

Offshore markets drive trading of emerging market currencies¹

FX markets for the currencies of emerging market economies grew more rapidly than those for major currencies between 2016 and 2019, rising from 19% to almost 25% of global turnover. At the same time, these currencies attracted a wider range of participants and saw a rapid increase in offshore trading activity. Offshore markets tended to drive onshore markets during times of global market stress.

JEL classification: F31, G12, G23.

In foreign exchange (FX) markets, the trading of emerging market economy (EME) currencies outgrew that of major currencies between 2016 and 2019. While global turnover rose by 33%, the turnover of EME currencies rose by almost 60% over this period, to \$1.6 trillion. This article highlights recent trends in the trading of EME currencies and discusses the main drivers of their recent growth.

One notable trend in EME currency trading was an increase in the share of trading generated by hedge funds, proprietary trading firms (PTFs) and other financial customers. A second trend was a surge in offshore trading. An important driver here was the growing appetite of global investors for EME assets. In addition, the electrification of FX trading enabled smaller players to participate in a market traditionally dominated by inter-dealer trading among large banks. Finally, activity continued to be influenced by restrictions on currency convertibility.

The remainder of this article is organised as follows. The next section describes the growth in FX markets for EME currencies between 2016 and 2019, drawing on data from the BIS Triennial Central Bank Survey.² We then detail changes in the composition of market participants, instruments and trading venues and analyse their drivers. The last section summarises the key policy implications.

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² For information about the Triennial Survey, see www.bis.org/statistics/rpfx19.htm.

Key takeaways

- Markets for EME currencies grew faster than those for major currencies between 2016 and 2019.
- Global demand for emerging market assets and the electrification of trading drove recent growth.
- During times of FX market stress, offshore markets for EME currencies tend to drive onshore prices.

Growth of FX trading in EME currencies

For many years, FX trading in EME currencies has outgrown that of advanced economy (AE) currencies. The average daily turnover of EME currencies rose by almost 60% between April 2016 and April 2019, to almost \$1.6 trillion (Graph 1, left-hand panel). This boosted the share of EME currencies in global turnover to 23%, up from 19% in 2016 and 15% in 2013.

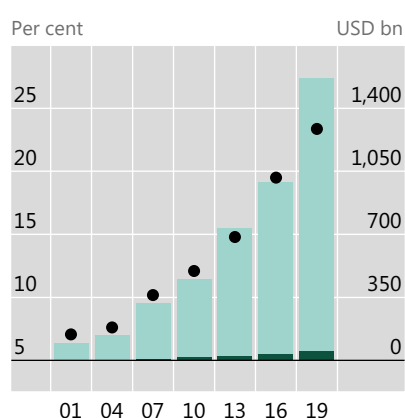
The increase in FX turnover was particularly pronounced in many Asian currencies (Graph 2). The Chinese renminbi was the most traded EME currency, at \$289 billion per day in April 2019, but its 48% growth between 2016 and 2019 was moderate when compared with that of many other currencies (see Packer et al (2019) in this issue).

Trading in the Indian rupee, Indonesian rupiah and Philippine peso more than doubled, despite continued restrictions on their convertibility. In contrast, many of the more freely convertible EME currencies, such as the Mexican peso, Singapore dollar and South African rand, experienced below average growth. The Hong Kong

Turnover in EMEs FX markets continued to rise

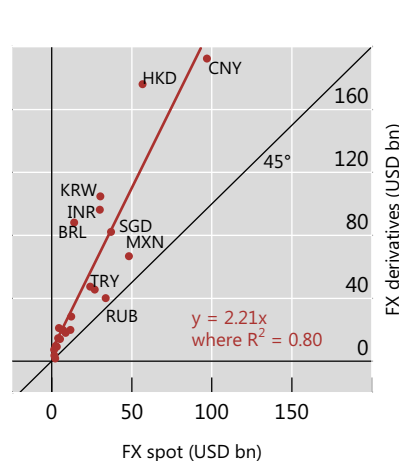
Graph 1

Total FX turnover in EME currencies^{1,2}

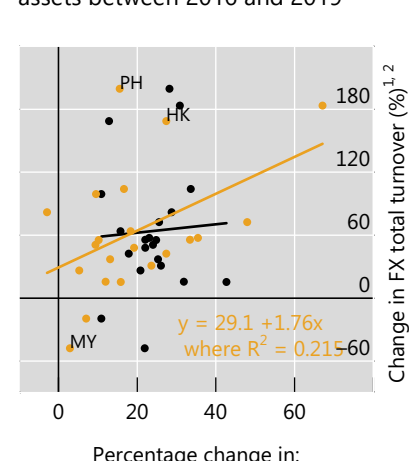


Lhs: ● Share in global turnover
Rhs: ■ Over-the-counter derivatives
■ Exchange-traded derivatives

FX derivatives vs spot in EME currencies in 2019^{1,3}



Change in FX turnover vs international trade and external assets between 2016 and 2019⁴



● Total trade⁵ ● IIP assets⁶

¹ OTC data are adjusted for local and cross-border inter-dealer double-counting. EME currencies = ARS, BRL, CLP, CNY, COP, CZK, HKD, HUF, IDR, INR, KRW, MXN, MYR, PEN, PHP, PLN, RUB, SAR, SGD, THB, TRY and ZAR. Turnover at constant exchange rate in April 2019. ² FX data include OTC (spot, outright forwards, FX swaps, currency swaps and options) and exchange-traded transactions (futures and options). ³ FX derivatives = Total OTC turnover minus spot transactions for each currency plus exchange-traded transactions. Slope is statistically significant at 1% level. ⁴ ARS excluded from the sample. ⁵ Sum of merchandise exports and imports over 12 months to April of each year. ⁶ External assets (from the international investment position) as of Q1; for Malaysia, Q4 2018. Slope is statistically significant at the 5% level.

Sources: IMF, *Balance of Payments and Direction of Trade Statistics*; national data; BIS Triennial Central Bank Survey; authors' calculations.

dollar stood out with one of the largest increases in turnover, due probably to temporary factors in April 2019 related to local funding conditions.

