UNIVERSITY OF KWAZULU-NATAL

MODELLING EXPORT GROWTH IN SOUTH AFRICA WITH A FOCUS ON THIRD-COUNTRY EFFECTS AND STOCK MARKET LIQUIDITY

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ABSTRACT

After considering the potential benefits of exports in ameliorating lacklustre economic growth, this thesis analyses South Africa's exports to the world and to its trading partners. It notes that gaps in erstwhile studies on export behaviour were attributable to linear modelling, overlooking the role of the financial economy, and an overreliance on exchange rate volatility as an explanatory variable, which in part, resulted in the exchange disconnect puzzle. The gaps are addressed by employing non-linear models, consideration of financial economic variables, and third-country effects which collectively addressed the summary objective of establishing the existence of short-run and long-run linear and asymmetric relationships of South Africa's exports with real and financial economic variables.

A unique exports dataset obtained from the South African Revenue Services (SARS), is used to undertake multivariate time-series and cross-sectional analysis beginning with the linear autoregressive distributed lag model (ARDL) and the pooled mean group (PMG) before progressing to consider non-linearity with the non-linear ARDL (NARDL), the quantile ARDL (QARDL), the Markov-switching model, the threshold autoregressive (TAR) model and the panel threshold model. The analysis is conducted in cognisance with the endogenous growth theory and the finance-led growth hypothesis which propose an interdependence between the real and financial economies.

This thesis finds that stock market illiquidity and volatility possess both a linear and asymmetric negative relationship with exports in the short-run and long-run. Further, exports were consistently weaker at higher thresholds of the financial economic variables. Exchange rate relationships and third-country effects are not consistently significant; confirming the exchange disconnect puzzle. This thesis concludes that non-linear models and the financial economy must be considered when analysing South African export demand because they provide a nuanced analysis of export behaviour. The findings imply that future research in the subject area must consider the financial economy. In addition, policy makers should incentivise ease of capital flows to export growth projects because investors react to changing risk and liquidity

costs induced by diminishing exports. This thesis recommends the accommodation of financial market stability and liquidity within the scope of South Africa's trade policy to attain sustained exports contribution towards economic growth.

Keywords: *exports, liquidity, non-linearity, trade policy, volatility*

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

AfCFTA – African Continental Free Trade Area
ADF – Augmented Dickey-Fuller
AGOA – African Growth and Opportunity Act
AIC – Akaike Information Criterion
ARCH – Autoregressive Conditional Heteroscedasticity
ARDL – Autoregressive Distributed Lag Model
ARDL – Non-linear ARDL
ARMA – Autoregressive Moving Average
ASEAN – Association of South East Asian Nations
BELN – Botswana, Eswatini, Lesotho and Namibia
CUSUM – Cumulative Sum
DF GLS – Dickey-Fuller Generalised Least Squares
DTI – Department of Trade and Industry
ECM – Error Correction Model
ECT – Error Correction Term
EGARCH – Exponential generalised autoregressive conditional heteroscedasticity
EU – European Union
FDI – Foreign Direct Investment
GARCH – Generalised Autoregressive Conditional Heteroscedasticity
GARCH-M – GARCH-in-mean
GATT – General Agreement on Tariffs and Trade
GDP – Gross Domestic Product
IMF – International Monetary Fund
IPS – Im-Pesaran-Shin
JSE – Johannesburg Stock Exchange
JSE ALSI – Johannesburg Stock Exchange All Share Index
JSE ALTX – Johannesburg Stock Exchange Alternative Exchange
LLC – Levin Lin and Chu
MENA – Middle East and North African
MS-ARDL – Markov-Switching autoregressive distributed lag
MS-VECM – Markov-Switching vector error correction model

MTAR – Multivariate Threshold Autoregressive

NDP – National Development Plan

OECD – Organisation for Economic Co-operation and Development

OLS – Ordinary Least Squares

PMG – Pooled Mean Group

PP – Phillip-Perron

QARDL – Quantile ARDL

SACU – Southern African Customs Union

SADC FTA – Southern African Free Trade Area

SA-EU – South Africa – European Union

SA-EU TDCA – South Africa European Union Trade Development and Cooperation Agreement

SARB – South African Reserve Bank

SARS – South African Revenue Services

SAVI – South African Volatility Index

SBIC – Schwartz-Bayesian Information Criterion

SETAR – Self-exciting Threshold Autoregression

SIC – Schwartz Information Criteria

SOEs – State-Owned Enterprises

SSE – Sum of Squared Errors

STAR – Smooth transition autoregressive

TAR – Threshold Autoregressive

TVECM – Threshold Vector Error Correction Model

UK – United Kingdom

USA – United States of America

VAR – Vector Autoregression

VECM – Vector Error Correction Model

WTO – World Trade Organisation

CHAPTER 1: SCOPE AND PURPOSE OF THE STUDY

1.1 Background to the Study

"South Africa's trade policy should become more focussed, identifying opportunities for exports in external markets and using trade agreements and facilitation to achieve these. It must remain pragmatic and evidence-based in pursuing core socio-economic goals, particularly decent work and inclusive and balanced growth, without acceding unnecessarily to narrow interests or failing to respond to real economic needs." (Economic Development, 2011: 54).

South Africa's trade policy agenda is set in line with the goal of attaining sustainable long-term economic growth and the Department of Trade and Industry (DTI) quotes the desired economic growth rate to be 5.4% per annum according to the National Development Plan (NDP) (DTI, 2019). However, Fowkes, Loewald and Marinkov (2016) highlighted that the goal of maintaining a desired sustainable economic growth rate has remained an elusive policy objective for South Africa. The Quarterly Bulletin published by the South African Reserve Bank (SARB) in December 2019 suggested that South Africa's real gross domestic product (GDP) growth projections for 2019 were lowered by both the International Monetary Fund (IMF) and the National Treasury from the 0.8% recorded in 2018, to between 0.5% and 0.7%. Fedderke and Mengisteab (2017) had earlier predicted that the lacklustre growth in the South African economy was likely to remain persistent for the foreseeable future unless urgent remedial actions could be found and immediately implemented.

According to the Organisation for Economic Co-operation and Development (OECD) (2018), the subdued economic growth rate experienced by South Africa has been further aggravated by factors such as rising domestic government debt, policy uncertainty on land reform, and unreliable electricity supply among others. The assumption of non-performing state-owned enterprises' (SOEs) debt has been one of the leading causes of rising government debt and budget deficit, with Eskom and South African Airways being cases in point. Although the domestic economic

prospects are gloomy with limited fiscal space to stimulate economic growth, the OECD (2018) noted that South Africa had room to expand their exports especially because favourable commodity prices were foreseeable. The SARB (2019) had similar positions, highlighting that global economic growth going forward would be spurred if trade cooperation and a reduction of trade barriers were to materialise.

Although South Africa's economy may be hamstrung by the problem of subdued long-term economic growth, its trade policy has the potential to be a key avenue to unlocking higher levels of growth (Edwards and Lawrence, 2012 and Ajmi, Aye, Balcilar and Gupta, 2015). The trade policy is essential for growth as Fowkes *et al*. (2016) highlighted that there was an interrelationship between South Africa's declining economic growth and its performance in the export market. This observation is complemented by the SARB (2019) whose trade statistics highlighted that in the third quarter of 2019 net exports had made the largest contribution to real GDP growth; adding 3.2% (boosted by manufactures and agricultural exports).

Further, exports could have contributed a higher percentage towards the GDP growth rate for South Africa had there been no trade tensions between the United States of America (USA) and China which weighed negatively on international trade. The International Monetary Fund (IMF) (2019) concurred with the position that exports would be a key driver of economic growth for South Africa, while Haddoud, Nowinski, Jones and Newbery (2019) outlined that export growth benefits include foreign currency earnings, labour assimilation, international portfolio inflows, product demand during domestic economic downturns and positive trade balance which are urgently needed. Considering South Africa's subdued economic growth and the potentially crucial role the trade policy may have in ameliorating growth, there is need to review the policy and interrogate its relationship with economic growth.

There is evidence to suggest that South Africa's trade policy has remained consistent because Van der Merwe (2004) summarised it as outward-looking, having an objective of nurturing long-term economic growth with price stability and Calì and Hollweg (2017) in a later study, made a similar characterisation of the trade policy. The point that the cultivation of exports can nurture the domestic real economic growth can be

attributed to two schools of thought: the *export-led* growth and the *growth-led* export hypotheses (Ajmi *et al*., 2015). Proponents of the export-led growth hypothesis postulate that increasing exports will boost economic growth. However, opponents of this hypothesis believe that exports cannot lead domestic economic growth; hence, the existence of the growth-led exports hypothesis which argues that growth is the leading side of this relationship. The significance of these two hypotheses is evidenced by South Africa's trade policy which remains centred on maintaining international trade relationships with an aim of targeting export growth while maintaining price stability (Van der Merwe, 2004 and Vijayashri, 2013). However, empirical evidence on the export-led growth and growth-led exports hypotheses, which became popular after the collapse of the Bretton Woods system of fixed exchange rates in 1973, has been inconclusive with findings split between the two hypotheses (Chang, Simo-Kengne and Gupta, 2013).

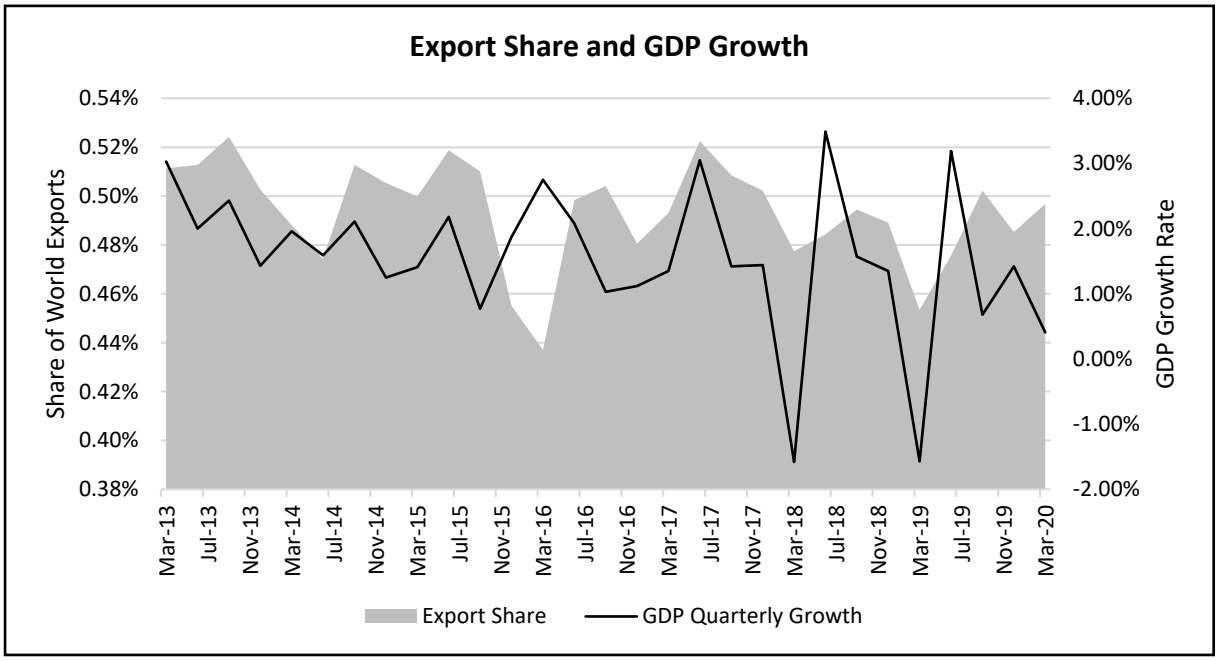
Regardless of whether one subscribes to the view of economic growth preceding export growth or *vice-versa*, there should be a consensus that both South Africa's economic growth and export growth are a cause for concern and require urgent intervention. According to the economic data obtained from Standard and Poor's Capital IQ, nominal quarterly economic growth is on a downward trend and was negative on two occasions; reaching a negative 1.58% in March 2018 and negative 1.57% in March 2019 as illustrated in Figure 1.1. During the same time, data available from the World Trade Organisation (WTO) shows South Africa's share of world exports on the decline which suggested a waning contribution of South Africa on the global trade stage. Figure 1.1 shows the declining export volumes of South Africa on a global scale by illustrating that during the period beginning March 2013 until March 2020, South Africa's global export share averaged 0.49%; it had a maximum share of 0.52% and a minimum of 0.44%.

These observations of a declining export share on the global stage and weak economic growth are a cause for concern because they are occurring against the backdrop of a trade policy that seeks to increase exports and views them as a potentially vital avenue for growth. Edwards and Lawrence (2012), who were critical of South Africa's existing economic strategy, suggested that the trade policy was

supposed to be more focused on improving exporters' access to emerging markets to achieve a higher sustainable economic growth rate after describing the current economic strategy as inflexible and domestic centric.

Figure 1.1, which complements the position by Fowkes *et al*. (2016) of an interrelationship between South Africa's declining economic growth and its performance in the export market, validates the criticism by Edwards and Lawrence (2012) as it raises questions about whether the existing trade policy needs refinement to achieve its main objective of exports contributing more towards economic growth for South Africa, or does it need to be better implemented in its current form.

Figure 1.1: South Africa's Share of Global Trade and GDP Growth



The traditional view is that exporters are concerned about exchange rate volatility because volatility increases profit risk for the exporters, hence, trade policies ought to be focused on reducing exchange rate volatility (Krugman, 2007, Bahmani-Oskooee, Harvey and Hegerty, 2013 and Choudhry and Hassan, 2015). However, exchange rate volatility has tended to be an unreliable risk factor empirically, suggesting that any interventions meant to reduce currency volatility are not only expensive for the government but will most likely have an ambiguous effect on South African export

growth. Fowkes *et al*. (2016) proposed that South Africa's current trade policy was supposed to be focused on trade competitiveness by ensuring that the growth of the domestic price level was similar to those of key trading partners in order to maintain stable relative prices. Such a policy may be relevant but given the marked economic decline, there most likely is a need to expand the scope of the current trade policy to improve the efficacy of interventions since studies such as Giannellis and Papadopoulos (2016) and Pan and Mishra (2018) have proven that the economy is interlinked by various channels.

Giannellis and Papadopoulos (2016) highlighted that the balance sheet channel, for example, linked the real and financial economies thereby implying that analysis of exports should not only be limited to a consideration of real economic factors. This view builds up from earlier points suggested by Grossman and Helpman (1991), Balcilar and Ozdemir (2013) and Ajmi *et al*. (2015) who stated that economic growth can be enhanced by exports indirectly through efficiency gains by access to capital goods, economies of scale, ease of foreign exchange, transfer of know-how through opening of the economy, improved productivity because of exposure to international competition among others. The financial economic dimension means that an analysis of South Africa's exports must encapsulate both the real and financial economies; something which is necessary to better inform the trade policy in this current poor economic growth climate. The real economy and the financial economy are linked because the former is concerned with the total production of goods and services whilst the latter focuses on the distribution of the produced resources in markets and the associated monetary activities (Reinert, 2012 and Giannellis and Papadopoulos, 2016). However, to the best of the author's knowledge, existing studies on export demand, at least in South Africa, have not interrogated the financial economic channels' influence on South African export demand behaviour. Addressing this gap not only improves the theoretical and practical understanding of export behaviour but also better informs trade policy.

As the global economy becomes more integrated with higher risks of intra- and international economic and financial spill-overs, studying the linkage(s) between the real and financial economies is a relevant gap that this doctoral thesis explores.

Identification of the gap in the literature finds its origins from earlier theoretical assertions of the *finance-led growth* hypothesis popularised by McKinnon (1973) and supported by subsequent studies conducted by King and Levine (1993), Levine (1997), Bekaert, Harvey and Lundblad (2005) and Bertocco (2008). The finance-led growth hypothesis, which postulates of an interlinkage between financial development and real economic growth, implies that South African export growth is influenced by developments in the financial economy.

In line with this finance-led growth hypothesis, Levine and Zervos (1996) later proposed the *endogenous growth theory* which assumes that the relationship between economic growth and financial development is endogenous. This was because the depth of the financial markets facilitated efficient resource allocation required for economic growth; where, depth of the stock market was one that had features of higher quantity, quality or enhanced efficiency of services offered (Pradhan, Arvin and Hall, 2019). If financial market development is endogenous, changes in the stock market may lead or be led by economic growth and Pan and Mishra (2018) alluded that the nature of the interplay between the real and financial economies makes the direction of causality between the two economies theoretically debatable.

The global financial crisis of 2008 was an episode in recent history which further persuaded the merit of considering the financial economy because during that time, credit constraints in the financial markets caused a depression of real economic output and international trade (Kim, 2013, Giannellis and Papadopoulos, 2016 and Fufa and Kim, 2018). Giannellis and Papadopoulos (2016) found that during financial crises the dependence of the domestic industrial sector on the stock market increased and that intra-national spill-overs were transferred through the balance sheet channel whilst international spill-overs came through an indirect channel. Holmes and Maghrebi (2016) pointed out that investors' expectations of future real economic output could be observed on the stock market's behaviour; making the stock market a dependable predictor of business cycles and real economic activity. This view was shared by Kim (2013) who examined the relationship between stock market liquidity and the real economy in South Korea between 1995 and 2011 and found that stock market liquidity was a predictor of positive economic growth as proxied by GDP. In addition, Kim's

study established that the illiquidity of small, young, non-dividend paying, distressed, and hard to arbitrage firms were more informative in predicting economic downturns.

The findings by Kim (2013) could be reconciled with those obtained earlier by Kayacetin and Kaul (2009) who established that the aggregate stock market's order flows contributed to forecasting changes in real industrial production in the USA. Further, Næs, Skjeltorp and Ødegaard (2011) pointed out that market-level liquidity was associated with the real economy because investors changed their portfolios depending on the business cycle; a view which was later confirmed by Holmes and Maghrebi (2016). Investors may change their positions during business cycles to counter downside risk because returns are affected by the underlying regime-switching behaviour of economic and financial time-series.

Regime-switching, which is especially attributable to negative shocks, is whereby a series may change its mean, volatility or relationship with its previous values (Brooks, 2008). This phenomenon which tends to happen during financial crises must be considered if export behaviour is to be better understood because long-run and short-run relationships may be different; caused by varying stages of the business cycle. According to Pan and Mishra (2018), in periods of economic depression or financial crises there tends to be spill-overs between the real and financial economies and since little is known about this relationship in the South African context, this research gap is explored by this thesis.

Based on the findings by Kayacetin and Kaul (2009), Næs *et al*. (2011) and Kim (2013), it is conceivable that the stocks of South African firms engaged in international trade respond to changes in real export output. The findings are consistent with the view that stock ownership brings with it both cash flow and control rights and the ability to trade stocks occupies a pivotal role in the governance, valuation, and performance of firms (Fang, Noe, and Tice, 2009). According to observations by Bahmani-Oskooee *et al*., (2013) and Choudhry and Hassan (2015), uncertainty about export quantities poses profit and earnings risks for investors, which will be reflected on the stock market. This view was consistent with the earlier theoretical assertions by Levine and Zervos (1996) who held the position that liquidity lowered the downside risk of long-

term investments because investors may need to quickly and cheaply withdraw their investment at any time if the risk-reward prospects became unfavourable. Changes in the firm's earnings prospects can be reflected in the corresponding stock's liquidity and volatility and a recent study by McKane and Britten (2018) on the Johannesburg Stock Exchange (JSE) suggested that stock market liquidity was a crucial factor for investment decision making.

Foreign income and relative prices tend to be the most popular economic factors used in modelling export relationships regardless of whether the given study subscribed to either the export-led growth or growth-led exports hypothesis. Even though these two factors have tended to be reliable in explaining the variability of exports, generic studies analysing export relationships have centred on exchange rate volatility as being theoretically the main factor affecting exports. Although the common view was that exchange rate volatility would depress exports, De Grauwe (1994) posited that exports could be viewed as a real option which would be exercised if profitable. Given that an option's value increases with higher volatility, one could validly agitate that more can be exported when exchange rates become more volatile. This view was later supported by studies such as McKenzie (1999), Bahmani-Oskooee and Hegerty (2007) and Bahmani-Oskooee, Nosheen and Iqbal (2017) who cautioned that the marginal utility from exporting may increase with exchange rate volatility, leading to higher exports. These two opposing theoretical standpoints make it apparent that formulating a policy aiming at reducing exchange rate volatility may be futile since the theory is ambiguous about exchange rate volatility effects on exports.

In light of the theoretical debate on the effects of exchange rate volatility on exports, studies such as the ones conducted by Obstfeld and Rogoff (2005), Dubas, Lee and Mark (2010) and Berg and Mark (2015) have shown that exports and exchange rate relationships sometimes tend to be weak or undetectable; commonly referred to as the *exchange disconnect puzzle*. Evidence of the exchange disconnect puzzle has been detected by South African studies, for example, Bah and Amusa (2003), Takaendesa, Tsheole and Aziakpono (2006), Sekantsi (2011), Khosa, Botha and Pretorius (2015) and Aye, Gupta, Moyo and Pillay (2015) found that exchange rate volatility negatively affected South Africa's exports; while Todani and Munyama

(2005), Schaling (2007), Wesseh and Niu (2012) and Nyahokwe and Ncwadi (2013) found either a weak relationship or in some cases, no relationship at all.

The exchange disconnect puzzle suggests that other economic factors may have a more statistically significant influence on exports. In order to counter the exchange disconnect puzzle, recent studies analysing international trade such as Choudhry and Hassan (2015), Bahmani-Oskooee, Hegerty and Xi (2016a) and Bahmani-Oskooee *et al*. (2017) employed third-country effects; including exchange rate volatilities of trade competitors and/or partners when analysing bilateral international trade. Cushman (1986) first proposed third-country effects to capture phenomena such as international competition in the export market, monetary policy heterogeneity and regional linkages. The importance of considering third-country effects comes from the fact that trade patterns may change in a bilateral situation if there are better price prospects elsewhere (Obstfeld and Rogoff, 2005). For example, if Country B conducts monetary policy in the same manner as Country C, but Country A sticks with its domestically centred monetary policy, it would cause interest rates in Countries A and B to respond differently to shocks from Country C, which will result in exchange rate fluctuations between Countries A and B.

It is notable that existing South African studies do not have a consensus on the effect of exchange rate volatility on exports and this scenario has been attributed to various factors such as sampling, model risk, volatility measures and omitted factors such as financial economic innovations (Kim, 2013; Ajmi *et al*., 2015; Giannellis and Papadopoulos, 2016; and Bahmani-Oskooee *et al*., 2017). Kantor and Barr (2005) and Bahmani-Oskooee *et al*. (2017) suggested that the interplay of several factors made empirical determination of export behaviour difficult.

Considering that South Africa faces dim economic growth prospects, analysing and understanding the behaviour of one of its avenues for growth is of urgent importance to both policymakers and investors. In one hand, policy makers will be more informed to formulate a more comprehensive and robust economic strategy to spur export growth whilst incentivising participation in the financial economy. On the other hand, investors will better understand the net effects on their portfolios in both the long-run

and the short-run of holding listed South African stocks (especially those engaged in international trade) when there are shocks to export demand. In addition, this study contributes towards a theoretical foundational framework from which future South African export demand can be modelled. The openness of the South African economy makes it susceptible to both international and intra-national economic and financial spill-overs which further necessitates analysis of export demand and its behaviour. In addition to exploring the gaps identified in this section, it is equally crucial to consider how the export behaviour should be modelled and analysed.

1.2 Analysing South African Exports

The previous section highlighted that South Africa faced depressed economic growth, but exports were one of the avenues through which growth could be spurred. However, existing domestic studies analysing export behaviour had gaps with respect to considering the real and financial economies' interaction, their possible regime-switching behaviour, as well as third-country effects. Exploration of these gaps offers an opportunity for policy makers and investors to better understand export behaviour since world economies have become more integrated where contagion and market spill-overs are a common occurrence. Apart from the gaps identified above, existing studies differed in their analysis of export relationships with respect to data sampling, omitted explanatory variables and their approach to econometric modelling.

Earlier South African studies analysing exports mostly sampled aggregated annual and quarterly export data. Aggregated data was whereby studies coalesced all export categories into one series and then analyse them as one economic variable. Although this is helpful in providing an overview of the total exports, it overlooks heterogeneity of exports and implies that all South African export categories were uniformly affected by identified risk factors; something which may not always be the case (Wesseh and Niu, 2012). According to the export data obtained from South African Revenue Services (SARS), South Africa's exports are dominated by basic resources/mining output, so combining all the exports may skew the results towards the significance of factors that mostly influence resources output. What may be more appropriate would be to analyse export categories by themselves to identify factors pervasive in those

sectors.[1] In addition, higher frequency data such as monthly data would assist in increasing the degrees of freedom *ceteris paribus*.

There is competition in the export market which influences trade patterns because price prospects change and as such, variables such as third-country effects ought to be considered in export behaviour analysis in South Africa. Evidence of third-country effects were shown by Edwards and Jenkins (2015) who established that Chinese manufactured exports were crowding out South Africa's exports to Europe. They established that South African manufactured exports were depressed by up to 10% from their potential in 2010 due to Chinese exports; suggesting the presence and significance of the third-country effects phenomenon on South Africa's exports. The inclusion of third-country effects on South Africa's exports is an important addition to this study, particularly on disaggregated export data because, for example, the type of competition in the exports market for the mining resources sector is different from the agricultural sector. This makes third-country effects and the disaggregation of export data able to cater for heterogeneity in export relationships, and importantly, speaks to the unique contribution made by this doctoral thesis.

Matthee, Rankin, Webb and Bezuidenhout (2018) found that in South Africa, highly competitive and productive exporting firms were better positioned to attract institutional investors which would likely improve the corresponding stocks' liquidity. This suggested that poor performance in the real economy would be associated with correspondingly lower liquidity in the financial market. The findings by Mathee *et al*., were reconcilable with the earlier observations made by Rankin (2013) who studied export dynamics among South African exporting firms and found that South African firms producing for exports to developed markets tended to be more productive compared to non-exporting firms.

It is conceivable that a dampened or uncertain export outlook can be associated with higher stock volatility and an increased liquidity premium. When modelling export demand functions, financial economic factors such as stock market liquidity and stock

[1] Figure 2.3 unravels the export composition by product category and Table 2.1 displays product export categories to individual trading partners in detail.

market volatility must be considered because they capture the costs on the investor's holdings, and they reflect changes of export prospects. Considering the current export and economic growth trajectory for South Africa, it is reasonable to expect that the two financial economic variables of stock market volatility and liquidity are critical in assessing the investor side of the economy as the economic prospects remain grim. Formulating methods to capture these two dynamics in an export demand function is a gap that this thesis pursues to fill.

While the exchange rate determines whether exported goods would be relatively more expensive or not, the uncertainty of the level of the exchange rate (volatility of the exchange rate itself) is a factor. A study by Todani and Munyama (2005) found that different ways of measuring volatility affected the findings on exports. These findings suggested the likelihood of model risk which could have arisen because of uncertainty on model choice itself, model misspecification, or that input parameters of the model may be unobservable (Barrieu and Scandolo, 2015). It is worth noting that economic and financial variables such as exchange rates, stock market liquidity and exports are not constant over time; they are affected by business cycles and may respond asymmetrically in these cycles (Aye *et al.*, 2015 and Holmes and Maghrebi, 2016).

Cognisant of implications of model risk, Ajmi *et al*. (2015) argued for the use of models that accounted for asymmetric adjustments in South African studies on macroeconomic variables. This was motivated by the realisation that positive and negative shocks tended not to draw a response of a similar magnitude. Financial and economic time-series tend to have regime-switching characteristics where they change their behaviour and, in such cases, it may not be appropriate to estimate a linear model with a single mean value for the entire sample. Regime-switching behaviour tends to be highly prevalent in resource-rich economies such as South Africa where commodity prices are vulnerable to business cycle fluctuations (Bergholt, Larsen and Seneca, 2019). Non-linear models may, therefore, be able to capture the nuances around export relationships in different periods for instance, Kim (2013) highlighted that real and financial economic variables tended to possess a stronger relationship during economic crises, but this relationship was weaker in non-crisis periods.

The popular linear models which are unable to account for asymmetric relationships are limited in capturing the nuances of the relationships and as such, newer non-linear models are a valuable addition as they can account for the asymmetries. This thesis makes an original contribution by using these newer models to account for non-linearities in South African export demand functions. Economic cycles may be coupled with volatility and in addition, information from previous cycles or periods may continue to be relevant in current and future periods and this may result in different econometric relationships in the short-run and the long-run. All these asymmetric factors must be accounted for if South Africa's exports are to be better modelled with a view of informing the trade policy.

1.3 Research Problem

Shocks or changes to variables deemed to affect export demand such as relative prices or volatility of the exchange rate are likely to cause profit uncertainty for firms. The volatility can be however, a potential source for profits for the same firms, and in addition, firms have differing exposure to market volatility such that different economic sectors should react differently based on the nature of the products that they export. Kantor and Barr (2005) established that firms on the JSE had varying sensitivities to exchange rate movements and this was caused by their sources of revenue. The findings by Kantor and Barr (2005) imply the product categories (and the exporting firms by extension) would have heterogeneous relationships with identified economic risk factors such as exchange rate volatility. As a result, analysing exports by product categories or their export sectors enables the unravelling of more diverse relationships as opposed to the case with aggregated exports.

Findings may be unique from one study to the next because of the distinctiveness of a given economy and its stock market. According to the data on the FTSE Russell (2020) factsheet, basic resources were the single largest sector on the JSE ALSI Index, accounting for 28.08% of the index as at 31 January 2020. This weighting suggests that poor performance in the resources/mining sector would likely result in significant changes of the index level. This position is confirmed by assertions made by Fang *et al.* (2009), Kayacetin and Kaul (2009), Kim (2013) and Holmes and

Maghrebi (2016) that investors are proactive on stocks whose firms are in the real economy. This suggested that the stock market would be responsive to changes in the real economic output. To that end, there is logical expectation that investors in South Africa would be cognisant of the changing prospects of the exporters which will affect volatility and liquidity costs of the underlying stocks.

Third-country effects are another factor that reflects the real-world setting where, export volumes are influenced by international competition, as such, they are most likely a factor for South African exporting firms. Third-country effects have not been given adequate attention by South African literature even though they are plausibly related with exports. The lack of unanimity in South African studies provided an opportunity for this doctoral thesis to extend research on exports further. Another relevant and crucial issue is the fact that over time, the variables of stock market illiquidity, stock market volatility, exchange rate volatility, and third-country effects, may be more unpredictable in varying stages of the business cycle. It is plausible that these variations of states may have their own equilibria and therefore, influence the observed relationships if accounted for with greater nuance.

The gaps identified above; arising from the financial economy, third-country effects and non-linear modelling of export relationships must be considered when analysing South Africa's exports in the current circumstances of depressed economic growth. The following points summarise the research gaps, how this study addresses them, and outlines the arising original contributions made to existing knowledge by this thesis.

1. Existing South African studies mainly focused on exports as having a relationship with real economic variables. This created a gap in knowledge on how exports may be linked with the financial economy. This study fills that gap by incorporating financial economic variables in the form of stock market illiquidity and stock market volatility, these two variables having been identified as relevant because of their links through both the balance sheet channel (earnings prospects) and indirect channels (spill-overs between real and financial economies especially during economic crises). Filling this gap enables

an improved understanding of the export behaviour which is crucial for South African policy makers especially as the existing trade policy is failing to reach its intended goal of significantly contributing towards long-run economic growth.

2. It was noted that South African studies' main methods of analysis carried the assumption of linearity of export relationships. The assumption of linearity, however, left a gap in knowledge as it assumes that positive and negative shocks in any of the explanatory variables draws a response of the same magnitude. If the assumption of linearity is relaxed, it remains unknown how South Africa's exports react to positive and negative shocks emanating from the real and financial economies. This study contributes to existing knowledge by applying non-linear models that account for asymmetric relationships to establish how real and financial economic shocks influence export behaviour. The contribution made here is especially useful when predicting the effect of real economic downturns on exports as well as how stock market liquidity and volatility changes during those times; as this highlights the nuances of export relationships which improves understanding from policy and investor standpoints.

3. A further gap existing in South African research is with respect to third-country effects and the heterogeneity of export categories within a non-linear model. As highlighted earlier, a product category has its own unsystematic risk but more specifically, there is competition in the export market and as such, third-country effects are helpful in accounting for exchange rate volatility of trade competitors. Analysis of various product categories require panel data analysis but as previously explained, non-linear models may supersede the use of linear models as they are more realistic. This gap was addressed by incorporating heterogeneous non-linear panel data models, which enabled a deeper understanding of these relationships in both the long-run and the short-run, whilst simultaneously accounting for the heterogeneity of each product category and third-country effects.

Having identified these gaps and formulating the remedies required which would add knowledge to existing literature on South Africa's exports, this doctoral thesis considered the following research questions and objectives.

1.4 Research Questions and Objectives

The following questions were addressed by achieving the objectives listed below.

Question 1. What is the nature of the relationship of stock market liquidity, exchange rate volatility and third-country effects with South Africa's exports? Are there symmetric or asymmetric responses by exports to positive and negative shocks in these factors?

Objective 1. To investigate short-run and long-run relationships and analyse symmetric or asymmetric responses of exports to shocks of exchange rate volatility, third-country effects and stock market illiquidity.

Question 2. Are there regime switches in liquidity, exchange rate volatility and third-country effects, and what are their implications for South Africa's exports?

Objective 2. To investigate the existence and significance of regime switches in the period of study and evaluate their effect on both aggregated and disaggregated South African exports.

Question 3. What are the cross-sectional effects of liquidity dynamics, exchange rate volatility and third-country effects on South African export categories?

Objective 3. To undertake a cross-sectional analysis of both aggregated and disaggregated exports to evaluate the effect of illiquidity on long-run export growth.

1.5 Research Methodology

To achieve its objectives outlined in section 1.4, this thesis employed a wide range of approaches which utilised both linear and non-linear methodologies. The methods of analysis employed filled the research gaps identified in section 1.3 while achieving the specific research objectives laid out in section 1.4.

The first objective of the study was achieved by employing the linear autoregressive distributed lag (ARDL) model by Pesaran, Shin and Smith (1999, 2001), the non-linear ARDL (NARDL) by Shin, Yu and Greenwood-Nimmo (2014) and the quantile ARDL (QARDL) by Cho, Kim, and Shin (2015). These models were essential in testing for long-run and short-run relationships between exports and the explanatory variables of exchange rate volatility, third-country effects and stock market illiquidity. The ARDL tested for the existence of linear relationships, while the NARDL and QARDL tested the significance of asymmetries in the short-run and long-run relationships.

The second objective which centred on structural breaks and regime switches within the data series, employed the Markov-Switching model and the threshold models. The Markov-Switching model enabled the study to establish if the data series that were analysed could be captured better if certain exogenous factors induced change in the behaviour of exports and other macroeconomic series. In addition, the threshold regressions, which included the self-exciting threshold autoregression (SETAR), analysed the regime-switching behaviour by making the hypothesis that the change in behaviour of exports and other macroeconomic variables was caused by a known and observable variable.

The third objective required an analysis of the cross-section of exports and consequently, required panel data modelling. Panel data analysis was undertaken using the dynamic pooled mean group (PMG) model and the threshold panel data model by Hansen (1999). The PMG was instrumental for testing short-run heterogeneity on the cross-section of export categories whilst simultaneously testing for common long-run dynamic relationships on a cross-section of export categories. In addition, the threshold panel data model evaluated the export demand functions when

certain levels of a selected exogenous variable (for example, stock market illiquidity) had been reached.

1.6 Original Contribution

Achieving the study's objectives resulted in making an original contribution which can be summarised in four interrelated aspects which jointly address the overarching subject of this thesis: to model the export growth in South Africa with a focus on third-country effects and stock market liquidity. Firstly, this doctoral thesis made a novel contribution by incorporating financial economic variables of stock market illiquidity and stock market volatility into South Africa's export demand. Previous related South African studies overlooked this aspect, but its incorporation was valuable because the real and financial economies are interrelated and investors in Rand leveraged stocks are affected by export prospects. This contribution enabled to understand the type of relationship financial markets had with export output in both the long-run and the short-run which provided a foundational understanding in the South African context. With this contribution, further knowledge of the nuances of the relationships from one product category to the next gave further contextual information on how investors and market participants reacted to changes in export output. Further, the results showed that there was merit in widening the scope of the existing trade policy to consider the financial economic aspects because stock market illiquidity and stock market volatility had a strongly negative impact on export growth in both the long-run and the short-run.

Secondly, the utilisation of non-linear models which included the NARDL, the QARDL, the Markov-Switching model, the SETAR and the panel threshold model enabled to capture the export demand relationships in series with structural breaks and regime switches. The employment of these non-linear methodologies was unique in this area of analysing export demand as extant relatable literature focused on linear-based methods of analysis. Using the non-linear methods enabled the capturing of the effects of positive and negative shocks on exports as well as threshold effects. The subsequent novel findings emanating from the utilisation of non-linear models made a significant finding that South Africa's exports improved under lower stock market

volatility and illiquidity in both the short-run and long-run. In addition, negative shocks of the macroeconomic factors tended to weigh greater than positive shocks of the same magnitude with varying degrees based on export destination, thereby, confirming asymmetric relationships.

Thirdly, the study made a significant contribution by exploring the heterogeneity of exports in dynamic and non-linear panel data models. Existing South African studies on exports using panel data which include Wesseh and Niu (2012), Chang, Simo-Kengne and Gupta (2013) and Khosa, Botha and Pretorius (2015) limited their scope by not considering non-linearity which limited their ability to determine the effect of changes in an econometric relationship at higher or lower levels/thresholds of a given state variable. Another gap emanating from this limitation from existing studies was that this thesis was able to establish threshold levels at which a product category began to be affected by exchange rate volatility or stock market illiquidity. This further contribution to knowledge was valuable because it showed the levels at which investors began to react to positive or negative changes in any given export category and the extent to which they reacted in each case.

These four contributions to knowledge are important and relevant given the current state of dire economic growth prospects. Policy makers, investors and scholars stand to benefit from these contributions; South African policy makers need to know the macroeconomic interrelationships to formulate a more holistic trade policy that promotes long-run economic growth while investors have a vested interest in establishing the changing liquidity costs and increased risk (volatility) on their investments that are induced by poor export and economic growth. Scholars and researchers can build on the findings of this study to formulate improved econometric models that better capture export relationships for South Africa.

1.7 Structure of the Thesis

This thesis is structured as follows:

Chapter 1 – *Scope and Purpose of the Study*. This chapter provides a background, context and the motivation for undertaking the study. In addition, the chapter outlines the research problem, sets the research objectives of the thesis, as well as the methods employed to attain the set objectives. Lastly, this chapter explains how achieving the set objectives resulted in original contributions to existing knowledge.

Chapter 2 – *Export Growth, Exchange Rates and Financial Markets Review*. This chapter undertakes a review of South Africa's exports and their relationship with the financial markets after which, a comprehensive literature review is undertaken. The literature review provides information on progress made and opportunities for further research that exists where this study contributes to the knowledge base in this subject area. In addition, the comprehensive review of exports and the stock market assists in making a compelling case for the inclusion of financial market factors in the analysis of South Africa's exports.

Chapter 3 – *The Modelling of South African Exports with Stock Market Liquidity*. In this chapter, the initial part of the first objective, to establish the short-run and long run relationships between exports and the explanatory variables, is achieved. This is done by applying the popular ARDL model and the PMG to analyse the linear long-run and short-run relationships of South African export demand functions to the world and four major regions: Africa, America, Asia and Europe. The chapter makes a significant contribution by introducing financial market variables of stock market volatility and illiquidity into the export demand functions and establishing their relationships with exports.

Chapter 4 – *A Non-Linear Analysis of South African Exports and Selected Macroeconomic Variables*. This chapter addresses the second part of the first research objective by establishing the non-linearity of the South African export demand relationship with the real and financial economic variables. This chapter

employs the NARDL and the QARDL methodologies on total South African exports to the rest of the world and to its trading partners. The chapter interrogated the possibility of non-linear behaviour of economic and financial time-series over the duration of the study. The fourth chapter makes a significant contribution, which added to the previous chapter, by drawing inferences on asymmetric export demand relationships from perspectives of investors and policy makers.

Chapter 5 – *Regime-switching Effects of South African Exports*. This chapter expands on the analysis of South African export demand by examining non-linear relationships by accounting for regime-switching and structural breaks. The chapter employs the Zivot and Andrews break-point tests and the Markov-Switching and threshold models to detect regime switches and subsequently model them in export demand. This chapter's contribution emanates from its determination of the different levels and thresholds that exchange rate volatility, stock market volatility and illiquidity had on South Africa's exports.

Chapter 6 – *The Cross-Section of South African Exports*. In this chapter, a large dataset comprising of product-level exports to the world and to selected trading partners (China, Germany, Japan, United Kingdom and the USA) are analysed. This chapter employs the PMG and the threshold panel data model to analyse the export demand functions across export destinations and product categories. The analysis enables a holistic view of the heterogeneity of export demand behaviour over a range of product categories to export destinations.

Chapter 7 – *Conclusion*. This chapter concluded the thesis by reviewing the research objectives and consolidating the findings obtained in all the chapters. Importantly, this chapter outlines the implications of the findings on South Africa's existing trade policy and summarises the contribution made by the thesis after which the limitations and areas for future research are outlined.

CHAPTER 2: EXPORT GROWTH, EXCHANGE RATES AND FINANCIAL MARKETS REVIEW

2.1 Introduction

South Africa has an open economy and considers its trade policy as one of the instruments to implement its industrial strategy. According to the DTI (2019), the main objectives of the trade policy are fostering industrial development and upgrades, employment growth and increasing value-added exports. The trade policy is implemented within a framework which ensures the ease of financial capital inflows and outflows as well as inward and outward foreign direct investment (FDI). The policy of trade openness has largely remained consistent as evidenced by Van der Merwe (2004) who described it as outward-looking with the objective of fostering long-term economic growth with price stability, and a later relatable study by Calì and Hollweg (2017) which made a similar characterisation of the existing trade policy. The trade policy, which is a key instrument for South Africa's goal to attain a sustainably higher economic growth rate, has been supported by establishing trade agreements. The purpose of this chapter is to provide a background and overview of South Africa's trade policy and export contribution towards growth. In addition, it analyses how export growth has been evaluated while suggesting improvements to the analysis to fill the gap left by erstwhile studies of South Africa's exports.

Some of the regional trade agreements began as early as 1910 with Southern African Customs Union (SACU) which includes Botswana, Eswatini, Lesotho and Namibia (BELN) and later the 2008 Southern African Free Trade Area (SADC FTA) (DTI, 2019). Arguably the most significant step towards trade liberalisation and economic integration was joining the trade liberalisation convention which saw the adoption of liberal policies in the late 1980s known as the *Washington Consensus* (De Wet, 1995 and Ajmi *et al*. 2015). Other notable trade agreements included the General Agreement on Tariffs and Trade (GATT), the South Africa – European Union (SA-EU) Trade, Development and Cooperation Agreement (SA-EU TDCA) among others (DTI, 2019).

Although South Africa has trade agreements in place, Edwards and Lawrence (2012) highlighted that the desired long-term economic growth would be achieved if the following key goals were prioritised:

i. Take advantage of growth in emerging markets by improving access of South African exports to those markets.

ii. Intensively participate in the manufacturing sector to increase exports of goods and services to both developed and emerging market economies.

iii. Enhance mineral development by both domestic and international investors to take advantage of the strong global markets in this sector and move up the value chain.

iv. Benefit from Africa's growth prospects through increasing integration with the continent, reducing trade barriers, increasing goods and services exports, and position South Africa as the centre for regional integration and cooperation.

These points highlight that there is a framework and scope for South Africa to improve exports which will advance the country's economic growth prospects. South Africa's exports can be enhanced by diversifying between the developed market economies which mostly consume resources output and the emerging market economies which would purchase manufactured output (Edwards and Lawrence, 2012). This means that South Africa's exports can be enhanced if the trade policy is implemented in a way that would enable the economy to diminish the adverse effects of commodity price cycles through benefitting from high growth in emerging market economies (Botha and Schaling, 2020). These will help achieve the main goal of the existing trade policy of contributing significantly to South Africa's economic growth which has been depressed. Given these dynamics, it is essential to analyse South Africa's exports to developed and emerging market economies as well as the performance of individual product categories which is vital as it may provide more nuanced direction to which improvements can be suggested to the current trade policy. The recent African Continental Free Trade Area (AfCFTA) agreement which came into effect in 2019, but

is still being implemented, will provide easier access for South African exports to reach the rest of Africa (Simo, 2020). This is the largest trade agreement on the continent and is a significant opportunity for South Africa's export growth once fully implemented by all member states because it gives access to more than a billion people.

Although the trade policy focuses on the real economic aspects, the DTI (2019) significantly highlighted that the trade policy is implemented with the understanding that there is need for the ease of financial capital inflows and FDI. Ease of international flows, however, falls short of addressing issues pertaining the stability of the financial or capital markets which are important for investors to raise funding or liquidate their holdings. As Levine and Zervos (1996) highlighted, the depth of the financial markets was essential for economic growth because it facilitated efficient resource allocation required for economic growth. Since the direction of causality between the real and financial economies is theoretically debatable, it makes financial economic factors even more relevant to examine in the context of South Africa's exports.

Consideration of the links to both the real and financial economies is especially beneficial since literature has been split between some supporting the export-led growth hypothesis; Balaguer and Manuel (2004), Shirazi and Manap (2004), Jordaan and Eita (2007) and Saad (2012), and others favourably viewing the growth-led exports hypothesis; Dodaro (1993), Ukpolo (1998), Giles and Williams (2000), Tang and Lai (2011) and Abbas (2012). Studies such as Dutt and Ghosh (1996) in South Africa and internationally by Ramos (2001), Amavilah (2003), and Pazim (2009) who failed to establish any relationship between exports and economic growth strengthen the indirect hypothesis linking exports to the real and financial economies. This is because, in addition to direct channels linking the real and the financial economies, the balance sheet channel is one avenue through which changes of real economic output can affect the financial economy (Giannellis and Papadopoulos, 2016 and Pan and Mishra, 2018). Balcilar and Ozdemir (2013) and Ajmi *et al*. (2015) have the view that indirect channels linking the real and financial economies ought to be given attention.

This thesis considers both the real and financial economies in its analysis of South Africa's exports to key trading partners and the rest of the world motivated by the need to understand this potential contributor to economic growth; something which South Africa desperately needs. The following sections undertake a comprehensive review of the variables that likely influence export behaviour drawn from both real and financial economies which are employed in econometric analysis in the subsequent chapters. The comprehensive review begins by providing a background to South Africa's export growth and an analysis of its behaviour particularly during the various economic cycles including the significant global financial crisis of 2008. Subsequently, the traditionally popular economic variables of foreign income, relative prices and exchange rate volatility are reviewed to better understand their behaviour and potential influence on exports. The financial economic variables of stock market illiquidity and volatility are motivated for and reviewed in the context of their effect on exports which contributed significantly to filling the gap of how changes of stock market liquidity and volatility influenced changes of export prospects.

To fulfil this chapter's purpose, this chapter was structured such that Section 2.2 conducts a review of the real economic variables beginning with exports followed by exchange rates which have been a popular economic variable in related studies. This is followed by a review of the financial economic variables whose inclusion addressed a gap in existing South African studies. The literature review undertaken in section 2.3 offers an opportunity for this study to analyse one of the gaps of non-linear modelling of export relationships which was identified in Chapter 1. In analysing and reviewing the modelling gap, the literature review comprehensively examines the methods of analyses employed, the economic variables and frequency of data considered and the results that were ultimately arrived at in previous studies.

2.2 South Africa's Export Growth and the Financial Economy

To undertake a comprehensive analysis of South Africa's exports against the backdrop of the real and financial economies, this thesis searched for high frequency export data to trading partners and the rest of the world. A unique dataset of monthly exports was constructed from data sourced from the South African Revenue Services (SARS)

only available for the period between December 2003 and December 2019. This data comprised aggregate and product-level exports to the rest of the world; country-specific and aggregated exports had to be drawn and scrupulously sorted over the duration of this period to obtain monthly aggregated and product-level exports to the trading partners. After obtaining the export data series to trading partners and to the rest of the world, the thesis prepared and analysed data for the other economic and financial variables for the corresponding period.

