

# Foreign Exchange Imbalances: A Markov-Switching Approach for South Africa

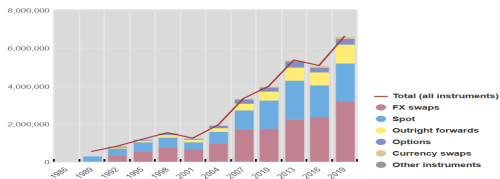
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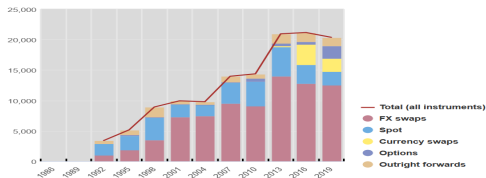
# Introduction - Foreign Exchange market

## Foreign Exchange market turnover Daily in millions of USD

### 1- Global FX turnover



### 2- FX turnover - South Africa



Source : BIS Triennial Central Banks Survey of Foreign Exchange and Over-the-counter (OTC) Derivatives Markets in 2019

# Introduction - Literature

- Micro level – Microstructure
  - ▶ FX market  $\Rightarrow$  short to medium run exchange rate movements
- Macro level – Imperfect financial markets
  - ▶ Exchange rate determined in the FX market
  - ▶ Financial intermediaries ability to bear risk (Gabaix and Maggiori (2015))
- Dell'Eva and Viegi (mimeo)
  - ▶ Tractable macroeconomic model

## Aim of the paper

Estimate Dell'Eva and Viegi (mimeo) for South Africa

# Introduction - The paper

## Methodology

- Macro model – Exchange rate driven by positions and risk in the FX market
  - ▶ Non linearity in exchange rate movements
- Estimate with Bayesian Markov-Switching
  - ▶ Switching driven by the VIX

## South Africa

- The ZAR is highly volatile
  - ▶ Is there a global financial cycle able to explain part of this volatility?
- Simulation of shocks with the estimated parameters
  - ▶ Is South Africa affected differently?

## Introduction - Contributions

- Switching do appear
  - ▶ Driven by a Global Financial Cycle
- Exchange rate volatility is larger in the risky regime
- The SARB accounts for risk and adapts its response
- Simulation of shocks
  - ▶ All depends on the households' incentive to consume domestic or foreign goods
  - ▶ Shocks  $\Rightarrow$  South Africa is affected in a different manner according to the regime

## The model – FX market and exchange rate

- South Africa trades with the rest of the world and have access to international financial markets
- Financial institutions act as intermediaries in the international financial markets
  - ▶ Their ability to bear risk is limited
  - ▶ Risk premium.
- The country borrows in international financial markets
  - ▶ The financier is long in ZAR
  - ▶ The ZAR depreciates today and appreciate further
  - ▶ The tighter the risk-bearing capacity, the larger the current depreciation.

# The model

- Standard equations derived from the micro founded model

$$x_t = E_t[x_{t+1}] - \frac{1}{\sigma} \left( r_t - E_t[\pi_{Ht+1}] - \bar{r}r_t \right) + \delta \Delta E_t e_{t+1} + g_t, \quad (1)$$

$$\pi_{Ht} = \beta E_t \pi_{Ht+1} + \kappa x_t + u_t, \quad (2)$$

$$\pi_t = \pi_{Ht} + \alpha \Delta e_t + w_t, \quad (3)$$

$$r_t = \rho_r r_{t-1} + (1 - \rho_r)(\gamma_\pi \pi_t + \gamma_x x_t) + q_t, \quad (4)$$

- The expected depreciation is

$$UIP \quad \Rightarrow \quad \Delta e_{t+1} = r_t - m_{t+1} - m_t, \quad (5)$$

$$Risk \quad \Rightarrow \quad \Delta e_{t+1} = (1 - \Gamma)r_t + (\Gamma - 1)m_{t+1} - (1 + \Gamma)m_t. \quad (6)$$

# Bayesian Markov-Switching

- The volatility of the shock on the VIX follows an independent two states Markov process

$$\Gamma_t = \rho_\Gamma \Gamma_{t-1}^{(s_t)} + \sigma_{\Gamma_t}^{(s_t)} \epsilon_t. \quad (7)$$

