inter-dealer and dealer-customer segments.\textsuperscript{37} Another important microstructure issue is market liquidity. Contrary to the common belief that the FX market is highly liquid and efficient, liquidity may not be uniform and abundant for every FX swap, for every maturity, and at every point in time.\textsuperscript{38}

\textsuperscript{35}For instance, segmentation in money markets (Ranaldo, Schaffner, and Tsatsaronis, 2019) might affect the market quality of FX swaps. Moreover, large (international) banks raise significant funding in U.S. dollar, while smaller banks tend to fund themselves in their domestic currencies. More research on the interplay between monetary policy, financial stability, and the structure of international capital markets is warranted.

\textsuperscript{36}Using data on inter-dealer transactions, Syrstad and Viswanath-Natraj (2020) provide evidence that order flow determines the FX swap rate and thus increases the cost of dollar funding, especially at quarter-end periods.

\textsuperscript{37}Ranaldo and Somogyi (2021) shows that asymmetric information risk is priced in FX spot rates. Cespa, Gargano, Riddiough, and Sarno (2021) show that currencies with abnormally low volumes display strong return reversals. Regarding FX derivatives, a first step in this direction has been taken in Hau, Hoffmann, Langfield, and Timmer (forthcoming) showing that FX dealers exert discriminatory pricing in FX forward and swap rates.

\textsuperscript{38}Krohn and Sushko (2021) show strong commonality in liquidity between FX spot and swap markets that can be impaired by funding constraints and when the largest dealers pull back.
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