Firms, Currency Hedging and Financial Derivatives *

Laura Alfaro[1], Mauricio Calani[2], and Liliana Varela[3]

[1]Harvard Business School, NBER and CEPR
[2]Central Bank of Chile
[3]London School of Economics and CEPR

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Abstract

The use of foreign currency is prevalent in international markets. Firms in international trade and capital markets must decide how to cope with foreign currency risk associated with buying inputs and selling output abroad as well as financing. In this chapter, we overview the emerging literature exploiting new granular data sets and analyzing the use of FX derivatives and currency risk management, which are both shaped by the existence of financial frictions.

Keywords: Firms, foreign currency, financial hedging, FX derivatives, cash flow, risk management.
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1 Introduction

Foreign currency (FX) derivative markets are among the largest in the world. They have seen impressive development over the last decades, surpassing spot market turnover in advanced and emerging economies. The size and scope of the financial derivatives markets have expanded along with the adoption of more flexible exchange rates, the growth of spot currency markets, the development of derivative products, and deeper financial integration in the world's capital markets.[1] In particular, the outstanding worldwide notional amount of over-the-counter (OTC) derivatives has grown at an annual rate of 9% since 2000 (BIS 2022*a*,*b*).

Firms outside the US use the dollar extensively. The unrivaled dollar dominance in the international monetary system places the dollar as the main currency for pricing in global trade (Goldberg & Tille 2009, Gopinath 2015), capital markets and funding to banks and non-financial firms (Eichengreen & Hausmann 1999, Rey 2015, Bruno & Shin 2015) and, finally, as a reserve currency (Ilzetzki et al. 2019). Beyond monetary policy and trade spillovers, the dollar dominance directly exacerbates vulnerabilities associated with currency mismatches, rendering economies susceptible to changes in market sentiment, sudden stops, and systematic risk.[2] Policy recommendations to counter these risks have included promoting local currency debt and floating exchange rates, among others, to shield economies from currency and financial crises.

An alternative currency risk management approach is using financial instruments, FX derivatives. Although foreign currency derivative markets are among the largest markets in the world and have grown impressively in the last decades (BIS 2022*a*), their use by non-financial corporations is relatively understudied despite the importance it has for them. In 2022, the share of foreign exchange global derivative turnover attributable to non-financial institutions was about ten times the value of world trade of merchandise, reaching $424 billion (BIS 2022*a*, WTO 2022). These corporate customers use foreign exchange derivatives to hedge and settle working capital needs, international trade financing, and investment.[3]

[1] Derivatives are financial contracts that commit counterparties to exchange cash payments related to the value of a commodity or financial asset (underlying asset) (Kohn et al. 2003). There are four main financial contracts: futures, forwards, swaps, and options. See Appendix C for a glossary of terms and definitions.

[2] Kaminsky & Reinhart (1999), Krugman (1999), Chang & Velasco (1998), Corsetti et al. (1999), Calvo (2005).

[3] Corporate demand for foreign exchange and foreign exchange derivatives typically multiplies the counterpart financial operations, (Atkin 2004). The bulk of the transactions undertaken on the inter-dealer market is generated by deals with end-users, and the more complex the transaction, the more multiplier effect. When comparing the statistics of financial and non-financial derivatives, it is important to keep this in mind.

The extensive use of vehicle currencies[4], prominently the US dollar, and the increasing importance of emerging markets economies (EMEs) associate (we need something better than "associate") with the growing turnover of derivatives over the last decades. In EMEs, where output, exchange rates, interest rates, and capital flows are generally more volatile than in advanced economies, derivatives can enhance risk management and enable access to capital. As such, the share of EME currencies in global FX turnover rose to 23% in 2019, from 19% in 2016 and 15% in 2013, growing steadily in the last decade BIS (2022*a*). This was particularly pronounced in many Asian currencies, where the Chinese Renminbi (RMB) has been the most-traded EME currency in recent years, and in 2022 it became the fifth more traded currency overall BIS (2022*a*).[5] FX hedging is of higher importance in EMEs because of their higher exposure to FX and the lower relevance of the local interest rate. Thus, access to the FX derivatives market is essential for business.

For the most part, the international macro literature has abstracted from derivatives or focused on their use by financial institutions. Following Froot et al. (1993), under capital market imperfections, hedging (either full or partial) can add value to firms. Therefore, financial policy, including hedging, allows an integral role in risk management. This paradigm is based on the fact that value is created when companies make sound investments that ultimately increase their operating cash flow. It treats financial policy as critical in enabling companies to make valuable investments. Moreover, it recognizes that companies face real trade-offs in financing their investments and the costs of doing or not doing them.

Yet, little is known about foreign exchange derivatives used at the firm level and their relationship with the real economy. This has been due, in part, to the limited data available. However, some EMEs have taken the lead in granular data collection since the late 1990s following the financial crises of the 1980s and 1990s, many fueled by dollarization, foreign currency debt, and currency mismatches.[6] In the developed world, new granular data appeared after the G-20 regulatory response to the Global Financial Crisis, with high-quality data available after 2018.[7]

Research is starting to open the black box of corporate firm FX hedging and its link with

[4]See Eichengreen & Hausmann (1999), Calvo & Reinhart (2002), Cespedes et al. (2004), Goldberg & Tille (2009), Rey (2015), Gopinath (2015), Bruno & Shin (2015), Ilzetzki et al. (2019), Gopinath et al. (2020), Gopinath & Stein (2020), Amiti et al. (2022), Gopinath & Itskhoki (2022), Ilzetzki et al. (2022), among others.

[5]RMB share in global FX turnover increased from less than 1%, 20 years ago to more than 7% in 2022.

[6]For instance, Albagli et al. (2021) document that the FX derivatives market developed in Chile after the adoption of a freely floating exchange rate, and not the other way around.

[7]The BIS complies and publishes three sets of statistics on derivatives: quarterly statistics on derivatives traded on organized exchanges, semiannual statistics on outstanding positions in over-the-counter (OTC) derivatives markets (reaching dealers in 12 jurisdictions), and triennial statistics on OTC derivatives and foreign exchange market activity (reaching dealers in more than 30 additional jurisdictions). The BIS has held the triennial survey since 1986 and is the most comprehensive database on this matter.

the real economy. The first generation of papers relied on information on the net positions of listed or multinational firms or survey data for most developed economies (e.g., Geczy et al. 1997, Allayannis et al. 2001, Graham & Rogers 2002).

The new available granular derivatives data matched to firm characteristics allows for measuring exposure accurately, for which only proxies were available in previous studies and actual gross use of derivatives. Alfaro, Calani & Varela (2021), for example, use data on the universe of trade, foreign currency debt, and FX derivatives at the transaction level and document novel results about firms' currency exposure and hedging policies. First, they show that invoicing in USD is not a sufficient condition to be operationally hedged, as different timing, maturity, and amounts of payables and receivables in foreign currency create currency exposure. Hence, firms are not able to operationally hedge their currency exposure even if they are large exporters and importers and borrow in foreign currency. Second, the use of FX financial hedging is concentrated around the largest exports, importers, and foreign currency debt holders, who use it intensively to hedge currency risk. Yet hedging is significantly costly as different maturities lead firms to hedge their gross transactions, and, as a result, firms are more likely to hedge larger amounts. Third, using an exogenous regulatory measure that affected the supply of FX forwards to firms, they show that FX hedging affects firms' size and trade and, hence, adds value to the firm. This new set of results underscores the role of frictions in the timing and maturity of payments in limiting natural hedging and using FX derivatives.

In this chapter, we focus on the use of FX by firms and transaction exposure.[8] Several review articles and handbook chapters in international economics have studied currency mismatches (Burstein & Gopinath 2014; Kose, Ohnsorge, Reinhart & Rogoff 2022; Forbes 2021; Gopinath & Itskhoki 2022; Ilzetzki et al. 2019, among others). However, as mentioned, most have abstracted from firms' use of financial FX hedging. As we overview in this chapter, most currency crises in the 1980s and 1990s occurred in countries with fixed exchange rates (de facto o de jure) and limited FX markets. The FX derivative market has expanded substantially since the 2000s in countries with flexible regimes, and FX hedging has increasingly become a possibility for firms. The handbook chapter by Du & Schreger (2021) explores the use of derivatives in the financial system with a focus on banks. The handbook chapter by Ranaldo (2023) discusses foreign exchange swaps, which are intensively used by the financial sector, while firms, as we document below, tend to use forwards.

This chapter is organized as follows. First, we give a brief historical background on the surge of the FX market and FX derivatives after the 1970s, including recent trends and

[8]Transaction exposure is the sensitivity of "realized" domestic currency values of the firm's contractual cash flows in foreign currencies to unexpected exchange rate changes. Whenever the firm has foreign-currency-denominated receivables or payables, it is subject to transaction exposure, and their settlements are likely to affect the firm's cash flow position.

the critical reforms that the G-20 placed after the Global Financial Crisis. Then, we go over the trends in EMEs from the crisis in the 1980s to recent years. After discussing the trends, we provide an organizing framework to understand corporate hedging based on Froot et al. (1993). We end by examining recent evidence of the real economic implications of FX derivative markets to shed light on the market's real linkages. Finally, the last section concludes.

2 Collapse of Bretton Woods and the Modern Era of FX Derivatives

2.1 Development of the FX Derivative Markets Post-Bretton Woods

The collapse of Bretton Woods in the 1970s gave a path to floating exchange rate regimes worldwide (Figure 1). These were introduced during significant economic instability and uncertainty, which brought exchange rate volatility and new risks. This environment inspired the creation of new financial instruments to protect operators from fluctuations in interest and exchange rates. The trend started in the United States but spread to Britain by the early 1980s. Much of the financial innovation, which involved the creation of mathematically complex products, was enabled by an accompanying revolution in computer technology and telecommunications.