- The risky regime (vol,2) is the one with the highest volatility  $\Rightarrow \sigma_\Gamma(\text{vol}, 2) > \sigma_\Gamma(\text{vol}, 1)$

- The Markov-Switching rational expectations model is

$$E_t \left[ \Psi + \Phi_{s_{t+1}} X_{t+1}(s_t) + \Theta_{s_t} X_t(s_t, s_{t-1}) + \Xi_{s_t} X_{t-1}(s_{t-1}, s_{t-2}) + \eta_{s_t} \Omega_t \right] = 0, \quad (8)$$

- $s_t = (1, 2)$  and denotes the two alternative regimes
  - $T = [p_{s_t, s_{t+1}}]$  is the Markov transition probability with  $[p_{s_t, s_{t+1}}] = \text{prob}(s_{t+1} | s_t)$
- We allow the monetary policy parameters to take different values according to the regime
  - $\gamma_\pi(\text{coef}, 1)$ ,  $\gamma_\pi(\text{coef}, 2)$ ,  $\gamma_x(\text{coef}, 1)$ ,  $\gamma_x(\text{coef}, 2)$ ,  $\rho_r(\text{coef}, 1)$  and  $\rho_r(\text{coef}, 2)$



# Data

- From 1990 to 2019
- Data from the QPM
  - ▶ Output gap, CPI, nominal exchange rate and nominal interest rate
  - ▶ Annual interest rate so

$$r_{obs} = \log\left(1 + \frac{r_{data}}{4 * 100}\right) \quad (9)$$

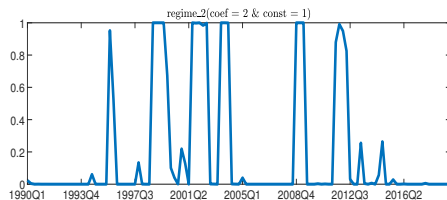
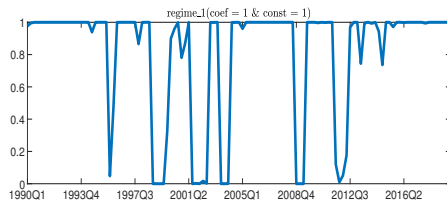
- Federal Reserve Economic Data (FRED)
  - ▶ Producer Price Index (PPI)  $\Rightarrow$  seasonally adjust
- Yahoo finance
  - ▶ VIX

## Parameters and estimations

Table: Prior and posterior distributions of structural parameters

Parameters	Distribution	Prior				Posterior	
		a	b	Low	High	Initial	Mode
$\gamma$	Gamma(a,b)	28.67	0.09	1.750	3.250	2.9	0.958
$\sigma$	Gamma(a,b)	10.29	0.23	1.325	3.775	0.88	0.628
$\mu$	Gamma(a,b)	22.95	0.13	2.000	4.000	1.1	1.238
$\beta$	Beta(a,b)	120.50	5.80	0.920	0.980	0.99	0.992
$\alpha$	Beta(a,b)	19.21	43.47	0.215	0.405	0.15	0.125
$\gamma_{\pi}(coef, 1)$	Gamma(a,b)	3.263	0.393	0.375	2.625	1.5	0.974
$\gamma_{\pi}(coef, 2)$	Gamma(a,b)	3.263	0.393	0.375	2.625	1.5	1.077
$\gamma_x(coef, 1)$	Gamma(a,b)	11.455	0.049	0.325	0.875	0.5	0.399
$\gamma_x(coef, 2)$	Gamma(a,b)	11.455	0.049	0.325	0.875	0.5	0.502
$\rho_r(coef, 1)$	Gamma(a,b)	11.455	0.049	0.325	0.875	0.4	0.827
$\rho_r(coef, 2)$	Gamma(a,b)	11.455	0.049	0.325	0.875	0.4	0.725
$\sigma_{\Gamma}(vol, 1)$	InvGamma(a,b)	0.3261	0.00015	0.0001	2	0.01	0.061
$\sigma_{\Gamma}(vol, 2)$	InvGamma(a,b)	0.3261	0.00015	0.0001	2	0.8	0.811
$coef_{tp12}$	Beta(a,b)	1.0043	2.0056	0.0256	0.7761	0.0206	0.023
$coef_{tp21}$	Beta(a,b)	1.0043	2.0056	0.0256	0.7761	0.0338	0.854

