ZAR Risk and Return Spillovers in a Global Model of the Foreign Exchange Network

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The views expressed are those of the authors and do not necessarily represent those of the South African Reserve Bank or Reserve Bank policy.

Motivation

- We develop a network model to capture the dynamic interactions among foreign exchange (FX) returns and realised risk measures among a large panel of 20 developed and emerging market currencies, including the rand (ZAR).

- We demonstrate how this framework can be used to assess the sensitivity of a given currency to shocks from other currencies and to provide narratives contextualising currency movements, focusing on the ZAR.

Summary of findings

- We show that variations in the risk-return profile of the USDZAR correlate with variations in the risk-return profile of many other currencies, and that this is especially notable with respect to emerging market currencies.
- We interpret this as evidence of the ZAR's role as a bellwether emerging market currency.
- We show that the model is able to highlight risk transmission channels in a timely manner during foreign exchange flash crashes and periods of heightened financial market uncertainty.

Introduction

- Much policy debate about relative volatility of ZAR and factors influencing ZAR volatility, but trelatively little research into nature and drivers of ZAR volatility.

- Likewise, trend depreciation of ZAR has drawn attention to directional risks, yet there is an absence of research into skewness of ZAR (i.e. implied risk that ZAR could move in a particular direction).

- We construct a database of log-returns and higher-order realised moments for ZAR and large number of emerging market (EM) and developed market (DM) currencies.

- We develop and estimate an empirical network model to measure intensity of bilateral FX risk and return spillovers among currencies.

Dataset

- 12 DM currencies and 8 EM currencies
- Construct returns and a variety of higher-moment risk measures for each currency from Refinitiv intra-day data (and compare our estimates to Bloomberg estimates in our data appendix)
- Following conventions described in Andersen et al. (2003), we consider a trading day to start at 21:05GMT and to end at 21:00GMT.
- Convention is to construct mid-rates at five-minute intervals ($n = 288$), which balances asymptotic considerations against microstructure noise, to compute first four realised moments of the return distribution at daily frequency

Calculation of daily log-returns

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

where:

- $r_{it,j} = \log\left(p_{it,j}/p_{it,j-1}\right)$ is jth period-to-period intraday log-return or for currency i on day t
- $p_{it,j}$ denote jth intraday mid-rate

Calculation of realized variance

- Realised variance:

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

- Scaled by trading days per year N to obtain annualised measure:

$$V_{it} = N \cdot UV_{it}.$$

- Rrealised variance captures dispersion of returns, which is a measure of uncertainty.

Calculation of higher moments

- Realised skewness measures degree of asymmetry of returns

$$Q_{it} = \sqrt{n} \sum_{j=1}^{n} r_{it,j}^3 \Big/ \left(UV_{it}\right)^{3/2}.$$

- Realised kurtosis measures mass in tails of return distribution: larger K_{it} indicate higher probability of extreme FX returns

$$K_{it} = n \sum_{j=1}^{n} r_{it,j}^4 \Big/ \left(UV_{it}\right)^2.$$

Network model

- We adopt a modified version of Diebold and Yilmaz (2009, 2014), in which the structure of the network of bilateral spillover effects is estimated via a decomposition of variance of forecast errors obtained from a VAR model.

