WP/21/47

IMF Working Paper

Foreign Exchange Intervention: A Dataset of Public Data and Proxies

by Gustavo Adler, Kyun Suk Chang, Rui C. Mano, Yuting Shao

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Strategy and Policy Review and Research Department

Foreign Exchange Intervention: A Dataset of Public Data and Proxies

Prepared by Gustavo Adler, Kyun Suk Chang, Rui C. Mano, Yuting Shao*

Authorized for distribution by Rupa Duttagupta and Daniel Leigh

February 2021

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Abstract

Foreign exchange intervention (FXI) is a highly debated topic. Yet, comprehensive and comparable data on FXI is hard to find. This paper provides a new dataset of FXI covering a large number of countries over the period 2000-20 at monthly and quarterly frequencies. It includes publicly available data for about 40 countries and carefully constructed proxies for 122 countries. Proxies are focused on both spot and derivative transactions that alter the central bank's foreign currency position and account for a wide range of central bank operations, including vis-à-vis residents, the first proxy to do so to our knowledge. The paper discusses the merits of the new proxy relative to coarser measures traditionally used like the change in reserves, and potential definitional differences with published data. The paper also presents stylized facts using our newly constructed FXI proxies. The dataset is updated periodically and [can be found here](#).

JEL Classification Numbers: F31, F33, E58

Keywords: Foreign Exchange Intervention; Spot and derivatives FX markets.

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* We are indebted to Elizabeth Holmquist and Justin Matz for their clarifications on the IMF's Monetary and Financial Statistics; and Rupa Duttagupta and Daniel Leigh for their support. We also thank IMF country teams for helpful comments, especially M. Alnassa, G. Bannister, C. de Barros Serrao, J. Bricco, E. Cabezón, T. Callen, J. Canales Kriljenko, P. Cashin, N. Choueiri, T. Chrimes, E. Flores, A. Galicia-Escotto, M. Goretti, R. Green, S. Gupta, A. Hajdenberg, G. Heenan, S. Jain-Chandra, J. Jauregui, A. Jewell, J. Jonas, P. Kopyrski, S. Kothari, M. Kryshko, R. Lafarguette, Y. Lu, P. Madrid, N. Magud, J. Menkulasi, K. Miyajima, D. Nyberg, M. Omoev, D. Rodriguez, K. Ross, C. Saborowski, L. Spahia, A. Spilimbergo, R. Veyrune, J. Yu and L. Zeng. We are also thankful to country authorities for providing useful information and feedback.

I. INTRODUCTION

Exchange rate policy and the use of foreign exchange intervention (FXI) are central aspects of policy making in open economies and highly debated topics. Yet, information on FXI remains scant for most countries. As a result, macroeconomic research on a wide range of aspects related to the use of FXI has often relied on coarse proxies—typically, changes in the stock of central bank’s reserves or reserve flows from balance-of-payment statistics¹—including for analysis on exchange rate regimes (see, for example, Ilzetzky et al, 2017), currency manipulation (Bayoumi et al, 2015; Gagnon 2012 & 2013) and exchange rate management more broadly (Adler et al, 2019; Blanchard et al, 2015; Daude et al, 2016; Dominguez 2012 and 2020, etc.). These coarse proxies of FXI, however, are often polluted by valuation changes and investment income flows, as well as distorted by central bank foreign currency transactions vis-à-vis residents and nonresidents that affect the level of reserves but do not constitute foreign exchange intervention (i.e., exchange of local and foreign currency assets).

This paper provides a new dataset that compiles published and proxied FXI, for both operations in spot and derivative markets, covering 2000-20 and an ample set of countries. Specifically, the dataset includes:

- 1) Published FXI data covering 39 countries at monthly and 43 countries at quarterly frequency.²
- 2) Proxied FXI data for 122 countries at monthly and quarterly frequency.

To our knowledge, this is the most comprehensive dataset of FXI for macroeconomic analysis. Our proxies provide a more accurate measure than coarser measures traditionally used in macroeconomic analysis of transactions that alter the central bank’s foreign currency position. It does so by accounting for a wide range of central bank operations, including vis-à-vis residents and non-resident entities. This work complements the recent work by Fratzscher et al (2020), who focus on identifying periods when interventions took place through news searches for a smaller group of countries, although still relying on traditional coarse proxies of FXI to quantify the actual degree or magnitude of FXI.

Despite the growing transparency in FXI operations over time, the share of countries that publish such data remains low (Figure 1). Specifically, about 74 percent of (non-reserve currency issuing) central banks of advanced economies publish FXI data, while only 16 percent of those of emerging market and developing countries do it. Typically, countries that publish FXI data at least at quarterly frequency also do it on a monthly basis.

¹ A notable exception is the work by Fratzscher et al (2019), who document the use of FXI and its implications using published FXI data for 33 countries. However, the data were provided to the authors on a confidential basis, precluding further analysis by other authors.

² The time-series coverage varies across countries with data for a few of them going back to 1990, while others report only very recent data. Some countries report FXI data on a semi-annual or annual basis, see Appendix Table 1.1. Given the low frequency of releases, data for the latter cases are not included in the dataset.

Figure 1. Coverage of publicly available FXI data

Sources: Various. See Appendix Table A1.1 for further details.

Notes: Based on countries that report FXI data at least on a quarterly frequency. Statistics for AE and EMDE groups are based on quarterly FXI publication.

Moreover, a large number of countries that do not publish FXI data likely manage their exchange rates significantly, at least periodically, through foreign exchange interventions. This is apparent from Figure 2, which indicates that non-publishing countries display at least as much, if not more, variation in changes in reserves as countries that publish FXI data. Reliable proxies of foreign exchange intervention are, thus, key for any comprehensive cross-country analysis on exchange rate policy.

Figure 2. Change in Reserves and FXI Publication

Sources: IMF, International Finance Statistics; IMF, Information Notice Systems; International Reserves and Foreign Currency Liquidity Template; and IMF staff calculations.

Notes: The figure reports the cumulative distribution of the country-specific standard deviation of changes in reserves, distinguishing between countries that reported FXI data for most of the sample period and those that did not. Based on countries that report FXI data at least on a quarterly frequency.

The rest of the paper is organized as follows: Section II explains in broad terms how our FXI proxy is constructed. Section III presents some stylized facts based on this proxy. Section IV describes our new dataset of publicly available FX interventions. Section V assesses the performance of our proxy relative to other proxies. Section VI concludes.

II. CONSTRUCTING FXI PROXIES

The literature on FXI is rich and long dated, yet the vast majority of the papers overlook defining FXI. We define FXI as ‘*any transaction that changes the central bank’s foreign-currency position*’ This definition has 4 key elements:

- i. A focus on active transactions, which means that changes in foreign currency positions that are passive, such as those arising from the interest income on reserve assets or from changes in asset prices are not considered interventions. Such variations in foreign currency positions are not driven by contemporaneous actions of the central bank.
- ii. A focus on the central bank as the main entity conducting foreign exchange interventions. Thus, the definition excludes foreign currency operations by other public sector entities as they are normally not involved in exchange rate policy and for which data limitations are more severe. See further discussion on this in section V.D.
- iii. A focus on the central bank’s foreign currency position, encompassing any exchange of foreign and domestic currency assets. This is consistent with the most relevant channel through which FXI can have macroeconomic effects—the portfolio balance channel.³ Whether FXI operations are sterilized or unsterilized—which is about the type of domestic currency asset (money or debt) supplied in exchange for foreign currency assets—is beyond the scope of this work.
- iv. The definition encompasses all transactions that meet the above criteria, irrespective of the stated intent (for example, to accumulate reserves without meaning to affect the exchange rate), as the intent is not verifiable and these operations can still affect the exchange rate.

The proxies of FXI developed in this paper follow these 4 key elements and encompass both operations in spot markets (“spot” proxy) as well as operations with derivatives (“derivative” proxy) as both affect the central bank’s foreign currency position. A “broad” proxy that includes both the spot and derivative transactions is also reported.

Spot interventions

Most of the literature on the macroeconomic implications of FXI has focused on coarse proxies, primarily based on the change in the stock of international reserves.⁴ Such measures, however, can deviate from the concept of FXI defined above in meaningful ways. In particular:

- *Valuation changes.* Changes in the stock of reserves may reflect FXI but also valuation changes due to varying market prices of reserve assets or exchange rate movements among reserve currencies. These variations affect the central bank’s foreign currency position but are not a product of active transactions. As shown in the left panel of Figure 3 below, valuations changes can be a significant component of changes in stocks of reserves.

³ The portfolio balance theory—modelled in the work of Kouri (1976), Henderson and Rogoff (1982), Kouri (1983), Branson and Henderson (1985), Kumhof (2010), Gabaix and Maggiori (2015), among others — establishes that FXI can affect the exchange rate when domestic and external assets are imperfect substitutes. Sterilized interventions increase the relative supply of domestic currency assets, driving currency risk premia up and, thus, exerting depreciation pressures on the exchange rate.

⁴ Another branch of the literature, trying to identify the effects of FXI on exchange rates, has focused on high frequency (daily or intra-day) FXI data and individual countries for which actual daily FXI data are available. A drawback of this line of research, however, is that it does not allow to draw conclusions on the macroeconomic implications of FXI policies and, especially in earlier literature, is circumscribed to the small number of countries that published FXI data, typically with a heavy focus on advanced economies.

- *Investment income.* Similarly, changes in the stock of reserves partly reflect the return on investments. While this component is slow-moving and smaller on average than valuation changes (Figure [3], right panel), it also needs to be stripped out from changes in reserves to capture more accurately actual foreign exchange transactions. This adjustment is particularly important when assessing whether FXI is one-sided or two-sided, as income flows are positive by definition and thus always contribute to increasing reserves. Such income flows can be particularly large in economies with large reserve holdings.

Figure 3. Changes in reserves, valuation changes and investment income
(in percent of previous quarter stock of reserves, simple average)

Sources: IMF, Balance of Payment; IMF, International Finance Statistics; and IMF staff calculations.

Note: Simple averages calculated across the country sample. Valuation changes calculated by subtracting quarterly balance-of-payments reserves flow from quarterly change in the stock of reserves. Reserve income flow is taken directly from balance-of-payments statistics for countries reporting it. Each chart uses only countries whose data are available for both variables, hence the difference in the variable "change in reserves" across the two charts.

- *Other foreign currency assets and liabilities vis-à-vis nonresidents.* Changes in reserves can also reflect reallocation of foreign assets, between reserve and non-reserve assets. This is particularly relevant for economies that have accumulated significant reserve assets and where reserve holdings may exceed levels consistent with precautionary liquidity buffers. In these economies, central banks may choose to invest part of their foreign currency holdings in less liquid (non-reserve) assets. Thus, portfolio management operations affect the level of reserves without altering the central bank's foreign currency position. Similarly, reserve levels may vary as central banks borrow or repay loans from foreign entities (in foreign currency), without entailing interventions in the foreign exchange market or changes in the overall foreign currency position. The latter typically include loans from the International Monetary Fund and other official creditors.
- *Foreign currency assets and liabilities vis-à-vis residents.* Changes in reserves (or foreign assets more broadly) may also reflect foreign currency operations vis-à-vis residents but do not necessarily affect the overall foreign currency position of the central bank. For example, operations on behalf of other domestic entities (e.g., the general government) entail changes in foreign assets but with an offsetting change in the liabilities vis-à-vis the domestic counterpart. Similarly, government foreign currency deposits (and withdrawals) at the central bank imply variations in reserves without changes in the foreign currency position. Changes in foreign-currency deposits of domestic (banking) institutions at the central bank also alter the latter's gross foreign-currency assets without affecting its net foreign-currency position.