Between 1973 and 1985, FX markets had to respond to two oil price shocks, petrodollar recycling, the replacement of soaring inflation by rapid disinflation, political upsets on both sides of the Atlantic, and a sea change in US and British economic policies during the early 1980s. The political wave of deregulation in Britain, via the new Conservative government of Margaret Thatcher, gave a particular impulse to the financial sector. For example, allowing free FX contributed to the rising tide of business undertaken in the City's dealing rooms. This wave in the financial industry, later called Big Bang, allowed London to lay undisputed claim to the world's biggest foreign exchange center title, displacing New York. Furthermore, London's role as the capital of the global FX markets can be attributed to several other factors, for example, the advantage it has long obtained by serving as a financial bridge between Europe and the United States. Also, the close political and trading ties, the use of a common language, and a similar legal framework have helped concentrate transatlantic financial activity in London over the years. In turn, this has concentrated European trading in US dollars in the same location. Adopting the US dollar as a vehicle currency allowed the London FX market to punch above its weight (Atkin 2004).

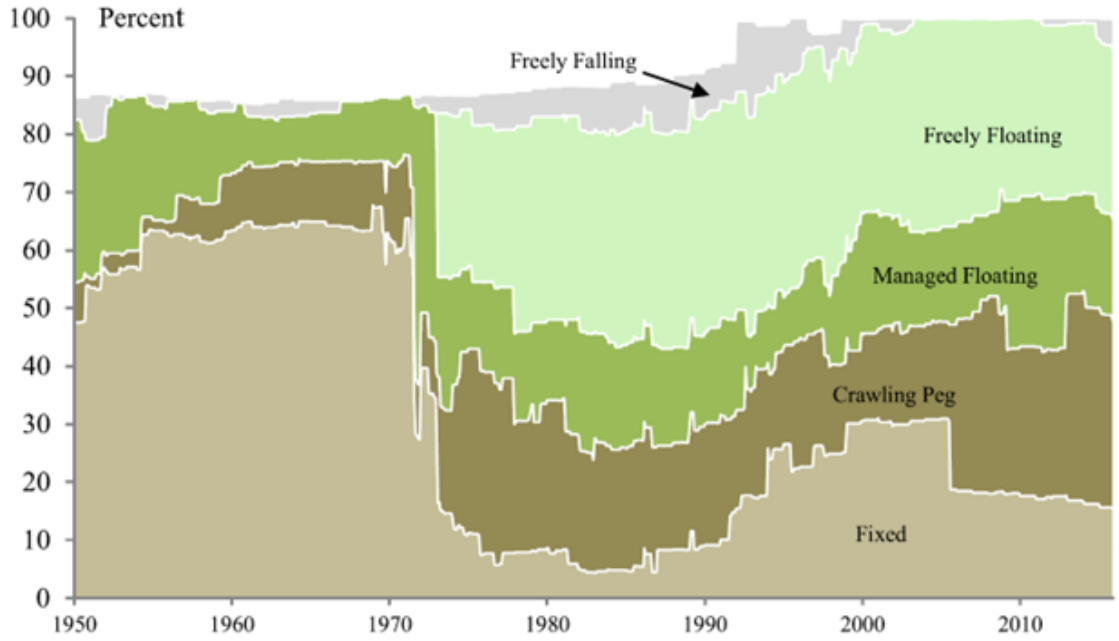

Figure 1: Exchange rate arrangements of countries, weighted by world GDP in each group

This shows the relative importance of exchange rate arrangements from 1949-2016. We highlight the fall in fixed exchange rate regimes in the 1970s and the appearance of free-floating regimes. Fixed exchange regimes later came back partially in the 1990s. See Ilzetzki et al. (2019) for more details. Source: Ilzetzki et al. (2019)

The widespread adoption of floating exchange rates stimulated the demand for Forward cover from companies seeking to protect themselves from volatile exchange rate movements and increased the opportunities for successful proprietary trading. The FX market displayed two features that appealed to dealers during this time. One was the existence of pronounced trends involving several important currencies. The other was the existence of significant intra-day currency fluctuations that provided trading opportunities even for those dealers who were obliged, by internal rules, to close out their currency positions at the end of each working day. Of course, it also exposed them to risks.

Innovation (e.g., advances IT, Reuters monitor system, SWIFT; automated clearing, CHIPS, CHAPS) and deregulation (e.g., abolition of capital controls; Britain's Big Bang) further gave an impulse to the financial sector innovation to deal with FX volatility. Financial futures were the first new instruments to come off the production line (the International Monetary Market—IMM—of the Chicago Mercantile Exchange, May 1972); interest rate futures followed shortly after that (Chicago Board of Trade's mortgage-backed securities contract, October 1975; IMM's 90 day US Treasury bill contract, January 1976), both in the United States. The first listed currency options were introduced on the Philadelphia Stock Exchange in 1982. Around that time, banks in the United States and Europe developed an

OTC market in currency options by banks. Most of the new ideas originated in the United States. Whatever the reasons, the genius of the City was not so much to innovate as it was to import ideas that had been developed elsewhere and put them into production (Atkin 2004). In September 1982, the London International Financial Futures Exchange (LIFFE) started trading currency futures contracts and later currency options (1985). In the early, 1980s, currency swaps began to be traded as well.

Currency futures and options increased the array of hedging instruments available to companies and investors.[9] However, whereas options provided a new technique for covering exposures, futures offered little that was not already available in the forward exchange market. In the United States, the currency futures market attracted early interest from individuals and small companies who found it difficult to enter the forward exchange market or do so on attractive terms. This retail demand did not exist in the United Kingdom.

As noted by (Atkin 2004), before the start of futures trading, Edmond de Rothschild told the chairman of the Chicago Mercantile Exchange that the demand for futures trading in the major currencies was serviced by forward exchange market big companies and institutional investors. The forward market displayed the following advantages of the futures market, which led to the eventual failure of LIFFFE. 1. No margin requirement on foreign exchange, while banks generally traded forward exchange with their corporate customers without seeking any additional collateral; Forward exchange can be traded for longer maturities and for negotiated maturity dates, whereas currency futures are subject to fixed shorter maturity dates; An exact amount of cover can be obtained in the forward market, whereas only round amounts divisible by the unit size of the contract can be covered on futures exchanges and low unit size an inconvenience for large transactions. (p.153). While the short-term interest rate and long-term bond contract were a success, as there was no previous form of covering o means previously had g interest exposure), the demand for its currency contracts remained weak. Currency options, in contrast to futures, provided operators with an alternative way of hedging which allowed for eventual growth.

A temporary setback in the FX exchange market occurred in the late 1990s. There were three main factors. The first one was the introduction of the euro. Eliminating the legacy currencies of the eurozone reduced the global inventory of liquid and internationally traded currencies. Second, a significant consolidation in the banking industry happened, and the volume of foreign exchange business undertaken by merged entities was generally lower than the combined volume undertaken previously by the partners. Third, the expansion in electronic booking and new technologies increased the transparency of market prices, meaning that deals traditionally executed by phone to facilitate price discovery were no longer necessary, leading to a more efficient market with fewer opportunities for arbitrage

[9] See Gürkaynak & Wright (2023) for a recent overview of options and futures.

and an overall fall in turnover. The London foreign exchange market punching above its weight continued after this setback, the decline of UK importance in the world, and after BREXIT. As of 2022, a steady 38% of world FX turnover was held in the UK and 20% in the United States.

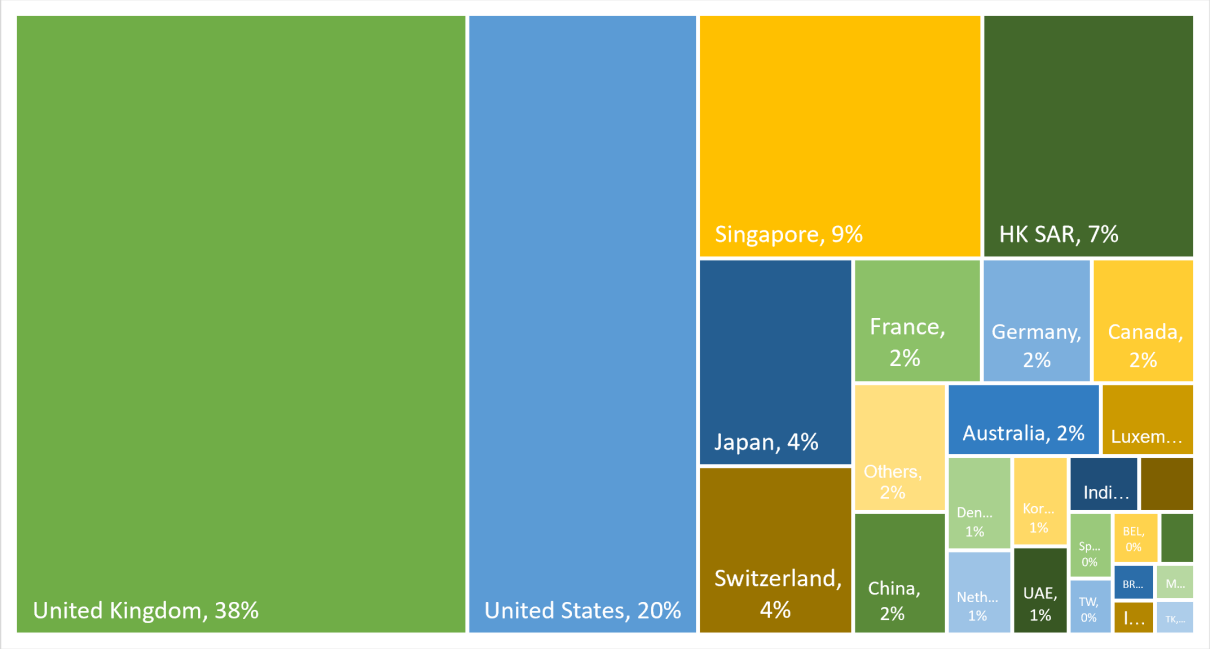

Figure 2: OTC foreign exchange turnover, relevance by country (daily averages, April 2022)

This shows the relative importance of notional values of the OTC market by derivative market issuance as of 2022.[10] Trading tends to occur in the same time zone jurisdictions. Latin American currencies tend to be traded in New York, central and eastern European currencies in London, and Asian currencies in Hong Kong and Singapore.

