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**-RESEARCH ARTICLE-**

# A NON-LINEAR ANALYSIS OF SOUTH AFRICAN EXPORTS AND SELECTED MACROECONOMIC VARIABLES

**K. R. Tsunga**
School of Accounting, Economics and Finance, University of KwaZulu-Natal.
Email: kudzitsunga@gmail.com.
Orcid ID: 0000-0002-5957-7547

**P Moores-Pitt**
School of Accounting, Economics and Finance, University of KwaZulu-Natal.
Email: moorespittp@ukzn.ac.za
Orcid ID: 0000-0003-1792-7462

**K. McCullough**
School of Accounting, Economics and Finance, University of KwaZulu-Natal.
Email: mcculloughk@ukzn.ac.za
Orcid ID: 0000-0001-8100-8028

## Abstract

South African studies largely model export behaviour with linear assumptions and real economic factors, generally ignoring non-linear and financial considerations. This study addressed this by applying non-linear methodologies and considered financial economic factors. The non-linear autoregressive distributed lag model (NARDL) and the novel quantile autoregressive distributed lag model (QARDL) established a long-run relationship from 2003 to 2019; with varied asymmetric relationships evidenced. Long-run positive and negative effects for stock market illiquidity and volatility did not have similar magnitudes on exports to the world (asymmetric effects). Negative effects were greater than positive ones, indicating that worsening market liquidity conditions have a greater effect on exports than improving liquidly conditions. The QARDL model showed a clear asymmetric, quantile dependent, relationship. Short-run asymmetries were more dominant than long-run asymmetries. Significant and asymmetric illiquidity highlighted that this relationship was influenced by business cycles.

**Keywords and Phrases**: Asymmetry, financial economy, non-linear, real economy, quantile dependent

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## 1. INTRODUCTION

Analysing South African export behaviour has increasingly become relevant following lacklustre economic growth that is projected to remain below 1% for the foreseeable future. The significance of comprehending the nature and extent of exports arises from the hypothesis that exports are a key mechanism that can boost economic growth, with the International Monetary Fund (IMF) (2019) and research by Ajmi, Aye, Balcilar and Gupta (2015), expounding this premise. The analysis of export behaviour patterns in relation to other macroeconomic variables had previously captured researchers' interest following the collapse of the Bretton Woods system of fixed exchange rates between 1968 and 1973, where significant currency fluctuations were experienced (Bahmani-Oskooee, Harvey and Hegerty, 2013). Studies which examined that period found mixed evidence on the impact of currency volatility impact on export activity – a phenomenon referred to as the *exchange disconnect puzzle* (Choudhry and Hassan, 2015).

Notwithstanding the exchange disconnect puzzle, there is unanimity amongst existing studies that exports have maintained a relationship with macroeconomic variables, particularly with the two real economic variables of foreign incomes in trading partners and the relative prices of the exported goods (Moslares and Ekanayake, 2015). The popularity of the two real economic factors was mainly motivated from the hypothesis that exports as a real economic variable would be influenced by factors emanating from the real economy and the debate of whether exports would lead economic growth or the opposite was true, has remained.

South African studies have analysed export behaviour patterns and their findings suggested the existence of the exchange disconnect puzzle because Takaendesa, Tsheole and Aziakpono (2006), Sekantsi (2011) and Aye, Gupta, Moyo and Pillay (2015) found that exchange rate volatility negatively affected South African exports; while Todani and Munyama (2005), Wesseh and Niu (2012) and Nyahokwe and Ncwadi (2013) found either a weak relationship or no relationship at all. However, these studies have research gaps emanating from the methods of analysis which use an assumption of linearity (Johansen's cointegration and the autoregressive distributed lag (ARDL)). These models' assumption of linearity may be inappropriate because they overlook the potential for financial and economic time-series to change their mean, volatility, or relationships with previous values over time.

Non-linearities can be accounted for in South African export demand functions with the non-linear ARDL (NARDL) model, an adaption of the ARDL model which detects short-run and long-run non-linearities. In addition, the quantile ARDL (QARDL) of Cho, Kim, and Shin (2015) considers non-linearity by combining quantile regression and the ARDL model. The QARDL facilitates observation of macroeconomic heterogeneity of South African export relationships by identifying location asymmetries in the long-run relationship improving comprehension of the relationship (Benkraiem, Hoang, Lahiani and Miloudi, 2018).

South African literature has overlooked the financial economy's influence on real economic output (exports included), a significant omission considering that the *finance-growth* hypothesis introduced by Schumpeter (1934) which later inspired the endogenous growth theory by Levine and Zervos (1996) postulated that stock market depth facilitates efficient resource allocation essential for economic growth. Giannellis and Papadopoulos (2016) found evidence suggesting that real economic output (industrial production and GDP) were related to stock market investor activity (market liquidity) indicating the existence of a relationship between the real and financial economies. Valuable knowledge can be gained by incorporating stock market liquidity and volatility into export demand functions because they reflect investor behaviour in different levels of export output; an area which has not been well researched to date. This article presents a unique contribution to the area of trade policy by addressing this gap and considering asymmetries and financial economic effects on South African export behaviour.

The article is structured as follows: section 2 reviews relevant literature, section 3 outlines the data and methodology employed, section 4 presents the results and section 5 concludes.

## 2. LITERATURE REVIEW

South Africa's open and outward-looking trade policy targeting export growth gave impetus for researchers to analyse export behaviour and growth (Ajmi *et al*., 2015). Erstwhile studies were ostensibly dominated by linear analysis, but latter South African studies suggested that non-linear methods could be more appropriate. This review considered the potential contribution of non-linearity to the discourse.