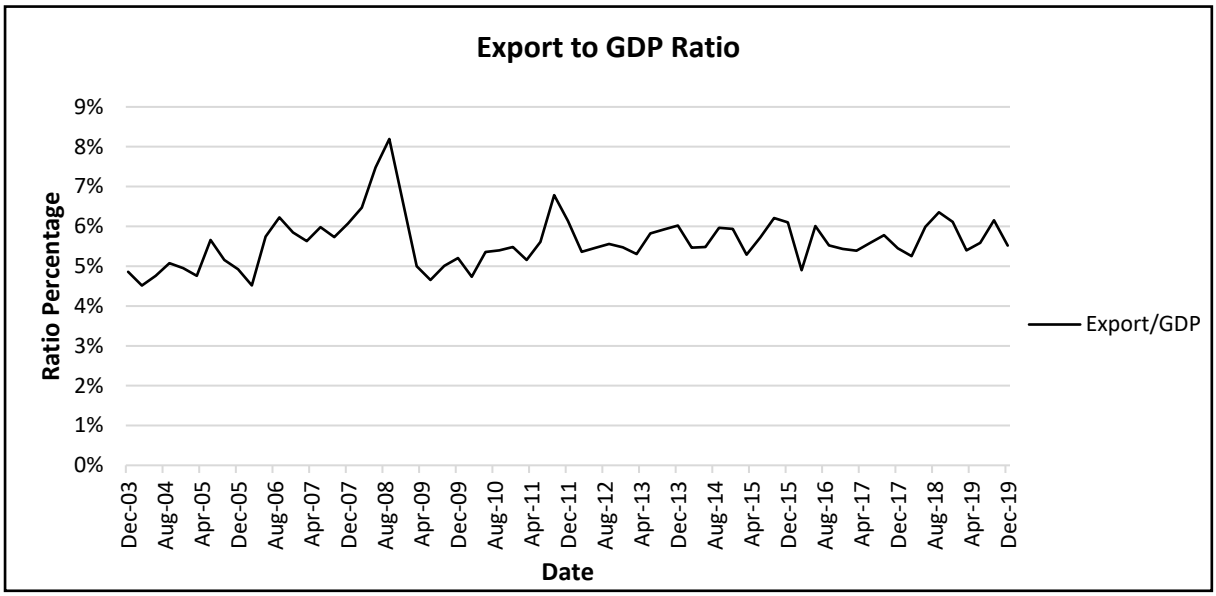
2.2.1 Export Growth

In Chapter 1, Figure 1.1 showed that both GDP growth and South Africa's share of global exports were waning over time, suggesting that its exports were not performing well relative to other nations' exports *ceteris paribus*. Notwithstanding the fact that South Africa's trade policy aims to increase the proportion exports contribute towards economic growth, GDP growth remains largely domestically driven. This section evaluates the real economic factors of GDP and exports before looking at the financial economy. To begin by analysing the real economy is essential as Reinert (2012) stated that the financial sector invests in the real economy, hence, the financial sector is useful when real economic activity transpires. Sustained real economic activity and export growth is essential for South Africa because export growth will ensure strong balance of payments. This will in turn, provide support for imports of intermediate and capital goods required to boost growth in the long-run (Chisiridis and Panagiotidis, 2018). To better understand exports and GDP, this thesis calculated the ratio between total South African nominal exports and nominal GDP (export to GDP ratio) from data sourced from Standard and Poor's Capital IQ database between December 2003 and December 2019 and plotted the results in Figure 2.1.

The results show that the export to GDP ratio averaged 5.6% per quarter, and during this time the ratio hardly deviated from this average as suggested by the standard deviation of 0.65%. However, there was a notable spike in the ratio in September 2008 where the ratio reached a maximum of 8.2% at the onset of the global financial crisis, followed by a sharp reversal to below 5% by March 2009 as the crisis was unravelling. Although there was a recovery of the export to GDP ratio from March 2009 until

September 2011, there was a swift reversal thereafter which ended in June 2012. After June 2012, the ratio tended to smoothen out where it largely ranged between 5% and 6% per quarter.

Figure 2.1: South Africa's Export to GDP Ratio



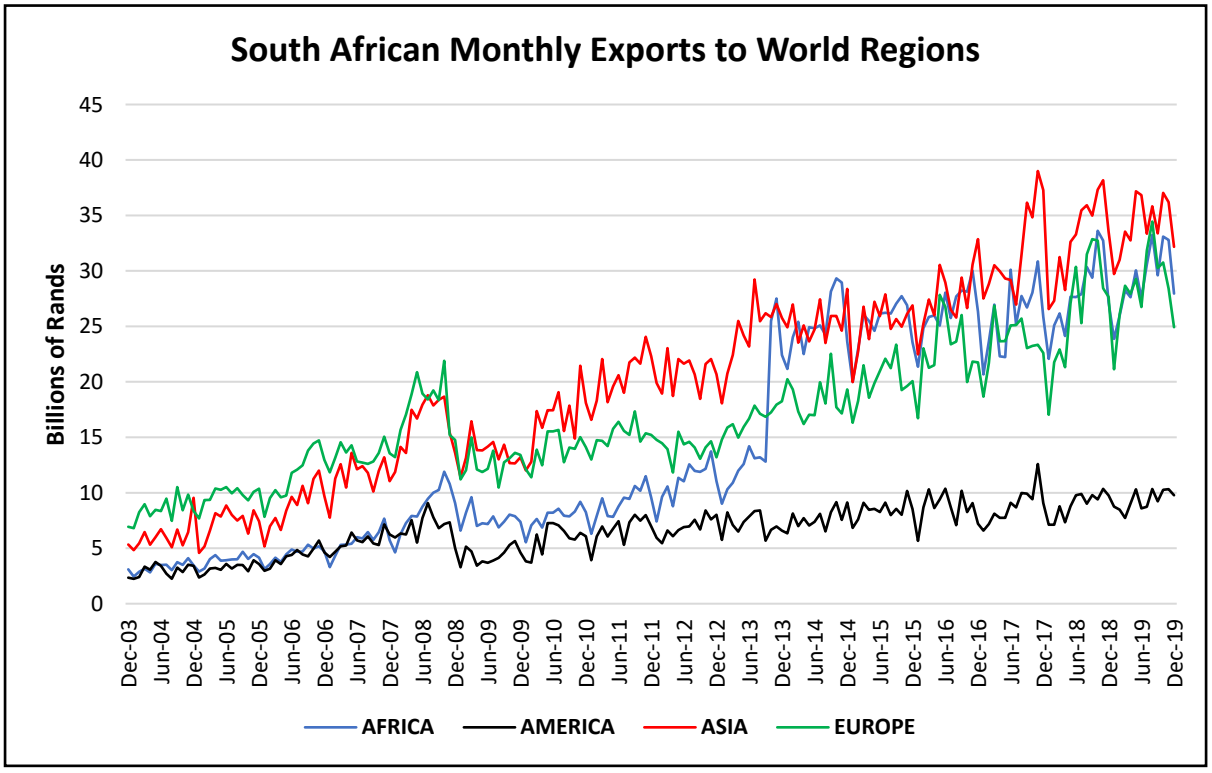
Although the export to GDP ratio this study calculated in Figure 2.1 may not offer conclusive evidence on whether South Africa's exports can be deemed mostly related through a direct channel to economic growth or via an indirect channel, it provides some explanation why South African studies such as the one by Dutt and Ghosh (1996) could not find evidence supporting the relationship between exports and economic growth. This is because the ratio seems not to have changed considerably over time although there were some small fluctuations during the period reviewed; illustrating that the exports contribution to aggregate economic growth hardly increased during the reviewed period.

What can be deduced from the observation of changes in the export to GDP ratio is that the global financial crisis had a greater negative impact on domestic sectors compared to exports at the onset while the gradual global recovery helped restore the ratio to the pre-crisis level. Further, it shows that the policy of promoting export growth does not seem to be attaining the desired results because South Africa's export share on the global market is declining whilst the exports' contribution to GDP remain largely

stagnant. This makes it relevant to consider other channels such as the financial economy that may have had effects from or responded to the sharp decline in aggregate exports as opposed to primarily focusing on the popular traditional real economic factors (Giannellis and Papadopoulos, 2016 and Pan and Mishra, 2018).

South African products are exported all over the world, but the main destinations can be categorised into four main world regions; Africa, Asia, Europe and America (this includes North America and South America). In Figure 2.2 below this study unravelled total aggregate South African exports to the world into the four main regions listed above to analyse their behaviour between December 2003 and December 2019. The graph illustrates the heterogeneity of export behaviour from one region to the next supporting the point of view against aggregation of exports that was presented in section 1.2 (Wesseh and Niu, 2012 and Edwards and Jenkins, 2015).

Figure 2.2: South Africa's exports to World Regions



Apart from exports to the American region, all the series showed a significant underlying upward trend, however, all these trends were characterised by deviations

from the underlying trend especially towards the end of 2008 and after 2015. Exports to all the four regional destinations experienced a significant abrupt decline between August 2008 and April 2009; a period which coincided with the global financial crisis. There was a steep incline of exports to Africa between September and December 2013 and the series began to fluctuate at a higher export level. The notable fluctuations in all the series which tended to become more pronounced after 2015, presented an opportunity for this thesis to analyse this behaviour using econometric analysis.

Exports to geographic regions were suggestive of the weightings of likely risk factors that affected total South African exports; for instance, Asian markets, primarily driven by China, have grown to become crucial for South African output (Angomoko and Malefane, 2017). This suggests that economic growth or currency fluctuations in Asia and Europe may have a greater impact on South Africa's total exports compared to other regions (Motsumi, Swart, Lekgoro, Manzi and de Beer, 2014). Notably, exports to America hardly grew when compared to the other regions, suggesting that this region was losing influence on total South African exports. The observations of these export series could be reconciled with Figure 2.1 which showed that the period around the global financial crisis saw a declining of exports towards the country's GDP. Further, it becomes evident that the nominal growth of South Africa's exports to these four regions has not been large enough to increase South Africa's exports on the global stage.

South Africa's monthly exports were decomposed into product categories for the period of study and Figure 2.3 summarises the findings.

Figure 2.3: Share of Total Contribution to Exports

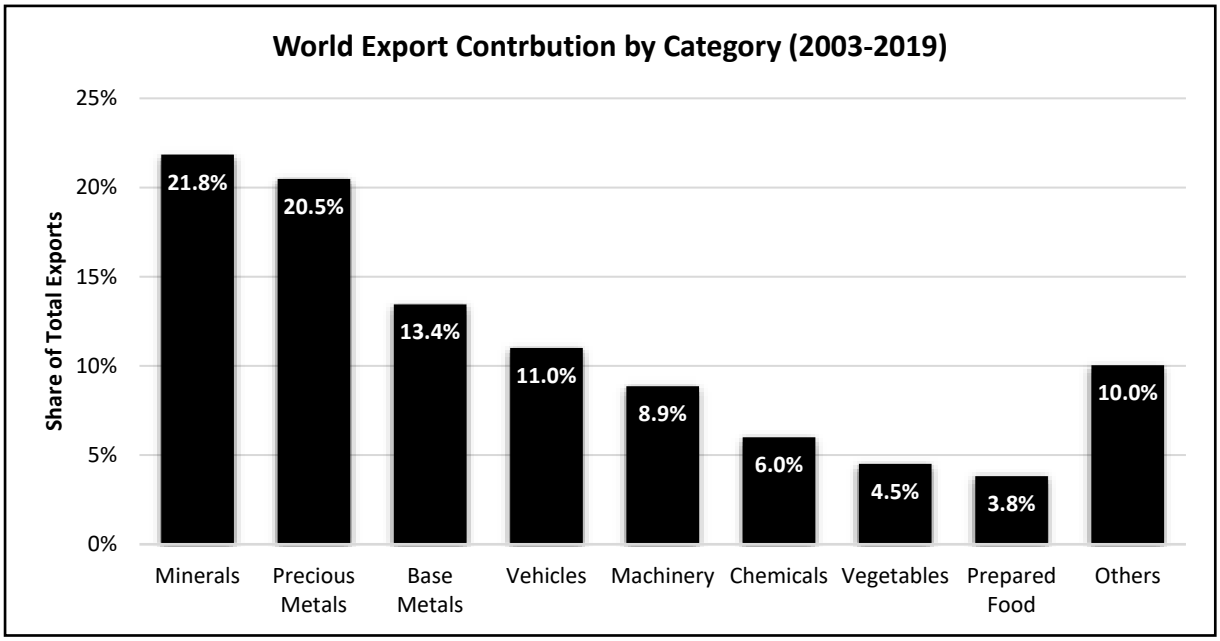
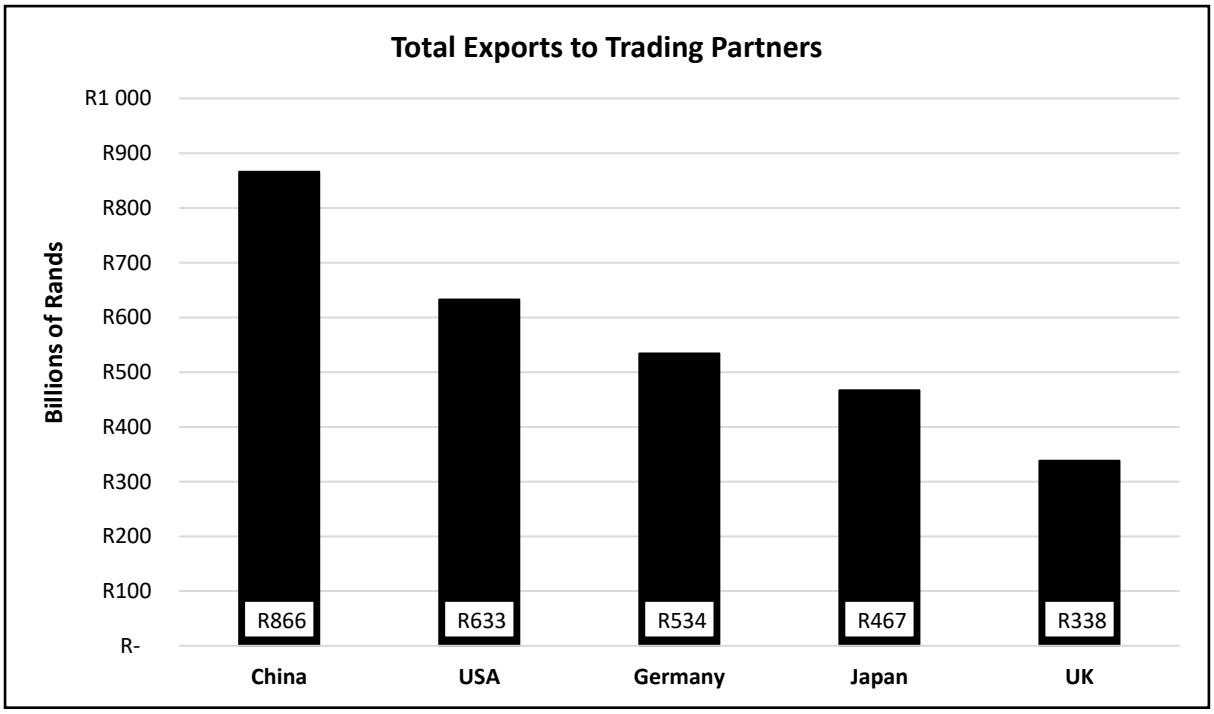


Figure 2.3 shows that the top three exports were resource or mining related; they comprised mineral products, precious metals and base metals with 55.7% of total exports. Industrial manufacturing (vehicles, machinery and chemicals) accounted for 25.9%. These statistics highlight that South Africa's exports are concentrated in resources and manufactured output which, when combined, amounted to 81.6% of total exports during the study period. The concentration of exports primarily in resources and manufactured output is a legacy of the policy conceived before economic liberalisation which focused on developing a comparative advantage in capital intensive primary and manufactured commodities (Edwards and Lawrence, 2008).

In line with the proposition of disaggregation and heterogeneity of export series based on product and destination suggested by Wesseh and Niu (2012), this thesis analysed the export composition to specific individual countries. From the monthly export data that were sourced from SARS, analysis on individual countries could only be validly undertaken from January 2010 until December 2018. During this period, it was established that the top five dominant countries to consistently receive South Africa's exports were China, Germany, Japan, the United Kingdom (UK) and the USA. These countries tend to have large, resilient and leading economies in their respective

regions and in the world. Total exports to the five recipient countries summarised in Figure 2.4 show that in the nine years reviewed, China was the dominant export destination with a total of 866 billion Rand worth of exported goods. This was followed by the USA and Germany while the trading partner that consumed the least amount of goods amongst these five countries was the UK which imported South African goods worth 338 billion Rands. According to the third-country effects proposal by Cushman (1986), it is plausible that South Africa's exports to any of the five countries was biased towards the country with the best price prospects however, further information with regards to the actual goods being sold to these countries was required.

Figure 2.4: Export Share to Key Trading Partners (2010-2018)



Analysis of product exports to top five export destinations provided a perspective on whether the top five countries were competing for the consumption of similar export output. The data showed that although each trading partner had a different product mix, there were similarities with respect to the distribution of exports. The exports to a given destination tended to be highly concentrated although South Africa had twenty-two product export categories. On average, the top nine export categories to each of

the five trading partners accounted for nearly 97% of total exports to that trading partner.

Table 2.1: Export Categories to Trading Partners

Export Category	China	Germany	Japan	UK	USA
Base Metals	16.1%	16.3%	13.8%	3.8%	18.1%
Chemicals	1.4%	3.1%	2.5%	2.1%	9.9%
Machinery	0.8%	5.2%	0.5%	7.4%	8.1%
Mineral products	70.1%	6.8%	16.3%	4.9%	9.3%
Plastics	0.7%	0.6%	0.0%	0.9%	0.8%
Precious Metals	2.3%	16.3%	45.3%	43.0%	25.0%
Prepared Food	0.8%	2.4%	1.5%	5.5%	1.7%
Specialised Equipment	0.0%	29.3%	0.0%	0.8%	0.5%
Textiles	2.4%	0.4%	0.1%	0.8%	0.4%
Vegetables	0.9%	1.6%	2.3%	13.2%	2.1%
Vehicles	0.4%	14.6%	10.0%	13.5%	22.0%
Wood Materials	2.8%	0.6%	6.8%	1.6%	0.4%
Others	1.3%	2.8%	0.9%	2.5%	1.7%

Table 2.1 shows that 88.5% of all exports to China were resource-based; with mineral products accounting for 70.1% whilst base metals were 16.1%. Exports to Japan were mainly in the mining sector; precious metals (45.3%) followed by mineral products (16.3%), base metals (13.8%) combining to constitute 75.4%. Germany and the USA had similar proportions of base metal exports (with 16.3% and 18.1% respectively) but uniquely, the largest export category to Germany was specialised equipment with 29.3%. This was markedly different from all the other partners who tended to have exports distributed amongst more categories. Exports to the UK were mainly in precious metals (43%) followed by vehicles and vegetables which had 13.5% and 13.2% respectively. Exports to the USA were slightly more diversified, but the major product was precious metals (25%), followed by vehicles (22%), base metals (18.1%) and chemicals with 9.9%.

The data summarised in Table 2.1 suggested that mining resources output had the greatest option for export destinations compared to export categories such as machinery and agriculture-based products. Although the exports are evidently concentrated in resources output, Ajmi *et al*. (2015), IMF (2019) and the SARB (2019) contended that exports were a key avenue for South Africa's growth and the OECD (2018) specifically posited that resources exports were to fetch favourable prices in the foreseeable future; giving South Africa opportunity to achieve meaningful growth. The concentration of resources exports could mean that third-country effects and exchange rate volatility could be of greater influence when analysing resources output compared to manufactured output because more price prospects were available in the former compared to the latter. However, econometric analysis was required to evaluate this assertion.

Section 1.1 and 1.2 in the previous chapter highlighted that exchange rate volatility has been the main factor assumed to affect exports owing to the view that it increases profit risk for exporters. However, the exchange disconnect puzzle has suggested that exchange rate volatility may not be a critical factor for exporters. It is imperative to establish if and how the Rand's exchange rate level and volatility may influence export quantities. The following section reviews the Rand's exchange rate and relative prices to show why regardless of the exchange disconnect puzzle, exchange rates remain a popular risk factor in related studies. In addition, the third-country effects are introduced as an additional variant to exchange rate volatility.

2.2.2 Exchange Rates

According to the IMF (2019), the Bretton Woods system of fixed exchange rates collapsed between 1968 and 1973, but the major event precipitating the collapse of the system happened in August 1971, after the USA suspended the United States of America Dollar (US Dollar) convertibility into gold. This event later culminated into the wide adoption of floating exchange rate regimes globally; raising concern over possible negative effects of volatile currency values (Van der Merwe, 2004 and De Haan, Pleninger and Sturm, 2018). The uncertainty of currency values was thought to increase risk in the international trade markets whose net effect was thought to discourage trade. This concern prompted studies amongst policy makers and scholars alike to investigate the effect of exchange rate volatility on exports (Arezki, Dumistrescu, Freytang and Quintyn, 2014).

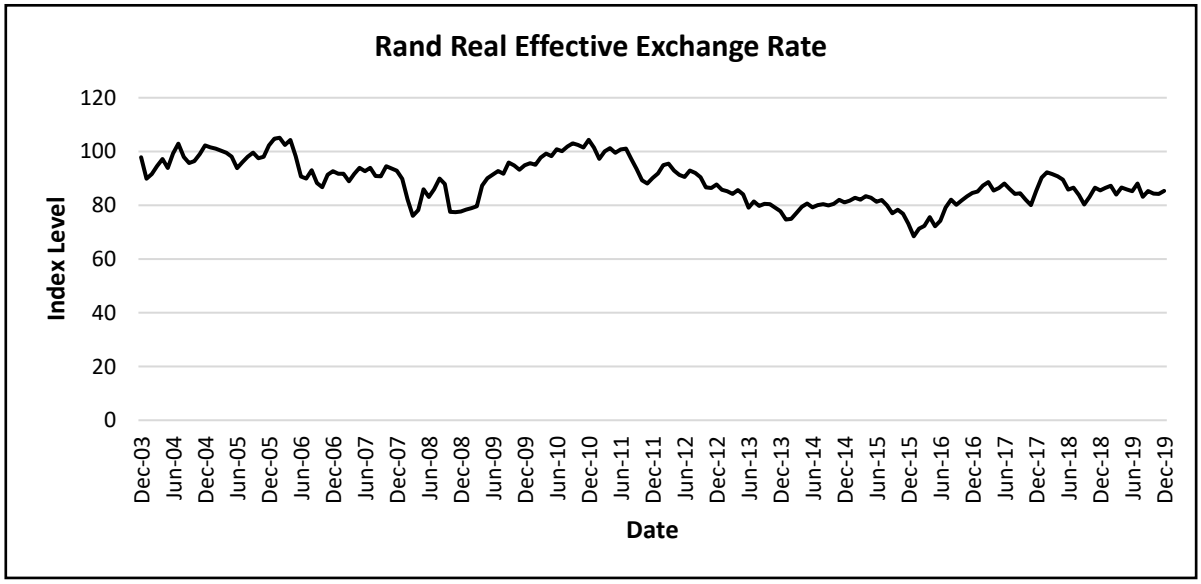
Although conflicting findings of exchange rate volatility impact on exports have been established, it remains a relevant factor in studies on international trade. Those in favour of exchange rate volatility being a crucial factor affecting exports have the view that exporters may be risk averse and unexpected currency fluctuations pose a profit risk (McKenzie, 1999, Krugman, 2007, Bahmani-Oskooee *et al*., 2013 and Choudhry and Hassan, 2015). However, if exporters were of the view that exchange rate volatility was an opportunity for more profits, export output would increase (McKenzie, 1999, Bahmani-Oskooee and Hegerty, 2007 and Bahmani-Oskooee *et al*., 2017). The position taken by some which sees exchange rate volatility being an opportunity for higher exports is further supported by the real option point of view (De Grauwe, 1994). A real option can be defined as an embedded investment opportunity which manifests in the form of an option to delay, abandon, change or suspend a financial or economic activity (Lambrecht, 2017). By adopting this definition of real options first proposed by Myers (1977), the implication is that if exporting and international trade are viewed as a choice for firms, then an increase of exchange rate volatility would increase the value of the exports which would mean that exercising this option would occur once it is profitable for the exporters to do so.

These positions suggest that there is a possibility that exchange rate volatility could either have a positive or negative effect on international trade depending on the underlying source of the volatility or risk aversion of the international trade protagonists (Choudhry and Hassan, 2015). Although there are differing points of view on the effect of exchange rate volatility on exports, it is reasonable to expect some sort of relationship between exports and exchange rates (Lee and Wang, 2015). However, the behaviour of exchange rate volatility itself has remained an area of interest with a recent study by Boateng, Claudio-Quiroga and Gil-Alana (2020) employing fractional integration to examine the dynamic structure of nominal exchange rates in South Africa. After noting that Rand value against the major trading currencies, which included the US Dollar, the British Pound and the Euro was of concern, Boateng *et al*.'s (2020) analysis led to the conclusion that nominal exchange rates tended to be nonstationary with some degree of mean reversion and breakpoints which hinted of non-linear behaviour.

The discussion around the role of exchange rates has two aspects: the exchange rate level and the exchange rate's volatility. Although the volatility of exchange rates tends to draw more attention, the exchange rate level, which is the relative price of one currency to another, reflects the cost of the internationally traded goods and services. Earlier studies took the position that exchange rates were the main determinant of exports; further, they had the opinion that exports were better harboured by a weaker currency. This assumption precipitated some to analysed whether currency devaluation could boost the trade balance with the key findings tending to establish either the *Marshall-Lerner condition* or the *J-curve* (Bahmani-Oskooee, Halicioglu, and Hegerty, 2016b). The Marshall-Lerner condition is when currency devaluation improves the trade balance if trade demand elasticity was greater than one (more than unit-elastic) while the J-curve is when devaluation deteriorates the trade balance in the short-run but improves it in the long-run (Kulkarni 1996, Bahmani-Oskooee and Hosny 2013, Bahmani-Oskooee *et al*. 2016b and Sahoo, 2018).

The SARB computes the real effective exchange rate index of the Rand versus the currencies of the country's top twenty trading partners[2] which are used to gauge the competitiveness of South African goods in the export market (Motsumi *et al*., 2014). Figure 2.5 plots the Rand's weighted real effective exchange rate index against the top twenty trading partners from December 2003 until December 2019, and it shows a gradual decline in the Rand value over the period in question. The gradual decline can be attributed to the fact that the weighting of the index is dominated by the Euro, the US Dollar and the Chinese Yuan which constituted close to two thirds of the index. However, the Rand has depreciated against these currencies and Motsumi *et al*. (2014) quoted that in the index, the weighting was 29.26% for the Euro area, 20.54% for China and 13,72% for the USA.

Figure 2.5: Rand Real Effective Exchange Rate



Theoretically, one would expect that the progressively declining relative cost of South African goods increased export quantities over the study period, however, consideration must be given to the fact that other factors such as income levels in those trading partners could affect the ability to purchase South African products (Todani and Munyama, 2005, Choudhry and Hassan, 2015, Moslares and Ekanayake,

[2] The top twenty trading partners (in descending order of weighting) are: Euro area, China, United States of America, Japan, United Kingdom, India, Republic of Korea, Botswana, Thailand, Sweden, Switzerland, Zambia, Malaysia, Zimbabwe, Australia, Brazil, Canada, Mozambique, Poland, Israel, Hong Kong and Singapore.

2015). As suggested in the previous chapter, real and financial economic factors have an impact on exports and as such, focus on the exchange rate and its volatility is likely insufficient to explain variability of exports.

In addition to factors from the real economy, Lee and Wang (2015) highlighted that the stock market and the exchange rate were important indicators of a country's state of its financial markets. This is because there is an interrelationship between exchange rates and the stock market as theorised by the goods market model and the portfolio approach. The goods market model is of the view that currency depreciation causes exports to become more competitive which should enhance the stocks of the exporting firms thereby increasing their stock prices. The portfolio approach, which takes a position opposing the goods market model, asserts that a rise in stock prices implies an increase of investor demand for a country's assets, and therefore, must result in domestic appreciation against foreign currencies (Lee and Wang, 2015). The goods market model implies a positive relationship between exchange rates and the stock market, whilst the portfolio approach implies that the same relationship should be negative. Notwithstanding these antagonistic theoretical approaches, both the goods market model and the portfolio approach suggest that there is merit in the consideration of the financial sector when analysing South Africa's exports.

2.2.3 The Financial Economy

The financial economy, which is mainly concerned with mobilising savings, the allocation of capital, exerting corporate control and aiding investors with risk management has been motivated as having an influence on real economic growth (Levine and Zervos, 1996). However, influential and pioneering studies such as the one by Robinson (1952) had the view that the financial sector merely responded to growth in the real economy. This point of view is increasingly being challenged by more modern approaches, such as the endogenous growth theory by Levine and Zervos (1996) which postulates that stock market depth fosters long-term real economic growth. Where the depth of the stock market indicates that the market has enhanced efficiency, higher quantity and quality of services rendered (Pradhan *et al*., 2019). The endogenous growth theory, which gets its inspiration from the finance-led

growth hypothesis earlier proposed by McKinnon (1973), has yielded three hypotheses namely: the supply-leading hypothesis, the demand following hypothesis and the feedback hypothesis, all of which have all been empirically tested with studies establishing varied but reconcilable findings.

The supply-leading hypothesis asserts that stock market depth is a necessary precondition for economic growth. This hypothesis suggests that there is unidirectional causality from stock market depth to economic growth and some studies, which include Tsouma (2009), Enisan and Olufisayo (2009) and Kolapo and Adaramola (2012), have found evidence in support of this hypothesis. The demand-following hypothesis suggests that there should be unidirectional causality from economic growth to the stock market. Studies such as the ones conducted by Liu and Sinclair (2008), Panopoulou (2009), Odhiambo (2010) and Kar, Nazlioglu and Agir (2011) obtained empirical results confirming the validity of this hypothesis. Lastly, the feedback hypothesis suggests bidirectional causality between stock market depth and economic growth. This hypothesis postulates that stock market depth is an indispensable aspect of economic growth and as such, stock market depth and economic growth are interrelated and therefore there must be bidirectional causality between the two. Hassapis and Kalyvitis (2002), Rashid (2008), Hou and Cheng (2010) and Cheng (2012) confirmed the existence of bidirectional causality between economic growth and stock market depth, thereby confirming the feedback hypothesis.

Although there are varying hypotheses on the relationship between real economic growth and the financial economy, there is evidence to suggest that the two are interlinked. Other studies that investigated the relationship between the real and financial economies in developed markets include those conducted by Barro (1990), Fama (1990), Atje and Jovanovich (1993), Korajczyk (1996), Levine and Zervos (1998), Giannellis, Kanas and Papadopoulos (2010) and Kanas and Ioannidis (2010) which tended to find a strong and positive link. Giannellis and Papadopoulos (2016) found that intra-national spill-overs between the real and financial economies were transferred through the balance sheet channel whilst international spill-overs came through an indirect channel. Ogunmuyiwa (2010) noted that in Nigeria, which was an

emerging market economy, investor sentiment (measured by market turnover ratio) positively affected economic growth (measured as market capitalization as a percentage of GDP) between 1984 and 2005.

One avenue through which the real and financial economies intersect can be illustrated by the fact that firms that produce real economic output have investors who possess an interest in the financial position and future earnings of the firm. The expectation that investors have regarding future real economic output can be observed in the stock market's behaviour, making the stock market a predictor of business cycles and real economic activity (Holmes and Maghrebi, 2016). During the various stages of a business cycle, firms are exposed to market risk or systematic risk factors which are common to all economic players such as recessions in addition to their own firm-specific risks (Bodie, Kane and Marcus, 2013). Since investors can diversify firm-specific risk, Ibrahim and Haron (2016) highlighted that it was crucial for investors to understand the implications of systematic risk on their portfolios. This means that investors in exporting firms have an interest on the prospects of the firms in line with their changing risk-return preferences as business cycles unravel. Investors' ability to withdraw their investment when they decide to do so depends on liquidity in the market; once liquidity is low, withdrawing the investment becomes costly and if uncertainty about export prospects rises, volatility on the market will increase. Næs *et al*. (2011) and Holmes and Maghrebi (2016) further asserted that market-level liquidity was associated with the real economy because investors changed their portfolios depending on the business cycle.

Firms undertaking export activities have their own business risks and investors assess these sensitivities and allocate their portfolios based on their risk appetite and potential returns for bearing that risk. Kantor and Barr (2005) and Holdsworth, Barr and Kantor (2007) summarised the four types of revenue and cost scenarios for firms on the JSE based on their business structures. The four scenarios are summarised below:

- **Rand Play Firms** – These are almost completely South African based firms; both their revenues and costs are realised in South Africa. The firms that are classified as Rand play firms tend to be mostly players in the retail business

sector. The revenue and cost structure of the Rand play firms are summarised in equation 2.1.

$$(R)Revenue_t - (R)Cost_t \quad (2.1)$$

- **Rand Hedge Firms** – The Rand hedged firms are almost completely foreign based, therefore, they generate foreign revenues whilst incurring foreign costs. Their revenue structure is given by equation 2.2.

$$R/\$_t * (\$Revenue_t - \$Cost_t) \quad (2.2)$$

- **Rand Leveraged Firms** – These types of firms are domiciled in South Africa and sell products abroad. This means that they generate foreign revenues whilst incurring domestic costs; usually these are resource stocks which export mined resources. Equation 2.3 summarises the revenue structure of these firms.

$$R/\$_{t+n} * \left[\$Revenue_{t+n} - (R)Cost_t * \left(\frac{CPI_{t+n}}{CPI_t}\right) * \left(\frac{1}{R/\$_{t+n}}\right)\right] \quad (2.3)$$

- **Mixed Firms** – They have characteristics of both Rand hedge and Rand leverage firms.

Where, the dollar sign, $, represents foreign currency, Rt represents the Rand value of revenues and costs, $R/\$_t$ represents the prevailing exchange rate between the Rand and a given foreign currency unit at time t and CPI represents the consumer price index used to consider the effects of inflation in the long-term.

Equations (2.1), (2.2) and (2.3) illustrate that the susceptibility to currency volatility directly affects firms' profitability meaning that investors may be cognisant of changes which likely impact the exporting (Rand leveraged) firms' earnings potential. Based on the four scenarios above, South African exporters are typically classified as Rand leveraged firms because they are domestically located but sell goods abroad to earn

foreign currency. Earnings of Rand leveraged stocks will be affected by translation risk among other factors such as global prices and overheads of production. The translation risk, which is also referred to as accounting exposure, arises because revenue earned abroad must be converted into South African Rand when creating consolidated financial statements (Menon and Viswanathan, 2005).

Fluctuations between the Rand and foreign currency creates uncertainty on the Rand value of the earnings in the future and Loderer and Pichler (2000) noted that exporters tended to manage their currency exposures. To hedge the translation risk exporters can use combinations of operational and financial hedges: operational hedges work through offsetting revenues and costs with foreign subsidiaries while financial hedges utilises currency derivatives such as currency forwards, futures, money market hedges, swaps and options contracts (Ito, Koibuchi, Sato and Shimizu, 2016). Aye *et al*. (2015) suggested that there was evidence that South African exporters employed various financial hedges to mitigate downside risk from currency movements. Given these hedging dynamics, investors of Rand leveraged firms have a vested interest in the successful management of translation risk.

Stocks give shareholders access to earnings of Rand leveraged firms; increased earnings galvanise interest and positive sentiment in the stock which generates liquidity by producing institutional investor demand (Fang *et al.*, 2009). This suggests that stock market liquidity can be used as a measure of investors' expectations on future real economic output; if investors predict a decline in real export output and consequently of firm earnings, the liquidity of stocks with gloomier prospects would decline (Kayacetin and Kaul, 2009, Næs *et al*., 2011, Kim, 2013 and Holmes and Maghrebi, 2016). Matthee *et al*. (2018) found that in South Africa, highly competitive and productive exporting firms were more likely to attract institutional investors and had more liquid stocks; this suggested that poor real performance would be associated with lower liquidity.

2.2.3.1 Liquidity in the Stock Market

Liquidity is desirable in capital markets because its abundance enables investors to enter and exit the market at low transaction costs (Pastor and Stambaugh, 2003 and Keene and Peterson, 2007). Keene and Peterson (2007) explained that when a given security became illiquid, investors faced the risk of incurring significant losses in value of that security once they attempted to dispose it. This complements the earlier assertions by Levine and Zervos (1996) who had theorised that increased liquidity eased investor access to information which improved governance of firms. Consequently, liquidity would influence firms' economic activities because investors tended to favour long-term high return projects if they could quickly and cheaply withdraw their capital at any time in the future when they decided to. This means that poor South African export growth weighs negatively on the liquidity of stockholdings thereby disincentivising future investments because investors become wary of the illiquidity costs.

Although liquidity is a key financial concept that is related with the viability of the underlying business of a given stock, it is complicated to define and measure empirically because it has many dimensions. As a result, several liquidity measures have been derived and used in the literature to capture its different dimensions (Gabrielsen, Marzo and Zagaglia, 2012). The four main dimensions of liquidity can be summarised as tightness/cost, depth/quantity, time/immediacy, and resiliency (Sarr and Lybek, 2002, Lesmond, 2005 and Chollete, Næs and Skjeltop, 2007).

The property of "tightness" of the market measures a trader's ability to reverse a position quickly and is usually proxied by the bid-ask spread; smaller spreads signal higher liquidity levels (Chollete *et al*., 2007: 4). Depth of the market is measured by the total number of transactions that are executed per day. The time dimension is concerned with the ability to immediately complete a transaction on an asset whilst resiliency is the power of the market to return to equilibrium after a random shock (Sarr and Lybek, 2002, Lesmond, 2005, Chollete *et al*., 2007, Gabrielsen *et al*., 2012, Fufa and Kim 2018, and Pan and Mishra, 2018).

Given the different aspects of liquidity that exist, several definitions of liquidity have been proposed, however, for the purpose of this study a working definition which encompasses the various dimensions of liquidity listed above was taken from Chollete *et al*. (2007: 4) who defined liquid markets as markets where investors had:

"… an ability to trade large quantities quickly at low cost with little price impact."

Owing to the various dimensions of liquidity, a lack of consensus on a working definition and in some cases data unavailability, various measures for it exist. There is no consensus on one agreed upon liquidity measure thus, several measures have been developed and applied by studies analysing liquidity in stock markets. These measures are spread between the trade and order-based models with the former being based on volume and turnover estimations reflecting of *ex-post* liquidity whilst the latter assess transactional aspects of the market (Chollete *et al*., 2007).

Volume based measures use the total number of stocks traded as a principal component in estimating liquidity and are the most common in the literature. There is a popular order-based liquidity measure developed by Amihud (2002) which makes the assumption that liquidity is not directly observed but is a reflection of order flow on prices. This means that if the liquidity of a security is high then it can be traded at high volumes with little price impact which is in line with the working definition adopted from Chollete *et al*. (2007). The Amihud (2002) measure calculates the illiquidity of a stock by computing the daily ratio of the absolute stock return to its Rand volume. This is calculated as follows:

$$ILLQ_{it} = \frac{1}{Days_{it}} \sum_{j=1}^{Days_{it}} \frac{|r_{i,j,t}|}{Vol_{i,j,t}} \qquad (2.4)$$

Where, $r_{i,j,t}$ represents the return for stock i on day j of month t, $Days_{it}$ are the number of days for which there was transaction data for stock i in month t and $Vol_{i,j,t}$ is the Rand volume of trade for stock i on day j in month t (Hearn, Piesse and Strange, 2010).

The resultant market illiquidity is calculated as follows:

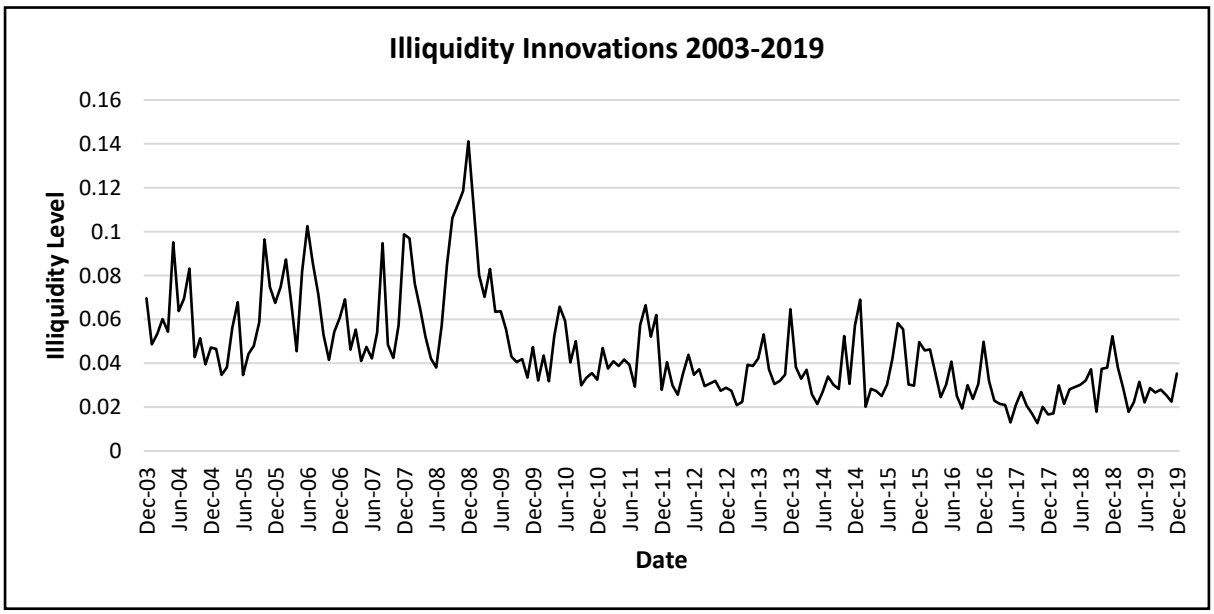
$$ILLQ_{Mt} = \frac{1}{N_t}\sum_{i=t}^{N_t} ILLQ_{it} \quad (2.5)$$

Where, $ILLQ_{Mt}$ is the market-wide illiquidity and N_t is the total number of stocks.

The Amihud (2002) illiquidity model has grown to become the leading measure of market illiquidity and studies analysing relationships amongst macroeconomic variables such as the ones by Næs *et al*. (2011) and Kim (2013) found that stock market illiquidity affected real economic output. Lou and Shu (2017) highlighted that the Amihud (2002) illiquidity measure was a widely used liquidity proxy and that between 2009 and 2015 more than one hundred and twenty articles published in the Journal of Finance, the Journal of Financial Economics, and the Review of Financial Studies had utilised this measure.

This thesis calculated the monthly Amihud (2002) illiquidity innovations of the Johannesburg Stock Exchange All Share Index (JSE ALSI) from data available from the Iress database between December 2003 and December 2019 and these are plotted in Figure 2.6.

Figure 2.6: Amihud (2002) Illiquidity Innovations on the JSE ALSI



The graph showed the trend of illiquidity on the JSE which suggested it was volatile although it was improving over time because of the declining trend in this measure (indicating increasing liquidity). It was notable that illiquidity was at its highest between June 2008 and June 2009 which coincided with the global financial crisis. Notably, Kim (2013) explained that the drying up of liquidity during the global financial crisis negatively affected the real economy meaning that during this period real economic output such as exports had declined and the findings in Figure 2.2 in section 2.2.1 complement this position. Giannellis and Papadopoulos (2016) had a similar view when they found that the dependence of the domestic industrial sector on the stock market increased during times of financial instability such as the global financial crisis of 2008.

The Amihud (2002) illiquidity innovations plotted in Figure 2.6 complements the view that illiquidity increases during economic crises and when firms' earnings potential declines. This observation would entail that the lower exports observed around that crisis period reduced the certainty on Rand leveraged firms' earnings thereby lowering their stocks' liquidity. The increased illiquidity costs would have weighed negatively on shareholders and discouraged more investments because McKane and Britten (2018) found that liquidity was a crucial factor for investment decision making on the JSE. In addition to higher illiquidity, poor or uncertain real economic prospects may cause the underlying stocks to become more volatile as investors may have to constantly adjust their evaluation. Thus, stock market volatility must be considered when one analyses the relationships between the real and financial economies.

2.2.3.2 Stock Market Volatility

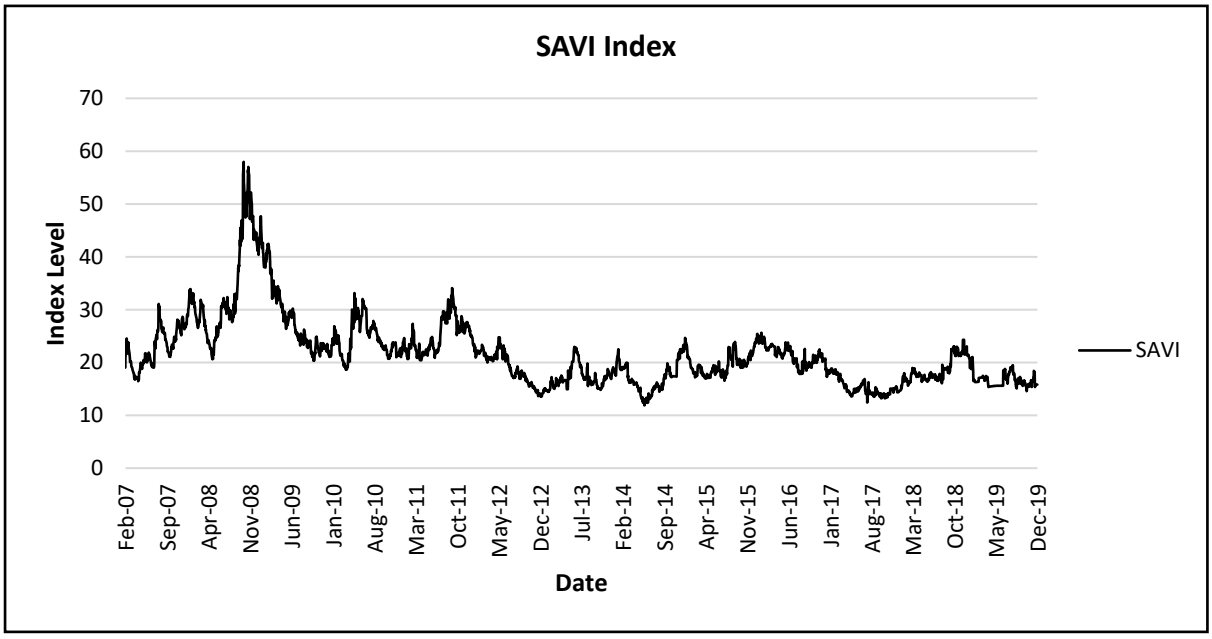
Volatility on the stock market is closely related with economic prospects because it can be viewed as a sentiment indicator that can be reflective of the future earnings prospects of listed firms (Holmes and Maghrebi, 2016). Adu, Alagidede and Karimu, (2015) observed that in emerging stock markets, the JSE included, returns tended to be volatile but predictable in the long-term. Such a finding could be reconciled with the study by Giannellis and Papadopoulos (2016) which established that the dependence of the domestic industrial sector on the stock market tended to increase during

financial crises and that there were intra-national spill-overs which were transferred through the balance sheet channel and international spill-overs which came through an indirect channel. This suggested an interplay between economic output and the stock markets, however, Pan and Mishra (2018) cautioned that the leading side of the interplay between the real and financial economies remained theoretically debatable.

Several South African studies have analysed returns on the JSE and detected volatility; Mangani (2008), Makhwiting, Lesaoana and Sigauke (2012), Mandimika and Chinzara (2012), Adu *et al*. (2015) and Makoko and Muzindutsi (2018). The studies had a consensus that volatility on the stock market was highly persistent but did not seem to be priced. Since research on volatility on the JSE suggested that said volatility was persistent, it implies that investors may be constantly adjusting their holdings in anticipation of pertinent material factors affecting their future earnings. This may hold true for stocks of resource Rand leveraged firms especially in economic downturns as suggested by the findings that during financial crises stock market volatility tended to lead a decline in real economic output such as exports.

The significance of volatility in the stock market saw the development of the South African Volatility Index (SAVI), launched in February 2007, designed to measure the JSE expectation of three-month volatility (Kotze, Joseph and Oosthuizen, 2009). The SAVI uses *at-the-money* call options expiring in three months' time to estimate volatility based on the JSE's Top 40 firms. Kotze *et al*. (2009: 1) highlighted that there was a negative relationship between the SAVI and the return of the market index, and that the SAVI could be referred to as a "*fear gauge*" of the market. This meant that there was an expectation that deteriorating economic prospects would be associated with an increase in the SAVI. In Figure 2.7 below, data on the SAVI, sourced from the Iress database, is presented for the period beginning February 2007 (when the index was incepted) until December 2019.

Figure 2.7: South African Volatility Index (SAVI) 2007-2019



The SAVI showed a steep increase of volatility in the period leading up to the global financial crisis and peaked in November 2008 and this was complemented by figures 2.1 and 2.2 which illustrated that during the same period, South Africa's export output deteriorated. This observation can be reconciled with the findings by Giannellis and Papadopoulos (2016) and Pan and Mishra (2018) which suggested that there were spill-overs between the real and financial economies which became more pronounced during economic crises. There was a steep decline of the SAVI as the global financial crisis waned around April 2010 after which there were two notable peaks in July 2010 and October 2011 which was a period of the European debt crisis. It is likely that the European debt crisis would affect South Africa considering that the SARB had put its largest weighting (29.26%) on the Euro area when calculating South Africa's relative price index (Motsumi *et al*., 2014). A trend of a steady decline in the index was observed with notable variability in the SAVI which suggested the likelihood of predictable real and financial economic outlook, albeit subdued.