Our “spot” proxy adjusts for all above-mentioned factors. In broad terms:⁵

- The proxy uses available information on the composition of reserve assets to estimate valuation changes. Specifically, it relies on information on the type of assets from the International Reserves and Foreign Currency Liquidity Template⁶; and on the currency composition of individual countries from the International Reserves and Foreign Currency Liquidity Template, when available, or country-group aggregates from the Currency Composition of Official Foreign Exchange Reserves (COFER) dataset.⁷ Estimates of valuation changes are necessary for the FXI proxy at *monthly* frequency as the starting point for this proxy is the change in the stock of reserves, which is “polluted” by valuation changes. At the quarterly frequency, on the other hand, our proxy is based on balance-of-payments (BOP) data—which are transaction-based—and, thus, does not require an adjustment for valuation changes, except where BOP data is not available and the change in the stock of reserves is used also for the quarterly proxy.
- Estimates of investment income on reserve assets are also based on the available information on the composition of assets, combined with information on market interest rates as well as interest payments by issuers of reserve currencies (to approximate average coupon rates on longer-term securities). At the quarterly frequency, we use investment income on reserves reported by some countries as part of their BOP statistics. Estimates of investment income are applied to both the monthly and quarterly FXI proxy.
- The proxy adjusts for changes in other foreign assets and liabilities based on available information in the Standardized Report Forms of the IMF’s Monetary and Financial Statistics. This includes holdings of non-reserve foreign assets as well as liabilities vis-à-vis all foreign creditors, including IMF and other official creditors.
- Finally, the proxy adjusts for variations in foreign currency assets and liabilities vis-à-vis domestic entities, also using information available from the IMF’s Monetary and Financial Statistics. As discussed below, this is a key improvement vis-à-vis proxies used in the literature up to now.⁸

FXI through Currency Derivatives

Operations with foreign exchange derivatives have also become increasingly important instruments for intervention in foreign exchange markets. With varying magnitudes, these have been commonly used by AEs and are increasingly used in EMDEs, as shown in Figure 4. Moreover, these numbers may underestimate the true frequency of FXI with derivatives as they are based on data reported to International Reserves and Foreign Currency Liquidity Template and some countries do not report data to it. Capturing interventions with derivatives is key as they may entail similar effects on exchange rates than interventions in spot markets (see Nedeljkovic and Saborowski, 2019; and Chapter 5 in Chamon et al 2019). It is also important because some central banks use FX swaps to manage FX market liquidity and smooth market functioning. These FX swaps are combinations of

⁵ See further details in Appendix 2.

⁶ Available at <https://data.imf.org/?sk=2DFB3380-3603-4D2C-90BE-A04D8BBCE237>. Reserve assets are decomposed into Currency and Deposits, Securities, Position at the IMF, SDR holdings, Gold and Other foreign currency assets.

⁷ Available at <https://data.imf.org/?sk=E6A5F467-C14B-4AA8-9F6D-5A09EC4E62A4>.

⁸ Reclassifications or definitional changes in the IMF’s Monetary and Financial Statistics can reduce the accuracy of the FXI proxies if not adjusted for. Series were checked comprehensively and adjusted to exclude datapoints corresponding to identified breaks. See Appendix 3 for a list of adjustments.

spot and mirroring forward interventions and do not necessarily affect the central bank's FX position once both elements (the spot and forward legs) are taken into account.

The dataset includes a proxy of FXI with derivatives—"derivative" proxy, reported separately—that encompasses changes in the aggregate short and long positions in forwards and futures in foreign currencies vis-à-vis the domestic currency (including the forward leg of currency swaps), and financial instruments denominated in foreign currency but settled by other means (e.g., in domestic currency), as reported in the International Reserves and Foreign Currency Liquidity Template.⁹

Figure 4. Frequency of Changes in FX Derivative Positions
(percent of group sample)

Sources: IMF, International Reserves and Foreign Currency Liquidity Template (IRFCLT); and IMF staff calculations.

Note: Based on reported changes in short and long positions in forwards and futures in foreign currencies vis-à-vis the domestic currency (including the forward leg of currency swaps), and financial instruments denominated in foreign currency but settled by other means. These may underestimate the true extent of FXI with derivatives if economies that do not report to the IRFCLT also use FX derivatives.

III. STYLIZED FACTS FROM OUR FXI PROXY

Our dataset allows for a comprehensive view on the use of FXI as a policy instrument over the last two decades, and unveils some interesting stylized facts:

- *The notion that EMDEs tend to intervene more heavily in FX markets than AEs does not always hold.* As a group, EMDEs, relied significantly more on FXI than AEs before the global financial crisis (GFC), and this holds even after excluding China (see Figure 5). In the post -GFC period, however, the extent of foreign exchange intervention in EMDEs has been comparable to that observed in (non-reserve issuer) AEs. The FXI patterns in the latter group have been dominated by economies with large financial sectors which have deployed FXI in significant degrees to cope sizable capital flows (e.g., Hong Kong SAR, Singapore, Switzerland).¹¹

⁹ For countries using FX swaps frequently, it is advisable to use the "broad" proxy as it combines the spot and forward legs of the swap and, thus, provides a more accurate read of the change in the central bank's net foreign currency position.

¹¹ This analysis excludes data for major reserve currency-issuers—i.e., the U.S., the U.K., Japan and Euro area countries. The picture for all AEs shows very limited FXI in percent of GDP if these economies are included.

Figure 5. Foreign Exchange Intervention by Group
(broad proxy, in percent of GDP)

Sources: authors' estimations.

Note: Estimated average quarterly foreign exchange intervention (using "broad" proxy=spot plus derivatives) weighted by 3-year moving average nominal GDP.

- Interventions are mostly in spot markets and asymmetric (with a bias towards FX purchases) in both income groups. Figure 6 further compares the frequency of FXI in spot and derivative markets between non-reserve issuer AEs and EMDEs, as a function of their overall size. Again, we find that both EMDEs and AEs intervene frequently, especially in spot markets, with both conducting spot interventions of absolute size of at least 0.25 percent of GDP per quarter about $\frac{3}{4}$ of the time. Our dataset also reveals that, even after adjusting for investment income, there is significant asymmetry in the use of FXI, with purchases of foreign currency being significantly more frequent than sales. This is visible for EMDEs as well as AEs. The use of derivatives, on the other hand, remains limited in comparison to spot interventions, although it is more prevalent in AEs than EMDEs.¹² Within AEs, financial centers display a particularly extensive use of FXI, especially through derivatives (see Appendix Figure A1.1). The patterns of FXI for other AEs are similar to those observed in EMDEs.

¹² The apparent symmetry in FXI through derivatives should be interpreted with caution as it may simply reflect the normal unwinding of derivative positions as they come due. In addition, some central banks use swaps (involving a spot plus forward FXI) to manage liquidity in the FX market without altering their FX position. In these cases, the spot and derivative FXI measure may fully offset each other; and a broad measure encompassing both spot and derivatives may provide a more accurate representation of the degree of FXI. See further discussion in Appendix 2.

Figure 6. Size and Symmetry of Foreign Exchange Intervention (frequency)

Sources: authors' estimations.

Notes: Based on quarterly observations and using our "broad" proxy=spot plus derivatives transactions.

- While there is significant variation within groups, the degree of exchange rate management in EMDEs and AEs is similar. Using our proxy of FXI, we can characterize countries' degree of exchange rate management computing an index of the following form:

$$\rho_i = \frac{\sigma_i^{FXI}}{\sigma_i^{FXI} + \sigma_i^{NEER}} \quad (1)$$

where σ_i^{FXI} is the standard deviation of our broad FXI proxy (in percent of GDP) and σ_i^{NEER} is the standard deviation of the change in the nominal effective exchange rate, both for the full sample period. The index takes the value 0 for countries that do not intervene (pure floating) and 1 for those that intervene and whose nominal effective exchange rate does not move (de facto pegs).^{13,14} Figure 7 displays the values of equation (1) for AEs and EMDEs. While on average AEs allow for slightly greater exchange rate flexibility in comparison to EMDEs, the distributions are not very different and there is considerable variation within both groups. Among AEs, economies with large financial sectors (like Hong Kong SAR, Iceland, Singapore, Switzerland, etc.) tend to display a higher degree of exchange rate management than other AEs. Within EMDEs, there is also a wide range of values, with some large EMDEs displaying flexible regimes comparable to the most flexible AEs (Mexico, South Africa, Colombia, Brazil, Turkey), while others displaying highly managed regimes (including because they have de jure fixed exchange rate regimes, like Bulgaria and Saudi Arabia).

Figure 7. Degree of Exchange Rate Management, 2000-20
(Index)

Sources: IMF, International Finance Statistics; IMF, Information Notice Systems; International Reserves and Foreign Currency Liquidity Template; and IMF staff calculations.

Notes: The figure reports the index ρ as defined in equation (1) computed over the full sample period (thus, the index may not reflect the most recent pattern of exchange rate management). It varies from 0 (pure floating) to 1 (peg). Major reserve-issuing countries (Euro area economies, Japan, the U.K. and the U.S.) are excluded.

¹³ The sample of countries includes de jure pegs and it is expected that they display a high degree of exchange rate management by the nature of the exchange rate regime. Also, it is important to highlight that the degree of intervention may be a result of the extent of exchange rate volatility (e.g., countries with intrinsic low exchange rate volatility may choose not to intervene, as opposed to countries facing high currency volatility). The analysis of determinants of the degree of exchange rate management, however, is beyond the scope of this paper.

¹⁴ Strictly, economies with pegs can display movements in the NEER as they normally fix their currencies relative to one (or a basket of) currencies different from the basket used to compute the NEER. In practice, the index shows intuitive results at least in terms of relative values among countries (see also Adler et al, 2019).

- *Interventions remain dominated by transactions in spot markets.* While interventions in foreign currency derivatives have become more frequent, as indicated by Figure 4 above, their size remains smaller than interventions in spot markets. At the same time, we find that derivatives are used significantly during financial crises, as shown by the spikes in the aggregate series during the global financial crisis and the European crisis (Figure 8). This allows central banks to preserve liquidity buffers while still providing foreign currency hedging during episodes of heightened exchange rate market pressures.

Figure 8. Spot versus Derivatives
(absolute value, percent of GDP)

Sources: International Reserves and Foreign Currency Liquidity Template; and authors' calculations.

Notes: Spot and Derivatives denote quarterly sum of the respective absolute values across countries as a share of their (3-year moving average) group GDP.

- *Countries that intervene less are more inclined to publish their FXI operations.* As shown in Figure 9, our data indicate that countries that publish FXI data also intervene less in foreign exchange markets, as illustrated by the greater mass in the density function around zero, in comparison to countries that do not publish FXI data. That is, the lack of publication does not indicate a lack of use of the instrument, but the contrary.

Figure 9. FXI Proxy for Publishing and Non-publishing Economies
(percent of GDP, broad FXI proxy)

Sources: Country authorities and authors' calculations.