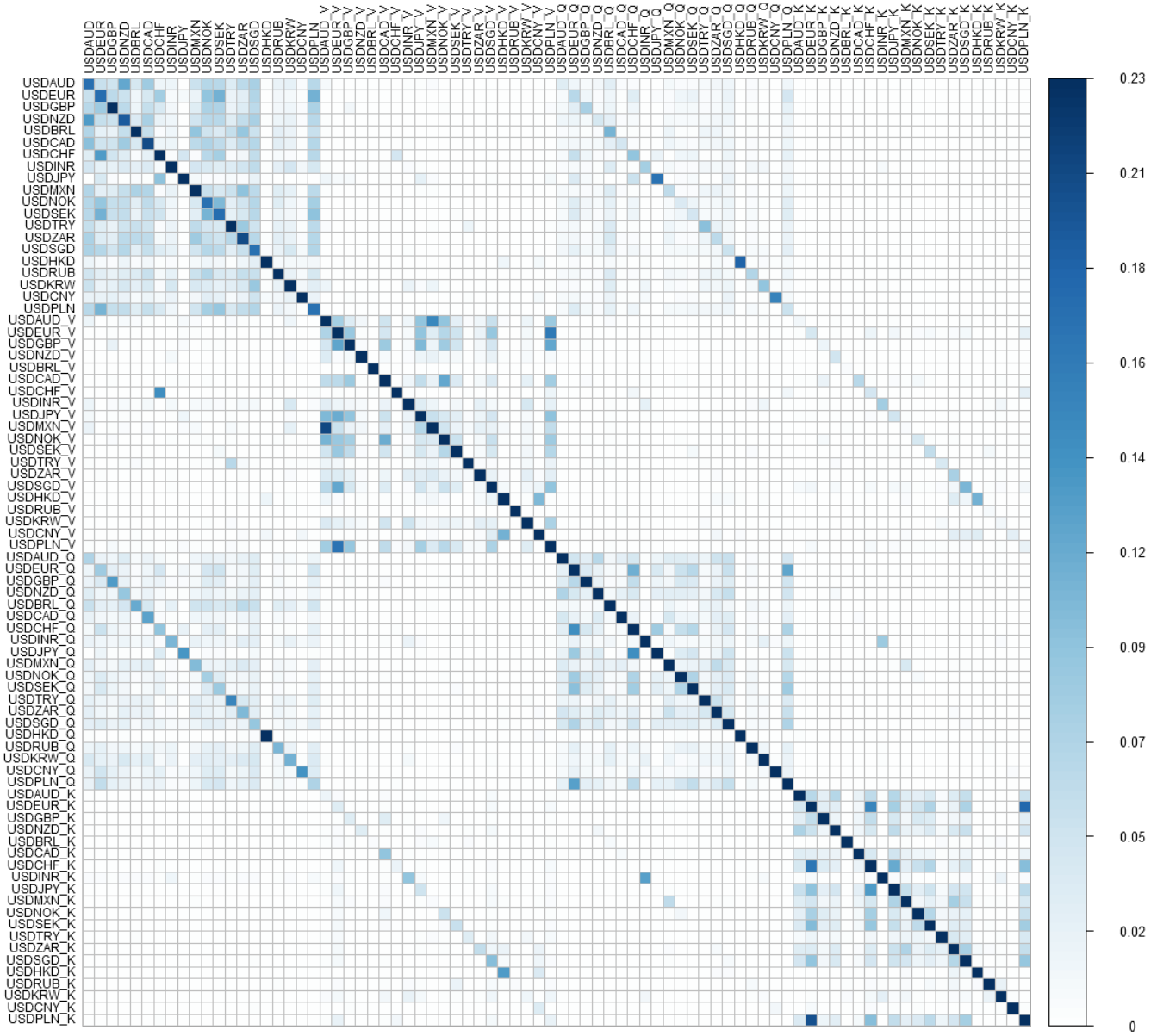
- By analysing structure of the network on a rolling sample basis, we track evolution of spillovers over time.

- The spillover statistics that we obtain can be used to shed light on how changes in a currency's risk-return profile transmit through global foreign exchange markets and to assess the degree to which such changes reflect global and local factors.