Although stock market volatility has been widely studied, researchers are of the opinion that volatility is inherently unobservable and has been commonly estimated by either fitting parametric econometric models such as generalised autoregressive conditional heteroscedasticity (GARCH), or by studying direct indicators of volatility

such as *ex-post* squared or absolute returns (Andersen, Bollerslev, Diebold and Labys, 2001). The use of ex-post squared returns was criticised to be a crude measure of total risk of financial assets and it may not be appropriate if the exchange distribution is non-normal. The moving average as a measure of volatility has been popular but questioned since it likely underestimates the effect of exchange rate risk and could be inconsistent with the rational behaviour that economic agents have (Arize, Osang and Slottje, 2000).

The GARCH non-linear model developed by Bollerslev (1986) and Taylor (1986) is most popular when forecasting volatility because it is parsimonious, it avoids over fitting and is less likely to breach non-negativity constraints (Brooks, 2008). The model allows the conditional variance to be dependent upon previous own lags. For example, in this GARCH (1,1) variance equation (2.6):

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_{t-1}^2 \qquad (2.6)$$

σ_t^2 is known as the conditional variance because it is a one-period ahead estimate for the variance calculated based on any past information thought to be relevant. The GARCH (1,1) model written above, which is widely used, can be extended to a GARCH (*p*,*q*) formulation, where the current conditional variance is parameterised to depend upon q lags of the squared error and p lags of the conditional variance:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \, u_{t-i}^2 + \sum_{j=1}^{p} \beta_j \, \sigma_{t-j}^2 \qquad (2.7)$$

The GARCH (1,1) should be sufficient to capture volatility clustering in the data and it is not common for a higher order model to be required. South African studies on the JSE conducted by Makhwiting *et al*. (2012) and Makoko and Muzindutsi (2018) arrived at the conclusion that the GARCH (1,1) model had the highest ability to forecast volatility on both the JSE ALSI and JSE alternative index (JSE ALTX). Ordinary least squares (OLS) cannot be used in GARCH modelling because it minimises residual sum of squares (RSS) but the RSS only depends on parameters in the conditional mean equation, and not the conditional variance which makes it inappropriate. Linear

models are unable to explain some features of financial data which include leptokurtosis, volatility clustering/pooling and leverage effects (Brooks, 2008). With the GARCH model, the conditional variance depends on the lags of the squared residuals up to lag p and its own previous values up to lag q. This thesis modelled volatility using GARCH because it is more parsimonious in capturing exchange rate and stock market volatility.

2.2.4 Summary

Section 2.1 highlighted that although South Africa had a trade policy whose aim was to boost exports in order to grow the economy, this goal has remained unrealised. It suggested that there was need to focus on South Africa's exports so that they prioritise high growth emerging market economies especially in Africa. Further, motivations for export analysis to consider relationships between the real and financial economies were suggested as steps that would assist with the formulation of a more comprehensive trade policy. Section 2.2 has provided an overview of South Africa's exports, their behaviour and contribution towards economic growth from 2003 until 2019. It was apparent that exports grew at the same pace with economic growth as illustrated by the largely constant export to GDP ratio. The exports have not risen to become a more significant contributor to GDP growth despite having a policy in place which seeks to boost economic growth by increasing export output. In addition, the exports were not diversified, rather, they were concentrated within the mining resources sector; a trend that did not change over the period of study. During the period studied, the Rand's real effective exchange rate declined, illustrating a gradual deterioration of the Rand's strength against major currencies. This weakness could have had a positive effect on the export volumes because total nominal export volumes grew, however, other factors must be considered, and econometric analysis must be conducted before such a conclusion is arrived at.

A case for the inclusion of the financial economy was made in line with this study's objective of incorporating the financial market variables into export behaviour. It pointed out that the financial markets and the real economy were linked through both direct and indirect channels and that resource stocks were Rand leveraged. This

suggested that stock market activity could be linked to the real economy because there was likely a symbiotic relationship between the real and the financial economies which was suggested to strengthen during economic downturns. In addition, it was highlighted that investors preferred higher liquidity and that when illiquidity and stock market volatility increased poorer export output was either already realised or expected. To that end, section 2.2.3 looked at stock market illiquidity and stock market volatility as financial market variables. The theoretical assertions were that stock market volatility and illiquidity would most likely be negatively associated with export output. It was noted that there were various measures of volatility and stock market liquidity measures and resolved to employ GARCH volatility measurement and used the Amihud (2002) illiquidity measure. It was noted that during financial crises, economic and financial time-series changed their behaviour, and this would likely have implications on the relationships between the real and financial economies.

Although the common practice has been linking exports growth to exchange rate volatility and relative prices, recent developments validate the consideration of the financial economy. The endogenous growth theory by Levine and Zervos (1996) and the subsequent studies by Kayacetin and Kaul (2009), Næs *et al*. (2011) and Kim (2013) showed the real economy and the financial economies were supposed to be viewed as being interrelated. For instance, Næs *et al*. (2011) showed that liquidity was related with the real economy and could predict economic aggregates such as, economic growth (changes in GDP), investments, among others using quarterly data while Chen, Chou, and Yen (2015) showed that liquidity could predict turning points in the economic growth patterns. Chipaumire and Ngirande (2014) concluded that stock market liquidity had an impact on growth in South Africa, while a study in Nigeria by Ogunmuyiwa (2010) noted that investor sentiment of the stock market was crucial for economic growth and development. In addition, the study suggested that stock market liquidity and investor sentiment Granger-caused economic growth (Ogunmuyiwa, 2010).

There is reasonable evidence which compels this thesis to consider the financial economy in its analysis of South African export growth. Another important issue is how best the analysis could be undertaken considering that varied methods of analysis

exist and given that phenomena such as volatility of variables and financial crises can influence the observed relationships. There is extant literature on export analysis, and this made it essential to conduct a comprehensive review of the literature before this thesis undertook its own analysis of South Africa's exports. The following section undertook a literature review where it focused on the variables, samples and methods employed by similar studies.

2.3 Literature Review

While section 2.2 made a compelling case for consideration of both the real and financial economic variables when analysing South Africa's exports, this section reviews the studies that modelled export behaviour by focusing on the modelling techniques and the variables that were considered. Further, the review unravels the gap of employing non-linear modelling first motivated for in section 1.2 as well as highlighting the exchange disconnect puzzle. In addition to highlighting the gaps in the literature, this review reconciles the various studies to establish commonality in their findings. To aid with highlighting the modelling gap identified in the previous chapter, this review has broadly divided the literature into two: the ones that used linear modelling techniques and those that employed non-linear models.

Grouping the studies based on either linear or non-linear models was essential because it unravelled the evolution of modelling techniques; illustrating how the latter studies have gravitated towards non-linear modelling. Further, it helped show the commonality of the techniques used by either South African or international studies. The literature review noted that the main methods of analysis were cointegration and the ARDL model. Data sampling tended to be over a ten to twenty-year period using quarterly data, although a few of the more recent studies used monthly frequency.

Although the literature was grouped based on modelling techniques, the most common element on all studies was that the main factors employed as explanatory variables were exchange rate volatility, foreign income and relative prices. This observation highlighted the dominance of real economic variables in the analysis of export behaviour, as explained in Chapter 1. The next section chronologically reviews studies

that employed linear modelling techniques to analyse export behaviour; these studies provide a foundational background from which latter studies developed.

2.3.1 Review of Studies with Linear Modelling

Linear regression analysis fits a model with one mean where the underlying assumption is that positive and negative shocks of the same magnitude from a regressor yield similar responses from the dependent variable (Shin, Yu and Greenwood-Nimmo, 2014). Linear modelling techniques have proven to be popular, however, latter studies have critiqued them for being overly restrictive. Sections 2.3.1.1 and 2.3.1.2 respectively review South African and international literature that employed linear-based modelling techniques to analyse export growth and behaviour.

2.3.1.1 South African Literature

South African studies analysing export behaviour tended to increase after economic liberalisation that culminated with the adoption of a fully freely floating Rand exchange rate in 2000 (Aron, Farrell, Muellbauer and Sinclair, 2014). Most of the studies were motivated by the assumption that exchange rate volatility would depress South Africa's exports. One of the earliest studies after the full liberalisation of the Rand exchange rate was conducted by Bah and Amusa (2003). Their study analysed South Africa's exports to the USA between the first quarter of 1990 and the last quarter of 2001 after hypothesising that exchange rate volatility would be a major source of trade depression. Bah and Amusa (2003) analysed export relationships with exchange rate volatility together with relative prices and foreign income using the Johannsen multivariate cointegration technique. Their study which had used the autoregressive conditional heteroscedasticity (ARCH) and the GARCH to measure exchange rate volatility, found that the Rand's volatility significantly depressed South Africa's exports in both the long-run and the short-run. This led them to make the conclusion that a stable currency together with sound macroeconomic fundamentals would enhance South African export growth (Bah and Amusa, 2003).

Todani and Munyama (2005) investigated how short-term volatility of the Rand affected export flows to the rest of the world on quarterly data between 1984 and 2004 using the ARDL model by Pesaran, Shin and Smith (2001). As explanatory variables to aggregate exports to the rest of the world, their study used relative prices, foreign income and exchange rate volatility. The study employed two volatility measures; the GARCH model and standard deviation of the moving average citing that at the time literature had no unanimity on the better volatility estimation method. The results obtained by Todani and Munyama (2005) suggested that the relationship between South Africa's exports and exchange rate volatility was either insignificant or positive.

In a study similar to the one by Bah and Amusa (2003), Takaendesa, Tsheole and Aziakpono (2006) examined South Africa's exports to the USA on quarterly data between 1992 and 2004. Their analysis employed cointegration techniques to estimate the short-term and long-term dynamics in addition to variance decomposition analysis to help understand the proportions of shocks by macroeconomic fundamentals to South Africa's exports. In addition to volatility, which was estimated using the exponential generalised autoregressive conditional heteroscedasticity (EGARCH), real economic variables of foreign income and relative prices were employed as explanatory variables (Takaendesa *et al*., 2006). They reached the conclusion that exchange rate volatility had a statistically significant negative effect on South Africa's exports to the USA.

Bah and Amusa (2003) and (Takaendesa *et al*., 2006) who both studied aggregated exports to the USA using similar methodologies and data frequency arrived at a reconcilable conclusion. In contrast, Todani and Munyama (2005) who used the ARDL model albeit on aggregated exports to the world, arrived at the conclusion that exchange rate volatility did not have a highly significant impact on exports and where it was significant, the effect was positive. This raised the possibility of exchange rate volatility not being universally reliable as a factor and modelling techniques having a bearing on observed relationships. Further, the lack of unanimity in the findings on exchange rate volatility fail to provide a concrete position on whether the volatility was indeed a concern for exporters. This created an opportunity for later studies to employ

other macroeconomic variables in addition to exchange rate volatility together with newer modelling techniques.

Schaling (2007) considered relationships between exchange rates, inflation and international competitiveness on South Africa's trade balance on quarterly data between 1994 and 2006. The study employed Johannsen's vector error correction model (VECM) to analyse the relationships and considered competitiveness as the real effective exchange rate. Schaling (2007) observed that a rise in the domestic price level which was faster than that of trading partners reduced competitiveness in the export market and that higher inflation appreciated the real exchange rate. This led to the conclusion that to boost exports, it was more important to focus on accessing rapidly growing markets and increase efficiencies in domestic production processes than to be concerned by exchange rate volatility (Schaling, 2007).

Although Schaling (2007) took a different angle by considering the instruments of the monetary policy, it provided a more holistic approach to the area of export growth and notably arrived at a conclusion similar to that of Todani and Munyama (2005) who stated that exchange rate volatility was not a crucial factor driving export behaviour. Further, it meant that exchange rate volatility was not supposed to worry policy makers, rather policies should be more concerned with the relative price levels because they dictated how expensive South Africa's exports were on the international markets.

A study by Sekantsi (2011) assessed the real exchange rate impact on South African quarterly exports to the USA between 1995 and 2007 using the ARDL model. As additional factors to exchange rate volatility, which was estimated using the GARCH model, the study employed foreign income, relative prices (which they motivated to proxy competitiveness of the products in international markets) and a dummy variable to capture the time when the African Growth and Opportunity Act (AGOA) trade agreement was put into effect in 2000. The study established that exchange rate volatility had a negative effect on South Africa's exports to the USA whilst a rise in foreign income increased them. These findings were consistent with those obtained by the earlier studies by Bah and Amusa (2003) and Takaendesa *et al*. (2006) who

had found exchange rate volatility to have a significantly negative effect on South Africa's exports to the USA.

Most of the earlier studies focused on total exports to the world or the USA, but Wesseh and Niu (2012) focused on both aggregate and disaggregated South African exports to China. Their study considered both quarterly data on exports (from 1995 to 2010) and monthly data on exports (from 1992 to 2010); analysing them using the ARDL model whilst estimating exchange rate volatility using both the standard deviation of the moving average and the GARCH model. In addition to exchange rate volatility, their study considered foreign income and relative prices as explanatory variables. While Wesseh and Niu (2012) found foreign income positively linking with total export growth to China, relative prices carried the opposite sign which was unexpected. They found that exchange rate volatility tended not to affect aggregate South African exports, however, when exports were disaggregated by product category, the effects could be positive, negative or non-existent depending on the export product category (Wesseh and Niu, 2012). Notably, the mineral products to China which have the largest contribution were not affected by the exchange rate volatility.

The study by Wesseh and Niu (2012) was significant because it considered monthly product-level exports in addition to the aggregated exports which most South African studies did not do. The benefit of the study was that it had a higher frequency data and in addition, it analysed exports to an emerging market economy which the study by Schaling (2007) had motivated for when it stated that focus ought to be put towards destinations with a high affinity for economic growth. The findings showing exchange rate volatility not being a major factor affecting exports contradicted those analysing exports to the USA which showed it to be a major factor. A related study which was undertaken by Nyahokwe and Ncwadi (2013) analysed South African monthly exports to the rest of the world between 2000 and 2009. Their study, which considered relative prices and money supply as additional variables to exchange rate volatility, employed the VECM. They were unable to establish a statistically significant relationship between exchange rate volatility and exports.

After noting the importance of exports for South African economic growth, Chang, Simo-Kengne and Gupta (2013) investigated causality between South African GDP and exports from South Africa's nine provinces. Their study, which used annual data, applied a panel granger causality analysis and established that there was unidirectional causality from GDP to exports in Mpumalanga province, but bidirectional causality was established in Gauteng province. However, no causality was established for the remaining provinces, although they found that the provinces were highly integrated suggesting that they were complementary in growing exports (Chang *et al*., 2013). Although Chang *et al*. (2013) study did not consider multiple variables, their findings accommodated the growth-led exports thesis which hugely influenced earlier studies that only considered real economic variables as influencing exports.

Khosa, Botha and Pretorius (2015) used panel data analysis to evaluate the impact of exchange rate volatility on the exports of nine emerging market economies namely Argentina, Brazil, India, Indonesia, Mexico, Malaysia, Poland, South Africa and Thailand on a monthly basis between 1995 and 2010. Other explanatory variables for the study included foreign income, relative prices and terms of trade; exchange rate volatility was estimated using standard deviation of the moving average and the GARCH model. After analysing the export relationships using panel data and the Pedroni residual cointegration method, Khosa *et al*. (2015) established that in addition to having long-run relationship with exports, exchange rate volatility negatively affected exports regardless of the volatility measure used.

After noting that South Africa's export performance was underperforming when compared with other developing countries with a relatable profile since the unravelling of the 2008 global financial crisis, Fowkes, Loewald and Marinkov (2016) investigated the potential role of the exchange rate on South Africa's exports. Fowkes *et al*. (2016) hypothesised that the decline of both South Africa's exports and economic growth could have been exacerbated by either high Rand exchange rate volatility or the exchange rate level. Their analysis, which was conducted on quarterly data between 1995 and 2012, formulated an export demand function for South Africa's manufactured exports (gross value added) and had relative prices, foreign demand, and exchange rate volatility as explanatory variables. To evaluate the macroeconomic relationships,

Fowkes *et al*., (2016) used impulse response functions, variance decompositions and a smooth transition model while estimating exchange rate volatility using standard deviation and GARCH modelling. The study established that exchange rate volatility was not a significant factor for South Africa's manufactured exports. However, the exchange rate level or relative prices was significant, in addition, a lower currency valuation seemed to favour the expansion of exports (Fowkes *et al*., 2016).

South African studies reviewed above highlight the existence of the exchange disconnect puzzle as exchange rate volatility did not prove to be a universally dependable explanatory variable for export behaviour. There is strong evidence form the literature that the exchange rate level as measured by the relative prices are much more consequential for exports; where, lower relative prices boosted South Africa's exports. Fowkes *et al*. (2016) also noted this phenomenon by stating that while literature on South African exports was extant, it had not been able to provide conclusive findings on whether the Rand's exchange rate volatility inhibited exports.

The phenomenon of failure to conclusively establish the impact of exchange rate volatility on exports and other macroeconomic variables contributed to South African studies such as Aye, Gupta, Moyo and Pillay (2015) and Ajmi, Aye, Balcilar and Gupta (2015) considering the possibility of model risk in previous studies. Since the erstwhile studies conducted their analyses using linear-based methodologies, it left a gap in knowledge with respect to possible non-linear relationships between exports and macroeconomic variables. This is because not much is known regarding the possible asymmetric responses that exports may have to shocks of the popular explanatory variables of foreign income and relative prices especially in varying business cycles notwithstanding the fact that there was more unanimity on their significance under the linear models. In addition, the financial economic factors, which have been largely overlooked, may possess some non-linear relationships with South Africa's exports. The studies reviewed above had an apparent focus on real economic variables as the main factors affecting exports. However, in chapter 1 and section 2.3, it was made clear that both real and financial economies can have an influence on export behaviour, thus, the financial economy ought to be considered. This left a research

gap needing exploration: to examine the role of the South African financial economy in the behaviour of exports.

It was evident that earlier studies mainly used quarterly data for periods ranging from ten to twenty years which may have limited the statistical power of their models. This is because using low frequency data with few observations smoothens actual exchange rate variability thereby dampening the ability to detect the trade-risk relationship (McKenzie, 1999 and Wang and Barrett, 2002). Nearly all South African studies (except for Wesseh and Niu, 2012) used aggregated trade data however, the implication of aggregation is that exchange rate volatility effects are uniform across countries, economic sectors and firms (Sekantsi, 2011 and Wesseh and Niu, 2012). Thus, by employing monthly data on exports to various destinations that are disaggregated by product category may provide a more comprehensive understanding around these issues; this is a limitation that this doctoral thesis aims to address.

2.3.2.2 International Literature

Interest in analysing export growth and behaviour grew internationally since the collapse of the Bretton Woods system of fixed exchange rates as researchers sought to evaluate the effect that currency volatility would have on global trade (Chang *et al*., 2013). The findings obtained by international studies provides a broader perspective of this macroeconomic discussion especially in assisting to address some of the limitations of South African studies that were reviewed in section 2.3.1.1. International literature with similar objectives to the South African studies were helpful in addressing the problem of the exchange disconnect puzzle in addition to assessing the commonality of methods and subsequent findings.

Sauer and Bohara (2001) noted that there was a theoretical expectation that exchange rate volatility and international trade, erstwhile studies at that time seemed to suggest that the impact of exchange rate volatility was ambiguous. Consequently, their study employed a panel data model to analyse annual trade for ninety-one countries for twenty-three years. These countries which comprised developed and emerging market economies also included South Africa and their panel data approach

comprised both random and fixed effects methodologies. The results obtained by Sauer and Bohara (2001) showed that the negative effects of exchange rate volatility tended to affect the developing markets in Latin America and Africa but not for those emanating from Asia or developed countries. These results confirmed their initial assertions that exchange rate volatility effects tend to have an ambiguous effect on trade. This led to the conclusion that each trade scenario ought to be tested before a position on the effect of exchange rate volatility could be taken.

Egger (2001) used dynamic panel data analysis to study the relationships and determinants of bilateral trade and FDI between European Union (EU) member states. The study found that exports and the stocks of outward FDI were substitutes with respect to changes in transport costs but were compliments with respect to most of the other determinants. Hsiao and Hsiao (2006) who employed panel data analysis between 1986 and 2004 to examine Granger causality between GDP, exports, and FDI in East and South-eastern Asian emerging market economies namely China, Korea, Taiwan, Hong Kong, Singapore, Malaysia, Philippines, and Thailand. They estimated a vector autoregression (VAR) model for the three variables to establish the Granger relationships and panel data analysis using fixed and random effects for each of the emerging economies. They established that FDI had unidirectional causality on GDP, indirect causality on exports but, there was bidirectional causality between exports and GDP. Hsiao and Hsiao (2006) stated that their results from panel data causality had superior results compared to time-series causality analysis.

Some later studies have attempted to address the exchange disconnect puzzle and one of these studies was conducted by Choudhry and Hassan (2015). Their study investigated how exchange rate volatility influenced the UK's trade with three developing countries: Brazil, China and South Africa. Their study which spanned from January 1991 until December 2011 focused on the third-country effects phenomenon (estimated by the British Pound and US Dollar volatility) influence on the trade whilst employing the ARDL methodology. Their study found third-country effects were significant for trade with all the three countries included in the analysis. Their study concluded that policies that minimise exchange rate volatility would benefit trade

between the UK and the three trading partners after finding that the volatility of direct exchange rates with the countries analysed had an inhibiting effect on trade.

Another study which considered third-country effects was conducted by Bahmani-Oskooee, Hegerty and Xi (2016a). Their study analysed the trade relationship between Japan and the USA between 1983 and 2013 on a monthly basis. Cognisant of the exchange disconnect puzzle, Bahmani-Oskooee *et al*. (2016a) employed third-country effects which were estimated as the volatility of both the Yen-Renminbi and Dollar-Renminbi exchange rates. After applying ARDL cointegration methodology to eighty-eight export industries and eighty-nine import industries individually, they found that not more than half of the firms were affected by Dollar/Yen volatility, and of those, more than half were negatively affected (Bahmani-Oskooee *et al*., 2016a). Third-country effects were significant in a similar proportion of cases, although more USA export industries increased because of external risk, suggesting that traders were attracted to the Japanese market because of events in China at that time.

Vieira and MacDonald (2016) investigated the impact of real effective exchange rate volatility on export volumes as well as the impact of the 2008 financial crisis for one hundred and six countries between 2000 and 2011. The study established that increase in real effective exchange rate volatility reduced export volumes and the opposite was true when volatility was lower. However, they established that the results were not robust when oil exporting countries were removed from the sample, further, the study observed that export volumes increased after the financial crisis of 2008. Vieira and MacDonald (2016) concluded that policy makers should put in place measures that protected against currency fluctuations if exports were to be harboured. This study made a notable addition by being cognisant of the fact that financial economic cycles which included the global financial crisis weighed on observed exports which highlights the interdependence between the real and financial economies.

Bahmani-Oskooee, Nosheen and Iqbal (2017) assessed 116 USA export industries to Pakistan between 1980 and 2014 on an annual basis. Their study employed the ARDL model on and considered third-country effects which were proxied by the Rupee-Yen

volatility and Dollar-Yuan volatility, motivated by the increased role of China in the global economy. Their study established that third-country effects were significant in more than half of the industries, and particularly for large exporting USA industries. Their findings highlighted the significance of not only considering the bilateral but including the exchange rate volatilities of trade competitors. These findings which were reconcilable with those obtained by Choudhry and Hassan (2015) and Bahmani-Oskooee *et al*. (2016a) suggested that there was value in considering third-country effects in addition to exchange rate volatility which had been shown to be ambiguous.

Meniago and Eita (2017) focused on Sub-Sharan trade after noting that trade openness was being adopted in these emerging market economies where freely floating exchange rate regimes which likely exposed them to exchange rate volatility. Consequently, they investigated exchange rate volatility effects on trade in thirty-nine selected Sub-Saharan Africa (including South Africa) using annual data between 1995 and 2012 using panel data analysis. To estimate exchange rate volatility, Meniago and Eita (2017) employed three different measures, namely, standard deviation, GARCH and Hodrick-Prescott filter. Their analysis led to the findings that the choice of volatility measure impacted on their observations on exchange rate volatility on trade in the Sub-Saharan region. When exchange rate volatility was estimated with standard deviation and the Hodrick-Prescott filter, it depressed exports (and imports as well), however, the negative impact was minimal suggesting that if there were to be a policy to reduce the volatility, it would be of little value.

The findings that were obtained by the international studies had reconcilable conclusions with those made by South African literature. These studies which employed linear models and were moulded in the form of the South African studies reviewed in 2.3.1.1 provided the perspective that third-country effects helped address the exchange disconnect puzzle. Although linear modelling such as Johansen's cointegration and the ARDL were popular in related studies (especially true in the South African context), usage of non-linear modelling is gaining popularity because of the realisation that non-linear models are better able to capture more sophisticated relationships of macroeconomic variables. The non-linear models used to capture econometric relationships between variables such as that of exports against several

different macroeconomic variables include the non-linear ARDL (NARDL), the quantile ARDL (QARDL), threshold modelling and the Markov-Switching regressions. These more sophisticated models may be essential to capture the nuances of South African export demand functions; something necessary improve trade policy to enhance exports given the current scenario of weak economic growth.

By employing these non-linear models to estimate South African export demand, this thesis makes an original contribution towards a better understanding of export growth. In addition, this thesis's analysis provides a unique input towards the formulation of improvements to South Africa's trade policy. Improvements to the trade policy are essential because the current policy objective of contributing more towards economic growth has not been realised and policy enhancements are essential.

2.3.2 Literature with Non-linear Modelling

Non-linear methods are beginning to grow in popularity due to their more flexible assumptions of data series, chief of which is that economic series tend to change their behaviour over time and that positive and negative shocks of the same magnitude do not always yield comparable responses. However, it is notable that South African studies mostly employed linear models with notable exceptions being Ajmi *et al*. (2015) and Aye *et al*. (2015) who began to consider non-linearity in the modelling of export behaviour.

One notable South African study conducted by Pretorius and Botha (2007) considered the forecasting accuracy of a pure linear multivariate ordinary least squares (OLS) model and a non-linear smooth transition autoregressive (STAR) specification of a macroeconomic model. Their used quarterly data between 1990 and 2004 to forecast the relationship between exports (without gold); international commodity prices and the Rand/US Dollar exchange rate. Pretorius and Botha (2007) found results which suggested that STAR models produced more accurate forecasts compared to purely linear models. The results of their paper speak to the potential value of unpacking non-linear analysis in this space, to deepen and improve understanding of macroeconomic relationships.

A study by Aye, Gupta, Moyo and Pillay (2015) examined the impact of real effective exchange rate uncertainty on South African quarterly aggregate exports to the world between 1986 and 2013. Their study used the GARCH-in-mean (GARCH-M) model in a bivariate model where real effective exchange rate and its lags were the explanatory variables. They found that uncertainty of the real effective exchange rate had a negative effect on South Africa's exports and after incorporating asymmetries based on propositions by Engle and Kroner (1995) they established that real exports responded asymmetrically to negative and positive shocks to real effective exchange rate shocks of the same size. These findings were essential in proving that erstwhile South African studies may have benefited from considering non-linearity; further, it highlighted that non-linearity ought to be considered when analysing export demand functions.

Ajmi, Aye, Balcilar and Gupta (2015) investigated the link between South African annual exports and economic growth between 1911 and 2011 using Granger causality tests. Their analysis established that there was no causality of statistical significance between the two variables and that the resulting vector autoregression (VAR) was unstable, leading them to consider non-linear methods of analysis. Ajmi *et al*. (2015) applied the Hiemstra and Jones (1994) non-linear Granger causality test which established unidirectional causality from GDP to exports an in another non-linear test, the Diks and Panchenko (2006), showed that there was bi-directional causality. This led them to make the conclusion that non-linearities and structural breaks ought to be considered if the econometric relationships are to be better understood.

Foster (2006) examined the relationship between exports and economic growth in Africa using threshold regression. The model was used to establish if African countries benefited more from exports when they had reached a certain level of development and openness. The study suggested that there was a positive relationship between exports and growth in Africa and the threshold model showed that it was not necessary for a country to reach a certain level of development or to have an existing export base for this relationship to hold, although the relationship was stronger for countries with higher rates of export growth. The study by Djeddour and Boularouk (2013) focused on the specification of the threshold autoregressive (TAR) model to forecast USA oil

exports between 1991 and 2004. They found that, when compared to linear autoregressive moving average (ARMA) models, the TAR model was a better predictor of USA's oil exports.

An international study by Yasar, Nelson and Rejesus (2006) analysed the productivity and exporting status of firms in Turkey using quantile regressions after noting that OLS estimates were adversely influenced by outliers. They arrived at the conclusion that continuously exporting firms were more productive, and this was pervasive along the conditional output distribution; increasing toward the upper tail of the distribution (Yasar *et al*., 2006). A similar study by Wagner (2006) using quantile regression on Germany manufacturing plants found that the impact that plant characteristics had on export activities varied according to export/sales ratio. The study carried the opinion that its findings assisted in crafting better policies to suit firms with different characteristics falling in the different quantiles (Wagner, 2006).

Vu, Holmes, Lim and Tran (2014) analysed the relationship between exports and profit in Vietnam between 2005 and 2009. Their study used a panel data quantile approach which unravelled that export participation was positively related with firms with higher profits and lower for those with less profits. However, no relationship could be established when the OLS method was used. Vu *et al*. (2014) concluded that productivity advantages of exporters with low profit growth were absorbed by costs relating to trading activities in overseas markets. In a similar study, Shahbaz, Zakaria, Shahzad and Mahalik (2018a) examined energy-growth linkages in top ten energy consuming countries using quantile-on-quantile method on quarterly data between 1960 and 2015. They posited that quantile-based regressions allowed for a more precise description of the dependence structure that existed between economic growth and energy consumption, which conventional OLS could not do.

Lee and Huang (2002) used a multivariate threshold autoregressive (MTAR) model which was introduced by Tsay (1998) to measure the causal relationship between exports and economic growth in East Asian countries. Their MTAR model had two regimes defined by the threshold variable between 1961 and 2000 using quarterly data. The results showed that for some outward-oriented countries, the conventional

approach allowing for one regime was unable to determine the existence of an exports-led growth relationship; but their two-regime MTAR found strong evidence of an exports led-growth relationship.

A recent study by Tansuchat and Yamaka (2018) developed the Markov-Switching autoregressive distributed lag (MS-ARDL) model, which accounts for short-run and long-run non-linearities, to analyse Thailand's rice exports to Nigeria. They found that the MS-ARDL captured both short-run and long-run behaviours of export demand in the two regimes. A similar study by Boonyakunakorn, Pastpipatkul and Sriboonchitta (2018) forecasted Thailand's exports to the Association of South East Asian Nations (ASEAN) countries from January 2002 until December 2016 using monthly data. The study established that exports to ASEAN were non-linear after conducting linear tests and, in addition, there were two thresholds that were established. The Boonyakunakorn *et al*. (2018) arrived at the conclusion that amongst threshold models, the SETAR model was most suitable for forecasting.

Bahmani-Oskooee and Arize (2020) noted that African countries had received the least attention on the analysis of exchange rate uncertainty on trade. They proceeded to use NARDL models on exports and imports after utilising GARCH as a volatility measure. Bahmani-Oskooee and Arize (2020) employed quarterly data between 1973 and 2015 and sampled 13 countries (including South Africa) Their results suggested that there were significant long-run effects in a third of the countries, when they employed non-linear models, they discovered that long-run effects become more significant in almost all the import and export demand functions for all the countries sampled.

Analysis of international trade using methods that account for non-linearity is continuing to gain popularity and Hunegnaw and Kim (2020) analysed the effect of real exchange rates on the trade balance in East Africa. Their study employed both the linear ARDL in a pooled mean group (PMG) and NARDL models on agriculture, manufacturing and mining sectors using annual data between 1980 until 2016 on twelve East African countries: Burundi, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Tanzania, Uganda, and Zambia. In

addition to the real effective exchange rate, GDP and foreign income were employed as control variables. Hunegnaw and Kim (2020) found that results from the linear ARDL model run using the PMG and dynamic fixed effects models implied that in the long-run, a depreciation of the real effective exchange rate improved manufacturing and mining trade balances while worsening that of agriculture. In addition, the NARDL suggested that the asymmetric effects were only present for trade balances for real effective exchange rate on the manufacturing sector. The study recommended that sector analysis was better than aggregated analysis on trade because sectors had varying exposures to identified risk factors (Hunegnaw, and Kim, 2020).

After noting the need for analysis of exchange rate volatility and trade flows in emerging markets, Bahmani-Oskooee and Arize (2020) analysed the impact of exchange rate volatility on imports and exports of thirteen African countries namely; Algeria, Cameroon, Ethiopia, Ghana, Kenya, Mauritius, Morocco, Nigeria, South Africa, Tanzania, Tunisia, Uganda and Zambia to exchange rate volatility. In each of the county's demand functions, they employed world income, real effective exchange rate and the volatility of the real effective exchange rate as explanatory variables. Their study found that after employing the linear ARDL, there were significant long-run effects in a third of the countries but when the NARDL analysis was utilised, they found significant long-run asymmetric effects on trade flows for most of the countries. For South Africa, they found some asymmetric adjustments on trade to changes of exchange rate volatility. Bahmani-Oskooee and Arize (2020) outlined that their results implied that policy makers who had an export-oriented economic policy could be guided by their findings on investing in sectors that benefit from volatility of the exchange rate in cases where a floating exchange rate was in effect.

Dada (2020) analysed the effect of asymmetric structure of exchange rate volatility on trade for seventeen countries in the sub-Saharan region; Burundi, Cameroon, Central African Republic, Congo, Cote d'Ivoire, Equatorial Guinea, Gabon, The Gambia, Ghana, Lesotho Malawi, Nigeria, Sierra Leone, South Africa, Togo, Uganda and Zambia between 2005 and 2017. The study employed the GARCH (1,1) and asymmetric components of exchange rate volatility were generated using the cumulative partial sum by Granger and Yoon (2002) while the analysis was conducted

using the two-step generalised method of moments to address the endogeneity problem. Dada (2020) found that there was persistent volatility clustering in the region and the volatility had a negative effect on trade in the region and the effect of negative volatility was higher than that of positive volatility. This led to the recommendation that risk diversification for traders was essential and regulators needed to stabilise their exchange rates in the region.

Studies employing non-linear methods of analysis on exports broadly dealt with non-linearity in two ways. The first one was to break the time-series into quantiles and the second was to consider regimes or thresholds which were applied in either a purely time-series or panel data format. Quantile regressions established how the export relationships changed from one percentile of the observations to the next while threshold analysis was used to identify the various levels of a state variable which when reached resulted in a change of the observed relationships. Both these non-linear methods enable to obtain more sophisticated relationships of the exports and economic variables which add valuable knowledge on export behaviour in the South African context.

2.4 Summary

The literature review showed that the South African studies which included Bah and Amusa (2003), Aziakpono *et al*. (2005) and Schaling (2007) used Johansen's cointegration and found that exchange rate volatility negatively affected South Africa's quarterly exports. Progressively, latter domestic and international studies tended to use the ARDL framework and these include Todani and Munyama (2005) who found that negative effects of currency volatility on exports between 1984 and 2004, with similar findings made by Sekantsi (2011) between 1992 and 2010 on quarterly data. However, Wesseh and Niu (2012) concluded there was no effect of currency volatility on both monthly and quarterly exports to China. Nyahokwe and Ncwadi (2013) made similar conclusions about exchange rate volatility on exports to the world between 2000 and 2009.

The findings in South African studies were mixed although there was an inclination to the conclusion that exports were negatively affected by exchange rate volatility. International studies showed that there was value in considering third-country effects. It was also evident from the international literature that non-linear modelling was increasingly popular – likely due to the fact that these models are better suited to data such as these. Specifically, models such as the TAR were more advantageous due to their capacity to measure relationships simultaneously between the dependent and explanatory variables (Aleem and Lahiani, 2014). Khosa *et al*. (2015) noted that it could be possible that volatility of the exchange rate may have a relationship if it reaches a certain threshold and this can be determined by the threshold models. Dynamic panel data models can be applied with non-linear relationships such as quantile and regime-switching considerations (Hu, Guo, Deng and Wang, 2014).

Another clear omission from South African literature was that of not unravelling and exposing the financial economic relationship with exports even there is literature suggesting a relationship between the real and financial economies. The finance-led growth hypothesis and the endogenous growth theory developed by Levine and Zervos (1996) which were largely overlooked my South African studies analysing export behaviour must be considered given the urgent need to boost economic growth. Levine and Zervos (1996) who had established a strong positive relationship between stock market development as measured by stock market size, liquidity and international integration and long-run economic growth as measured by GDP meant that growth in the financial sector warranted growth in the real sector. South Africa has a relatively well-developed financial economy compared to other Sub-Saharan economies; however, it is currently on a low economic growth trajectory compared with other economies on the African continent with lesser developed financial markets. This is another reason to investigate how crucial real economic factor such as exports relate with financial economic factors in the South African context.

Given the increasing episodes of exchange rate volatility and likelihood of structural breaks in South African export series, the models such as the TAR and Markov-Switching models are especially beneficial for this study. As highlighted in section 1.5 these methods of analyses are considered by this study which fills gaps identified by

the research objectives listed in section 1.4. However, for the contributions to be explicitly evaluated, the starting point would be that of building from the popular linear models whilst applying variables from the financial economy as motivated for in section 2.2.3. This is performed on a more recent dataset before delving into the non-linear models some of which have been reviewed in this chapter.

The following chapter modelled South Africa's exports to the world whilst incorporating both real and financial economic variables. Analysis of exports which considers the financial economy and non-linear analysis help inform and refine South Africa's trade policy, which is crucial considering the current circumstances of weak economic growth. Consequently Chapter 4 and 5 investigate the significance of considering non-linearities when modelling South African export demand functions; the former considering non-linearity and quantile dependency while the latter considers threshold relationships and regime-switching behaviour. Chapter 6 undertakes a cross-sectional analysis by utilising dynamic panel data and threshold panel data modelling.

CHAPTER 3: THE MODELLING OF SOUTH AFRICAN EXPORTS WITH STOCK MARKET LIQUIDITY[3]

3.1 Introduction

Sustainable economic growth is a priority objective for policy makers in emerging markets, however, this goal is often elusive in these economies (Ademola, Bankole and Adewuyi, 2016). South Africa faces a long-term economic growth dilemma; the current annual growth rate is projected to remain below 1% per annum for the foreseeable future unless interventions are made (Fedderke and Mengisteab, 2017). Agencies such as the International Monetary Fund (IMF) (2019) and South African Reserve Bank (SARB) (2019) expressed the view that exports are a key avenue for increasing South Africa's annual economic growth rate. The view of exports as an avenue for growth emanates from the assumption that they bring benefits that include foreign currency earnings, labour assimilation, international portfolio flows, product demand during domestic economic downturns and positive trade balance *inter alia* which South Africa needs (Haddoud, Nowinski, Jones and Newbery, 2019).

South Africa's trade policy remains consistently outward-looking with the objective of fostering long-term economic growth with price stability (Calì and Hollweg, 2017). This chapter investigated whether the scope of this policy must be broadened for financial economic considerations based on the endogenous growth theory by Levine and Zervos (1996), which postulates that the depth of a stock market fosters long-run economic growth because it facilitates efficient allocation of resources, capital accumulation and technological innovation.

There is growing literature in emerging markets analysing real economic growth. These include the work of Pradhan, Arvin and Hall (2019) who studied twenty-five Association of Southeast Asian Nations (ASEAN), Kar, Nazlioglu and Agir (2011) who reviewed fifteen Middle East and North African (MENA) countries and Enisan, and

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Olufisayo (2009) who analysed seven Sub-Saharan countries. In these studies, there is a view that the role of the financial economy in fostering real economic growth tends to get overlooked. It is relevant to conduct similar analysis in the South African context considering that Yartey and Adjasi (2007) noted that South Africa had a relatively well-developed financial economy compared to other Sub-Saharan economies, however, it is currently on a low economic growth trajectory.

According to the Department of Trade and Industry (DTI, 2019), South Africa's long-term economic growth rate according to the National Development Plan (NDP) is 5.4% per annum but the annual growth rate is projected to remain below 1% per annum. According to data from Standard and Poor's Capital IQ database, since 2000 (after the Rand became fully floating) until 2019, exports have constituted an average of 5.64% of nominal GDP per annum and this ratio has not changed over this period (displaying a standard deviation of 0.68%).

Exports can be an avenue for growth, there is merit in reviewing the trade policy to evaluate their potential contribution of the financial economy. Although the endogenous growth theory suggests an interrelationship between real and financial economic variables, extant literature on South African export behaviour which include Schaling (2007) Sekantsi (2011) and Wesseh and Niu (2012) proposed real economic variables and exchange rate volatility as the main explanatory variables. This is attributable to the *export-led* growth and *growth-led* exports approaches used to understand export behaviour, but empirical findings are divided about the validity of the two hypotheses.

The focus on exchange rate volatility, which developed into prominence after the collapse of the Bretton Woods system of fixed exchange rates between 1968 and 1973, influenced the assumption that exports were harboured more effectively by a weaker and stable currency (IMF, 2019). Studies by Bahmani-Oskooee, Harvey and Hegerty (2013) and Choudhry and Hassan (2015) found evidence suggesting that risk averse exporting firms were deterred by exchange rate volatility because the volatility increased profit risk. Schaling and Kabundi (2014) examined the impact of currency devaluation on trade and found evidence supporting the *J-curve* effect. Despite an *a*

priori expectation of a relationship between exports and exchange rate volatility, a number of previous studies which included Todani and Munyama (2005), Nyahokwe and Ncwadi (2013) and Wesseh and Niu (2012), found the relationship to be weak or undetectable - commonly referred to as the *exchange disconnect puzzle* (Bahmani-Oskooee, Hegerty and Xi, 2016). Bahmani-Oskooee *et al*. (2016) explained that one popular solution to this phenomenon is the inclusion of third-country effects (including exchange rate volatilities of trade competitors when analysing bilateral international trade). This remedy has not yet been explored in the South African context.

Consideration must be afforded to both the real and financial economies when modelling South African variables in this context, because the low economic growth is a concern for both investors and policy makers. An investigation into the possible factors influencing export behaviour is necessary. There is a gap emanating from erstwhile studies overlooking the endogenous growth theory in the context of export growth. Consequently, key questions such as the long-term and short-term effects of financial economic factors on South Africa's exports and how these may vary with export destination are open questions which this study has researched. The main objective of investigating these questions is to acquire whether the existing trade policy considers the immediate need to establish avenues to cultivate economic growth.

3.2 Literature Review

The dominance of exchange rate volatility in export analysis left a void in South African literature and studies that have researched the exchange disconnect puzzle include Bahmani-Oskooee *et al*. (2016), who analysed the trade relationship between Japan and the United States of America (USA) between 1983 and 2013 and estimated third-country effects as the volatility of both the Yen-renminbi and Dollar-Renminbi exchange rates. After applying a multivariate ARDL cointegration methodology on 88 export industries and 89 import industries, Bahmani-Oskooee *et al*. (2016) found less than fifty percent of the firms to be affected by Dollar/Yen volatility, and of those, more than half were negatively affected. Third-country effects were significant in a similar proportion of cases; suggesting that traders were attracted to the Japanese market due to events in China at the time.

Bahmani-Oskooee, Nosheen and Iqbal (2017) assessed the effect of third-country effects on 116 USA industries exporting to Pakistan. Third-country effects were proxied by Rupee-Yen volatility and Dollar-Yuan volatility, motivated by the increased role of China in the global economy. Using an ARDL cointegration method for the period 1980 until 2014 with annual frequency, they found that third-country effects were significant in more than half of the industries, and particularly for large exporting USA industries. Choudhry and Hassan (2015) studied the role of exchange rate volatility in determining the United Kingdom's (UK) real imports from Brazil, China, and South Africa from 1991 to 2011. Third-country effects were measured as the Pound/US Dollar exchange rate. Using the ARDL method, they found that exchange rate volatility occupied a significant role in the determination of trade.

Tansuchat and Yamaka (2018) used the Markov-Switching autoregressive distributed lag (MS-ARDL) model to analyse short-run and long-run non-linearities of Thailand's rice exports to Nigeria. They found that the MS-ARDL captured both short-run and long-run behaviours of export demand in the two regimes. Hunegnaw and Kim (2020) analysed the effect of real exchange rates on the trade balance in East Africa using both the linear ARDL in a pooled mean group (PMG) and NARDL models between 1980 until 2016 on twelve East African countries: Burundi, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Tanzania, Uganda, and Zambia. Hunegnaw and Kim (2020) found that results from the linear ARDL model run using the PMG and dynamic fixed effects models implied that in the long-run, a depreciation of the real effective exchange rate improved manufacturing and mining trade balances while worsening that of agriculture. In addition, the NARDL suggested that the asymmetric effects were only present for trade balances for real effective exchange rate on the manufacturing sector. In a similar study, Bahmani-Oskooee and Arize (2020) analysed the impact of exchange rate volatility on imports and exports of thirteen African countries namely; Algeria, Cameroon, Ethiopia, Ghana, Kenya, Mauritius, Morocco, Nigeria, South Africa, Tanzania, Tunisia, Uganda and Zambia to exchange rate volatility. Their study established that after employing the linear ARDL, there were significant long-run effects in a third of the countries but when the NARDL analysis was utilised, they found significant long-run asymmetric effects on trade flows for most of the countries.

Earlier South African studies focused on exchange rate volatility as the main influence of export behaviour. These include Bah and Amusa (2003) who found that real Rand exchange rate volatility had statistically significant negative effects on quarterly exports both in the short-run and in the long-run between 1990 and 2004 after using generalised autoregressive heteroscedasticity (GARCH) and cointegration methods. Todani and Munyama (2005) used an ARDL model on quarterly data (1984 to 2004) and found that exchange rate volatility negatively affected export flows but choice of volatility influenced the results. Takaendesa, Tsheole and Aziakpono (2006) investigated South Africa's exports to the USA using quarterly data from 1992 to 2004 using an exponential GARCH model and found that real exchange rate volatility had a negative effect on real exports.

Schaling (2007) analysed the relationship between exchange rates, inflation and competitiveness in South Africa on a quarterly basis between 1994 and 2006. A weak relationship between real effective exchange rate and export volumes was found using Johansen's cointegration model. Sekantsi (2011) assessed the real exchange rate impact on South African quarterly exports to the USA between 1995 and 2007. GARCH and ARDL models showed that exchange rate volatility had a negative effect on exports to the USA. Wesseh and Niu (2012) used an ARDL model and found that between 1992 and 2010 South African aggregate exports to China were largely unaffected by exchange rate volatility in the short-term after using both monthly and quarterly data. After disaggregating the data by exports, they found that exchange rate volatility could have both positive and negative effects.

Nyahokwe and Ncwadi (2013) examined South African monthly exports to the rest of the world between 2000 and 2009 and could not find a statistically significant relationship between exchange rate volatility and exports. Khosa, Botha and Pretorius (2015) found that between 1995 and 2010, exchange rate volatility negatively affected monthly aggregated exports for nine emerging market economies including South Africa, regardless of the volatility measure used. Aye, Gupta, Moyo and Pillay (2015) examined the impact of real effective exchange rate uncertainty on South African aggregate exports from 1986 to 2013 and found that exchange rate uncertainty had a

significantly negative influence on exports, and that real exports responded asymmetrically to negative and positive shocks to the explanatory variables.

For the purpose of this chapter, it was accepted that existing South African literature does not consider the financial economy notwithstanding the motivations of the endogenous growth theory and the finance-growth hypothesis. In addition, these studies lacked unanimity on the role of their most popular factor: exchange rate volatility. Their samples mostly comprised quarterly data for periods ranging from ten to twenty years which may have limited the statistical power because of their low frequency (Todani and Munyama, 2005). In this context, it is essential to consider that exporters' attitudes towards risk and the availability of hedging facilities influence how exchange rate volatility affects exports (Khosa *et al*., 2015). There is value in understanding if and how the financial economy is related with South Africa's exports given the potential significance exports have in the current low growth climate. Overlooked financial economic variables such as stock market liquidity or volatility were found to be reflective of investor behaviour and expectations towards changes in export output and as such must be included in the analysis.

3.3 Data and Methodology

In this section, the data required to analyse South Africa's exports and the method of analysis are respectively outlined.

3.3.1 Data

Data on total South African monthly exports to the world and four geographic locations: Africa, America (both North and South America), Asia and Europe were sourced from South African Revenue Services (SARS) only for the period beginning December 2003 until December 2019. The monthly nominal exports constituted the variable to be analysed with select real and financial economic explanatory variables. Relatable studies investigating the J-curve effect on trade have established strong causal links between the nominal and real exchange rates on export volumes (Bahmani-Oskooee and Ratha, 2004). Todani and Munyama (2005) posited that nominal series better

captured the volatility driven uncertainty faced by exporters and a study comparable to this thesis by Neumann (2020) modelled Germany's nominal export demand to the European Union (EU) between 1995 and 2014. After considering foreign demand and the real effective exchange rate as explanatory variables, Neumann (2020) found that a 1% increase in the real effective exchange rate increased nominal exports by 0.3 to 0.5% *ceteris paribus*.