Note: Based on broad FXI proxy (spot plus derivatives) at quarterly frequency. The support of the distributions is limited to ± 0.05 , and thus absolute intervention beyond that value appear as a mass in the extremes of the chart. Based on countries that report FXI data at least on a quarterly frequency.

IV. PUBLISHED DATA

In addition to our FXI proxies, the accompanying dataset includes time-series of publicly available information on FXI. To our best knowledge, this is the most comprehensive dataset of published FXI. Putting these data together entailed a multi-stage effort. First, we searched through central bank websites, aided by the information reported in the IMF's AREAER.¹⁵ The format of available data varies significantly across countries as some central banks provide time-series directly in a usable format while others report scattered FXI data information through separate reports, for example monthly or quarterly reports on monetary and exchange rate policies. Thus, a second effort entailed hand-collecting information from such reports. Country-specific details, including sources, are available in Appendix Table A1.1. Finally, the collected information was shared and discussed with various IMF country teams. In some cases, central banks were contacted to corroborate the collected information.

The dataset includes published FXI for 43 countries at quarterly frequency and for 39 countries at monthly frequency.¹⁷

As discussed in detail in Section V.D, an important issue regarding published FXI data is that there is no uniform definition or template for reporting FXI and, in some cases, reported series may not correspond to the concept of FXI of interest (i.e., transaction-based changes in the foreign-currency position of the central bank). In fact, in most cases, there is no easily accessible and clear definition of the published FXI series (some exceptions are Australia, Costa Rica and Mexico). Thus, it is unclear whether the treatment of certain FX transactions is uniform across countries. For example,

¹⁵ See Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) at <https://www.imf.org/~media/Files/Publications/AREAER/areaer-2018-overview.ashx>.

¹⁷ Fourteen of these countries also publish weekly data. On other hand, some countries report FXI data on an annual basis. These are not included in the dataset.

differences in the treatment of operations done with or on behalf of the government or state-owned enterprises,¹⁸ or the treatment of exporter surrendered requirements may give rise to significant differences in what is reported as FXI across countries. Also, in some cases, reported series may only encompass operations in FX markets (excluding bilateral transactions with other, private or public, entities) while in others the series may report any exchange of foreign and domestic currency assets.

V. COMPARING PROXIED AND PUBLISHED FX INTERVENTIONS

This section compares published FXI data with commonly used measures of FXI and our spot proxy to assess whether the latter approximates published FXI better.²⁰

However, the analysis should be interpreted with caution. It is based on the premise that published FX series encompass all transactions of the central bank that alter its foreign exchange position (consistent with the definition of FXI used in this paper), although in some cases reported series may be defined differently. To mitigate this discrepancy, published FXI data were not used for the analysis in this section where definitional differences between our proxy and the published FXI data were likely, i.e. where stated definitions clearly departed from the FXI concept in this paper. Specifically, two main criteria were used to exclude published FXI data from the analysis below. Firstly, countries classified as freely floating for at least 10 years in the AREAER dataset (which overwhelmingly report zero interventions in most periods) were excluded. This encompassed United States, United Kingdom, Canada, Japan, Euro area, Australia, New Zealand, and Mexico. Secondly, Angola, Bolivia, Nicaragua, Nigeria, and Turkey were also excluded on account of large discrepancies between published FXI and the change in reserves (e.g., published interventions are mostly one-sided while the stock of reserves drifts in the opposite direction over time). Users of our dataset are advised to treat the data for these countries with particular caution as proxies and published FXI series may correspond to different FXI definitions.²¹

A first glance at the data indicates that our spot proxy for FXI matches published interventions—where available—more closely than the change in the stock of reserves (see Figure 10 for a comparison at the monthly frequency). The raw correlation of proxied and published FXI is 0.61 while that of changes in reserves and published FXI is 0.54. Moreover, proxied and published interventions rarely have different signs, with only about 0.5 percent of country/month observations having a meaningfully different sign.²² The relatively low correlation is driven by a few outliers for which

¹⁸ Transactions with the government and SOEs as counterparts are considered FXI under the definition used in this paper, while FX transactions done on behalf of these other entities do not qualify as FXI.

²⁰ A caveat to the analysis in this section is that it can only be done for countries that published FXI data. As these economies may be more transparent and provide more granular data to construct our spot proxy, a selection bias may influence the results.

²¹ To aid users of the dataset, Appendix Table A2 reports results of country-by-country regressions of the type:

$x_{i,t} = \alpha_i + \beta_i x_{i,t}^* + \varepsilon_{i,t}$, where $x_{i,t}^*$ is published FXI data, $x_{i,t}$ is either the change in reserves or our spot proxy for country i and period t , both expressed in percent of GDP and $\varepsilon_{i,t} \sim N(0, \sigma_i)$. These regressions span 2000-19. In principle, $\alpha_i = 0$ and $\beta_i = 1$ if proxies and published data are consistent up to idiosyncratic measurement error.

However, some countries reported in Appendix Table A2 show systematic departures between the change in reserves or our spot proxy and published data as well as very low correlation, or even negative, between proxies and published FXI. See further details on the methodology in the section below.

²² A meaningful difference in sign is one in which the same country/month observation has different signs of published and proxied FXI, defined relative to the variable's country-specific standard deviation. An observation

published FXI is reported to be zero but our proxies assign it a non-zero value, with the difference possibly reflecting a narrower definition of FXI used by some of these central banks.²³

Figure 10. Correlation with published FXI. Spot proxy vs. change in reserves
(share of GDP, monthly frequency)

Sources: IMF International Financial Statistics and authors' estimates.
Note: Published data includes only spot interventions.

In what follows, we compare our spot proxy as well as other coarser proxies with published FXI data more formally to learn about the information content in these different measures, and to identify which specific adjustments to the coarse measures are useful to provide a more accurate picture of FXI.

A. Comparing Proxies: Univariate Regressions

We start by using a classic measurement error framework (see, for example, Greene, 2000) to compare more formally the accuracy of our spot proxy versus coarser measures traditionally used. Specifically, consider the following measurement error equation:

$$x_{i,t} = \alpha_i + \beta x_{i,t}^* + \varepsilon_{i,t} \quad (2)$$

where $x_{i,t}^*$ is published FXI data, $x_{i,t}$ is the FXI proxy for country i and period t , both expressed in percent of GDP²⁴ and $\varepsilon_{i,t} \sim N(0, \sigma^\varepsilon)$. In this specification, α_i captures any systematic deviation between proxied and published data and the error term is assumed to be random measurement error.

is said to be positive if it is larger than its country-specific standard deviation, while it is said to be negative if it is smaller than its country-specific standard deviation multiplied by -1.

²³ Figure 10 does not control for country-specific differences in the average level of proxy and published data, although correlations are broadly similar to the ones reported above when using country-demeaned data.

²⁴ The three-year backward moving-average level of yearly GDP in the denominator is used to ensure that monthly or quarterly variations come primarily from changes in the numerator.

If proxies are polluted only by classic measurement error, $\alpha_i \approx 0$, $\beta \approx 1$. In addition, if there is no measurement error, then $\sigma^\varepsilon \approx 0$.²⁵

The coefficient β above is estimated using a panel fixed effects estimator for the changes in reserves as well as for our spot proxy. These comparisons are done both for the monthly and quarterly proxies as the construction of each of these proxies varies (due to availability of balance of payments data, which are purged of valuation effects, at different frequencies) as explained before.

The spot proxy displays a coefficient closer to 1, including statistically, compared to the regressions using the change in reserves or BOP flows, although the difference is small (see Table 1). The r-squared of the regressions using the spot proxy are also considerably higher, pointing to greater accuracy of the latter vis-à-vis the other, coarser, measures. Moreover, the constant is several times smaller in the case of the spot proxy, indicating that the latter displays significantly smaller systematic deviations on average²⁶ from the published data than the other proxies, partly due to the fact that the spot proxy strips out investment income from the growth in international reserves.

Table 1. Published and Proxies of FXI. Full Sample (2000-19)

	Monthly		Quarterly		
	(1) Change in reserves	(2) Spot Proxy	(3) BOP flow	(4) Change in reserves	(5) Spot Proxy
Published Data	0.927*** (0.054)	0.940*** (0.031)	0.865*** (0.048)	0.892*** (0.052)	0.918*** (0.048)
Constant	0.001*** (0.000)	0.000*** (0.000)	0.002*** (0.000)	0.003*** (0.000)	0.001*** (0.000)
Observations	4177	4177	1503	1503	1503
# Countries	23	23	26	26	26
R-squared	0.294	0.391	0.500	0.462	0.626
Adjusted R-squared	0.294	0.391	0.500	0.462	0.626
P-value ($\beta = 1$)	0.193	0.067	0.009	0.048	0.101

Source: authors' estimations

Notes: Standard errors clustered at the country level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

As shown in Table 2, the advantage of the spot proxy vis-à-vis the coarser measures is even more evident when the sample period is restricted to the last decade (2010-19). This is visible in the larger differences in the β coefficient and the r-squared, and reflects the fact that, with growing stocks of reserves (and foreign currency assets more broadly) over time, valuation changes have become larger and, thus, leading to a lower accuracy of the change in the stock of reserves as a proxy for FXI. A similar notion applies to the investment income component, although the secular decline in global interest rates has reduced the importance of this component over time (see also Appendix 1). Finally, the adjustments made due to changes in central banks' FX positions are also typically available only after 2002, and for some cases later, making the spot proxy more accurate in more recent years.

²⁵ Alternatively, the published data can be regressed on the different proxies and our conclusions hold. Since the variance of any of the proxies tends to be higher than the variance of the published data (in part, reflecting non-zero variations in the spot proxy during periods of no intervention), beta coefficients are smaller for all proxies under this alternative specification.

²⁶ The reported constant is a (weighted) average of the country fixed effects.

Table 2. Published and Proxies of FXI. Recent years (2010-19).

	Monthly		Quarterly		
	(1) Change in reserves	(2) Spot Proxy	(3) BOP flow	(4) Change in reserves	(5) Spot Proxy
Published Data	0.869*** (0.049)	0.933*** (0.054)	0.839*** (0.067)	0.831*** (0.074)	0.931*** (0.072)
Constant	0.001*** (0.000)	0.000** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.001*** (0.000)
Observations	2538	2538	926	926	926
# Countries	23	23	26	26	26
R-squared	0.209	0.318	0.410	0.354	0.570
Adjusted R-squared	0.209	0.318	0.409	0.353	0.569
P-value ($\beta = 1$)	0.014	0.222	0.024	0.031	0.346

Source: authors' estimations.

Notes: Standard errors clustered at the country level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

B. A Horse Race: Spot Proxy vs. Changes in Reserves

An alternative approach to evaluate the usefulness of our proxy vis-à-vis changes in reserves is through 'horse race' regressions of the following type:

$$x_{i,t}^* = a_i + \gamma_1 x_{i,t}^1 + \gamma_2 x_{i,t}^2 + \xi_{i,t} \quad (3)$$

where $x_{i,t}^*$ is published FXI data; $x_{i,t}^1$ is the change in reserves; and $x_{i,t}^2$ is our spot proxy, all expressed in percent of GDP. For quarterly data, we also compare changes in reserves against reserve transactions as recorded in the balance of payments.