A notable exception to the rapid increase in EME currencies' turnover was the Malaysian ringgit, which experienced a 48% decline in turnover between 2016 and 2019. New administrative restrictions contributed to the sharp decline in ringgit turnover. The Malaysian authorities banned offshore trading of non-deliverable forwards (NDFs) by domestic entities.³ As a result, offshore trading in the ringgit collapsed between 2016 to 2019. While measures were also introduced to promote onshore trading, the rise in onshore trading could not outweigh the decline in offshore trading.

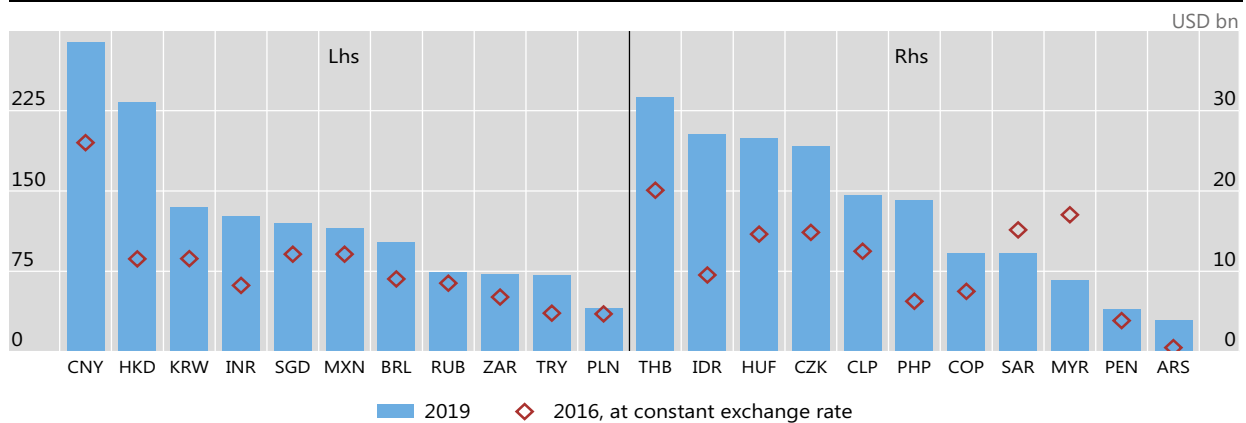
For EME currencies, as for AE currencies, the turnover of FX derivatives greatly exceeded spot transactions. Derivatives trading in EME currencies approached \$1.1 trillion per day in April 2019, whereas spot trading was less than \$0.5 trillion. The volume of derivatives trading was, on average, double that of spot trading for both EME and AE currencies (Graph 1, centre panel).⁴ Notable exceptions included the Mexican peso and Russian rouble, where derivatives trading in April 2019 was low relative to spot trading, and the Hong Kong dollar, where derivatives trading was relatively high. For most EME currencies, the FX derivatives markets were larger and more developed than those for interest rate derivatives (see Box A).

In line with global patterns, trading on over-the-counter (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.⁵ In April 2019, exchange-traded derivatives accounted for a substantial share of activity in only two currencies: the Brazilian real (36%) and the Indian rupee (13%).

Turnover in most EME currencies grew, particularly in emerging Asia

Total FX turnover by currency, daily average turnover in April¹

Graph 2



¹ OTC transactions are adjusted for local and cross-border inter-dealer double-counting. Data include OTC (spot, outright forwards, FX swaps, currency swaps and options) and exchange-traded transactions (futures and options).

Sources: BIS derivatives statistics and Triennial Central Bank Survey; authors' calculations.

³ NDFs are forward contracts that do not involve an actual exchange of currencies. Instead, they entail a settlement of the difference between the actual and a pre-agreed exchange rate in a single US dollar payment at maturity.

⁴ The ratio understates spot trading because, in the Triennial Survey, the spot leg of FX swaps is not reported. This bias is more sizeable for AE currencies, given their larger share of FX swaps trading.

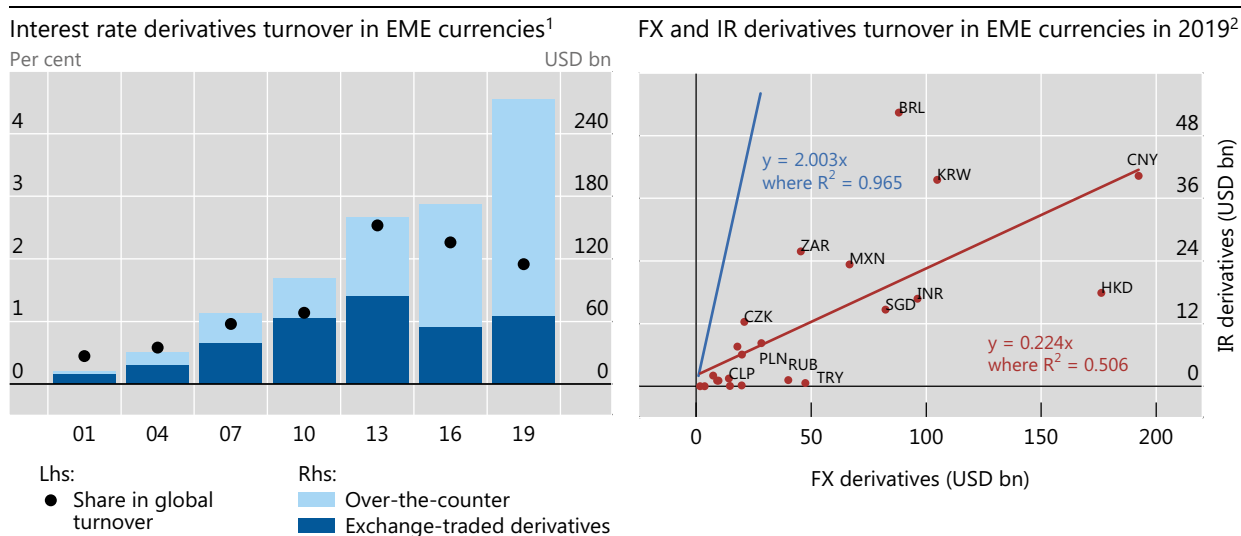
⁵ The dominant share of OTC markets is partly explained by the greater flexibility that OTC deals offer to meet special demands, such as for specific maturities and trading currency pairs not involving the US dollar (Wooldridge and Xia (2019)). While the US dollar remained dominant, as the currency on one side of 99% of all trades on exchanges in April 2019, its share in OTC markets was lower, at 90%.