Data on explanatory variables for the corresponding period were sourced from Bloomberg, SARS, SARB and Standard and Poor's Capital IQ. It comprised exchange rate data of all trading partners, South Africa's effective exchange rate and industrial production for the four regions. Lastly, opening and closing prices and trade data (number, volume and value of traded stocks) on the Johannesburg Stock Exchange (JSE) stock indices namely, the All Share Index (ALSI) and the Mining Index were consolidated. The two financial economic factors of stock market illiquidity and volatility were estimated from the stock market data detailed above. The Amihud (2002) illiquidity volume-based measure was used to estimate liquidity in the South African stock market. Lou and Shu (2017) noted that the Amihud (2002) illiquidity measure has grown to become the most widely-used liquidity proxy in finance research, mentioning that between 2009-2015 more than one hundred and twenty articles published in the Journal of Finance, the Journal of Financial Economics, and the Review of Financial Studies employed the illiquidity measure. Subsequently, exchange rate volatility and third-country effects were estimated using the exchange rates of major trading partners, namely: the USA Dollar and the Chinese Yuan (Bahmani Oskooee *et al.*, 2016 & 2017).

Consistent with related literature by Todani and Munyama (2005), Choudhry and Hassan (2015) and Bahmani Oskooee *et al*. (2016 & 2017), foreign income of the trading partners which indicated the potential demand for South Africa's exports was proxied by industrial production. Relative prices were proxied by the real effective exchange rate, which was a weighted average amongst a collection of the respective trading partners' currencies (Todani and Munyama, 2005 and Choudhry and Hassan, 2015). Consideration of this factor was influenced by empirical findings such as Arize (1995) who found that whether nominal or real exchange rate was employed as an

explanatory variable, the relationship with export flows was unaffected. This was due to the high correlation between the two variables. Kumar and Dhawan (1991), Mahdavi and Sohrabian (1993) and Wesseh and Niu (2012) whose studies focused on export flows, resolved to employ both real and nominal effective exchange rates as explanatory variables. In this regard, Bahmani-Oskooee (1998) who analysed export volumes' association with real and nominal variables explained that having both real and nominal variables increased possibility of detecting cointegrating vectors. After noting that either nominal or real economic variables could be analysed, this thesis utilised the available real effective exchange rate data considering the recent analysis by Neumann (2020) who modelled Germany's nominal export demand. Importantly, this thesis firmly focused on the contribution of the financial economic variables of stock market illiquidity and volatility to the discourse.

Volatility was measured using the GARCH (1,1) model developed by Bollerslev (1986) which is most popular when forecasting volatility, because it is parsimonious, avoids over-fitting and is less likely to breach non-negativity constraints (Brooks, 2008). The model allows the conditional variance to be dependent upon previous own lags and standardised residuals are used to estimate volatility (Choudhry and Hassan, 2015).

Descriptive statistics were calculated before undertaking unit root tests to ensure the variables were either stationary at levels or had one unit-root as required by the ARDL model. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests for stationarity were used on the time-series and, in addition, panel unit root tests were undertaken as required by the dynamic pooled mean group (PMG) to ensure that the panel did not have more than one unit root. The panel unit root tests were undertaken using the Im-Pesaran-Shin (IPS), Levin, Lin and Chu (LLC), ADF and PP unit root tests for stationarity. With all the series integration orders established, ARDL modelling was employed using E-views software.

3.3.2 Methodology

This study used an export demand function that can be linearly modelled as follows:

$$lnXP_{i,t} = \alpha_0 + \omega lnY_{i,t} + \psi lnR_{i,t} + \phi lnEX_{i,t} + \theta lnTE_{\kappa,t} + \gamma lnTE_{\nu,t} + \vartheta lnSV_{i,t} + \lambda lnLQ_{i,t} + \varepsilon_t \quad (3.1)$$

In equation (3.1), $lnXP_{i,t}$ are the exports to the world as the dependent variable. The explanatory variables are represented by $lnY_{i,t}$ which represents foreign income for the export destination, $lnR_{i,t}$ representing relative prices while exchange rate volatility is $lnEX_t$ and the two third-country effects variables are represented by $TE_{\kappa,t}$ and $TE_{\nu,t}$ respectively. The stock market factors of volatility and illiquidity are represented by $lnSV_{i,t}$ and $lnLQ_{i,t}$ respectively, with α_0 being a constant and ε_t representing the normally distributed error term.

The *a-priori* was that the foreign income coefficient ω was expected to have a positive relationship with exports because higher income in a trading partner was expected to increase its ability to consume more exports. The relative prices coefficient ψ, was expected to have a negative relationship with exports, because if South African goods were relatively cheaper, more could be exported. The exchange rate volatility coefficient ϕ,was expected to be negatively related with exports as this increased uncertainty of the export prices. On the contrary, mixed evidence was found on this factor in the literature (Bahmani-Oskooee *et al*., 2016). The signs on the third-country effects coefficients θ and γ were not certain and this chapter's objective was to establish them in accordance with studies by Bahmani-Oskooee *et al*. (2013), Choudhry and Hassan (2015), Khosa *et al*. (2015) and Bahmani-Oskooee *et al*. (2016). The illiquidity coefficient λ, was measured using the Amihud (2002) illiquidity measure and was expected to be negatively related with exports as a result of the assumption that stock market illiquidity increased with poor exports. Stock market volatility coefficient ϑ, was expected to be negatively related to exports as it reflected uncertainty in the financial markets about export output.

To test for long-run and short-run relationships, this study applied the ARDL model of Pesaran, Shin and Smith (1999, 2001). This model is useful for testing long-run and short-run cointegrating relationships among variables as it is not reliant on the integration order of the variables and can identify multiple cointegrating vectors. With the ARDL, y_t, which is the dependent variable (exports in this study), X_t is a kx1 vector of explanatory variables given section 4.2.1 above, the basic ARDL (p, q, …, q) model can be presented as follows assuming that the lag order *q* is the same for all variables:

$$y_t = c_0 + c_1 t + \sum_{i=1}^{p} \phi_i \, y_{t-i} + \sum_{i=1}^{q} \beta_i' \, X_{t-i} + u_t \qquad (3.2)$$

Where *t=max (p, q), …, T*, and *i* represents the lag number and the variables in (y_t, X_t) are allowed to be purely I(0), purely I(1), or cointegrated. The optimal lag orders p and q which tend to be different across regressors were obtained by minimising a model selection; for example, the Akaike information criterion (AIC) or the Schwartz-Bayesian information criterion (SBIC). The model can be reparameterised as follows:

$$\begin{aligned} \Delta lnXP_t = {} & \alpha_0 + \sum_{i=1}^{n} \psi_i \, lnXP_{t-i} + \sum_{i=0}^{n} \beta_i \, \Delta lnLQ_{t-i} + \sum_{i=0}^{n} \beta_i \, \Delta lnSV_{t-i} + \\ & \sum_{i=0}^{n} \theta_i \, \Delta lnTE_{t-i} + \sum_{i=0}^{n} \phi_i \, \Delta lnTE_{t-i} + \sum_{i=0}^{n} \zeta_i \, \Delta lnEX_{t-i} + \sum_{i=0}^{n} \xi_i \, \Delta lnY_{t-i} + \\ & \sum_{i=0}^{n} \psi_i \, \Delta lnR_{t-i} + \lambda_0 lnXP_{t-1} + \lambda_1 lnLQ_{t-1} + \lambda_2 lnTE_{t-1} + \lambda_3 lnTE_{t-1} + \lambda_4 lnEX_{t-1} + \\ & \lambda_5 lnY_{t-1} + \lambda_6 lnR_{t-1} + \varepsilon_t \end{aligned} \qquad (3.3)$$

Where Δ is the difference operator and the other variables are as defined earlier. The first part of the equation with ψ, β, θ, ϕ, ζ and ξ represents short run dynamics of the exports demand model, whilst the second part with λ represent the long-run relationship. The hypothesis is as follows:

$$H_0 : \lambda_0 = \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = 0$$

$$H_1 : \lambda_0 \neq \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq \lambda_6 \neq 0$$

The null hypothesis suggests that there is no long-run relationship between exports and the variables, the alternative hypothesis suggested a statistically significant

relationship. The bounds test of Pesaran *et al*., (1999) were conducted to test for cointegration and F-statistics greater than critical values at the five percent level and suggested significant cointegrating relationships. After bounds tests, error correction models were estimated and the reparameterised error correction model (ECM) of the ARDL from equation (3.2) is presented as follows:

$$\Delta Y_t = \theta\left[Y_{i,t-t} - \lambda'_i X_{i,t}\right] + \sum_{j=1}^{p-1} \xi_{ij}\, \Delta Y_{i,t-j} + \sum_{j=o}^{q-1} \beta'_{ij}\, \Delta X_{i,t-j} + \vartheta_i + \varepsilon_{it} \qquad (3.4)$$

Where, θ is the speed of adjustment for the group, λ' is the vector of long-run relationships and the error correction term is represented by $\left[Y_{i,t-t} - \lambda'_i X_{i,t}\right]$. Standard tests for heteroskedasticity and model stability were undertaken using the Breusch-Pagan-Godfrey and the CUSUM tests, respectively.

To analyse the effects of the select macroeconomic variables on a cross-section of the four geographic locations, panel data modelling was considered because of its benefits of greater degrees of freedom, increased efficiency and a reduction in collinearity amongst explanatory variables (Baltagi and Song, 2006). The pooled mean group (PMG) of the panel autoregressive distributed lag model (PARDL) by Pesaran, Shin and Smith (1999) was utilised by this chapter because it detects the long-run equilibrium relationship in both the long-run and short-run, achieves low collinearity, increases degrees of freedom while increasing estimation efficiency, considers cross-sectional characteristics amongst the groups simultaneously and captures the dynamic interaction amongst the variables (Pesaran *et al*., 1999).

The dynamic panel data model, PMG, begins by adopting the basic structure of the autoregressive distributed lag (ARDL) (p, q, q, …, q) model by Pesaran *et al*. (1999) as follows:

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij}\, y_{i,t-j} + \sum_{j=0}^{q} \delta'_{ij}\, x_{i,t-j} + \mu_i + \varepsilon_{it} \qquad (3.5)$$

Where, y_{it} denotes the dependent variables for a group i, which were the product export series in this study, and x_{ij} (k x 1) is the vector of real and financial explanatory

variables for the group as explained in equation (3.1). δ_{ij} are (k × 1) coefficient vectors, groups are denoted by i = 1, 2, …, N, time periods by t = 1, 2, …, T, whereas μ_i represents the fixed effects and ε_{it} is the error term. Equation (3.5) be reparametrized into equation (3.6) below to structure the long-run and short-run dynamic panel data model.

$$\Delta y_{it} = \left(\varphi_i y_{i,t-1} + \beta'_i x_{it}\right) + \sum_{j=1}^{p-1} \lambda_{ij}^{*} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}^{*\prime} \Delta x_{i,t-j} + \mu_i + \varepsilon_{it} \qquad (3.6)$$

Where, $\Delta y_{it} = y_{it} - y_{i,t-1}$, $\varphi_i = -\left(1 - \sum_{j=1}^{p} \lambda_{ij}\right)$, $\beta_i = \sum_{j=0}^{q} \delta_{ij}$, $\lambda_{ij}^{*} = -\sum_{m=j+1}^{p} \lambda_{im}$ and

$\delta_{ij}^{*} = -\sum_{m=j+1}^{q} \delta_{im}$.

The parameter φ_i is the error correction speed on adjustment term; if $\varphi_i = 0$, then it would suggest no evidence of a long-run relationship. The PMG imposes homogeneity in the long-run coefficients whilst simultaneously allowing for heterogeneity in the short-run coefficients and error variances. It also assumes that error terms are not serially correlated and are distributed independently of the regressors. The second assumption is that there is a long-run relationship with the dependent and explanatory variables, and the last assumption is that long-run parameters are the same across the regions (constituents).

3.4 Results

The results begin by outlining summary statistics which were necessary for understanding the data used in this chapter before the regression analysis was undertaken.

3.4.1 Descriptive Statistics

Table 3.1 displays summary statistics of South Africa's exports to each of the four geographic regions and the world, where, "World" referred to all combined exports recorded for the period (including those to the Oceania region and the ones that were

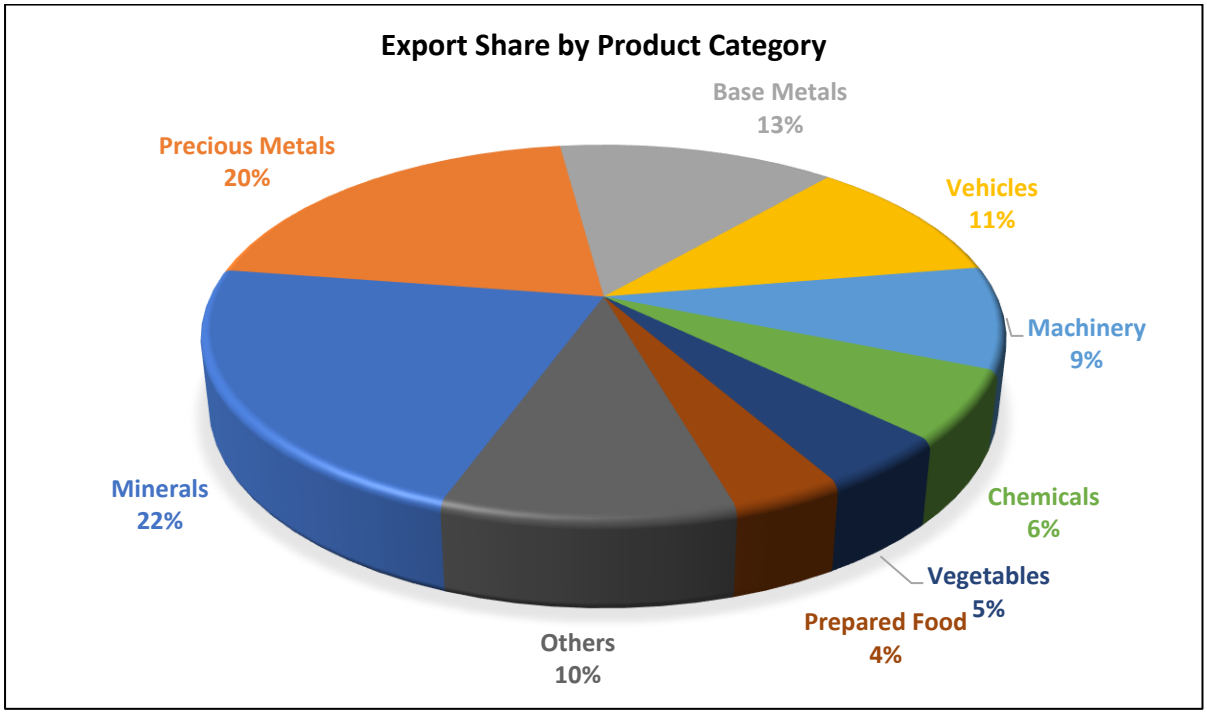
not classified). Exports to the four main regions (Africa, America, Asia and Europe) constituted 90.3% of total South Africa's exports to the world for the study period; the remaining 9.7% were unclassified exports and those to Oceania that were not consistently available for meaningful individual analysis. The table shows that South African nominal exports to the world grew by 368% from December 2003 until December 2019. This growth was driven by substantial export growth to Africa, Asia and America, which recorded growth rates of 805%, 504% and 318%, respectively.

Table 3.1: Total Exports to the Rest of the World (Millions of Rands)

Export Destination	Average Monthly Exports	Standard Deviation	Minimum	Maximum	Sum	Export Share	Nominal Growth
AFRICA	14 727.77	9 931.34	2 441.85	33 615.40	2 842 460.55	22.7%	805%
AMERICA	6 585.85	2 231.60	2 239.38	12 590.20	1 271 069.20	10.2%	318%
ASIA	20 112.04	9 219.15	4 580.40	39 001.40	3 881 624.48	31.1%	504%
EUROPE	17 028.50	6 110.16	6 805.82	34 445.13	3 286 499.71	26.3%	259%
WORLD	64 762.51	28 070.87	19 333.17	123 353.34	12 499 164.56	100.0%	368%

Trade with emerging markets (Asia and Africa) presents a growth opportunity for South Africa's exports, however, it also exposes the economy to risks unique to those markets during various stages of the business cycle. From the export data obtained from SARS, Figure 3.1 illustrates the contribution of product category exports to the rest of the world during the study period. It is evident that exports were dominated by mining resources, manufacturing and agricultural output during the study period. Of the twenty-two product categories, the top ten accounted for approximately 94% of all exports.

Figure 3.1: South African Export Contribution by Product Category



The top three exports (contributing over 55%) were resource-based: mineral products, precious metals and base metals contributed 22%, 20% and 13% respectively. The next significant contributors were manufactures namely vehicles, machinery and chemicals, respectively contributing 11%, 9% and 6%. Vegetables and prepared food stuffs contributed approximately 9% together. These findings suggest that mining resource stocks have a huge contribution towards South Africa's total exports which made it relevant to consider the impact of liquidity in this sector on exports.

3.4.2 Unit Root Tests

Unit root tests were conducted on all the variables using the ADF and the PP tests for stationarity at one, five and ten percent significance levels. Results from the unit root tests are summarised in Table 3.2.

The ADF suggested that all export series had a unit root at their levels after considering the intercept only, but when the trend was included, only exports to Africa, Asia and the World had a unit root. When the PP only considered the intercept, exports to America were the only stationary export series, but when the trend was included, all

export series were stationary at their levels. The PP suggested that foreign income was non-stationary under intercept and trend, contrary to the ADF, which implied the series to be stationary. Both the ADF and PP tests showed that the relative price variable was non-stationary with a unit-root under both an intercept and trend restrictions. All the remaining series: currency volatility, stock market volatility and illiquidity were all stationary with no unit roots. The mixture of both stationary and non-stationary time series in addition to the fact that none of the series had more than one unit root validated the use of the ARDL method of analysis.

Table 3.2: Tests for Stationarity

	ADF (Intercept)		PP (Intercept)		ADF (Intercept & Trend)		PP (Intercept & Trend)		Zivot and Andrews	
VARIABLE	Level t-stat	Unit Root t-stat	Level t-stat	Unit Root t-stat	Level t-stat	Unit Root t-stat	Level t-stat	Unit Root t-stat	Test Statistic	Break Date
AFRICA	-1.028	**-3.731***	-1.171	**-18.046***	-2.749	**-3.760****	**-4.716***	-	**-5.840***	Oct 2013
AMERICA	-2.454	**-15.227***	**-3.121****	**-**	**-4.076***	-	**-7.177***	-	**-6.146***	Dec 2008
ASIA	-1.737	**-16.446***	-1.845	**-31.752***	**-3.190*****	**-4.930***	**-6.224***	-	**-5.096****	Nov 2008
EUROPE	-1.612	**-13.609***	**-2.797*****	**-22.564***	**-4.330***	-	**-6.215***	-	**-6.388***	Nov 2008
WORLD	-1.240	**-4.472***	-1.619	**-24.443***	-2.469	**-4.524***	**-6.597***	-	**-6.049***	Dec 2008
EXPLANATORY VARIABLES										
Foreign Income	**-3.733***	-	**-2.986***	-	**-3.722****	-	-2.984	**-8.055***	**-5.688***	Nov 2009
Relative Price	-0.933	**-10.250***	-1.174	**-11.077***	-2.899	**-10.220***	-2.527	**-11.041***	4.300	May 2004
Exchange Volatility	**-10.671***	-	**-10.590***	-	**-10.640***	**-**	**-10.556***	-	**-7.404***	Jun 2016
ZARUSD Volatility	**-13.971***	-	**-13.973***	-	**-13.943***	**-**	**-13.945***	-	**-14.220***	Mar 2016
ZARCNY Volatility	**-14.219***	-	**-14.243***	-	**-14.181***	**-**	**-14.203***	-	**-14.497***	Aug 2011
CNYUS Volatility	**-14.923***	-	**-24.396***	-	**-15.12132**	**-**	**-27.553***	-	**-11.917***	May 2018
EURCNY Volatility	**-18.434***	-	**-18.83937**	-	**-18.396***	**-**	**-18.80541**	-	**-12.638***	Aug 2008
ZAREUR Volatility	**-11.881***	-	**-11.918***	-	**-11.850***	**-**	**-11.887***	-	**-7.108**	Jan 2009
Stock Market Volatility	**-11.331***	-	**-11.441***	-	**-11.781***	**-**	**-11.774***	-	**-12.167***	May 2007
Stock Market Illiquidity	**-4.893***	**-**	**-4.687***	-	**-6.210***	**-**	**-6.158***	-	**-7.619***	May 2009
Mining Index Illiquidity	**-4.825***	**-**	**-4.620***	-	**-6.331***	**-**	**-6.420***	-	**-7.350***	July 2006

*(Where: *1%, **5% and ***10% significance levels and t-stat is the Test Statistic)*

After noting that economic and financial time-series data tended to change behaviour over time, the Zivot and Andrews (1992) tests which accounted for structural breaks were employed. The results showed that all series except relative prices were trend stationary with a structural break occurring at a date indicated in the last column. It was notable that the change in behaviour of the export series tended to coincide with the advent of the global financial crisis as the breaks were detected between November and December 2008. The anomaly was that of exports to Africa which may not have been sensitive to global changes since most of South Africa's exports were mining resource-related, mainly sold outside Africa. Panel unit root tests were undertaken in Table 3.3 as required by the PMG using the IPS, LLC, ADF and PP tests.

Table 3.3: Panel Unit Root Tests

Panel Unit Root Test	Level	Unit Root
Levin, Lin & Chu t*	2.89277	15.7709*
Breitung t-stat	-1.58173**	
Im, Pesaran and Shin W-stat	-2.53400*	-
ADF - Fisher Chi-square	19.5071**	-
PP - Fisher Chi-square	170.464*	-

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

Results from the unit root tests suggested that the PMG could be validly applied because only the Levin, Lin and Chu test suggested a unit root while all the other tests rejected the null hypothesis of a unit root process.

3.4.3 Regression Results

The chapter's analysis began with the analysis of total monthly exports to the rest of the world before analysing exports to the four geographic regions.

3.4.3.1 Total Exports to the World

Table 3.4 displays the ARDL short-run coefficient estimates of total exports to the world under three scenarios shown by column titles: "Three Common Factors"; "Stock Market Illiquidity & Stock Market Volatility" and "Mining Index Illiquidity & Stock Market Volatility". Under the "Three Common Factors" column, there are coefficients of three

explanatory variables of foreign income, relative prices and exchange rate volatility; similar to Sekansti (2011), Khosa *et al*. (2015) and Fowkes, Loewald and Marinkov (2016). Under "Stock Market Illiquidity & Stock Market Volatility" the two financial economic variables of stock market volatility and stock market illiquidity where added as explanatory variables to the export demand equation. In the last column titled "Mining Index Illiquidity & Stock Market Volatility" indicated that in this column, the illiquidity variable was calculated from the JSE's mining index as an extension to the analysis.

Table 3.4: South Africa's Total Exports to the World (Short-run)

Variable and Lags	Three Common Factors	Stock Market Illiquidity & Stock Market Volatility	Mining Index Illiquidity & Stock Market Volatility
Exports to the World			
Exports (-1)	**0.4585***	**0.3771***	**0.4300***
Exports (-2)	-0.0102	0.0802	0.0073
Exports (-3)	**0.3473***	**0.4118***	**0.4149***
Exports (-4)	-0.1128	-	**-0.1529*****
Exports (-5)	-	-	**0.1325*****
Real Economic Factors			
Foreign Income	**-0.3227*****	**0.1082****	0.4135
Foreign Income (-1)	**0.3897****	**-**	0.3884
Relative Prices	**-0.2019*****	-0.0468	-0.1529
Exchange Rate and Third-Country Effects			
Exchange Volatility	-0.0046	0.0145	0.0154
Exchange Volatility (-1)	**-0.0124*****	**-0.0211***	**-0.0233***
Exchange Volatility (-2)	**-0.0142*****	**-0.0205***	**-0.0168****
Exchange Volatility (-3)	**0.0186****	**0.0174****	**0.0143****
Exchange Volatility (-4)	-	-	-0.0096
ZARUSD Volatility		0.0041	-0.0044
ZARCNY Volatility		**0.037833****	**0.0395****
Financial Economic Factors			
Stock Market Volatility		**-0.0229***	**-0.0318***
Stock Market Volatility (-1)		**-0.0217***	**-0.0324***
Stock Market Volatility (-2)		**-0.0173****	**-0.0131*****
Stock Market Volatility (-3)		-0.0035	0.0001
Stock Market Volatility (-4)		**0.0176****	**0.0146****
Stock Market Volatility (-4)			**-0.0140*****
Stock Market Illiquidity		**-1.6079***	-0.05606
Stock Market Illiquidity (-1)		**-1.2898****	**-0.1362****
Stock Market Illiquidity (-2)		-0.4133	-0.0345
Stock Market Illiquidity (-3)		**1.0475*****	**0.1015****
Stock Market Illiquidity (-4)		**1.0350****	
R-squared	0.9609	0.9685	0.9697
Adjusted R-squared	0.9582	0.9646	0.9648
F-statistic	358.2300	243.3994	197.1907

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

The coefficient estimates under the “Three Common Factors” in the first column show that foreign income and relative prices were significant as expected; the first lag of foreign income was negative suggesting a 1% increase of foreign income decreased exports by 0.3%. Its second lag was positive suggesting a 1% increase of foreign income increased exports by 0.39% in the short run. An increase in relative prices of 1% decreased export quantities by approximately 0.2% in the short-run similar with findings by Todani and Munyama (2005), Takaendesa *et al*. (2006) and Sekansti (2011) in their relatable analysis. The export lags suggested that current export growth was positively impacted by exports in the previous periods.

Exchange rate volatility was negative and persistent as suggested by the three significant lags, consistent with the view of exchange rate volatility being a detriment towards exports; similar to Bah and Amusa (2003), Todani and Munyama (2005) and Sekantsi (2011). The findings established under “Three Common Factors” were a significant confirmatory update on the influence of the real economic factors on South Africa’s exports however, the focus of this chapter was to evaluate the inclusion of the financial economic variables into the export demand function, hence it added stock market volatility and illiquidity.

In both the last two columns, “Stock Market Illiquidity & Stock Market Volatility” and “Mining Index Illiquidity & Stock Market Volatility” export lags remained consistently influential, however, only foreign income remained positive and significant under “Stock Market Illiquidity & Stock Market Volatility” column while relative prices were no longer significant in the short-run in either columns. The foreign income coefficient under “Stock Market Illiquidity & Stock Market Volatility” column suggested that 1% increase of foreign income increase exports by approximately 0.11%. Foreign income tended to be more pervasive compared to relative prices in the short-run because when stock market illiquidity was considered, it remained significant.

Exchange rate volatility in the last two columns remained negative and persistent in the short-run on South Africa’s exports to the rest of the world consistent with findings by Bah and Amusa (2003). The third-country effects proxied by the volatility between the rand and dollar (ZARUSD Volatility) and rand and yuan (ZARCNY Volatility) were

not persistent. The latter tended to be associated with increased exports in the short-run in both the last two columns which could be explained by the exponential growth of exports to China which persisted regardless of currency fluctuations.

The short-run coefficients of the financial economic factors had negative and persistent coefficients consistent with the *a-priori* expectation that volatility and illiquidity in the stock market would be associated with lower export performance. The short-run coefficients of financial economic variables are consistent with the thesis that when exports were dampened, stock market liquidity costs were higher as investors would demand a premium on exporting stocks consistent with the findings by Kim (2013). This remained consistent under both "Stock Market Illiquidity & Stock Market Volatility" and "Mining Index Illiquidity & Stock Market Volatility"; showing the pervasiveness of this financial economic factor which was also affirmed by illiquidity of the mining stocks in the last column.

The long-run model was estimated to ascertain the impact of the real and financial economic variables on export growth in the long-term and the results are displayed in Table 3.5.

Table 3.5: South Africa's Total Exports to the World (Long-run)

Variable	Three Common Factors	Stock Market Illiquidity & Stock Market Volatility	Mining Index Illiquidity & Stock Market Volatility
Real Economic Factors			
Foreign Income	**1.6026***	**0.8264***	**0.6806***
Relative Price	-0.2997	-0.3572	-0.9089
Exchange Rates and Third-country Effects			
Exchange Volatility	-0.2799	-0.0737	-0.1186
ZARUSD Volatility		**0.2890*****	**0.2346****
ZARCNY Volatility		0.0310	-0.0262
Financial Economic Factors			
Stock Market Volatility		**-0.3650***	**-0.4543***
Stock Market Illiquidity		**-9.3833****	**-0.7439***
C	1.070576	7.1862	**10.6308***
F-statistic	**3.598818****	**4.2958***	**4.2454***

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

"Stock Market Illiquidity & Stock Market Volatility" and "Mining Index Illiquidity & Stock Market Volatility" columns show that both stock market illiquidity and volatility had

strong long-run relationships with South Africa's exports; reconcilable with Levine and Zevos (1996) endogenous growth theory together with Giannellis *et al*. (2010) and Fufa and Kim (2018) who found a strong positive link between the real and financial economies and Kurilova, Stepanova and Topornin (2018) who arrived at similar findings.

Only the real economic factor of foreign income had a long-run effect where its 1% increase boosted exports by 1.6% under "Three Common Factors"; 0.8% under "Stock Market Illiquidity & Stock Market Volatility" and 0.68% under "Mining Index Illiquidity & Stock Market Volatility"; reconcilable with Todani and Munyama (2005) and Sekansti (2011) who found similar coefficients. Although exchange rate volatility did not exhibit long-run relationships with South Africa's exports to the rest of the world, the third-country volatility of the Rand and the US dollar had a positive long-run relationship in the last two columns. The elusiveness of exchange rate volatility on South Africa's exports was reconcilable with Todani and Munyama (2005), Wesseh and Niu (2012) and Fowkes *et al*. (2016) who highlighted the exchange disconnect puzzle alluded to earlier in the introduction.

Under all the three columns in Table 3.5, the F-statistics from the bounds tests of Pesaran *et al.*, (1999) rejected the null hypothesis of no levels relationships thereby strongly suggesting the existence of cointegrating relationships that led to the estimation of the error correction model in Table 3.6.

Table 3.6: Error Correction Models – World Exports

Variable and Its Lags	Three Common Factors	Stock Market Illiquidity & Stock Market Volatility	Mining Index Illiquidity & Stock Market Volatility
Exports			
D (Exports (-1))	**-0.41605***	**-0.4920***	**-0.4017***
D (Exports (-2))	**-0.43118***	**-0.4118***	**-0.3945***
D (Exports (-3))	-0.03123	-	0.0205
D (Exports (-4))	**-0.15413****	**-**	**-0.1325****
Real Economic			
D (Foreign Income)	-0.14014	**-**	**0.4135****
D (Foreign Income (-1))	**-**	**-**	**0.6875***
Exchange Rates and Third Country Effects			
D (Exchange Volatility)	-0.00995	**0.0145****	**0.0154****
D (Exchange Volatility (-1))	-0.00451	0.00302	0.0120
D (Exchange Volatility (-2))	**-0.0181***	**-0.0174***	-0.0048
D (Exchange Volatility (-3))	-	-	0.0096
Financial Economic Factors			
D (Stock Market Volatility)		**-0.0229***	**-0.0318***
D (Stock Market Volatility (-1))		0.003198	0.0122
D (Stock Market Volatility (-2))		**-0.0141*****	-0.0008
D (Stock Market Volatility (-3))		**-0.0176***	-0.0007
D (Stock Market Volatility (-4))		-	**0.0140****
D (Stock Market Illiquidity)		**-1.6079***	-0.056064
D (Stock Market Illiquidity (-1))		**-1.6693***	-0.067031
D (Stock Market Illiquidity (-2))		**-2.0825****	**-0.1015****
D (Stock Market Illiquidity (-3))		**-1.0350***	
Error Correction Term	**-0.079985***	**-0.130925***	**-0.168271***
R-squared	0.370457	0.5101	0.536806
Adjusted R-squared	0.342163	0.473498	0.487178
Durbin-Watson stat	1.979335	1.893297	2.067126
Residual Diagnostics			
Breusch-Pagan-Godfrey: F-statistic	1.101716	0.959905	1.135697

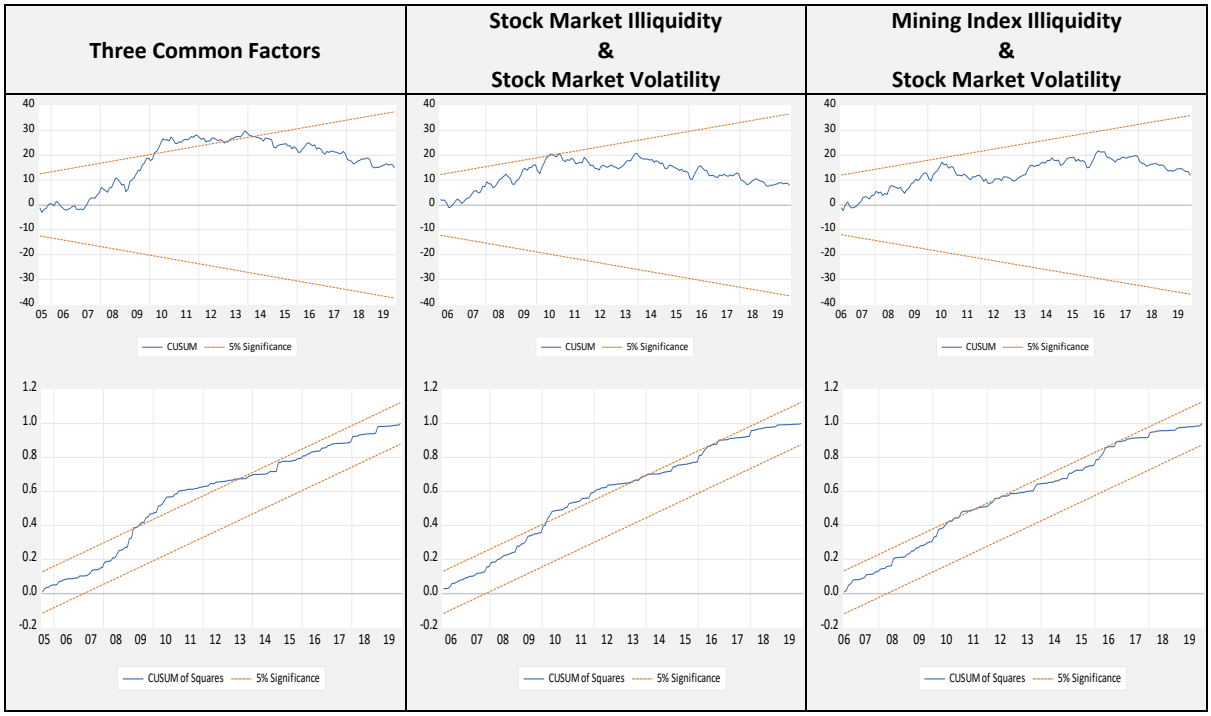
*(Where: *1%, **5% and ***10% significance levels)*

The error correction term under "Three Common Factors" suggested an adjustment towards equilibrium of 8%; this readjustment was higher at 13.09% under "Stock Market Illiquidity & Stock Market Volatility" and 16.83% under "Mining Index Illiquidity & Stock Market Volatility". Tests for heteroscedasticity were undertaken using the Breusch-Pagan-Godfrey tests with a null hypothesis of homoscedasticity. The resultant F-statistics were 1.101716, 0.959905 and 1.135697 under the three respective columns which could not be rejected meaning there was homoscedasticity.

CUSUM and CUSUM of squares stability tests undertaken in Figure 3.2 show the CUSUM tests suggesting that all models were stable except for the "three common factors" implied a marginal deviation from equilibrium between 2010 and 2013 was observed. The more stringent CUSUM of squares tests complemented the CUSUM

tests suggesting that the relationships observed largely held true for the duration of the study.

Figure 3.2: CUSUM Stability Tests



(Estimates at 5% significance level)

Analysis was extended to include exports to four regions and the results are reviewed in the following section.

3.4.3.2 Exports to Geographic Regions

Table 3.7 summarises the PMG results for the long-run and short-run error correction models. The long-run coefficients for foreign income and relative prices showed that the two real economic variables were influential to exports for the four regions in the long-run. This suggested that higher incomes in the four regions boosted South Africa's exports where a percentage increase of the income raised exports by 0.43% in the long-run. A percentage increase of relative prices decreased exports by 0.78% in the long-run which was in line with the expectation that the price competitiveness was a factor affecting exports to these regions. Similar long-run coefficients were

obtained by Todani and Munyama (2005), Sekansti (2011) and Wesseh and Niu (2012) on South Africa's exports to the world, the USA and China respectively.

Table 3.7: PMG Estimation of Long-run and Short-run Models

Long-Run Model		Short-run Error Correction Model	
	-	D(Exports (-1))	**-0.3632***
	-	D(Exports (-2))	**-0.2487***
Real Economic Variables			
Foreign Income	**0.4340****	D(Foreign Income)	-0.2020
Relative Prices	**-0.7760*****	D(Relative Prices)	0.1354
Exchange Rates and Third-Country Effects			
Exchange Rate Volatility	-0.1472	D(Exchange Rate Volatility)	**0.0238***
ZARUSD Volatility	0.1023	D(ZARUSD Volatility)	0.0080
ZARCNY Volatility	0.0324	D(ZARCNY Volatility)	**-0.0100*****
Financial Economic Variables			
Stock Market Volatility	**-0.1581***	D(Stock Market Volatility)	**0.0116***
Stock Market Illiquidity	**-13.5710***	D(Stock Market Illiquidity)	**0.8175****
		Error Correction Term	**-0.1383***
		Intercept term	1.4338*

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

The observation that neither exchange rate volatility nor third-county effects had long-run relationships with exports to the regions was similar to previous South African studies which included Todani and Munyama (2005), Nyahokwe and Ncwadi (2013) and Wesseh and Niu (2012) who found exchange rate volatility effects on exports as undetectable or weak. The results were reflective of the observations made in Table 3.5 that long-run relationships between total exports to the world were weak.

As a result, reconcilable with the position by Fowkes *et al*. (2016) that South Africa's trade policy should not be guided by exchange rate volatility. The stock market variables' relationship with exports, similar to observations made in 4.3.1; showed stock market volatility and illiquidity negatively affecting exports in the long-run; consistent with the findings of Giannellis and Papadopoulos (2016) and Fufa and Kim (2018).

The error correction model suggested a readjustment of 13.83% towards a long-run equilibrium once deviations in the short-run occurred. These short-run deviations were observed on exports suggesting that there were statistically significant deviations of

export lags in the short-run, which decreased with each successive lag. Although real economic variables did not possess a statistically significant short-run deviation with exports, exchange rate volatility and the factor of the volatility between the Rand and the Chinese Yuan were significant. This meant that exchange rate volatility and third-country effects were, at best, a factor in the short-run, however, long-run economic growth was not affected by exchange rate volatility. Statistically significant short-run deviations of stock market volatility and stock market illiquidity that were markedly smaller compared to their observed long-run coefficients, suggested that the two financial economic factors were of greater influence in the long-run.

3.5 Summary and Conclusion

This chapter answered part of the first research question set in Section 1.4 which enquired about the nature of the relationship between stock market liquidity, exchange rate volatility and third-country effects with South Africa's exports. Answering this research question achieved the objective of ascertaining the short-run and long-run dynamics of the export relationships between South Africa's exports and the selected variables. This chapter's novel analysis by considering financial economic variables in export demand functions, validated the assertions of the endogenous growth theory and the finance-growth hypothesis of interrelationships between the real and financial economies. The significance and persistence of stock market volatility and illiquidity in both the short-run and long-run were reconcilable with the recent findings by Matthee, Rankin, Webb and Bezuidenhout (2018) who illustrated that in South Africa, more competitive and productive exporting firms were more likely to attract institutional investors and had more liquid stocks which led them to the conclusion that poor real performance was associated with lower liquidity of the corresponding stock. This chapter's findings of a sustained negative relationship between exports, stock market volatility and illiquidity also validated the observations by Giannellis and Papadopoulos (2016) and Fufa and Kim (2018) who suggested a symbiotic relationship between the real and financial economy which is greater during times of real economic crises.

Since exports are a potential growth avenue for South Africa, there was scope for this chapter to recommend whether there was evidence validating broadening the scope

of the current trade policy. The results which showed that exports to the world had a strongly negative relationship with stock market volatility and illiquidity in both the short-run and the long-run thereby, implying that investors changed portfolio holdings in accordance to changes of real economic output as motivated by Kurilova *et al*. (2018), suggested that there was merit in broadening the scope of the current trade policy. It is this chapter's recommendation that in addition to South Africa's trade policy being focused on trade competitiveness by ensuring price level stability, it should be expanded. This chapter goes a step further to recommend that the existing policy must be expanded to enhance financial market stability and reduction of liquidity costs to investors because stock market illiquidity and volatility negatively impact long-term export growth prospects.

Although the common real economic variables of foreign income and relative prices were found to have expected relationships with exports with the former being more dominant, exchange rate volatility and third-country effects were suggestive of the exchange disconnect puzzle with exchange rate volatility tending to negatively affect total exports to the world in the short-run. The results on real economic variables and exchange rate volatility were confirmatory to earlier South African studies which had relatable findings hence, this chapter updated the existing South African studies.

The findings by this chapter which are an original contribution, provide a foundation for future research in this area to better understand the nuances of the econometric relationships analysed above. Future research can employ alternative modelling techniques such as those that account for non-linearity which include threshold or quantile regressions among others to further unravel the econometric relationships. The analysis of South Africa's exports which considers non-linearity has the potential to improve on the current understanding of how export relationships change under various economic scenarios which will potentially improve the efficacy of trade policy interventions as South Africa attempts to advance sustainable long-run economic growth. Chapter 4 which follows looks at South African export behaviour with the consideration of non-linearities and asymmetries.

CHAPTER 4: A NON-LINEAR ANALYSIS OF SOUTH AFRICAN EXPORTS AND SELECTED MACROECONOMIC VARIABLES [4]

4.1 Introduction

The previous chapter made a significant foundational contribution on the effect of financial economic variables on South African export growth. Further, it showed that the factors were persistent, indicating that highly liquid and stable financial markets helped galvanise South African export growth in the long-run. The financial economic variables' contribution towards export growth complemented the traditional real economic variables of foreign income and relative prices which showed that high foreign incomes and lower relative prices improved South African export growth. Notwithstanding these important findings, Chapter 3 left a gap with its modelling because it did not account for the possible existence of non-linear relationships between exports and real economic variables and financial economic variables in the short-run or long-run relationships. Consequently, this chapter investigates the possible existence and implications of non-linearity of export relationships in the form of short-run, long-run and location asymmetries.

It was crucial to investigate these types of non-linear relationships because it assisted to understand if exports responded symmetrically to changes of real and financial factors. Accounting for asymmetries has practical benefits to policy makers because it helps them understand for example, if improvements of liquidity in the financial markets drew a greater or lower response of exports than a deterioration of the same magnitude in the long-run and the short-run. This informs policy makers on the magnitude of intervention required to improve export growth when there is an improvement or deterioration of a financial economic variable. This chapter set out to achieve the second part of the first objective by establishing the existence and effect

[4] The published and peer-reviewed journal article version of this chapter is that of the PhD candidate Mr Kudzanai Tsunga, with the listed co-authors having offered the support and guidance of dissertation supervisors. The citation is as follows: Tsunga, K. R., Moores-Pitt, P. and McCullough, K., (2020). "A non-linear analysis of South African exports and selected macroeconomic variables." International Journal of Economics and Finance Studies. Vol. 12, No. 2, pp. 436-452. Doi: 10.34109/ijefs.202012212.

of asymmetric relationships between South Africa's exports and selected real and financial economic variables.

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 Africa's 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, thereby, 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 chapter 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 remainder of this chapter is structured as follows: section 4.2 reviews relevant literature, section 4.3 outlines the data and methodology employed, section 4.4 presents the results and section 5.5 concludes.

4.2. 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 between 1911 and 2011 using linear Granger causality tests and found no causality. After applying the Hiemstra and Jones (1994) and Diks and Panchenko (2006) non-linear Granger causality tests, Ajmi *et al*. (2015) found unidirectional causality from GDP to exports and bi-directional causality from the two causality tests respectively. This led to the conclusion that non-linearities and structural breaks had to be considered to model export relationships. A similar conclusion was arrived at by Aye *et al*. (2015) who examined the impact of real effective exchange rate uncertainty on total quarterly South African exports to the rest of the world between 1986 and 2013. After employing the GARCH-in-mean (GARCH-M) model in a bivariate model and incorporating asymmetries based on propositions by Engle and Kroner (1995), Aye *et al*. (2015) found that real exports responded asymmetrically to negative and positive shocks of the real effective exchange rate of a similar magnitude.

Although the studies by Ajmi *et al*. (2015) and Aye *et al*. (2015) motivated for South African studies to consider non-linearity, 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. On the other hand, Schaling (2007) concluded that South Africa's trade balance was negatively affected by exchange rate volatility. However, after analysing monthly exports to the world, Nyahokwe and Ncwadi (2013) found that exchange rate volatility had no effect. Those that applied the ARDL to analyse South Africa's exports include 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 and 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 consistent and reconcilable. This provided a foundational background for this thesis however; their linear methodologies were a limitation as they could not evaluate if the factors had asymmetric relationships or not. In addition, it was not clear from the studies how the relationships they had detected held in different economic conditions such as high economic growth or during a recession.

The gap from overlooking asymmetries validated the review of related international studies beginning with the earlier works of Yasar, Nelson and Rejesus (2006) who looked at exports in the context of productivity of firms in Turkey. The study employed quantile regressions after noting that ordinary least squares (OLS) estimates were adversely influenced by outliers. Yasar *et al*. (2006) arrived at the conclusion that continuously exporting firms were more productive, and this was pervasive along the conditional output distribution; increasing toward the upper tail of the distribution. The use of quantile regressions enabled to establish how relationships held over a range of the data distribution, something that linear-based models are unable to achieve.

In a study similar to the one by Yasar *et al*. (2006), Wagner (2006) employed quantile regression on Germany manufacturing plants and found that the impact of plant characteristics on export activities varied according to the export/sales ratio. The study argued that the findings assisted in crafting policies better suited to firms with different characteristics falling in the different quantiles. Vu, Holmes, Lim and Tran (2014) analysed the relationship between exports and profit in Vietnam between 2005 and 2009. Their study used a panel data quantile approach and established that the

quantile approach was able to unravel that export participation was positively related with firms with higher profits and lower for those with less profits. However, no relationship could be established when the OLS method was used. Vu *et al*. (2014) concluded that productivity advantages of exporters with low profit growth were absorbed by costs relating to trading activities in overseas markets.

Kwasi-Obeng (2018) studied the effects of exchange rate volatility on export diversification in Ghana after noting that most previous similar studies assumed a linear relationship. The study proceeded to employ the NARDL on annual export data between 1984 to 2015 with other explanatory variables emanating from the real economy (GDP, inflation, infrastructure, openness and gross fixed capital formation). The study concluded that exchange rate volatility exhibited an asymmetric relationship with export diversification. Another related study conducted in an emerging market economy was conducted by Sahoo (2018) who analysed the relationship between service exports and the exchange rate in India. The study employed both the ARDL and the NARDL methods on annual data between 1975 and 2015. Sahoo (2018) arrived at the conclusion 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.

Accounting for non-linear behaviour of econometric relationships in varying quantiles has been motivated for by researchers analysing macroeconomic variables and recent studies considering the development of the QARDL. Studies such as Shahbaz, Zakaria, Shahzad and Mahalik (2018a) employed a quantile-on-quantile (QQ) method on quarterly data between 1960 and 2015 to analyse energy and growth linkages. The QARDL was recently applied by Lahiani, Miloudi, Benkraiem and Shahbaz (2017) to analyse the relationship between monthly oil prices between 1997 and 2015 in the USA. Their study found that oil and energy prices were cointegrated across quantiles and that the oil price significantly predicted individual petroleum prices in the short-run. This finding further supported the position that the nuances around econometric relationships amongst economic variables were better understood when using non-linear models.

The QARDL was used by Shahbaz, Lahiani, Abosedra and Hammoudeh (2018b) to analyse the quantile behaviour of the relationship between levels of globalisation and energy consumption in the Netherlands and Ireland between 1970 and 2015 using quarterly data. Shahbaz *et al*. (2018b) established that the relationship was quantile dependent, a result which suggested that traditional studies that employed linear analyses may have obtained misleading results. Benkraiem *et al*. (2018) analysed the relationship between monthly oil prices and stock indices in France, Germany, Italy and the UK between 1999 and 2016 using the QARDL. They held the opinion that the QARDL was a suitable model for analysing the relationships amongst macroeconomic variables because the QARDL accounted for distributional asymmetry of relationships in both the short-run and the long-run.