The results point to the superiority of our spot proxy over the change in reserves (Table 3). Specifically, our spot proxy adds significantly to the r-squared of the regression at the monthly frequency (going from column 1 to 2). Also, its coefficient in column 2 is positive and significant at 1 percent level, meaning that an upward change in our spot proxy correlates with purchases reported in published FXI, controlling for changes in reserves. That is, there is significant additional informational content in our proxy in relation to the information included in the changes in reserves. The same holds for quarterly data, where also reserve transactions as recorded in the BOP seem to improve on the change in reserves (column 4 compared to 3). Our spot proxy, though, dominates the BOP reserve flow since its coefficient becomes insignificant in a three-way regression (column 5). The r-squared again is also considerably larger when the spot proxy is introduced.

Table 3. Horse Race: Changes in Reserves vis-à-vis Spot Proxy (2000-19)

	Monthly		Quarterly		
	(1)	(2)	(3)	(4)	(5)
	Dependent Variable: Published Data				
Change in reserves	0.317*** (0.080)	0.132** (0.056)	0.518*** (0.095)	0.150** (0.070)	0.161** (0.077)
BOP flow				0.431** (0.157)	0.011 (0.152)
Spot Proxy		0.316*** (0.059)			0.541*** (0.089)
Constant	0.001*** (0.000)	0.000*** (0.000)	0.000 (0.001)	0.000 (0.001)	0.000 (0.000)
Observations	4177	4177	1503	1503	1503
# Countries	23	23	26	26	26
R-squared	0.294	0.420	0.462	0.507	0.649
Adjusted R-squared	0.294	0.419	0.462	0.506	0.649

Source: authors' estimations.

Notes: Standard errors clustered at the country level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

C. Dissecting the Spot Proxy

An approach similar to the above can be used to assess the value of specific elements of our proxy. This entails dissecting the spot proxy into its different components in order to assess their individual contributions. To this end, we construct “intermediate” proxies to be included in equation (3), one for each main adjustment made to the changes in reserves as part of the construct of our spot proxy, introducing adjustments incrementally. Such a horse race allows to evaluate the individual importance of each adjustment in terms of providing information that correlates with published FXI data that is not already embedded in the change in reserves. That is, a significant coefficient on any one of these intermediate proxies indicates that the adjustment that makes this intermediate proxy different has additional information and is helpful in getting our spot proxy closer to published FXI data. Moreover, changes in the value and statistical significance of the coefficient of the change in reserves serve as a test on whether the spot (intermediate or final) proxies subsume the information embedded in the change in reserves.

Table 4 displays horse races at monthly frequency across the different adjustments made to arrive at our final proxy, confirming that several of our adjustments to changes in reserves improve the FXI proxy, bringing it closer to the published FXI data. First, we evaluate the adjustments for investment income and valuation changes (column 2). Although the coefficient of the corresponding intermediate proxy that adjusts for income and valuation effects is not significant at the 10 percent level, partly reflecting collinearity, it is significant at 15 percent level and it increases the r-squared, suggesting that while the contribution may be small, it adds information. Adjusting for the position of the central bank vis-à-vis the IMF (column 3) moves the FXI proxy substantially closer to published data as indicated by the highly significant coefficient of the intermediate proxy and the higher r-squared.²⁷ Column (4) shows that adjustments to the net position of the central bank vis-à-vis other non-residents do not seem to add much on their own (the coefficient is insignificant and the r-squared is broadly unchanged). Finally, the adjustment for central bank's positions vis-à-vis residents (column 5), is found to have the largest impact, with a coefficient that is highly significant and a material

²⁷ While the contribution to the r-squared is small—reflecting that transactions vis-à-vis the IMF are infrequent—the coefficient is highly significant, pointing to the importance of this adjustment to get a more accurate measure of FXI.

impact on the r-squared. Note that, in this case, the coefficient on the adjustment vis-à-vis other non-residents becomes negative (and highly significant), denoting some offsetting between the two adjustments for central bank positions relative to non-residents and residents. Finally, note that the coefficient on the change in reserves is always insignificant in columns (2)-(5) indicating that all the relevant information in the change in reserves (and more) is contained in our proxy. Appendix Table A1.3 shows similar findings for the proxies at quarterly frequency, as appendix Tables A1.4 and A1.5 focused on most recent years (2010-19).

Table 4. A horserace between proxies. (2000-19, monthly frequency)

	Dependent Variable: Published Data				
	(1)	(2)	(3)	(4)	(5)
Change in reserves	0.317*** (0.080)	0.122 (0.088)	0.142 (0.087)	0.141 (0.087)	0.130 (0.100)
Adjustment added: Valuation and income effects		0.217 (0.137)	-0.222* (0.119)	-0.224* (0.120)	-0.191 (0.131)
Adjustment added: CB position relative to IMF			0.447*** (0.074)	0.410*** (0.092)	0.468*** (0.088)
Adjustment added: Position relative to other non-residents				0.040 (0.026)	-0.329*** (0.069)
Adjustment added: Position relative to residents					0.425*** (0.047)
Constant	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.000*** (0.000)
Observations	4177	4177	4177	4177	4177
# Countries	23	23	23	23	23
Within R-squared	0.294	0.304	0.331	0.332	0.464
Adjusted R-squared	0.294	0.304	0.331	0.332	0.463

Source: authors' estimations.

Notes: Standard errors clustered at the country level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

D. Possible Future Refinements

While the proxy of FXI presented in this paper entails a refinement relative to previous measures, there is scope for further improvements along some dimensions, if more granular data become available. Specifically:

- **Currency composition:** A limitation in the computation of valuation changes arises from the limited reporting of country-specific information on the currency composition of central banks reserves (and foreign assets more broadly). The available information is currently provided by country authorities to the IMF as part of their submissions to Currency Composition of Official Foreign Exchange Reserves (COFER) database, but the individual country data is confidential. Some progress has been made with individual reporting and publication of data under the International Reserves and Foreign Currency Liquidity Template, although the current set of countries remains small. Thus, valuation changes for most countries are estimated on the basis of aggregate currency shares. For many countries and in early years, this assumption is likely innocuous as the US dollar dominates reserve holdings. For countries with close economic ties to economic areas that issue other reserve currencies, however, other reserve assets may play a greater role (e.g., Eastern European economies may hold larger than average reserve shares in Euro-denominated assets).²⁸ In addition, while still relatively low, some currencies (like the Swiss

²⁸ See Anderson et al (2020).

Franc, Canadian dollar, Australian dollar, Renminbi) have gained some ground in reserve holdings over time.

- **Equity holdings.** As foreign currency holdings grow, surpassing desirable levels of liquidity buffers for precautionary motives in some economies, investment diversification towards higher return and less liquid assets—including equity—is likely to take place. Consequently, valuation changes may become more volatile and difficult to estimate unless granular data on such investments are made available.
- **Coverage.** In line with the rest of the literature, our work focused on foreign currency transactions by the central bank. In some cases, however, operations by other public entities (like the central government, public banks, sovereign wealth funds or state-owned enterprises) share some of the key characteristics of central bank interventions (Bayoumi et al 2015). Limited data on the balance sheets of these public entities, especially at high frequency and breaking down positions by currency, precludes a broader coverage of foreign currency transactions at this point.
- **Consistency in published data.** The comparisons made in Section V.A-C assumed, except for a few cases, that published FXI data reflects the concept of FXI of interest closely. As mentioned before, however, there is limited information on the definition of FXI used by central banks and, thus, it is possible that the definition of reported series may differ across countries. Converging on a commonly agreed definition will help ensure that published data is consistent, increasing their usefulness for direct cross-country analysis as well as for evaluating the accuracy of available proxies.

VI. CONCLUSIONS

Exchange rate management remains a central topic of international economics and a key element of policy making. Yet, data on central bank interventions in foreign exchange markets remain scant.

This paper provides a new database of publicly available data and carefully constructed proxies for FXI—for both operations in spot and derivative markets, at monthly and quarterly frequencies—focusing on transactions that alter the central bank’s foreign currency position. The dataset significantly expands available FXI data, and improves on previously used measures by accounting for a wide range of central bank operations, including, crucially, operations vis-à-vis residents. These data are particularly useful for rigorous and comprehensive cross-country macroeconomic analysis aimed at shedding light on the merits and downsides of FXI as a policy tool—a key aspect of the IMF’s Integrated Policy Framework.

APPENDIX 1: ADDITIONAL TABLES AND FIGURES

Appendix Table A1.1. Countries that Publish Foreign Exchange Intervention Data

IFS Code	Country Name	Frequency	Intervention Type			Source
			Spot	Forward-like (forward/ futures/ swaps)	Other derivatives (options, repos, reverse repos...)	
914	Albania	D, Q	√			CB Website time series + Time series complied from multiple reports
614	Angola	M	√			CB Website time series
213	Argentina	D	√			CB Website time series
193	Australia	D	√			CB Website time series
513	Bangladesh	Q	√			Time series complied from multiple reports
218	Bolivia	M	√			CB Website time series
963	Bosnia and Herzegovina	M	√			CB Website time series
223	Brazil	D	√	√	√	CB Website time series
156	Canada	M	√			Time series complied from multiple reports
233	Colombia	D	√	√	√	CB Website time series
238	Costa Rica	D	√			CB Website time series
960	Croatia	D	√		√	CB Website time series
935	Czech Republic	M	√	√		CB Website time series
128	Denmark	M	√			Time series complied from multiple reports
163	Euro area	D	√			CB Website time series
644	Ethiopia	Q	√			Time series complied from multiple reports
915	Georgia	D	√			CB Website time series
336	Guyana	M	√			Time series complied from multiple reports
532	Hong Kong SAR	D	√			CB Website time series
176	Iceland	M	√			CB Website time series
534	India	M	√	√		CB Website time series
436	Israel	M	√			Time series complied from multiple reports
343	Jamaica	D, Q	√			Time series complied from multiple reports
158	Japan	M	√			Time series complied from multiple reports
916	Kazakhstan	M	√			CB Website time series
542	Korea	Q, HY	√			Time series complied from multiple reports
684	Mauritius	M	√			CB Website time series
273	Mexico	M	√			CB Website time series
921	Moldova	M	√	√		Time series complied from multiple reports
686	Morocco	M	√			CB Website time series
196	New Zealand	M	√			CB Website time series
278	Nicaragua	M	√			Time series complied from multiple reports
694	Nigeria	M	√			CB Website time series
288	Paraguay	D	√			CB Website time series
293	Peru	D	√			CB Website time series
922	Russia	M	√			CB Website time series
576	Singapore	HY	√			CB Website time series
146	Switzerland	Q, A	√			CB Website time series
186	Turkey	M	√		√	CB Website time series
926	Ukraine	W	√			CB Website time series
112	United Kingdom	M	√			Time series complied from multiple reports
111	United States	M	√			Time series complied from multiple reports
927	Uzbekistan	M	√			Time series complied from multiple reports
754	Zambia	W	√			CB Website time series

Sources: Various.

Notes: "Time series complied from multiple reports" indicates that information on FXI was collected from multiple, scattered sources. Typically, these are monthly or quarterly reports on monetary and exchange rate policies. This table reflects our best knowledge as of December 2020 and may not reflect all countries that publish FXI data.