FX instruments dominate derivatives markets in EMEs

The relative size of FX and interest rate derivatives markets differs markedly between EMEs and AEs. The turnover of interest rate derivatives in EMEs rose significantly between April 2016 and April 2019, increasing from \$173 billion to \$273 billion (Graph A1, left-hand panel).^① Nevertheless, in April 2019, the turnover of FX derivatives denominated in EME currencies was still more than four times greater than that of interest rate derivatives. This was in stark contrast to AE currencies, where trading in the two asset classes was on a more equal footing. In the right-hand panel of Graph A1, the red line suggests that the ratio of interest rate to FX derivatives turnover is much smaller than one for EME currencies on average, indicating that FX instruments predominate in EME derivatives markets. In comparison, the blue line, for AEs, revealed more activity in interest rate derivatives than in FX derivatives.

FX outweighs interest rate instruments in EME derivatives trading

Graph A1



¹ EME currencies = ARS, BRL, CLP, CNY, COP, CZK, HKD, HUF, IDR, INR, KRW, MXN, MYR, PEN, PHP, PLN, RUB, SAR, SGD, THB, TRY and ZAR; AE currencies = AUD, CAD, CHF, EUR, GBP, JPY, NOK, NZD, SEK and USD. Interest rate derivatives include OTC (forward rate agreements, options, overnight indexed swaps, other interest rate swaps and other instruments). OTC derivatives are adjusted for local and cross-border inter-dealer double-counting. Turnover at constant exchange rate in April 2019. ² FX derivatives = OTC and XTD excluding spot transactions. IR derivatives = OTC and XTD transactions. Blue line corresponds to AEs; red line corresponds to EMEs.

Sources: BIS derivatives statistics and Triennial Central Bank Survey; authors' calculations.

The notional amounts outstanding painted a similar picture. For EME currencies, FX and interest rate derivatives markets were similar in size, whereas for AE currencies interest rate derivatives volumes exceeded those of FX derivatives by a large margin (see Aramonte and Huang (2019) in this issue).

The smaller scale of interest rate derivatives activity in EMEs, as compared with AEs, reflected several factors. Less-developed bond markets and benchmark rates in EMEs meant more limited demand for interest rate derivatives. In addition, tighter control of capital markets in EMEs further curbed demand, by restricting the investor base. The EMEs that stood out in terms of interest rate derivatives activity were Mexico and South Africa, which have better developed bond markets than most other EMEs, as well as freely convertible currencies.

Changes in the turnover of interest rate derivatives varied considerably across currencies (Annex Table A1, second and third columns). Most Asian currencies witnessed significant increases. In particular, renminbi interest rate derivatives increased more than threefold, overtaking the Mexican peso as the most actively traded EME instrument in this category. On the other side of the spectrum, interest rate derivatives trading declined in several Latin American currencies (Argentine peso, Chilean peso, Colombian peso and Peruvian sol).

① See Ehlers and Hardy (2019) in this issue for an overview of recent trends in global interest rate derivatives markets.

Evolving market structure

Two notable trends have characterised the FX market for EME currencies in recent years; first, the increased presence of non-bank financial institutions; second, the rapid growth in forwards, in particular NDFs, and the related increased role of offshore transactions.

Rising prominence of non-bank financial institutions

In general, the growth of FX trading is linked more strongly to financial motivations than to trade in goods and services. In the right-hand panel of Graph 1, the orange line shows a positive relationship across EMEs between the growth in gross external financial assets and FX turnover. By contrast, the black line shows that the relationship between trade in goods and services and FX turnover was much weaker.⁶ These results accord with the dominant role of financial factors in driving activity in FX markets, as documented elsewhere (eg Schrimpf and Sushko (2019a) in this issue).

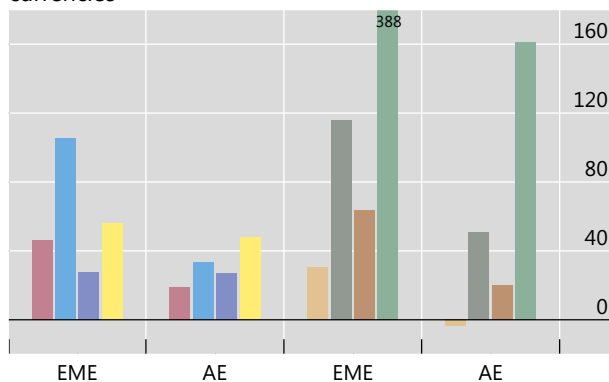
Consistent with the dominant role of financial factors, the recent growth in FX turnover for EME currencies was led by trading with non-bank financial institutions (NBFIs). This contrasts with AE currencies, where smaller (non-dealer) banks played

Growth of EME currencies trading was driven by non-bank financial institutions¹

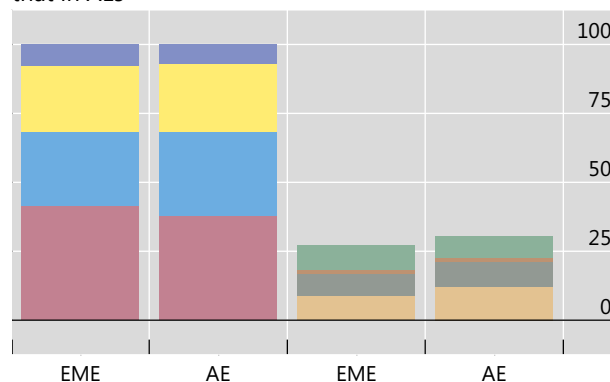
In per cent

Graph 3

OFIs are increasingly important counterparties for EME currencies²



Market ecosystem for EME currencies becomes more like that in AEs³



Counterparty:

RD
NBFI
NFC
Banks

NBFIs:

Institutionals
HF and PTFS
Official sector
Others

EME currencies = ARS, BRL, CLP, CNY, COP, CZK, HKD, HUF, IDR, INR, KRW, MXN, MYR, PEN, PHP, PLN, RUB, SAR, SGD, THB, TRY and ZAR; AE currencies = AUD, CAD, CHF, EUR, GBP, JPY, NOK, NZD, SEK and USD.