Source: BIS (2022*b*)

Financial instruments like derivatives have been critical in managing exchange rate risk throughout the last decades. Different types of entities can benefit from using these tools in a variety of ways; for example, non-financial firms can use derivatives to hedge their exposure to changes in the value of currencies and interest rates; energy companies can also use derivatives to hedge changes in commodity prices; asset managers can use derivatives to take on their desired investment exposure effectively; pension funds can use derivatives to hedge inflation and interest rate risk in long-dated pension liabilities or hedge exchange rate risk when buying foreign assets; governments can use financial derivatives products to reduce the interest rate and exchange rate risks; banks can use derivatives to manage the risk mismatches between their assets and liabilities, etc. The desire to hedge only results in liquid markets if somebody is willing to take the other side of the transaction. A financial intermediary could sell the appropriate insurance for idiosyncratic risks that are easily diversifiable, but creating a market for macroeconomic risks, such as exchange rate and

interest rate risk, is much more difficult unless agents are exposed to such risks in opposite ways and are willing to be involved in the market (BIS 2016*a*).

2.1.1 Growth of the Derivatives Market and G-20 OTC Reforms

Although it has been the largest financial market in the world, the global FX market, both spot and derivatives were quite opaque and decentralized. This is one of the main reasons why the market was not easy to map accurately and regularly. BIS Central Bank Survey is the most comprehensive source of global FX spot and OTC[11] However, it is infrequent (triennial): it only provides a snapshot of activity in April.[12]

The 2000s saw a fast-growing trend in derivatives markets that ended in the Global Financial Crisis in 2007/8 and the following regulatory response.The evolution of derivatives notional amounts shows the predominance of interest rates derivatives: above 70% of the total amount. However, this comparison somehow inflates the relative importance of interest rate derivatives because of the role of the financial system as the main intermediary and different regulations. The figure also shows the changes before and after the GFC; when interest rate derivatives stopped their exponential growth, credit derivatives declined, and FX derivatives continued growing after a short-term fall.

Figure 3 shows the growth of total FX instruments on a net-net basis (panel A), eliminating cross-border double-counting when calculating global results. We highlight the importance of FX swaps and the growing importance of outright forwards (panel B). Note, however, that the non-financial sector uses forwards more intensively compared to the financial sector (see Alfaro et al. (2021), ISDA (2022)).

Before the Global Financial Crisis erupted in 2007-08, the legislative OTC markets framework was uneven across jurisdictions. Following the financial crisis, the G20 initiated a series of reforms designed to strengthen the regulation and oversight of the financial system and tasked the Financial Stability Board (FSB) with coordinating the reforms and assessing their implementation. An essential part of these reforms is a commitment to enhancing the regulation of OTC derivatives markets to improve transparency and mitigate systemic risk BIS (2012), Brunnermeier et al. (2013). Specifically, all standardized OTC derivative con-

[11] Derivatives are disproportionately traded over the counter, particularly in EME. OTC trading exceeds exchange-based trading by a factor of three, with Brazil being the one important exception (the OTC derivative market is smaller than the exchange-traded market).

[12] April has been historically 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 (Ranaldo 2023). FX derivatives trading activity, conducted since 1986, has been growing, with the April 2022 snapshot an exception because of the war in Ukraine and its effects on the financial markets. Therefore, caution must be considered when comparing data from the 2022 triennial survey.

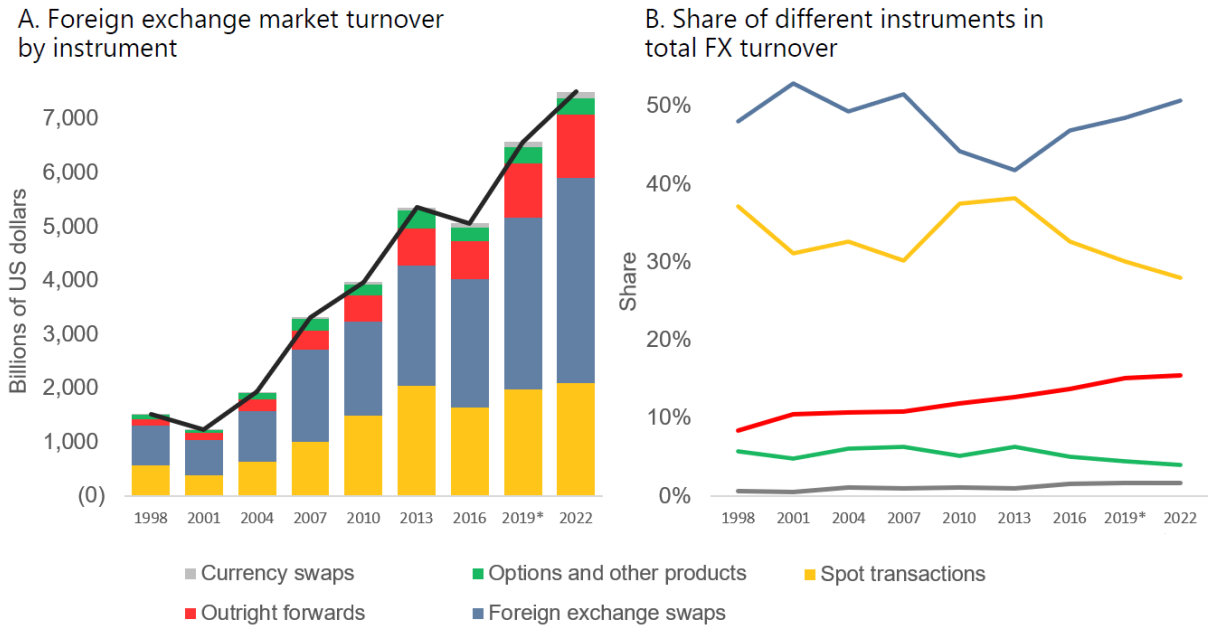

Figure 3: Global foreign exchange market turnover on a net-net basis and disaggregated by instruments in value (daily average as of April) and by share of total turnover
Source: BIS (2022*b*).

tracts should be traded on exchanges or electronic trading platforms, where appropriate, and cleared through central counterparties by 2012 at the latest. Even if the FX derivatives market did not play a role in the causes of the Global Financial Crisis, as the credit derivatives did, the regulatory response was wide enough to capture the FX market.

The reform can be briefed in five significant commitments (ISDA 2022).[13] First, mandatory margin requirements should be set for non-cleared derivatives, focusing on mitigating counterparty risk. The second commitment can be stated as "more capital requirements." The main goal of these reforms was to ensure that capital levels required for non-cleared transactions were higher than those for cleared trades, thereby facilitating a migration to clearing. The primary avenue for implementing the goal was the development of Basel III, which overhauls the treatment of market risk, counterparty credit risk, and exposure to central counterparties (CCPs). It is good to point out that adopting the Basel III standards is optional for most emerging and developing markets, and most have not adopted it.

Third, it is required to clear standardized derivatives through CCPs. Today, most derivatives are cleared in major jurisdictions. A cleared derivatives transaction is one in which a transaction between two counterparties is transformed into one where each counterparty faces the CCP. A CCP acts as a buyer to every seller and the seller to every buyer. Clearing provides several benefits: less exposure, less complexity, more transparency, and reduced

[13] See also Ranaldo (2023).

counterparty risk. As indicated by ISDA (2022), mandatory clearing requirements might not be an appropriate tool in jurisdictions with a relatively small derivatives market or exchange controls, as derivatives in these markets might not be sufficiently standardized, and the lack of market depth may not be adequate to establish a cost-efficient CCP. Clearing and margins' primary aim is to reduce systemic risk at the cost of implementing additional infrastructure.

The fourth point refers to comprehensive reporting requirements intended to enhance transparency and enable regulators to identify better and monitor risks. There are two types; the first is regulatory reporting of transactions by counterparts to the regulator or supervisors. The second is public reporting of transactions along with prices. Finally, the fifth point refers to the call for standardized OTC derivatives to be traded on electronic trading platforms or exchanges to protect against market abuse and improve market transparency – both pre-trade, which allows counterparties to better compare prices before executing a trade and post-trade, which enables parties to see prices at which trades have been executed. As of 2021 and according to FSB (2021), reforms were advanced; however, several FSB member jurisdictions have not yet implemented the commitments. For example, implementing final higher capital requirements for non-centrally cleared derivatives (NCCDs) was in place in 15 of 24 FSB member jurisdictions. Margin requirements for NCCDs were in force in 16 jurisdictions. Trade reporting requirements for OTC derivatives transactions were in force in almost all members, and more than 80% of new transactions must be reported (see Figure 10 in Appendix A). Central clearing requirements were in force in 17 FSB members.

3 FX Derivatives Markets in Emerging Markets

3.1 Sovereign and Currency Crises

In the late 1970s, banks in the United States (and other industrial countries) recycled OPEC (Organization of the Petroleum Exporting Countries) surplus to emerging markets, particularly Latin America. This occurred within a background of soaring commodity prices and high inflation in advanced economies, coupled with low real interest rates and weak loan demand in the United States. Capital flows through bank lending surged during this period. However, in the early 1980s, the situation changed dramatically. Interest rates rose sharply as the U.S. Federal Reserve acted to reduce spiraling double-digit inflation, thus dampening economic activity and lowering commodity prices and demand. As most of the loans had either short maturities or variable interest rates, the prospects for repayment

quickly deteriorated. In 1982, debtor countries, led by Mexico, could not secure the added credit they needed to pay the high interest and offset the shortfall of export earnings. Mexico's debt moratorium sent shock waves worldwide, and the highly exposed and leveraged banks retrenched from emerging markets and Latin America in particular. One after another, developing countries experienced currency, banking, or both crises (Kaminsky & Reinhart 1999) and sovereign default (Alfaro & Kanczuk 2005, 2009). Numerous crises, including some of the worst hyperinflations uncorrelated to wars, occurred in Latin America during the "lost decade" that followed.