Ajmi *et al*. (2015) investigated the link between South Africa's annual exports and economic growth from 1911 to 2011 using linear Granger causality and found no causality. After applying non-linear Granger causality tests, Ajmi *et al*. (2015)

concluded that non-linearities and structural breaks had to be taken into consideration to model export relationships after finding bi-directional causality. Aye *et al*. (2015) arrived at similar conclusions after finding that real quarterly South African exports responded asymmetrically to the real effective exchange rate between 1986 and 2013 after incorporating asymmetries.

South African literature using non-linear models on export relationships with macroeconomic variables is sparse; most studies either used Johansen's cointegration or the linear ARDL. Takaendesa *et al*. (2006) analysed exports to the United States of America (USA) and found exchange rate volatility being an impediment to export growth. After analysing monthly exports to the world, Nyahokwe and Ncwadi (2013) found that exchange rate volatility had no effect. Studies that applied the ARDL to analyse South African exports included Todani and Munyama (2005) who examined total quarterly exports to the world between 1984 and 2004, Sekantsi (2011) who reviewed quarterly exports to the USA between 1995 and 2007 and Wesseh and Niu (2012) who analysed total and sector-level monthly exports to China from 1992 to 2010. Todani and Munyama (2005) found a weakly positive effect, Sekantsi (2011) found a negative effect while Wesseh and Niu (2012) found no effect of exchange rate volatility on total exports, but detected both positive and negative effects on product-level exports.

Although South African studies showed varied results for their main factor of focus, exchange rate volatility, findings on relative prices and foreign income were reconcilable. The gap from overlooking asymmetries validated the review of related international studies like Kwasi-Obeng (2018) who analysed exchange rate volatility effects on Ghanaian export diversification using the NARDL and found that exchange rate volatility had an asymmetric relationship with export diversification. Sahoo (2018), who analysed the relationship between service exports and the exchange rate in India, employed both the ARDL and the NARDL methods on annual data between 1975 and 2015. Sahoo (2018) concluded that there existed a long-run relationship between exports and the economic variables. However, there was no asymmetric relationship between exports and exchange rate volatility, but the opposite was true with exports and FDI.

The QARDL was employed to ascertain nonlinear macroeconomic relationships in international studies, for example, Benkraiem *et al*. (2018) investigated monthly oil prices and stock indices in France, Germany, Italy and the UK. The QARDL allows for unravelling nonlinear relationships more comprehensively compared to linear modelling. International studies provided evidence that nonlinearities may exist amongst macroeconomic variables and Kwasi-Obeng

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(2018) highlighted this phenomenon in an emerging market economy. Analysis using nonlinear methods to account for asymmetries contributed new knowledge on the extent to which exports responded to selected macroeconomic factors.

## 3. DATA AND METHODOLOGY

South African export data were sourced from the South African Revenue Services (SARS) and comprised total exports to the world, including four major world regions (Africa, America [North and South], Asia and Europe) between December 2003 and December 2019. Total exports to individual trading partners (China, USA, Germany, Japan and the UK) were only available consistently from January 2010 until December 2018. Foreign income was proxied by industrial production, consistent with Choudhry and Hassan (2015) and Bahmani-Oskooee *et al*. (2013). The real effective exchange rate indicated the relative prices of South African goods to export destinations while exchange rate volatility measured the risk of currency value uncertainty. Third-country effects were proxied by exchange rate volatilities of major trading partners, namely the U.S. Dollar, Euro, Japanese Yen and the Chinese Yuan (Bahmani-Oskooee *et al.,* 2013). Stock market illiquidity and volatility were estimated using stock market price and trade data (number of trades, volume of trades and value of traded stocks) from the Johannesburg Stock Exchange All Share Index. Stock market illiquidity was estimated using the Amihud (2002) measure; a widely accepted proxy. Exchange rate volatility and stock market volatility were estimated using the GARCH (1,1) non-linear model. Natural logarithms were applied to series to achieve a more symmetric distribution in line with Choudhry and Hassan (2015) and Kwasi-Obeng (2018). Descriptive statistics clarify the distribution of export data, and were followed by stationarity tests. Finally, regression analysis was undertaken beginning with the NARDL followed by the QARDL. All models were tested for stability using the CUSUM and CUSUM squared tests. The export demand function was estimated as follows:

$$lnXP_{i,t} = \alpha_0 + \omega lnY_{i,t} + \psi lnR_{i,t} + \phi lnEX_{i,t} + \theta lnTE_{\kappa,t} + \gamma lnTE_{\nu,t} + \lambda lnLQ_{i,t} + \vartheta lnSV_{i,t} + \varepsilon_t \quad (1)$$

Where, $lnXP_{i,t}$ are the exports to the world, region or a partner, $lnY_{i,t}$ is foreign income for the export destination and $lnR_{i,t}$ represents relative prices. $lnEX_t$ is exchange rate volatility whilst $TE_{\kappa,t}$ and $TE_{\nu,t}$ were third-country effects. Stock market illiquidity and volatility are $lnLQ_{i,t}$ and $lnSV_{i,t}$ respectively, with $\alpha_0$ being a constant and $\varepsilon_t$ was a normally distributed error term.