Counterparty: RD = reporting dealers; Banks = non-reporting banks; NBFI = non-bank financial institutions; NFC = non-financial customers; HF & PTFS = hedge funds and proprietary trading firms; Others = others and undistributed.

¹ FX OTC daily average turnover in April adjusted for local and cross-border inter-dealer double-counting. ² Growth rate in FX turnover in April 2019 with respect to April 2016 at constant exchange rate for EME and AE currencies. Spot transactions included. ³ FX OTC turnover in 2019 by counterparty as percentage of turnover by all counterparties. Spot transactions included.

Sources: BIS Triennial Central Bank Survey; authors' calculations.

⁶ Interestingly, growth in gross external financial liabilities plays a less significant role, probably reflecting that EME liabilities consist mainly of equity and foreign direct investments, which generate less turnover owing to both their longer term and lower hedging requirements.

the leading role (Graph 3, left-hand panel). Among NBFIs, the rise of “other” financial institutions (those not categorised as institutional investors, hedge funds, property trading firms or the official sector) was especially pronounced. This category includes retail aggregators.

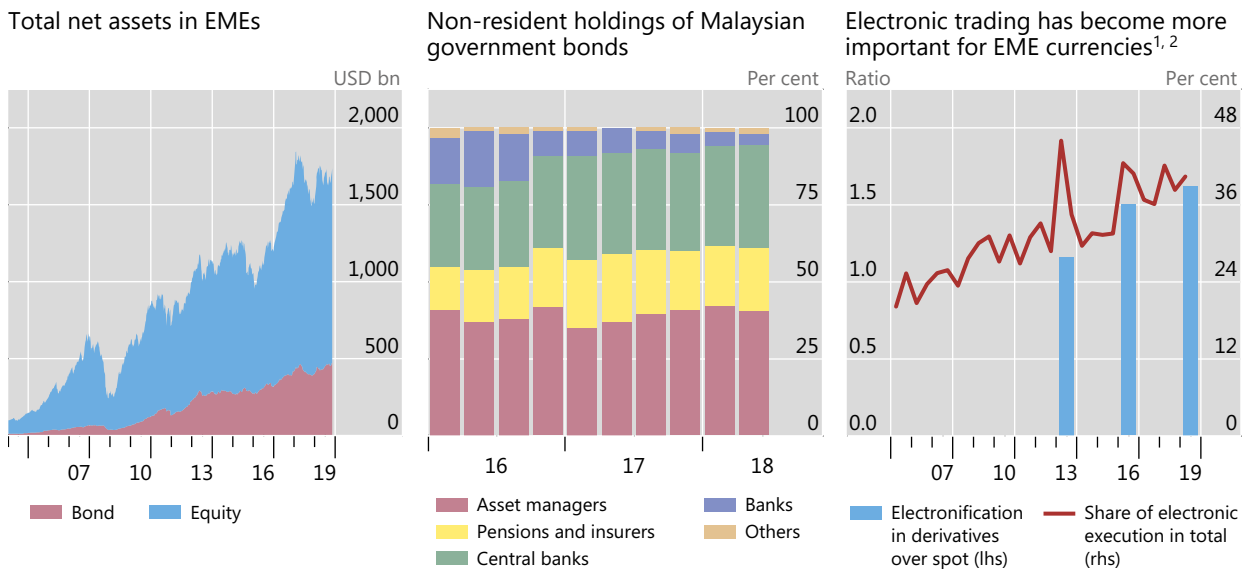
These developments brought the composition of market participants more into line with that of AE currencies (Graph 3, right-hand panel). However some differences remained. For example, despite growing at a faster rate over the past three years, the share of institutional investors continued to be smaller in EME currencies than in AE currencies.

The rising share of NBFIs reflects increased non-bank and foreign demand for EME assets as financial intermediation shifts from banks to capital markets in EMEs. For example, the participation of foreign investors in local currency bond markets in EMEs has increased (BIS (2019)). Assets under management by dedicated EME equity and bond funds have doubled over the past decade (Graph 4, left-hand panel). In contrast, bank demand for EME assets has moderated. The share of banks in the Malaysian government bond market, for example, has fallen markedly over the last three years (Graph 4, centre panel).

Hedge funds and PTFs, which are active in algorithmic trading, also saw swifter increases, as compared with their activity in AE currencies. This rise is attributable in large part to the continuing electronification of global FX markets (see Holden et al (2019) in this issue). As shown by the blue bars in the right-hand panel of Graph 4, electronic trading of EME currencies grew at a faster pace in derivatives than in the spot market.

Rising demand for non-bank EME assets and growing electronification

Graph 4



¹ Trading of USD/Latin American currency pairs (ARS, BRL, CLP and MXN) in North America. Data for April and October. ² Total FX OTC turnover that involves all electronic execution methods in derivative instruments (FX swaps and outright forwards) over the total FX turnover that involves spot transactions.

Sources: Federal Reserve Bank of New York; EPFR; national data; BIS Triennial Central Bank Survey; authors' calculations.

Rapid growth in forwards and offshore trading

Outright forwards saw the sharpest increase in turnover in FX markets for EME currencies, followed by FX swaps and options (Graph 5, left-hand panel). On the other hand, turnover in currency swaps declined. This pattern was in sharp contrast to that seen in AE currencies, where currency swaps increased more than other instruments. As a result, the differences between EME and AE currencies in terms of forwards vis-à-vis FX swaps became more pronounced (Graph 5, centre panel).

NDFs contributed most to the increase in outright forwards. Driven in large part by increased market electronication, NDF turnover almost doubled (see Box B). Historically, NDFs have been used to meet hedging demands involving currencies that are not fully convertible because they allow for payoffs related to a currency's performance without requiring funding in the underlying currency. This trend continued for some currencies, even where controls on non-residents participating in onshore markets were relaxed.

The increase in NDF turnover was broad-based; most of the top six most traded NDFs in EME currencies saw a marked increase (Graph 5, right-hand panel). The renminbi saw more modest growth, of less than 20%, probably reflecting authorities' initiatives to encourage hedging in the onshore deliverable forwards market.

