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Content

„Snažte se dělat věci nejlépe na světě
a svět si vyšlape cestičku k Vašim dveřím.“

Tomáš Baťa

AFRICAN FLOATING CURRENCIES AND THE EUR/USD FLUCTUATION

Gábor Dávid Kiss

Abstract

Current paper analyzes the developments of extreme fluctuations of floating African currencies in the light of developments on Euro to US dollar market between 2000 and 2015. Sample countries trade destinations are well diversified nowadays, but the US and European trade relations are still significant. Currency fluctuations are evaluated by the developments in their foreign trade and monetary policy as well, but the existing political, real and financial links were not able to cause contagion under recession periods or at extreme trading days.

Keywords: Africa, floating regime, contagion, extreme fluctuation

1 INTRODUCTION

Current paper evaluates the consequences of floating on Sub-Saharan African currencies to see the possible trade-offs between price-competitiveness and foreign exchange (FX) exposure. Peg to a key currency eliminates FX exposure, but price-competitiveness can be biased by appreciating trends of the selected key currency – while the maintenance can be expensive under turbulent times as well. Floating regime has the advantage of adaption in our current two-key-currency world, but later defined contagions and divergences can ruin the profitability due to unexpected change in currency common movements.

After the definition of contagion and its background, special African trade-programs will be summarized in the theoretical chapter. Current study tested daily closing data of floating currencies from Kenya (KES), Ghana (GHS), South Africa (ZAR), Tanzania (TZS), Uganda (UGX), Gambia (GMD), Madagascar (MGA) and Mozambique (MZN) in USD denomination against EUR/USD rate between March 8 2000 and March 6 2015 acquired from Bloomberg database. The basic statistics and the ways to analyze their extreme fluctuation, volatility and correlation is the content of the data and methods chapter. Results are supporting the advantages of floating regime, which was remarkably robust on key currency developments.

2 THEORETICAL BACKGROUND

This chapter defines contagion channels to study vulnerability of sample countries. Floating exchange rate regime was applied in the selected countries, while their external balance is in focus of the presented international initiatives in the following paragraphs.

Contagions could be broadly defined as the cross-country transmission of shocks or the general cross-country spillover effects, which does not need to be related to crises. Current paper applies the World Bank's very restrictive definition[5]: a relative increase in cross-country correlations during "crisis times" to "tranquil times". Contagion is based on three fundamental links among countries, like financial, real and political links. Financial link is supported by connections through the international financial system (for example: cross-border commercial bank networks, lending, portfolio investments, etc.). Real links are in connection with international trade or FDI-driven cross-border division of labor. Political link is in connection with exchange rate arrangement country-groups. We can talk about

[5] see: http://go.worldbank.org/JIBDRK3YC0

interdependence, when the upper difference between correlations under extreme and normal conditions is insignificant – meaning that upper links has no significant impact on exchange rates.

The analyzed African country set followed free floating exchange rate mechanism combined with monetary aggregate target in the majority of the cases (Kenya, Tanzania, Uganda, Gambia, Madagascar, Mozambique) or inflation targeting framework (Ghana, South Africa) (IMF 2013). Main trading partners were the European Union, United States, China and India in 2012 (CIA 2015). Foreign trade was supported via a rich and chaotic net of regional integration agreements fostering trade of goods and services among selected countries and key economic areas (EU, US, Indian and Chinese markets) (Udvari 2012). Aid for Trade (AfT) initiative was created after the G8 Summit in 2005 to improve supply-side capacities of recipient countries instead of former "trade not aid" philosophy. The objective of this program was to integrate recipient countries in the world economy, to diversify their foreign trade and to maintain their price-competitiveness under current environment with decreasing tariffs – where former Generalized System of Preferences (GSP) became obsolete (Udvari 2011). The European Union focuses most of its international aid-activity on African countries since the first Lome Agreement in 1975 even in the current Cotonou Agreement between 2000 and 2020 trough its financial (European Development Fund, dedicated EIB credits, economic stability aid programs) and trade instruments (GSP, unilateral preferences, WTO agreements and European Partnership Agreements) (Udvari 2008, 2011, 2012). Project financing was a traditional field of World Bank Group, especially International Development Association (IDA) to provide interest-free loans for governments of Heavily Indebted Poor Countries (HIPC). Funding for corporate sector has a bigger variety: among another WB subridiaries and regional development banks, the China-Africa Development Fund was established in 2007 to finance development projects on commercial basis for corporate sector, supported by China Development Bank (CADF 2013).