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The *a-priori* expectation was a positive foreign income coefficient because higher income in the destination increased its import ability. A negative relative prices coefficient was expected because higher exports accompany low prices. The exchange rate volatility coefficient was expected to be negative while signs on third-country effects coefficients were uncertain but mixed signs were expected. Stock market illiquidity and stock market volatility coefficients were expected to be negatively related with exports because rising illiquidity and volatility in the financial markets signalled poorer export prospects. The NARDL and QARDL models were employed to analyse the non-linear relationships of the export demand functions. Equation (1) was specified into an ARDL model of Pesaran, Shin and Smith (2001) and Pesaran, Shin and Smith (1999) as follows:

$$XP_t = \alpha + \sum_{i=1}^{p} \varphi_i \, XP_{t-i} + \sum_{i=0}^{q_1} \omega_i \, Y_{t-i} + \sum_{i=0}^{q_2} \psi_i \, R_{t-i} + \sum_{i=0}^{q_3} \phi_i \, EX_{t-i} + \sum_{i=0}^{q_4} \theta_i \, TE_{\kappa,t-i} + \sum_{i=0}^{q_5} \gamma_i \, TE_{\nu,t-i} + \sum_{i=0}^{q_6} \lambda_i \, LQ_{t-1} + \sum_{i=0}^{q_7} \vartheta_i \, SV_{t-i} + \varepsilon_t \quad (2)$$

Where, $\varepsilon_t$ is the error term, $p$ is the lag order of the dependent variable whilst $q_1, \ldots, q_7$ represent lag orders of the explanatory variables. The optimal lag orders $p$ and $q$, which tend to vary across regressors, are obtained by minimising model selection criteria. The NARDL considers non-linearity by generating a series of both positive and negative partial sums; the asymmetric error correction model is:

$$XP_t = \alpha + XP_{t-1} + \omega_1^+ Y_t^+ + \omega_2^- Y_t^- + \psi_1^+ R_t^+ + \psi_2^- R_t^- + \phi_1^+ EX_t^+ + \phi_2^- EX_t^- + \theta_1^+ TE_t^+ + \theta_2^- \, TE_t^- + \gamma_1^+ TE_t^+ + \gamma_2^- TE_t^- + \lambda_1^+ LQ_t^+ + \lambda_2^- LQ_t^- + \vartheta_1^+ SV_t^+ + \vartheta_2^- SV_t^- + \sum_{i=1}^{p} \varphi_i \, XP_{t-i} + \sum_{i=0}^{q_1} \omega_i \, Y_{t-i}^+ + \sum_{i=0}^{q_1} \omega_i \, Y_{t-i}^- + \sum_{i=0}^{q_2} \psi_i \, R_{t-i}^+ + \sum_{i=0}^{q_2} \psi_i \, R_{t-i}^- + \sum_{i=0}^{q_3} \phi_i \, EX_{t-i}^+ + \sum_{i=0}^{q_3} \phi_i \, EX_{t-i}^- + \sum_{i=0}^{q_4} \theta_i \, TE_{\kappa,t-i}^+ + \sum_{i=0}^{q_4} \theta_i \, TE_{\kappa,t-i}^- + \sum_{i=0}^{q_5} \gamma_i \, TE_{\nu,t-i}^+ + \sum_{i=0}^{q_5} \gamma_i \, TE_{\nu,t-i}^- + \sum_{i=0}^{q_6} \lambda_i \, LQ_{t-i}^+ + \sum_{i=0}^{q_6} \lambda_i \, LQ_{t-i}^- + \sum_{i=0}^{q_7} \vartheta_i \, SV_{t-i}^+ + \sum_{i=0}^{q_7} \vartheta_i \, SV_{t-i}^- + D_t + \varepsilon_t \quad (3)$$

The error correction model in equation (3) enabled the study to establish short-run and long-run asymmetries in line with this article's primary objective. The QARDL of Cho *et al*. (2015) analysed location asymmetries by converting equation 2 into:

$$Q_{XP_t} = \alpha(\tau) + \sum_{i=1}^{p} \varphi_i \, (\tau) XP_{t-i} + \sum_{i=0}^{q_1} \omega_i \, (\tau) Y_{t-i} + \sum_{i=0}^{q_2} \psi_i \, (\tau) R_{t-i} + \sum_{i=0}^{q_3} \phi_i \, (\tau) EX_{t-i} + \sum_{i=0}^{q_4} \theta_i \, (\tau) TE_{\kappa,t-i} \sum_{i=0}^{q_5} \gamma_i \, (\tau) TE_{\nu,t-i} + \sum_{i=0}^{q_6} \lambda_i \, (\tau) LQ_{t-1} + \sum_{i=0}^{q_7} \vartheta_i \, (\tau) SV_{t-i} + \varepsilon_t(\tau) \quad (4)$$

Where, $\varepsilon_t(\tau)$ is the error term that can be defined as $XP_t - Q_{XP_t}(\tau|F_{t-1})$ with $Q_{XP_t}(\tau|F_{t-1})$ is the $T^{th}$ quantile of $XP_t$ conditional on the information set $F_{t-1}$ defined above; p and q are lag orders in the model. Serial correlation of the error term $\varepsilon_t$, was avoided by generalising the QARDL ECM as follows:

$$Q_{\Delta \mathrm{XP}_t} = \alpha(\tau) + \rho(\tau)[XP_{t-1} - \beta_Y(\tau)Y_{t-1} - \beta_R(\tau)R_{t-1} - \beta_{EX}(\tau)EX_{t-1} - \beta_{TE_\kappa}(\tau)TE_{\kappa,t-1} - \beta_{TE_\nu}(\tau)TE_{\nu,t-1} - \beta_{LQ}(\tau)LQ_{t-1} - \beta_{SV}(\tau)SV_{t-1}] + \sum_{i=1}^{p-1}\varphi_i(\tau)\Delta XP_{t-1} + \sum_{i=0}^{q_1-1}\omega_i(\tau)\Delta Y_{t-i} + \sum_{i=0}^{q_2-1}\delta_{R_i}(\tau)\Delta R_{t-1} + \sum_{i=0}^{q_3-1}\delta_{EX_i}(\tau)\Delta EX_{t-1} + \sum_{i=0}^{q_4-1}\delta_{TE_{\kappa,i}}(\tau)\Delta TE_{\kappa,t-1} + \sum_{i=0}^{q_5-1}\delta_{TE_{\nu,i}}(\tau)\Delta TE_{\nu,t-1} + \sum_{i=0}^{q_6-1}\delta_{LQ_i}(\tau)\Delta LQ_{t-1} + \sum_{i=0}^{q_7-1}\delta_{SV_i}(\tau)\Delta SV_{t-1} + \varepsilon_t(\tau) \quad (5)$$

The ECM parameter ρ tested the quantile dependent long-run relationships; the long-run, short-run and export lag coefficients obtained from the QARDL were jointly tested by utilising Wald tests with a Chi-squared distribution; having a null hypothesis of zero quantile relationships.