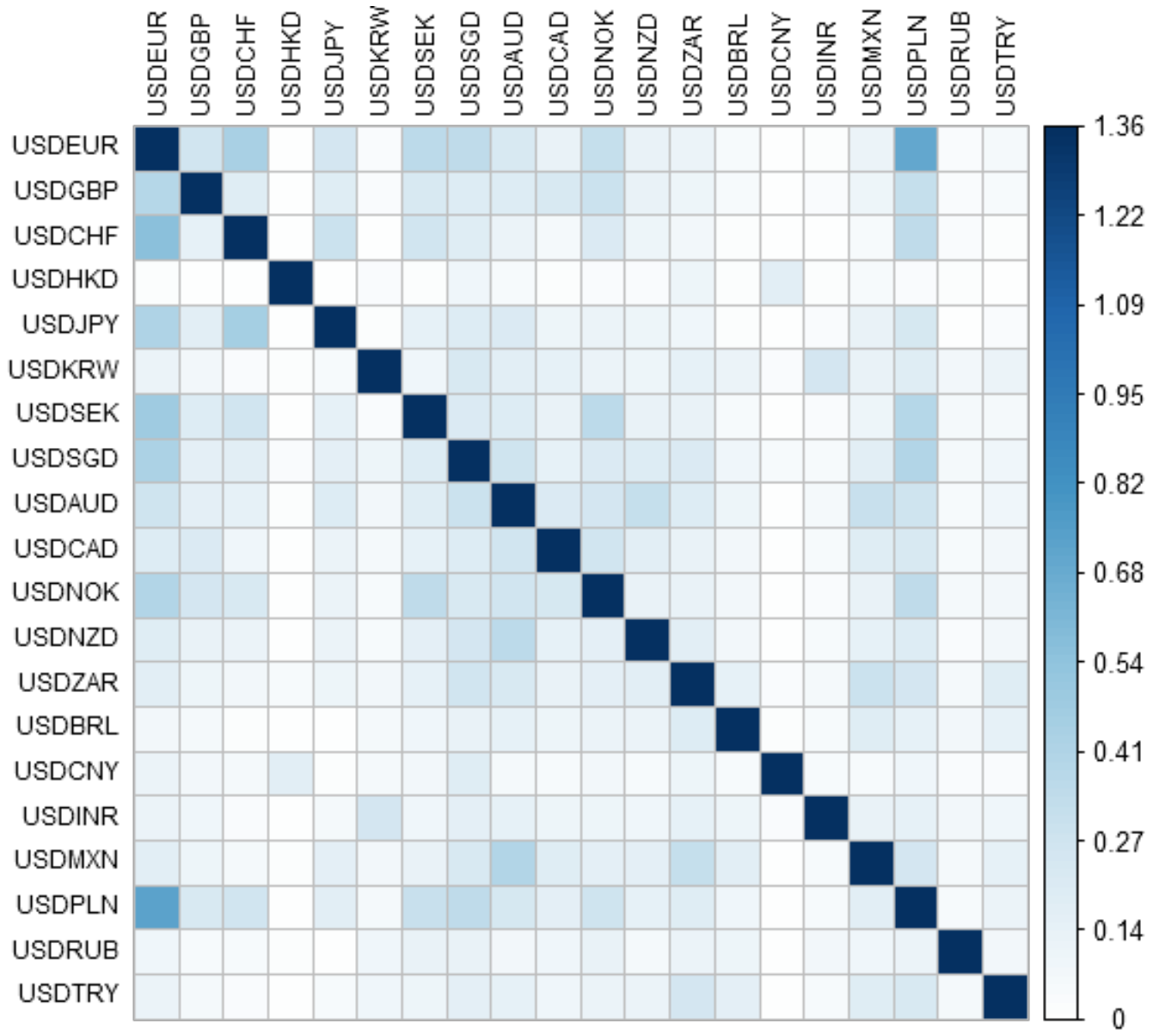
Network model

- Diebold and Yilmaz (2009) show that a decomposition of forecast error variance from a VAR model can be interpreted as a weighted directed network
- Approach generalised by Diebold and Yilmaz (2014) to achieve invariance to the order of the variables in the VAR model and by Greenwood-Nimmo et al. (2021) to facilitate block aggregation of the estimated network
- We apply the aggregation-robust framework of Greenwood-Nimmo et al. (2021) because it allows us to switch freely between different aggregation routines in order to study different aspects of FX connectedness