Despite the upper presented wide range of support channels, Lomé and Cotonou Agreements had no significant impact on sigma (income deviations), beta (less developed has bigger growth-potential) and stochastic (entire country-group develops among a common trend) convergence (Gáspár - Udvari 2011) or trade with European countries (Udvari 2014).

Foreign exchange (FX) exposure can have a crucial impact on the competitiveness of analyzed African countries due to their floating currency regime framework. Combined with high dependence on euro and US dollar denominated markets (China is considered here, because of the 2% floating band of RMB against US dollar[6]) and diverse financial and trade support channels, contagion on currency market is a real option. This is the opposite strategy than followed by member states[7] of West African Economic and Monetary Union[8], where CFA franc has a fixed parity to the Euro (656 to 1).

3 DATA AND METHODS

Methods to capture temporal distribution of extreme FX fluctuations and contagions under recession periods in developed markets are presented in this chapter. Current study tested daily closing data of floating currencies from Kenya (KES), Ghana (GHS), South Africa (ZAR), Tanzania (TZS), Uganda (UGX), Gambia (GMD), Madagascar (MGA) and Mozambique (MZN) in USD denomination against EUR/USD rate between March 8 2000 and March 6 2015 acquired from Bloomberg database.

[6] http://www.pbc.gov.cn/publish/english/955/2014/20140317160839706274217/20140317160839706274217_.html

[7] Benin, Burkina-Faso, Côte d'Ivoire, Mali, Niger, Senegal, Togo, and Guinea-Bissau

[8] http://go.worldbank.org/FKHEP1VQF0

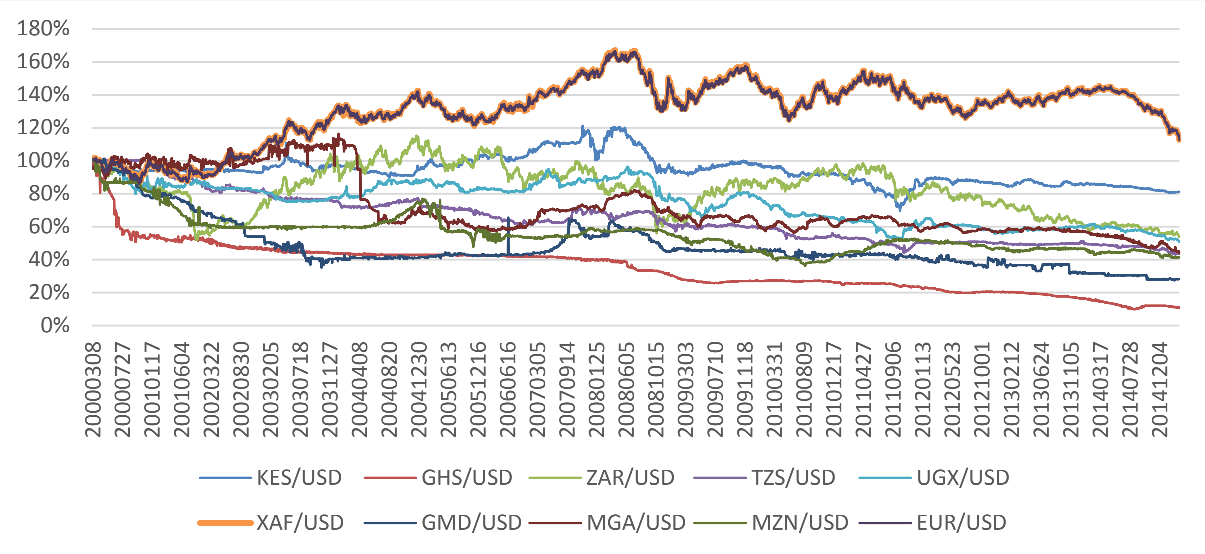

Fig. 1 – Developments of selected African currencies between 2000 and 2015 (March 8 2000=100%). Source: Bloomberg

CFA Franc (XAF) followed strictly the euro, due to its fixed regime, showing an appreciation against US dollar during the entire time set on Fig. 1. Kenyan Shilling (KES) and South African Rand (ZAR) presented an appreciating trend before the crisis only, otherwise all off the entire currency set depreciated against the US dollar – price-competitiveness improved from this aspect.