Appendix Table A1.2. Country-by-country Regressions of Published on Proxied FXI

Economy	Change in Reserves		Spot Proxy		Broad Proxy	
	alpha	beta	alpha	beta	alpha	beta
Albania	0.00*	0.75*	0.00*	0.64*	0.00*	0.64*
Angola	0.01*	0.06	0.02*	0.44	0.02*	0.44
Argentina	0.00*	0.70*	0.00*	0.98*	0.00*	1.00*
Australia	0.00*	-0.5*	0.00*	-0.72*	0.00*	3.35*
Bangladesh	0.00	0.83*	0.00	0.83	0.00	0.83
Bolivia	0.01	0.79*	0.01	0.86*	0.01	0.86*
Bosnia and Herzegovina	0.00*	1.10*	0.00	1.01*	0.00	1.01*
Brazil	0.00	0.94*	0.00*	1.04*	0.00*	1.09*
Canada	0.00*	-21.03	0.00*	-14.5	0.00*	-13.45
Colombia	0.00	0.64	0.00	0.62	0.00*	0.60
Costa Rica	0.00*	0.86*	0.00*	1.05*	0.00*	1.05*
Croatia	0.00	0.67*	0.00*	0.51	0.00*	0.51
Czech Republic	0.01	0.99*	0.00	1.10	0.00	1.10
Denmark	0.00*	0.82	0.00*	1.06*	0.00*	1.06*
Ethiopia	0.00*	0.67*	0.00*	0.85*	0.00*	0.85*
Georgia	0.00*	0.85*	0.00*	0.83*	0.00*	0.82*
Guyana	0.00*	-0.10	0.00*	-0.11	0.00*	-0.11
Hong Kong SAR	0.01	0.98*	0.00	0.88*	0.00	0.88*
Iceland	0.00*	0.49	0.00*	0.9*	0.00*	0.9*
India	0.00*	1.22	0.00	0.98*	0.00*	1.07*
Israel	0.00*	0.96*	0.00*	0.80*	0.00*	0.81*
Jamaica	0.01	0.57	0.00*	0.24	0.00*	0.24
Kazakhstan	0.01	0.73	0.00*	0.74	0.00*	0.77
Mauritius	0.00*	0.9*	0.00*	0.73	0.00*	0.73
Mexico	0.00	0.85*	0.00	0.70*	0.00	0.69*
Moldova	0.00*	1.23	0.00*	0.94	0.00*	0.94
New Zealand	0.00*	0.53	0.00*	0.56*	0.00*	0.73*
Nicaragua	0.00	0.77*	0.00*	0.46	0.00*	0.46
Nigeria	0.01	0.42	0.01*	0.48	0.01*	0.48
Paraguay	0.00*	1.20*	0.00*	0.97*	0.00*	0.97*
Peru	0.00	0.80	0.00*	1.02*	0.00*	1.03*
Russia	0.00*	0.88	0.00*	0.83	0.00*	0.86
Turkey	0.00*	0.04*	0.00	1.19*	0.00*	1.14*
Uzbekistan	0.00*	-0.30	0.01*	0.68*	0.01*	0.68*
Zambia	0.00*	0.28*	0.00*	-0.03	0.00*	-0.03

Notes: Constant and slope coefficients of country-by-country regressions of proxy on published FXI are reported. A star denotes p-value smaller than 0.05.

Appendix Table A1.3. A horserace between proxies. Full sample (2000-19, quarterly frequency)

	(1)	(2)	(3)	(4)	(5)	(6)
	Published Data	Published Data	Published Data	Published Data	Published Data	Published Data
Change in reserves	0.518*** (0.095)	0.150** (0.070)	0.440 (0.589)	-0.054 (0.509)	-0.066 (0.511)	-0.212 (0.437)
Adjustment added: BOP flows		0.431** (0.157)	-0.145 (1.120)	0.238 (0.990)	0.262 (0.991)	0.623 (0.874)
Adjustment added: Valuation and income effects			0.287 (0.574)	-0.227 (0.502)	-0.236 (0.503)	-0.395 (0.435)
Adjustment added: CB position relative to IMF				0.654*** (0.084)	0.593*** (0.118)	0.570*** (0.140)
Adjustment added: Position relative to other non-residents					0.056 (0.087)	-0.479*** (0.158)
Adjustment added: Position relative to residents						0.643*** (0.052)
Constant	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.001 (0.001)	0.001 (0.001)	-0.000 (0.001)
Observations	1503	1503	1503	1503	1503	1503
# Countries	26	26	26	26	26	26
Within R-squared	0.462	0.507	0.507	0.539	0.540	0.675
Adjusted R-squared	0.462	0.506	0.506	0.538	0.538	0.674

Source: authors' estimations.

Notes: Standard errors clustered at the country level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendix Table A1.4. A horserace between proxies. (2010-19, monthly frequency)

	(1)	(2)	(3)	(4)	(5)
	Published Data	Published Data	Published Data	Published Data	Published Data
Change in reserves	0.241** (0.094)	0.052 (0.068)	0.078 (0.065)	0.073 (0.067)	0.078 (0.090)
Adjustment added: Valuation and income effects		0.205 (0.136)	-0.190** (0.089)	-0.179* (0.091)	-0.104 (0.112)
Adjustment added: CB position relative to IMF			0.390*** (0.119)	0.330** (0.128)	0.381*** (0.134)
Adjustment added: Position relative to other non-residents				0.053* (0.026)	-0.312** (0.111)
Adjustment added: Position relative to residents					0.392*** (0.094)
Constant	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.000*** (0.000)
Observations	2538	2538	2538	2538	2538
# Countries	23	23	23	23	23
Within R-squared	0.209	0.221	0.238	0.240	0.386
Adjusted R-squared	0.209	0.220	0.237	0.239	0.385

Source: authors' estimations.

Notes: Standard errors clustered at the country level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendix Table A1.5. A horserace between proxies. (2010-19, Quarterly frequency)

	(1)	(2)	(3)	(4)	(5)	(6)
	Published Data	Published Data	Published Data	Published Data	Published Data	Published Data
Change in reserves	0.426*** (0.141)	0.045 (0.065)	1.760** (0.667)	1.120 (0.684)	1.199 (0.714)	0.871 (0.622)
Adjustment added: BOP flows		0.445** (0.204)	-2.979** (1.406)	-2.299 (1.393)	-2.452 (1.447)	-1.603 (1.249)
Adjustment added: Valuation and income effects			1.709** (0.662)	1.048 (0.674)	1.138 (0.703)	0.796 (0.618)
Adjustment added: CB position relative to IMF				0.654*** (0.148)	0.451** (0.178)	0.512*** (0.134)
Adjustment added: Position rel. to other non-residents					0.180* (0.104)	-0.530*** (0.132)
Adjustment added: Position relative to residents						0.659*** (0.114)
Constant	0.001 (0.001)	0.001 (0.001)	0.002* (0.001)	0.002* (0.001)	0.002* (0.001)	0.001 (0.001)
Observations	926	926	926	926	926	926
# Countries	26	26	26	26	26	26
Within R-squared	0.354	0.411	0.413	0.444	0.450	0.620
Adjusted R-squared	0.353	0.409	0.412	0.442	0.447	0.618

Source: authors' estimations.

Notes: Standard errors clustered at the country level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Figure A1.1. Size and Symmetry of Foreign Exchange Intervention. Financial Centers and other AEs.
(frequency)

Sources: authors' estimations.

Notes: Based on quarterly observations and using our "broad" proxy=spot plus derivatives transactions.

APPENDIX 2: GENERAL METHODOLOGY FOR BUILDING THE PROXIES

A. Conceptual Framework

As discussed in the main text, we are interested in a concept of foreign exchange intervention that captures central bank's transactions that alter its net foreign currency position. To derive a proxy for such a concept, consider a simplified version of a central bank's balance sheet (expressed in local currency):

$$RES + OFA + FCDA + LCDA = FL + FCDL + LCDL + EQ$$

where *RES* denotes foreign currency reserves; *OFA* are other foreign assets; *FCDA* denotes foreign currency domestic assets; *LCDA* are Local-Currency Domestic Assets; *FL* are foreign liabilities; *FCDL* are foreign currency domestic liabilities; *LCDL* are domestic currency domestic liabilities; and *EQ* denotes equity or net worth. This expression can also be written in terms of the net foreign and local currency positions, as:

$$NFCP = NLCP + EQ$$

where $NFCP = RES + OFA + FCDA - FCDL - FL$ and $NLCP = LCDA - LCDL$. It follows that:

$$dNFCP = dNLCP + dEQ$$

Our interest lies only in changes of *NFCP* arising from transactions and thus have a counterpart on change in the *NLCP* (not in the equity position, *EQ*):

$$dNFCP^{FXI} = dNLCP^{FXI}$$

In many cases, only the overall change in the net foreign currency position, which includes investment income and valuation changes, is observed:

$$dNFCP = FXI + NFCP_InvIncome + NFCP_Val$$

Thus, an estimate of *FXI* can be built from the observed change in *NFCP* and the estimated investment income and valuation changes.

$$Est[FXI] = dNFCP - Est[NFCP_InvIncome] - Est[NFCP_Val]$$

Since reserve assets tend to dominate *NFCP*, valuation changes and income flows will be primarily driven by reserve assets. This means that *FXI* can be estimated as:

$$Est[FXI] = dNFCP - Est[RES_InvIncome] - Est[RES_Val]$$

This can also be written as:

$$\begin{aligned} Est[FXI] &= dRES \\ &+ d(OFA - FL) \\ &+ d(FCDA - FCDL) \\ &- Est[RES_InvIncome] - Est[RES_Val] \end{aligned}$$

The latter equation highlights how a refined proxy of *FXI* departs from the coarse measure of changes in reserves (*dRES*) to include changes in other assets and liabilities, changes in foreign assets and liabilities vis-à-vis residents; and estimated investment income and valuation changes. These

adjustments are key as changes in reserves can vary for a number of reasons without entailing a transaction that alters the central bank's NFCP (i.e., FXI):

- Changes in reserves can reflect reallocation between reserve and non-reserve foreign assets. This is particularly relevant in economies with significant reserve assets—where reserve holdings may exceed levels consistent with precautionary liquidity buffers and, thus, central banks may choose to invest part of their foreign currency holdings in less liquid assets.
- Similarly, reserve levels may vary as central banks borrow from or repay loans to foreign entities, without entailing changes in the foreign currency position.
- In some economies, the central bank conducts operations with foreign exchange on behalf of other domestic entities (most commonly the central government). This can temporarily affect the holdings of reserve and non-reserve foreign currency assets, but they also entail a corresponding foreign currency liability vis-à-vis those domestic entities.
- Similarly, in many emerging and developing economies, banks are allowed to take on deposits in foreign currency, with associated reserve requirements. This can translate in changes in foreign currency (reserve or non-reserve) holdings of the central bank with corresponding foreign currency liabilities vis-à-vis domestic banks.

B. Constructing the FXI proxy

This section describes how different sources of data are used to construct a proxy of FXI with the adjustments described above.

Non-reserve foreign currency asset and liabilities

Information on reserve assets comes from the Fund's International Financial Statistics (IFS). Non-reserve foreign assets and liabilities as well as foreign currency position vis-à-vis residents are obtained from the IMF's Monetary and Financial Statistics (MFS). Appendix Table A2.1 provides details of the data coverage.

Valuation changes and investment income

Estimating investment income and valuation changes entails using available information on the structure of assets and liabilities in terms of their currency and asset composition. In order to understand how different sources of information are combined, consider the stock of reserves which can be written as the sum of its components as follows:

$$RES = \sum_c \sum_a S^c P_a^c H_a^c$$

where S^c denotes the exchange rate US dollar per currency c ; P_a^c is the price of asset type a expressed in currency c ; and H_a^c is the (quantity) holding of asset type a denominated in currency c .