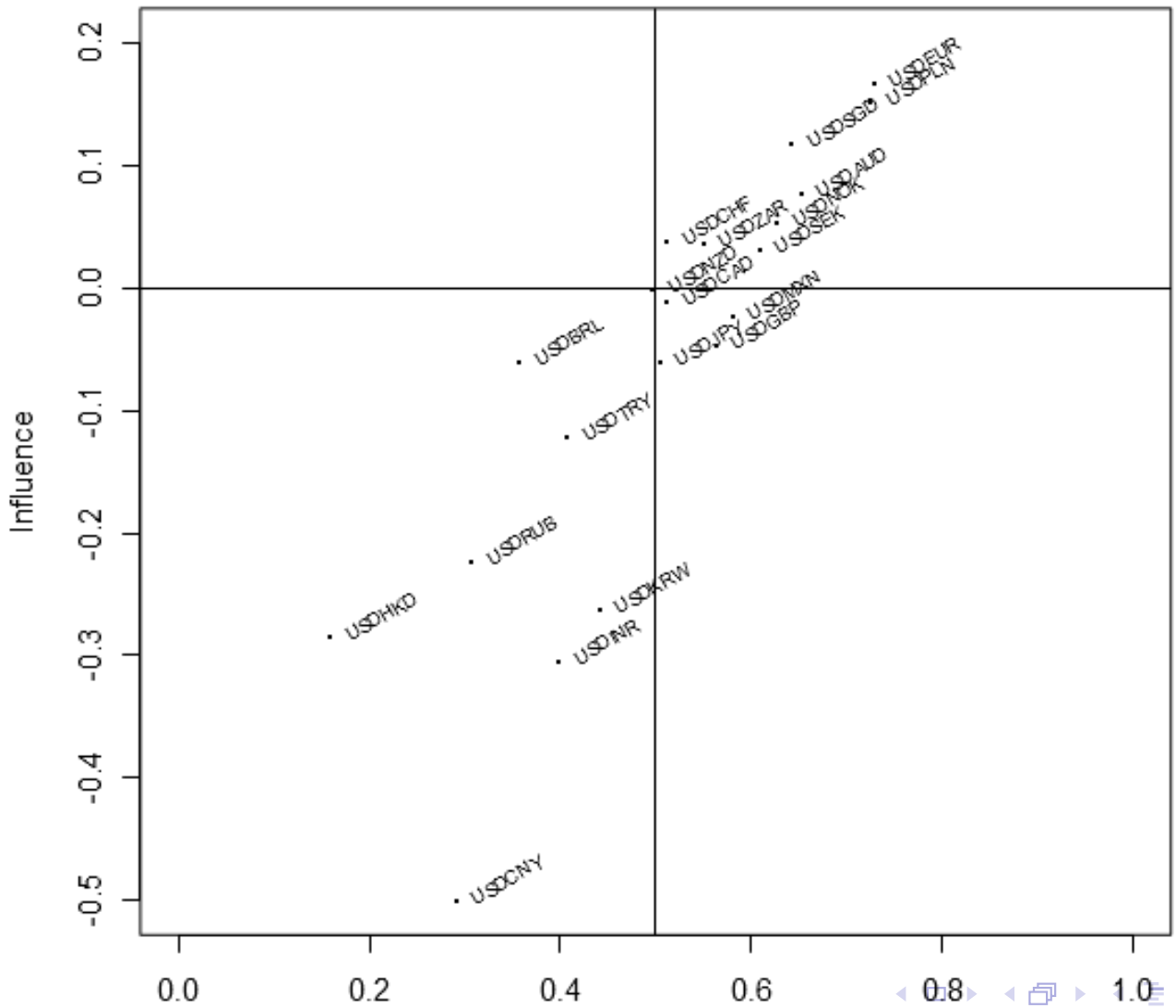
Disaggregate Connectedness over the Full Sample



Connectedness among Currencies over the Full Sample



Influence and Dependence of Currencies over Full Sample



Rolling-Sample Network Statistics

(a) Disaggregate spillover index

(b) Currency spillover index

Connectedness of the ZAR with DM/EM Currencies

(a) ZAR vs. All DM Currencies

(b) ZAR vs. All EM Currencies

Using the FX Network for Narrative Analysis

- Our model can be used to contextualise abrupt movements in exchange rates
- We consider three classes of event: (i) idiosyncratic domestic events; (ii) idiosyncratic foreign events; and (iii) global events.

