ERSA Policy Bulletin
July 2021

The impact of global FX liquidity on the rand[1]

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- The Covid crisis saw significant declines in market liquidity and calls for central banks to step in. Most research into foreign exchange (FX) liquidity does not consider a large cross section of emerging market currency pairs or include the ZAR in its analysis. We document a large decline in FX market liquidity during the Covid crisis for 20 of the most traded currency pairs and show that global FX liquidity affects the USDZAR.

- We show that common variation in major exchange rates is associated with common variation in FX market liquidity. We provide some evidence that the ZAR plays role as a bellwether emerging market currency: that the ZAR reacts quickly and strongly to changes in global liquidity.

- Commonality in FX liquidity suggests that increased financial integration may increase exposure to global liquidity shocks. Our findings suggest, however, that there are some currencies that could offer diversification opportunities to mitigate such shocks. Using the USDZAR as example, we also show that the relationship between FX liquidity and volatility changes over time. Together with the difficulty of determining the causes of FX liquidity in real time, this implies identifying opportunities to intervene is difficult in practice.

[1] *Authorised for distribution by Theo Janse van Rensburg.* ***SARB Economic Note*** - South African Reserve Bank Economic Notes are short economic analyses written for internal SARB discussion. They are written by staff members or fellows of the Economic Research Department, sometimes in collaboration with other SARB staff. The views expressed in these Notes are those of the author(s) and do not necessarily represent South African Reserve Bank positions. While every precaution is taken to ensure the accuracy of information provided in these publications, the South African Reserve Bank shall not be liable to any person for inaccurate information, omissions or opinions contained herein.

Introduction[2]

The Covid crisis saw significant declines in market liquidity and calls for central banks to step in. Most research into foreign exchange (FX) liquidity does not consider a large cross-section of emerging market currency pairs or include the rand (ZAR) in its analysis, so this note sheds light on the intra-day behaviour of foreign currency rates and FX market liquidity for 20 of the most traded currency pairs.

A liquid market allows an asset to be sold quickly at a low cost, without inducing a change in the market price. FX market liquidity will likely have real effects on the economy because it may affect risk premia embedded in exchange rates and therefore affect the costs of hedging for firm exposure to exchange rate volatility. Characterising FX liquidity is also useful for understanding the impact of central bank decisions or operations on financial markets, or the impact of regulations on market making and market liquidity. Finally, market liquidity may be relevant for monetary policy as market conditions could affect the transmission of monetary policy to the cost of funds in different segments of financial markets. Our contribution is to show:

- That there is evidence of cross-sectional variation in forex liquidity;
- That price dynamics of major currencies are associated with liquidity in foreign exchange markets;
- That there was a decline in FX market liquidity during the Covid crisis;
- That global FX liquidity affects the USDZAR.

2. Measuring liquidity

FX liquidity matters because it tends to be related to risk. Liquidity tends to be low when market volatility is high, since market makers may be concerned that they may not be able to on-sell their inventories. Liquidity therefore can affect how sensitive a currency is to shocks. Illiquidity implies large trades have larger impacts on prices in individual markets, while shocks in illiquid markets could transmit more strongly to other markets. Unfortunately there are relatively few studies into the drivers of FX liquidly, although these generally show liquidity to be affected by spikes in global risk or tightening funding constraints, particularly in riskier currency markets (Mancini et al. 2013). Karnaukh et al. (2015) show that liquidity tends to fall during periods of 'flight to safety', with developed economies and traditional carry currencies most strongly affected. They also find that FX commonality strengthens in distressed markets. We assess whether there is a relationship between estimates of realised volatility based on intraday data from Greenwood-Nimmo et al. (2021) and our measure of FX liquidity.

2.1 Data description

We construct a measure of liquidity based on intra-day Refinitiv data, which is the only data source we have access to that provides a long history of FX data.[3] The data features the following fields: 'open' (first price of an intraday price snapshot, based on quoted rates), 'last' (the most recent updated quoted price), 'open/close bid/ask' (opening/closing bid/ask price of

[2] Thanks to Konstantin Makrelov and Theo Janse van Rensburg for comments.

[3] Our dataset only includes the spot market, which is said to represent slightly less than a third of total foreign exchange market trading (Bank for International Settlements 2019). It is difficult to assess how representative trading data is given the large number of international trading platforms. However, Refinitiv is the largest platform for FX pricing.

a snapshot), and 'volume' (last traded volume of the trade price). We define a trading day as 21:05 to 21:00 and remove all weekends, New York Stock Exchange holidays, days where more than 95% of the return observations are 0. This leaves a sample of 252 observations per year spanning from 2006-02-27 to 2020-11-03.

2.2 Measuring liquidity

A common measure of liquidity is the bid-ask spread (see for example, Bessembinder 1994), which measures the difference between the highest price available to buyers and the lowest price available to sellers to receive a unit of the quote currency. The bid-ask spread tends to increase when there are fewer limit orders to buy or sell or market makers become more worried about their ability to execute trades (such as during periods of increased volatility). Asa result, it is often used as a measure of the cost of trading.