The investment income on reserves can, therefore, be written in terms of investment income on the individual components:

$$RES_InvIncome = \sum_c \sum_a i_a^c w_a^c$$

where $w_a^c = \frac{S^c P_a^c H_a^c}{\sum_c \sum_a S^c P_a^c H_a^c}$ is the share of currency - asset type a in total reserves.

Appendix Table A2.1. Coverage of Central Banks' Foreign Currency Positions Data

IFS code	Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
128	Denmark																					
142	Norway																					
144	Sweden																					
146	Switzerland																					
156	Canada																					
174	Greece																					
176	Iceland																					
181	Malta																					
186	Turkey																					
193	Australia																					
196	New Zealand																					
199	South Africa																					
213	Argentina																					
218	Bolivia																					
223	Brazil																					
228	Chile																					
233	Colombia																					
238	Costa Rica																					
243	Dominican Republic																					
248	Ecuador																					
253	El Salvador																					
258	Guatemala																					
268	Honduras																					
273	Mexico																					
278	Nicaragua																					
283	Panama																					
288	Paraguay																					
293	Peru																					
298	Uruguay																					
299	Venezuela																					
313	Bahamas, The																					
336	Guyana																					
343	Jamaica																					
369	Trinidad and Tobago																					
419	Bahrain																					
423	Cyprus																					
433	Iraq																					
436	Israel																					
439	Jordan																					
443	Kuwait																					
446	Lebanon																					
449	Oman																					
453	Qatar																					
456	Saudi Arabia																					
466	United Arab Emirates																					
469	Egypt																					
474	Yemen																					
487	West Bank and Gaza																					
512	Afghanistan																					
513	Bangladesh																					
516	Brunei Darussalam																					
518	Myanmar																					
522	Cambodia																					
524	Sri Lanka																					
528	Taiwan Province of China																					
532	Hong Kong SAR																					
534	India																					
536	Indonesia																					
542	Korea																					
544	Lao P.D.R.																					
546	Macao SAR																					

Source: Monetary and Financial Statistics Dataset

Appendix Table A2.1 (continued). Coverage of Central Banks' Foreign Currency Positions Data

IFS code	Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
548	Malaysia																					
558	Nepal																					
564	Pakistan																					
566	Philippines																					
576	Singapore																					
578	Thailand																					
582	Vietnam																					
612	Algeria																					
614	Angola																					
616	Botswana																					
622	Cameroon																					
628	Chad																					
634	Congo, Republic of																					
636	Congo, Democratic Republic of the																					
642	Equatorial Guinea																					
644	Ethiopia																					
646	Gabon																					
652	Ghana																					
656	Guinea																					
664	Kenya																					
672	Libya																					
674	Madagascar																					
684	Mauritius																					
686	Morocco																					
688	Mozambique																					
694	Nigeria																					
698	Zimbabwe																					
714	Rwanda																					
728	Namibia																					
732	Sudan																					
738	Tanzania																					
744	Tunisia																					
746	Uganda																					
754	Zambia																					
853	Papua New Guinea																					
911	Armenia																					
912	Azerbaijan																					
913	Belarus																					
914	Albania																					
915	Georgia																					
916	Kazakhstan																					
918	Bulgaria																					
921	Moldova																					
922	Russia																					
924	China																					
926	Ukraine																					
927	Uzbekistan																					
935	Czech Republic																					
936	Slovak Republic																					
939	Estonia																					
941	Latvia																					
942	Serbia																					
944	Hungary																					
946	Lithuania																					
948	Mongolia																					
960	Croatia																					
961	Slovenia																					
962	North Macedonia																					
963	Bosnia and Herzegovina																					
964	Poland																					
968	Romania																					

Source: Monetary and Financial Statistics Dataset

The International Reserves and Foreign Currency Liquidity Template (*IRFCLT*) provides information on the composition of assets. Information on the currency structure is available from the Currency Composition of Official Foreign Exchange Reserves (*COFER*) dataset and *IRFCLT*. However, for most categories of asset types, there is no information of the currency structure within the asset type. The only exceptions are the IMF position and SDR holdings, which are denominated in SDRs (and gold holdings, which can be valued at the price of gold in US dollars). Thus, for all other asset types, the currency structure is assumed to be invariant. That is, $S^c P_a^c H_a^c = S^c P^c H^c$, which implies that $\frac{S^c P_a^c H_a^c}{\sum_a S^c P_a^c H_a^c} = w^c$ and therefore $w_a^c = w^c w_a$.

The above expression for the income on reserves can, thus, be written as:

$$RES_InvIncome = \sum_c \sum_a i_a^c w^c w_a$$

In turn, valuation changes arising from both exchange rate and asset price movements can be expressed as:

$$RES_Val = \sum_c \frac{dS^c}{S^c} w^c + \sum_c \sum_a \frac{dP_a^c}{P_a^c} w^c w_a$$

In order to estimate these components, currency weights of the five major currencies (USD, Euro, Yen, Pound, Renminbi) as well as the SDR are considered as the account for the vast majority of reserves. Country-specific currency weights (w^c) are taken from the Reserve Template, when data are reported. Otherwise, group averages from COFER are used. As mentioned, individual country information is confidential for all COFER reporting economies.

Asset type weights are based on the country-specific information available in the IRFCLT. The key categories included there are: (i) Currency and Deposits; (ii) Securities; (iii) Position at the IMF; (iv) SDR holdings; (v) Gold; (vi) Other foreign currency assets. As shown in Appendix Figure A2.1, the bulk of foreign assets is held in the form of Securities and Currency & Deposits, which have relatively stable shares over time, although there is considerable cross-sectional heterogeneity. Other forms of reserves, like claims on the IMF, SDRs, Gold and Other Assets represent a small fraction of total reserves for most countries.

Appendix Figure A2.1. Weights by asset type
(share of total foreign currency assets)

Sources: International Reserves and Foreign Currency Liquidity Template (IRFCLT), and authors' calculations.
Notes: Cross-section percentiles 25, 50 and 75 among economies reporting to IRFCLT (and with GDP larger than US\$10 billion in 2019) are depicted.

Data on the asset structure of reserves is available for about 50-60 percent of the countries in the sample from the IRFCLT (see Appendix Figure A2.2). We complement that information with partial information available in MFS. Concretely, MFS reports gold and SDR holdings of central banks, which we use to calculate the weight of those two items in countries' reserves.

Using this information, asset weights are constructed as follows: (i) based on country-specific shares reported in the IRFCLT, when available; (ii) when country-specific information is only available for some (most recent) periods, shares are spliced backwards using median weights observed for other countries to account for broad trends in the asset structure, while maintaining heterogeneity in levels; (iii) when no country-specific information is available in IRFCLT, we use MFS based data for the weights on gold and SDR assets and use the median breakdown of foreign currency assets from IRFCLT for the rest of the assets; and (iv) finally, if no information is available from either MFS or IRFCLT the median of the weights observed for all countries in IRFCLT are used.

Appendix Figure A2.2 illustrates the coverage of available country-specific asset-type weights, which has grown over time but remains only slightly above half of the sample of countries of analysis. For most AEs and some EMDEs, there is ample information since the early 2000s, while data for smaller EMDEs and LICs remains limited.

Appendix Figure A2.2. Coverage of data on asset structure

Sources: International Reserves and Foreign Currency Liquidity Template (IRFCL), and authors' calculations.

Investment income

Some countries report investment income on reserves as part of the income balance in their balance-of-payments statistics, although in many cases providing short time series (Appendix Figure [A2.3]). This provides an exact measure of the investment income on reserves that needs to be netted out. When available, such series are used as a measure of income on reserves.

Appendix Figure A2.3. Investment Income on Reserves

Sources: *International Reserves of Foreign Currency Liquidity*, *Balance of Payments Statistics*, author's calculations.

Notes: Left panel depicts cross-section percentiles 25, 50 and 75 among economies (with GDP larger than US\$ 10 billion in 2019) reporting to IRFCLT and BOP. Right panel shows the share of countries in the sample with reported BOP data on investment income on reserves.

Otherwise, the interest on reserves is estimated using available information on currencies and asset types combined with estimates of the coupon rate on the different instruments as follows:

Appendix Table A2.2. Interest rates (i_a^c)

	USD	Euro	Yen	Pound	Other	SDR
Currency & Deposits	3-month US interbank rate	3-month Euro interbank rate	3-month Yen interbank rate	3-month Pound interbank rate	<i>Basket of the other currencies</i>	--
Securities	Effective rate ¹	Effective rate ¹	Effective rate ¹	Effective rate ¹	<i>Basket of the other currencies</i>	--
SDR	--	--	--	--	--	SDR rate
IMF Position	--	--	--	--	--	SDR rate
Gold	--	--	--	--	--	--
Other	<i>Same as securities</i>					--

¹ Effective interest rate paid by the corresponding reserve-issuing countries.

Source: Authors' calculations.

As shown in Appendix Table A2.2, the interest rate on short-term assets like currency and deposits can be estimated fairly accurately with the prevailing market rate. Estimating the coupon rate on longer-term securities, however, is more challenging as the holdings of this type of securities may encompass a portfolio of different maturities with coupon rates that may be different from the prevailing market rates. To overcome this obstacle, the effective rate paid by reserve currency-issuing countries, available from their public accounts, is used. A synthetic portfolio combining 2-year and 10-year bonds purchased over the last 2 and 10 years, respectively, which are shown to track the effective interest rate paid closely over the sample period (Appendix Figure A2.4).

$$\bar{i}_t^c = (0.7) * \sum_{l=1}^{10} \left(\frac{1}{10}\right) i_{t-l}^{c,10y} + (0.3) * \sum_{l=1}^2 \left(\frac{1}{2}\right) i_{t-l}^{c,2y}$$

Appendix Figure A2.4. Effective interest rate and 10-Year Treasury Bond Yield

Sources: *World Economic Outlook*, *Haver Analytics*, and authors' calculations.

Note: Effective interest rate is imputed by dividing general government interest expense by general government gross debt. Synthetic portfolio composed of 70 percent of 10-year maturity bonds purchased over the last 10 years and 30 percent of 2-year maturity bonds purchased over the last 2 years.

Valuation changes are estimated with the following assumptions for asset prices:

Appendix Table A2.3. Asset Prices (P_a^c)

	USD	Euro	Yen	Pound	Other	SDR
Currency & Deposits	1	1	1	1	1	--
Securities	10-year US Treasury	10-year German Bond	10-year Bond	10-year Bond	Basket of other currencies	--
SDR	--	--	--	--	--	1
IMF Position	--	--	--	--	--	1
Gold	Price in US dollars	--	--	--	--	--
Other	Same as securities					--

Source: Author's calculations.