Led by the robust growth in NDFs, the share of offshore trading in FX turnover increased for most EME currencies (Graph 6, left-hand panel). In April 2019, the volume of offshore trading in EME currencies exceeded that of onshore trading in all major regions. Latin American currencies had the highest share of offshore trading. In contrast, the offshore/onshore ratio for Asian EME currencies has stalled since 2016, due largely to a sizeable shift to onshore trading of the renminbi.⁷

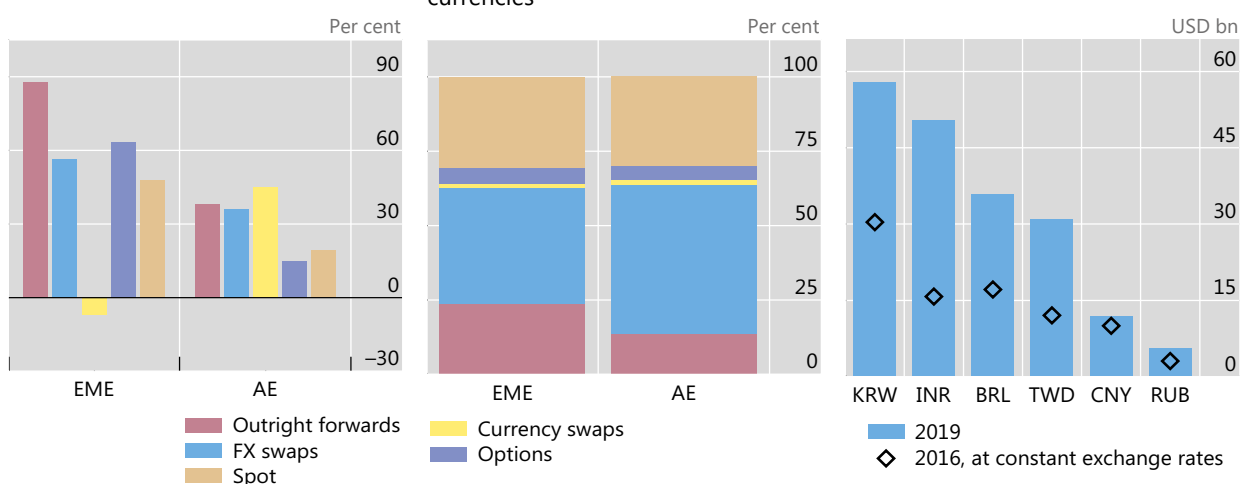
Rapid growth in forwards led by NDFs

Graph 5

Outright forwards outgrew other instruments in EME currencies^{1,2}

Share of outright forwards outgrew other instruments in EME currencies^{1,3}

Top six NDFs in EME currencies⁴



¹ Daily average turnover in April adjusted for local and cross-border inter-dealer double-counting. EME currencies = ARS, BRL, CLP, CNY, COP, CZK, HKD, HUF, IDR, INR, KRW, MXN, MYR, PEN, PHP, PLN, RUB, SAR, SGD, THB, TRY and ZAR; AE currencies = AUD, CAD, CHF, EUR, GBP, JPY, NOK, NZD, SEK and USD. ² Growth rate in FX turnover in April 2019 with respect to April 2016 at constant exchange rates for EME and AE currencies. ³ FX turnover by instrument as a percentage of turnover by all instruments in 2019. ⁴ At constant exchange rates in 2019.

Sources: BIS Triennial Central Bank Survey; authors' calculations.

⁷ The ratio for EM Asia excluding China continued to increase between 2016 and 2019.

Strictly offshore trades (where both counterparties are located offshore) dominate the market for FX turnover in EME currencies (Graph 6, centre panel). By the location of a trade, defined as the location of the sales desk of the reporting dealer, a trade can be classified as either “strictly domestic” (between two parties located onshore), “onshore-offshore” (between one party located onshore and the other offshore) or “strictly offshore” (both parties located offshore).

The rapid expansion of strictly offshore trading was broad-based (Annex Table A2).⁸ Except for the Hong Kong dollar and the Malaysian ringgit, all other EME currencies were traded mainly between two parties located outside the domestic jurisdiction as of April 2019.

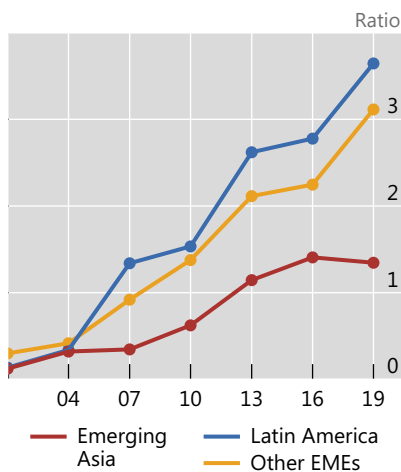
The vast majority of offshore FX transactions in EME currencies took place in a handful of locations. London played the most notable role, followed by New York, Singapore and Hong Kong SAR.

The prominence of offshore trading is not specific to EME currencies. It reflects the network effects that have led to a highly concentrated market structure within a handful of global financial centres. For EME currencies, capital account and currency convertibility restrictions represent an additional factor behind the higher share of offshore trading. In particular, jurisdictions with heavier capital account restrictions tend to have a higher share of offshore trading of derivatives (Graph 6, right-hand panel). In other words, capital controls appeared to boost the offshore trading of derivatives – NDFs in particular – at the expense of onshore trading.