## 4. RESULTS

Table 1 presents the descriptive statistics where nominal export growth to the world was largely driven by the growth of exports to Africa, Asia and America, which recorded growth rates of 805%, 504% and 318%, respectively. The highest total exports to regions was for Asia whilst China had the highest receipts amongst the individual countries. Deviations from mean exports created an opportunity to explore using the non-linear methods of analysis. Unit root tests were conducted on all the series using the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests at the one percent, five percent and ten percent significance levels. There was a mixture of integration orders for exports in both periods; all export series and relative prices had a unit root, but none exceeded a single unit root and so the ARDL models could be validly applied.

**Table 1. Exports to the Rest of the World (Millions of Rands)**

| **PANEL A: Exports to Regions and Rest of the World (Dec 2003 – Dec 2019)** | | | | | | |
|---|---|---|---|---|---|---|
| Destination | Nominal | Mean | SD | Minimum | Maximum | Total |
| Africa | 805% | 14727.77 | 9931.34 | 2441.85 | 33615.4 | 2 842 461 |
| America | 318% | 6585.85 | 2231.60 | 2239.38 | 12590.2 | 1 271 069 |
| Asia | 504% | 20112.04 | 9219.15 | 4580.40 | 39001.4 | 3 881 624 |
| Europe | 259% | 17028.50 | 6110.16 | 6805.82 | 34445.1 | 3 286 500 |
| World | 368% | 64762.51 | 28070.87 | 19333.17 | 123353.3 | 12499 165 |
| **PANEL B: Exports to Trading Partners and Rest of the World (Jan 2010 – Dec 2018)** | | | | | | |
| China | 156% | 8020.82 | 1935.48 | 3211.19 | 12686.6 | 866 248 |
| Germany | 202% | 4945.13 | 1923.61 | 2401.06 | 11366.0 | 534 074 |
| Japan | 48% | 4321.83 | 704.57 | 2694.67 | 6152.5 | 466 758 |
| UK | 60% | 3130.46 | 1097.34 | 1240.02 | 8625.4 | 338 089 |
| USA | 140% | 5857.18 | 1306.44 | 2671.36 | 10619.5 | 632 575 |

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The Zivot and Andrews (2002) tests showed export series to Africa with a breakpoint of October 2013, America and the world with December 2008 while Asia and Europe had November 2008. For individual countries, China's breakpoint was March 2014; Japan, January 2016; UK, October 2016; USA, January 2018; but Germany had no break-date. Breakpoints in 2008 coincided with the global financial crisis. These breakpoints suggested the presence of non-linear behaviour.

### 4.1. NARDL Analysis

Foreign income and relative prices asymmetric effects tend to be more detectable when total exports to the world were considered as opposed to those destined for individual geographic regions. Foreign income had a significant coefficient for short-run asymmetry in Africa, long-run asymmetry in the world and America and long-run negative effects in the world and Asia. Relative prices had significant long-run positive effects for the world and Africa. This suggested that exports to the world and the regions were non-linearly sensitive to changes of the real economic variables. For example, exports to Africa were more price-sensitive to positive effects. The availability of substitutes for South African exports explains these asymmetric relationships. Positive changes of relative prices on world export demand showed that favourable relative prices of South African goods had a greater effect than an increase of the same magnitude in the long-run.