Currency and Deposits, the SDR and IMF position are taken at nominal value, implying that only exchange rate changes lead to valuation changes for this component. Consistent with the estimation of interest income, security holdings are assumed to combine 2- and 10-year bonds purchase in previous 2 and 10 years respectively. The market price of the basket of securities in currency c can, thus, be estimated as:

$$P_t^c = (0.7) * \sum_{RM=1}^{10} \left(\frac{1}{10}\right) P^{c,10, RMY} + (0.3) * \sum_{RM=1}^2 \left(\frac{1}{2}\right) P^{c,10, RMY}$$

where $P_t^{c,M,RMY}$ is the price of a bond of original maturity M and residual maturity in years RMY that pays out interest $\alpha^{c,M}$ on a quarterly basis, is given by:

$$P_t^{c,M,RM} = \alpha^{c,M} \frac{\left[1 - \left(1 + \frac{i^{RM}}{4}\right)^{-RM}\right]}{i^{RM}/4}$$

where i^{RM} is the observed M-quarter maturity (residual) market yield and RM is the number of quarters of residual maturity. Information on the yield curve at each point in time is used to estimate changes in these prices. This entail a refinement with respect to previous estimations (e.g., Dominguez, 2012) which assumed a 10-year residual maturity bond was systematically held.

Gold holdings are valued at end of period market rates. Exchange rates are end-of period nominal rates vis-à-vis the US dollar (e.g., USD/Euro), as reported in *International Financial Statistics*.

VII. ADJUSTMENTS AT DIFFERENT FREQUENCIES

The requirements for the computation of the FXI proxy depend on the frequency of interest.

Quarterly frequency. The computation of FXI proxies at quarterly frequency makes use of the data from balance-of-payments statistics, which report changes in reserves on a transaction basis and, thus, are not polluted by valuation changes. Thus, quarterly proxies based on BOP flows only require adjusting for investment income flows.

Monthly frequency. Monthly proxies present additional challenges as transaction-based data (akin to those provided by balance-of-payment statistics) are rarely available. Thus, proxies rely on changes in stocks, which not only contain investment income flows but also exchange rate and asset prices changes. Thus, monthly proxies need to be adjusted for valuation changes as well.

Appendix Tables A2.4 and A2.5 provide details on how different country-specific information is used to estimate valuation changes and investment income for specific countries and periods of time, at quarterly and monthly frequency, respectively.

Appendix Table A2.4. Basis for Valuation and Income Adjustments. Quarterly Frequency

Appendix Table A2.4 (continued). Basis for Valuation and Income Adjustments. Quarterly Frequency

Appendix Table A2.5. Basis for Valuation and Income Adjustments. Monthly Frequency

Appendix Table A2.5 (continued). Basis for Valuation and Income Adjustments. Monthly Frequency

Foreign Exchange Derivatives

Operations using foreign exchange derivatives include changes in aggregate short and long positions in forwards and futures in foreign currencies vis-à-vis the domestic currency (including the forward leg of currency swaps), and financial instruments denominated in foreign currency but settled by other means (e.g., in domestic currency), as reported in the International Reserves and Foreign Currency Liquidity Template. Some clarifications are important:

- These notional amounts are not reported as part of the central bank's balance sheet, which only includes the market value of derivative positions (i.e., in- and out-of-the money positions) and, thus, may under or overestimate the actual FX derivative position.
- While changes in the notional amount properly capture new FXI operations through derivatives (e.g., a sale of FX forward), they would also capture the unwinding of derivative positions when they come due (in the previous example, this would result from the actual provision of FX as dictated by the previously sold forward FX contract). However, the unwinding of positions would normally be mirrored by other components of the central bank's balance sheet (drop in FX holdings in the example). Thus, a broad measure of FXI that encompasses spot and derivatives could adequately capture the initial FXI operation with derivatives while netting out their automatic unwinding.²⁹
- Some central banks use FX swaps to manage liquidity and smooth market functioning. These FX swaps are combinations of spot and mirroring forward interventions and do not necessarily affect the central bank's FX position and, thus, do not represent FXI as defined in this paper. The spot and forward legs of these swaps are captured in our proxies for spot and derivative FXI, respectively. For countries using FX swaps frequently, a broad FXI measure that combines (adds) the spot and derivative FXI proxies provides a more accurate read of actual FXI operations
- Swap lines *among central banks* are also, in general, of different nature. While they provide foreign currency liquidity, they do not alter any of the central banks' net foreign currency positions. Specifically, when swap lines are first established, they entail only contingent credit lines with no impact on the balance sheet or derivative positions of either central bank. When the swap lines are activated or drawn, there is an increase in both central banks' foreign assets and liabilities. Despite the fact that a draw down entails a swap of currencies, there is no change in net foreign currency positions of either central bank as the exchange of currencies only serve the purpose of providing collateral. Any variation in the value of one currency relative to the other triggers an additional provision of the depreciated currency to maintain the parity in the value of currency holdings. Thus, there is no currency risk in the swap lines for any of the participating central banks.³⁰

²⁹ The use of non-deliverable forwards and currency swaps poses additional challenges as the unwinding of notional amounts when the contract comes due do not necessarily result in mirroring changes in other elements of the central bank's balance sheet.

³⁰ This description follows with the correct statistical treatment of central bank swaps but in practice certain central banks may follow different recording practices.

APPENDIX 3: AD-HOC ADJUSTMENTS TO PROXIED FXI

Country	Period	Type of adjustment	Comments
Bolivia	Jan, 2004	Proxy not reported	Decrease in central government foreign currency securities due to a reclassification to national currency.
Bosnia & Herzegovina	2000-2001	Proxy not reported	Outliers in the raw data (for the change in reserves)—pending verification
Dominican Republic	Aug, 2005	Proxy not reported	Outliers in the raw data —pending verification.
Egypt	Jun, 2008	Proxy not reported	Large decrease in foreign currency loans to non-residents—pending verification.
El Salvador	Jan, 2000	Proxy not reported	Outliers in the raw data (for the change in reserves)—pending verification
Euro Area	All	Proxy not reported	Major reserve currency economies are excluded
Guinea	May, 2011	Proxy not reported	Large one-time operation—pending verification.
Hungary	Jun, 2009	Proxy not reported	Some raw data on central bank balance sheet is based on estimations from the ECB data.
Jamaica	Mar, 2017	Proxy not reported	Break in the series due to introduction of the Standardized Report Form (SRF).
Japan	All	Proxy not reported	Major reserve currency economies are excluded
Macao SAR	Feb, 2012	Proxy not reported	Break in the series due to a new legislation on gross reserves.
Macao SAR	Jan 2013; Jan 2014; Jan 2015; Feb 2016	Proxy not reported	Transfer of funds to the fiscal reserve at the beginning of each year.
Madagascar	Jan 2006	Proxy not reported	Break in the series due to introduction of SRF.
Mauritius	Jan-Nov, 2000	Proxy not reported	Outliers in the raw data (for the change in reserves)—pending verification
Morocco	2000; Jan-Feb, 2001	Proxy not reported	Outliers in the raw data (for the change in reserves)—pending verification
Mozambique	Jul, 2004	Proxy not reported	Part of the medium- and long-term foreign liabilities of the central bank transferred to the treasury.
Nicaragua	Jan 2006; Dec 2011	Proxy not reported	Outliers in raw data—pending verification
North Macedonia	2000; Jan-Feb 2001	Proxy not reported	Outliers in the raw data (for the change in reserves)—pending verification
Pakistan	Jun 2015; Jul & Sep 2016	Proxy not reported	Data to be revised
Romania	Dec 2005; Jan & Jul 2007	Proxy not reported	Outliers in various series pending verification
Saudi Arabia	2000-2004; Jan-Feb, 2005	Proxy not reported	Outliers in the raw data (for the change in reserves)—pending verification
Singapore	May, 2019	Proxy not reported	Transfer of reserves to sovereign wealth fund.

Sri Lanka	All	Source replaced	Gross reserves from IFS includes government reserves. Central bank gross reserves from MFS used instead.
Tanzania	2000-2003	Proxy not reported	Large drop in gross reserves—pending verification.
Thailand	Jan, 2003	Proxy not reported	Break in the series due to introduction of SRF.
Tunisia	May, 2017	Manual adjustment	Reserve number interpolated to treat large one-time spike in the data.
United Kingdom	All	Proxy not reported	Major reserve currency economies are excluded
United States	All	Proxy not reported	Major reserve currency economies are excluded
Venezuela	Jun, 2014	Proxy not reported	MFS data reporting stopped.
Zambia	Nov-Dec, 2002	Proxy not reported	Break in the series due to introduction of SRF.

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APPENDIX 4: SUMMARY METADATA FOR PUBLISHED FXI

Country Name	Albania
Coverage	2004Q2 – 2019Q4; 2013M10 - 2020M9
Agency	Central Bank
Types of operations	Spot
Frequency	Monthly, Quarterly
Reported format	Euro
Link	https://www.bankofalbania.org/Markets/Operations_of_the_Bank_of_Albania/Interventions_in_the_foreign_exchange_market/
Note	Starting October 2013, daily data available.

Country Name	Angola
Coverage	2000M1 – 2020M9
Agency	Central Bank
Types of operations	Spot
Frequency	Monthly
Reported format	Millions of U.S. Dollars and Euros
Link	https://www.bna.ao/Conteudos/Artigos/lista_artigos_medias.aspx?idc=222&idsc=14088&idl=1

Country Name	Argentina
Coverage	2003M1 – 2020M9
Agency	Central Bank
Types of operations	Spot
Frequency	Daily, Monthly
Reported format	Millions of U.S. Dollars
Link	http://www.bcra.gov.ar/PublicacionesEstadisticas/Informe_monetario_diario.asp

Country Name	Australia
Coverage	1989M1 – 2020M6
Agency	Central Bank
Types of operations	Spot
Frequency	Daily
Reported format	Millions of Local Currency
Link	http://www.rba.gov.au/statistics/tables/

Country Name	Bangladesh
Coverage	2005Q1 – 2020Q2
Agency	Central Bank
Types of operations	Spot
Frequency	Quarterly

Reported format	Millions of U.S. Dollars
Link	https://www.bb.org.bd/pub/publictn.php
Note	Partial data available through various reports on CB website

Country Name	Bolivia
Coverage	2008M12 – 2020M9
Agency	Central Bank
Types of operations	Spot
Frequency	Monthly
Reported format	Millions of U.S. Dollars
Link	https://www.bcb.gob.bo/?q=estad-sticas-semanales

Country Name	Bosnia and Herzegovina
Coverage	1998M1 – 2020M8
Agency	Central Bank
Types of operations	Spot
Frequency	Monthly
Reported format	Millions of Local Currency
Link	http://statistics.cbbh.ba/Panorama/novaview/SimpleLogin_en_html.aspx
Note	2013M5 available only in the local language website

Country Name	Brazil
Coverage	2000M1 – 2020M9
Agency	Central Bank
Types of operations	Spot, forward and forward like (Swap), and other derivatives (Options)
Frequency	Monthly, daily (from 2009)
Reported format	Millions of U.S. Dollars
Link	Monthly: https://www.bcb.gov.br/en/financialstability/internationalreserves;Daily:Series code: 17843 - spot net intervention & code: 24425 - net forward interventions & code: 24427 - net foreign currency loans and foreign currency repos & code: 24448 - Banco Central net Repo lines of credit intervention

Country Name	Canada
Coverage	2009M1 – 2020M9
Agency	Central Bank
Types of operations	Spot
Frequency	Monthly
Reported format	Millions of Local Currency
Link	https://www.canada.ca/en/departement-finance/services/publications/monthly-official-international-reserves.html