Tab. 1 – Basic statistics of currency logarithmic differentials. Source: author's calculations

					normal distribution	autocorrelation	heteroscedasticity	stationarity
currency	mean	std	skewness	kurtosis	Jarque-Bera (p)	Ljung-Box (p)	ARCH-LM (p)	ADF (p)
KES/USD	0,00	0,01	0,28	18,60	0,00*	0,00**	0,08	0,00
GHS/USD	0,00	0,01	1,78	39,88	0,00*	0,00**	0,00***	0,00
ZAR/USD	0,00	0,01	1,07	17,89	0,00*	0,22	0,50	0,00
TZS/USD	0,00	0,01	-0,87	30,73	0,00*	0,00**	0,00***	0,00
UGX/USD	0,00	0,01	0,46	16,63	0,00*	0,00**	0,07	0,00
XAF/USD	0,00	0,01	-0,06	5,08	0,00*	0,00**	0,00***	0,00
GMD/USD	0,00	0,02	-0,03	169,73	0,00*	0,00**	0,03***	0,00
MGA/USD	0,00	0,01	1,77	58,07	0,00*	0,00**	0,00***	0,00
MZN/USD	0,00	0,01	0,92	49,84	0,00*	0,00**	0,00***	0,00
EUR/USD	0,00	0,01	-0,05	4,59	0,00*	0,83	0,86	0,00

Notes: *: lack of normal distribution, **: autocorrelation at 2 lags, ***: heteroscedasticity at 2 lags, ****: unit root

Logarithmic differentials (1) of FX rates were tested to understand their basic characteristics on Tab. 1.

$$r_t = \ln(\frac{p_t}{p_{t-1}}) \quad (1)$$

Where r_t represents logarithmic return on trade day *t*, and *p* is FX rate.

Currencies had enormous fifth moments (kurtosis) compared to the ideal level of 3, suggesting that large magnitude fluctuations are more probable that they should be under the assumption of normal distribution. After this result the rejection of normal distribution by Jarque-Bera test was not a surprise. Time series were autocorrelated with 2 lag, falsifying the common assumption about weak market efficiency. The appearance of heteroscedasticity suggest the future application of Generalized Autoregression Heteroscedasticity (GARCH) models to avoid correlation bias following Forbes and Rigobon (2002). There was no unit root in the data by the ADF test.

Contagions were defined as significant increase in correlations due to some kind of shock (2)

$$\rho_{shock} \gg \rho_{tranqil}, \tag{2}$$

where ρ_{shock} represents correlation under shock periods and $\rho_{tranqil}$ are correlations under "normal" periods. Current paper analyses two forms of shocks on the selected currency set a short-run and a long-run approach will be applied.

Short-run shocks were defined by non-normal distributed unconditional quantile of empirical data, referred as *fat tailed extreme returns* ($r_{\mathbb{X}fat}$) computed by the difference on the tails between theoretical normal and empirical distribution utilizing its "S"-shaped from, described by Clauset (2007) and Gabaix et al. (2003) to see the difference between theoretical and empirical returns under p_L low probability (3).

$$r_{\mathbb{X}fat+,p_L} \gg r_{normal,p_L} \; or \; r_{\mathbb{X}fat-,p_L} \ll r_{normal,p_L} where \; p_L \ll p_{E(r)} \tag{3}$$

Fat tailed extreme returns can appear both on negative ($r_{\mathbb{X}fat-,p_L}$) and positive ($r_{\mathbb{X}fat+,p_L}$) side of probability distribution under p_L low probable cases which are far from the probability of the expected value ($p_{E(r)}$).

Long-run shocks were defined by business cycles in the US and Eurozone following NBER[9] and CEPR Euro Area Business Cycle Dating Committee[10] data. Recession was defined by both of them as "a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales". US recession periods were defined by this method between Mach and November 2001 as well as between December 2007 and June 2009. Eurozone was in recession between January 2008 and April 2009 (which was really close to the US recession period) and after July 2011 and not ended yet.

Different GARCH models were fitted on data to manage heteroscedasticity of underlying data before later correlation fitting, following Cappeiello, Engle and Sheppard (2006). The applied GARCH(p,q), GJR GARCH(p,o,q), TARCH(p,o,q) and APARCH(p,o,q) (4-8) models can be useful to capture volatility developments and their clustering in time (heteroscedasticity).