## Table 2. NARDL on Total Exports to Regions (2003-2019)

| Coefficient | Long-run Effect [+] | Long-run Effect [-] | Long-run Asymmetry | Short-run Asymmetry | ECT | Adj $R^2$ |
|---|---|---|---|---|---|---|
| **WORLD** | | | | | | |
| Foreign Income | -0.059 | **-0.351*** | **2.783***** | 2.4570 | **-0.726*** | 0.3944 |
| Relative Prices | **-0.894**** | 0.319 | 0.5295 | 0.0594 | | |
| Exchange Rate Volatility | -0.042 | 0.064 | 0.9974 | 0.1092 | | |
| ZARUSD Volatility | -0.016 | -0.001 | 0.4795 | 0.9339 | | |
| ZARCNY Volatility | 0.077 | -0.061 | 1.841 | 0.0898 | | |
| Stock Market Volatility | **-0.087*** | **0.077**** | 0.7446 | 0.730 | | |
| Stock Market Illiquidity | **-2.604***** | **4.863*** | **17.4*** | 0.0019 | | |
| **AFRICA** | | | | | | |
| Foreign Income | 0.049 | -0.253 | 0.1078 | **4.596*** | **-0.3946*** | 0.2204 |
| Relative Prices | **-2.615*** | 1.597 | 0.2589 | 0.4616 | | |
| Exchange Rate Volatility | 0.179 | -0.129 | 0.8234 | 0.8549 | | |
| ZARUSD Volatility | -0.097 | 0.033 | 1.068 | 1.2090 | | |
| ZARCNY Volatility | 0.148 | -0.124 | 0.5762 | 0.1954 | | |
| Stock Market Volatility | **-0.140***** | **0.146***** | 0.0365 | 0.7505 | | |
| Stock Market Illiquidity | **-7.382***** | **9.377**** | 2.104 | 0.0033 | | |
| **AMERICA** | | | | | | |
| Foreign Income | 0.020 | -0.089 | **5.809**** | 0.0009 | **-0.56078*** | 0.3186 |
| Relative Prices | -0.655 | -0.087 | 0.2885 | 1.088 | | |
| Exchange Rate Volatility | -0.089 | 0.058 | 0.4923 | 0.4909 | | |
| ZARUSD Volatility | -0.013 | 0.063 | 0.8073 | 1.1850 | | |
| ZARCNY Volatility | 0.092 | -0.083 | 0.1395 | 0.0488 | | |
| Stock Market Volatility | **-0.100***** | **0.105***** | 0.05235 | 0.9185 | | |
| Stock Market Illiquidity | -2.882 | **5.876**** | **6.71**** | 0.0673 | | |
| **ASIA** | | | | | | |
| Foreign Income | 0.145 | **-0.333***** | 0.2039 | 1.2580 | **-0.58558*** | 0.3223 |
| Relative Prices | 0.085 | 0.984 | 0.6554 | 0.2641 | | |
| Exchange Rate Volatility | -0.219 | 0.176 | 1.4200 | 0.2552 | | |
| ZARUSD Volatility | -0.004 | 0.008 | 0.0083 | 0.2498 | | |
| ZARCNY Volatility | 0.041 | -0.005 | **3.247***** | 0.0181 | | |
| Stock Market Volatility | **-0.111**** | 0.081 | 2.388 | 2.4150 | | |
| Stock Market Illiquidity | **-4.166***** | **6.787*** | **8.316*** | 0.2000 | | |
| **EUROPE** | | | | | | |
| Foreign Income | 0.037 | -0.028 | 0.3701 | 1.7350 | **-0.5225*** | 0.4776 |
| Relative Prices | 0.402 | 0.347 | 0.7399 | 0.6794 | | |
| Exchange Rate Volatility | -0.094 | 0.187 | **8.029*** | 0.2889 | | |
| ZAREUR Volatility | -0.007 | -0.096 | **14.96*** | 0.0802 | | |
| ZARCNY Volatility | 0.079 | -0.049 | **2.927***** | 0.1269 | | |
| Stock Market Volatility | -0.045 | 0.014 | 2.075 | 1.5650 | | |
| Stock Market Illiquidity | -1.963 | 0.982 | **3.378***** | 0.1151 | | |

(*Where: *1%, **5% and ***10% significance levels*)

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The significant error correction terms for all the export demand functions indicated an adjustment to the long-run equilibrium when short-run deviations occurred. The demand function for export to the world had the highest readjustment of 72.6% readjustment whilst those for Africa, America, Asia and Europe were 39.5%, 56.1%, 58.6% and 52.3% respectively, thereby suggesting export relationships deviated considerably in the short-run.

Long-run asymmetries of exchange rate volatility of the Rand and Yuan were significant on Asian export demand whilst long run asymmetries for third-country effects and exchange rate volatility were significant for European export demand. This supports Jenkins and Edwards (2015) who found Chinese exports were crowding out South African exports to Europe by approximately 10%. Consistent significance of currency volatility in other export demand functions was elusive, evidence of the exchange disconnect puzzle (Bahmani-Oskooee *et al*., 2013). Hedging ability, and trade agreements such as the South Africa – European Union Trade, Development and Cooperation Agreement (SA-EU TDCA) may ameliorate the negative effects of increased exchange rate volatility, rendering Rand volatility less consequential on exports to trading partners. Stock market volatility long-run effects were significant to the world, Africa, America and Asia. For Africa and Asia, long-run negative effects carried a greater magnitude than positive ones suggesting that increased stock market volatility had a greater long-run effect on exports to these regions than a decline of stock market volatility. For exports to the world, positive and negative coefficients of stock market volatility were of similar magnitude. The effects for stock market illiquidity were comparable with those for stock market volatility because higher illiquidity tended to have a greater effect on exports.

The findings on the financial economic factors were two-fold. Firstly, it confirmed the finance-growth hypothesis of financial variables having a relationship with real economic variables originally theorised by Schumpeter (1934) and, secondly, it showed that this relationship was asymmetric. This represents a significant contribution to knowledge on South African export behaviour and its relationship with the financial economy in South Africa as this was a previously overlooked area. The analysis was extended to individual trading partners in Table 3. Stock market volatility had significant long-run positive effects for China, Japan and the UK and long-run negative effects for Japan. Stock market illiquidity had significant long-run positive effects for the UK and long-run asymmetry for China and the UK, suggesting that its nonlinear relationships were more subdued compared to the scenario in Table 2. Nonetheless, the two

financial economic variables continued to be significant in explaining export behaviour.