Country Name	Colombia
Coverage	1999M12 – 2020M9
Agency	Central Bank
Types of operations	Spot, forward and forward like (Swap), and other derivatives (Options)
Frequency	Daily
Reported format	Millions of U.S. Dollars
Link	https://www.banrep.gov.co/es/estadisticas/intervencion-diaria-traves-diferentes-mecanismos

Country Name	Costa Rica
Coverage	1999M12 – 2020M9
Agency	Central Bank
Types of operations	Spot, forward and forward like (Swap), and other derivatives (Options)
Frequency	Daily
Reported format	Millions of U.S. Dollars
Link	https://www.banrep.gov.co/es/estadisticas/intervencion-diaria-traves-diferentes-mecanismos

Country Name	Croatia
Coverage	2000M1 – 2020M9
Agency	Central Bank
Types of operations	Spot, other derivatives (Options)
Frequency	Daily
Reported format	Millions of Local Currency and Euros
Link	https://www.hnb.hr/en/statistics/statistical-data/financial-sector/central-bank-cnb/monetary-policy-instruments-and-liquidity

Country Name	Czech Republic
Coverage	1997M5 – 2020M8
Agency	Central Bank
Types of operations	Spot, forward and forward like (Swap)
Frequency	Monthly
Reported format	Millions of U.S. Dollars and Euros
Link	https://www.cnb.cz/en/financial-markets/foreign-exchange-market/cnb-foreign-exchange-trading/index.html

Country Name	Denmark
Coverage	2011M1 – 2020M9
Agency	Central Bank

Types of operations	Spot
Frequency	Monthly
Reported format	Billions of Local Currency
Link	https://www.nationalbanken.dk/en/pressroom/Pages/2020/09/DNN202009421.aspx

Country Name	Ethiopia
Coverage	2006Q2 – 2020Q1
Agency	Central Bank
Types of operations	Spot
Frequency	Quarterly
Reported format	Millions of U.S. Dollars
Link	https://nbebank.com/quarterly-bulletin/
Note	CB shared 2006Q3-Q4 and 2009Q2 data, given these reports are not available online

Country Name	Eurozone
Coverage	2000Q3 – 2020Q2
Agency	Central Bank
Types of operations	Spot
Frequency	Quarterly publication of daily frequency
Reported format	Millions of Euro
Link	https://www.ecb.europa.eu/stats/balance_of_payments_and_external/international_reserves/fx_interventions/html/index.en.html

Country Name	Georgia
Coverage	2009M3 – 2020M9
Agency	Central Bank
Types of operations	Spot
Frequency	Daily
Reported format	Millions of U.S. Dollars
Link	https://www.nbg.gov.ge/index.php?m=306&lng=eng

Country Name	Guyana
Coverage	2008M1 – 2020M8
Agency	Central Bank
Types of operations	Spot
Frequency	Monthly
Reported format	Millions of U.S. Dollars
Link	https://www.bankofguyana.org.gy/bog/images/research/Reports/abnov2019.pdf

Country Name	Hong Kong SAR
Coverage	1998M9 – 2020M9
Agency	Central Bank
Types of operations	Spot
Frequency	Daily
Reported format	Millions of Local Currency
Link	https://www.hkma.gov.hk/media/eng/doc/market-data-and-statistics/monthly-statistical-bulletin/T070102.xls

Country Name	Iceland
Coverage	1999M1 – 2020M9
Agency	Central Bank
Types of operations	Spot
Frequency	Monthly
Reported format	Millions of Local Currency
Link	https://si2.data.is/?sid=1wrq#

Country Name	India
Coverage	1995M6 - 2020M8
Agency	Central Bank
Types of operations	Spot, forward and forward like (Swap)
Frequency	Monthly
Reported format	Millions of U.S. Dollars
Link	https://dbie.rbi.org.in/DBIE/dbie.rbi?site=publications http://www.rbi.org.in/scripts/BS_ViewBulletin.aspx

Country Name	Israel
Coverage	1989M1 – 2020M9
Agency	Central Bank
Types of operations	Spot
Frequency	Monthly
Reported format	Millions of U.S. Dollars
Link	http://www.boi.org.il/en/NewsAndPublications/PressReleases/Pages/Foreigntax.aspx
Note	Missing values treated as no intervention, as per Caspi et al, 2018

Country Name	Japan
Coverage	1991M5 - 2020M9
Agency	Ministry of Finance
Types of operations	Spot
Frequency	Monthly
Reported format	Billions of Local Currency

Link	https://www.mof.go.jp/english/international_policy/reference/feio/index.htm
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Country Name	Jamaica
Coverage	2003Q3 – 2017Q2; 2017M6 - 2020M9
Agency	Central Bank
Types of operations	Spot
Frequency	Quarterly
Currency of intervention	U.S. Dollar
Units reported	Millions of U.S. Dollars
Link	http://boj.org.jm/publications/publications_show.php?publication_id=3
Note	Partial data available through various CB reports. Starting June 2017, Central Bank publishes announcements of each intervention.

Country Name	Kazakhstan
Coverage	1996M1 – 2020M6
Agency	Central Bank
Types of operations	Spot
Frequency	Monthly
Reported format	Millions of U.S. Dollars
Link	https://www.nationalbank.kz/index.cfm?docid=3236&switch=english

Country Name	Korea
Coverage	2018H2 - 2020Q2
Agency	Central Bank
Types of operations	Spot
Frequency	Half year in 2018H2 and 2019H1, quarterly starting 2019Q3
Reported format	Millions of U.S. Dollars
Link	https://www.bok.or.kr/eng/bbs/B0000298/list.do?menuNo=400374&pageIndex=1
Note	Starting 2019Q3, intervention data is published on a quarterly basis.

Country Name	Mauritius
Coverage	1999M4 – 2020M9
Agency	Central Bank
Types of operations	Spot
Frequency	Monthly
Reported format	Millions of U.S. Dollars
Link	https://www.bom.mu/publications-statistics/monthly-statistical-bulletin

Country Name	Mexico
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Coverage	1996M1 – 2020M9
Agency	Central Bank
Types of operations	Spot
Frequency	Monthly
Reported format	Millions of U.S. Dollars
Link	https://www.banxico.org.mx/SielInternet/consultarDirectorioInternetAction.do?sector=4&accion=consultarCuadro&idCuadro=CF169&locale=es

Country Name	Moldova
Coverage	2005M1 – 2020M9
Agency	Central Bank
Types of operations	Spot, forward and forward like (Swap)
Frequency	Monthly
Reported format	Millions of U.S. Dollars
Link	https://www.bnm.md/bdi/pages/reports/dovre/DOVRE2.xhtml

Country Name	Morocco
Coverage	2018M1 – 2018M11
Agency	Central Bank
Types of operations	Spot
Frequency	Daily
Reported format	Millions of U.S. Dollars
Link	http://www.bkam.ma/Marches/Principaux-indicateurs/Marche-des-changes/Resultats-des-adjudications-en-devises?startDate=01%2F12%2F2013&endDate=01%2F01%2F2020&block=a966ed6a650b490e680b70f20886496d#address-e3688ae3555d6cf354a258340ff3609d-a966ed6a650b490e680b70f20886496d

Country Name	New Zealand
Coverage	2004M7 – 2020M9
Agency	Central Bank
Types of operations	Spot
Frequency	Monthly
Reported format	Millions of Local Currency
Link	https://www.rbnz.govt.nz/statistics/f5

Country Name	Nicaragua
Coverage	2000M1 – 2019M11
Agency	Central Bank
Types of operations	Spot
Frequency	Monthly
Reported format	Millions of U.S. Dollars

Link	https://www.bcn.gob.ni/estadisticas/mercados_cambiaros/estadisticas_mensuales/1119/
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Country Name	Nigeria
Coverage	2008M1 – 2017M6
Agency	Central Bank
Types of operations	Spot
Frequency	Monthly
Reported format	Millions of U.S. Dollars
Link	http://statistics.cbn.gov.ng/cbnonlinestats/QueryResultWizard.aspx

Country Name	Paraguay
Coverage	2013M1 – 2020M9
Agency	Central Bank
Types of operations	Spot
Frequency	Daily
Reported format	Millions of U.S. Dollars
Link	https://www.bcp.gov.py/compras-y-ventas-de-divisas-del-bcp-i666

Country Name	Peru
Coverage	1995M1 – 2020M9
Agency	Central Bank
Types of operations	Spot
Frequency	Daily
Reported format	Millions of U.S. Dollars
Link	https://estadisticas.bcrp.gob.pe/estadisticas/series/diarias/resultados/PD04658MD/html

Country Name	Russia
Coverage	2008M8 – 2020M9
Agency	Central Bank & Ministry of Finance
Types of operations	Spot
Frequency	Monthly
Reported format	Millions of U.S. Dollars and Euros
Link	2008M8 – 2017M1: http://www.cbr.ru/eng/archive/db/valint/ ; 2018M1 - present: https://www.minfin.ru/ru/statistics/fedbud/oil/?id_65=122094-svedeniya_o_formirovanii_i_ispolzovanii_dopolnitelnykh_neftegazovykh_dokh_odov_federalnogo_byudzheta_v_2018-2020_godu
Note	Bank of Russia Annual report indicates there was no intervention in 2017: http://www.cbr.ru/Collection/Collection/File/9170/ar_2017_e.pdf

Country Name	Switzerland
Coverage	2020Q1-Q2
Agency	Central Bank
Types of operations	Spot
Frequency	Quarterly
Reported format	Millions of Local Currency
Link	https://data.snb.ch/en/topics/snb#!/cube/snbfxtr

Country Name	Turkey
Coverage	2013M6 – 2020M9
Agency	Central Bank
Types of operations	Spot and Other derivatives (Options)
Frequency	Monthly
Reported format	Millions of U.S. Dollars
Link	http://www.tcmb.gov.tr/wps/wcm/connect/a57592ac-61d2-406f-bd07-353a09962a80/Monthly+Buying+and+Selling+Amounts.pdf?MOD=AJPERES&CV

Country Name	Ukraine
Coverage	2018M1 – 2020M9
Agency	Central Bank
Types of operations	Spot
Frequency	Weekly
Reported format	Millions of U.S. Dollars
Link	https://bank.gov.ua/files/Finmarket/InterventionsResults_eng.xlsx

Country Name	United Kingdom
Coverage	2010M6 – 2020M9
Agency	Government
Types of operations	Spot
Frequency	Monthly
Reported format	Millions of Local Currency
Link	https://www.gov.uk/government/collections/statistical-release-uk-official-holdings-of-international-reserves

Country Name	United States
Coverage	1973M3 - 2020M6
Agency	Central Bank
Types of operations	Spot
Frequency	Daily from 1973M3 - 2011Q1, Quarterly from 2011Q2-2020Q2
Reported format	Millions of U.S. Dollars

Link	https://fred.stlouisfed.org/categories/32145?t=usa&ob=pv&od=desc; https://www.newyorkfed.org/markets/quar_reports.html
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Country Name	Uzbekistan
Coverage	2017M1 – 2020M6
Agency	Central Bank
Types of operations	Spot
Frequency	Monthly
Reported format	Millions of U.S. Dollars
Link	http://www.cbu.uz/en/publikacii/buleten/

Country Name	Zambia
Coverage	2013M1 – 2019M3
Agency	Central Bank
Types of operations	Spot
Frequency	Weekly
Reported format	Millions of U.S. Dollars
Link	https://www.boz.zm/monetary-and-financial-statistics-New.htm

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