Idiosyncratic Domestic Events

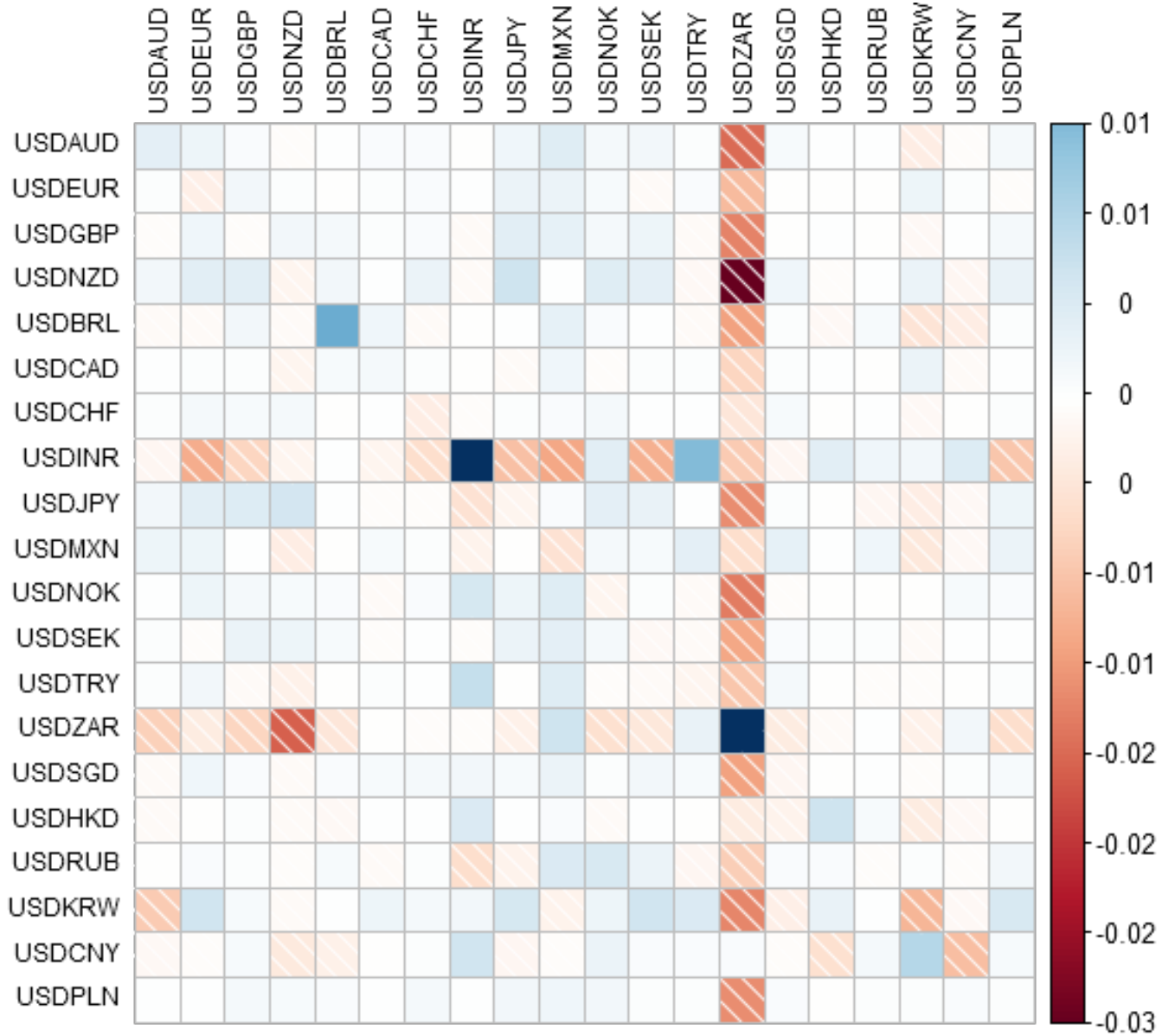
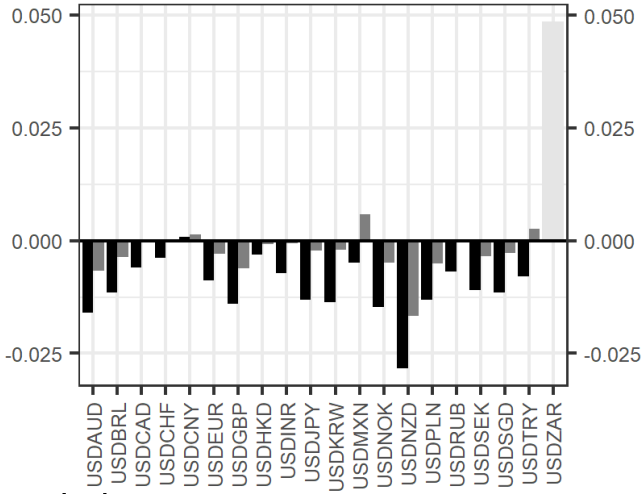
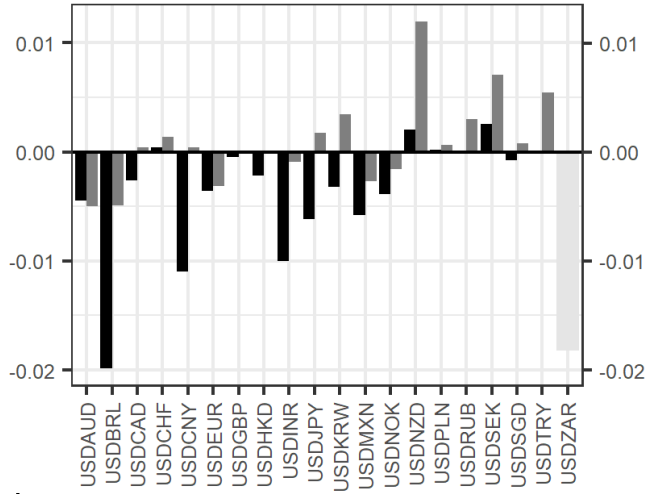