Instead of using the bid-ask spread directly, we construct a measure of the proportional cost of executing a trade that takes the level of the currency pair into account:

$$L = \left(P^a - P^b\right) / P^m$$

where a,b and m characterize the ask, bid and mid quotes, respectively at time *t* at 5 minute intervals. The latter is defined as $P^m = (P^a + P^b)/2$. This measure implies that the spread would tend to be lower in more liquid markets: the closer *L* to zero, the more liquid the market. However, our measure is not a measure of the absolute volume of liquidity, instead it captures how liquidity has evolved over time.

Since price quotes may only be applicable for small trade quantities or only valid for short periods of time, several other measures of liquidity are commonly used to capture information about the depth and breath of available quotes. Unfortunately, we do not have access to the intra-day data required to construct alternative measures.[4]

3. Commonality in liquidity changes across currencies

Table 1 compares the statistical properties of 20 of the most traded FX pairs, showing that there is a lot of cross-sectional differences in the variation in liquidity in individual currency pairs.[5] Figure 1 shows that there is a strong relationship between the liquidity in the currency pairs in our sample. There are a small number of currencies that stand out as having liquidity dynamics that differ, on average, from most of the most traded currencies. These include the emerging market currencies CNY and RUB, but also the major developed country currencies GBP, EUR and CHF, which may imply that there could be some diversification opportunities for investors to mitigate global liquidity shocks.

To measure developments in global liquidity, we extract a principal component of our currency pair liquidity measures following Hasbrouck and Seppi (2001) and Korajczyk and Sadka (2008). We then use our global measure to test the sensitivity of currency pairs to global liquidity. Following Mancini et al. (2013), we regress liquidity in each currency market *i* on a constant and global FX market liquidity *global*:

[4] For example, another category of liquidity measures seek to capture how order flows affect exchange rates. Unfortunately, our dataset does not include data on buyer- or seller-initiated trade volumes, so we cannot construct measures of price impacts.

[5] Refinitiv changed their pricing filter for USDZAR quotes from contributors, causing a fall in contributing spreads reported by Refinitiv. For this reason our table is focused on the post-2016 sample period.

$$|L_{i,t}| = c + \beta_i |L_{global,t}| + \epsilon_{i,t}$$

where $_{i,t}$ represents an idiosyncratic liquidity shock and β_i captures the impact of global liquidity on individual FX market liquidity.

Since high values of our global liquidity measures implies low liquidity (i.e. the closer values to 0 are the higher liquidity is estimated to be), Figure 2 suggest that the global financial crisis period was characterised by low liquidity in FX markets. Global liquidity is estimated to have been high at start of the Covid crisis, but has decreased over recent months. Decomposing the measure into emerging markets and developed markets measures separately (Figure 3), suggests that this reflected high developed market liquidity in early 2020, which reversed later. The first principal component explains a large proportion of common FX variance (Figure 4). Figure 5 compares the contribution of each currency pair to the common variance captured by the first two principal components and we find that the ZAR makes a large contribution to common variance.

Table 1: How do liquidity changes vary across currencies?

	Mean	Med	SD	ADF	AR(1)
USDTRY	0.00090	0.00077	0.00048	0.05651	0.90052
USDRUB	0.00089	0.00046	0.00079	0.12246	0.88262
USDKRW	0.00089	0.00095	0.00034	0.05338	0.87717
USDMXN	0.00088	0.00080	0.00029	0.08046	0.86535
USDZAR	0.00087	0.00080	0.00033	0.15492	0.86486
USDNZD	0.00052	0.00052	0.00005	0.53188	0.78440
USDNOK	0.00050	0.00044	0.00041	< 0.01	0.83018
USDPLN	0.00049	0.00037	0.00025	0.27231	0.92869
USDSEK	0.00045	0.00037	0.00022	0.12837	0.82741
USDCNY	0.00041	0.00035	0.00019	< 0.01	0.74133
USDCHF	0.00036	0.00034	0.00007	0.06507	0.35147
USDAUD	0.00031	0.00031	0.00004	0.44197	0.78379
USDSGD	0.00030	0.00029	0.00004	0.35029	0.69437
USDCAD	0.00025	0.00024	0.00003	0.43321	0.73876
USDINR	0.00024	0.00023	0.00009	0.01656	0.60335
USDEUR	0.00024	0.00024	0.00002	0.44614	0.62883
USDGBP	0.00024	0.00024	0.00003	0.34171	0.81426
USDBRL	0.00023	0.00019	0.00012	< 0.01	0.29568
USDJPY	0.00022	0.00021	0.00002	0.66677	0.75390
USDHKD	0.00005	0.00004	0.00002	0.02115	0.87022