Dada (2020) evaluated the asymmetric structure of exchange rate volatility on trade for seventeen countries in the sub-Saharan region between 2005 and 2017. These included Burundi, Cameroon, Central African Republic, Congo, Cote d'Ivoire, Equatorial Guinea, Gabon, The Gambia, Ghana, Lesotho Malawi, Nigeria, Sierra Leone, South Africa, Togo, Uganda and Zambia. Dada (2020) utilised the GARCH (1,1) and asymmetric components of exchange rate volatility were generated using the cumulative partial sum by Granger and Yoon (2002). The study made the finding that that there existed persistent volatility clustering in the region. In addition, the volatility had a negative effect on trade in the region and the effect of negative volatility was higher than that of positive volatility. In a similar study employing non-linear methods, Bahmani-Oskooee and Arize (2020) analysed the impact of exchange rate volatility on imports and exports of thirteen African countries which included Algeria, Cameroon, Ethiopia, Ghana, Kenya, Mauritius, Morocco, Nigeria, South Africa, Tanzania, Tunisia, Uganda and Zambia to exchange rate volatility. After employing the linear ARDL, there were significant long-run effects in a third of the countries but when the NARDL analysis was utilised, they found significant long-run asymmetric effects on trade flows for most of the countries.

South African literature suggested that the linear methods of analysis could establish relationships between exports and macroeconomic variables, although there was evidence of the exchange disconnect puzzle. Importantly, South African studies

provided foundational background although they did not probe the relationships further by accounting for asymmetries in the established relationships. In this regard, emerging market studies by Kwasi-Obeng (2018) and Sahoo (2018) showed that there was a possibility that exports may possess asymmetric relationships with macroeconomic variables. Studies employing quantile regressions and the QARDL suggested that analysing asymmetries in quantiles were more appropriate compared to linear models because they were better positioned to unravel relationships in varying periods of the time-series (or quantiles).

Given the gap existing in South African studies pertaining to the accounting for asymmetries and the consideration of the financial economy, this study applies non-linear models to South African export demand functions in order to analyse whether economic exports responded asymmetrically to macroeconomic variables. This contributed new knowledge on the extent to which a given macroeconomic factor for instance, stock market illiquidity would affect exports when it improved or deteriorated. The following section outlines the data used and the methodology applied by the study to achieve its research objectives.

4.3 Data and Methodology

4.3.1 Data

To conduct the analysis, this thesis sourced data on South Africa's exports to its trading partners and the rest of the world from South African Revenue Services (SARS). The data set comprised total exports to the world and to four major world regions namely, Africa, America (both North and South), Asia and Europe between December 2003 and December 2019 similar to the dataset in the previous chapter. However, in this chapter, the dataset was expanded to include total exports to individual trading partners (China, USA, Germany, Japan and the UK) whose data were only available consistently from January 2010 until December 2018. Exports formed the dependent variable whilst explanatory variables included the traditional/real economic variables (foreign income of trading partners, relative prices,

exchange rates) and financial economic variables (stock market volatility and stock market illiquidity).

Foreign income was proxied by industrial production which was consistent with related studies by Choudhry and Hassan (2015), Moslares and Ekanayake (2015) and Bahmani Oskooee *et al*. (2016 & 2017). The real effective exchange rate indicated the relative price of South African goods to export destinations while exchange rate volatility measured the risk of currency value uncertainty (Todani and Munyama, 2005 and Choudhry and Hassan, 2015). Third-country effects were proxied using the exchange rates of major trading partners, namely: the U.S. Dollar, Euro, Japanese Yen and the Chinese Yuan (Bahmani Oskooee *et al.*, 2016 & 2017). Lastly, the financial market variables of stock market illiquidity and stock market volatility were estimated using stock market data comprising stock market price and trade data (number of trades, volume of trades and value of traded stocks) on the Johannesburg Stock Exchange (JSE) All Share Index (ALSI).

Stock market illiquidity was estimated using the Amihud (2002) measure which is widely accepted as a liquidity proxy (Næs *et al*., 2011, Kim, 2013 and Lou and Shu, 2017). In this study, exchange rate volatility and the volatility of the stock market were estimated using the GARCH (1,1) non-linear model developed by Bollerslev (1986) and Taylor (1986). The GARCH (1,1) is one of the most popular models to forecast volatility and South African studies estimating volatility on the JSE and the Rand such as Makhwiting, Lesaoana and Sigauke (2012), Khosa *et al*. (2015) and Makoko and Muzindutsi (2018) found the model sufficiently capturing volatility. Table 4.1 summarises all the variables employed by the study which were all in monthly frequency.

Table 4.1: Variables Employed by the Study

Variable	Code	Description	Data Source	Duration
1. Exports	World Africa America Asia Europe	World represents all South Africa's global export output while the continental names represent exports to that world region (Other unclassified exports and exports to Oceania region are included in total exports to the World but could not be analysed individually)	SARS	2003-2019
	China Germany Japan UK USA	The export codes represent the total exports to that country.	SARS	2010-2018
2. Foreign Income	PRDN	Industrial Production for the given export destination	Capital IQ	2003-2019
3. Relative Prices	RELP	South Africa's real effective exchange rate.	SARB	2003-2019
4. Exchange Rate Volatility	EXCH	Volatility of Rand exchange rate. Bilateral Exchange rate using GARCH (1,1)	Iress	2003-2019
4. Third-Country Effects	ZARCNY Volatility ZARUSD Volatility ZAREUR Volatility ZARGBP Volatility USDCNY Volatility EURCNY Volatility GBPCNY Volatility	Volatility between: Rand and Chinese Yuan Rand and United States Dollar Rand and Euro Rand and the British Pound United States Dollar and Chinese Yuan Euro and Chinese Yuan British Pound and Chinese Yuan	Iress	2003-2019
5. Stock Market Illiquidity	ILLQ	Liquidity proxies required price and trade data (number, volume and value of traded stocks per day) on the JSE stock indices namely, the All Share Index (ALSI) and the Mining Index.	Bloomberg and Iress	2003-2019
6. Stock Market Volatility	ALSI	Closing prices on the JSE ALSI whose volatility was estimated using GARCH (1,1)	Iress	2003-2019

Variables were transformed into their natural logarithms as this makes the variability of series more similar and compresses skewness by compressing upper end of the distribution while simultaneously stretching the lower end for a more symmetric distribution (Halling, Pagano, Randl and Zechner, 2008 and Brennan, Huh and Subrahmanyam, 2013). Such a transformation is also in line with other export-considering studies such as Todani and Munyama (2005), Choudhry and Hassan (2015) and Kwasi-Obeng (2018).

The study began by presenting summary and descriptive statistics to understand the distribution of export data. Since this study employed ARDL models, tests for stationarity needed to be undertaken to ensure that none of the variables had an integration order greater than one unit-root (Pesaran, Shin and Smith, 1999 & 2001).

The stationarity tests were undertaken using the Augmented Dickey-Fuller and Phillips-Perron tests for stationarity and in addition, breakpoint tests were conducted using the Zivot and Andrews test. After the unit root tests were completed, regression analysis was undertaken beginning with the NARDL followed by the QARDL (these are detailed next).

4.3.2 Methodology

The following equation modelled the general South African export demand function to the world and to its trading partners adopted in this study:

$$lnXP_{i,t} = \alpha_0 + \omega lnY_{i,t} + \psi lnR_{i,t} + \phi lnEX_{i,t} + \theta lnTE_{\kappa,t} + \gamma lnTE_{\nu,t} + \lambda lnLQ_{i,t} + \vartheta lnSV_{i,t} + \varepsilon_t \quad (4.1)$$

Where, $lnXP_{i,t}$ are the exports to the world, region or a given country, $lnY_{i,t}$ represents foreign income for the export destination and $lnR_{i,t}$ represents relative prices. Exchange rate volatility is represented by $lnEX_t$ whilst the two third-country effects variables are represented by $TE_{\kappa,t}$ and $TE_{\nu,t}$ respectively. The stock market factors of liquidity and volatility are represented by $lnLQ_{i,t}$ and $lnSV_{i,t}$ respectively, with α_0 being a constant and ε_t representing the normally distributed error term.

The *a-priori* expectation was that the foreign income coefficient, ω would have a positive relationship with exports. This was based on the model's assumption that higher income in the export destination would increase that partner's ability to consume more exports. In addition, relative prices coefficient, ψ, was expected to have negative relationship with exports because when South African goods were relatively cheaper, there was an expectation that exports would consequently increase. The exchange rate volatility coefficient ϕ, was expected to be negatively related with exports as this increased uncertainty of the export prices, however, mixed evidence has been found on this factor in the South African literature reviewed. The signs on the third-country effects coefficients θ and γ were not certain and this study's objectives was to establish them but since they were based on exchange rate volatility,

would likely have mixed evidence as well. Coefficients of stock market illiquidity λ and stock market volatility ϑ, were expected to be negatively related with exports because deteriorating illiquidity and rising volatility in the financial markets would signal poorer export prospects.

The NARDL and QARDL were then employed to analyse the non-linear relationships of the export demand functions. Firstly, the equation (4.1) was specified into an ARDL model of Pesaran *et al*. (2001). The resultant ARDL error correction model is presented in equation (4.2) as follows.

$$XP_t = \alpha + \sum_{i=1}^{p} \varphi_i \, XP_{t-i} + \sum_{i=0}^{q_1} \omega_i \, Y_{t-i} + \sum_{i=0}^{q_2} \psi_i \, R_{t-i} + \sum_{i=0}^{q_3} \phi_i \, EX_{t-i} + \sum_{i=0}^{q_4} \theta_i \, TE_{\kappa,t-i} + \sum_{i=0}^{q_5} \gamma_i \, TE_{\nu,t-i} + \sum_{i=0}^{q_6} \lambda_i \, LQ_{t-1} + \sum_{i=0}^{q_7} \vartheta_i \, SV_{t-i} + \varepsilon_t \quad (4.2)$$

Where, ε_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 Akaike Information Criterion (AIC) or the Schwartz-Bayesian Information Criterion (SBIC) (Moslares and Ekanayake, 2015).

The ARDL above can estimate linear long-run and short-run relationships, but the NARDL by Shin, Yu and Greenwood-Nimmo (2014) considers non-linearity through its ability to generate a series of both positive and negative partial sums. The partial sums which are generated for each regressor are summarised in equation (4.3). For example, the partial sums for illiquidity, for instance, can be symbolised as follows:

$$POS_t = \sum_{t=1}^{t} \Delta \, LQ_i^{+} = \sum_{i=1}^{t} max \, (\Delta LQ_i, 0)$$

$$NEG_t = \sum_{t=1}^{t} \Delta \, LQ_i^{-} = \sum_{i=1}^{t} min \, (\Delta LQ_i, 0) \quad (4.3)$$

The asymmetric error correction model for the NARDL that was proposed by Shin *et al*. (2014) from the export demand function presented in equation (4.1) can be presented in the form of equation (4.4) as follows:

$$XP_t = \alpha + XP_{t-1} + \omega_1^+ Y_t^+ + \omega_2^- Y_t^- + \psi_1^+ R_t^+ + \psi_2^- R_t^- + \phi_1^+ EX_t^+ + \phi_2^- EX_t^- + \theta_1^+ TE_t^+ + \theta_2^- TE_t^- + \gamma_1^+ TE_t^+ + \gamma_2^- TE_t^- + \lambda_1^+ LQ_t^+ + \lambda_2^- LQ_t^- + \vartheta_1^+ SV_t^+ + \vartheta_2^- SV_t^- + \sum_{i=1}^{p} \varphi_i XP_{t-i} + \sum_{i=0}^{q_1} \omega_i Y_{t-i}^+ + \sum_{i=0}^{q_1} \omega_i Y_{t-i}^- + \sum_{i=0}^{q_2} \psi_i R_{t-i}^+ + \sum_{i=0}^{q_2} \psi_i R_{t-i}^- + \sum_{i=0}^{q_3} \phi_i EX_{t-i}^+ + \sum_{i=0}^{q_3} \phi_i EX_{t-i}^- + \sum_{i=0}^{q_4} \theta_i TE_{\kappa,t-i}^+ + \sum_{i=0}^{q_4} \theta_i TE_{\kappa,t-i}^- + \sum_{i=0}^{q_5} \gamma_i TE_{\nu,t-i}^+ + \sum_{i=0}^{q_5} \gamma_i TE_{\nu,t-i}^- + \sum_{i=0}^{q_6} \lambda_i LQ_{t-i}^+ + \sum_{i=0}^{q_6} \lambda_i LQ_{t-i}^- + \sum_{i=0}^{q_7} \vartheta_i SV_{t-i}^+ + \sum_{i=0}^{q_7} \vartheta_i SV_{t-i}^- + D_t + \varepsilon_t \quad (4.4)$$

The error correction model in equation (4.4) enabled the study to establish short-run and long-run asymmetries in line with this chapter's primary objective. In addition, the study required the QARDL to analyse location asymmetries and this entailed converting equation (4.2) into the QARDL of Cho *et al*. (2015) as follows:

$$Q_{XP_t} = \alpha(\tau) + \sum_{i=1}^{p} \varphi_i (\tau) XP_{t-i} + \sum_{i=0}^{q_1} \omega_i (\tau) Y_{t-i} + \sum_{i=0}^{q_2} \psi_i (\tau) R_{t-i} + \sum_{i=0}^{q_3} \phi_i (\tau) EX_{t-i} + \sum_{i=0}^{q_4} \theta_i (\tau) TE_{\kappa,t-i} \sum_{i=0}^{q_5} \gamma_i (\tau) TE_{\nu,t-i} + \sum_{i=0}^{q_6} \lambda_i (\tau) LQ_{t-1} + \sum_{i=0}^{q_7} \vartheta_i (\tau) SV_{t-i} + \varepsilon_t(\tau) \quad (4.5)$$

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 ε_t, was avoided by generalising the QARDL (Lahiani *et al*., 2017 and Shahbaz *et al*., 2018b). The model was generalised as follows:

$$Q_{\Delta \mathrm{XP}_t} = \alpha + \rho XP_{t-1} + \psi_Y Y_{t-1} + \psi_R R_{t-1} + \psi_{EX} EX_{t-1} + \psi_{TE_\kappa} TE_{\kappa,t-1} + \psi_{TE_\nu} TE_{\nu,t-1} + \psi_{LQ} LQ_{t-1} + \psi_{SV} SV_{t-1} + \sum_{i=1}^{p} \varphi_i \Delta XP_{t-1} + \sum_{i=0}^{q_1-1} \omega_i \Delta Y_{t-i} + \sum_{i=0}^{q_2-1} \delta_{R_i} \Delta R_{t-1} + \sum_{i=0}^{q_3-1} \delta_{EX_i} \Delta EX_{t-1} + \sum_{i=0}^{q_4-1} \delta_{TE_{\kappa,i}} \Delta TE_{\kappa,t-1} + \sum_{i=0}^{q_5-1} \delta_{TE_{\nu,i}} \Delta TE_{\nu,t-1} + \sum_{i=0}^{q_6-1} \delta_{LQ_i} \Delta LQ_{t-1} + \sum_{i=0}^{q_7-1} \delta_{SV_i} \Delta SV_{t-1} + v_t(\tau) \quad (4.6)$$

Using the model in equation (4.6), there remains a likelihood of contemporaneous correlation between v_t and ΔR_t, ΔY_t, ΔEX_t, $\Delta TE_{\kappa,t}$, $\Delta TE_{\nu,t}$, ΔLQ_t and ΔSV_t. The previous correlations can be avoided by employing the projection of v_t on ΔR_t, ΔY_t, ΔEX_t, $\Delta TE_{\kappa,t}$, $\Delta TE_{\nu,t}$, ΔLQ_t and ΔSV_t with the form, $v_t = \gamma_R \Delta R_t + \gamma_Y \Delta Y_t + \gamma_{EX} \Delta EX_t + \gamma_{TE_\kappa} \Delta TE_{\kappa,t} + \gamma_{TE_\nu} \Delta TE_{\nu,t} + \gamma_{LQ} \Delta LQ_t + \gamma_{SV} \Delta SV_t + \varepsilon_t$. The resulting innovation ε_t, is

uncorrelated with ΔR_t, ΔY_t, ΔEX_t, $\Delta TE_{\kappa,t}$, $\Delta TE_{v,t}$, ΔLQ_t and ΔSV_t. The QARDL ECM which arises can then be presented as follows:

$$Q_{\Delta \mathrm{XP}_t} = \alpha(\tau) + \rho(\tau)[XP_{t-1} - \beta_Y(\tau)Y_{t-1} - \beta_R(\tau)R_{t-1} - \beta_{EX}(\tau)EX_{t-1} - \beta_{TE_\kappa}(\tau)TE_{\kappa,t-1} - \beta_{TE_v}(\tau)TE_{v,t-1} - \beta_{LQ}(\tau)LQ_{t-1} - \beta_{SV}(\tau)SV_{t-1}] + \sum_{i=1}^{p-1}\varphi_i(\tau)\Delta XP_{t-1} + \sum_{i=0}^{q_1-1}\omega_i(\tau)\Delta Y_{t-i} + \sum_{i=0}^{q_2-1}\delta_{R_i}(\tau)\Delta R_{t-1} + \sum_{i=0}^{q_3-1}\delta_{EX_i}(\tau)\Delta EX_{t-1} + \sum_{i=0}^{q_4-1}\delta_{TE_{\kappa,i}}(\tau)\Delta TE_{\kappa,t-1} + \sum_{i=0}^{q_5-1}\delta_{TE_{v,i}}(\tau)\Delta TE_{v,t-1} + \sum_{i=0}^{q_6-1}\delta_{LQ_i}(\tau)\Delta LQ_{t-1} + \sum_{i=0}^{q_7-1}\delta_{SV_i}(\tau)\Delta SV_{t-1} + \varepsilon_t(\tau) \quad (4.7)$$

Where, the cumulative impact of previous export on current exports is given by $\varphi_* = \sum_{j=1}^{p-1}\varphi_j$, while the impact of the explanatory variables (foreign income, relative prices, exchange rate volatility, third-country effects, stock market illiquidity and stock market volatility) are given by $\omega_* = \sum_{j=1}^{q_1-1}\omega_j$, $\psi_* = \sum_{j=1}^{q_2-1}\psi_j$, $\phi_* = \sum_{j=1}^{q_3-1}\phi_j$, $\theta_* = \sum_{j=1}^{q_4-1}\theta_j$, $\gamma_* = \sum_{j=1}^{q_5-1}\gamma_j$, $\lambda_* = \sum_{j=1}^{q_6}\lambda_j$, and $\vartheta_* = \sum_{j=1}^{q_7}\vartheta_j$ respectively.

The long-term cointegrating parameters of the explanatory variables in equation (4.1) are calculated as follows:

$\beta_{R*} = -\frac{\varphi_R}{\rho}$, $\beta_{Y*} = -\frac{\varphi_Y}{\rho}$, $\beta_{EX*} = -\frac{\varphi_{EX}}{\rho}$, $\beta_{TE_{\kappa}*} = -\frac{\varphi_{TE_\kappa}}{\rho}$, $\beta_{TE_{v}*} = -\frac{\varphi_{TE_v}}{\rho}$, $\beta_{LQ*} = -\frac{\varphi_{LQ}}{\rho}$ and $\beta_{SV*} = -\frac{\varphi_{SV}}{\rho}$

The cumulative short-term parameters and the long-term cointegrating parameters are calculated using the delta method. It is worth noting that the ECM parameter ρ should be significantly negative (Shahbaz *et al*., 2018b). To statistically investigate the short-term and long-term non-linear and asymmetric impacts of the explanatory variables on exports were used. The Wald test asymptotically follows a Chi-squared distribution and is used to test the null and alternative hypotheses for the short-term and long-term parameters. The following section presents the results.

4.4 Results

4.4.1 Descriptive and Summary Statistics

The descriptive statistics which are displayed in Table 4.2 show the growth and variability of exports to a given destination. In the table, Panel A summarises export series between December 2003 and December 2019 while panel B shows exports to trading partners between January 2010 and December 2018. Panel A shows that nominal growth of total exports to the world increased by 368% and this was largely driven by the growth of exports to Africa, Asia and America, which recorded nominal growth rates of 805%, 504% and 318%, respectively. The last column shows that Asia had the highest total export receipts amongst the regions followed by Europe and Africa whilst America had the lowest total receipts. Although nominal export growth was observed, the exports tended to be characterised by significant fluctuations as evidenced by high monthly standard deviations from mean monthly exports. The deviations were an opportunity for this study to explore using the non-linear methods of analysis and establish the extent to which the independent variables in the export demand functions could explain the variability of these exports.

Table 4.2: Exports to the Rest of the World (Millions of Rands)

PANEL A: **Exports to Regions and the Rest of the World (December 2003 – December 2019)**						
Destination	**Growth**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**	**Total Exports for Study Period**
AFRICA	805%	14727.77	9931.34	2441.85	33615.4	2 842 461
AMERICA	318%	6585.851	2231.60	2239.38	12590.2	1 271 069
ASIA	504%	20112.04	9219.15	4580.4	39001.4	3 881 624
EUROPE	259%	17028.5	6110.16	6805.82	34445.13	3 286 500
WORLD	368%	64762.51	28070.87	19333.17	123353.3	12 499 165
PANEL B: **Exports to Trading Partners and the Rest of the World (January 2010 – December 2018)**						
	Growth	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**	**Total Exports for Study Period**
CHINA	156%	8020.815	1935.482	3211.187	12686.59	866 248
GERMANY	202%	4945.133	1923.607	2401.055	11366.02	534 074
JAPAN	48%	4321.833	704.5666	2694.686	6152.451	466 758
UK	60%	3130.455	1097.341	1240.021	8625.368	338 089
USA	140%	5857.178	1306.435	2671.36	10619.54	632 575
WORLD	180%	77891.89	19708.74	36574.2	122087	8 412 324

Panel B which summarises exports to trading partners for a shorter period (from January 2010 until December 2018), showed that nominal export growth to trading partners was lower than that of total exports to the world in the same period; except for exports to Germany. This suggested that total South African export growth may have been driven by exports to other emerging market trading partners as suggested by high export growth to Africa (shown in Panel A). Similar to exports to the regions, those to individual trading partners were characterised by high standard deviations from the mean exports during the study period. This observation suggested that econometric analysis could be valuable to understand this behaviour of exports to trading partners. Before undertaking the econometric analysis, the study conducted unit root tests since they were requisites for applying the NARDL and QARDL models.

4.4.2 Unit Root Tests

In line with the ARDL framework, all the variables were required to have integration orders not exceeding one; meaning they could be integrated of order one or order zero (stationary). Unit root tests were conducted on all the series using the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests for stationarity at the one percent, five percent and ten percent significance levels to ensure robustness of the decision of the integration order of the variables. In addition, the data were tested for breakpoints using the Zivot and Andrews (1992) breakpoint test. Results of the unit root tests undertaken for the two periods; December 2003 until December 2019 and January 2010 until December 2018 are presented in panels A and B of Table 3 respectively.

The results displayed in Table 4.3 show the existence of a mixture of integration orders amongst the variables. Importantly, however, none of the variables in either panel A or B had an integration order of greater than one, meaning that the ARDL models could be validly applied. This is a key advantage of ARDL models because in the case of mixed integration orders, the popular Johannsen's cointegration technique would not be validly applicable.

In panel A, the Zivot and Andrews (1992) breakpoint tests suggested all export series to have breakpoints which occurred either in November or December 2008; a period coinciding with the unravelling of the global financial crisis. This hinted at the link between the real and the financial economies as suggested by studies such as Kim (2013) and Giannellis and Papadopoulos (2016) because a change in exports (real economic output) was influenced by changes in financial markets. In addition, the breakpoints for the other explanatory variables in Panel A were more varied.

Table 4.3: Tests for Stationarity

PANEL A: Exports to Regions and the Rest of the World (December 2003 – December 2019)										
	ADF (Intercept)		PP (Intercept)		ADF (Intercept&Trend)		PP (Intercept & Trend)		Zivot and Andrews	
VARIABLE	Level t-stat	Unit Root t-stat	Level t-stat	Unit Root t-stat	Level t-stat	Unit Root t-stat	Level t-stat	Unit Root t-stat	Test Statistic	Break Date
AFRICA	-1.028	**-3.731***	-1.171	**-18.046***	-2.749	**-3.760****	**-4.716***	-	**-5.840***	Oct 2013
AMERICA	-2.454	**-15.227***	**-3.121****		**-4.076***		**-7.177***		**-6.146***	Dec 2008
ASIA	-1.737	**-16.446***	-1.845	**-31.752***	**-3.190*****	**-4.930***	**-6.224***		**-5.096****	Nov 2008
EUROPE	-1.612	**-13.609***	**-2.797*****	**-22.564***	**-4.330***		**-6.215***		**-6.388***	Nov 2008
WORLD	-1.240	**-4.472***	-1.619	**-24.443***	-2.469	**-4.524***	**-6.597***		**-6.049***	Dec 2008
PRDN	**-3.733***	-	**-2.986***	-	**-3.722****		-2.984	**-8.055***	**-5.688***	Nov 2009
RELP	-0.933	**-10.250***	-1.174	**-11.077***	-2.899	**-10.220***	-2.527	**-11.041***	4.300	May 2004
EXCH	**-10.671***	-	**-10.590***	-	**-10.640***		**-10.556***		**-7.404***	Jun 2016
ZARUSD	**-13.971***	-	**-13.973***	-	**-13.943***		**-13.945***		**-14.220***	Mar 2016
ZARCNY	**-14.219***	-	**-14.243***	-	**-14.181***		**-14.203***		**-14.497***	Aug 2011
ALSI	**-11.331***	-	**-11.441***	-	**-11.781***		**-11.774***		**-12.167***	May 2007
ILLQ	**-4.893***	**-**	**-4.687***	-	**-6.210***	**-**	**-6.158***	-	**-7.619***	May 2009
PANEL B: Exports to Trading Partners and the Rest of the World (January 2010 – December 2018)										
CHINA	**-4.602***		**-4.370***		**-5.475***		**-5.441***		**-5.618***	Mar 2014
GERMANY	-0.618	**-12.546***	-1.919	**-18.579***	-2.547	**-12.525***	**-4.694***		-4.454	Oct 2013
JAPAN	**-7.643***		**-7.720***		**-8.030***		**-8.139***		**-6.304***	Jan 2016
UK	-2.411	**-13.128***	**-5.998***		**-9.605***		**-9.610***		**-9.896***	Oct 2016
USA	**-4.449***		**-6.181***		**-9.530***		**-9.520***		**-10.034***	Jan 2018
WORLD	-1.563	**-3.985****	**-2.748*****	**-19.515***	**-3.985***		**-7.422***		**-6.152***	Oct 2013
PRDN	-1.029	**-8.751***	**-1.050**	**-8.626***	-2.226	**-8.738***	-2.226	**-8.613***	-3.405	Dec 2012
RELP	**-0.929**	**-8.234***	**-0.985**	**-8.262***	-1.939	**-8.200***	-1.718	**-8.228***	-4.638	Jul 2016
EXCH	**-8.287***		**-8.287***		**-8.248***		**-8.248***		**-9.106***	Feb 2016
CNYEUR	**-10.433***		**-10.487***		**-10.444***		**-10.492***		**-9.174***	Jan 2017
CNYUSD	**-8.081***		**-8.535***		**-8.112***		**-8.511***		**-10.971***	May 2014
GBPCNY	**-13.321***		**-13.267***		**-13.321***		**-13.267***		**-11.179***	Jan 2014
USDJPY	**-10.679***		**-10.621***		**-10.679***		**-10.621***		**-13.703**	July 2014
ZARCNY	**-13.134***		**-13.134***		**-13.115***		**-13.114***		**-13.903***	Feb 2016
ZAREUR	**-11.684***		**-11.632***		**-11.628***		**-11.578***		**-12.439***	Feb 2014
ZARGBP	**-12.804***		**-12.809***		**-12.746***		**-12.752***		**-13.632***	Feb 2016
ZARJPY	**-11.926***		**-11.932***		**-11.864***		**-11.869***		**-12.284***	Jul 2016
ZARUSD	**-12.710***		**-12.736***		**-12.647***		**-12.672***		**-13.466***	Feb 2016
ALSI	**-10.127***		**-10.137***		**-10.311***		**-10.320***		**-10.845***	Jun 2017
ILLQ	**-5.919***		**-5.919***		**-6.594***		**-6.597***		**-7.251***	Feb 2017

*(Where: *1%, **5% and ***10% significance levels and t-stat is the Test Statistic)*

In panel A, the ADF showed that all export series became stationary after the first difference under the intercept only condition, however, when the trend was added, only the export series to America and Europe were stationary at their levels. Under the PP test for stationarity, only the export series to America was stationary at its level when the intercept was considered, but all export series were stationary when both the intercept and trend were accounted for. Most explanatory variables were stationary under both the ADF and PP tests with intercept and intercept with trend except for the relative price series.

In both scenarios the two methods to test for stationarity had reconcilable findings where the relative price series had to be differenced once before it became stationary. Most explanatory variables were stationary under both the ADF and PP with intercept and intercept with trend except for the relative price series. In both scenarios the two methods to test for stationarity had reconcilable findings where the relative price series had to be differenced once before becoming stationary.

In panel B, all the export series had a mixture of integration orders and the ADF test with intercept and no trend suggested that half of the export series (Germany, UK and World exports) were non-stationary at levels and needed to be differenced once. When the ADF had both intercept and trend, only the export to Germany series had an integration order of one. The PP test with the intercept only suggested that export series to Germany and the world were non-stationary in level terms but became stationary after the first difference. Under the intercept and trend condition in the PP test, only the exports to Germany series had a unit root.

The Zivot and Andrews (1992) tests suggested the existence of structural breaks in all the export series however, unlike in panel A where there was a significant economic event (the global financial crisis of 2008), other exogenous factors needed to be investigated to establish if they could be attributed to the change in behaviour of series. The detection of structural breaks amongst the variables was suggestive of non-linear behaviour which would require non-linear regression models (Perron, 1989 and Zivot and Andrews, 1992). In addition, the various unit root tests ensured that none of the variables had an integration order greater than one whilst showing that there was a mixture of integration orders; making ARDL modelling suitable for the dataset.

4.4.3 Regression Results

Analysis began with the NARDL whose purpose was to establish long-run and short-run asymmetric relationships around conditional means. Subsequent analysis using the QARDL focused on non-linear relationships across a range of quantiles. Export demand functions for the longer period (December 2003 until December 2019) were analysed first, beginning with total exports to the world followed by exports to the four regions (Africa, America, Asia and Europe). Thereafter, analysis moved to the shorter period (January 2010 until December 2018) which looked at total exports to the individual trading partners.

4.4.3.1 NARDL Results

Table 4.4 summarises the results of the export demand function to the world where the top row indicates the columns of long-run positive, long-run negative, short-run asymmetry and long-run asymmetry coefficients respectively. The coefficients of foreign income, relative prices, stock market volatility and stock market illiquidity suggested that these variables had some form of a non-linear long-run relationship with total exports to the world.

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 Africa's 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 4.4: Total Exports to the World and Regions (2003-2019)

Coefficient	Long-run Effect [+]	Long-run Effect [-]	Long-run Asymmetry	Short-run Asymmetry	ECT	Adj R^2
WORLD						
Real Economic						
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 and Third-country Effects						
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		
Financial Economic						
Stock Market Volatility	**-0.087***	**0.077****	0.7446	0.730		
Stock Market Illiquidity	**-2.604*****	**4.863***	**17.4***	0.0019		
AFRICA						
Real Economic						
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 and Third-country Effects						
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		
Financial Economic						
Stock Market Volatility	**-0.140*****	**0.146*****	0.0365	0.7505		
Stock Market Illiquidity	**-7.382*****	**9.377****	2.104	0.0033		
AMERICA						
Real Economic						
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 and Third-country Effects						
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		
Financial Economic						
Stock Market Volatility	**-0.100*****	**0.105*****	0.05235	0.9185		
Stock Market Illiquidity	-2.882	**5.876****	**6.71****	0.0673		
ASIA						
Real Economic						
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 and Third-country Effects						
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		
Financial Economic						
Stock Market Volatility	**-0.111****	0.081	2.388	2.4150		
Stock Market Illiquidity	**-4.166*****	**6.787***	**8.316***	0.2000		
EUROPE						
Real Economic						
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 and Third-country Effects						
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		
Financial Economic						
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*)

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% 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 Edwards and Jenkins (2015) who found Chinese exports were crowding out South Africa's exports to Europe by approximately 10%. Consistent significance of currency volatility in other export demand functions was elusive; which was 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 and the endogenous growth theory of financial variables having a relationship with real economic variables, 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. Table 4.5 summarised results on similar analysis conducted on exports to trading partners.

Table 4.5: Total Exports to Trading Partners

	Long-run effect [+]	Long-run effect [-]	Long-run asymmetry	Short-run asymmetry	ECT	Adj R^2
CHINA						
Real Economic						
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 and Third-country Effects						
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		
Financial Economic						
Stock Market Volatility	**0.154** **	-0.109	0.8588	1.239		
Stock Market Illiquidity	-7.065	0.287	**4.258** **	0.346		
GERMANY						
Real Economic						
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 and Third-country Effects						
Exchange Rate Volatility	-0.099	0.010	1.272	0.6766		
ZAREUR Volatility	0.012	0.047	2.1400	0.0511		
CNYEUR Volatility	0.042	-0.050	0.0501	0.0056		
Financial Economic						
Stock Market Volatility	0.024	0.050	**5.163** **	0.5231		
Stock Market Illiquidity	-5.681	-0.331	1.881	0.5582		
JAPAN						
Real Economic						
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 and Third-country Effects						
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		
Financial Economic						
Stock Market Volatility	**-0.107** **	**0.080*** **	0.9063	**3.641*** **		
Stock Market Illiquidity	-4.750	1.643	2.043	0.00536		
UK						
Real Economic						
Foreign Income	-0.018	-0.008	0.3529	0.4791	**-0.9317***	0.5028
Relative Prices	**-5.476***	0.404	**2.802*** **	1.808		
Exchange Rate and Third-country Effects						
Exchange Rate Volatility	-0.306	0.331	0.2693	0.5782		
ZARGBP Volatility	**0.220** **	**-0.160*** **	**5.439** **	0.1149		
GBPCNY Volatility	0.067	**-0.133***	**7.779 ***	1.152		
Financial Economic						
Stock Market Volatility	**0.092*** **	-0.003	**7.758 ***	**4.45** **		
Stock Market Illiquidity	**-7.582*** **	4.152	**2.638*** **	0.00003		
USA						
Real Economic						
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 and Third-country Effects						
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*** **		
Financial Economic						
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*)

The analysis was extended to individual trading partners in Table 4.5. 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 on foreign income to China suggested that lower growth in China was the greater concern for South Africa's exports to that country; this was reasonable, as it was the largest individual destination. The findings on relative prices suggested that non-linear behaviour was present for this variable on exports to China, the UK and the USA. For exports to China, a decline of the relative price had a greater response than an increase of the relative price in the long-run; suggesting that declining prices of goods sold to China wielded a greater response than price increases. Long-run asymmetries which were significant on exports to China and the UK meant that there was asymmetric behaviour in the long-run and the short-run asymmetries for exports to the USA suggested non-linear behaviour of relative prices in the short-run.

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 Edwards and Jenkins (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. This suggested that exchange rate volatility and third-country effects were not dominant factors influencing South Africa's exports. The literature showed the significance of currency volatility to be varied and elusive; the exchange disconnect puzzle encountered by studies such as Choudhry and Hassan (2015), Bahmani-Oskooee, Hegerty and Xi (2016a) and Bahmani-Oskooee, Nosheen and Iqbal (2017) which may explain this study's findings of exchange rate volatility or third-country effects as not being dominant factors affecting South Africa's exports.

The results suggested that the financial market factor of stock volatility had significant long-run positive effects for China, Japan and the UK and long-run negative effects

only for Japan. The long-run asymmetries were significant for the UK whilst the long-run asymmetries were significant for Japan UK and the USA. These showed that volatility in the stock market was associated with exports mainly to three trading partners where positive changes for stock market volatility were more significant. This showed that increased stock market volatility was a greater factor for exports compared to decreasing stock market volatility. Stock market illiquidity had significant long-run positive effects for the UK and long-run asymmetry for China and the UK. These results were less pronounced than those observed for the World and for the regions which can be attributable to fact that exports to the trading partners represented a small fraction of total exports. As such, investors may react to a larger change to total exports as opposed to deviations to a single destination especially when multiple destinations existed.

The results showed that non-linearity was present in export demand functions and they were strongest for financial economic variables. This was a significant contribution of the study since this was an area not previously explored by erstwhile South African studies. Further, the results showed that the popular real economic variables of foreign income and relative prices had asymmetric effects on South Africa's exports, albeit less pronounced compared to the financial economic variables. However, the exchange rate volatility and third-country effects were not consistently significant, highlighting the exchange disconnect puzzle encountered in the literature. The NARDL employed in this section assumed a single conditional mean for each export demand function but this could be expanded by analysing the export demand functions across a range of quantiles.

4.4.3.2 QARDL Analysis

The QARDL of Cho *et al*. (2015) was applied to analyse the dynamic export relationships in quantiles, which offered further insight into export relationships. The QARDL error correction model simultaneously tested the quantile dependent long-run relationship and associated dynamic adjustments in the short-run. In this regard, the long-run coefficients obtained from the QARDL were jointly tested with Wald tests with a null hypothesis of zero quantile long-run relationships and an alternative of the

presence of quantile relationships. The Wald tests which asymptomatically follow a Chi-squared distribution, also tested the non-linearity on short-run parameters and the lags of exports across quantiles. Tables 4.6 and 4.7 present the QARDL results for export demand functions to the world regions and the trading partners respectively. There were three default quantiles selected: the twenty-fifth percentile, fiftieth percentile and seventy-fifth percentile; information criteria were used to automatically select the lag orders for all the models.

Table 4.6 summarises the Wald tests for quantile dependent asymmetries where long-run asymmetries were significant for Africa, America and Asia. What this observation entailed was that exports to these three regions were affected differently by the macroeconomic variables depending on the total level of exports (quantile levels). In these regions, the long-run models showed that real economic variables were also consistently larger for lower quantiles indicating the lower exports were more responsive to changes of foreign income and relative prices which was consistent with the expectation. The macroeconomic factors affecting total exports to the World and to Europe tended to be consistent regardless of whether exports were high (in higher quantiles) or low (in the lower quantiles) in the long-run. For instance, export demand functions for Africa and Asia showed that 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; consistent with the expectation that poorer exports would be associated with lower stock market liquidity. Although the opposite effect was observed for exports to America, this could be explained by the fact that exports to Africa and Asia constituted approximately half of the total exports to the world during the study period and may have weighed heavier on the behaviour of investors during the period of study.

Table 4.6: Quantile Dependent Short-run and Long-run Relationships (Regions)

	Long-run (Beta Matrix)			**Short-run** (Gamma Matrix)			**Exports Lags**
Quantile	0.25	0.5	0.75	0.25	0.5	0.75	
WORLD							
Foreign Income	0.6306	0.441	-0.0552	0.082	0.0621	-0.0048	
Relative Prices	-1.5655	-0.9404	0.5276	-0.2037	-0.1325	0.0458	
Exchange Rate Volatility	0.204	0.0003	0.2124	0.0265	0	0.0184	
ZARUSD Volatility	0.0809	0.0929	-0.1943	0.0105	0.0131	-0.0169	
ZARCNY Volatility	0.4295	0.2923	0.1437	0.0559	0.0412	0.0125	
Stock Market Volatility	-0.0405	-0.2446	-0.2248	-0.0053	-0.0345	-0.0195	
Stock Market Illiquidity	-19.275	-12.554	-16.545	-2.5081	-1.7692	-1.4359	
Wald T-stat		1.3768			**7.5741****		0.18882
AFRICA							
Foreign Income	3.1625	0.5438	0.5644	0.2185	0.0696	0.0693	
Relative Prices	2.674	-3.7172	-2.878	0.1848	-0.4759	-0.3533	
Exchange Rate Volatility	-4.2948	-0.0455	0.1167	-0.2967	-0.0058	0.0143	
ZARUSD Volatility	-0.2746	0.1496	-0.0216	-0.019	0.0191	-0.0027	
ZARCNY Volatility	0.496	0.0544	0.109	0.0343	0.007	0.0134	
Stock Market Volatility	0.019	-0.1907	-0.0992	0.0013	-0.0244	-0.0122	
Stock Market Illiquidity	-29.7871	-17.371	-18.49	-2.0581	-2.2241	-2.27	
Wald T-stat		**8.8543****			**4.6003*****		1.9069
AMERICA							
Foreign Income	0.8712	0.01	0.0608	0.2838	0.0027	0.0182	
Relative Prices	-0.9178	-1.2027	-0.7101	-0.2989	-0.3204	-0.2122	
Exchange Rate Volatility	-0.3021	-0.3178	-0.1943	-0.0984	-0.0847	-0.0581	
ZARUSD Volatility	0.3054	-0.0825	-0.0142	0.0995	-0.022	-0.0042	
ZARCNY Volatility	-0.1065	-0.0233	0.1903	-0.0347	-0.0062	0.0569	
Stock Market Volatility	-0.1765	-0.2397	-0.1282	-0.0575	-0.0638	-0.0383	
Stock Market Illiquidity	-1.9261	-13.377	-14.579	-0.6274	-3.5638	-4.3572	
Wald T-stat		**5.3509*****			**38.0914***		**5.1248*****
ASIA							
Foreign Income	-3.078	0.5854	0.3096	-0.1349	0.0879	0.0518	
Relative Prices	-8.3097	-0.3403	-0.5286	-0.3643	-0.0511	-0.0885	
Exchange Rate Volatility	3.6987	-0.3768	-0.0296	0.1622	-0.0566	-0.005	
ZARUSD Volatility	-0.0243	-0.013	-0.1908	-0.0011	-0.002	-0.0319	
ZARCNY Volatility	0.8946	0.2108	0.3933	0.0392	0.0317	0.0658	
Stock Market Volatility	-2.6719	-0.149	-0.1412	-0.1171	-0.0224	-0.0236	
Stock Market Illiquidity	-76.634	-13.774	-13.028	-3.3596	-2.0682	-2.1802	
Wald T-stat		**6.3879****			**4.8092*****		1.1823
EUROPE							
Foreign Income	0.1507	0.1243	-0.0891	0.0145	0.0182	-0.0129	
Relative Prices	-2.2075	-1.3767	-1.9241	-0.2121	-0.2019	-0.2784	
Exchange Rate Volatility	-1.0301	0.5165	1.1645	-0.099	0.0757	0.1685	
ZAREUR Volatility	0.3847	0.495	0.3118	0.037	0.0726	0.0451	
ZARCNY Volatility	0.1735	0.041	0.745	0.0167	0.006	0.1078	
Stock Market Volatility	-0.2022	-0.1773	-0.2213	-0.0194	-0.026	-0.032	
Stock Market Illiquidity	-16.0962	-8.4282	-11.167	-1.5469	-1.2358	-1.6157	
Wald T-stat		2.1005			**12.276***		0.3033

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

The short-run models for the world and all the regions showed that there was quantile dependency of the coefficients which meant that the level of exports (whether they were low or high) had a bearing on the observed short-run coefficients. This was apparent on total exports to the world where the coefficients for stock market illiquidity became more negative when exports decreased from the higher quantile (high exports) towards the lower quantiles (lower exports). Observations on illiquidity and stock market volatility coefficients for other regions showed a more mixed scenario although those for Asia, which constituted the largest total exports amongst the regions, were similar to those for total to the world.

Other risk factors such as relative prices carried greater magnitudes for lower quantiles indicating that lower exports were more sensitive to a change of the risk factors. Coefficients for exchange rate volatility were more influential for lower quantiles (except for Asia) like what was observed for relative prices. This suggested that higher export output was less susceptible to risk factors as opposed to poorer export output. Third-country effects were much more varied and would be better understood when individual countries were analysed. Export lags where only significant for America where the first lag had a greater effect on exports at a lower quantile, meaning that lower exports in the previous period had a greater impact on export in the current period compared to a situation where the previous exports were lower. Since this was not consistently the case for all the regions, it meant that previous exports influence on current exports in these regions were not dependent on the level of exports (were not quantile-dependent).

The QARDL results on the export demand functions to world regions showing relationships to be quantile dependent, suggested that the relationships were more sophisticated than what had previously been predicted by a linear relationship. The presence of non-linearities by the models support the earlier study by Ajmi *et al*. (2015) and Aye *et al*. (2015) who suggested non-linear modelling of South African export relationships. Such modelling has been previously overlooked, and so this finding supporting their hypothesis offers a unique contribution, and empirical supporting evidence. Similar QARDL estimations were made on exports to trading partners between January 2010 until December 2018 and the results are shown in Table 4.7.

Table 4.7: Quantile Dependent Short-run and Long-run Relationships (Partners)

	Long-run (Beta Matrix)			**Short-run** (Gamma Matrix)			**Export Lags**
Quantile	0.25	0.5	0.75	0.25	0.5	0.75	
CHINA							
Foreign Income	-0.133	0.1102	0.0265	-0.0602	0.0527	0.0124	
Relative Prices	-5.6109	-4.309	-4.3959	-2.5412	-2.0602	-2.0565	
Exchange Rate Volatility	-0.0076	-0.0059	0.0027	-0.0034	-0.0028	0.0013	
CNYUSD Volatility	-0.5086	-0.8884	-1.0895	-0.2304	-0.4248	-0.5097	
ZARCNY Volatility	0.0809	0.2292	0.1598	0.0366	0.1096	0.0748	
Stock Market Volatility	0.0486	-0.0058	-0.0119	0.022	-0.0028	-0.0056	
Stock Market Illiquidity	0.0609	0.0835	0.0636	0.0276	0.0399	0.0297	
Wald T-stat		**5.0845292*** **			**18.322341***		0.0311
GERMANY							
Foreign Income	-0.0639	14.0619	-0.5455	-0.0081	0.0199	-0.1057	
Relative Prices	-2.7545	10.0057	-10.1963	-0.3504	0.1415	-1.9758	
Exchange Rate Volatility	0.5722	12.4302	0.2865	0.0728	0.0176	0.0555	
ZAREUR Volatility	-0.5902	-103.317	-3.6175	-0.0751	-0.1462	-0.701	
CNYEUR Volatility	-1.4091	-154.334	-0.7737	-0.1793	-0.2183	-0.1499	
Stock Market Volatility	-0.0805	-2.8953	0.1738	-0.0102	-0.0041	0.0337	
Stock Market Illiquidity	-0.4319	-41.8279	-0.435	-0.0549	-0.0592	-0.0843	
Wald T-stat		2.464022			**13.854068***		0.772664
JAPAN							
Foreign Income	-0.0353	-0.0662	-0.0147	-0.0185	-0.0368	-0.011	
Relative Prices	-7.5803	-1.7175	2.5878	-3.9715	-0.9545	1.9304	
Exchange Rate Volatility	0.035	0.0044	-0.0033	0.0183	0.0024	-0.0024	
ZARJPY Volatility	-0.0355	0.2028	-0.5067	-0.0186	0.1127	-0.3779	
USDJPY Volatility	-0.6015	-0.2747	-0.3496	-0.3152	-0.1526	-0.2608	
Stock Market Volatility	0.0016	0.0727	0.0187	0.0008	0.0404	0.014	
Stock Market Illiquidity	0.1443	-0.0372	-0.0005	0.0756	-0.0207	-0.0004	
Wald T-stat		0.443578			**7.1232807****		**9.0651184*****
UK							
Foreign Income	-0.0705	0.0085	0.0751	-0.0745	0.007	0.0347	
Relative Prices	-1.3641	-6.2481	-26.086	-1.4416	-5.1589	-12.039	
Exchange Rate Volatility	0.0047	0.0202	0.0689	0.005	0.0167	0.0318	
ZARGBP Volatility	-2.2734	-2.5365	-2.7001	-2.4026	-2.0943	-1.2461	
GBPCNY Volatility	0.2603	0.0629	-0.9824	0.2751	0.0519	-0.4534	
Stock Market Volatility	0.0185	0.0598	0.2688	0.0195	0.0494	0.124	
Stock Market Illiquidity	0.1605	0.0834	0.0642	0.1696	0.0689	0.0296	
Wald T-stat		**6.6973000****			**157.04235***		**21.621034***
USA							
Foreign Income	-0.036	-0.0129	-0.0311	-0.0307	-0.0085	-0.0245	
Relative Prices	-6.9822	-2.9447	-4.9772	-5.9614	-1.9284	-3.931	
Exchange Rate Volatility	-0.0131	-0.0148	-0.0484	-0.0112	-0.0097	-0.0383	
ZARUSD Volatility	-1.2186	-1.7885	-1.6732	-1.0404	-1.1713	-1.3215	
USDJPY Volatility	-0.0059	0.3155	0.0771	-0.005	0.2066	0.0609	
Stock Market Volatility	-0.017	-0.0503	-0.0558	-0.0146	-0.0329	-0.0441	
Stock Market Illiquidity	0.0342	-0.0027	0.0301	0.0292	-0.0018	0.0237	
Wald T-stat		0.096167			**26.812598***		1.16774

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

The Wald tests suggested that long-run asymmetries were present for export demand functions to China and the UK because the coefficients were statistically significantly varied from one quantile to the next. For China, the long-run coefficients for foreign income were most impactful in the middle quantiles whilst relative prices had a greater influence in the lower quantiles. This meant exports tended to be more sensitive to changes of commodity prices when the exports of those commodities were lower. This made sense given that exports to China over the study period tended to be mining resources, but, exchange rate volatility and third-country effects were varied in the quantiles. As for the UK, the long-run coefficients were more varied than those observed for China and the financial market factors of stock market volatility and stock market illiquidity being positively related with exports. This may be because the UK commanded the least amount of exports during the study period and as such, did not skew financial market reaction compared to that of China which received the highest export volumes.