GARCH (p,q): $$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \, \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_i \, \sigma_{t-j}^2. \tag{4}$$

where σ_t^2 represents present variance, ω is a constant term, p denotes the lag number of squared past ε_{t-i}^2 innovations with α_i parameters, while q denotes the lag number of past σ_{t-j}^2.variances with β_i parameters to represent volatility persistence. Asymmetric GARCH models can be introduced via

9 http://www.nber.org/cycles.html
10 http://www.cepr.org/content/euro-area-business-cycle-dating-committee

$\begin{cases} S_{t-i}^{-} = 1, if\, \varepsilon_{t-i} < 0 \\ S_{t-i}^{-} = 0, if\ \varepsilon_{t-i} \geq 0 \end{cases}$ to capture asymmetric reaction on losses. (5)

GJR GARCH (p,o,q): $\sigma_t^2 = \ \omega + \sum_{i=1}^{p} \alpha_i |\varepsilon_{t-i}| + \sum_{i=1}^{o} \gamma_i S_{t-i}^{-} |\varepsilon_{t-i}| + \sum_{j=1}^{q} \beta_i \, \sigma_{t-j}^2$, (6)

TARCH (p,o,q): $\sigma_t = \ \omega + \sum_{i=1}^{p} \alpha_i \, \varepsilon_{t-i}^2 + \sum_{i=1}^{o} \gamma_i \, S_{t-i}^{-} \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_i \, \sigma_{t-j}$, (7)

APARCH (p,o,q): $\sigma_t^\delta = \omega + \sum_{i=1}^{p} \alpha_i (|\varepsilon_{t-i}| - \gamma_i \varepsilon_{t-i})^\delta + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^\delta$, (8)

where $\alpha_i > 0$ $(i=1,\dots,p)$, $\gamma_i + \alpha_i > 0$ $(i=1,\dots,o)$, $\beta_i \geq 0$ $(i=1,\dots,q)$, $\alpha_i + 0{,}5\ \gamma_j + \beta_k + < 1$ $(i=1,\dots,p,$ $j=1,\dots,o,$ $k=1,\dots,q)$ and δ index parameter can be between 1 and 2.

Modell selection was made with focus on homoscedastic residuals and minimal Akaike Information Criteria (AIC). This study applies DCC-GARCH[11] model, following Engle (2002), to analyze the daily common movements of the selected markets.

Sample countries directing their foreign trade into the direction of US dollar (or USD-pegged) and euro-denominated markets. A fixed exchange rate against euro endangers price-competitiveness under a period of euro-appreciation, while a floating regime is able to adapt. However, economic actors have to manage their FX exposure on both side of their balance sheets, where a sudden change in currency common movement can undermine project-profitability. For deeper understanding of the impact of shocks on common movements, contagion, divergence and interdependence was defined to capture all possible outcomes.

Contagion (9) occurs between $euro, c_k$currencies when the ρ^{euro,c_k}cross-market correlation becomes significantly higher due to a shock derived from EUR/USD market ($r_x^{EUR/USD}$) spreading to others or as a result of other external factors (Forbes and Rigobon, 2002; Campbell et al., 2002; Bekaert et al., 2005):

$$r_x^{EUR/USD} = 1 \ \rightarrow \rho_n^{euro,c_k} \ll \rho_x^{euro,c_k}, \quad (9)$$

Interdependence (10) occurs between $euro, c_k$currencies when the ρ^{euro,c_k}cross -market correlation is not significantly different, but the level of correlation is consistently high (Forbes and Rigobon, 2002):

$$r_x^{EUR/USD} = 1 \ \rightarrow \rho_n^{euro,c_k} \approx \rho_x^{euro,c_k}, \quad (10)$$

Divergence (11) occurs between $euro, c_k$currencies when the ρ^{euro,c_k}cross-market correlation becomes significantly lower due to a shock derived from one market ($r_x^{EUR/USD}$) spreading to others or as a result of other external factors (Bearce 2002):

$$r_x^{EUR/USD} = 1 \ \rightarrow \rho_n^{euro,c_k} \gg \rho_x^{euro,c_k}, \quad (11)$$

This chapter summarized the available information on data and the applied methodology to test, how selected African currencies behaved under market shocks.

4 RESULTS

The lack of normal distribution at the logarithmic returns suggested a success on the detection of fat tailed extreme fluctuations. Tab. 2 contains the results of the method, suggesting that the remaining *r(n)* truncated distribution converged closer to the ideal values of first four moments: 0,1,0,3. At the same time, the applied method was able to manage the asymmetric

[11]The estimation based on the Oxford MFE and UCSD toolboxs, developed by Kevin Sheppard: http://www.kevinsheppard.com/

appearance of extreme returns, while their overall mass remained lower than 10% in the entire data set.