Note: Using the end of sample 2016-01-02 to 2020-11-03

Figure 1: Relationship between liquidity for currency pairs

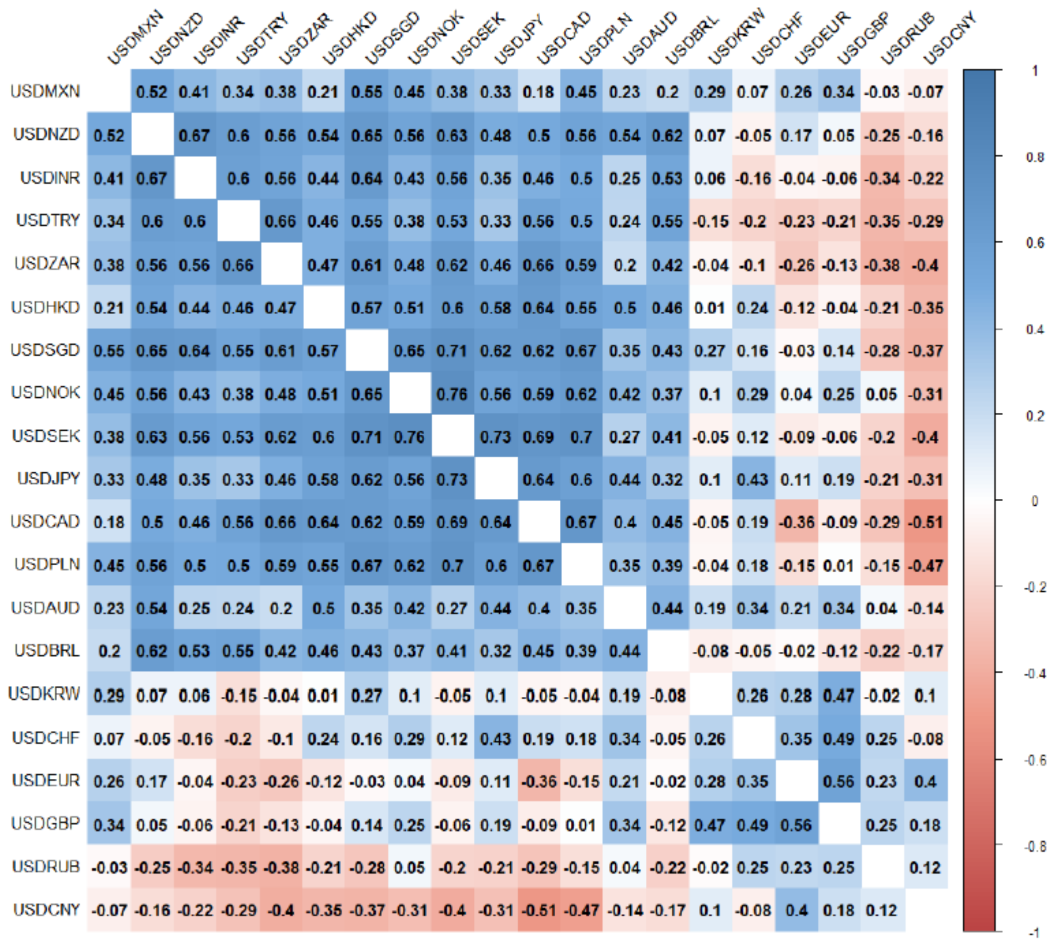


Figure 2: Global liquidity measure

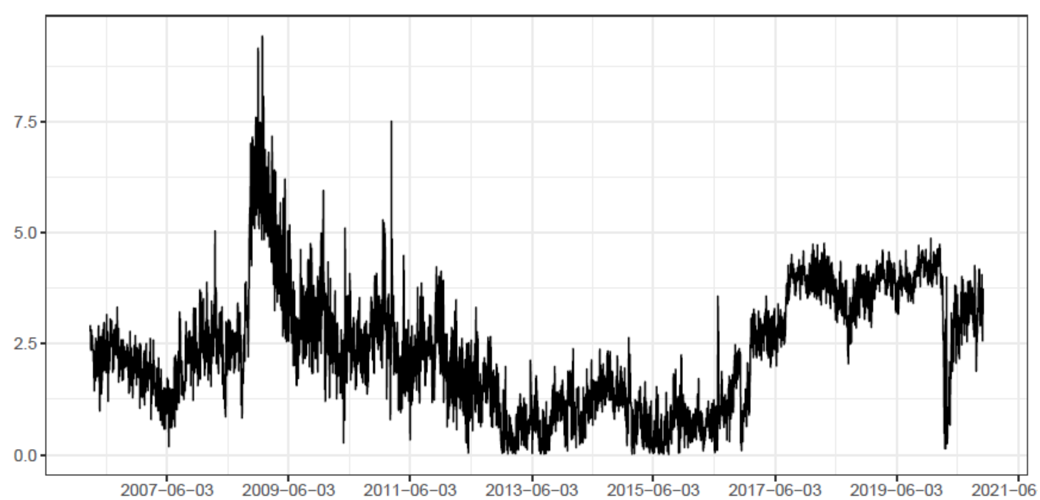


Figure 3: Global liquidity measure

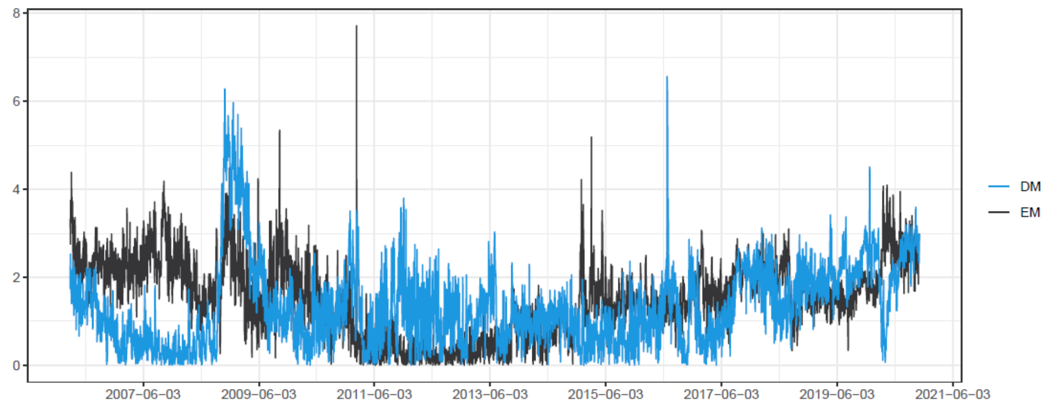


Figure 4: Percentage of common variance explained by each principal component

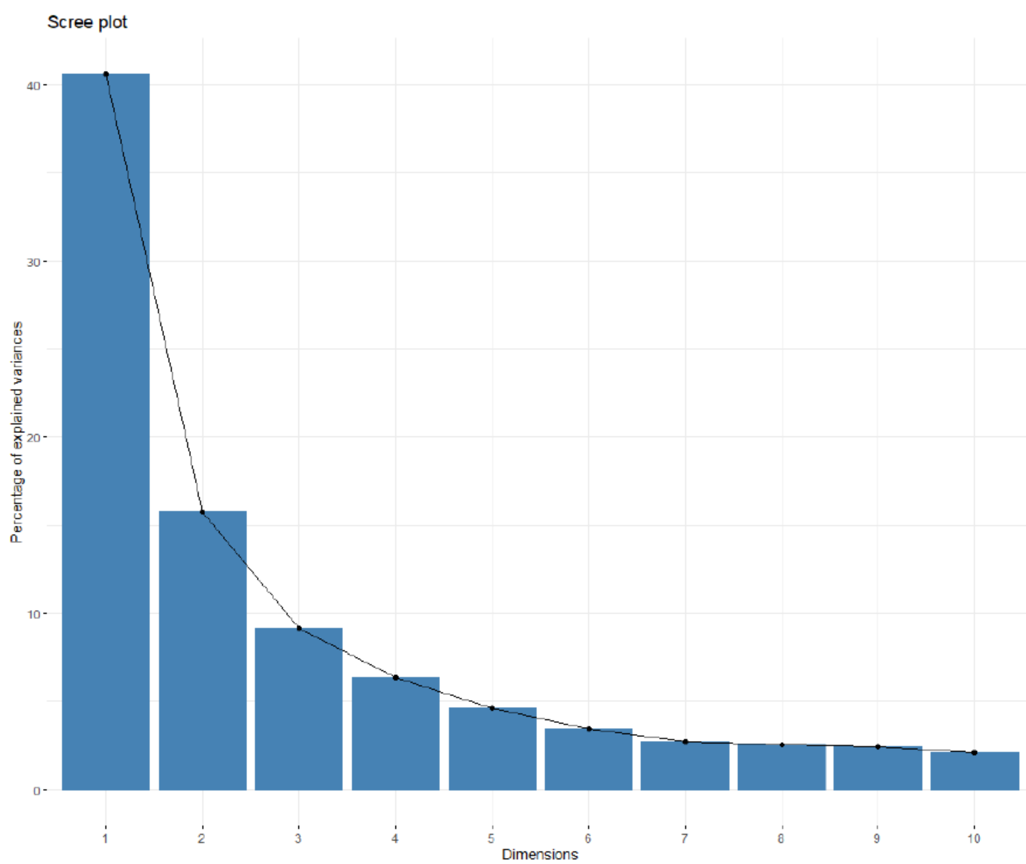


Figure 5: Contribution to first two principal components

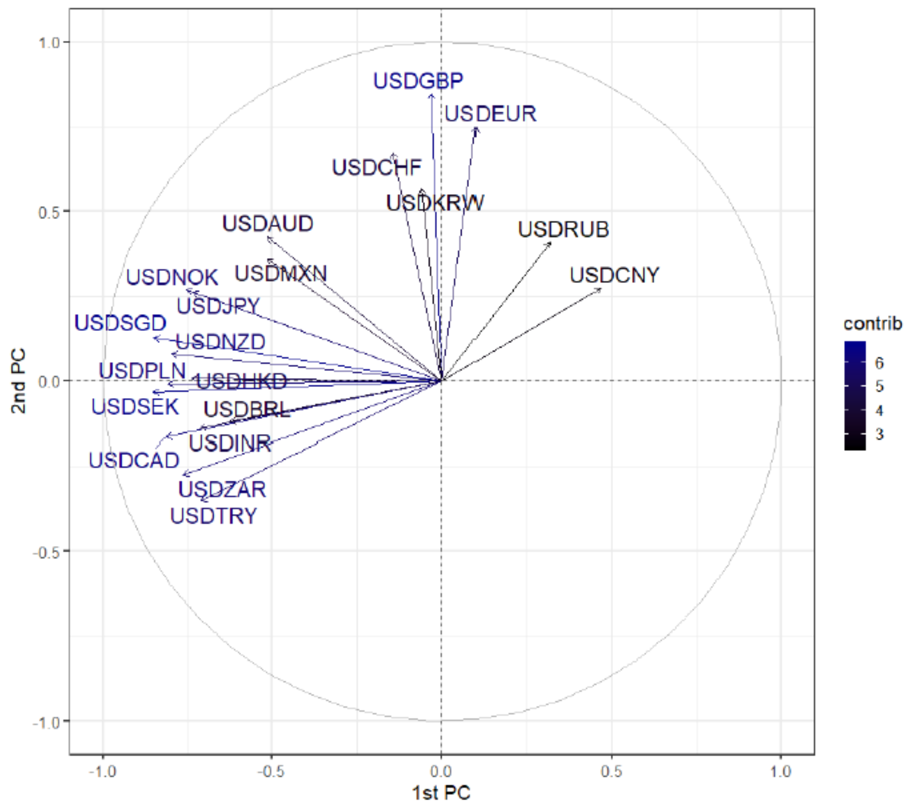


Table 2 assesses the effects of global liquidity on each currency pair. We find that global liquidity has a statistically significant impact on liquidity for each currency pair (i.e. p-values below 1 percent significance), with higher global liquidity tending to be associated with higher individual currency liquidity on average for all pairs except the CHF (a currency pair for which global liquidity cannot explain much of its variance, as measured by $R - squared$). The slope coefficient suggests that effects of global liquidity are also strong for the ZAR, although clearly a meaningful part of USDZAR liquidity is explained by other factors.