The Wald test statistics on the short-run coefficients suggested that asymmetries tended to be dominant in the short-run compared to the long-run; exports to all trading partners had quantile dependent coefficients. The signs on the coefficients varied from one export destination and quantile to the next signalling, the heterogeneity of export relationships by destination and quantile. None of the lags of exports had a non-linear relationship in any of the export demand functions suggesting that previous exports' effect on current exports to the trading partners were not statistically significant from one quantile to the next.

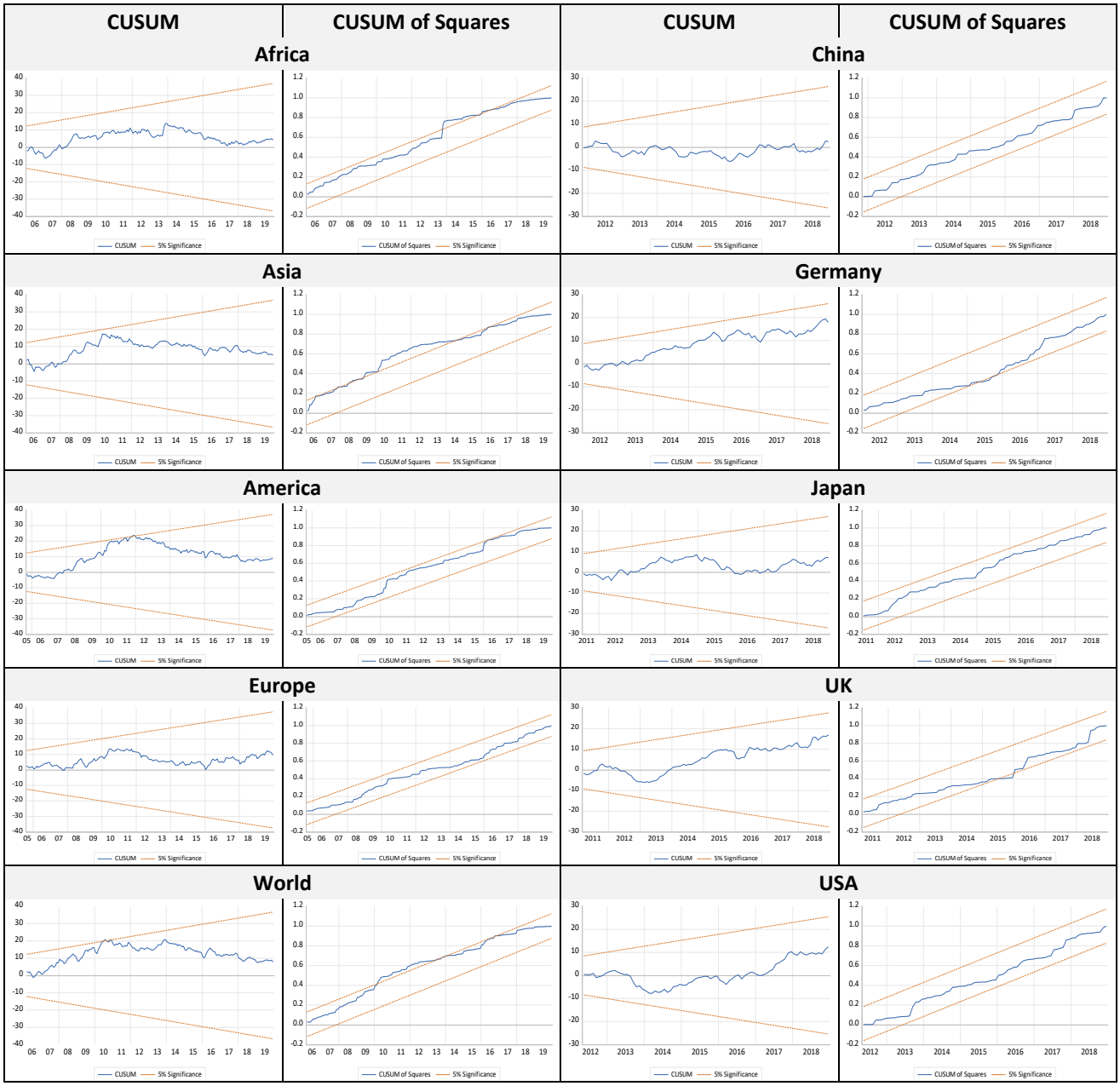
Reconcilable findings from the NARDL and QARDL on non-linearity suggested that policy interventions to boost exports should be cognisant of the sophisticated interrelationships between real and financial economic variables, where negative shocks from the financial economy tend to exert a greater magnitude compared to positive shocks. In addition, the location asymmetries meant the efficacy of policy interventions to boost exports would be dependent upon the current levels of exports because the QARDL showed that the responses to macroeconomic factors were depended upon the export quantile (level). 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. The results on the financial economic factors complimented both the finance-growth hypothesis and the endogenous growth theory.

It is conceivable that the availability of hedging, trade agreements and attitudes towards exchange rate risk may reduce the influence of exchange rate volatility and third-country effects on exports. For instance, McKenzie, 1999, Bahmani-Oskooee and Hegerty, 2007 and Bahmani-Oskooee, Nosheen and Iqbal, 2017 alluded to the fact that some exporters may view exchange rate volatility as an opportunity to profit by increasing output whilst some may reduce output in light of the increased currency volatility. For example, the South Africa – European Union (SA-EU) Trade, Development and Cooperation Agreement (SA-EU TDCA) (DTI, 2019) may ameliorate the negative effects of increased exchange rate volatility thereby, rendering the volatility of the Rand not highly consequential on exports to trading partners. After Fowkes *et al*. (2016) made similar observations on exchange rate volatility effects on South Africa's exports, they conceded that the exchange rate level (or the relative prices), rather than its volatility was supposed to be of interest to policy makers.

To evaluate the stability of the export relationships that were established by the two models above, the NARDL and the QARDL, the cumulative sum (CUSUM) and CUSUM of squares analysis was undertaken on all export demand functions. The results from the CUSUM and CUSUM of squares stability tests which were conducted at the 5% significance level are results are presented in Figure 4.1.

Figure 4.1: CUSUM and CUSUM of Squares Tests



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.

4.5 Summary and Conclusion

This chapter considered financial and real economic variables as well as third-country effects to analyse South African export behaviour using non-linear modelling in line with the objective of analysing the existence of asymmetric relationships in export demand functions. The NARDL and QARDL models established long-run and asymmetric relationships – highlighting the value of considering non-linearity. 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 chapter 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 chapter 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. These findings complemented those obtained in Chapter 3 because they showed that the financial economic factors influenced South Africa's exports. This further strengthens the recommendation that South Africa's trade policy ought to accommodate the financial economic factors while being cognisant that they exhibit an asymmetric relationship with exports.

The observation that there were asymmetries between South Africa's exports and the financial economic variables highlighted that this relationship was likely influenced by

business cycles. This observation, which could be reconciled with the assertions by Kayacetin and Kaul (2009), Ogunmuyiwa (2010), Kim (2013), Chipaumire and Ngirande (2014) and Holmes and Maghrebi (2016) that liquidity in stock markets was positive for real economic activity and related with business cycles. Consequently, it is essential to consider how business cycles, which may cause change of behaviour of macroeconomic variables, may play a role in influencing the relationships between South Africa's exports and financial economic variables.

Various stages of business cycles have differing impact on economic activity. Therefore, it is plausible that macroeconomic factors' impact on exports may be dependent upon the stage of a business cycle. As such, considering the possible impact of business cycles on export demand and growth is essential towards formulating a more sustainable export strategy to assist with South African economic growth. It is in the interest of policy makers to comprehend how export demand changes in varying stages of a business cycle which is highly likely especially after considering that this chapter has already found that South African export demand has an asymmetric relationship with economic variables. The next chapter considers business cycle influences on South African export demand to ascertain their implications for export growth.

CHAPTER 5: REGIME-SWITCHING EFFECTS OF SOUTH AFRICAN EXPORTS

5.1 Introduction

The previous chapter showed that export relationships had both short-run and long-run asymmetries which were quantile dependant, especially in the short-run. This revelation was a significant contribution to existing literature because it exposed that linear assumptions, though popular, were inadequate and had left a gap in knowledge. However, after achieving the set objectives of Chapter 4, there remained a gap pertaining to the behaviour of South African export demand during varying stages of business cycles. Understanding the impact of business cycles on export relationships was essential because the economy is seldom in a static state. Therefore, policy makers must make continuous adjustments to their policies depending on the economic state. This chapter set out to achieve the objective of ascertaining whether there were regime-switches and their significance on South African export growth. Using non-linear methods that account for business cycles is an important contribution to better understanding South African export demand because effective policy interventions may need to be business cycle dependent.

Modelling the behaviour of economic time series such as export output is a popular concern in econometric studies, with the issue of using either linear or non-linear models drawing considerable interest (Granger, 2008). The case for non-linear models emanates from the observation that economic and financial time series tend to exhibit non-linear behaviour: they fluctuate (change their behaviour, mean and volatility), have structural breaks, and asymmetries arising from business cycles (Brooks, 2008, Granger, 2008, Ferrara, Marcellino, and Mogliani, 2015 and Chang, Choi and Park, 2017). As these export series may have asymmetric adjustments to positive and negative shocks of the same magnitude, they may be assumed to behave in a non-linear fashion. This non-linear behaviour, particularly changes in mean and volatility, is often referred to as '*regime-switching*' behaviour.

Models such as the threshold autoregressive model (TAR) and its variants, and the Markov-Switching model (first introduced by Hamilton (1989)), were developed to

model data series with regime switches. In some studies, the TAR and the Markov-Switching models have been extended into the threshold vector error correction model (TVECM) first introduced by Balke and Fomby (1997), the Markov-Switching vector error correction model (MS-VECM), and the Markov-Switching autoregressive distributed lag (MS-ARDL) recently developed by Tansuchat and Yamaka (2018). Both the TAR and Markov-Switching models have been used to analyse real economic output by studies which include Teräsvirta, Van Dijk and Medeiros (2005), Djeddour and Boularouk (2013), Camacho, Quiros and Poncela (2014) and Boonyakunakorn, Pastpipatkul and Sriboonchitta (2018).

The advantage of the TAR and Markov-Switching models is that they are flexible enough to allow for more than one mean for the entire sample, and as a result, can capture these changing, regime-switching, dynamics. These models are especially important to be utilised in the area of South African export growth mainly because the current climate of subdued economic growth may see real gross domestic product (GDP) growth remain below 1% per annum for the foreseeable future according to Fedderke and Mengisteab (2017). The South African Reserve Bank through its SARB (2020) noted that the GDP growth rate had contracted by an annual rate of 2% in the first quarter of 2020 and that the recession was expected to continue into the third quarter of 2020 as the effects of the COVID-19 pandemic continue to afflict the economy. The recent COVID-19 global pandemic will likely exacerbate the already dire economic growth prospects. For instance, Topcu and Gulal (2020) highlighted that the COVID-19 pandemic would have a negative impact globally through its disruption of labour markets, supply chains and consumption behaviour arising from lockdowns aimed at managing infection rates. In addition, capital flows and investments to emerging market economies was expected to become depressed.

The likelihood of a protracted subdued economic growth rate is a major concern for South Africa however, it remains conceivable that exports will assist with economic recovery once economic restrictions are eased. Studies conducted by Ajmi, Aye, Balcilar and Gupta (2015) and Fowkes, Loewald and Marinkov (2016) have motivated for exports as a crucial avenue for growth; highlighting that the trade policy was key to unlocking long-term economic growth. In addition, Fowkes *et al*. (2016) made the point

that there existed a statistically significant relationship between South Africa's declining economic growth and its performance in the export market. The SARB's (2020) revelation that real net exports had made the largest contribution of 4.6% towards GDP growth in the first quarter of 2020 indicated that the export sector could be crucial for South Africa's economic recovery. Utilising models that account for regime switches as South Africa navigates its economic path during the lower part of the business cycle is relevant because it contributes to a better understanding of export behaviour which in turn improves the effectiveness of policy interventions.

Interest in analysing export behaviour began in the period after the collapse of the Bretton Woods system of fixed exchange rates in 1973, where concern was focused on adverse implications of exchange rate volatility (Bahmani-Oskooee, Harvey and Hegerty, 2013 and Choudhry and Hassan, 2015). Although exports have been studied since the fixed exchange rate era, analysing international trade remains crucial as global interdependence increases. Although analysis of South Africa's exports has occurred previously, these analyses have largely overlooked the implications of accounting for non-linearities in the form of regime-switching behaviour of macroeconomic variables. This is surprising as accurately modelling export behaviour in South Africa is increasingly becoming crucial in the current circumstances of stagnating economic growth which has caused institutions such as the International Monetary Fund (IMF) (2019) and the South African Reserve Bank (SARB) (2019) to propose exports as one of the avenues through which growth can be encouraged.

South Africa's trade policy has remained consistently focused on being outward-looking with an objective of cultivating long-term economic growth with price stability (Calì and Hollweg, 2017). Notwithstanding this trade policy, the objective to achieve a desired long-term economic growth rate has remained elusive (Fowkes *et al*. 2016). This further highlights the importance of analysing exports because they seem not to have contributed enough to achieve the desired growth objective. This thesis sourced South African export data. Consequently, a unique dataset was obtained from the South African Revenue Services (SARS) of total monthly exports to the world (December 2003 – December 2019) and to five leading trading partners, namely:

China, Germany, Japan, UK and USA (only available for the period January 2010 – December 2018).

Figure 5.1: Total Exports to the World and Trading Partners (Billions of Rands)

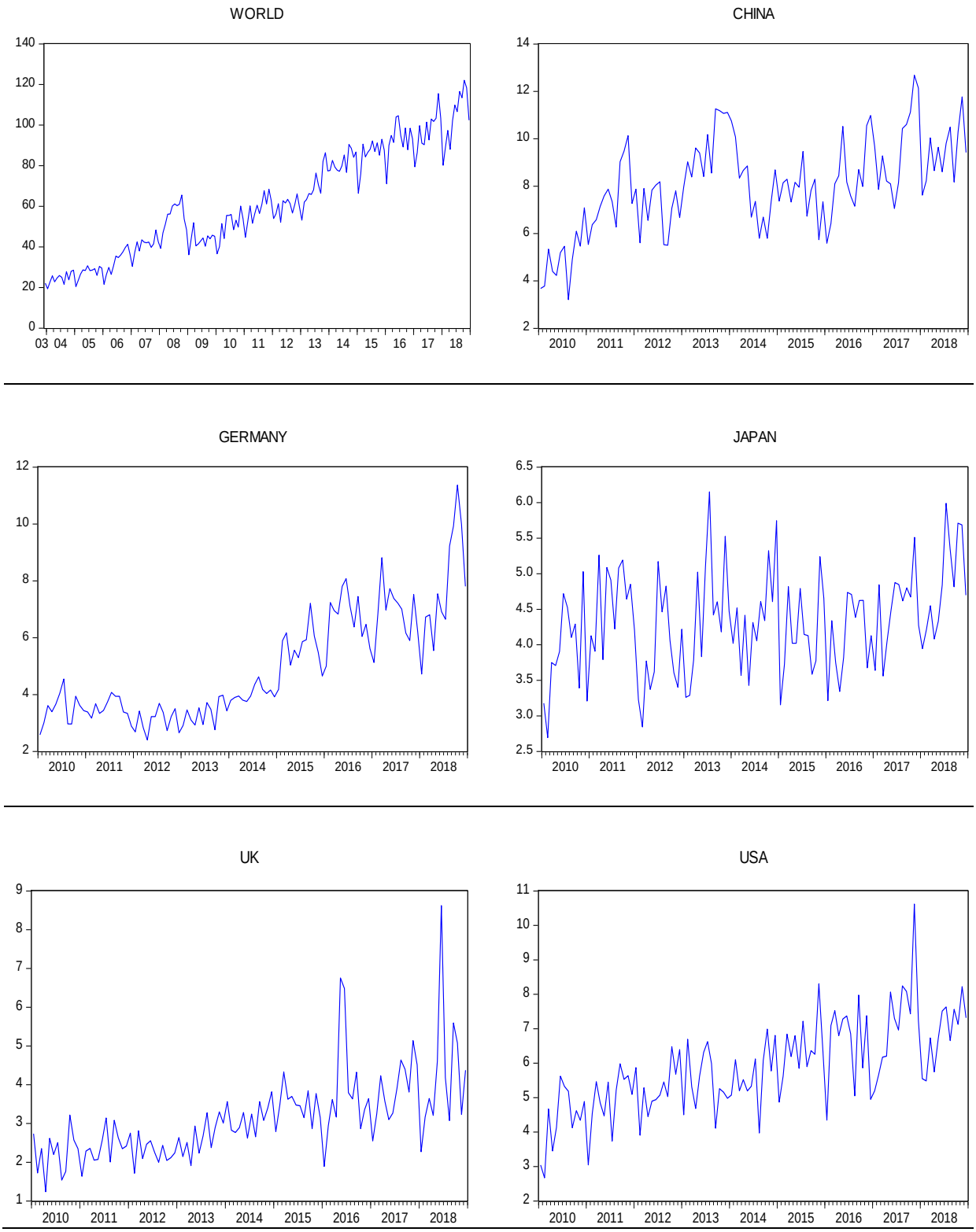


Figure 5.1 presents total exports to each of these trade destinations, with the vertical axis representing total exports in billions of Rand while the horizontal axis marks the dates. All total nominal exports have, on average, been on an upward trend; however, these trends were dominated by significant fluctuations which have increased in the five years leading up to December 2018.

The fluctuations were more pronounced for exports to the Asian countries (China and Japan) whilst fluctuations for the European countries (Germany and the UK) tended to become more pronounced after 2015. In all the series, there were indications of changes in behaviour; for instance, exports to China changed from an upward trend to a significant downward trend between 2013 and 2014, only to resume the upward trend with more fluctuations thereafter (similar fluctuating behaviour was observed on the other country-based exports). In addition, total exports to the world (which cover a longer period) showed a significant decline between August 2008 and March 2009; a period which coincided with the global financial crisis of 2008. This particular visual inspection of these time-series' behaviour strengthens the support for this research which employs models capable of accounting for structural breaks and regime-switching behaviour evidenced in Figure 5.1.

In addition to the econometrical considerations of more realistically accounting for the reality of structural breaks and regime switches, it is increasingly becoming important to consider the economic aspect of the interplay between the financial and real economies (Gogineni, 2010, Degiannakis, Filis, and Floros, 2011, Giannellis and Papadopoulos, 2016 and Pan and Mishra, 2018). The financial economy likely plays a crucial role in South African export behaviour based on the endogenous growth theory first proposed by Levine and Zervos (1996) who were of the view that financial market depth facilitated efficient resource allocation, capital accumulation and technological innovation thereby, fostering long-run economic growth. It is noteworthy that financial market participant behaviour which is influenced by present value of future real economic output affects their investment patterns on corresponding exporting stocks which in turn, are reflected by stock market liquidity and volatility (Kurilova, Stepanova and Topornin, 2018).

Several studies considering the existence of a relationship between the real and the financial economies included the financial economic factors as stock returns, volatility and liquidity; these studies include: Levine and Zervos (1998), Kayacetin and Kaul (2009), Ogunmuyiwa (2010), Næs *et al*. (2011), Kim (2013), Chipaumire and Ngirande (2014), Chen, Chou, and Yen (2015) and Pan and Mishra (2018). These studies' analyses centred on evaluating the relationship between stock market liquidity and gross domestic product (GDP) or industrial production and tended to find a positive relationship; strengthening the view of an interconnected relationship between the real and financial economies. Pan and Mishra (2018) stated that stock market liquidity was a predictor of real GDP growth and industrial production whilst Fufa and Kim (2018) found that liquidity had a statistically significant impact on growth, especially in middle income countries. Significantly, the studies by Næs, Skjeltorp and Ødegaard (2011), Kim (2013), Chen *et al*. (2015) highlighted that financial time series' relationship tended to strengthen during financial crises; highlighting the influence of business cycles on econometric relationships.

South Africa is currently experiencing weak economic growth regardless of having an existing trade policy which targets export growth as an avenue to boost long-run economic growth. Fowkes *et al*. (2016) suggested that the trade policy ought to focus on trade competitiveness by ensuring that the domestic price level growth remained comparable to that of trading partners. Although this policy position may assist with maintaining current export levels, the interlinkage of real and financial economies in the presence of busyness cycles which may cause non-linear behaviour must be considered. Thus, the existing trade policy must broaden its scope to consider non-linear behaviour of economic variables to formulate remedies that will ameliorate downside risk of economic shocks through interventions in both the real and financial economies.

Consequently, it is pertinent to establish if there are regime switches in South Africa's exports and consider how this affects their relationship with selected economic and financial variables. This has been a gap in existing South African studies, as the domestic literature tended to focus on real economic variables, leaning on the deteriorating Rand value against major currencies and its volatility as a major factor.

In addition, linear models were the main method of analysis – a limitation as economic relationships tend to be non-linear. Establishing the different regimes and thresholds and their effect on exports is a unique contribution that this research offers to existing knowledge on South African export relationships. The potential for more complex models accounting for regime switches to provide a deeper understanding of exports is a key objective of this chapter. Uncertainty about export output and the continued decline of South African economic growth is a concern for both investors and policy makers, therefore, an investigation into the likely factors influencing export behaviour is essential. This chapter specifically contributes to knowledge in the area of export demand by accounting for non-linearity in the form of regime switching and threshold modelling. This enables it to consider business cycle influence on South Africa's exports growth which improves trade policy interventions in varying levels of the business cycle. The findings enable practitioners to better understand how positive and negative shocks of real and financial variables are related with rand leveraged stocks in varying economic cycles.

Findings made by this thesis have practical implications for policy makers and investors. It assists South African policy makers formulate a more robust export-oriented trade policy that not only focuses on the real economy but also speaks to the financial economy by suggesting that stability in the financial markets assists with export growth. The regime-switching and threshold analysis also assists investors better understand and prepare for exports fluctuations on their portfolios in both the long-run and the short-run in varying business cycles. Lastly, the findings made by this study contribute towards a theoretical foundational framework from which future South African export demand can be modelled.

The following section conducts a theoretical review to unravel the phenomena of business cycles and regime-switching behaviour of economic and financial time-series in the cycles. The literature review which succeeds the theoretical review analyses relatable erstwhile studies and considers their methods and subsequent findings.

5.2 Literature and Theoretical Review

Analysis of economic and financial time-series requires consideration of the possibility that they may be influenced by random shocks during the period of study. The random shocks, which may be endogenous or exogenous, can either have a temporary or permanent effect on the behaviour of a given macroeconomic time-series. Business cycles tend to exert a considerable influence on the impact and severity of shocks, with industries having varying sensitivities at different points of the business cycle. For instance, cyclical firms would fare worse than defensive firms in an economic decline cycle, while the opposite is true in an economic boom (Bodie, Kane and Marcus, 2013). Economic output tends to vary depending on the stage of a business cycle which affects their earnings potential. Financial economic participants react to the variability of real economic output or change their behaviour based on the predictability of future earnings influenced by business cycle stages. The change of behaviour by financial market participants may be reflected by the variability of stock market liquidity and volatility. Since business cycles may induce regime-switching behaviour to both real and financial economic time-series, they must be analysed and understood.

5.2.1 Business Cycles

Business cycles, which are commonly understood as recurring patterns of economic recessions and recoveries affect firm output and earnings during the transitions between peaks and troughs (Bodie *et al*., 2013). According to Grinin, Tausch and Korotayev (2016) the business cycles which occur and last between seven and eleven years, also referred to as Juglar cycles, are divided into four distinct phases. The business cycle phases are as follows:

1) **Recovery** – this is the phase where economic growth begins after a period of a fall and economic stagnation; immediately succeeds the trough in the business cycle.

2) **Expansion** – in this phase of the economic cycle, the growth accelerates to an economic boom.

3) **Recession** – in the recession phase, the euphoria of prosperity is replaced by panic accompanying the collapse which is ultimately succeeded by the economic downturn.

4) **Depression** – Balance is achieved in this phase where the economic decline stops; however, any form of pronounced growth is absent (this is also referred to as the trough).

Given the impact that business cycles have on both the real and financial economies, hypotheses to describe and understand them from both the developed and emerging market standpoints have been proposed. Patroba and Raputsoane (2016) highlighted that interest on business cycles is higher in emerging market economies because in these economies, business cycles tended to be subject to significant levels of volatility in the growth trend as compared to developed economies where the volatility is more moderate. The phenomenon of emerging markets being characterised by a volatile trend which in turn, determines the behaviour of the economy at business cycle frequencies is captured by the *cycle is trend* hypothesis.

Although business cycle effects remain relevant to date, they were of interest to earlier study such as Long and Plosser (1983) who noted that their effect on the real and financial variables, was characterised by two broad categories namely, deviations from the trend and that various measures of economic activities move together. Aguiar and Gopinath (2007) investigated business cycles in emerging market economies and discovered that these markets were characterised by strong counter-cyclical current accounts and increased volatility. Although they referred to their findings as the *sudden stop* phenomenon, they were similar to those obtained later by Patroba and Raputsoane (2016) in emerging markets. Patroba and Raputsoane (2016) investigated and tested the *cycle is trend* hypothesis in South Africa between 1946 and 2014. They established that permanent productivity shocks were more important compared to transitory ones. Patroba and Raputsoane (2016) further showed that during business cycle fluctuations, emerging markets tend to show large changes in trade patterns especially in periods of economic crises.

Bergholt, Larsen and Seneca (2019) highlighted that resource-rich countries were especially vulnerable to business cycle fluctuations because they impacted on commodity prices and affected terms of trade. South Africa, which is an emerging market economy whose exports are resource-dominated, is likely vulnerable to business cycle fluctuations and therefore, these must be considered. Economic time-series tend to be impacted by fluctuations emanating from the business cycle and these shocks could be random, have a transitory or permanent impact. In addition, the shocks may lead to regime-switching behaviour on a given macroeconomic series. As a result, shocks to the series must be considered and their impact assessed to evaluate their influence on observed econometric relationships.

5.2.2 Regime-Switching Behaviour

The conventional view on economic and financial time series was that current shocks tended to have no significant effect on the long-run movement of a series, rather, these effects were temporary (short-term) in nature. However, the findings by Nelson and Plosser (1982) that random shocks had permanent effects on the long-run level of a macroeconomic time series suggested that fluctuations were not transitory. This consequently renewed interest on modelling time series, now accommodating for non-linearities. Prior to this, the most popular method of analysing economic time series tended to be ordinary least squares (OLS) based methods which assumed that the underlying data had a constant mean and variance (are stationary) (Glynn, Perera and Verma, 2007). However, it is seldom the case that economic or financial time series have a constant mean or variance; instead, they tend to have means and variances that change over time (these series tend to have one or more unit roots). This means that previous values of a series have an influence on future values of that series and as a result, the series are not stationary (Dickey and Fuller, 1979 and Brooks, 2008).

Perron (1989) asserted that macroeconomic time series were not characterised by a unit root, instead, persistence only arose from large and infrequent shocks, with the economy returning to its deterministic trend following smaller and more frequent shocks. One of the most popular methods of testing for unit root processes in time series analysis is the Augmented Dickey-Fuller (ADF) (1979) test. However, Perron

(1989) posited that Dickey-Fuller's (1979) method did not account for the possible existence of structural breaks in the data, leading to a bias that reduced the ability of the ADF test to reject a false unit root process. Perron (1989) suggested that allowing for a known or exogenous structural break in the ADF test would improve the method's ability to accurately detect unit root processes. The Dickey-Fuller Generalised Least Squares (DF GLS), developed by Elliot *et al*. (1996), is more robust compared to the traditionally more popular ADF and Phillip-Perron (PP) tests in small sample sizes (Glynn *et al*., 2007).

Considering the need to account for structural breaks in macroeconomic data series, Zivot and Andrews (1992) extended the model suggested by Perron (1989) (which treats the structural breaks as endogenous) through the development of a sequential test using the full sample and a different dummy variable for each possible break in the data (Byrne and Perman, 2007). The Zivot and Andrews (1992) test performs the ADF unit root test for every possible observation and selects the break date which yields the minimal *t*-statistic. Unlike Perron's (1989) model, which assumes the exact time of the breakpoint, Zivot and Andrews (1992) employ a data dependent algorithm to proxy Perron's (1989) subjective procedure to determine the break points.

Zivot and Andrews proposed three models to test for a unit root and these models are summarised in the equations below. Model 5.1 (which is also referred to as the crash model) permits a one-time change in the level or intercept of the series, model 5.2 allows for a one-time change/break of the slope or growth of the trend function, and model 5.3 combines one-time changes in both the level and slope of the trend function of the series (Glynn *et al*., 2007).

$$y_t = \alpha_0 + \alpha_1 DU_t + d(DTB)_t + \beta t + \rho y_{t-1} + \sum_{i=1}^{k} \phi_i \, \Delta y_{t-i} + \varepsilon_t \ , \qquad (5.1)$$

$$y_t = \alpha_0 + \gamma DT_t^* + \beta t + \rho y_{t-1} + \sum_{i=1}^{k} \phi_i \, \Delta y_{t-i} + \varepsilon_t \qquad (5.2)$$

and

$$y_t = \alpha_0 + DU_t + d(DTB)_t + \gamma DT_t + \beta t + \rho y_{t-1} + \sum_{i=1}^{k} \phi_i \Delta y_{t-i} + \varepsilon_t \quad (5.3)$$

Where, the intercept dummy DU_t represents a change in the level; $DU_t = 1,\ if\ (t > 1)$ and zero if otherwise. The slope dummy variable, DT_t (also DT_t^*) represents a change in the slope of the trend function and $DT^* = t - TB$, $(or\ DT_t^* = t,\ if\ t > TB)$ and zero otherwise, the crash dummy $(TB) = 1\ if\ t = TB + 1$ and zero otherwise and TB is the break date. This can be summarised as follows:

$DU_t = \{^{1 \ldots\ldots if\ t > TB}_{0 \ldots\ldots otherwise}$, and

$DT_t = \{^{1 - TB \ldots\ldots if\ t > TB}_{0 \ldots\ldots otherwise}$

Each of the three models has a unit root with a break under the null hypothesis, as the dummy variables are incorporated in the regression under the null hypothesis. In all the three models, the null hypothesis is that $\alpha = 0$ and this implies that the series has a unit root with a drift that excludes any structural break, and alternative is that $\alpha < 0$ which implies that the series is a trend-stationary process with a one-time break that occurs at an unknown point in time.

According to the Zivot and Andrews model, the choice of the break point is established by minimising the one-sided t-statistic. Perron (1989) suggested that most economic time series are modelled adequately with model 5.1 or 5.3 which are the models which tend to be mostly used in empirical literature. However, Sen (2003) showed that if one used model 5.1 when the break happens according to model 5.3, there will be a substantial loss in statistical power which made model 5.3 the most prudent choice.

There is a reasonable expectation that the total exports depicted in Figure 5.1 may have structural breaks or regime-switching behaviour, indicating for the use of the subsequent employment of models which can accommodate such characteristics. Although tests for structural breaks and models accounting for breakpoints and regime-switching behaviour are necessary for economic and financial time series.

Chapter 3 and Chapter 4 showed that South African literature has tended to overlook these dynamics notwithstanding the fact that they could play a crucial role in understanding the export dynamics. The following section undertakes a review of related literature that has investigated relationships between exports and macroeconomic variables, highlighting the gap in knowledge that this thesis aims to address.

5.2.3 Empirical Review

South Africa's open and outward-looking trade policy targeting export growth while maintaining a freely floating exchange rate motivated research on export behaviour and growth (Vijayashri, 2013). While early South African literature on export growth is dominated by methodologies that employ linear methods of analysis, latter South African studies make the concession that non-linear methods could be more appropriate. Those employing linear methods to analyse South African export behaviour mainly employed Johansen's cointegration, the ARDL and linear panel data analysis. Although linearity assumptions may have restricted the scope of analysis for the studies that employed them, these studies provide a background from which this thesis can build and address the gaps in knowledge on South African export demand functions.

Previous research employing Johansen's cointegration included Bah and Amusa (2003) who evaluated South Africa's quarterly exports to the United States of America (USA) between 1990 and 2001, Takaendesa, Tsheole and Aziakpono (2006) who similarly examined quarterly exports to the USA between 1992 and 2004, Schaling (2007) who analysed South Africa's quarterly trade balance between 1994 and 2006, and Nyahokwe and Ncwadi (2013) who examined South African monthly exports to the rest of the world between 2000 and 2009. All the studies arrived at the conclusion that exchange rate volatility discouraged exports, with the exception of Nyahokwe and Ncwadi (2013) who found that exchange rate volatility had no effect on exports.

South African studies which employed the ARDL model included Todani and Munyama (2005) who analysed aggregated quarterly exports to the world between

1984 and 2004, Sekantsi (2011) who examined quarterly exports to the USA from 1995 to 2007, and Wesseh and Niu (2012) who analysed total and sector-level exports to China between 1992 and 2010 using monthly data. Todani and Munyama (2005) found a weakly positive effect, Sekantsi (2011) found negative effect, while Wesseh and Niu (2012) found no effect on aggregated exports (but detected both positive and negative effects on product-level exports).

Chang, Simo-Kengne and Gupta (2013) who investigated causality between annual provincial exports and GDP from 1995 and 2011 and Khosa, Botha and Pretorius (2015) who evaluated the impact of exchange rate volatility on the exports of nine emerging market economies (including South Africa) from 1995 to 2010 employed linear panel data analysis. Chang *et al*. (2013) found both bidirectional and unidirectional causality (GDP to exports) while Khosa *et al*. (2015) concluded that exchange rate volatility negatively affected exports. The findings were reconcilable amongst the various methods of analysis but the varied results on exchange rate volatility, which was their main factor of focus, suggested the existence of the exchange disconnect puzzle.

Recently, Bahmani-Oskooee and Arize (2020) investigated the impact of exchange rate volatility on imports and exports of thirteen African countries namely; Algeria, Cameroon, Ethiopia, Ghana, Kenya, Mauritius, Morocco, Nigeria, South Africa, Tanzania, Tunisia, Uganda and Zambia to exchange rate volatility. With the focus being of exchange rate volatility influence on trade, their study employed world income, real effect exchange rates and real effective exchange rate volatility as control variables. After employing the employing the linear ARDL the study found that there were significant long-run effects in a third of the countries, however, after the NARDL model was employed significant long-run asymmetric effects on trade flows for most of the countries. For South Africa, Bahmani-Oskooee and Arize (2020) found some asymmetric adjustments on trade to changes of exchange rate volatility which led to the conclusion that export-oriented policy makers ought to invest in sectors that benefitted from exchange rate volatility.

Although all these studies provided a foundational contribution on South African export behaviour, their analysis was limited to establishing an overall relationship between exports and macroeconomic variables. This restricted their ability to interrogate how the relationship between exports and economic variables has evolved over time; for instance, how the relationship would change from a high exchange rate volatility period to a low volatility period (regime-switching). Non-linear analysis that considers regime-switching and threshold phenomena on South Africa's exports is limited but crucial considering the submissions made in sections 5.2.1 and 5.2.2.

Given the scant nature of literature exclusively addressing threshold and regime-switching effects on South African export behaviour, international studies that accounted for these non-linear effects were considered. These studies include the one conducted by Lee and Huang (2002) who employed a multivariate threshold autoregressive (MTAR) model earlier introduced by Tsay (1998) to estimate the causal relationship between exports and growth in East Asian countries. After running an MTAR with two regimes on quarterly data between 1961 and 2000 they confirmed the export-led growth relationship for outward oriented countries, however the linear models could not establish this relationship (Lee and Huang, 2002). Another study by Foster (2006) examined the relationship between exports and economic growth in Africa using threshold regression. This study's aim was to establish if African countries benefited more from exports when they had reached a certain level of development and openness. Foster (2006) made the finding that there existed a positive relationship between exports and growth in Africa and that it was not necessary for a country to reach a certain threshold of development or to have an existing export base for this relationship to hold. However, the relationship between exports and growth tended to be stronger for countries with higher rates of export growth.

The threshold model employed by Foster (2006) highlighted that there was more to be understood on export relationships when non-linearity was introduced compared to a case where only the linear relationships were considered. This was further highlighted by Pretorius and Botha (2007) who considered the forecasting accuracy of a pure linear multivariate ordinary least squares (OLS) model and a non-linear smooth transition autoregressive (STAR) model. After analysing quarterly data between 1990

and 2004 to forecast the relationship between exports (without gold); international commodity prices and the Rand/US Dollar exchange rate, Pretorius and Botha (2007) found results which suggested that STAR models produced more accurate forecasts compared to purely linear models. This finding was similar to the conclusion reached by Djeddour and Boularouk (2013) who focused on the specification of the TAR in forecasting USA oil exports between 1991 and 2004. Djeddour and Boularouk (2013) found that the TAR model was a better predictor of USA's oil exports compared to linear autoregressive moving average (ARMA) models.

Ajmi *et al*. (2015) noted that the analysis of South Africa's exports could be improved if non-linearity was considered. This was after their study had initially employed Granger causality tests to analyse the relationship between South Africa's economic growth and annual exports from 1911 and 2011 and failed to establish any causality of statistical significance. Consequently, Ajmi *et al*. (2015) applied the Hiemstra and Jones (1994) non-linear Granger causality test which established unidirectional causality from GDP to exports; in another non-linear test, the Diks and Panchenko (2006) model, showed that there was bi-directional causality. This led them to make the conclusion that non-linearities and structural breaks ought to be considered if the econometric relationships are to be better understood.

Fourie, Pretorius, Harvey, Henrico and Phiri (2016) explored the existence of a non-linear relationship between exchange rate volatility and economic growth in South Africa between 1970 and 2016 using a smooth transition model. Their study established that there existed a non-linear relationship; regime-switching behaviour was of influence on growth of government spending. Fourie *et al*. (2016) found that exchange rate volatility was significant and positively affected economic growth when government spending was below 6%, however, when government spending was above 6% exchange rate volatility tended to have an insignificant effect on economic growth. These findings led to Fourie *et al*. (2016) concluding that with the adoption of a freely floating exchange rate regime, fiscal spending was of importance if exchange rate volatility was to impact economic growth.

A study by Tansuchat and Yamaka (2018) used a Markov-Switching ARDL (MS-ARDL) model, which accounts for short-run and long-run non-linearities, to analyse Thailand's rice exports to Nigeria. They found that the MS-ARDL captured both short-run and long-run behaviours of export demand in the two regimes. A similar study that was conducted by Boonyakunakorn, Pastpipatkul and Sriboonchitta (2018) forecasted Thailand's exports to ASEAN countries from January 2002 to December 2016 using monthly data. The study established that exports to ASEAN were non-linear after conducting linear tests and in addition, there were two thresholds which applied. Boonyakunakorn *et al*. (2018) concluded that the SETAR model was the most suitable model for forecasting export performance.

Earlier studies analysing South Africa's exports harboured the view that exchange rate volatility was the main risk for exporters and in addition, there was likely a linear and inverse relationship between exports and exchange rate volatility. However, a recent study by Boateng, Claudio-Quiroga and Gil-Alana (2020) found that the nominal exchange rates between the Rand and major currencies which included the US Dollar, British Pound, Euro, Japanese Yen, Chinese Yuan and the Australian Dollar tended to exhibit non-linear behaviour. Boateng *et al*. (2020) found that between 2010 and 2018, most of the nominal exchange rates possessed an integration order of one; they had one unit root. However, they found that there was some persistence to the behaviour as highlighted by some degree of mean reversion. In addition, the Bai and Perron (2003) tests showed that all the nominal exchange rates had four breakpoints, thereby, confirming the need for consideration of non-linearity.

While a considerable number of South African studies reviewed above established some general relationships between export behaviour and macroeconomic variables, not much was done to ascertain how the relationships were affected by business cycles and regime-switching behaviour. This omission coupled with overlooking of the financial economic variables inhibited their ability to examine the nuances of these relationships in varying stages of the business cycle. Those that employed threshold analysis had a strong view that such consideration vastly improved their understanding of macroeconomic behaviour which is important to note for this study.

Considering the findings that were made by Fourie *et al*. (2016), it is possible that South Africa's Rand volatility may have a relationship that changes when the volatility is at a higher level compared to when it is at a lower level. This possibility, which is probed using regime-switching modelling, is pertinent considering that after Chapter 3 had established short-run and long-run relationships, Chapter 4 showed that there were asymmetric relationships in the export demand functions. The regime-switching effects may hold true for other economic variables such as those emanating from the financial economy (for instance, stock market illiquidity) which have also not been given much attention by South African literature analysing export behaviour.

Given the increasing episodes of variability of South Africa's exports and the benefits associated with TAR and Markov-Switching models, considering the benefits of accounting for regime-switching and threshold effects coupled with the interactions between the real and financial economies; this study addresses a gap in South African literature. The following section discusses the data and presents the method of analysis employed to achieve the set objective of investigating the existence and significance of regime switches in the period of study and evaluate their effect on South Africa's exports.

5.4 Data and Methodology

5.4.1 Data

Monthly export data were sourced from SARS for the period between December 2003 and December 2019 which was similar to the dataset used in Chapter 4. However, this chapter focused on total exports to the world and to the top individual trading partners as it was expected that that individual trading partners were more likely to have unique relationships with South African export demand as opposed to entire world regions.

Table 5.1 summarises total exports to the rest of the world and to trading partners followed by the explanatory variables employed by the study. The first real economic variable used was foreign income to trading partners. Foreign income represented potential demand for South Africa's exports and was proxied by industrial production in the export destinations; consistent with studies by Todani and Munyama (2005), Choudhry and Hassan (2015), Moslares and Ekanayake (2015) and Bahmani-Oskooee *et al*. (2016a & 2017). The second variable, also consistent with previous studies, is that of relative prices. Relative prices, representative of the comparative price of South African exported goods, were proxied by the real effective exchange rate which was a weighted average of a basket of the respective trading partners' currencies (Todani and Munyama, 2005 and Choudhry and Hassan, 2015). The South African Reserve Bank (SARB) computes the real effective exchange rate of the Rand versus the currencies of the country's top twenty trading partners which are used to gauge the competitiveness of South African goods in the export market (Motsumi, Swart, Lekgoro, Manzi and de Beer, 2014)

The next explanatory variable employed was exchange rate volatility, which has been traditionally popular in related studies. Third-country effects were then included, which were estimated as the exchange rate volatility of a trade competitor when analysing export demand to a given trading partner. Third-country effects mainly employed included Chinese Yuan and the US Dollar mainly because the former has emerged as a global force for international trade whilst the latter is because most global transactions are conducted using the dollar. According to data available from the

World Trade Organisation (WTO), South Africa's share of global exports are on the decline: during the period beginning March 2013 until December 2019, South Africa's global export share averaged 0.49%; it had a maximum share of 0.52% in September 2013. However, there was a declining trend from that time until December 2019 where export share closed below the average of 0.49%. This scenario makes it essential to consider whether the volatilities of other major export competitors (third-country effects) have had a role to play in the declining trend. Edwards and Jenkins (2015) showed that China was one of the main countries eroding South Africa's exports, especially those to Europe. Similar studies by Choudhry and Hassan (2015), Bahmani-Oskooee *et al*. (2016a) and Bahmani-Oskooee *et al*. (2017) also took this pragmatic approach when estimating third-country effects.

Table 5.1: Summary and Description of the Variables

Variables	Code	Description	Source	Duration	Frequency
1. Exports	WORLD	Exports to the World	SARS	2003-2019	Monthly
	CHINA GERMANY JAPAN UK USA	Exports to China, Germany, Japan, UK and USA	SARS	2010-2018	Monthly
2. Foreign Income	PRDN	Industrial Production of the export destination	Capital IQ	2003-2019	Monthly
3. Relative Prices	RELP	Real effective exchange rate	SARB	2003-2019	Monthly
4. Exchange Rate Volatility	EXCH Volatility	Volatility of Rand exchange rate.	Iress	2003-2019	Monthly
4. Third-Country Effects	ZARCNY Volatility ZARUSD Volatility ZAREUR Volatility ZARGBP Volatility USDCNY Volatility EURCNY Volatility GBPCNY Volatility	Exchange rate volatility of competing exporters. This depended on the export demand being examined; could be CNYUSD or CNYEUR	Iress	2003-2019	Monthly
5. Stock Market Illiquidity	ILLQ	Liquidity proxies required price and trade data (number, volume and value of traded stocks per day) on the JSE stock indices namely, the All Share Index (ALSI) and the Mining Index.	Bloomberg and Iress	2003-2019	Monthly
6. Stock Market Volatility	ALSI	Closing prices on the JSE ALSI whose volatility was estimated using GARCH (1,1)	Iress	2003-2019	Monthly

As motivated for in the second chapter's section 2.2.3 and this chapter's section 5.1, the study employed financial economic factors in the form of stock market illiquidity and stock market volatility. Stock market illiquidity was estimated using the Amihud illiquidity measure, as this measure was most suitable for monthly frequency data and was employed by related studies such as Næs *et al*. (2011) and Kim (2013) to analyse relationships between liquidity and real economic output. To estimate volatility (both exchange rate volatility and stock market volatility), this study employed the GARCH non-linear model developed by Bollerslev (1986) and Taylor (1986) which is parsimonious, avoids over fitting and is less likely to breach non-negativity constraints (Brooks, 2008). Studies analysing stock market volatility on the Johannesburg Stock Exchange (JSE) have largely reached a consensus that the GARCH (1,1) model sufficiently captured and forecasted volatility on both the JSE's all Share Index (JSE ALSI) and the JSE Alternative exchange (JSE ALTX) (Makhwiting, Lesaoana and Sigauke, 2012 and Makoko and Muzindutsi, 2018). Variables were transformed into their natural logarithms because this helps to ensure that the variability of each series is more similar. Using natural logs also compressed skewness by compressing the upper end of the distribution while simultaneously stretching the lower end for a more symmetric distribution (Halling, Pagano, Randl and Zechner, 2008 and Brennan, Huh and Subrahmanyam, 2013).

Threshold regressions established how the relationship between exports and the explanatory variables changed at different levels of a state variable and in this study's case, the variables of interest were exchange rate volatility, stock market volatility and stock market illiquidity. With all the data series prepared for analysis, summary and descriptive statistics were considered. These were followed by unit root tests on all the variables that were later employed in the regression analysis. The regression analysis was conducted using the Markov-Switching and threshold models on South African export demand functions. The export demand functions were first set on total exports to the world and then exports to the trading partners.

5.4.2 Methodology

This chapter is aimed at achieving the objective of ascertaining the existence of, and significance of, structural breaks and regime-switching by utilising the Markov-Switching and threshold models respectively. The two models were applied on export demand functions to the world and trading partners in line with related studies by Choudhry and Hassan (2015) and Bahmani-Oskooee *et al*. (2016a & 2017) who similarly formulated export demand functions. This study's initial export demand function (it is later transformed to cater for structural breaks and regime-switching) is presented as follows:

$$lnXP_{i,t} = \alpha_0 + \xi lnY_{i,t} + \psi lnR_{i,t} + \zeta lnEX_{i,t} + \theta lnTE_{\kappa,t} + \phi lnTE_{\nu,t} + \beta lnLQ_{i,t} + \lambda lnSV_{i,t} + \varepsilon_t \quad (5.4)$$

Where, $lnXP_{i,t}$ represents exports to the world or a given trading partner, foreign income to the world or a trading partner is represented by $lnY_{i,t}$ and $lnR_{i,t}$ represents relative prices, $lnEX_t$ is the exchange rate volatility whilst $nTE_{\kappa,t}$ and $nTE_{\nu,t}$ represent the third-country effects. Stock market illiquidity and stock market volatility are represented by $lnLQ_{i,t}$ and $lnSV_{i,t}$ respectively. The terms α_0 and ε_t respectively represent the intercept term and the normally distributed error term.