The drought in capital flows lasted until 1990. Debt restructuring and negotiation paved the way for a rediscovery of emerging markets. Renewed access to international capital markets in the wake of the debt crisis resolution and financial liberalizations led to a surge in available external capital. Mexico, for example, implemented a successful inflation stabilization plan and, having signed the North American Free Trade Agreement (NAFTA), attracted many foreign investors. Notwithstanding the 1994-1995 Mexico crisis, capital flows to East Asian miracle economies, such as those in Korea and Malaysia, increased significantly, especially after 1995, when short-term interest rates in Japan headed toward unprecedented lows. Emerging countries experienced a surge of capital inflows. A period of extreme financial turbulence followed, starting in Asia and spreading to Latin America and other regions, causing a sharp reduction in capital flows and currency and financial crises.

The emerging market crises of the 1990s and early 2000s were characterized by high foreign currency debt and currency mismatches. There is a long strand of literature studying currency crises in emerging markets during the nineties (see Kaminsky & Reinhart 1999, Krugman 1999, Chang & Velasco 1998, Corsetti et al. 1999, Aghion et al. 2001, Cespedes et al. 2004, Calvo & Reinhart 2002, Calvo 2005). Currency mismatches, such as dollar liabilities versus domestic-currency assets, fueled exchange rate volatility and increased systemic risk. Developing countries are often characterized by their inability to borrow externally in their own currencies and their extensive domestic liability of dollarization/indexation. This exacerbates problems related to significant exchange rate movements. This accounts for the tendency of emerging market floaters to be guided more heavily than industrial countries by exchange-market developments, a reduced monetary autonomy phenomenon that Calvo & Reinhart (2002) have labeled "fear of floating." Currency mismatches and troubles associated with early financial liberalization and domestic factors were present in most of the crises in developing countries in the 90s and early 2000s, (Alfaro, Asis, Chari & Panizza 2019). These two decades imposed early experiences regarding currency crises in the developing world, especially in Latin America, and, in some cases, brought more attention and regulation to the FX market.

3.2 Recent Developments

The dominance of FX derivatives as traded instruments in emerging and developing economies reflects that the most critical risk factor for such economies has been the development of the FX rate, particularly where a large percentage of the local financial system's balance sheet is denominated in foreign currency. Most policymakers and market participants see FX risk as a leading risk factor and one they want to hedge (ISDA 2022).

Derivatives exposures of dealers headquartered in EMEs are concentrated, by far, in FX instruments, whereas those of dealers from advanced economies were concentrated in interest rate instruments. FX risk has been front and center in the minds of market participants and policymakers for a long time. In 2019, the turnover of FX derivatives denominated in emerging and developing markets currencies was more than four times greater than that of interest rate derivatives BIS (2019). In advanced economies, trading in the two asset classes has been less divergent, and interest rate derivatives volumes exceeded those of FX derivatives.

In line with global patterns, trading on OTC markets greatly exceeded that on exchanges. For EME currencies, OTC FX derivatives accounted for 95% of the total turnover, slightly below their 98% global share of turnover BIS (2019). In 2019, exchange-traded derivatives accounted for a substantial percentage of activity in only two currencies: the Brazilian real and the Indian rupee. Virtually alone among emerging economies, Brazil deserves special mention since it boasts relatively large and well-developed onshore derivatives exchanges that trade FX and interest rate contracts in addition to stock and commodity instruments. Brazilian FX futures and options are non-deliverable in that they are settled in domestic currency. A particular combination of factors gave rise to such a large derivatives market, where exchange-traded, both onshore and non-deliverable, transactions predominate (BIS 2016*a*). Also, Brazil does have an early regulation on OTC booking that resumes in the phrase "if not registered, not legal."

The FX market for EME currencies, dominated by OTC transactions with some exceptions, has seen an increase in non-bank financial institutions (NBFIs); and rapid growth in non-Delivery Forwards (NDFs). NDFs are contracts that, unlike their deliverable counterparts, settle in the same currency (typically the US dollar) at maturity, based on the movement of the underlying exchange rate. NDFs are particularly popular for trading non-convertible currencies. The key currencies behind the NDFs surge include the Korean won, Brazilian real, Indian rupee, and New Taiwan dollar.

In general, the growth of FX trading is mainly linked everywhere to the financial side rather than to corporate. However, as stated before, behind each financial transaction are

end-user origination trades that have a multiplication effect. Establishing a link in the data between the corporate and financial sides is difficult. More data and research are needed to disentangle this link. When focusing on EME currencies' turnover, the median is roughly 6% of annual GDP, compared to 26% for AEs The difference is related to the more limited size of the financial sectors and the abovementioned accounting bias.

According to BIS (2019), a notable recent trend in EME currency trading is related to the rising of China in the global economy and related market-friendly reforms to improve the flexibility of its exchange rate. Since 2016, the People's Bank of China has made a concerted effort to withdraw from daily interventions in the FX market, which has significantly enhanced the flexibility of the RMB exchange rate (Jin et al. 2021). Looking ahead, it might be in China's interest to further increase exchange rate flexibility and ultimately establish a more flexible exchange rate regime, which will lay the foundation for its further opening of the capital market and will pave the way for the internationalization of the RMB (Jin et al. 2021). Still, China lacks an appropriate (in terms of its economic size) onshore FX derivative market and lacks an onshore FX futures market which typically forms a critical component of a well-functioning multi-layered FX market.

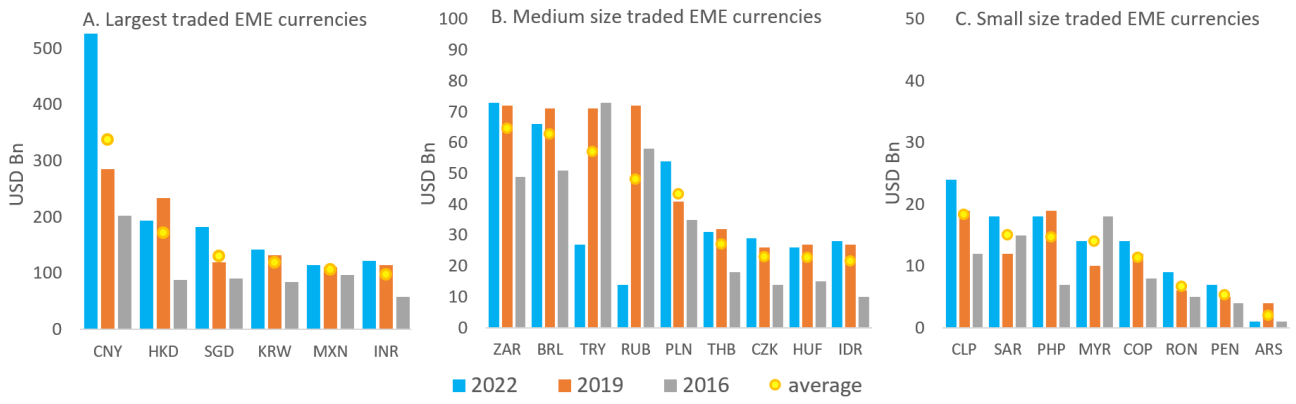

Figure 4: Turnover in EME currencies, daily average in April 2022, 2019, and 2016.

This graph shows the relative importance of FX trading transactions on emerging market currencies worldwide for 2022, 2019, and 2016. Currencies are divided into three groups according to the average turnover over the last years. The renminbi is the most traded currency from EME (also the fifth if we consider the world), and in 2022, it had an important rise.
Source: BIS (2022*b*).

According to the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (IMF 2022), most countries have limits on the financial sector's open FX positions. Financial stability is a concern when imposing macroprudential regulations on the FX market; however, these regulations can have unintended implications. In trade-dependent economies with nondominant currencies, nonfinancial firms' FX risk management is critical, even at the macroeconomic level. FX derivatives contracts may provide valuable means

for firms to manage their FX risk. Then, it would be reasonable to think that when such valuable hedging instruments are less available, firms may optimally reduce the underlying exposure by cutting their real output. Therefore, understanding the real implications of FX financial hedging is a question that is fundamental to finance and key for macroeconomic policymakers. Under firms' different integration strategies into global value chains and in the presence of capital market imperfections and financial constraints, exchange fluctuations can limit firms' innovation and productivity, see Alfaro, Cuñat, Fadinger & Liu (2022).

4 FX Derivatives in Corporates: Adding Value to the Firm and Implications

Although the FX derivatives market has had animpressive growth over the last decades, little is known about firms' use of FX derivatives and the links between the derivatives markets and the real economy. Even less academic work has focused on the implications of the (lack of) use of FX derivatives in emerging markets, even though such countries are more prone to FX volatility. Since the FX market has been predominantly traded OTC, the scarcity of data is one of the main problems in empirical research. Recently, new granular data sets started to open the black box, hand in hand with more regulation like the OTC reform after the Global Financial Crisis. In some cases, like Chile, Brazil, and Korea, early data availability at a firm level is exceptional, allowing good research on identification channels.

4.1 A Framework

In the Modigliani & Miller (1958) frictionless neoclassical framework, there is no role for hedging as it adds no value to the firm. The presence of market imperfections —such as financial frictions, transaction costs, and convex tax schedules—provides a rationale for the use of financial hedging as volatility becomes costly (Smith & Stulz 1985, Froot, Scharfstein & Stein 1993, Rampini & Viswanathan 2010 and Rampini, Sufi & Viswanathan 2014). This section develops the main insights of Froot et al. (1993), which provide a valuable theory starting point to this literature while providing examples.