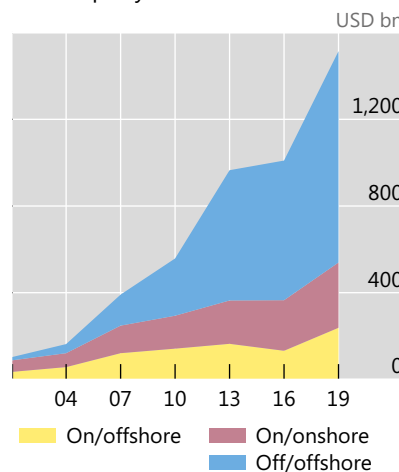
Share of offshore transactions increased in most regions

Graph 6

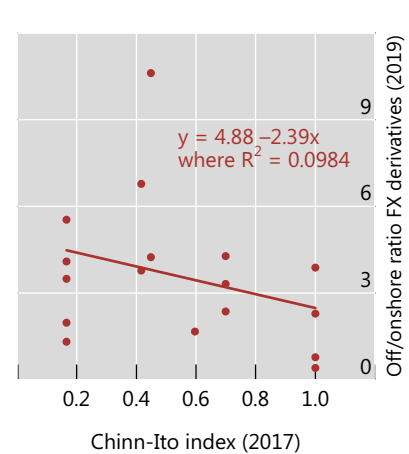
OTC offshore-to-onshore turnover^{1,2}



FX turnover in EME currencies by counterparty location^{2,3}



Chinn-Ito index and offshore-to-onshore ratio in EME currencies⁴



¹ Emerging Asia = CNY, HKD, IDR, INR, KRW, MYR, PHP, SGD and THB; Latin America = ARS, BRL, CLP, COP, MXN and PEN; Other EMEs = CZK, HUF, PLN, RUB, SAR, TRY and ZAR. ² Onshore transactions are defined as the turnover in the corresponding currency in the issuing jurisdiction (on a net-gross basis). Offshore transactions are defined as the difference between the total turnover of a currency on a net-net basis and the onshore transactions in the issuing jurisdiction. Includes total OTC derivatives and spot transactions. Excludes exchange-traded transactions. ³ EME currencies = ARS, BRL, CLP, CNY, COP, CZK, HKD, HUF, IDR, INR, KRW, MXN, MYR, PEN, PHP, PLN, RUB, SAR, SGD, THB, TRY and ZAR. ⁴ Offshore-to-onshore turnover in OTC FX derivatives in 2019. ARS, CZK, HUF, MYR, and PLN excluded from the sample. The p-value of the slope coefficient equals 0.11 in a one-sided t-student distribution with 15 degrees of freedom.

Sources: BIS Triennial Central Bank Survey; authors' calculations.

⁸ The Triennial Survey might overstate “strictly offshore” trading. Dealers report whether a trade is local, with a resident counterparty, or cross-border, with a non-resident. Therefore, trades between dealers located offshore and customers located onshore are included with offshore trades.

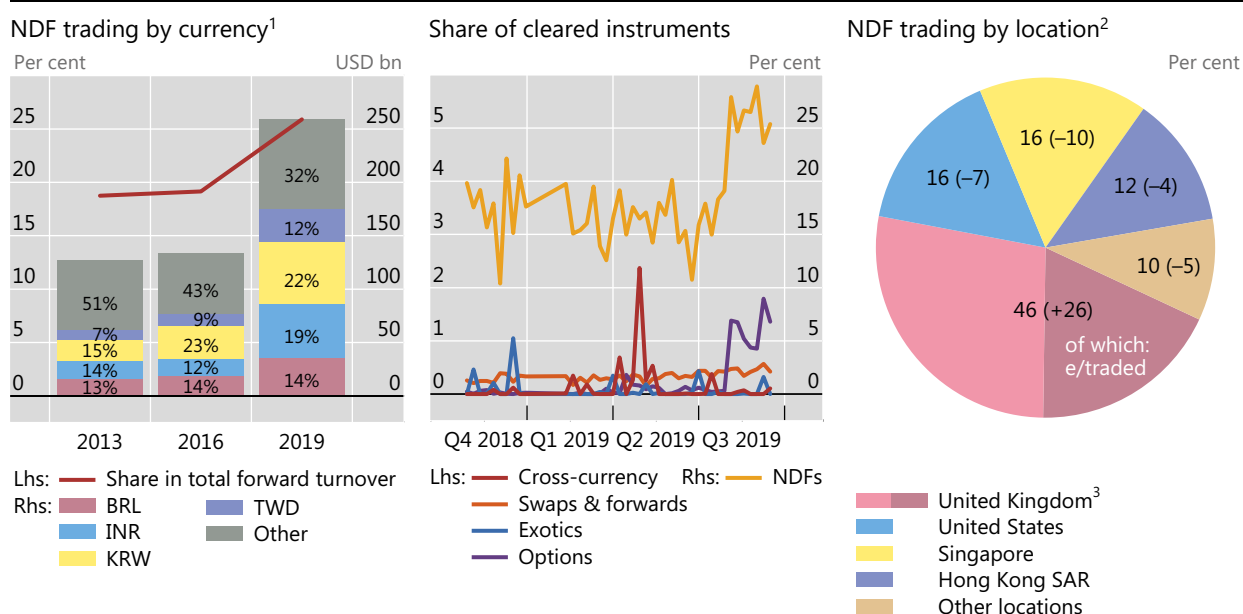
NDF markets thrive on the back of electronification

Andreas Schrimpf and Vladyslav Sushko

Trading of NDFs has almost doubled over the past three years, contributing significantly to the substantial increase in the trading of forwards recorded in the 2019 Triennial Survey. 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 NDF surge include the Korean won, Brazilian real, Indian rupee and New Taiwan dollar (Graph B1, left-hand panel).

Evolution of NDF trading by currency and location, and central clearing

Graph B1



Hedge funds and PTFs can trade NDFs to arbitrage or take directional bets. In the process, they serve as natural counterparties to market participants who need to hedge currency exposures. NDFs exemplify two main trends in the structure of global FX markets, as highlighted in the main text: (i) electronification of trading with other financial institutions, and (ii) concentration of trading activity in the largest FX centres.

The trend towards electronification in NDF markets rides on the inclusion of these instruments among those traded on the main electronic broking platforms: EBS emerged as the electronic venue for NDF trading, while Reuters (Refinitiv) Matching plans to launch NDF trading in 2020. Electronification has also benefited from central clearing, which enables multilateral netting and reduces the need to post margins. As highlighted in McCauley and Shu (2016), the NDF market microstructure has started evolving rapidly on the back of global legal and regulatory reforms for derivatives markets. Since 2015, NDFs have started the transition from a decentralised, bilateral microstructure to one characterised by centralised trading, disclosure and clearing. The gradual phase-in of uncleared margin rules, requiring firms to post initial margins for certain uncleared derivatives, has incentivised greater central clearing of NDFs. To date, NDFs represent the only type of FX derivative with any meaningful share of centrally cleared transactions (Graph B1, centre panel).