**Table 3. NARDL on Total Exports to Trading Partners**

| | Long-run effect [+] | Long-run effect [-] | Long-run asymmetry | Short-run asymmetry | ECT | Adj $R^2$ |
|---|---|---|---|---|---|---|
| **CHINA** | | | | | | |
| Foreign Income | 0.031 | **0.092*** ** | 1.509 | 2.008 | **-0.6413*** | 0.2128 |
| Relative Prices | **-5.055*** ** | **-5.659*** ** | **3.683*** ** | 0.0070 | | |
| Exchange Rate Volatility | -0.121 | 0.251 | **3.461*** ** | **4.746** ** | | |
| CNYUSD Volatility | -0.031 | -0.060 | 2.468 | 2.178 | | |
| ZARCNY Volatility | 0.009 | 0.003 | 0.0918 | 1.063 | | |
| Stock Market Volatility | **0.154** ** | -0.109 | 0.8588 | 1.239 | | |
| Stock Market Illiquidity | -7.065 | 0.287 | **4.258** ** | 0.346 | | |
| **GERMANY** | | | | | | |
| Foreign Income | 0.028 | 0.062 | **12*** | **3.702*** | **-0.6711*** | **0.1871** |
| Relative Prices | -2.506 | -3.493 | 1.626 | 0.3267 | | |
| Exchange Rate Volatility | -0.099 | 0.010 | 1.272 | 0.6766 | | |
| ZAREUR Volatility | 0.012 | 0.047 | 2.14 0 | 0.0511 | | |
| CNYEUR Volatility | 0.042 | -0.050 | .05006 | 0.0056 | | |
| Stock Market Volatility | 0.024 | 0.050 | **5.163** ** | 0.5231 | | |
| Stock Market Illiquidity | -5.681 | -0.331 | 1.881 | 0.5582 | | |
| **JAPAN** | | | | | | |
| Foreign Income | **-0.041*** ** | 0.036 | 0.7476 | 1.933 | **-0.8526*** | 0.5451 |
| Relative Prices | -1.391 | -1.491 | 0.5737 | 2.126 | | |
| Exchange Rate Volatility | -0.108 | 0.192 | **3.225*** ** | 2.523 | | |
| ZARJPY Volatility | 0.116 | -0.138 | 0.4471 | 0.065 | | |
| USDJPY Volatility | -0.010 | 0.040 | 0.5878 | 1.609 | | |
| Stock Market Volatility | **-0.107** ** | **0.080*** ** | 0.9063 | **3.641*** ** | | |
| Stock Market Illiquidity | -4.750 | 1.643 | 2.043 | .00536 | | |
| **UK** | | | | | | |
| Foreign Income | -0.018 | -0.008 | .3529 | 0.4791 | **-0.9317*** | 0.5028 |
| Relative Prices | **-5.476*** | 0.404 | **2.802*** ** | 1.808 | | |
| Exchange Rate Volatility | -0.306 | 0.331 | .2693 | 0.5782 | | |
| ZARGBP Volatility | **0.220** ** | **-0.160*** ** | **5.439** ** | 0.1149 | | |
| GBPCNY Volatility | 0.067 | **-0.133*** | **7.779 *** | 1.152 | | |
| Stock Market Volatility | **0.092*** ** | -0.003 | **7.758 *** | **4.45** ** | | |
| Stock Market Illiquidity | **-7.582*** ** | 4.152 | **2.638*** ** | .00003 | | |
| **USA** | | | | | | |
| Foreign Income | 0.099 | -0.060 | 0.5146 | 0.7484 | **-0.9509*** | 0.5181 |
| Relative Prices | -0.152 | 2.670 | 0.5018 | **6.275 ** ** | | |
| Exchange Rate Volatility | **-0.532** ** | **0.504*** ** | 0.4967 | 2.13 | | |
| ZARUSD Volatility | -0.058 | 0.027 | 0.9955 | 0.00841 | | |
| USDJPY Volatility | -0.005 | 0.023 | 0.1871 | **3.404*** ** | | |
| Stock Market Volatility | -0.026 | -0.004 | 0.8146 | **2.686*** ** | | |
| Stock Market Illiquidity | 3.446 | -0.010 | 1.892 | 0.6816 | | |

(*Where: *1%, **5% and ***10% significance levels*)

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Exchange rate volatility and third-country effects were mainly dominant for exports to the UK and to a lesser extent, the USA, China and Japan respectively. Volatility between the Rand and the Pound was significant in the long-run while third-country effects (volatility between Pound and Yuan) showed significant long-run negative effects and asymmetry impacting exports to the UK. This highlighted the effects of competing Chinese exports to Europe in the long-run suggested by Jenkins and Edwards (2015). Exchange rate volatility effects on exports to the USA had long-run positive and negative effects having similar magnitudes, while for exports to China, long-run and short-run asymmetries were present. The findings on foreign income and relative prices for individual trading partners were reconcilable with those for exports to the regions. The long-run negative effects to China suggested that lower growth in China was the greater concern for South African exports to that country. This was reasonable, as it was the largest individual destination.

Table 4 summarises the Wald tests for quantile dependent asymmetries where long-run asymmetries were significant for Africa, America, Asia, China and the UK. This meant that for these destinations, in the long-run, the effects of macroeconomic factors on exports depended on whether exports were high (high quantile) or lower (low quantiles). Location asymmetries were present for all short-run models for export demand functions to the world, specific regions and to trading partners as confirmed by the Wald tests. The full results for exports to the world between 2003 and 2019 illustrated that the coefficients changed in magnitude based on a quantile being analysed. The financial economic factors of stock market illiquidity and stock market volatility tended to weigh greater on exports in the lower and middle quantiles where exports were lower and consistent with the expectation that poorer exports would be associated with lower stock market liquidity. Similar observations were made on the real economic variables where the magnitude of their coefficients resided in the lower quantiles.

## 4.2. QARDL Analysis

Coefficients for exchange rate volatility were more influential for lower quantiles (except for Asia) as was observed for relative prices. This suggested that higher export output was less susceptible to risk factors as opposed to poorer export output. The lags of exports were only significant for America, Japan and the UK where the results suggested that exports in the previous period had an impact on current exports in an asymmetric manner for these destinations. The presence of

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non-linearities in the export demand functions supported the earlier motivations for non-linear modelling by Ajmi *et al*. (2015) and Aye *et al*. (2015).