Figure: Change in Spillovers when Nene was Dismissed

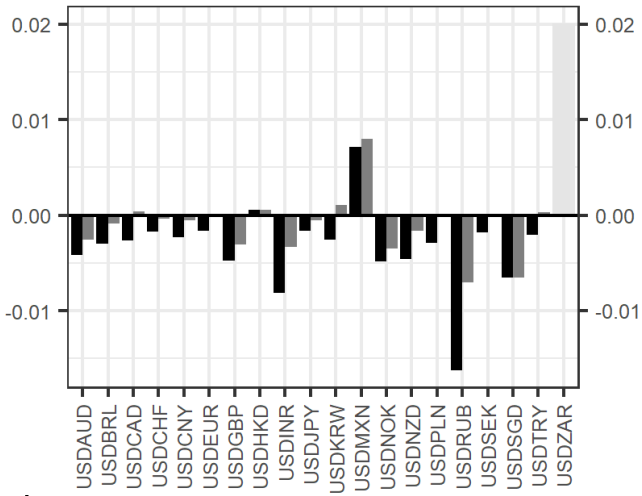
Domestic Event Days



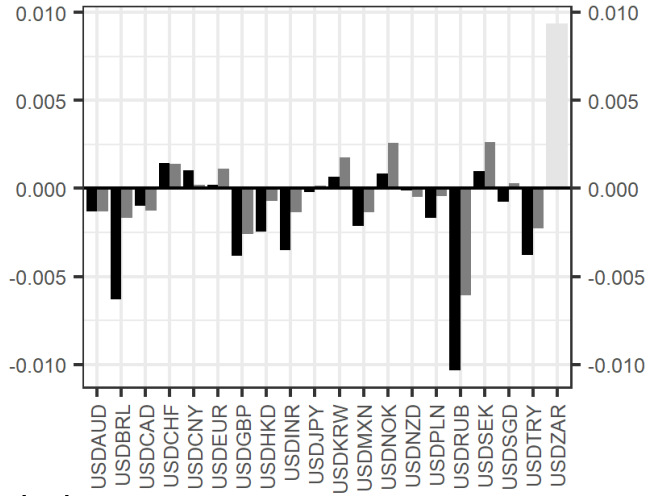
(a) Dismissal of Nene



(b) Appointment of Gordhan

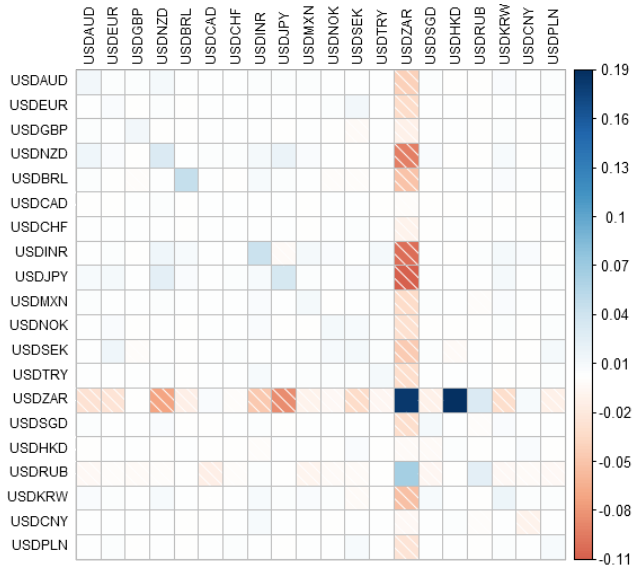


(c) Questioning of Gordhan

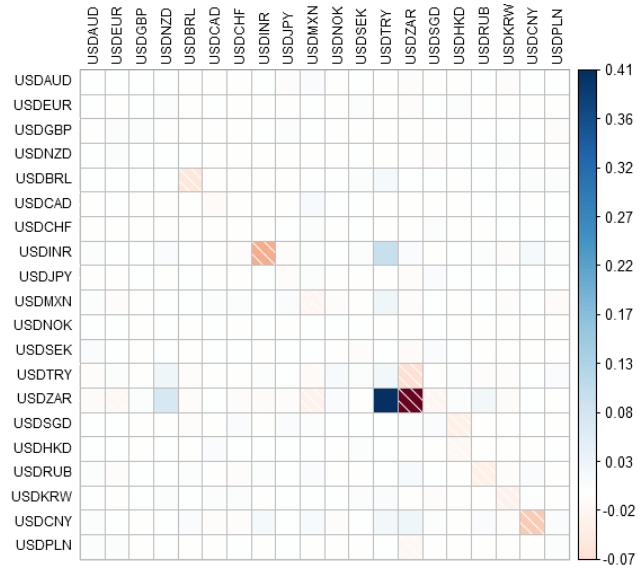


(d) Dismissal of Gordhan

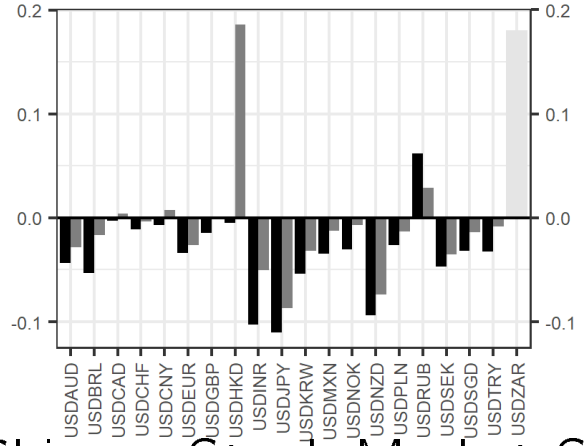
Foreign Idiosyncratic Events



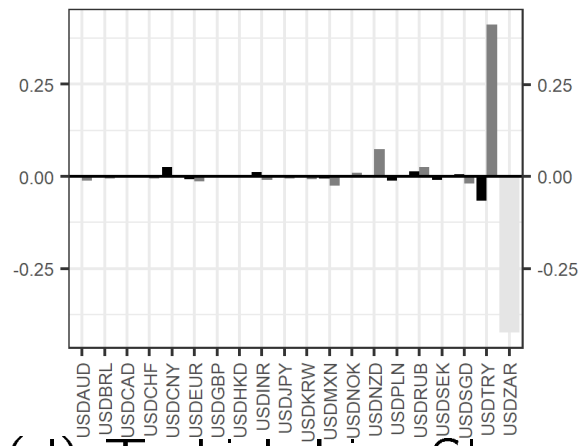
(a) Chinese Stock Market Slump



(b) Turkish Lira Slump

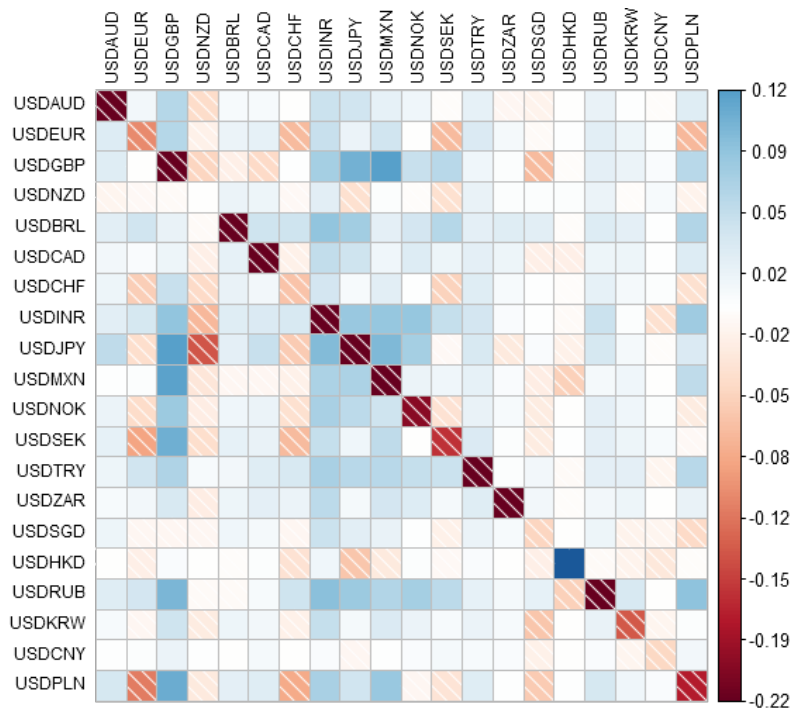