Table 2: Impact of global liquidity on currency pair liquidity

	β	p-value	adjusted R2
USDCHF	-0.0021	< 0.01	0.0208
USDRUB	0.0007	< 0.01	0.1006
USDHKD	0.0009	< 0.01	0.5455
USDCAD	0.0011	< 0.01	0.6628
USDGBP	0.0016	< 0.01	0.0006
USDEUR	0.0019	< 0.01	0.0097
USDJPY	0.0027	< 0.01	0.0412
USDCNY	0.0062	< 0.01	0.2194
USDAUD	0.0066	< 0.01	0.2652
USDSGD	0.0075	< 0.01	0.7220
USDINR	0.0103	< 0.01	0.5117
USDSEK	0.0113	< 0.01	0.7259
USDNOK	0.0122	< 0.01	0.5685
USDBRL	0.0195	< 0.01	0.3849
USDNZD	0.0196	< 0.01	0.6366
USDPLN	0.0223	< 0.01	0.6532
USDKRW	0.0259	< 0.01	0.0033
USDMXN	0.0327	< 0.01	0.2657
USDTRY	0.0420	< 0.01	0.5061
USDZAR	0.0622	< 0.01	0.5834

4. Do liquidity changes affect volatility?

To capture currency volatility, we calculate realized variance as the sum of squared intraday returns:

$$RV_{it} = \sum_{j=1}^{n} r_{it,j}^2$$

using 5-minute intraday returns. We then test the effect of liquidity on variance using:

$$RV_{i,t} = c + \beta L_{it} + \epsilon_{i,t}$$

where *i* denotes the currency pair.

Table 3 suggests that liquidity has a meaningful impact on volatility of most currency pairs, including the USDZAR. During periods of higher liquidity, the realized variance tends to fall.

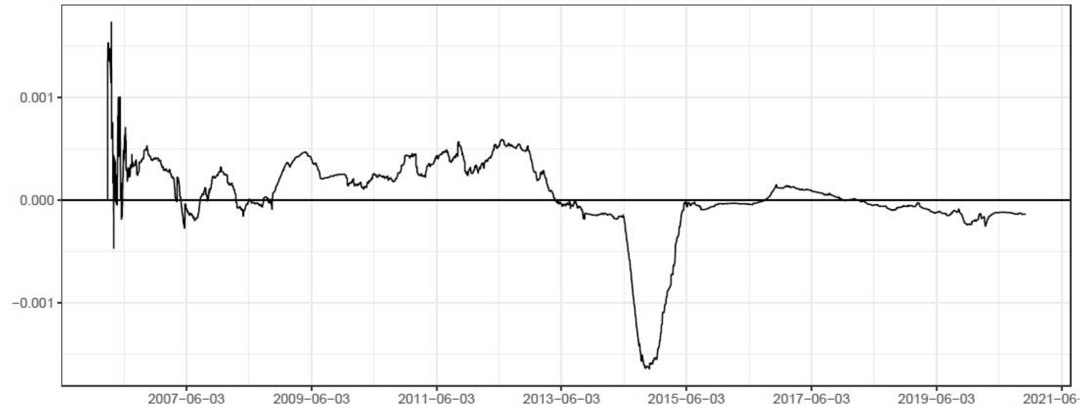
Figure 6 presents the estimate for the USDZAR using a time-varying parameter formulation of the model, showing that the relationship between global liquidity and the USDZAR varies alot over time. While being positive in the early part of the sample (i.e. higher global liquidity tended to be associated with higher ZAR volatility), it turned more meaningfully negative between 2014 and 2016, and has remained slightly negative on average more recently, in line with what we find for other currencies over the full sample. This demonstrates the importance of monitoring the evolving relationships in cross currency FX dynamics over time, and the difficulties associated with understanding the drivers of exchange rate volatility in real time.