Signs on third-country effects coefficients θ and ϕ were not certain, and one of this study's objectives was to establish them. However, the coefficients of stock market illiquidity β and stock market volatility λ were expected to be negatively related with exports because when these two variables are high, economic prospects tend to be poor. That is, during periods of economic downturn, with lower exports, it is believed that the market will tend to be more illiquid and more volatile, while the opposite is true during a real economic expansion where export output is increasing.

The study's *a-priori* expectation which was based on the export demand function's assumption that there was that of a positive relationship between the foreign income coefficient, ξ and exports to the world or a given trading partner. This was because

higher incomes to trading partners were expected to be associated with an increase in the consumption of South Africa's exports. A negative relationship between relative prices and exports was expected as a decline in the relative price of South African goods would likely increase exports. This is due to the widely held assumption that a decline in the cost of a good tends to be associated with an increase in the quantity of that good sold because its relative attractiveness on the global market would increase.

The exchange rate volatility coefficient ζ, was expected to be negatively related with exports as this increased uncertainty of the export prices however, it is worth noting that there has been mixed evidence established on this variable in the literature. A positive relationship would imply that exports rise with increased exchange rate volatility whilst a negative relationship would mean the opposite.

5.4.2.1 Markov-Switching Regression

The Markov-Switching model requires application of the assumption that regime switches of a state variable are determined exogenously, but the regime switches in the data series are identified endogenously. This implies that regime switches for South Africa's exports $XP_{i,t}$ in equation 5.4 changes its behaviour in a given state $s_{,t}$, due to some unobserved variable. The possible occurrences of different states can be split into m number of states (or regimes) denoted $s_{,t}, i = 1, \ldots, m$ corresponding to m regimes. For instance, an exogenous variable such as a recession, or a bear market may cause a low export regime while an economic boom or a bull market may result in a high export regime.

To determine the number of regimes in the data series and the lag length, information criteria was used with a focus on the Schwartz Information Criteria (SIC) due to its suitability to large samples. Equation 5.4 was transformed into a Markov-Switching model, with the two-state Markov model of order *q* presented as follows:

$$XP_t = \mu_{s_t} + \sum_{i=1}^{k} \delta_{s_t} XP_{t-i} + \beta_{s_t} O_t + \sum_{i=1}^{k} \lambda_{s_t,i} O_{t-1} + \epsilon_t, \qquad \epsilon_t \sim i.i.d.N(0, \sigma_{s_t}^2) \qquad (5.5)$$

Where, μ_{s_t} and $\sigma_{s_t}^2$ are the state-dependent mean and variance, respectively. The state dependent coefficients δ_{s_t}, β_{s_t} and λ_{s_t} represent the lagged relation and contemporaneous relationships between South Africa's exports and the real and financial economic variables. The movement in the state variable from one regime to the next is governed by the Markov process and this property is expressed by the probability function as:

$$P(s_t = j \mid s_{t-1} = i, s_{t-2} = k, \ldots, y_{t-1}, y_{t-2}, \ldots) = P(s_t = j \mid s_{t-1} = i,) = p_{ij} \quad (5.6)$$

Where the probability distribution at any given point of time depends only on the period immediately before it. The two-state Markov process is followed by both dependent and independent variables with a fixed transition probability matrix. In the general case, where there are m states, the transition probabilities can be summarised by the following matrix:

$$P = \begin{bmatrix} P_{11} & P_{12} & \cdots & P_{1m} \\ P_{21} & P_{22} & \cdots & P_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ P_{m1} & P_{m2} & \cdots & P_{mm} \end{bmatrix} \quad (5.7)$$

Where P_{11}, P_{12}, P_{21} and P_{22} are transition probabilities of regimes and in the general case P_{ij} is the probability of moving from regime i to regime j. At any given time, the variable is supposed to be in one of the m states, it must be true that:

$$\sum_{j=1}^{m} P_{ij} = 1 \forall_i \quad (5.8)$$

Where, $\sum_{j=1}^{m} P_{ij}$ represents the sum of probabilities for regimes i or j which are supposed to sum up to one as represented by $1\forall_i$. This meant that under this model, it was required that the state probabilities needed to sum to one.

Bergholt *et al*. (2019) highlighted that resource dominated economies were more exposed to regime switching behaviour because commodity prices fluctuated on international markets. Consequently, there was expectation of regime switching

behaviour for South African export demand because the top three exports were resources; mineral products, precious metals and base metals which contributed 22%, 20% and 13% respectively to total exports to the world. In addition to accounting for possible regime-switching using the Markov-Switching models, this thesis employed the threshold models. The benefits arising from using these two methods emanated from the two models' underlying assumptions on the causes of regime-switching behaviour.

5.4.2.2 Threshold Regression

Unlike with the Markov regressions, threshold models consider the state variable to be observable; this state could be an economic boom, a bull market, a period of low market liquidity or a bear market among other economic states (Brooks, 2008 and Kima, Piger and Startz, 2008). The benefit of using threshold modelling is derived from its difference with the Markov-Switching model in that regime-switching is endogenous; meaning that the variable causing the regime is known. The Markov model assumes that the variable inducing the switch is exogenous and remains unspecified (Ihle and von Cramon-Taubadel, 2008). This means that this study can isolate a given macroeconomic variable, such as illiquidity or exchange rate volatility for example, to ascertain if that variable's influence on export is contingent upon it reaching a certain level or threshold. The regimes can be modelled under a threshold regression and studies such as Ihle and von Cramon-Taubadel (2008), Pal and Mitra (2016) and Ters and Urban (2020) have analysed regimes under threshold regression. A simple example of a TAR model is one containing a first order autoregressive process in each of two regimes, where there is only one threshold (the number of thresholds is the number of regimes minus one).

$$y_t = \begin{cases} \mu_1 + \phi_1 y_{t-1} + u_{1t} \;\; if \; s_{t-k} \leq r \\ \mu_2 + \phi_2 y_{t-1} + u_{2t} \;\; if \; s_{t-k} > r \end{cases} \tag{5.9}$$

Where the dependent variable y_t is purported to follow an autoregressive process with intercept coefficient μ_1 and autoregressive coefficient ϕ_1 if the value of the state-

determining variable lagged *k* periods, denoted s_{t-k} is lower than some threshold value r.

If the value of the state-determining variable lagged *k* periods, is greater than or equal to that threshold value r, y_t is specified to follow a different autoregressive process, with intercept coefficient μ_2 and autoregressive coefficient ϕ_2. The state variable, s_{t-k}, can be any variable thought to make y_t shift from one set of behaviour to another. The decision regarding what may cause these shifts from one state to another should be influenced by economic or financial theory. If the value of k is zero it means that the current value of the state determining variable influences the regime that y is in at time t, but in many applications, k is set to 1, so that the immediately preceding value of *s* is the one that determines the current value of y.

The threshold model employed by the study can be generalised in the as the following threshold model:

$$y_{i,t} = \mu_i + \varphi y_{i,t-1} + \alpha' x_{i,t} + \sum_j \beta_1' z_{i,t}^j I(q_{i,t} \leq \gamma^j) + \sum_j \beta_2' z_{i,t}^j I(q_{i,t} > \gamma^j)\, \beta_2' z_{i,t}^j I + \varepsilon_{i,t}\,, \tag{5.10}$$

Where the subscript $i = 1, \ldots, N$ represents each of individual exports to given destination and $t = 1, \ldots, T$ represents the time variable. $y_{i,t}$ is the dependent variable (exports to any of the given destinations) and the variable $\varphi y_{i,t-1}$ represents the first lagged exports variable whilst μ_i is the intercept term. The vector of explanatory variables are represented by $x_{i,t}$ whilst $z_{i,t}^j$ is the j^{th} regime-dependent regressor which is the break variable and $q_{i,t}$ is the threshold variable for the case being greater or less than the unknown threshold level, γ^j and $I(\cdot)$ is an indicator function representing the regime defined by the threshold variable $q_{i,t}$ and the unknown threshold level takes the value of 0 or 1 depending on whether the threshold variable is below or above the threshold level. The slope parameters are the coefficients that are associated with the two different regimes. The error term $\varepsilon_{i,t}$ follows an independent and identical distribution.

In this study, for example, if stock market illiquidity is used as the threshold variable, and two regimes are detected, this would be modelled as follows:

$$lnXP_{i,t} = \alpha_0 + \xi lnY_{i,t} + \psi lnR_{i,t} + \zeta lnEX_{i,t} + \theta lnTE_{CNY,t} + \phi lnTE_{USD,t} + \lambda lnSV_{i,t} + \\ +\delta_1 lnLQ_{SA,t} I(TH_{it} \leq \lambda) + \delta_2 lnLQ_{SA,t} I(TH_{it} > \lambda) + \mu_i + \vartheta_i + \varepsilon_t \quad (5.11)$$

Where, TH_{it} is the threshold variable of interest (here illiquidity; however, results will show each of the economic and financial variables considered one at a time). λ is the estimated breakpoint, δ_1 is the low-illiquidity regime and δ_2 represents the high-illiquidity regime.

It is possible that the model can have more than one regime, and consequently, rather than restricting the model to a single regime, information criteria can be used to determine the optimal number of thresholds. Under the TAR approach, the variable *y* is either in one regime or another, given the relevant value of *s*, and there are discrete transitions between one regime and another. This is in contrast with the Markov-Switching approach, where the variable *y* is in both states with some probability at each point in time.

Although the Markov-Switching and threshold models are similar, they have differences which makes it important that this study employ both models. A threshold model is more appropriate in cases where there are no external impacts on data such as changes in political, economic or natural inferences; meaning that the data itself possess all information causing changes of the variables. However, if external forces are thought to be most influential to the data, then the Markov model may be more appropriate. Ihle and von Cramon-Taubadel (2008) pointed that series tend to have both cases where endogenous and exogenous effects are present. Due to the assumptions of the two models, their results are not necessarily similar, lending further support to considering both in this particular context where non-linear models have not previously been used in this South African context. Further, this study undertakes an analysis of South Africa's exports over a time-series where both endogenous and exogenous influences are likely to have occurred.

5.5 Results

After the data were ready for analysis, the study examined its distribution which involved calculation of the descriptive statistics, conducting unit root tests and non-linearity tests. Regression analysis ensued where the Markov-Switching, and threshold regressions were run to analyse total exports to the world and total exports to individual countries.

5.5.1 Descriptive Statistics and Analysis of Export Level Data

Monthly country-level exports data were available from January 2010 to December 2018, while total exports to the world were available from December 2003 to December 2019. As such, total exports to the world were compared to the exports to individual countries for the period beginning January 2010. Table 5.2 presented the total exports to the world and five trading partners (China, Germany, Japan, UK and USA) by rand value between January 2010 and December 2018.

Table 5.2: Total Exports to Trading Partners (Millions of Rands)

Total Exports Rest of the World (December 2003 -December 2018)						
Export Destination	**Growth**	**Mean Exports**	**Standard Deviation**	**Minimum**	**Maximum**	**Total Exports**
WORLD	368%	64 762.51	28 070.87	19 333.17	123 353.34	11130074
Exports to Trading Partners and the Rest of the World (January 2010 -December 2018)						
Export Destination	**Growth**	**Mean Exports**	**Standard Deviation**	**Minimum**	**Maximum**	**Total Exports**
CHINA	156%	8020.815	1935.482	3211.187	12686.59	866248
GERMANY	202%	4945.133	1923.607	2401.055	11366.02	534074.4
JAPAN	48%	4321.833	704.5666	2694.686	6152.451	466758
UK	60%	3130.455	1097.341	1240.021	8625.368	338089.1
USA	140%	5857.178	1306.435	2671.36	10619.54	632575.2
WORLD	180%	77891.89	19708.74	36574.2	122087	8412324

The highest nominal growth was recorded for exports destined for Germany where they more than trebled, this was followed by China and the USA which had 156% and 140% nominal growth respectively. Average exports to each country suggested that

China had the highest average monthly exports with over 8.02 billion Rand worth of goods being exported. This was followed by the USA which averaged over 5.86 billion Rand; with the lowest monthly average being that of exports to the UK which averaged more than 3.1 billion Rand per month. Although nominal growth of exports was recorded, it was volatile as suggested by the high monthly standard deviations particularly for China and Germany. The nominal growth and accompanying deviations from mean exports support the need to further analyse the observed variability.

5.5.2 Unit Root Tests

Unit root tests were undertaken on all the variables using the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests for stationarity at the five percent significance level. In addition, the data were tested for breakpoints using the Zivot and Andrews (1992) breakpoint test. The tests for stationarity and breakpoint tests on world exports and the corresponding explanatory variables were undertaken between December 2003 and December 2018 and the results are displayed in Panel A of Table 5.3.

Results in panel A show that exports to the rest of the world had a breakpoint in December 2008 which coincided with the global financial crisis. This hinted at the possibility of an exogenous factor influence; which is an underlying assumption of the Markov-Switching model (that regime-switching is exogenously induced) (Ihle and von Cramon-Taubadel, 2008). In addition, such a breakpoint suggests a link between the financial and real economic output, where South Africa's exports were impacted by changes in global financial markets (Kim, 2013 and Giannellis and Papadopoulos, 2016). The ADF and the PP tests suggest world exports have a unit root and that all the explanatory variables except relative prices are stationary in levels.

Table 5.3: Tests for Stationarity

PANEL A: Exports to the Rest of the World (December 2003 – December 2019)						
	Augmented Dickey-Fuller		Phillips-Perron		Zivot and Andrews	
Series	Level t-stat	Unit Root t-stat	Level t-stat	Unit Root t-stat	Test Statistic	Break Date
WORLD	-2.469	**-4.524***	**-6.597***		**-6.049***	Dec 2008
Foreign Income	**-3.722****		-2.984	**-8.055***	**-5.688***	Nov 2009
Relative Prices	-2.899	**-10.220***	-2.527	**-11.041***	4.300	May 2004
Exchange Rate Volatility	**-10.640***		**-10.556***		**-7.404***	Jun 2016
ZARUSD Volatility	**-13.943***		**-13.945***		**-14.220***	Mar 2016
ZARCNY Volatility	**-14.181***		**-14.203***		**-14.497***	Aug 2011
Stock Market Volatility	**-11.781***		**-11.774***		**-12.167***	May 2007
Stock Market Illiquidity	**-6.210***	-	**-6.158***	-	**-7.619***	May 2009
PANEL B: Exports to Trading Partners and the Rest of the World (January 2010 – December 2018)						
	Augmented Dickey-Fuller		Phillips-Perron		Zivot and Andrews	
Series	Level	Unit Root	Level	Unit Root	Test Statistic	Break Date
CHINA	**-5.475***		**-5.441***		**-5.618***	Mar 2014
GERMANY	-2.547	**-12.5247***	**-4.694***		-4.454	Oct 2013
JAPAN	**-8.030***		**-8.139***		**-6.304***	Jan 2016
UK	**-9.605***		**-9.610***		**-9.896***	Oct 2016
USA	**-9.530***		**-9.520***		**-10.034***	Jan 2018
Foreign Income	-2.226	**-8.738***	-2.226	**-8.613***	-3.405	Dec 2012
Relative Prices	-1.939	**-8.200***	-1.718	**-8.228***	-4.638	Jul 2016
Exchange Rate Volatility	**-8.248***		**-8.248***		**-9.106***	Feb 2016
ZARCNY Volatility	**-13.115***		**-13.114***		**-13.903***	Feb 2016
ZAREUR Volatility	**-11.628***		**-11.578***		**-12.439***	Feb 2014
ZARGBP Volatility	**-12.746***		**-12.752***		**-13.632***	Feb 2016
ZARJPY Volatility	**-11.864***		**-11.869***		**-12.284***	Jul 2016
ZARUSD Volatility	**-12.647***		**-12.672***		**-13.466***	Feb 2016
CNYEUR Volatility	**-10.444***		**-10.492***		**-9.174***	Jan 2017
CNYUSD Volatility	**-8.112***		**-8.511***		**-10.971***	May 2014
GBPCNY Volatility	**-13.321***		**-13.267***		**-11.179***	Jan 2014
USDJPY Volatility	**-10.679***		**-10.621***		**-13.703**	July 2014
Stock Market Volatility	**-10.311***		**-10.320***		**-10.845***	Jun 2017
Stock Market Illiquidity	**-6.594***		**-6.597***		**-7.251***	Feb 2017

*(Where: *1%, **5% and ***10% significance levels and t-stat is the Test Statistic)*

Tests for stationarity in panel B of Table 5.3 suggested all exports except for those to Germany were stationary in their levels. With exceptions for foreign income and relative prices (which both had unit roots), all the other explanatory variables were stationary. Breakpoint tests on export variables suggested the existence of structural breaks at varying periods, except for exports to Germany which did not have a

statistically significant break date. While there was no single identifiable exogenous event that could have caused breakpoints for exports in the period between 2010 and 2018, the existence of these breakpoints suggested regime-switching behaviour, thereby warranting the use of the Markov-Switching and threshold models. This highlights the value of the contribution to knowledge that Chapter 5 aims to make, as these initial findings highlight the existence of non-linear behaviour likely caused by business cycle influences. The results from the regression analysis on South African export demand functions are presented next.

5.5.3 Markov-Switching Regressions

Export demand functions were estimated under the Markov-Switching model beginning with exports to the world between 2003 and 2019. For this period, the demand function for exports to the world was estimated with two regimes: a low export regime and a high export regime. This enabled for a contrast to be made between the macroeconomic relationships that existed in the two states which would help inform trade policy particularly in instances where exports were depressed. The low export regime was expected to coincide with recessions and bear markets while higher exports were expected to occur in bull markets. Table 5.4 summarises the results obtained from the Markov-Switching model with two regimes for exports to the world. It displays the coefficient estimates for the two states, the transition probabilities between the two states, as well as the expected durations for each of the two states.

Table 5.4: Markov-Switching Model Estimates on Total Exports to the World

	Estimated Coefficients for Regimes	
Variables	**Low Export Regime** (State1)	**High Export Regime** (State2)
Real Economic		
Foreign Income	**1.2320***	**0.9935***
Relative Prices	**-1.9723***	**-0.6134***
Exchange Rates		
Exchange Rate Volatility	0.0070	**0.0457****
ZARUSD Volatility	-0.0118	**0.0573****
CNYUSD Volatility	-0.0218	0.0088
Financial Economic		
Stock Market Volatility	**-0.0241*****	**-0.0163*****
Stock Market Illiquidity	0.5018	0.5094
Intercept Term	**10.6631***	**6.7581***
Transition Probability Matrix		
From State to State	Low Export Regime (State1)	High Export Regime (State2)
Low Export Regime (State1)	**0.971346**	0.028654
High Export Regime (State2)	0.025104	**0.974896**

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

The results show that the traditionally popular real economic variables of foreign income and relative prices were consistently significant in both the high and low export regimes. This observation, together with the signs on the coefficients was in line with the study's assumptions presented in 5.4.2 that increased foreign incomes and declining relative prices encouraged higher South African exports to the rest of the world; it was consistent with South African studies such as Khosa *et al*. (2015) and Fowkes *et al*. (2016) who found relative prices or competitiveness as essential for South Africa's exports. Further, the coefficients' magnitudes showing higher sensitivity of exports in the low export regime compared to the higher export regime suggested that the real economic variables significance were of greater influence at the lower end of the business cycle or during economic recessions. On one hand, the lower export regime, a 1% increase in foreign income increased exports by 1.2% while a similar increase of foreign income in a higher export regime increased them by 0.99%. On the other hand, in the low export regime, a one percent decrease of relative prices increased exports by 1.97% whilst a similar decrease of relative prices in a high export regime caused exports to increase by 0.61%. These results suggested that economic

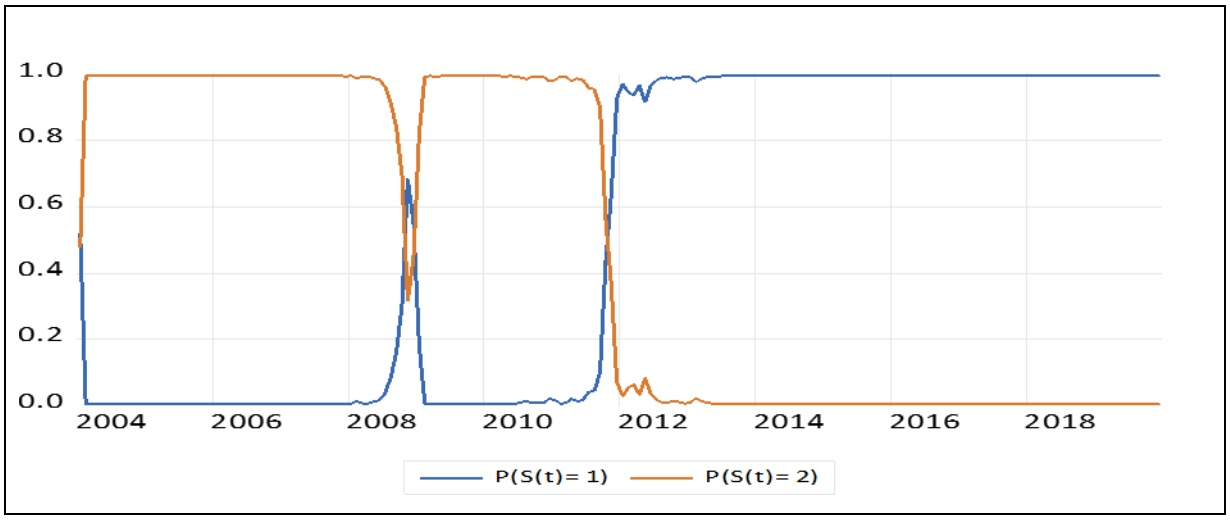
cycles have an impact on real economic variables such that, higher sensitivity tends to exist in economic downturns and recessions.

In the lower export regime, neither exchange rate volatility nor third-country effects were significant in explaining the variability of South Africa's exports to the world. However, in the high exports regime, exchange rate volatility and the volatility between the Rand and the US Dollar positively affected exports to the rest of the world. This phenomenon hinted at the existence of the exchange disconnect puzzle since the results suggested that exchange rate volatility did not have a clear impact on South Africa's exports to the world. The implication of these observations is that exchange rate volatility may not exert negative pressure on South Africa's export growth to the rest of the world. As highlighted in the literature review, findings on exchange rate volatility have not been unambiguous; Todani and Munyama (2005) found a weakly positive effect, Sekantsi (2011) found a negative effect, while Wesseh and Niu (2012) found no effect on aggregated exports at all. The findings on exports led to Fowkes *et al*. (2016) arriving at the conclusion that South African trade policy should overlook the Rand's volatility but focus on the price level instead. These findings support to this position that South African policy makers ought not to focus on attempting to manage the Rand's volatility but ensure that the domestic price level ensures price competitiveness of goods on the international markets.

The financial market factor of stock market volatility was significant under both regimes whilst illiquidity was not significant in either of the two regimes. The coefficient of stock market volatility suggested that its effects were slightly more pronounced under a lower export regime which was during a low economic growth scenario. This meant that uncertainty on stock market returns were associated with total exports in such a manner that the relationship would be more pervasive under lower exports or economic downturns. This observation suggested that financial economic participants faced high investment risks in lower export regimes compared to higher export regimes, thereby, highlighting that in a real economic downturn, financial economic participants faced higher risk; a scenario akin to the global financial crisis. This may become more relevant as South Africa finds itself entering the COVID-19 induced economic crisis whose effects are still unravelling.

In addition to understanding the relationship that existed under the two regimes (low exports and high exports), it was essential to know the likelihood of the occurrence and duration of the two regimes. The transition probability matrix in Table 5.4 and Figure 5.2 respectively summarise the transitions between the low and high export regimes.

Figure 5.2: Markov-Switching One-step Ahead Predicted Probabilities



The transitional probabilities suggested that both regimes were highly persistent and there was little likelihood of the lower regime to transition into a higher export regime and *vice-versa*. For instance, when exports were in a high regime, there was a 97.49% chance of remaining in that regime, while there was only a 2.51% of transitioning from a lower export regime into a higher export regime. This observation was reconcilable with the deterministic nature of nominal export growth to the world which was illustrated in Figure 5.1. The deduction from the transition probability matrix is illustrated by Figure 5.2 which shows the transitions occurring in 2008 and 2011, coinciding with the global financial crisis and the European debt crisis respectively. This was further evidence highlighting the impact of financial crises and business cycles on export and real economic growth.

Next, the Markov-Switching regression analysis with two regimes was undertaken on export demand functions to South Africa's trading partners between January 2010 and December 2018. Table 5.5 summarises the results from the Markov-Switching

regression analysis on export demand functions to trading partners and they suggested heterogeneity of export relationships by destination.

Between the two real economic variables of foreign income and relative prices the latter real economic factor exhibited a greater influence of exports variability for the low and high regimes in the respective trading partners. Although this observation was slightly different from what was obtained earlier in Table 5.4, it does highlight the heterogeneity of export relationships and showed that the relative prices was likely the most important factor for South Africa's trade policy as suggested by Fowkes *et al*. (2016). The policy implication of this result is that the price level of South African products on the export market must remain competitive to remain attractive to buyers since South Africa has no influence on income levels to the trading partner.

Firstly, in China's export demand function, in the low export regime, exports were negatively related with foreign income but positive in the high export regime. This suggested that in the low export regime, exports to China increased regardless of a decline in Chinese income where, a percentage decline of income in China was associated with an increase of exports of 0.05% while in the high export regime, a percentage increase of income in China resulted in an increase of 0.06% of exports to that country. A similar observation was made on exports to Japan where, the low export regime showed that a decline of foreign income was associated with an increase of exports to that country. Exports to the UK had foreign income being significant in both regimes where, in the low export regime, a percentage increase of foreign income was associated with a 0.08% increase of foreign income in the low regime and a 0.01% in the high regime. Exports to Germany and the USA were not affected by foreign incomes in neither of the two regimes contrary to the expectation.

Table 5.5: Exports to Trading Partners and the World

CHINA		
Variables	**Low Regime**	**High Regime**
Real Economic		
Foreign Income	**-0.0484*** **	**0.0559***
Relative Prices	-0.7969	**-0.9814***
Exchange Rates		
Exch Volatility	-0.0516	0.0247
ZARCNY Vol	-0.0667	0.0159
CNYUSD Vol	**-0.0754*** **	0.0076
Financial Economic		
Stock Volatility	**0.0935*** **	**0.0410*** **
Stock Volatility	4.6499	3.0169
Intercept	**10.2662***	**10.7003***
Transition Probability Matrix		
	Low	High
Low	**0.957940**	0.042060
High	0.026953	**0.973047**
Constant Expected Durations		
	Low	High
Durations	23.77537	**37.10123**

GEMANY		
Variables	**Low Regime**	**High Regime**
Real Economic		
Foreign Income	-0.0049	0.0241
Relative Prices	**-2.5317***	**-2.9276***
Exchange Rates		
Exch Volatility	0.0391	-0.0081
ZAREUR Vol	0.0155	0.0163
CNYEUR Vol	**-0.0463** **	0.0038
Financial Economic		
Stock Volatility	-0.0154	**-0.0583***
Stock Volatility	-0.5548	-1.6240
Intercept	**12.9408***	**14.0951***
Transition Probability Matrix		
	Low	High
Low	**0.958752**	0.041248
High	0.057464	**0.942536**
Constant Expected Durations		
	Low	High
Durations	**24.24379**	17.40209

JAPAN		
Variables	**Low Regime**	**High Regime**
Real Economic		
Foreign Income	**-0.0274** **	-0.0007
Relative Prices	**-0.9709***	**-0.7187***
Exchange Rates		
Exch Volatility	-0.0161	-0.0202
ZARJPY Vol	-0.0224	-0.0143
USDJPY Vol	0.0266	-0.0246
Financial Economic		
Stock Volatility	-0.0292	**-0.0356*** **
Stock Volatility	-3.4748	**4.0511** **
Intercept	**10.1570***	**9.6273***
Transition Probability Matrix		
	Low	High
Low	**0.829109**	0.170891
High	0.282161	**0.717839**
Constant Expected Durations		
	Low	High
Durations	**5.851693**	3.544081

UNITED KINGDOM		
Variables	**Low Regime**	**High Regime**
Real Economic		
Foreign Income	**0.0778** **	**0.0134*** **
Relative Prices	**-1.9864***	**-2.6335***
Exchange Rates		
Exch Volatility	0.0472	**-0.0545*** **
ZARGBP Vol	**0.4057***	-0.0337
GBPCNY Vol	**-0.1430** **	0.0249
Financial Economic		
Stock Volatility	-0.0983	-0.0139
Stock Volatility	-9.8589	**-3.1280*** **
Intercept	**11.7819***	**12.9801***
Transition Probability Matrix		
	Low	High
Low	0.283719	**0.716281**
High	**0.574149**	0.425851
Constant Expected Durations		
	Low	High
Durations	1.396100	**1.741709**

UNITED STATES OF AMERICA		
Variables	**Low Regime**	**High Regime**
Real Economic		
Foreign Income	-0.0639	-0.0174
Relative Prices	**-2.3570***	**-1.5274***
Exchange Rates		
Exch Volatility	-0.0300	-0.0154
ZARUSD Vol	**-0.1494***	0.0019
CNYUSD Vol	-0.0716	-0.0105
Financial Economic		
Stock Volatility	**0.1732***	-0.0227
Stock Volatility	-3.5325	-0.7619
Intercept	**13.0644***	**11.5523***
Transition Probability Matrix		
	Low	High
Low	0.310574	**0.689426**
High	0.144754	**0.855246**
Constant Expected Durations		
	Low	High
Durations	1.450481	**6.908287**

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

Between the two real economic variables, relative prices were more influential on export growth to trading partners. Relative prices were pervasive in both regimes to

the trading partners except for the case with China where it was only significant in the high export regime. Exports to Japan and the USA showed that relative prices caused a greater change of exports in the lower export regime compared to a higher export regime; while the opposite was true for exports to Germany and the UK. Exports to Germany were the most price sensitive where a 1% decline of relative prices resulted in a 2.53% increase of exports in the low regime and an increase of 2.93% in the high export regime. Japan had the lowest sensitivity where a 1% decline of relative prices increased exports by 0.97% in the low regime compared to a 0.72% in the high export regime.

The nuances around the sensitivities of exports may be attributable to the types of exports to the trading partners. For instance, exports to Germany are dominated by specialised equipment constituting 29.3% while exports to China were dominated by mineral resources output which constituted 88.5% of exports to that country.[5] Consequently, the price elasticity may vary from one product to the next caused by factors such as the availability of substitutes and that economy's affinity for the products in varying stages of the business cycle.

There was weak evidence of exchange rate volatility and third-country effects being impactful on exports to the trading partners in either a high or low export regime. This was similar to the results observed on total exports to the world that were presented in Table 5.4. The Rand's exchange rate volatility was significant and negative for exports to the UK in the high export regime while the direct exchange rate between the Rand and the British Pound was significant in the low export regime. The exchange rate between the Rand and the US Dollar was significant for exports to the USA.

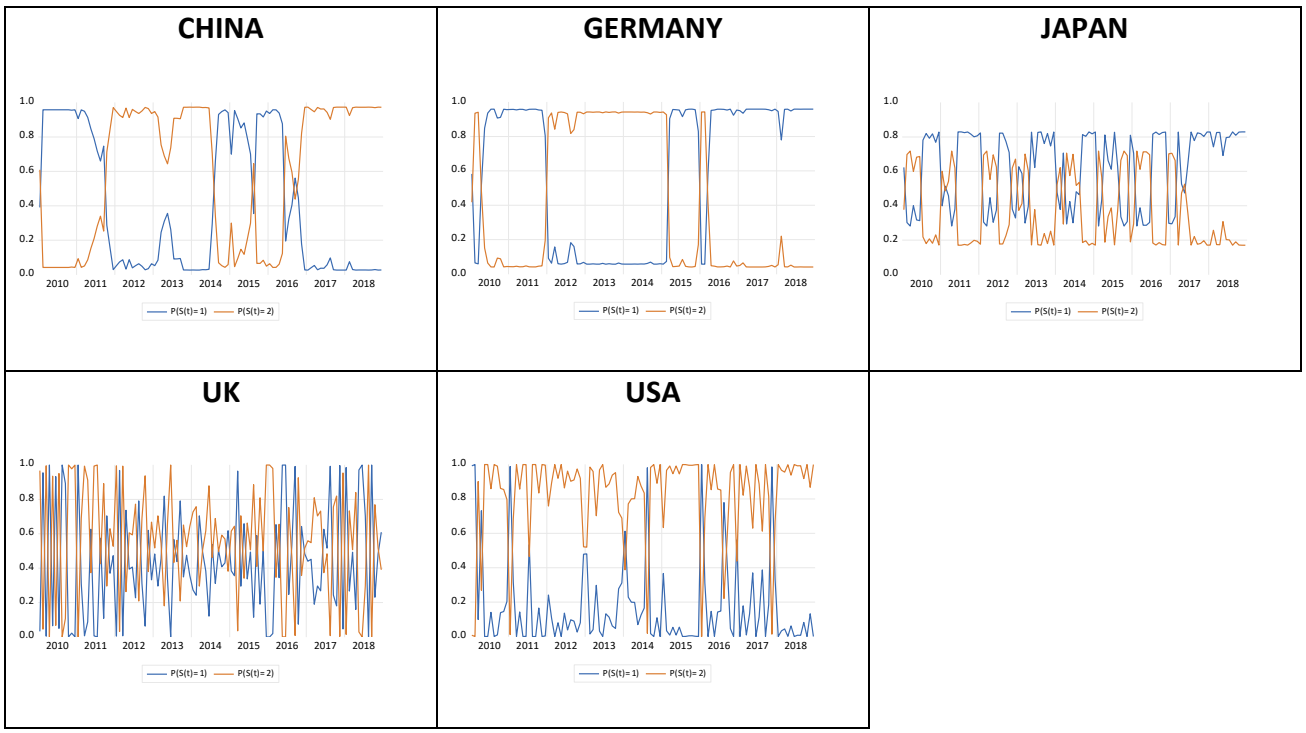
Exchange rate volatilities chosen as third-country effects proxies for exports to China, Germany and the UK had significant coefficients in the low export regime. In one hand, Direct exchange rates were significant to the UK and the USA only in the low export regimes on the other hand, third-country effects were significant in the low export regime for all trading partners except for the USA. The findings on the exchange rate

[5] Table 2.1 Summarised the top ten product categories to each of the five trading partners.

volatility and third-country effects show that capturing the effects of the exchange rate volatility was not apparent. The effects of this risk factor may not have an influence on South African export quantities. The existence of bilateral and multi-lateral trade agreements together with the ability to hedge exchange rate risk may be valid explanations to the observations around exchange rate volatility effects on exports to the trading partners.

The coefficients on financial economic factors showed that stock market volatility was the more significant factor compared to stock market illiquidity under the Markov-Switching model. Notably, stock market volatility was mostly significant in at least one regime on exports except those to the UK, in addition, stock market illiquidity was significant in at least one regime on export to Japan and the UK.

Figure 5.3: Markov-Switching One-step Ahead Predicted Regime Probabilities



Transition probability matrices from Table 5.5 and one-step ahead predicted regime probabilities in Figure 5.3 summarise the likelihood of switches between the low and high export regimes. Exports to China and Germany were unlikely to transition between regimes as illustrated in Figure 5.3 and their transition matrices showed that they both had a more than 95% chance of remaining in the low export regime and a

4% chance to transition to a high export regime. On the other hand, once in the high export regime, exports to China were 97.3% likely to remain in that regime and that high export regime was expected to last for 37.1 months while the low export regime would remain for 23.8 months. As for exports to Germany, there was a 94.3% likelihood for them to remain in the high export regime; the low export regime was expected to last 24.4 months while the high export regime would last 17.4 months.

Exports to Japan had higher transitions compared to China and Germany where, there was an 82.9% chance of remaining in the low export regime and a 71.7% chance of remaining in the high export regime. The transition from a high to a low export regime was 28.2% and the high export regime for Japan was likely to last for 3.5 months while low export regime would last for 5.9 months. The UK had the highest transitions, where the average duration of the high export regime was 1.74 months compared to an average of 1.40 months for the low export regime. This was confirmed by its transition probability matrix which showed that there was a 57.4% chance of transitioning from a high to a low export regime. The transition probability matrix for exports to the USA suggested that the high export regime was more dominant where, there was a 68.9% of transitioning from a low to a high regime while there was an 85.5% chance of remaining in a high export regime. In addition, it was expected that the high export regime would last 6.9 months and the low export regime only 1.5 months.

Results from the Marko-Switching model suggested that the real economic factor of relative prices was the most consistently influential factor of export determination. However, it is worth bearing in mind that the Markov-Switching model assumes that the regimes were induced by some unknown exogenous factor, therefore; the relationships observed above may have held differently if the variable triggering the regime switch was endogenously determined by the model. A threshold model which assumes the determination of regime switches endogenously, presented an opportunity to observe the export demand relationships under the endogenous determination assumption. The following section presents the results from threshold modelling of export demand relationships.

5.5.4 Threshold Regression Results

Threshold regressions established how the relationship between exports and the explanatory variables changed at different levels of a state variable and in this study's case, the variables of interest were exchange rate volatility (real economic), stock market volatility (financial economic) and stock market illiquidity (financial economic). The identified variables of interest were then each set as the threshold variable (resulting in three panels of threshold output – one for each threshold variable) to establish if a regime change of those variables would trigger a change in the observed relationships of export demand functions. In each of the export demand equations, the number of thresholds was determined by minimising the information criteria. The following section presents results from the threshold regressions beginning with total exports to the world between 2003 and 2019.

Table 5.6 presents the results of threshold regressions to the world where the threshold variables were exchange rate volatility, stock market volatility, stock market illiquidity and the lag of exports, respectively. In all but the last export demand function where the lag of exports was the threshold variable, information criteria determined that the optimal model would have two thresholds. The existence of two thresholds meant that there were three regions where export relationships would be analysed; below the lower threshold, between the lower and the upper threshold, and above the upper threshold. All these threshold models suggested that the common real economic factors (foreign income and relative prices) remained consistently statistically significant with expected coefficients, exchange rate volatility and third-country effects were depended on the threshold variable while financial economic factors were mostly significant in all scenarios. These results, especially for foreign income and relative prices were reconcilable with those obtained under the Markov-Switching model in Table 5.4 which also noted similar relationships.

Table 5.6: Threshold Regression Results on Exports to the World

Threshold Variable: **Exchange Rate Volatility**			
Variables	***t*** ≤ -0.3077	-0.3077 < ***t*** ≤ 0.0739	***t*** > 0.0739
Real Economic			
Foreign Income	**1.0957***	**0.5704***	**0.7087***
Relative Prices	**-1.1887***	**-4.3865***	**-1.9744***
Exchange Rates			
Exchange Rate Volatility	**0.1437***	**-1.1030****	**0.1176*****
ZARUSD Volatility	**0.1644****	**-0.2741****	**0.1252****
CNYUSD Volatility	**-0.0647****	0.0767	0.0110
Financial Economic			
Stock Market Volatility	**-0.0858***	-0.0155	**-0.0647***
Stock Market Illiquidity	**-5.4646***	**-4.9203****	**-7.3772***
Intercept	**8.7421***	**26.5904***	**15.0842***
Threshold Variable: **Stock Market Volatility**			
	t ≤ -0.0991	-0.0991 < ***t*** ≤ 1.0475	***t*** > 1.0475
Real Economic			
Foreign Income	**0.9691***	**0.9806***	-0.0621
Relative Prices	**-1.4783***	**-2.5748***	**-2.7121***
Exchange Rates			
Exchange Rate Volatility	**0.1860***	-0.0682	-0.0267
ZARUSD Volatility	**0.2115***	-0.0865	-0.0384
CNYUSD Volatility	**-0.0482****	0.0009	0.0508
Financial Economic			
Stock Market Volatility	**-0.0852****	**-0.1505*****	0.2451
Stock Market Illiquidity	**-5.0802***	**-3.1830****	**-15.2544***
Intercept	**10.8625***	**15.6564***	**23.7633***
Threshold Variable: **Stock Market Illiquidity**			
	t ≤ 0.0409	0.0409 < ***t*** ≤ 0.0486	***t*** > 0.0486
Real Economic			
Foreign Income	**1.0906***	0.4380	**0.5435***
Relative Prices	**-0.9180***	**-2.6173***	**-2.9214***
Exchange Rates			
Exchange Rate Volatility	0.0433	-0.0177	**0.1778***
ZARUSD Volatility	0.0315	-0.0758	**0.1937***
CNYUSD Volatility	0.0092	**-0.1070***	**-0.0443*****
Financial Economic			
Stock Market Volatility	-0.0257	**-0.1947***	**-0.0485****
Stock Market Illiquidity	-0.6311	**-44.3836***	**-4.9605***
Intercept	**7.4201***	**21.3764***	**20.3724***
Self-Exciting Threshold Regression (Exports Lag as Threshold Variable)			
	t ≤ 10.4894	***t*** > 10.4894	
Real Economic			
WORLD Export Lag	0.1775	**0.7719***	
Foreign Income	**0.9031***	**0.1190****	
Relative Prices	**-1.5811***	**-0.2505****	
Exchange Rates			
Exchange Rate Volatility	-0.0315	0.0280	
ZARUSD Volatility	-0.0328	**0.0493****	
CNYUSD Volatility	-0.0008	-0.0046	
Financial Economic			
Stock Market Volatility	-0.0045	**-0.0267***	
Stock Market Illiquidity	-0.4220	**-2.0170***	
Intercept	**9.4034***	**2.8878***	

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

When exchange rate volatility was selected as the threshold variable, exports had the highest sensitivity to foreign income below the lower threshold while this sensitivity was highest to relative prices between the two thresholds. Although the coefficients for the two real economic factors did not follow an obvious pattern around the threshold variables, their significance around the thresholds illustrated their pervasiveness in export determination. It was significant to note that effect of exchange rate volatilities on exports were dependent upon the threshold level of exchange rate volatility – a pertinent finding from a practical perspective. That is, the amount of volatility in the exchange rate is relevant.

Below the first threshold and above the second threshold, exchange rate volatility and volatility between the Rand and Dollar were positive. This meant that higher exports were realised when exchange rate volatility increased; in contrast, the volatility between the Yuan and Dollar was only significant and negative below the lower threshold. This illustrated the undependable nature of exchange rate volatility as a risk factor because detecting its effect may be contingent upon the exchange rate volatility level or the stage of a business cycle. Stock market illiquidity had its highest influence above the higher threshold of exchange rate volatility suggesting that as exchange rate volatility increased, illiquidity weighed more negatively on South Africa's exports. Stock market volatility on the other hand, was significant on either ends of the two thresholds (when high/low) indicating that stock market volatility was more of a concern in more extreme periods of the business cycle.

Stock market volatility as a threshold variable showed that the real economic variables were significant as expected but exchange rate volatility factors were only significant below the lower threshold where stock market volatility was in its lowest region. Stock market illiquidity remained highly significant around the two stock market volatility thresholds which suggested that deteriorating stock market liquidity conditions tended to occur when exchange rate volatility was in its most volatile region. This finding was reconcilable with the corresponding observation that the stock market volatility coefficient tended to be larger and highly significant at higher exchange rate volatility threshold levels. Where the threshold variable was stock market illiquidity, exchange rate volatility factors tended to be significant above the higher threshold contrary to

what was established where the financial economic variable of stock market volatility was the threshold variable. This was further evidence of the ambiguous nature exchange rate volatility tended to have on South Africa's exports.

The financial economic factors became stronger above the higher threshold of stock market illiquidity, meaning that deteriorating financial economic factors weighed negatively on South Africa's exports. This observation highlights the importance of the financial economic variables on South African export growth during business cycles because changes in the cycles, particularly declines, weighed negatively on exports.

When the SETAR was estimated, only one threshold was established where, below the threshold level, only the real economic variables were statistically significant, but, above the threshold level, export lags, relative prices, foreign income and stock market volatility were significant. This suggested that only the real economic factors were significant when export output was low, however as export output entered a higher regime, the financial economic factors tended to become more influential. These findings are in contrast to the expectation that the macroeconomic factors would be more influential when exports were lower (as was the case in the scenarios were the threshold variables were exchange rate volatility, stock market volatility and stock market illiquidity). This could be explained by the fact that in this case, the exports themselves cause regime switches which may have differed from the other three scenarios (highlighted the fact that export relationships were influenced by the factor thought to induce the regime switch). This suggested that at higher threshold levels, the relationships were more apparent. Importantly, this study was more concerned by factors from the financial economy (stock market illiquidity and volatility) as causing regime-switching and these were reconcilable with exchange rate volatility as the variable triggering regime switches.

Analysis of total exports to the rest of the world suggested that relationships were threshold dependent and these relationships were stronger at the negative extremes particularly for financial economic variables. Stock market illiquidity and stock market volatility tended to be more strongly relevant when exports were lower compared to when export output was higher. This observation was reconcilable with the hypothesis

that stock market players were concerned by lower real economic output levels which would drive up liquidity premiums. The observation on exchange rate volatility not being consistently significant suggested that the exchange disconnect puzzle could be an explanation to this phenomenon. The following section extends the threshold analysis to export demand functions to selected five trading partners.

Threshold analysis was undertaken on exports to the five trading partners for the period beginning January 2010 until December 2018. For all the threshold models estimated, information criteria determined one threshold to be optimal. This meant analysis of relationships was estimated and analysed on the two regions surrounding a single threshold; the results from which are displayed in Table 5.7. For all the export demand functions, three threshold variables (exchange rate volatility, stock market volatility and stock market illiquidity respectively) were selected. The observations under the three different threshold variables suggested that the export relationships were sensitive to the choice of the threshold variable; similar to what was observed in Table 5.6.

For all the three threshold export demand functions (exchange rate volatility, stock market volatility and stock market illiquidity) the real economic factor of relative prices was again the most consistent factor. This supported the view that the price of South African goods on the export market played a highly significant role on the quantities sold. However, foreign income was significant on exports to China and Germany when the threshold variable was exchange rate volatility and stock market volatility respectively. This observation around foreign incomes could be reconciled with the observation in the Markov-Switching regression in Table 5.5 where the types of goods sold to the trading partner may have had a bearing on their responsiveness to changes of foreign income for the study period. This would also suggest that any policy seeking to encourage growth through an export avenue should offer recommendations that are specific to classes of exports.