Consider a two-period economy. In period $t = 1$, a firm has endowment w, which can be used to finance investment I. The production technology is $\theta f(I)$ with $f'(.) > 0, f''(.) < 0$. The firm may use external finance e to finance investment beyond its endowment, $I = w + e$.

Importantly, external finance is costly. In particular, consider the convex cost schedule $C(e)$ with $C'(.) > 0, C''(.) > 0$. Thus, assuming for simplicity that the gross interest rate is one, the profit $P(w)$ of the firm is given by $P(w) = f(I) - I - C(I - w)$.

The firm's first order condition on this problem is given then by,

$$f'(I) - 1 = C'(e) \tag{1}$$

Note that the fact that the firm faces an increasing external finance schedule implies that there is under-investment with respect to the unconstrained benchmark with $I^U = (f')^{-1}(1)$. Random fluctuations in w reduce profits as long as $P(w)$ is concave. Using the first-order condition, it can be shown that

$$P''(w) = f''(I)\left(\frac{dI^*}{dw}\right)^2 - C''(e)\left(\frac{dI^*}{dw} - 1\right)^2 \tag{2}$$

where $f''(I)$ and $C''(e)$ are evaluated at $I = I^*$. Equation (2) can be rewritten as

$$P''(w) = \frac{-f''(I)C''(e)}{f''(I) - C''(e)} \tag{3}$$

which makes it clear how the interaction of investment and financing considerations determines hedging. If hedging is to be beneficial, two conditions must be satisfied:

1. Marginal returns on investment must be decreasing, $f''(\cdot) < 0$
2. Capital market imperfections such that volatility is costly. For example, the level of internal wealth must have an impact on the optimal level of investment, $C''(\cdot) > 0$

Firms with a concave profit function $P(w)$, increase their profits, on average, by hedging. Figure 5 captures this intuition. The benefits of hedging are greater the higher the volatility of the flows, and the higher the concavity of the profit function.

If we focus on linear hedging strategies (like forwards), this baseline framework can be used to speak about the optimal hedging ratio, h. Writing the internal funds, the hedging decision can be modelled as:

$$w = w_0(h + (1 - h)\epsilon),$$

where ϵ is the source of uncertainty, $\epsilon \sim N(1, \sigma^2)$. To account for changing investment opportunities, let $\theta = \theta(\epsilon)$. Thus, the firm solves, $\max_{\{h\}} P(w)$, which results in the first

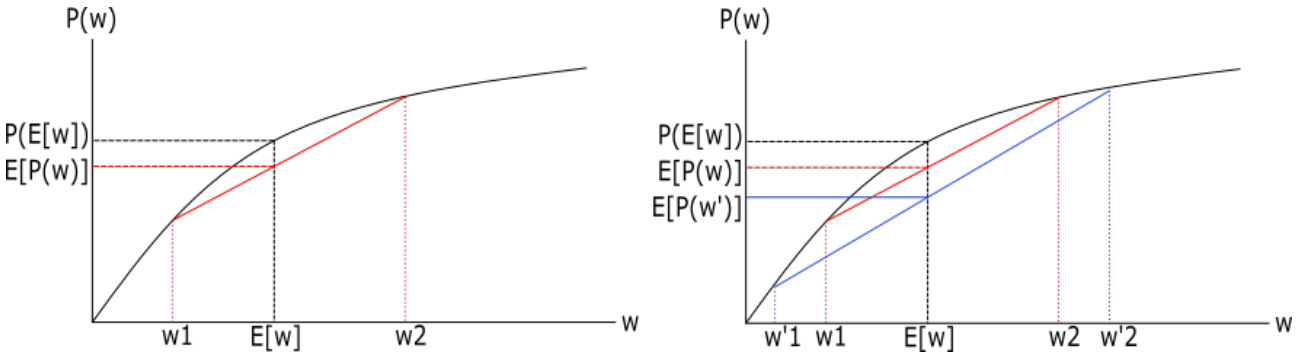

Figure 5: Benefits of hedging and volatility of w in FSS model

Notes: Firms that hedge receive on average $P(\mathbb{E}[w])$ and those that do not, receive $\mathbb{E}[P(w)]$. It is observed that the higher the dispersion in w, the difference between these measures grows, increasing the benefit of hedging. Therefore, as long as $P(\cdot)$ is concave, hedging will be beneficial.

order condition:

$$\mathbb{E}[P_w(1-\epsilon)w_0] = 0 \tag{4}$$

which can be reduced to $\text{cov}(P_w, \epsilon) = 0$. Then, a firm hedges optimally as long as it insulates the *marginal* value of the firm $P_w(w)$, and not necessarily the value of the firm, $P(w)$ from the origin of risk, ϵ. In this setup, complete hedging amounts to eliminating all risk, $h = 1$ and $w = w_0$. However, this may not be the optimal choice if $\theta = \theta(\epsilon)$. That is, if investment opportunities are correlated with the source of risk. In particular, a firm would choose $h < 1$ if $cov(\theta, \epsilon) > 0$. In this case, when ϵ is low, the endowment is low, bus so are the investment opportunities. The converse is also true. When ϵ is high, the investment opportunities are profitable, so the firm wants to get the larger cash-flow that comes from choosing $h < 1$. This idea is summarized in the timeline in Figure 6.

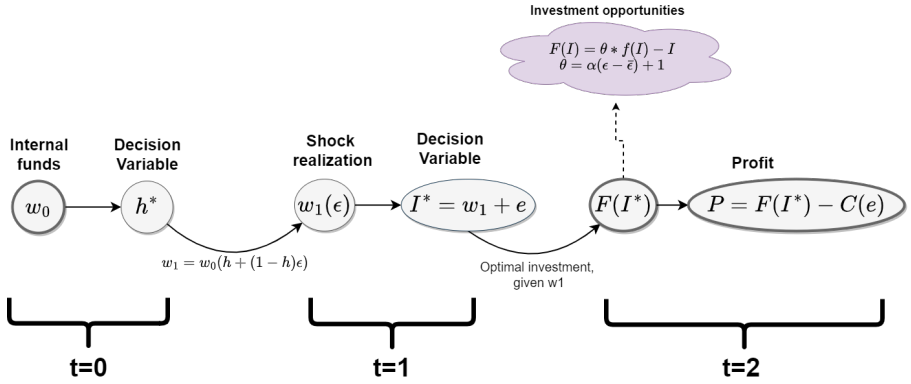

Figure 6: Timeline: Froot et al. (1993)

We now present a simple numerical exercise illustrating the main mechanisms for $\theta = \alpha(\epsilon - \bar{\epsilon}) + 1$. Table 1 presents the baseline calibration.

Table 1: Numeric Exercise: Calibration

Parameter	**Value**	**Name**
N_w	100	Net worth grid points
$[w_0^{min}, w_0^{max}]$	$[0.05, 0.8]$	Initial net worth
$\bar{\epsilon}$	1	Mean of ϵ
σ_ϵ^2	$1/25$	Variance of ϵ
N_ϵ	5	Number of states
$[\bar{\epsilon} - 2\sigma_\epsilon, \bar{\epsilon} + 2\sigma_\epsilon]$	$[0.06, 1.4]$	Discretization of ϵ
$\pi_{\epsilon,\epsilon'}$	$1/N_\epsilon$	Transition probability
α	0.3	Correlation term
θ	$\alpha(\epsilon - \bar{\epsilon}) + 1$	Investment opportunities
γ	$1/3$	Technology
$f(I)$	$(1/\gamma)I^\gamma$	Technology
ν	$1+\gamma$	Technology
$C(e)$	e^ν	Cost of external financing

As seen in Figure 7, the optimal hedging ratio increases with firm's size (w_0). This is because the volatility of the flows also increases with the size of the firm ($w = w_0(h + (1-h)\epsilon)$). However, this ratio has a limit. Due to the correlation between investment opportunities and flows, the firm does not need to be fully hedged. The firm is, in a sense, operationally hedged. The optimal hedging ratio reduces the volatility of external financing and maximizes the expected value of profits. Investment is increasing by w_0 because the firm prefers to finance itself with internal flows. This makes it possible to reduce external financing costs and increase investment. Overall, full hedging may not be optimal as it depends on the previous relationship. This result is in line with Salomao & Varela (2022) shows that firms might find it optimal not to hedge the currency risk and retain currency exposure to benefit from appreciations and the dynamic trade-off between currency risk and exploiting investment opportunities.

Figures 11 and 12 in the Appendix depict the extreme cases of $h = 0$ and $h = 1$, respectively. With $h = 0$, the fluctuations in w are entirely subject to the realizations of the ϵ shock, so they are more volatile. External financing decisions are negatively correlated with the realizations of w. That is, "good" realizations of w allow the firm to reduce its external financing. By reducing external financing, the firm can increase its investment. With $h = 1$, fluctuations in w are eliminated, and external financing decisions are no longer affected by different realizations of w. Since external financing cannot be reduced by positive realizations of w, the cost of external financing cannot be reduced either, thus decreasing the investment's convexity.

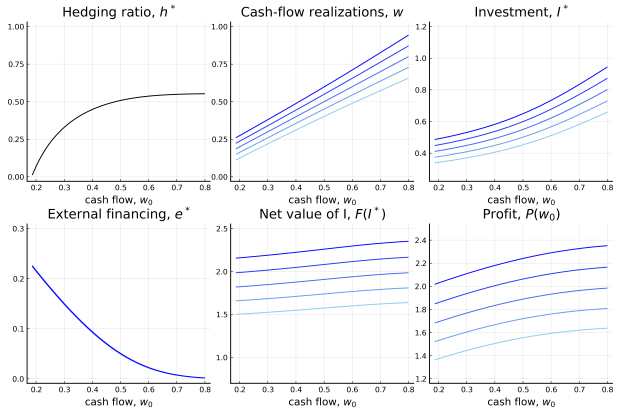

Figure 7: Calibration Exercise: Optimal Hedging Rate

(a) *Notes:* Darker lines represent better realizations of flows. Red lines correspond to the expected value.