Table 3: Relationship between liquidity and volatility

	β	p-value	adjusted R^2
USDRUB	-0.0102	< 0.01	0.525
USDNZD	-0.0068	< 0.01	0.282
USDTRY	-0.0057	< 0.01	0.174
USDGBP	-0.0036	0.135	0.0015
USDAUD	-0.0035	< 0.01	0.764
USDZAR	-0.0035	< 0.01	0.113
USDNOK	-0.0031	< 0.01	0.1592
USDKRW	-0.0031	< 0.01	0.592
USDPLN	-0.0031	< 0.01	0.1724
USDMXN	-0.0028	< 0.01	0.1091
USDSEK	-0.0025	< 0.01	0.757
USDJPY	-0.0019	< 0.01	0.630
USDCAD	-0.0017	< 0.01	0.620
USDCHF	-0.0016	0.9370	0.003
USDSGD	-0.0014	< 0.01	0.1719
USDINR	-0.0013	< 0.01	0.1866
USDEUR	-0.0010	< 0.01	0.0489
USDBRL	-0.0007	0.1497	0.003
USDCNY	-0.0001	< 0.01	0.0417
USDHKD	0.0000	< 0.01	0.0154

Note: A negative relationship implies higher global liquidity is associated with lower volatility in a given FX pair

Figure 6: Time-varying relationship between USDZAR and global liquidity



5. What do we know about how Covid affected ZAR liquidity?

To illustrate the impact of the Covid crisis on FX liquidity, we focus on developments in USDZAR liquidity. Figure 7 shows that bid-ask spreads were high around the time of the President's announcement if the state of emergency. Figure 8 plots the evolution of bid volumes over the course of the year, showing that liquidity increased slightly over the year, increasingslightly after implementation of lockdowns.

Figure 7: Bid-Ask Spread of USDZAR on the 15th of March 2020

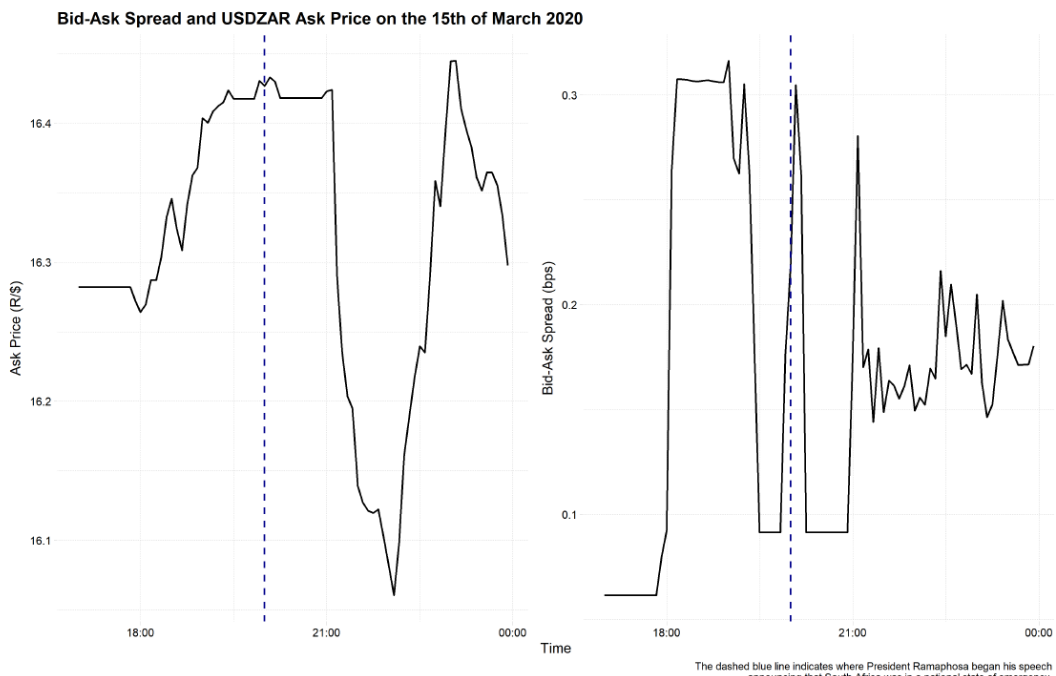
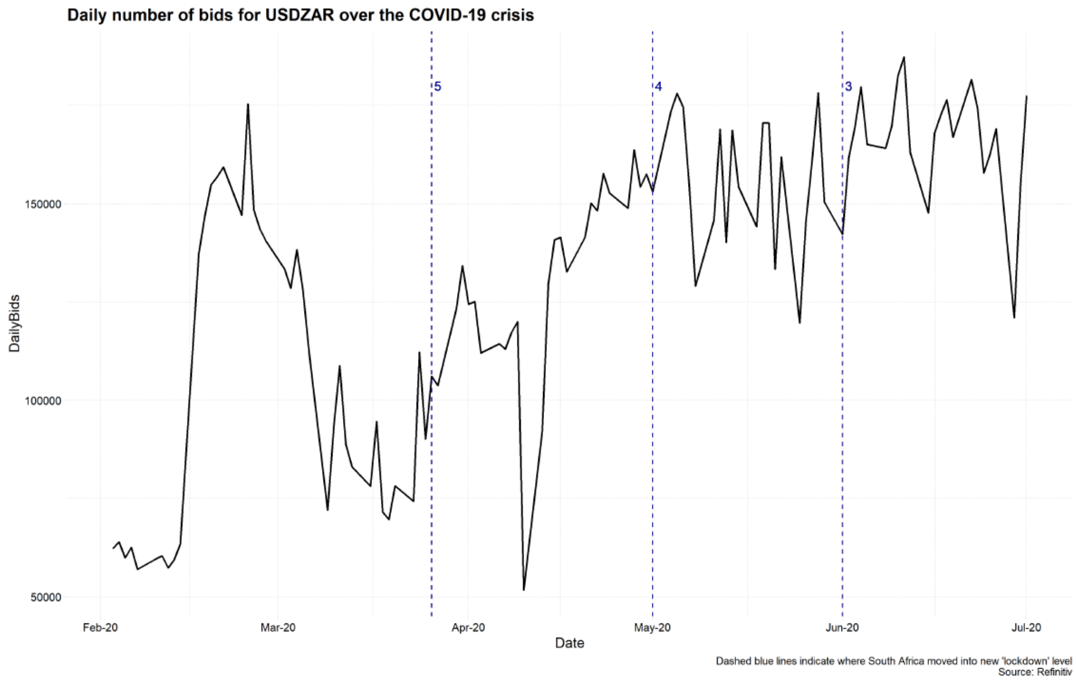