These forces have naturally led to a further concentration of trading in the main FX hubs, with the share of NDF trading in the United Kingdom more than doubling from 20% in 2016 to 46% in 2019 (Graph B1, right-hand panel). Given the popularity of NDF trading in Asian currencies, London's overlap with the trading hours of Hong Kong SAR and Singapore puts the city in an advantageous position.

Policy implications

The rapid expansion of offshore trading in EME currencies presents both opportunities and challenges. On the one hand, offshore trading can increase liquidity and cut transaction costs. Electronification can encourage trading by a wider range of market participants, while overlapping time zones allow round-the-clock trading. Increased FX liquidity can in turn boost foreign investment and trade in goods and services.

On the other hand, offshore trading can influence the price discovery process for exchange rates, in markets that are more difficult than onshore centres for central banks to monitor. Estimates for the four largest NDF currencies suggest that, while a bidirectional relationship exists between the onshore and offshore markets during normal times, offshore venues tend to drive movements in the onshore markets during times of global market stress (Box C). This raises challenges for central banks, which have historically limited their market monitoring and intervention policies to the onshore market.

Many central banks have responded to the challenges posed by offshore markets by expanding their monitoring activities. They can expand their coverage of fast-paced electronic markets by tapping larger volumes of data from more diverse sources. They can also enhance the scope and coverage of their market intelligence-gathering efforts (Markets Committee (2016, 2018)). The Korean authorities, for instance, have encouraged domestic entities to play a greater role in offshore markets, with the aim of increasing their monitoring capabilities for offshore markets via these entities. The move has also served to integrate the on- and offshore markets, reducing price discrepancies between the two.

Other central banks, such as those in Indonesia, Malaysia and Turkey, have taken steps to deepen their nascent onshore derivatives markets, often acting as the primary providers of liquidity. Initiatives such as extending onshore trading hours and providing more flexibility for foreign investors to hedge their positions in the domestic markets have also been considered (Reserve Bank of India (2019)).

Furthermore, while spot interventions still remain the dominant intervention tool, some central banks have reacted to the increasing weight of offshore derivatives in the FX market by increasing the use of derivatives in their FX intervention frameworks, including in offshore markets (BIS (2019)).

How onshore and offshore markets interact: an empirical investigation

Understanding the information flow between onshore and offshore markets is of prime importance, particularly for policymakers. It sheds light on the price formation process and reveals the venue of price discovery, which is critical for informing a central bank's FX intervention strategy and market monitoring efforts.

Policymakers often see spillovers from hard-to-monitor offshore markets as an area of concern (Central Bank of Malaysia (2018)). Indeed, the empirical analysis below shows that, while a bidirectional relationship exists between the onshore and offshore markets during normal times, it turns unidirectional during times of market stress, when offshore markets tend to drive onshore price developments.

In the absence of permanent frictions between the onshore and offshore markets, prices across venues are cointegrated, as confirmed by our empirical estimates. Short-run fluctuations and lead-lag relationships can then be studied using a vector error correction model for onshore spot and forward rates and offshore non-deliverable forward (NDF) rates. This represents the information flow between the onshore and offshore markets, and shows how it varies over time.^① The model consists of two sets of equations, the first of which captures the long-run relationship between spot and NDF rates. The second set examines how deviations from the long-term relationship affect the short-term dynamics of these rates, an "error correction" mechanism in the spirit of Engel and Granger (1987). This provides information about the direction of the linkage between onshore and offshore markets. The analysis focuses on five currencies with large NDF markets, namely the Brazilian real, Chinese renminbi, Indian rupee, Korean won and New Taiwan dollar.

The long-run equations are as follows:

$$\begin{aligned}\log(\text{spot})_t &= \beta_0^{\text{spot}} + \beta_1^{\text{spot}} \log(\text{NDF})_t + e_t^{\text{spot}} \\ \log(\text{NDF})_t &= \beta_0^{\text{NDF}} + \beta_1^{\text{NDF}} \log(\text{spot})_t + e_t^{\text{NDF}}\end{aligned}$$

β_1^{spot} and β_1^{NDF} quantify the strength of the long-run relationship between the two exchange rate measures, with a value close to 1 indicating a complete pass-through and the absence of permanent frictions between the two markets.

The short-run equations are as follows:

$$\begin{aligned}\Delta \log(\text{spot})_t &= \alpha_0^{\text{spot}} + \alpha^{\text{spot}}(e_{t-1}^{\text{spot}}) + \sum_{i=1, \dots, n} \alpha_{11,i}(\Delta \log(\text{spot})_{t-i}) + \sum_{i=1, \dots, n} \alpha_{12,i}(\Delta \log(\text{NDF})_{t-i}) + \epsilon_t^{\text{spot}} \\ \Delta \log(\text{NDF})_t &= \alpha_0^{\text{NDF}} + \alpha^{\text{NDF}}(e_{t-1}^{\text{NDF}}) + \sum_{i=1, \dots, n} \alpha_{21,i}(\Delta \log(\text{spot})_{t-i}) + \sum_{i=1, \dots, n} \alpha_{22,i}(\Delta \log(\text{NDF})_{t-i}) + \epsilon_t^{\text{NDF}}\end{aligned}$$

α^{spot} and α^{ndf} are the coefficients of interest. They reveal the rate of adjustment when the system departs from equilibrium. We use them as a measure of the direction of influence. For example, when α^{spot} is negative and statistically significant, it indicates that NDF rates will affect the dynamics of spot rates in the next period.