(c) Chinese Stock Market Slump

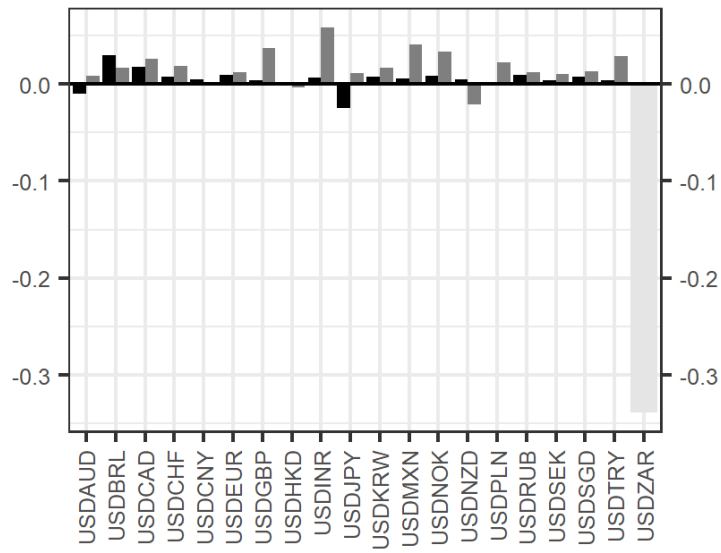


(d) Turkish Lira Slump

Global Events



(a) Systemwide Connectedness



(b) ZAR Connectedness

Figure: Change in Spillovers to/from ZAR over Brexit Referendum

Summary of findings

- Our model highlights risk transmission channels in a timely manner during FX flash crashes and periods of heightened financial market uncertainty.
- We show that variations in risk-return profile of USDZAR correlate with variations in the risk-return profile of many other currencies, and that this is especially true of EM currencies in our sample.
- We interpret this as evidence of ZAR's role as a bellwether EM currency, at least in times when South African idiosyncratic risk is not elevated.

Extra slides

Data

- We isolate innovations in higher-order moments as residual from a first order autoregression to account for greater persistence in realised moments than FX log-returns:

$$\hat{v}_{it} = V_{it} - \hat{a}_i + \hat{b}_i V_{it-1}, \tag{1}$$

- An extensive data appendix is available on request