Figure 8: Daily volume of bids placed over the COVID crisis



6. Conclusion

We show that common variation in major exchange rates is associated with common variation in foreign exchange market liquidity. In line with the literature, we also find that higher FX liquidity is associated with lower FX volatility. In the case of the rand, the currency makes a large contribution to common foreign exchange liquidity and its realised volatility is also itself strongly affected by global liquidity. This is consistent with the findings from Greenwood-Nimmo et al. (2021) that suggests that the USDZAR is typically a bellwether emerging market currency, in the sense that it is very sensitive to foreign risk shocks, reactingmore quickly and strongly to periods of heightened financial market uncertainty than most other emerging market currencies. We also show that there was a meaningful decline in global and USDZAR liquidity during the Covid crisis, along with a strengthening of the negative relationship between global liquidity and ZAR volatility.

Commonality in FX liquidity implies that there may be FX risks that cannot entirely be diversified away, which could explain the existence of carry trade returns. This also suggests that increased financial integration may increase exposure to global liquidity shocks. However, we do find that there are a small number of currencies that have liquidity dynamics that differ, on average, from most of the major currencies, and therefore could offer some diversificationopportunities for investors to mitigate such shocks.

Our analysis suggests that it is unlikely that a small country central bank could meaningfully affect domestic currency liquidity. In the case of the USDZAR, FX liquidity is large relative to the Reserve Bank's foreign exchange reserves (at around USD10 billion daily turnover). We also show that the relationship between FX liquidity and ZAR volatility changes over time. Since it is difficult to determine what is driving FX liquidity in real time, distinguishing between market frictions and market fundamentals to identify opportunities to intervene is also difficult in practice.

Further extensions of this work could seek to understand what can explain the drivers of FX market liquidity (and commonality in liquidity across FX markets). It would also be useful to source an order flow dataset to quantify the costs of illiquidity for investors. Such data would also allow the testing of whether large exchange rate changes reflect unusually large trades or amplified by selling momentum or demand to hedge options positions. Lastly, subscribing to high frequency dealt rates data would also enable ongoing monitoring of actual market conditions, as well as understanding how liquidity evolves across different currency pairs.

7. References

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Appendices

A. Differences in liquidity measures across different datasources

We use Refinitiv intraday data in our analysis as intraday Bloomberg data is not available for a long sample period and since Refinitiv is the largest platform for FX pricing. We briefly assess whether our results are likely to be robust to using different pricing sources or liquidity measures, focusing on the USDZAR. We start by constructing a daily bid-ask spread using Refinitiv intraday data and Bloomberg end of day data (Figure 9). It is clear that the data source used affects estimated liquidity dynamics for the USDZAR. Figure 10 suggests that there other data on FX liquidity are not correlated to the Refinitiv spreads we have used.

The same is true for using alternative definitions of liquidity. Figure 11 compares bid-ask spreads to the number of bids recorded in the Refinitiv data uses, showing that number of bids data is unlikely to accurately capture changes in liquidity given its strong upward trend.