4.2 Financial Constraint: Limiting Hedging

Rampini & Viswanathan (2010, 2013) and Rampini et al. (2014) stress the role of financial frictions in limiting hedging as there are competing demands on the firm's resources. The authors stress that collateral is needed to raisefinancing and for risk management. In particular, financially constrained firms may not engage in hedging because they rather use scarce resources in investment. That is, the financing needs for investment may override the hedging concerns. We similarly present a simple numerical exercise illustrating the main insights based on Rampini & Viswanathan (2010).

Assume that t t=0, the firm decides how much to invest in capital and how much debt capacity to maintain risk management. If the firm is small, the capital is very productive, thus the firm does not hold any financial slack. Due to the diminishing return to capital, at some point it is more profitable to maintain debt capacity (to cover bad states of nature) instead of investing it in additional capital. At t=1, the productivity of capital is so high (exogenously, not due to k_0), that the firm will invest all of it in capital and nothing to maintain financial slack. In this way $h_2(s) = 0$ in all states. Therefore, the model uncertainty resolves to $t = 0$.

In particular, the firm maximizes:

$$V_t(w(s^t), s^t) = \max_{d(s^t), k(s^t), w(s^{t+1}), h(s^{t+1})} d(s^t) + \beta \mathbb{E}[V_{t+1}(w(s^{t+1}), s^{t+1}) | s^t]$$

subject to, the budget constraint, $w(s^t) \geq d(s^t) + \wp k(s^t) + R^{-1}\mathbb{E}[h_{t+1}|s^t]$; net worth, $w(s^{t+1}) \leq A(s^{t+1})f_t(k(s^t)) + q(s^{t+1})k(s^t)(1-\theta) + h(s^{t+1})$; positive net worth, $w(s^{t+1}) > 0$; and credit restriction, $h(s^{t+1}) \equiv \theta q_{t+1}(s)k(s^t) - Rb(s^{t+1}) \geq 0$.

Table 2: Numeric Exercise: Calibration–Collateral Constraints

Parameter	Value	Name
$[w_0^{min}, w_0^{max}]$	$[1e{-}2, 3]$	Initial net worth
N_w	800	Net worth grid points
N_s	5	Number of states
$\pi_{s,s'}$	$1/N_s$	Transition probability
$q_1 = q_2$	1	Price of state contigent claim
β	0.95	Preferences
α	0.33	Technology
θ	0.8	Collateralization rate
R	$1/\beta$	Expected return
$A_1(s)$	$s/10$	Productivity $t = 1$
A_2	1.5	Productivity $t = 2$
$f(k)$	k^α	Technology

Figure 8 describes the timing of events while Table 2 the benchmark presents the parameters for the numeric exercise.

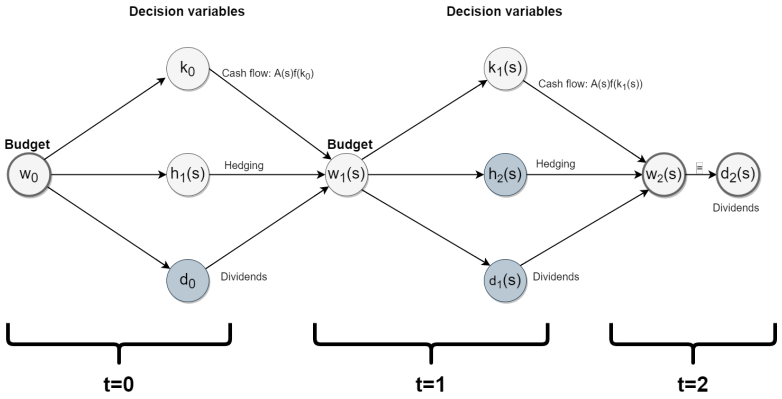

Figure 8: Timeline: Collateral Constraints)

Figure 9 displays areas of full, partial and no hedging against the distribution of net worth. Smaller firms engage in less risk management and may even use all their borrowing capacity and refrain from risk management altogether. For very low levels of net worth the main concern of firms is to finance investment and not to conserve debt capacity to carry out risk management. If funds are sufficiently scarce in period 0, it is optimal to allocate as many resources as possible to period 0, making it so that firms cannot move funds between states. That is, it cannot do hedging. In other words, credit restrictions limit the firm in the amount of funds that can move between periods and between states.

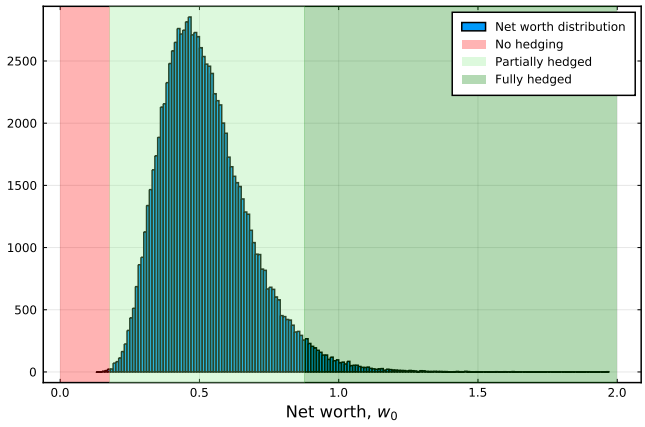

Figure 9: Hedging and Collateral Constraints.

4.3 Empirical Research: Firm's FX Risk Management

Early research already showed the value added of FX derivatives use, typically using surveys or balance sheet information from the non-financial sector. For example, Allayannis & Weston (2001) estimate (among US firms over the period 1990-95) that users of foreign currency derivatives command an average premium of 4.87% in firm value. Graham & Rogers (2002) examine a sample of US firms in the period 1994-95 and find that firms indeed hedge to increase debt capacity; the resultant tax benefits add about 1.1% to firm value. Finally, Geczy et al. (1997) using a sample of large US firms in 1990, find that firms use hedging with risk management motives. Their results are consistent with the hypothesis that hedging can reduce underinvestment costs associated with investment opportunities in the presence of financial constraints.[14]

The recent availability of granular data has allowed deeper analysis. In Chile, thanks to rich data on FX derivatives (FXD), firm-level balance sheets, and quasi-experimental scenarios of regulation changes, Alfaro et al. (2021) identify causal effects between the FXD market and the real economy. In the following two subsections, we will summarize this research and other related studies.

4.4 Currency Hedging under Dominant Currency

Foreign currency use can be a source of risk associated with currency mismatches, which firms can hedge using FXD. Alfaro, Calani & Varela (2021) uncover five facts about firms'

[14] An additional paper using data survey data is Bodnar et al. (2011). See also Adams & Verdelhan (2021) for a discussion and analysis of transaction and translation and exchange rate effects using listed firms' data for Japan and the US.

use of FXD and one causal link between the derivatives market and the real economy. The authors employ a unique dataset covering the universe of FXD transactions in Chile from 2005-2018, together with firm-level census data on employment, sales, international trade, trade credits, and foreign currency debt. This granular data allows them to estimate firms' foreign currency cash flows by currency and maturity and dissect their foreign currency transaction exposure arising from international trade and financing.

The authors show that payables and receivables in foreign currency are only slightly correlated, suggesting that firms do not match cash flows to be operationally (/naturally) hedged. For instance, the correlation between exports and imports—using various measures of cash flows and trade credits—is only between 2% and 3% (8% and 9%) during any given month (quarter). They show that this low correlation could arise from significant differences in the maturity of exports and imports financing, as the average maturity of trade credit from exports with direct vendors is 50% longer than that of imports (137 vs. 91 days) and 1,375 days for foreign debt.[15]

Firms employing FXD are the largest exporters, importers and foreign currency debt holders, and twice as large as exporters and importers firms non-using FXD. The finding echoes the literature in international trade (Bernard et al. 2007, Melitz 2003, Antras et al. 2017), multinational firms (Helpman et al. 2004, Alfaro & Chen 2018) and, foreign borrowing (Varela 2018, Salomao & Varela 2022), reporting selection into these markets. Large firms also shape trade and comparative advantage (Gaubert & Itskhoki 2021). The largest firms use FXD more at extensive and intensive margins, even after controlling for currency exposure. When assessing the use of FXD at the extensive and intensive margin, trade credit for exports and imports is associated with a higher probability and use of FXD, as is higher exchange rate volatility. The authors also find evidence that financial constraints limit firm's use of hedging, as in Rampini & Viswanathan (2010), Rampini et al. (2014).

At the transaction-level information of the data and like in most countries, the Chilean derivative market is predominantly OTC, implying bilateral relationships and search-and-bargaining features generally involve intermediaries (Duffie et al. 2005). Related to this, it is shown that contracts are priced differently within and across firms. For example, larger firms pay a lower premium when purchasing FX forwards.

Finally, a quasi-natural experiment that exogenously reduced the supply of FX forwards to firms is assessed to see how market-level conditions affect firms' FX financial hedging and their real outcomes. In particular, the focus is on a regulatory change to Pension Funds' (PFs) hedging requirements that reduced their sales of FX forwards to banks. The regula-

[15]Money-market hedging that would allow export receivables to be hedged using foreign currency debt would be hard to implement in terms of financial planning, as the median maturity of foreign debt is about three years longer than the median maturity of exports.

tion, implemented in 2012, allowed PFs to increase their share of non-hedged portfolios. As a result, PFs -who are net suppliers of FX forward– reduced their supply of FX derivatives. This lower supply affected firms seeking to take long FX positions (e.g., importers and foreign currency borrowers), who substantially reduced their purchases of FX forwards, a fall equivalent to 75% of quarterly imports. The paper shows that lower use of FXD had real implications as firms experienced a fall in employment and trade and, thus, FX financial hedging adds value to the firm.