**Table 4. QARDL – Exports to World Regions**

| **WORLD (2003-2019)** | | | | | | |
|---|---|---|---|---|---|---|
| | **Long-run (Beta Matrix)** | | | **Short-run (Gamma Matrix)** | | |
| **Quantile** | **0.25** | **0.5** | **0.75** | **0.25** | **0.5** | **0.75** |
| Foreign Income | 0.631 | 0.441 | -0.055 | 0.082 | 0.062 | -0.005 |
| Relative Prices | -1.566 | -0.940 | 0.528 | -0.204 | -0.133 | 0.046 |
| Exch Volatility | 0.204 | 0.000 | 0.212 | 0.027 | 0.000 | 0.018 |
| ZARUSD Vol | 0.081 | 0.093 | -0.194 | 0.011 | 0.013 | -0.017 |
| ZARCNY | 0.430 | 0.292 | 0.144 | 0.056 | 0.041 | 0.013 |
| Stock Mkt Vol | -0.041 | -0.245 | -0.225 | -0.005 | -0.035 | -0.020 |
| Illiquidity | -19.275 | -12.554 | -16.545 | -2.508 | -1.769 | -1.436 |
| Wald T-Statistic | 1.3768 | | | **7.5741**** | | |

| **Summary of QARDL Wald Tests for Asymmetries** | | | |
|---|---|---|---|
| | **Long-run** | **Short-run** | **Lags of Exports** |
| **Africa** | **8.8543**** | **4.6003***** | 1.9069 |
| **America** | **5.3509***** | **38.0914*** | **5.1248***** |
| **Asia** | **6.3879**** | **4.8092***** | 1.1823 |
| **Europe** | 2.1005 | **12.276*** | 0.3033 |
| **China** | **5.0845***** | **18.3223*** | 0.0311 |
| **Germany** | 2.464 | **13.8541*** | 0.7726 |
| **Japan** | 0.4436 | **7.1233**** | **9.0651***** |
| **UK** | **6.6973**** | **157.042*** | **21.6210*** |
| **USA** | 0.0962 | **26.8126*** | 1.16774 |
| **World (2010 -2018)** | 1.6343 | **8.5395**** | 0.5018 |

(*Where: *1%, **5% and ***10% significance levels*)

Reconcilable findings from the NARDL and QARDL on non-linearity suggested that policy interventions to boost exports should be cognisant of the sophisticated interrelationships between real and financial economic variables, where negative shocks from the financial economy tend to exert a greater magnitude compared to positive shocks.

CUSUM and CUSUM of squares stability tests were conducted at the 5% significance level to ascertain if the observed relationships held steady for the study period and results are presented in Figure 1. The CUSUM estimations show the relationships to be stable because deviations from the mean relationship were within the confidence interval and the more stringent CUSUM of squares complemented the CUSUM tests however, exports to Asia and the World marginally deviated between 2010 and 2013.

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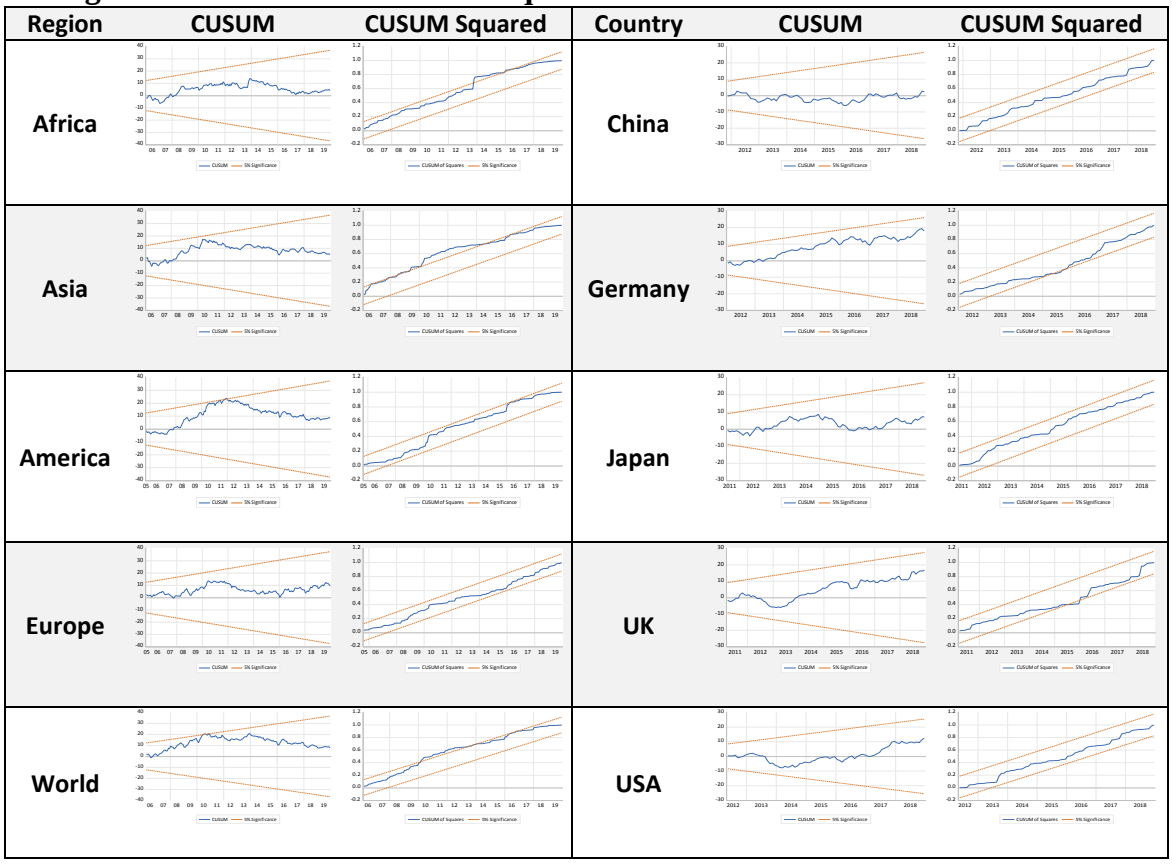
**Figure 1. CUSUM and CUSUM Squared Tests**