Tab. 2 – Fat tailed extreme returns. Source: author's calculations

currency		KES	GHS	ZAR	TZS	UGX	XAF	GMD	MGA	MZN	EUR
mean	entire	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	r(n)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
standard deviation	entire	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,01	0,01	0,01
	r(n)	0,00	0,01	0,01	0,00	0,00	0,01	0,01	0,01	0,01	0,00
skewness	entire	0,28	1,78	1,07	-0,88	0,46	-0,06	-0,03	1,77	0,92	-0,05
	r(n)	-0,02	0,05	-0,01	0,01	-0,05	-0,07	-0,04	-0,01	-0,09	-0,09
kurtosis	entire	18,60	39,87	17,89	30,72	16,62	5,09	169,68	58,48	49,82	4,59
	r(n)	3,79	4,75	2,93	3,22	3,16	2,55	4,62	4,17	4,77	2,53
X+ treshold		0,0104	0,0209	0,0232	0,0115	0,0126	0,0118	0,0392	0,0267	0,0304	0,0106
X- treshold		-0,0101	-0,0193	-0,0261	-0,0114	-0,0130	-0,0128	-0,0402	-0,0263	-0,0299	-0,0121
No extreme positive		102	81	95	117	105	170	60	61	62	193
No extreme negative		101	83	47	93	77	131	44	60	47	126
No Normal		3209	3248	3270	3202	3230	3111	3308	3291	3303	3093

Temporal distribution of fat tailed extreme returns was tested in Tab. 3, to check the increase of their mass under recession. US recession benchmark seemed to be better, the post July 2011 crisis in the Eurozone had not so much impact on extreme currency fluctuations.

Tab. 3 – Fat tailed extreme returns. Source: author's calculations

period		KES	GHS	ZAR	TZS	UGX	XAF	GMD	MGA	MZN	EUR	recession
US	March 2000 - February 2001	3%	16%	0%	3%	19%	14%	0%	5%	11%	19%	
	March 2001 - October 2001	**1%**	**13%**	**7%**	**13%**	**9%**	**14%**	**0%**	**11%**	**11%**	**17%**	"+"
	November 2001 - November 2007	5%	4%	5%	6%	4%	10%	5%	6%	4%	8%	
	December 2007 - May 2009	**21%**	**3%**	**10%**	**15%**	**10%**	**13%**	**1%**	**0%**	**1%**	**17%**	"+"
	June 2009 - February 2015	3%	3%	2%	4%	3%	5%	3%	2%	1%	6%	
EU	March 2000 - December 2007	5%	7%	5%	6%	6%	11%	4%	6%	5%	10%	
	January 2008 - March 2009	**21%**	**3%**	**13%**	**14%**	**10%**	**14%**	**1%**	**0%**	**2%**	**18%**	"+"
	April 2009 - June 2011	6%	0%	2%	6%	5%	8%	3%	1%	3%	10%	
	July 2011 - March 2015	**3%**	**5%**	**2%**	**4%**	**3%**	**4%**	**3%**	**2%**	**0%**	**5%**	"+"

Heteroscedasticity of time series were managed by different GACH models, where the selection was based on homoscedastic standardized residuals and lowest Akaike Information

Criteria (AIC). Alpha coefficient represented the importance of past innovations (with 1 or 2 lags), while gamma informs about asymmetric behavior (higher volatility under depreciation), as well as beta refers to the volatility persistence (Tab. 4). Traditionally the volatility persistence has the highest value, so the result at GMD/USD is quite exceptional.

Tab. 4 – GARCH model parameters. Source: author's calculations, UCSD toolbox

currency	model	constant	alpha 1	alpha 2	gamma	beta 1	beta 2	delta	AIC
KES/USD	TARCH(1,1,2)	0,00	0,23		0,04	0,40	0,36		-4,13
GHS/USD	APARCH(1,1,1)	0,00	0,07		-0,01	0,88		3,34	-3,68
ZAR/USD	APARCH(1,1,1)	0,00	0,08		-0,45	0,92		1,41	-3,14
TZS/USD	GJR GARCH(1,1,2)	0,00	0,26		0,07	0,47	0,23		-3,97
UGX/USD	APARCH(1,1,1)	0,00	0,20		-0,08	0,80		1,60	-3,81
XAF/USD	GJR GARCH(1,1,1)	0,00	0,03		0,02	0,95			-3,57
GMD/USD	TARCH(2,1,1)	0,01	0,15	0,38	0,10	0,42			-2,77
MGA/USD	APARCH(1,1,1)	0,00	0,02		0,05	0,94		3,98	-3,23
MZN/USD	GJR GARCH(1,1,2)	0,00	0,18		0,09	0,28	0,49		-3,37
EUR/USD	TARCH(2,1,1)	0,00	0,01	0,04	0,00	0,94			-3,64