The analysis reveals, first, that most currencies show a bidirectional relationship: spot prices affect subsequent NDF rates and vice versa.^② For the Chinese renminbi, Indian rupee and Korean won, this bidirectional relationship holds when the model is estimated over the full sample from January 2005 to October 2019 (Table C1, first row). The New Taiwan dollar stands out as the only currency with unidirectional spillovers from the NDF rates to spot rates. This could reflect the fact that offshore branches of local banks are allowed to participate in the NDF market, which brings additional information to the NDF rates.^③ Unlike the other currencies in the sample, the Brazilian real shows no significant evidence of spillovers from one market to the other. This may reflect the important role that exchange trading plays for the Brazilian real, with price discovery taking place largely in the futures market rather than in the offshore NDF or spot market.^④

Second, during times of global market stress, it is more likely that the offshore NDF markets will drive onshore prices (Table C1, second to fourth rows). For example, during the Great Financial Crisis (GFC) and the "taper tantrum", the Indian rupee saw spillovers from the NDF rates to the spot rates but not vice versa. Similar dynamics were also observed for the renminbi and New Taiwan dollar during the GFC, and for the Korean won during the taper tantrum and recent trade tensions. The pattern also manifests itself between the offshore NDF rates and the onshore forward rates (fifth to seventh rows).

The unidirectional influence from offshore to onshore markets during global market stress for Asian currencies likely reflects a number of factors. For one, the onshore and offshore markets span different time zones. As a result, news related to Europe and the United States that arrives during prime trading hours in London and New York is too

late for Asian trading hours. Thus, this news affects NDF rates first, before subsequently affecting the onshore prices the following morning. However, this is probably not the only reason, as the case of the Indian rupee shows. Here Reserve Bank of India (2019) finds the unidirectional flow to hold during market stress episodes, even though the NDF and spot prices are recorded at exactly the same time (the closing time of the onshore market). Other factors, such as different degrees of risk aversion and changes in the wealth of offshore investors during global market stress episodes, could contribute to the unidirectional influence.

Spillovers between onshore rates (spot/forward) and offshore rates (NDF)

Table C1

	BRL	CNY ¹	INR	KRW	TWD
Spot and NDF					
Full sample (January 2005–October 2019)	×	↔	↔	↔	←
GFC (September 2008–July 2009)	↔	←	←	⇒	←
Taper tantrum (May 2013–August 2013)	↔	⇒	←	←	×
Trade tensions (May 2018–December 2018)	×	×	×	←	×
Forward and NDF					
GFC (September 2008–July 2009)	⇒	←	←	←	←
Taper tantrum (May 2013–August 2013)	×	⇒	←	←	×
Trade tensions (May 2018–December 2018)	←	×	×	←	×

↔ indicates two-way causality between spot or forward and NDF; ← indicates NDF causes spot or forward; × indicates no relationship.

¹ One-month forward data start in 2007.

Sources: Bloomberg; authors' calculations.

In a few cases, spot rates have led the NDF rates during global stress episodes. One example is the Korean won during the GFC. This likely reflects the central bank's interventions in the onshore markets, which then become the primary venue of price discovery.^⑤

The finding that offshore centres tend to lead price discovery during times of stress presents central banks with both opportunities and challenges. The challenge lies in the fact that interventions are primarily restricted to the onshore spot markets, whereas the venues for price discovery during times of stress tend to be the offshore derivatives markets (Cavalino and Patel (2019)). However, the results also indicate that proactive interventions at such times could nevertheless help to counter trends originating in the offshore markets.

① The approach is similar to the one used in Reserve Bank of India (2019). See also Behera (2011). ② These results are consistent with prior studies, including McCauley et al (2014). ③ See Annex A in Tsuyuguchi and Wooldridge (2008). ④ For details of price discovery in Brazilian FX markets, see Garcia and Santos (2014). ⑤ See Garcia and Santos (2014) for how central bank interventions relate to the price discovery process. See Ryoo et al (2013) for the role of the Bank of Korea's interventions during the GFC.

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Annex tables

Growth in FX was broader-based than for interest rate derivatives¹

Table A1

	Turnover		
	FX spot and derivatives	Interest rate derivatives	
	2019 level (USD bn)	2019 level (USD bn)	% change from 2016
CNY	289	40	167.4
HKD	233	18	241.5
KRW	135	40	56.5
INR	126	17	179.3
SGD	119	15	23.9
MXN	115	23	-8.6
BRL	102	52	11.4
RUB	74	1	838.7
ZAR	72	26	55.2
TRY	72	1	1,135.3
PLN	41	8	50.6
THB	32	6	183.5
IDR	27	0	-23.2
HUF	27	8	-0.6
CZK	26	12	815.2
CLP	19	1	-64.4
PHP	19	0	61.2
COP	12	1	-25.1
SAR	12	1	41.6
MYR	9	2	-35.1
PEN	5	0	-84.0
ARS	4	0	-80.6

¹ Considers FX and IR OTC including spot and exchange traded transactions. Changes are computed at current exchange rates. Sources: BIS Triennial Central Bank Survey; authors' calculations.

FX turnover in most EME currencies is dominated by offshore trading¹

Table A2

	Strictly onshore (on-/onshore) ²		Strictly offshore (off-/offshore) ³		On-/offshore ⁴	
	2019 level (USD bn)	% change from 2016	2019 level (USD bn)	% change from 2016	2019 level (USD bn)	% change from 2016
BRL	7	-40.7	57	55.4	7	195.9
CNY	92	68.4	184	25.3	9	1279.6
HKD	43	161.4	87	176.3	102	158.9
INR	31	14.9	79	178.8	4	35.2
KRW	34	5.5	84	96.9	14	54.0
MXN	7	37.5	94	20.8	12	-10.5
RUB	20	-26.7	40	84.4	12	38.0
SGD	22	9.3	62	21.2	35	74.8
TRY	5	87.5	59	-3.4	8	-19.4

¹ Total OTC turnover, including spot and excluding exchange-traded derivatives. Onshore transactions = turnover in the corresponding currency in the issuing jurisdiction (on a net-gross basis). Offshore transactions = the difference between the total turnover of a currency on a net-net basis and the onshore transactions in the issuing jurisdiction. ² Onshore-onshore = transactions between two counterparties located onshore. ³ Offshore-offshore = transactions between two counterparties located offshore; data about the specific location of customers is not reported in the Triennial Survey, and therefore offshore-offshore may include transactions between offshore dealers and onshore customers. ⁴ Onshore-offshore = transactions between dealers located onshore and customers offshore.

Sources: BIS Triennial Central Bank Survey; authors' calculations.