## 5. CONCLUSION

This article considered financial and real economic variables as well as third-country effects to analyse South African export behaviour. The NARDL and QARDL models established long-run and asymmetric relationships – highlighting the value of considering nonlinearity. The NARDL suggested the presence of asymmetric effects because long-run positive and negative effects of financial market factors had dissimilar magnitudes on exports to the world. Negative illiquidity effects were greater than positive ones, meaning that worsening market liquidity conditions tended to have a greater effect on exports than improving liquidly conditions. The QARDL showed a clear quantile dependent asymmetric relationship which was dominant in the short-run, suggesting that the relationships

implied between exports and macroeconomic variables were dependent upon the export levels.

Policy interventions to increase exports should include reducing liquidity costs and stabilisation of capital markets as export deterioration drew a greater illiquidity response and illiquidity disincentivised investment in the real economy. The findings presented in this article indicate that financial economic variables must be included by practitioners when formulating export demand functions, because they capture investor perspectives on real economic prospects, consistent with the endogenous growth theory. This study makes a novel contribution by expounding the non-linear and quantile dependent effects of export behaviour and highlights the necessity for trade policy to encapsulate aspects of the financial economy in addition to that of the real economy.

## REFERENCES

Ajmi, A.N., Aye, G.C., Balcilar, M. & Gupta, R. (2015). Causality between exports and economic growth in South Africa: Evidence from linear and nonlinear tests. *The Journal of Developing Areas,* 49(2), 163-181.

Amihud, Y. (2002). Illiquidity and stock returns: cross-section and time-series effects. *Journal of Financial Markets,* 5(1), 31-56.

Aye, G.C., Gupta, R., Moyo, P.S. & Pillay, N. (2015). The impact of exchange rate uncertainty on exports in South Africa. *Journal of International Commerce, Economics and Policy,* 6(1), 1-22.

Bahmani-Oskooee, M., Harvey, H., & Hegerty, S.W. (2013). The effects of exchange-rate volatility on commodity trade between the US and Brazil. *North American Journal of Economics and Finance,* 25(1), 70-93.

Benkraiem, R., Hoang, T., Lahiani, A. & Miloudi, A., (2018). Crude oil and equity markets in major European countries: New evidence. *Economics Bulletin,* 38(4), 2094-2110.

Cho, J.S., Kim, T.H. & Shin, Y. (2015). Quantile cointegration in the autoregressive distributed-lag modeling framework. *Journal of Econometrics,* 188(1), 281-300.

Choudhry, T. & Hassan, S.S. (2015). Exchange rate volatility and UK imports from developing countries: The effect of the global financial crisis. *Journal of International Financial Markets, Institutions & Money,* 39(1), 89-101.

Giannellis, N. & Papadopoulos, A.P. (2016). Intra-national and international spillovers between the real economy and the stock market: The case of China. *The Journal of Economic Asymmetries*, 14(1), 78-92.

International Monetary Fund (IMF). (2018). *The end of the Bretton Woods System*. https://www.imf.org/external/about/histend.htm

Kwasi-Obeng, C. (2018). Is the effect of exchange rate volatility on export diversification symmetric or asymmetric? Evidence from Ghana. *Cogent Economics & Finance*, 6(1), 1-11.

Levine, R. and Zervos, S. (1996). "Stock market development and long-run growth." *The World Bank Economic Review*. 10(2), 323-339.

Moslares, C. & Ekanayake, E. M. (2015). The impact of exchange rate volatility on commodity trade between the United States and Spain. *International Journal of Business and Finance*, 9(4), 37-49.

Nyahokwe, O. & Ncwadi, R. (2013). The impact of exchange rate volatility on South African exports. *Mediterranean Journal of Social Sciences*, 4(3), 507-513.

Pesaran, M.H., Shin, Y. & Smith, R.J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3), 289-326.

Pesaran, M.H., Shin, Y. & Smith, R.P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, 94(446), 621-634.

Sahoo, M., (2018). "Exchange Rate and Service Exports from India: A Nonlinear ARDL Analysis." *Economics Bulletin*, 38(2), pp.1090-1101.

Schumpeter, J.A. (1934). The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest and the Business Cycle. translated from the German by Redvers Opie, New Brunswick (USA) and London: *Transaction Publishers. Journal of Comparative Research in Anthropology and Sociology*, 3(2), 1-3.

Sekantsi, L. (2011). The impact of exchange rate volatility on South African exports to the United States (U.S.): A bounds test approach. *Review of Economic and Business Studies*, 4(2), 119-139.

Takaendesa, P., Tsheole, T. & Aziakpono, M. (2006). Real exchange rate volatility and its effect on trade flows: New evidence from South Africa. *Studies in Economics and Econometrics*, *30*(3), pp.79-97.

Todani, K.T. & Munyama, T.V. (2005). Exchange rate volatility and exports in South Africa. *Working Paper, South African Reserve Bank.*

Wesseh, P.K & Niu, L. (2012). The impact of exchange rate volatility on trade flows: New evidence from South Africa. *International Review of Business Research Papers*, 8(1), 140-165.

Zivot, E. & Andrews, D.W.K., (2002). Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. *Journal of Business & Economic statistics*, 20(1), pp. 25-44.