In evidence regarding maturity hedging, Gurkaynak et al. (2022) exploit S&P500 firms' differential issuances of long-term floating rate debt, fixed debt, and interest risk hedging, which leads to differential cash flow exposure. The authors show that firms with more cash flow exposure see their stock price decline more on the day of FOMC forward guidance surprises. Moreover, firms with more cash flow exposure invest less, have fewer assets, and lower net worth in the following quarters. Hedging mitigates the cash flow and the real effects adding value to the firm.

Additional Evidence

Korea and Limits to FX Use by Banks. In the case of Korea, Jung (2021) shows how a macroprudential FX regulation caused a shortage of FX hedging instruments and, consequently, reduced exports. These findings have important implications. First, they imply that FX derivative contracts are essential hedging instruments for firms to manage their FX risks. Second, they suggest that a well-functioning FXD market can facilitate international trade. Third, they imply that macroprudential FX regulations can hurt real economic outcomes of the nonfinancial sector, even if they mitigate financial sector vulnerabilities.

In this paper, an exogenous shock to the supply of FXD hedging is caused by regulation that limits bank ratios of FXD positions to equity capital in Korea. Since the regulation constrained only a subset of banks, it was possible to estimate the bank-specific tightness of the measure. This cross-bank heterogeneity in the strictness of regulation provides an identification strategy for the empirical analysis, as the firm-bank relationship is persistent or "sticky." Jung (2021)'s results provide further evidence that a negative FXD supply shock can trigger a decline in exports, and regulations aiming to curtail financial intermediary risk-taking can negatively affect the real economy. In this setup, imbalances in hedging demand, banks' costly equity financing, firms' costly switch banking relationships, and firms' costly external financing play critical roles in explaining the empirical findings.

Brazil and 2007 OTC Reform. Araujo & Leão (2016) analyzed how a regulatory change in the OTC derivatives market in Brazil affected the non-financial sector. These changes generated additional costs for financial institutions that may be passed on to customers through the bank spread. With the intent to evaluate the impact of these proposals, BIS experts esti-

mated that the expected benefits of the regulatory changes outweighed the costs, according to the results of macroeconomic models (BIS Macroeconomic Assessment Group on Derivatives (MAGD) in 2013). The authors evaluate whether an exogenous increase in the cost of FXD after a regulation change in 2011 was transferred to non-financial firms through prices in OTC derivatives. The Brazilian government intended to charge non-resident investors to diminish carry trade, causing the local currency to appreciate. However, this cost was transmitted to non-financial firms — the so-called end-users of derivatives. The authors' results show that the cost of hedging in the OTC market more than doubled for non-financial companies exposed to a local currency devaluation (e.g., importers).

These results relate to the empirical literature that documents that the use of FX derivatives is more prevalent in firms with trade-related exchange rate exposure (Korea, Bae et al. (2018); Euro countries, Lyonnet et al. (2016); Germany, Kuzmina & Kuznetsova (2018); Brazil, Rossi-Júnior (2012); Chile, Miguel (2016); Colombia, Alfonso-Corredor (2018); and Mexico, Stein et al. (2021) among others). In addition, Fraschini & Terracciano (2021), find that French exporters turn to invoice in U.S. dollars when they access FX derivatives. Bahaj & Reis (2022) show that the introduction of swap lines allows firms to invoice in their own currency. Although a comprehensive welfare analysis is beyond the scope of this paper and any of the previous ones, these findings suggest that the cost increase should be a concern to the extent that it could prevent EME firms from hedging their FX positions as even under foreign currency pricing, firms retain substantial currency exposure.

5 Final Comments

The goal of this chapter was to highlight two things—first, the importance of foreign exchange derivatives, particularly in emerging markets where the use of foreign currency is prevalent. Second, stress the firm side of this market and show possible real economic linkages. We first summarized historical and background information about the foreign exchange derivative market and the trends in its use, focusing on emerging markets and emerging market currencies. Although there was a remarkable rise from low levels, derivatives markets in the developing world have a way to go further. These financial instruments have an essential role in supporting economic growth and the development of capital markets, and everything indicates that it should continue to increase. Regulation must consider implications and balance financial stability motives with its real consequences. More research is needed in this direction, and new coming data will allow us to do it.

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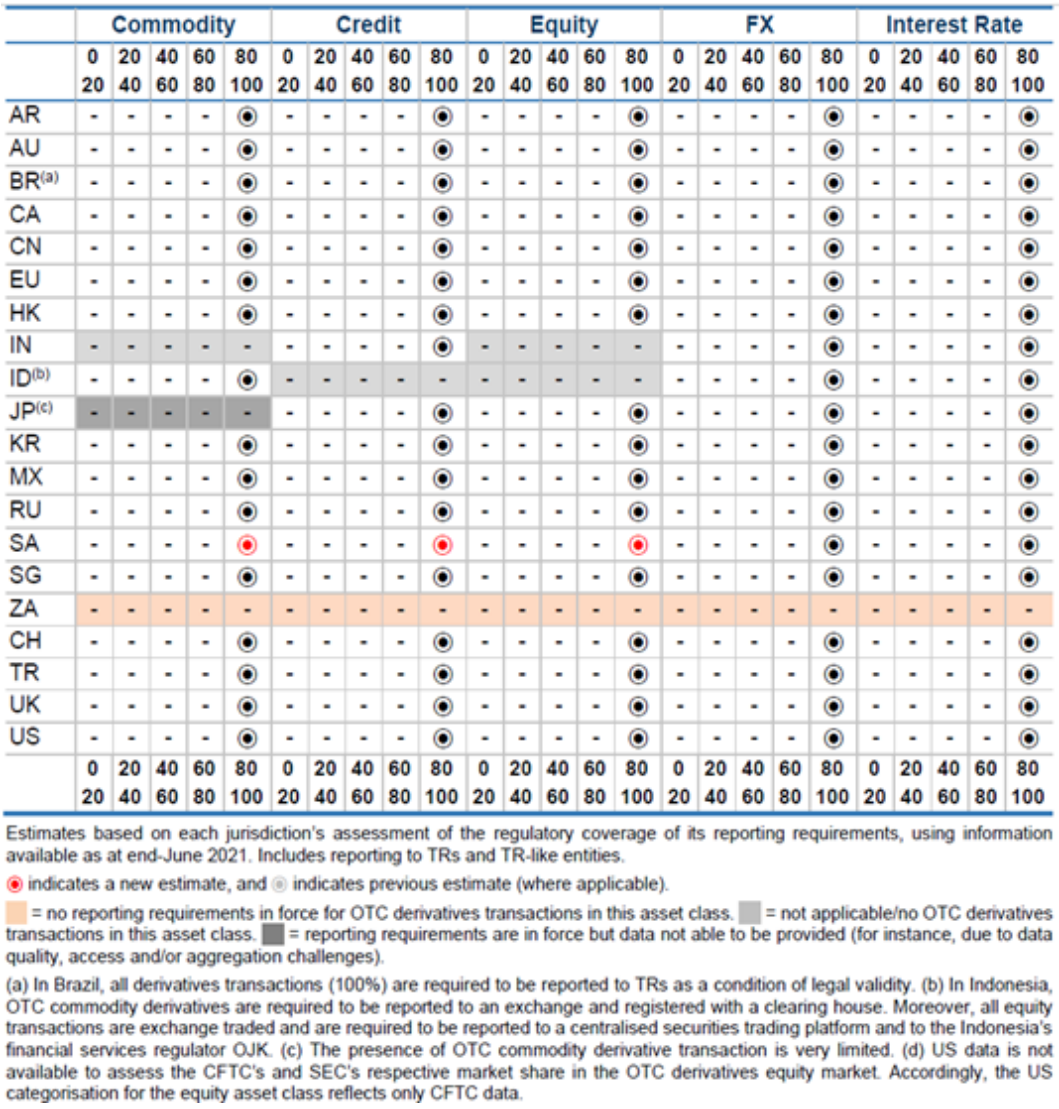
A G-20 OTC reform and coverage



	Commodity					Credit					Equity					FX					Interest Rate				
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	0 20	20 40	40 60	60 80	80 100	0 20	20 40	40 60	60 80	80 100	0 20	20 40	40 60	60 80	80 100	0 20	20 40	40 60	60 80	80 100	0 20	20 40	40 60	60 80	80 100

Estimates based on each jurisdiction's assessment of the regulatory coverage of its reporting requirements, using information available as at end-June 2021. Includes reporting to TRs and TR-like entities.

◉ indicates a new estimate, and ◉ indicates previous estimate (where applicable).

= no reporting requirements in force for OTC derivatives transactions in this asset class. = not applicable/no OTC derivatives transactions in this asset class. = reporting requirements are in force but data not able to be provided (for instance, due to data quality, access and/or aggregation challenges).

(a) In Brazil, all derivatives transactions (100%) are required to be reported to TRs as a condition of legal validity. (b) In Indonesia, OTC commodity derivatives are required to be reported to an exchange and registered with a clearing house. Moreover, all equity transactions are exchange traded and are required to be reported to a centralised securities trading platform and to the Indonesia's financial services regulator OJK. (c) The presence of OTC commodity derivative transaction is very limited. (d) US data is not available to assess the CFTC's and SEC's respective market share in the OTC derivatives equity market. Accordingly, the US categorisation for the equity asset class reflects only CFTC data.