Overall, these comparisons highlight the need to access additional datasets to enable the construction of additional measures of liquidity and enhance the confidence in such analysis.

Figure 9: Bid-ask spreads from different data providers

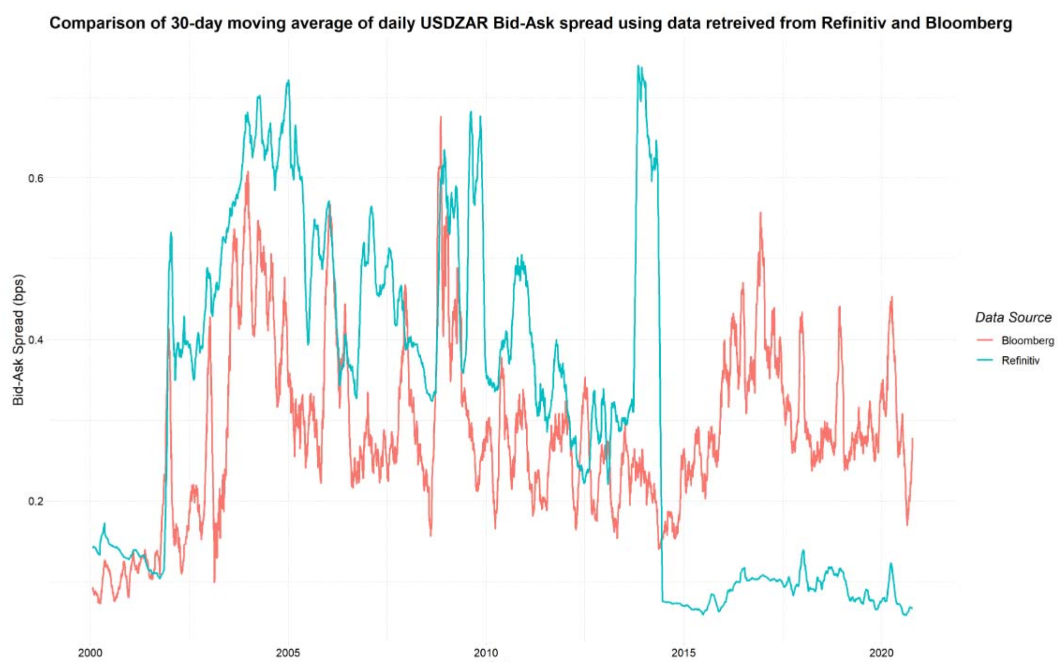

Figure 10: Comparison of Bloomberg, Refinitiv, and B12 survey data sources of daily bid-ask spread

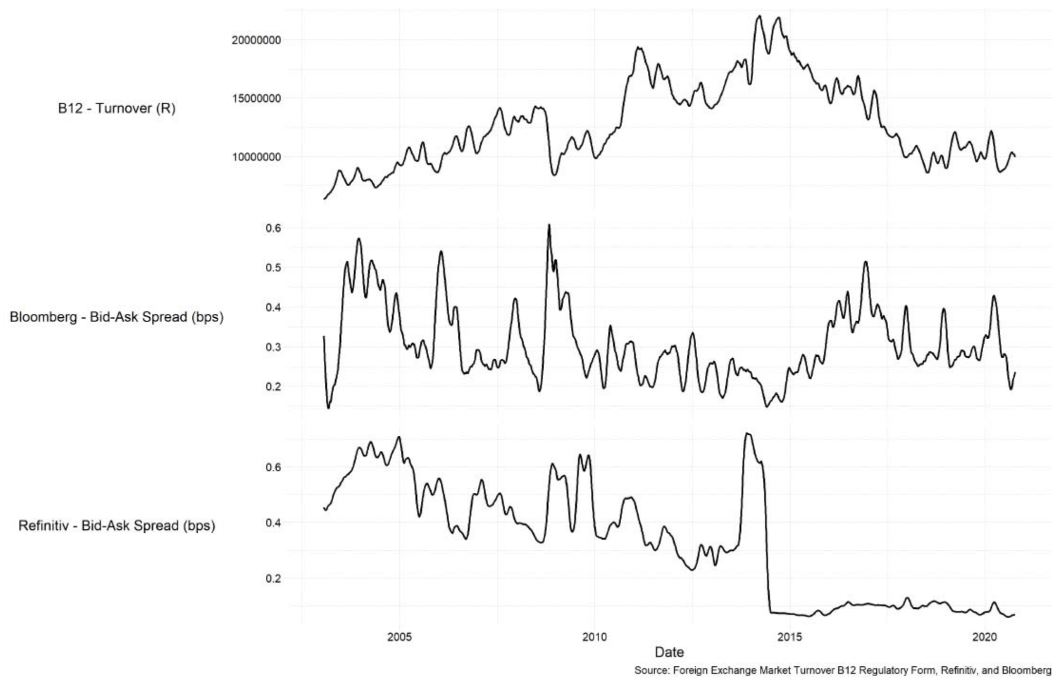

Figure 11: Comparison of liquidity measures