Dynamic conditional correlation between euro and regional currencies proved to be strong only for XAF due to the pegged regime (Tab. 5). Other African floating currencies were uncorrelated, only the South African Rand (ZAR) showed some weak common movement. These results suggesting weaker dependence, compared to the historically strong relations of Central-Eastern European currencies to euro Stavarek (2010) or Babetskaia-Kukharchuk et al. (2008). Therefore we can say that long-term correlation was not affected by business cycles in key economies (or by monetary responses on these developments).

Tab. 5 – Average dynamic conditional correlation. Source: author's calculations, UCSD toolbox

	period	KES	GHS	ZAR	TZS	UGX	XAF	GMD	MGA	MZN	recession
	March 2000 - February 2001	-0,02	0,00	0,43	0,00	0,07	0,74	-0,02	0,05	0,03	
	March 2001 - October 2001	**0,01**	**0,00**	**0,08**	**-0,01**	**0,07**	**0,71**	**-0,02**	**0,09**	**0,03**	**"+"**
	November 2001 - November 2007	0,03	0,00	0,42	0,00	0,07	0,70	-0,03	0,06	0,01	
	December 2007 - May 2009	**0,11**	**0,00**	**0,41**	**-0,01**	**0,08**	**0,94**	**-0,04**	**0,08**	**0,00**	**"+"**
US	June 2009 - February 2015	0,05	0,00	0,47	0,00	0,09	0,95	-0,05	0,07	-0,03	
	March 2000 - December 2007	0,02	0,00	0,40	0,00	0,07	0,71	-0,02	0,06	0,01	
	January 2008 - March 2009	**0,10**	**0,00**	**0,38**	**-0,01**	**0,08**	**0,93**	**-0,04**	**0,08**	**0,00**	**"+"**
	April 2009 - June 2011	0,11	0,00	0,54	-0,01	0,08	0,99	-0,04	0,08	-0,02	
EU	**July 2011 - March 2015**	**0,02**	**0,00**	**0,43**	**0,00**	**0,09**	**0,93**	**-0,06**	**0,06**	**-0,04**	**"+"**

Short-term currency market developments were captured in several cases when extreme and normal subsets of dynamic conditional correlations (DCCs) were compared with two-sided t-tests to capture contagions, divergences or interdependence. UGX presented significantly lower correlations on extreme trading days, compared to normal periods, while GMD and MZN suffered significant increase – but these results are biased, due to overall uncorrelation. EUR-pegged XAF had strong common movement which weakened under turbulent times, presenting a real divergence – and a vulnerability of the monetary framework.

Tab. 6 – Difference between dynamic conditional correlations under extreme (x) and normal (n) trading days. Source: author's calculations, UCSD toolbox

	KES	GHS	ZAR	TZS	UGX	XAF	GMD	MGA	MZN
avg. corr.(n)-avg. corr.(x+)	-0,0057	0,0014	-0,0231	0,0028	**0,0024 ****	0,0138	**-0,0042 ***	-0,0038	**-0,0061 ***
avg. corr.(n)-avg. corr.(x-)	-0,0036	0,0015	-0,0119	0,0003	**0,0038 ****	**0,0329 ****	**-0,0066 ***	-0,0041	**-0,0104 ***

Notes: *: contagion, **: divergence

5 CONCLUSION

Current article evaluated the FX exposure of the African countries with floating exchange rate regimes to compare them the pegged alternative, like XAF. Analyzed countries have many bounds to the developed countries: among ordinary trade relations, their integration into world economy is promoted via preferential tariff agreements, aid and discounted credit programs. Economic actors in sample countries had to pay the price of floating regimes as the results about fat tailed extreme fluctuations and volatility models suggested, but their currencies were uncorrelated with euro. Therefore contagions were not able to emerge on these markets despite the real, political and financial links among these countries and the Eurozone or US market, but the flexibility of the FX regimes allowed the depreciation against euro to maintain price-competitiveness.

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