Figure 10: Estimated regulatory coverage of reporting requirements: percent of all new transactions that are required to be reported

Source: FSB (2021)

B Additional Examples: Froot et al. (1993) Model

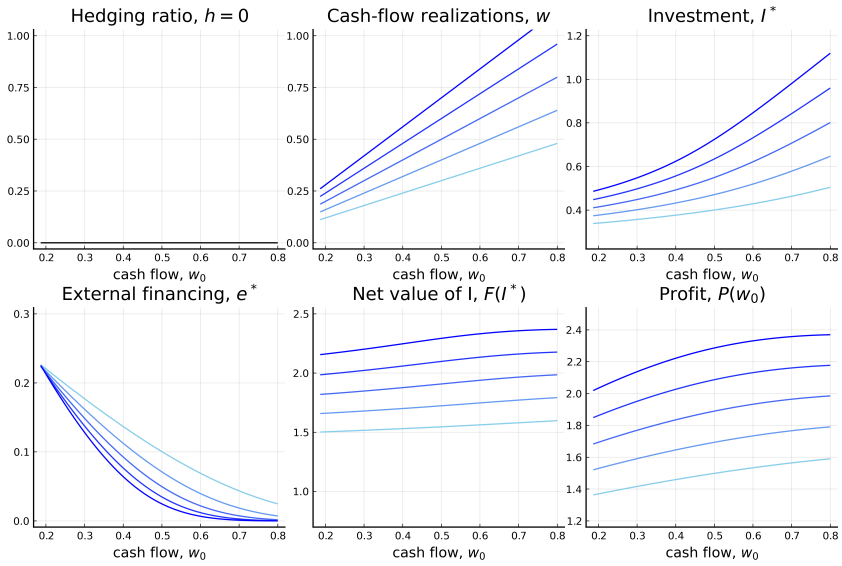

Figure 11: FSS Mode: Optimal Hedging Rate For $h = 0$

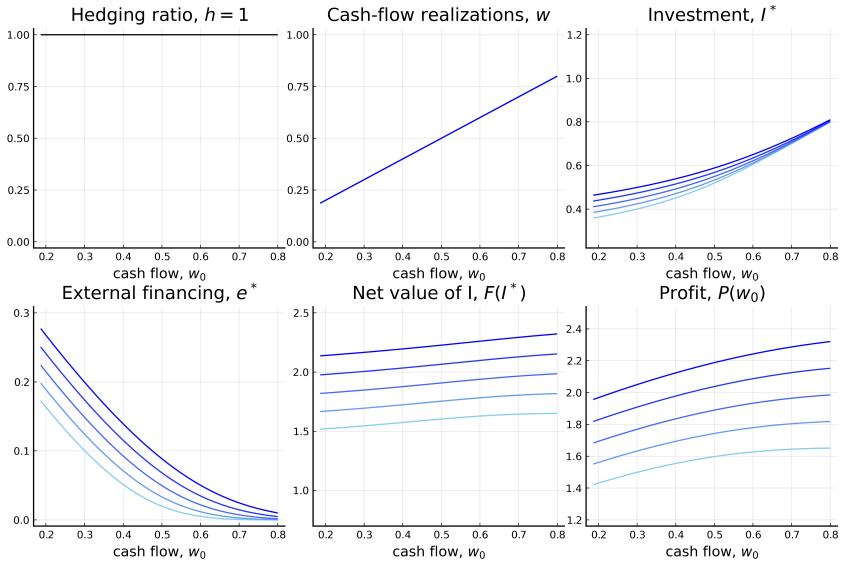

Figure 12: FSS Mode: Optimal Hedging Rate For $h = 1$

C Glossary

Based on BIS (2016*b*, 2022*a*, 2019, 2016*a*, 2012).

- **Basel I, II, III.** Set of regulations and guidelines from the Basel Committee. The Committee, headquartered at the Bank for International Settlements in Basel, was established to enhance financial stability by improving the quality of banking supervision worldwide and as a forum for regular cooperation between its member countries on banking supervisory matters. Up to 2022, three major accords (I, II, and III) included several regulatory and supervisory guidelines that member countries compromised to follow. One of the most important agreements established banks' capital requirements and risk measurements.

- **Central counterparty (CCP).** An entity that interposes itself between the two sides of a transaction, becoming the buyer to every seller and the seller to every buyer.

- **FX market.** A global decentralized, mostly over-the-counter (OTC) market for the trading of currencies. This market determines foreign exchange rates for every currency. It includes all aspects of buying, selling, and exchanging currencies at current or determined prices. In terms of trading volume, it is the largest market in the world, followed by the credit market.

- **FX market global participants.** The major participants are commercial and investment banks (Dealer Institutions). Banks buy and sell currencies on behalf of clients or for their accounts. These transactions are executed over the so-called interbank market, comprise the most significant part of all foreign exchange activities, and are dominated by a few banks. The second largest group in the interbank market comprises institutional investors like hedge funds, mutual and pension funds, and insurance companies; they use the foreign exchange market primarily to buy and sell foreign securities or for purposes of hedging, investing, or risk management. There are also non-financial corporations with locations and business relations worldwide using the foreign exchange market to execute cross-border payments, convert payments received in foreign currencies, and hedge with derivatives, future payments, and proceeds against potential exchange losses. Finally, the central bank's participation in the market is mostly limited to managing their foreign exchange reserves or buying and selling their currencies to affect the exchange rate.

- **FX market most common transactions/products.**

  - **Spot transaction:** The most common form of foreign exchange trading. This refers to a transaction where the buyer and seller exchange different currencies

for one another within one or two business days. The exchange rate referenced throughout this chapter is the price at which spot transactions are executed. That exchange rates change constantly is a source of risk for companies that do business in different currencies. This is because there is often a time lag between product or service delivery and payment, during which the exchange rate can develop unfavorably for one party.

  - (Outright) Forward Contract: Forward contracts involve an agreement to exchange two currencies at a pre-defined exchange rate on a specified date. Forward contracts can be arranged for any period, and currency pairs are typically used to hedge known future expenditures or proceeds.
  - **FX Swap:** A single transaction that combines a spot and forward contract going in opposite directions. The counterparties first exchange two currencies at the spot rate, then reverse the transaction using a forward contract. In both swap transactions, the amount of one currency is fixed. Banks and other dealer institutions widely use FX swaps to manage liquidity and avoid exchange rate risk for a temporary foreign currency position.
  - **Currency Swap:** A contract that commits two counterparties to exchange streams of interest payments in different currencies for an agreed-upon period and to exchange principal amounts in different currencies at an agreed-upon exchange rate at maturity.
  - **Options:** An option affords the holder the right to buy (call option) or sell (put option) a currency at a pre-defined exchange rate on a specified date. The holder is not obligated to exercise the option (in contrast to a forward contract).
  - **Currency swaption:** OTC option to enter into a currency swap contract.
  - **Currency warrant:** OTC option; long-dated (over one year) currency option.
  - **FX Futures:** FX futures oblige two counterparties to exchange a pre-determined amount of currency at a pre-defined exchange rate on a specified date. Forward differ from futures contracts in that the latter are standardized with regular maturity dates and traded on organized exchanges.

- **Hedge fund.** Unregulated investment fund and various types of money managers, including commodity trading advisers (CTAs), sharing some of the following features: they often follow a broad range of investment strategies that are not subject to borrowing and leverage restrictions, many of them using high levels of leverage; they often have a different regulatory mandate than ”institutional investors” and typically cater to sophisticated investors such as high net worth individuals or institutions; and they often hold long and short positions in various markets, asset classes and instruments, with regular use of derivatives for speculative purposes.

- **Non-Deliverable Forwards (NDFs) and Non-Deliverable Swaps (NDS).** An NDF or NDS is a cash-settled, usually short-term, forward contract. The notional amount is never exchanged: "non-deliverable." Two parties agree to take opposite sides of a transaction for a set amount of money—at a contracted rate, in the case of a currency NDF. This means that counterparties settle the difference between the contracted NDF price and the prevailing spot price. The profit or loss is calculated on the notional amount of the agreement by taking the difference between the agreed-upon rate and the spot rate at the time of settlement.

- **Onshore–offshore currency markets.** Offshore currency trading refers to the intermediation of funds denominated in each currency outside its country of issuance. It is how credit is provided and obtained in various currencies outside the jurisdiction of the country where the currency originates. The market where such intermediation takes place is known as the offshore currency market. The offshore currency market can be viewed as a parallel money market, which offers financial instruments that compete with similar products in the onshore market. The main difference between the two markets is that the offshore market separates the currency of denomination from the country of the jurisdiction (i.e., it takes the exchange risk of one country and combines it with the regulatory climate and political risk of another country where the financial center is located). Such a market generally emerges in places with highly developed financial structures, a broader array of instruments, and competitive, efficient institutions.

- **OTC Market.** The FX market is over the counter (OTC) when transactions are executed between two parties away from regulated exchanges.

- **Proprietary trading.** When a financial institution trades for direct gain instead of commission, the institution has decided to profit from the market rather than from commissions from processing trades.

- **Proprietary trading firm (PTF).** An entity that engages mainly in proprietary trading. PTFs include high-frequency trading firms.

- **Risks in the FX market:**

  - **Transaction risk:** refers to the impact of exchange rate changes on the value of committed cash flows (cash flows that lie in the future, but the nominal value of which is known). These are mostly receivable (payables) from export (import) contracts and repatriation of dividends. Usually, the time frame for committed transactions (the time between contracting and payment) is relatively short. However, it can sometimes reach several years, where deliveries are committed long in advance (e.g., US dollar-denominated forward sales of planes or building contracts). Transaction risk can be easily hedged using standard products

(mainly forwards). Hedging becomes more difficult for the longer term because the cash flow may be uncertain.

  - Translation risk: refers to the impact of exchange rate changes on the valuation of foreign assets (mainly foreign subsidiaries) and liabilities on a multinational company's consolidated balance sheet. Usually, translation risk is measured in net terms, i.e., net foreign assets minus net foreign liabilities.
  - Economic risk: refers to the impact of exchange rate movements on the present value of uncertain future cash flows. It comprises the effect of exchange rate variation on future revenues and expenses through both variations in price and volume.

- **Trade execution methods.** At the broadest level, we can distinguish between "voice" and "electronic" execution. Within each, we can differentiate between "direct" (bilateral) and "indirect" (brokered) trading. "Direct" includes relationship-based trading via phone, a chat system, a proprietary single-bank platform, or a direct electronic price stream. "Indirect" refers to the involvement of a third party in the matching process. This can, for instance, be a traditional voice broker, an electronic broking platform, or a multi-bank platform.