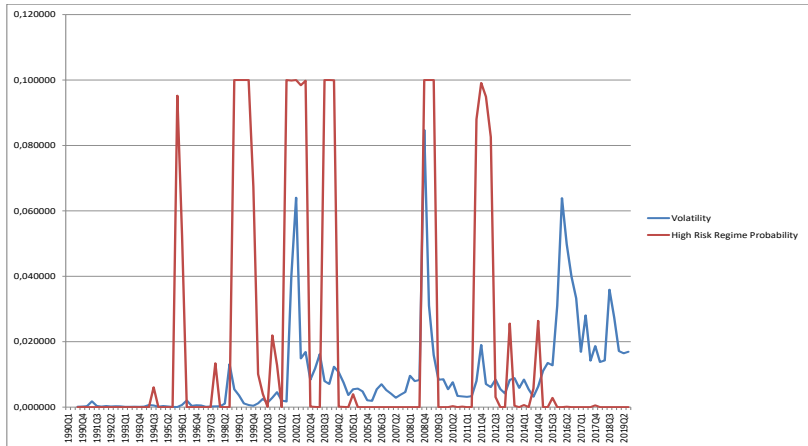
# From one regime to another



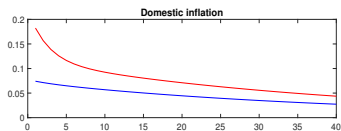
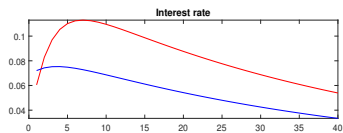
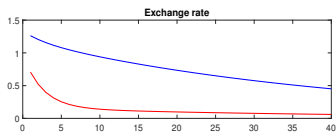
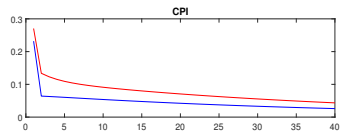
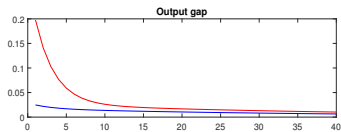
## • High risk regime

- ① 1995Q4 → US federal government shutdown
- ② 1998Q4 → Asian crisis
- ③ 2001Q3 → Global recession
- ④ 2003Q3 → War in Iraq
- ⑤ 2008Q4 → Global financial crisis
- ⑥ 2011Q3 → European debt crisis

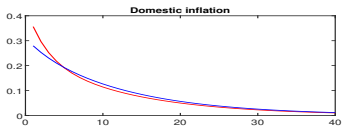
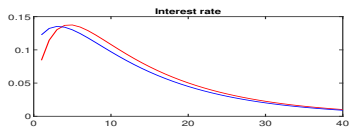
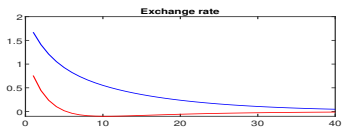
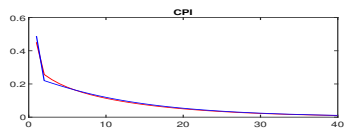
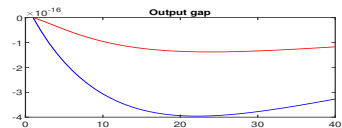
# Exchange rate volatility and risk



## Demand shock



## Supply shock



## Conclusion

- Markov-Switching driven by the VIX
- External factors (global financial cycle) determine whether South Africa is perceived as risky or not
- ZAR more volatile in the risky regime
- The SARB responds differently according to the regime
- Households' incentive to consume domestic or foreign goods determine the financier's position
  - ▶ Exchange rate movements
- The effect of the demand shock is absorbed by the financier
- The effect of a supply shock is exacerbated by the financier