Table 5.7: Threshold Regressions of Exports to Individual Countries

	Threshold Variable: **Exchange Rate Volatility**		Threshold Variable: **Stock Market Volatility**		Threshold Variable: **Stock Market Illiquidity**	
Exports to: **CHINA**	***t* ≤ -0.4696**	***t* > -0.4696**	***t* ≤ -0.1081**	***t* > -0.1081**	***t* ≤ 0.0383**	***t* > 0.0383**
Foreign Income	**0.0451****	**-0.0238****	-0.0174	-0.0075	0.0120	**-0.0737***
Relative Prices	**-1.1023****	**-1.3708***	**-0.8058*****	**-1.8789***	**-1.8811***	**0.3714**
Exchange Rate Volatility	0.0835	-0.0522	0.0473	**-0.0968****	-0.0162	0.0032
ZARCNY Volatility	0.0398	**-0.0705*****	-0.0094	-0.0397	-0.0085	-0.0059
CNYUSD Volatility	0.0040	-0.0144	-0.0057	-0.0144	0.0124	-0.0208
Stock Market Volatility	0.0564	-0.0173	**0.1259***	0.0673	0.0027	**0.0776****
Stock Market Illiquidity	2.0611	**-3.7412*****	1.2646	-1.9610	0.3246	**7.4900****
Intercept Term	**11.0085***	**11.6794***	**10.5751***	**12.4895***	**12.4457***	**8.0308***
Exports to: **GERMANY**	***t* ≤ -1.0690**	***t* > -1.0690**	***t* ≤ -0.5423**	***t* > -0.5423**	***t* ≤ 0.0302**	***t* > 0.0302**
Foreign Income	0.0875	0.0511	**-0.0952*****	**0.0898***	0.0705	0.0080
Relative Prices	**-2.2106****	**-3.1007***	**-3.0086***	**-3.1812***	**-3.7479***	**-2.6695***
Exchange Rate Volatility	**0.6290***	**0.0704*****	**0.0905****	-0.0148	-0.0583	**0.1164***
ZAREUR Volatility	-0.0324	0.0237	**0.1033*****	0.0067	-0.0188	**0.0646****
CNYEUR Volatility	0.0369	0.0128	-0.0797	0.0289	**0.0663*****	-0.0096
Stock Market Volatility	-0.0701	**-0.0694****	0.0536	-0.0313	**-0.1383***	-0.0390
Stock Market Illiquidity	-5.3159	-1.7278	-2.7446	-0.0446	-5.1432	0.5985
Intercept Term	**13.8303***	**14.2481***	**14.3253***	**14.3340***	**15.5579***	**13.3596***
Exports to: **JAPAN**	***t* ≤ 0.0975**	***t* > 0.0975**			***t* ≤ 0.0422**	***t* > 0.0421**
Foreign Income	-0.0020	-0.0077	-0.0063		-0.0049	-0.0346
Relative Prices	**-0.5754****	**-0.4141*****	**-0.3948****		**-0.6259***	-0.1597
Exchange Rate Volatility	-0.0155	**-0.0908*****	-0.0188		**-0.0351****	0.0605
ZARJPY Volatility	-0.0290	-0.0150	-0.0068		-0.0132	0.0550
USDJPY Volatility	0.0160	-0.0108	-0.0148		-0.0040	**-0.1308***
Stock Market Volatility	**0.0461*****	**-0.0971***	**-0.0366****		**-0.0582***	-0.0052
Stock Market Illiquidity	**3.9331*****	1.2425	1.5138		**4.6167*****	**10.4025****
Intercept Term	**9.3022***	**9.1263***	**9.0355***		**9.3824***	**8.1514***
Exports to: **UK**	***t* ≤ -1.0690**	***t* > -1.0690**	***t* ≤ -0.9891**	***t* > -0.9891**	***t* ≤ 0.0420**	***t* > 0.0420**
Foreign Income	0.0301	0.0125	**0.0645***	0.0110	**0.0308***	-0.0354
Relative Prices	**-1.4821*****	**-2.6033***	**-3.4304***	**-2.6051***	**-2.8707***	-1.2640
Exchange Rate Volatility	**0.3982***	**-0.0648*****	**0.1161****	**-0.0846***	**-0.0572*****	0.0761
ZARGBP Volatility	**0.2267***	-0.0160	0.0975	-0.0138	0.0062	0.0553
GBPCNY Volatility	**-0.1762***	0.0256	-0.1245	0.0168	0.0232	-0.0127
Stock Market Volatility	**-0.1537***	-0.0164	0.0111	**-0.0666****	-0.0423	-0.0722
Stock Market Illiquidity	**-9.8010****	**-3.2682*****	2.6329	-3.2479	1.7708	**15.1811****
Intercept Term	**11.5701***	**12.9489***	**14.2176***	**12.9735***	**13.2839***	**9.4861***
Exports to: **USA**	***t* ≤ 0.2345**	***t* > 0.2345**	***t* ≤ 0.0915**	***t* > 0.0915**	***t* ≤ 0.0322**	***t* > 0.0322**
Foreign Income	-0.0612	-0.0454	-0.0608	-0.0264	-0.07441	-0.00868
Relative Prices	**-2.2482***	**-1.2143***	**-1.6273***	**-1.5024***	**-1.60165***	**-1.58255***
Exchange Rate Volatility	0.0137	0.0816	0.0108	**-0.1287***	**-0.08533***	0.022532
ZARUSD Volatility	-0.0279	-0.0189	0.0073	**-0.1048***	**-0.05404***	-0.01093
CNYUSD Volatility	-0.0126	-0.0108	-0.0183	0.0029	0.044657	-0.03319
Stock Market Volatility	0.0412	-0.0262	0.0438	**0.1272****	0.010122	0.009051
Stock Market Illiquidity	-0.4068	1.1175	-0.3721	-3.4481	**-12.5821***	0.745798
Intercept Term	**12.9183***	**10.7726***	**11.7607***	**11.4366***	**11.99023***	**11.56921***

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

These results further highlight part of the contribution that this thesis has made, where the value of considering disaggregated data is seen[6]. Exchange rate volatility and third-country effects were not highly significant or dominant except for exports to the UK where below the threshold of exchange rate volatility, all the exchange rate factors affected exports to that partner.

The results further showed that in cases were illiquidity and stock market volatility were significant, they were positively related with exports to China and to an extent Japan; meaning that exports to China increased even when both financial economic variables became more adverse. While this was contrary to the observations on other trade partner's export demand functions, they could be explained by the fact that exports to China were not diversified, hence, may not have followed the conventional cycles; mineral resources constituted 88.5% of exports to that trading partner.

Threshold functions for exports to Germany showed relative prices as the main real economic factor for all three export demand functions. Notably the exchange rate volatility and the volatility between the Euro and the Rand were positively related with South Africa's exports where significant. However, exports to the USA were negatively impacted by exchange rate volatility where significant. This suggested that not only were exchange rate volatility effects on exports ambiguous, but their relationship with exports was also destination dependent. The findings on exchange rate volatility are reconcilable with the dissonance around their effects on South Africa's exports as highlighted in the literature review where: Takaendesa *et al*. (2006), Sekantsi (2011), Khosa *et al*. (2015) and Aye *et al*. (2015), found that exchange rate volatility negatively affected South Africa's exports while Todani and Munyama (2005), Schaling (2007), Wesseh and Niu (2012) and Nyahokwe and Ncwadi (2013), tended to find either a weak or no relationship at all.

Threshold regressions to the UK confirmed the real economic variables of foreign income and relative prices to be the most consistently significant variables both below and above the threshold variables. However, the financial market variables of stock

[6] Chapter 6 analyses disaggregated South African exports to the world and to trading partners.

market volatility and stock market illiquidity were more significant below the thresholds of state variables as opposed to above the threshold. The exchange rate variables were statistically significant below and above the threshold across the three models. Although export demand functions to the USA suggested that the traditionally common variables of foreign income and relative prices were consistent particularly in the lower thresholds, exchange rate volatility factors tended to be significant above the threshold of stock market volatility. It was notable that for exports to Japan, no statistically significant threshold could be established when stock market volatility was the threshold variable. This implied that stock market volatility did not trigger any change of export relationships with the macroeconomic variables and such, the relationships could be captured where one mean was estimated.

The results in Table 5.7 suggested that the thresholds of the state variables influence the observed relationships. For instance, the exchange rate volatility as the threshold variable tended to suit the export demand functions to the UK and Japan whilst stock market volatility suited functions to China, Germany, the USA and the world. The findings from the threshold regressions filled a gap identified in this chapter's introduction by showing that business cycles affected export growth in such a manner that the financial economic factors tended to weigh more negatively during an economic decline. The results support the points raised by Pretorius and Botha (2007) and Ajmi *et al*. (2015) that non-linearity would improve understanding of South African export behaviour.

5.6 Summary and Conclusion

In line with this chapter's research problem of establishing the existence and effects of regime-switching of financial market factors on export behaviour in South Africa, the Markov-Switching and threshold regression models were employed. The two models were suitable because they provided relevant contrasts based on their assumptions; the former assumed that regime-switching was exogenous whilst the latter assumed endogenous determination of the regime-switching. The breakpoint tests suggested a significant breakpoint for exports to the world in December 2008 which was an exogenous factor during the study period. However, to test for the significance of the factors of interest, the threshold model was necessary. Results from the Markov-

Switching model showed that it was unlikely for a high exports regime to transition into a low exports regime which was reconcilable with the nominal export growth shown in Figure 5.1 and Table 5.2. However, since the Markov-Switching model exogenously determined regime-switching, the threshold model provided an opportunity to examine the export relationships once the regime-switching was triggered by a known variable.

The threshold model findings offer a significant contribution to existing literature. It was established that not only were the financial factors significant in varying regimes, but also that their influence tended to strengthen when export growth to the world deteriorated. This observation was consistent when the threshold variables for stock market volatility, stock market illiquidity and exchange rate volatility were the threshold variables. These findings indicate that it is reasonable to expect the holders of Rand leveraged stocks to change their holdings when subdued export prospects are foreseeable. The findings give credence to the endogenous growth theory postulating stock market depth as having a relationship with changes in the real economy by Levine and Zervos (1996) and findings by Kim (2013) and Holmes and Maghrebi (2016) on the same theory.

This chapter found that the traditionally popular real economic variables of foreign income and relative prices were dominant under both the exogenous regime-switching assumptions of the Markov-Switching model and the endogenous regime-switching of the threshold model. The two variables were consistently significant under both low and high export regimes and thresholds; their effects were more pronounced in low export regimes for both total exports to the world and to trading partners. Although the traditional real economic factors were significant, exchange rate volatility was not a consistently significant factor which echoed the exchange disconnect puzzle discussed by Choudhry and Hassan (2015), Bahmani-Oskooee *et al*. (2016a) and Bahmani-Oskooee *et al*. (2017).

The establishment of forward markets, hedging and international trade treaties such as General Agreement on Tariffs and Trade (GATT), the South Africa – European Union (SA-EU) Trade, Development and Cooperation Agreement (SA-EU TDCA) among others (DTI, 2019) may ameliorate the effects of currency fluctuations since

they have ready markets. Further, the revelation by Aye *et al*. (2015) of South African exporters actively hedging exchange rate risk (presented in section 2.2.3) may explain the lack of significance of exchange rate volatility on exports; suggesting this hedging is largely effective. In addition, there are conflicting views of exchange rate volatility either increasing or decreasing exports if exporters are risk taking or risk averse. It is plausible that exporters may have viewed exchange rate volatility and third-country effects as an opportunity to increase their profits and output (McKenzie, 1999, Bahmani-Oskooee and Hegerty, 2007 and Bahmani-Oskooee *et al*., 2017). This could explain the mixed signs on exchange rate volatility and third-country effects observed in the instances where they were significant.

Chapter 3 and 4 were complementary on suggesting that South African trade policy ought to be broadened to account for financial economic effects on export growth; this chapter adds a dimension to the types policy interventions that can be made to grow exports in the long-run. The results from both the Markov-Switching and threshold models in this chapter suggested that to improve on export growth, policy makers must be wary about the stage of the business cycles because financial economic factors tended to be more influential during downturns compared to upturns. This means that factors that restrict liquidity or destabilise the financial markets must be addressed when an economic decline was foreseeable.

Overall, this chapter's original contribution to knowledge was the establishment that the financial economic factors of stock market volatility and stock market illiquidity had a negative relationship with exports which strengthened when the business cycle was in the decline phase as suggested by both the Markov-Switching and threshold models. The results meant that South Africa's exports could be enhanced if the trade policy is implemented in a way that would better absorb the adverse effects of commodity price cycles through benefitting from high growth in emerging market economies (Botha and Schaling, 2020). While the results obtained in this chapter were novel and their implications were significant for informing trade policy, there was scope to improve comprehension of export behaviour better through the disaggregation of the exports into sectors and product categories. Disaggregation helped achieved a more nuanced understanding of export behaviour by export sector and product

category. The main benefit for disaggregation was that policy makers would be able to set a more product orientated trade policy especially in instances where a specific desired outcome was required; something that may not be possible when only aggregated export behaviour was analysed. Thus, Chapter 6 which follows, undertakes a comprehensive analysis of South Africa's product-level exports to the world and to selected trading partners.

CHAPTER 6: THE CROSS-SECTION OF SOUTH AFRICAN EXPORTS

6.1 Introduction

In this final chapter of this doctoral thesis, focus is put towards analysing export growth and behaviour of South African product categories. While Chapters 3, 4, and 5 made significant contributions in the form of establishing the pervasiveness of financial economic variables, asymmetric quantile dependent relationships, threshold effects and regime-switching business cycle influences on export relationships, they still left a gap. This gap emanated from the fact that they did not address how these relationships held when a cross-section of individual product categories was analysed. Consequently, this chapter delves into the analysis of product-level exports and satisfies the objective of undertaking a cross-sectional analysis of disaggregated exports to evaluate the effect of real and financial economic variables on long-run export growth.

The cross-sectional analysis provided a more comprehensive evaluation of South Africa's exports which was an important addition to the findings in Chapters 3, 4, and 5 which had analysed aggregated exports to the world, regions and select trading partners. Another gap that needed addressing was knowing the effect a given macroeconomic variable (either financial and economic) had on total and sector-level South African exports when that variable reached a given level or threshold. The broad contribution from this chapter's analysis was that it enabled a more nuanced understanding which provided better informed sector-level policy considerations on improving South African export growth. Since this chapter's analysis was on individual product categories, a large dataset was compiled and required the use of panel data analysis.

Panel data models have been advocated for when analysing financial and economic data possessing time-series and cross-sectional characteristics (Arellano, 2003 and Baltagi, 2005). The benefits from employing panel data models over a purely time-series or cross-sectional analysis include greater degrees of freedom and a reduction in collinearity amongst explanatory variables which increases the efficiency of

econometric estimates (Hsiao, 2003 and Baltagi and Song, 2006). Although there is consensus on the benefits of employing panel data modelling, varied estimation methodologies exist. The varied methods can be attributed to the realisation of the existence of dynamics such as heterogeneity of parameters and non-linear behaviour of variables; that notwithstanding, Lee and Robinson (2015) noted that the most common method through which panel data has been applied is via static, linear parametric regressions alongside individual effects.

Studies employing dynamic heterogeneous panel data models are on the increase, with perhaps the most popular model being the pooled mean group (PMG) of the panel autoregressive distributed lag model (PARDL) by Pesaran, Shin and Smith (1999). The benefits of the PMG are that it detects the long-run equilibrium relationship in both the long-run and short-run, achieves low collinearity, and increases degrees of freedom while increasing estimation efficiency (Pesaran *et al*., 1999). Proponents of the PMG allude to the point that it considers cross-sectional characteristics amongst the groups simultaneously and captures the dynamic interaction amongst the variables (Lee and Wang, 2015).

Although there are benefits to employing dynamic panel data models such as the PMG over static panel data models, they do not consider non-linearity. Hu, Guo, Deng and Wang (2014) subscribed to the idea of accounting for non-linearity and explained that non-linear dynamic panel data models enabled more robust inferences to be drawn from the data generating process (as opposed to purely linear models). Studies that have modified dynamic heterogeneous panel data models to account for asymmetries include Dang, Kim and Shin (2012) and Seo and Shin (2016) who employed threshold modelling to dynamic panel data models to allow for asymmetries and individual heterogeneity. Dang *et al*. (2012) further outlined that Markov-Switching and smooth transition threshold models could be added to panel data models to capture special aspects of time-series behaviour such as regime switches or structural breaks. Although Chapter 5 employed Markov-Switching and threshold models, they analysed a time-series of exports but did not undertake a cross-sectional analysis on sector and product-level exports, which this chapter does.

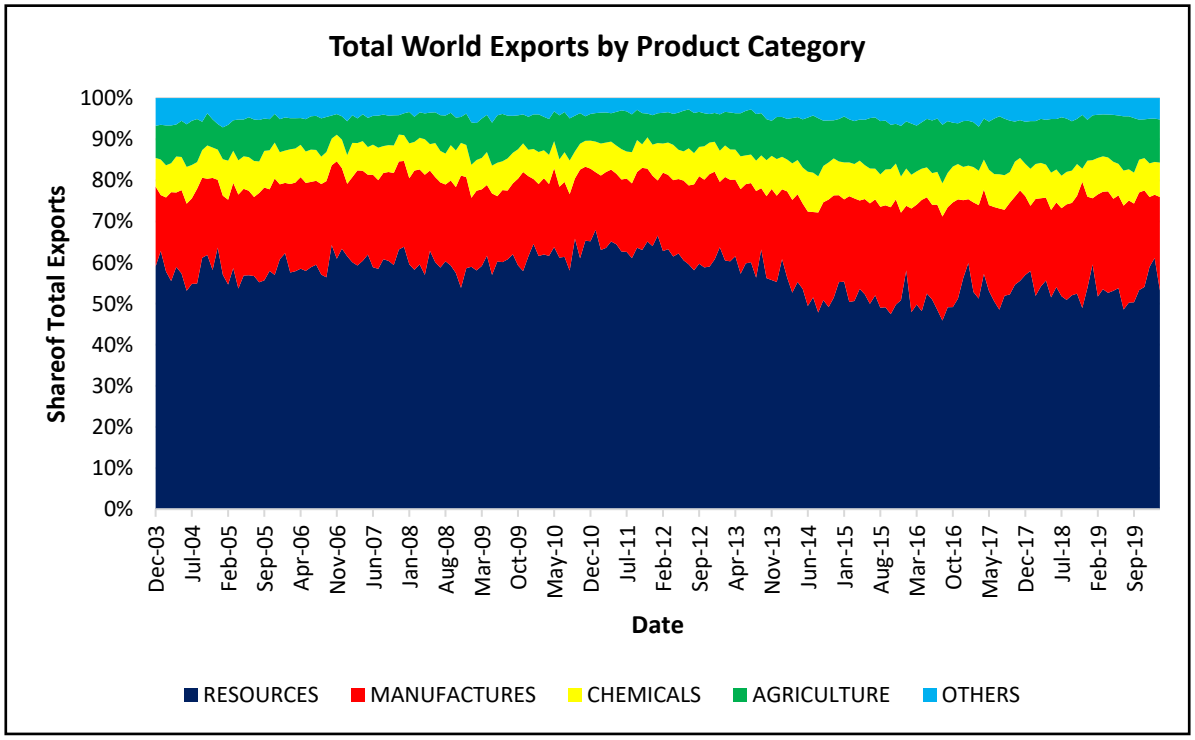
This chapter noted that panel data modelling could be suitably applied to analyse product level behaviour, which was considered to be essential to improve the scope of the current trade policy which has currently fallen short of achieving its objective of being a significant and consistent contributor to South African economic growth (Edwards and Lawrence, 2012 and Fowkes, Loewald and Marinkov, 2016). As highlighted in the introduction to Chapter 2, South Africa's current trade policy has the potential to increase its contribution towards export growth by targeting emerging market economies that have high growth potential. According to Edwards and Lawrence (2012), the export contribution could the improved by increasing manufacturing output, improving regional integration and enhancing mineral development by both domestic and international investors to take advantage of strong global markets. However, to realise the potential of exports, their behaviour needs to be analysed in conjunction with other real and financial economic variables especially at the sector level if the efficacy of policy interventions is to be improved. In Figure 1.1 from Chapter 1, it was evident that there was scope for improving exports' contribution towards real economic growth in the long-run.

The urgency of analysing South Africa's exports particularly at the product level has been accelerated considering the advent of the COVID-19 pandemic which has further diminished economic growth prospects (SARB, 2020). South Africa's slow economic growth will likely be worsened by diminished international capital flows to emerging market economies which has been observed since the onset of the COVID-19 pandemic (Topcu and Gulal, 2020). This situation further necessitates the development of a robust trade policy strategy that comprehends sector-level export behaviour as it will assist in revitalising South Africa's long-run economic growth prospects post the COVID-19 pandemic through the implementation of sector-specific policy interventions. Since Chapter 5 already identified that there were significant business cycle influences on South African export growth, there is scope for this chapter to extend this analysis on product and sector-level exports to obtain a more holistic view of these relationships.

In this chapter, South Africa's monthly product-level exports to the world were sourced from the South African Revenue Services (SARS) and coalesced to produce Figure

6.1 which displays five major sectors' contributions between 2003 and 2019. The graph illustrates that exports were concentrated in resources/mining (averaging approximately 60% per month) followed by vehicles and machinery (a combined average of approximately 20% per month. Although exports were highly concentrated, unravelling their fluctuations in varying economic cycles was important for this thesis because product category fluctuations likely had an earnings impact on firms engaged in trade of a given product, thereby, had a financial economic impact in addition to their real economic growth contributions.

Figure 6.1: Product Category Contribution to South Africa's Total Exports



Although the area of exports has been widely studied in South Africa, these studies (except for Wesseh and Niu, 2012) tended to employ aggregated data on a quarterly basis. The implication of this was that macroeconomic effects on exports were uniform across countries, economic sectors and firms (Sekantsi, 2011 and Wesseh and Niu, 2012). A further limitation was that the use of low frequency data with few observations smoothened the actual exchange rate variability thereby dampening the ability to detect the trade-risk relationship (McKenzie, 1999 and Wang and Barrett, 2002). This final chapter now employs monthly data on exports to various destinations that are

disaggregated by product category thereby increasing the comprehensiveness of the results and offering an original contribution to understanding the South African export market. This contribution helps to address some of the potential shortcomings of earlier research, by using this unique data set of monthly observations – the smallest time interval that many of these variables are available at.

Another limitation of erstwhile South African studies on export growth is that they tended to lean on exchange rate volatility as a major factor influencing exports, however, this factor has proven to be inadequate; leading to the exchange disconnect puzzle (Obstfeld and Rogoff, 2005, Dubas, Lee and Mark, 2010 and Berg and Mark, 2015). Although third-country effects were suggested by Bahmani-Oskooee, Hegerty and Xi (2016a) to assist with capturing effects of exchange rate volatility, Chapters 3, 4 and 5 found the third-country effects not to be consistently able to explain South Africa's exports variability. This led to the conclusion that exchange rate volatilities were not a major factor affecting South Africa's exports. Significantly, analysis from Chapter 3 showed that the financial economic factors of stock market illiquidity and volatility were persistent and indicated that higher stock market liquidity and lower volatility helped export growth in the long-run. These findings were complemented by Chapter 4 and 5 which employed non-linear methods of analysis where; Chapter 4 showed that the relationship between exports and financial economic variables to be asymmetric while Chapter 5 showed the strength of the same relationship to be regime dependent.

The findings on financial economic variables in the previous chapters complemented the motivations made by recent studies stating that attention ought to be given to the financial economy as opposed to the *status-quo*; where real economic variables such as relative prices and foreign income dominate the analysis. These recent studies include Kim (2013), Giannellis and Papadopoulos (2016) and Fufa and Kim (2018) who have shown that the real and financial economies have interdependence after being influenced by the early works of Schumpeter (1934) and later by McKinnon (1973) which was referred to as the finance-led growth hypothesis. This hypothesis gave rise to the endogenous growth theory by Levine and Zervos (1996) which proposed that analysis of real economic aggregates ought to consider the financial

economy. Those who have considered this theory include Kanas and Ioannidis (2010) and Fufa and Kim (2018) who found a strong positive link between the real and financial economies.

Studies by Næs, Skjeltorp and Ødegaard (2011) and Kim (2013) for example, noted that a decline in real output was associated with a decline in stock market liquidity. In addition, earlier South African research conducted by Kantor and Barr (2005) and Holdsworth, Barr and Kantor (2007) highlighted that Rand leveraged stocks were responsive to the underlying export prospects which was in line with latter studies by Næs *et al*. (2011) and Holmes and Maghrebi (2016) who explained that investors changed their portfolio holdings in anticipation or reaction to earnings predictions; this can be reflected by stock market liquidity and volatility.

Responses by financial market participants to changes of real economic prospects, exports included, makes stock market variables such as stock market volatility and illiquidity relatable with exports. Both real economic and financial variables may change their levels during different states of the economy; by employing linear panel data models mainly focused on real economic variables, South African studies left a gap. This gap arose because the erstwhile studies' linear methods could not discern changes of econometric relationships with both real and financial economic variables in various states of economic cycles. For instance, in the South African context, little is known on export relationships with real and financial economic variables at varying economic states that are associated with changes between high and low financial market volatility. Further, economic relationship changes that may occur at various thresholds or levels of the economic states and their effect on a cross-section of product categories is yet to be explored. This leaves a gap in knowledge on the effect a given macroeconomic variable (either financial and economic) has on total and sector-level South African exports when that variable reaches a given level or threshold.

Given that studies by Fedderke and Mengisteab (2017) and the IMF (2019) conceded that South Africa's annual economic growth rate was projected to remain below 1% per annum for the foreseeable future made the analysis of exports by product category

essential. The importance emanates from the position that South African policy makers need to know the nuances of export relationships amongst product categories to formulate policies that can make exports more resilient at varying levels of business cycles. This is important because appropriate policy interventions in specific export sectors is required considering that the South African Reserve Bank (SARB) (2019), the IMF (2019) and Ajmi *et al*. (2015) view exports as a key avenue for boosting South Africa's annual economic growth rate. In addition, scholars and investors must consider the financial economy together with non-linearity on each product category when modelling export demand functions because there is the possibility of heterogeneity amongst categories.

Analysis of the behaviour of the export categories in Figure 6.1 could be undertaken in a dynamic panel data model that allows for heterogeneity; however, the non-linearity aspects of these relationships must be considered because studies have shown that positive and negative shocks to exports tend not to result in reactions of a similar magnitude; the results in Chapter 4 unravelled this reality. The inclusion of financial economic variables in a non-linear panel data setting on product level exports have, to the best of the author's knowledge, not been investigated in a South African context. Hence, this study makes a significant contribution to existing knowledge on South African exports which would be of value to policy makers, investors and scholars.

The following section undertakes a literature review of erstwhile studies that employed panel data analysis on exports to provide a theoretical background on relatable studies.

6.2 Literature Review

The subject matter of exports has been internationally analysed since the collapse of the Bretton Woods financial system of fixed exchange rates which occurred between 1968 and 1973 (IMF, 2019). The interest grew out of the assumption that increased currency volatility would discourage exporters who were perceived to be risk averse (Choudhry and Hassan, 2015). The previous chapter showed that the fixation on exchange rate volatility left a gap as this variable could not adequately explain exports variability. Nonetheless the earlier South African studies in the area provided a vital background to build future studies on because of the mixed evidence found in these studies. Bah and Amusa (2003), Aziakpono, Tsheole and Takaendasa (2005), Takaendesa, Tsheole and Aziakpono (2006), Sekantsi (2011), Khosa, Botha and Pretorius (2015) and Aye, Gupta, Moyo and Pillay (2015), found that exchange rate volatility negatively affected South African exports. Others, such as Todani and Munyama (2005), Schaling (2007), Wesseh and Niu (2012) and Nyahokwe and Ncwadi (2013), tended to find either a weak or no relationship at all between South Africa's exports and exchange rate volatility.

Although these studies provided foundational knowledge on South African export behaviour, they mainly employed linear time-series analysis on total exports. The most notable exception to this was the study conducted by Wesseh and Niu (2012) who used a panel data model to analyse South Africa's product-level exports to China although exchange rate volatility was a main factor in that study. In addition, the panel data analysis in the study was conducted using linear modelling assumptions. Consequently, there remained a research gap on the analysis of South African cross-section of product-level or sector-level exports especially on the possibility of non-linear relationships. Investigating these possible relationships is motivated by Chapter 5 which hinted at the possibility that these product-level exports may be prone to threshold effects. This may mean that macroeconomic relationships may change at varying thresholds of economic state variables and this warranted further investigation.

Sauer and Bohara (2001) noted that there was a theoretical expectation that exchange rate volatility and international trade had an inverse relationship. At that time, erstwhile

studies seemed to suggest that the impact of exchange rate volatility was ambiguous. Consequently, Sauer and Bohara (2001) employed a panel data model to analyse annual trade for ninety-one countries for twenty-three years. These countries which comprised developed and emerging market economies, also included South Africa and their panel data approach comprised both random and fixed effects methodologies. The results obtained by Sauer and Bohara (2001) showed that the negative effects of exchange rate volatility tended to affect the developing markets in Latin America and Africa but not for those emanating from Asia or developed countries. These results confirmed their initial assertions that exchange rate volatility effects tend to have an ambiguous effect on trade. This led to the conclusion that each trade scenario ought to be tested before a position on the effect of exchange rate volatility could be taken.

After noting the importance of exports for South African economic growth, Chang, Simo-Kengne and Gupta (2013) investigated causality between South African GDP and exports from South Africa's nine provinces. Their study which used annual data, applied a panel granger causality analysis and established that there was unidirectional causality from GDP to exports in Mpumalanga province, but bidirectional causality was established in Gauteng province. However, no causality was established for the remaining provinces, but they found that the provinces were highly integrated suggesting they were complementary in growing exports (Chang *et al*., 2013). Although Chang *et al*. (2013) study did not consider multiple variables, their findings accommodated the growth-led exports thesis which hugely influenced earlier studies that only considered real economic variables as influencing exports.

Khosa, Botha and Pretorius (2015) used panel data analysis to evaluate the impact of exchange rate volatility on the exports of nine emerging market economies namely Argentina, Brazil, India, Indonesia, Mexico, Malaysia, Poland, South Africa and Thailand on a monthly basis between 1995 and 2010. Other explanatory variables for the study included foreign income, relative prices and terms of trade; exchange rate volatility was estimated using standard deviation of the moving average and the GARCH model. After analysing the export relationships using panel data and the Pedroni residual cointegration method, Khosa *et al*. (2015) established that in addition

to having long-run relationship with exports, exchange rate volatility negatively affected exports regardless of the volatility measure used.

Meniago and Eita (2017) were of the view that openness to trade played a highly significant role in the development of immerging market economies. They noted that most countries in Sub-Saharan Africa had adopted a freely floating exchange rate system which exposed their trade to the risk of exchange rate volatility. Consequently, Meniago and Eita (2017) investigated exchange rate volatility effects on trade in 39 selected sub-Saharan Africa (including South Africa) using annual data between 1995 and 2012 using panel data analysis. To estimate exchange rate volatility, Meniago and Eita (2017) employed three different measures namely, standard deviation, GARCH and the Hodrick-Prescott filter. Their analysis led to the findings that the choice of volatility measure impacted on their observations on exchange rate volatility on trade in the Sub-Saharan region. When exchange rate volatility was estimated with standard deviation and the Hodrick-Prescott filter, it depressed exports (an imports as well), however, the negative impact was very minimal suggesting that if there were to be a policy to reduce the volatility, it would be of little value.

Other relevant studies analysing export behaviour using panel data methods in emerging markets include Hsiao and Hsiao (2006) who employed both fixed and random effects panel data models in conjunction with vector autoregression (VAR) to analyse the relationship amongst GDP, exports, and FDI in East and South-eastern Asian emerging market economies namely China, Korea, Taiwan, Hong Kong, Singapore, Malaysia, Philippines, and Thailand between 1986 and 2004. After establishing that FDI had unidirectional causality on GDP, indirect causality on exports and bidirectional causality between exports and GDP Hsiao and Hsiao (2006) concluded that their panel data causality results were superior compared to those obtained from time-series causality analysis.

Another relatable study employing panel data analysis include Vu, Holmes, Lim and Tran (2014) who analysed the relationship between exports and profit in Vietnam between 2005 and 2009. Their study used a panel data quantile approach which unravelled that export participation was positively related with firms with higher profits

and lower for those with less profits. However, no relationship could be established when the OLS method was used. Vu *et al*. (2014) concluded that productivity advantages of exporters with low profit growth were absorbed by costs relating to trading activities in overseas markets. In a similar study, Shahbaz, Zakaria, Shahzad and Mahalik (2018a) examined energy-growth linkages in top ten energy consuming countries using quantile-on-quantile method on quarterly data between 1960 and 2015. They argued that quantile-based regressions allowed for a more precise description of the dependence structure that existed between economic growth and energy consumption, which conventional OLS could not do.

The study by Hunegnaw and Kim (2020) which investigated real exchange rate effect on trade balances in East Africa employed both the linear ARDL in a pooled mean group (PMG) and NARDL. The study focused on agriculture, manufacturing and mining sectors using annual data between 1980 until 2016 and the twelve countries analysed were; Burundi, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Tanzania, Uganda, and Zambia. The results from their dynamic PMG model implied that in the long-run, a depreciation of the real effective exchange rate improved manufacturing and mining trade balances while worsening that of agriculture while asymmetric effects were only present for trade balances for real effective exchange rate on the manufacturing sector. These results led to the conclusion that sector analysis was better than aggregated analysis on trade because sectors had varying exposures to identified risk factors (Hunegnaw, and Kim, 2020).

Although the literature employing static panel data models tends to be more dominant, non-linear panel data analysis stands to provide a more comprehensive contribution to the discourse. Recent studies cognisant to the benefits of non-linear panel data models include Seo and Shin (2016) who considered the asymmetric dynamics and unobserved individual heterogeneity simultaneously in a threshold panel. They noted that at that time, there was no study that had rigorously investigated non-linear asymmetry mechanisms in dynamic panels, especially in instances where the time periods were short. However, there existed extant literature on general method of moments (GMM) estimation of linear dynamic panel data models with dynamic

individual effects; as seen in Arellano and Bond (1991), Ahn and Schmidt (1995), Arellano and Bover (1995), Blundell and Bond (1998), Alvarez and Arellano (2003), and Hayakawa (2014). Consequently, they developed a dynamic threshold panel data model that accounted for asymmetries and established that these were more suitable compared to purely static linear models.

Prior to the Seo and Shin (2016) dynamic panel threshold model, Hansen (1999) developed a static threshold panel model where the coefficients could take a number of values depending on the value of the exogenous variable. This method was generalised by González, Teräsvirta and van Dijk (2005) who developed a smooth transition panel regression model which allowed for gradual change of coefficients from one regime to the next. However, both models were static panels which may have the limitation of being rigorous enough for heterogeneous panel dynamic panel data models (Seo and Shin, 2016). The limitation of static panel data models is that they assume exogeneity of either the regressors or the threshold variable or both. They noted that there was a limitation in studies looking at threshold regressions; least squares approach by Hansen (2000) and Seo and Linton (2007) required exogeneity for all covariates. This requirement was relaxed by Caner and Hansen (2004) however, they assumed that the threshold was exogenous.

Dang *et al*. (2012) proposed a generalised GMM for dynamic panel threshold models capable of providing consistent estimates of heterogeneous speeds of adjustment and procedures of validly testing threshold effects in short dynamic panels with unobserved individual effects. Other researchers who included Ramirez-Rondan (2013) proposed the maximum likelihood estimation techniques and Kremer, Bick and Nautz (2013) suggested the combination of forward orthogonal deviations transformation by Arellano and Bover (1995) as well as instrumental variable estimation of the cross-section model by Caner and Hansen (2004) to the Hansen (1999) model but notably, their underlying assumptions were that of exogeneity of the regressors and/or the transition variable.

The method by Seo and Shin (2016) looked at the best method to simultaneously model non-linear asymmetric dynamics and cross-sectional heterogeneity. Their

model achieves this by extending that the models of Hansen (1999, 2000) and Caner and Hansen (2004) into the dynamic panel data model with endogenous threshold variable and regressors. Their model proposed two estimation methods which are based on the first difference transformation and then evaluates their properties by the diminishing threshold effect asymptotes of Hansen (2000). Their model avoids the sample selection bias arising from the exogeneity assumption by the Hansen (1999) model. They noted that Hansen's (1999) static panel model was overly restrictive as the fixed estimator required covariates to be strongly exogenous if the estimator was to be consistent.

Literature analysing South African export behaviour mostly employed time-series analysis and those that employed panel data analysis used linear models. Most studies analysing exports used static panels and considered heterogeneity; however, South African research considering non-linearity within a panel context has not yet been established to the best knowledge of the author. Dynamic panel models can be applied with non-linear relationships such as regime-switching models, smooth transition threshold models and threshold models (Hu *et al*., 2014). The advantage of the threshold panel data models over the time-series threshold models that were employed in Chapter 5 are the increased degrees of freedom from the cross-sectional analysis; the fact that these models do not require any functional form of non-linearity, and the number of thresholds and their locations are determined endogenously (Chang, Khamkaew, McAleer and Tansuchat, 2010). This study expected that the relationship of the economic and financial variables would be captured in a dynamic panel however, few domestic studies could be referred to and as such, international literature was consulted.

There is growing acceptance that non-linear modelling may better suit economic time-series analysis. Specifically, the threshold model has grown to be one of the most popular non-linear models which splits the sample into classes based on a variable and whether it is above or below a given threshold. This is an important consideration in the South African context because exports which are a potential avenue to boost economic growth, ought to be thoroughly understood at various levels of shocks to variables in both the real financial economies. For instance, policy makers need to

understand how resources exports behave when exchange rate volatility or stock market volatility is at a high level compared to the behaviour when the volatility is lower. In addition, it is valuable to know how resources export behaviour differs from agriculture or manufactures exports under the same circumstances. Understanding these nuances enables a more effective and comprehensive trade policy to ensure resilience of these exports in varying stages of the business cycle. There are gaps in knowledge with respect to these aspects and the next section outlines the data and methodology that were employed and utilised to address these gaps.

6.3 Data and Methodology

6.3.1 Data

In line with this chapter's objective of undertaking a cross-sectional analysis, the data required differed from those required in Chapters 3, 4 and 5 in that product-level exports were required for this chapter's analysis. In this regard, monthly product-level exports to the world and to trading partners was sourced and obtained from SARS. The product-level export data from SARS was for product-level exports to the world and product-level exports to five trading partners; China, Germany, Japan, United Kingdom (UK) and the United States of America (USA). The data for product-level exports to the world were available from January 2004 until December 2019 while product-level exports to the five trading partners were available from January 2010 until December 2018.

In addition to export data, other variables required by the study included exchange rates between the Rand and currencies of trading partners. Exchange rate volatility has been thought to be a major risk factor faced by international traders and as such, has been a common risk factor in related studies. In addition to exchange rate volatility, two of the most common risk factors are foreign income and relative prices. Foreign income, proxied by that country's industrial production, indicates that country's likelihood to consume exports whilst relative prices were required to represent the comparative cost of South African goods in international markets. Lastly, financial market variables of stock market volatility and stock market illiquidity were prepared

from stock market data where illiquidity was estimated using the Amihud (2002) illiquidity measure. Table 6.1 below summarises the data, its full description and where they were sourced.

Table 6.1: Variables in the Analysis

Variable	Regression Name	Description	Source	Duration
1. Exports[7]	World	Product-level exports to the world	SARS	2004-2019
	China Germany Japan UK USA	Product-level exports to China Product-level exports to Germany Product-level exports to Japan Product-level exports to the UK Product-level exports to the USA	SARS	2010-2018
2. Foreign Income	PRDN	Industrial Production in each of recipient countries	Capital IQ	2004-2019
3. Relative Prices	RELP	Real effective exchange rate	SARB	2004-2019
4. Exchange Rate Volatility and Third-Country Effects	EXCH ZARUSD Volatility CNYUSD Volatility ZAREUR Volatility CNYEUR Volatility ZARJPY Volatility CNYJPY Volatility ZARGBP Volatility GBPCNY Volatility	Volatility of Rand exchange rate and Exchange rate volatility of competing exporters calculated using the GARCH (1,1) Volatility between the Rand and US Dollar Volatility between the US Dollar and Yuan Volatility between the Rand and the Euro Volatility between the Yuan and Euro Volatility between the Rand and Japanese Yen Volatility between the Yuan and Japanese Yen Volatility between the Rand and British Pound Volatility between the British Pound and Yuan	Iress	2004-2019
5. Stock Market Volatility	ALSI	Closing prices on the JSE ALSI	Iress	2004-2019
6. Stock Market Illiquidity	ILLQ	The study employed the Amihud (2002) illiquidity measure which required the following stock market data: - Opening and closing prices stock market prices of the JSE ALSI - Trading volume on the JSE ALSI	Bloomberg and Iress	2004-2019

With all the data gathered, the study noted that all product-level exports to individual countries were not consistently available. These missing data points would have resulted in an unbalanced panel data analysis which would consequently limit the objectives of the study. To circumvent this problem, the study grouped products into

[7] A comprehensive list and description of all product-level exports and categories to the destinations is provided in Appendix A1

five related categories namely: resources (including mining), manufactures (including machinery and vehicles), chemicals (including plastics), agriculture (including food), and others which are summarised in Table 6.2.

Table 6.2: Product Export Groupings for Trading Partners

Product Category	Description
Resources	These included all the mining and resources exports
Manufactures	Contained vehicles and technical manufactured output
Chemicals	All the chemical products including plastics
Agricultural Products	Agricultural products including food
Others	All the other remaining categories

With all the data gathered and series ready, preliminary analysis started with the summary statistics which included the descriptive statistics followed by correlation analysis; these assisted with providing a background on the distribution of the data before analysis was undertaken. After these preliminary analyses, panel unit-root tests were undertaken as required by dynamic panel data models. Maddala and Wu (1999) noted that panel unit root tests were a way to increase the power of unit root tests that were based on a single time series. In this regard, panel unit root tests were conducted using the Im-Pesaran-Shin (IPS), Levin, Lin and Chu, Augmneted Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests for stationarity. All the stationarity tests were undertaken with a null hypothesis which assumed a unit root process while the alternative hypothesis charged that the panel was stationary. After these preliminary analyses, panel data regressions ensued; beginning with the PMG and then followed by the threshold panel data analysis.

6.3.2 Methodology

The objective of the study was to model South Africa's export demand to the world and to trading partners. As such the general export demand function that was estimated can be summarised by equation 6.1 below:

$$lnXP_{i,t} = \alpha_0 + \xi lnY_{i,t} + \psi lnR_{i,t} + \zeta lnEX_{i,t} + \theta lnTE_{\kappa,t} + \phi lnTE_{\nu,t} + \beta lnLQ_{i,t} + \lambda lnSV_{i,t} + \varepsilon_t \quad (6.1)$$

Where, $lnXP_{i,t}$ represents exports to the world or a given trading partner, foreign income to the world or a trading partner is represented by $lnY_{i,t}$ and $lnR_{i,t}$ represents relative prices, $lnEX_t$ is the exchange rate volatility whilst $nTE_{\kappa,t}$ and $nTE_{\nu,t}$ represent the third-country effects. Stock market illiquidity and stock market volatility are represented by $lnLQ_{i,t}$ and $lnSV_{i,t}$ respectively. The terms α_0 and ε_t respectively represent the intercept term and the normally distributed error term.

The export demand function in 6.1 was based on the theoretical assumption that there would be a positive relationship between the foreign income coefficient, ξ and exports because higher incomes to trading partners were expected to be associated with an increase in the consumption of South Africa's exports. It anticipated a negative relationship between relative prices and exports because a decline in the relative price of South African goods would likely increase exports. The assumption was that a decline in the cost of a good would be associated with an increase in the quantity of that good sold because its relative attractiveness on the global market would increase. The exchange rate volatility coefficient ζ, was expected to be negatively related with exports as this increased uncertainty of the export prices however, it is worth noting that there has been mixed evidence established on this variable in the literature. A positive relationship would imply that exports rise with increased exchange rate volatility whilst a negative relationship would mean the opposite.

This chapter estimated equation 6.1 in a panel data model, and this involved utilising the PMG and the threshold panel data models. Section 6.3.2.1 outlines the reparameterization of the export demand function into a PMG model while section 6.3.2.2 details the threshold panel data model that was utilised.

6.3.2.1 Pooled Mean Group Estimation

The study undertook panel data analysis consisting dynamic linear and non-linear models respectively. The dynamic linear model employed was the popular dynamic PMG by Pesaran, Shin, and Smith (1999). The Hausman test was used to decide between either employing the mean group or the PMG. The dynamic panel data model, PMG, begins by adopting the basic structure of the autoregressive distributed lag (ARDL) (p, q, q, …, q) model by Pesaran *et al*. (1999) into the following model:

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij}\, y_{i,t-j} + \sum_{j=0}^{q} \delta'_{ij}\, x_{i,t-j} + \mu_i + \varepsilon_{it} \qquad (6.2)$$

Where, y_{it} denotes the dependent variables for a group i, which were the product export series in this study, λ_{ij} are the coefficient estimates for the lagged exports variable $y_{i,t-j}$. x_{ij} (k x 1) is the vector of explanatory variables for group i, which were outlined in Table 6.1 and equation 6.1. δ_{ij} are (k × 1) coefficient vectors, groups are denoted by i = 1, 2, …, N, time periods by t = 1, 2, …, T, whereas μ_i represents the fixed effects and ε_{it} is the error term.

Equation (6.2) can be reparametrized into equation (6.3) below to account for the long-run and short-run co-integration dynamic panel data model.

$$\Delta y_{it} = \varphi_i\left(y_{i,t-1} - \beta'_i x_{it}\right) + \sum_{j=1}^{p-1} \lambda^*_{ij}\, \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta^{*\prime}_{ij}\, \Delta x_{i,t-j} + \mu_i + \varepsilon_{it} \qquad (6.3)$$

Where, $\Delta y_{it} = y_{it} - y_{i,t-1}$ is a change in exports (the dependent variable), $y_{i,t-1}$ is the export lag, $\varphi_i = -\left(1 - \sum_{j=1}^{p} \lambda_{ij}\right)$ is the adjustment coefficient which is expected to be negative and significant if there are long-run relationships, while $\left(y_{i,t-1} - \beta'_i x_{it}\right)$ is the

error correction term. $\lambda_{ij}^{*} = -\sum_{m=j+1}^{p} \lambda_{im}$ represents the vector of the estimated short-run coefficients and $\delta_{ij}^{*} = -\sum_{m=j+1}^{q} \delta_{im}$ represents a vector of short-run estimates of the explanatory variables.

The PMG imposes homogeneity in the long-run coefficients whilst simultaneously allowing for heterogeneity in the short-run coefficients and error variances (Lee and Wang, 2015). It also assumes that error terms are not serially correlated and are distributed independently of the regressors. The second assumption is that there is a long-run relationship between the dependent and explanatory variables, and the last assumption is that long-run parameters are the same across the constituents.

6.3.2.2 Threshold Panel Data Estimation

Although dynamic panel data models have tended to gain popularity in latter studies, recent developments in panel data modelling advocate for the consideration of non-linearity or asymmetries. There are significant advantages in favour of using endogenous threshold panel data techniques compared to traditional models. Firstly, they do not require any functional form of non-linearity and in addition, the number of threshold and their locations are determined endogenously (Chang *et al*., 2010). Secondly, with these models, the asymptotic theory applies, and this means that it can be used to construct the appropriate intervals and a bootstrap method is available for use in assessing the statistical significance of threshold effects. The threshold effects are tested with a null hypothesis of a linear formulation versus an alternative hypothesis of a threshold effect. Given the likely benefits of the threshold regression method, this study employed the panel regression analysis proposed by Hansen (1999) to test for thresholds in South Africa's export demand functions. The econometric techniques that were developed by Hansen (1999) are appropriate for threshold regression with panel data. The model allows for fixed individual effects by dividing the observations into two or more regimes, depending on whether each observation is above or below the threshold level (Chang *et al*., 2010).

Data from the balanced panel data used by this study can be summarised as: $(y_{it}, q_{it}, x_{it} : 1 \leq i \leq n, 1 \leq t \leq T)$. Where, i represents the individual, t stands for the

time, the dependent variable y_{it} is scalar, q_{it} is the threshold variable and x_{it} is a k vector. The equation of interest, which is the export demand function can be summarised as follows:

$$y_{it} = \mu_i + \beta_1' x_{it} I(q_{it} \leq \gamma) + \beta_2' x_{it} I(q_{it} > \gamma) + \varepsilon_{it} \quad (6.4)$$

Where, $I(\cdot)$ is an indicator function and equation 6.4 can be rewritten as follows:

$$y_{it} = \begin{cases} \mu_i + \beta_1' x_{it} + \varepsilon_{it}, & q_{it} \leq \gamma \\ \mu_i + \beta_2' x_{it} + \varepsilon_{it}, & q_{it} > \gamma \end{cases}, \quad (6.5)$$

In equation 6.4 there is one threshold (hence two regimes; above and below the threshold) γ; β_1' and β_2' are the two regression slopes in either regimes. The model requires the elements of x_{it} to be time-invariant in order to identify the slope coefficients β_1' and β_2'. In addition, q_{it} which is the threshold variable, is not time-invariant. The fixed individual effect is represented by μ_i while the error term ε_{it}, is assumed to the independently and identically distributed, having a mean of zero and finite variance σ.

Hansen (1999) recommends a grid search selection of γ that minimizes the sum of squared errors (SSE), denoted $S_1(\gamma)$ which is obtained by least squares estimation of equation 6.4.

$$\hat{\gamma} = argmin\, S_1(\gamma) \quad (6.6)$$

Given the estimate of γ, namely $\hat{\gamma}$, β_1' and β_2' can then be estimated, the slope of the coefficient estimate is $\hat{\beta} = \hat{\beta}(\hat{\gamma})$. The residual variance is given by $\hat{\sigma}^2 = \frac{1}{n(T-1)} S_1(\hat{\gamma})$.

It is important to determine whether the threshold effect is statistically significant. The null hypothesis of no threshold effects (that is, a linear formulation) against the alternative hypothesis of threshold effects, is given as follows.

$H_0: \beta_1' = \beta_2'$

$H_0: \beta_1' \neq \beta_2'$

Under the null hypothesis, the threshold effect γ is not identified, so classical tests such as the Lagrange multiplier test do not follow a standard distribution. In order to address this problem, a bootstrap procedure is used to simulate the asymptotic distribution of the likelihood ratio test. Hansen (1999) showed that a bootstrap procedure attains the first-order asymptotic distribution, so p-values constructed from the bootstrap are asymptotically valid. In some applications, there may be multiple thresholds. Similar procedures can be extended to higher-order threshold models. This method represents another advantage of threshold regression estimation over the traditional approach, which allows for only a single threshold.

The multiple thresholds model may take, for example, the form of the following double threshold model:

$$y_{it} = \mu_i + \beta_1' x_{it} I(q_{it} \leq \gamma_1) + \beta_2' x_{it} I(\gamma_1 < q_{it} \leq \gamma_2) + \beta_3' x_{it} I(q_{it} > \gamma_2) + \varepsilon_{it} \quad (6.7)$$

Where, the thresholds are ordered so that $\gamma_1 < \gamma_2$ In the panel threshold model, Hansen (2000) also extended a similar computation to multiple thresholds. Applying the threshold model to the panel, it has the following general formula:

$$\dot{y}_{it} = \beta_1 y_{i,t-1} + \beta_2 X_{it} + \mu_i + \eta_t + \varepsilon_{it} \quad (6.8)$$

Where, $\dot{y}_{it}$ represents exports to a given destination, X_{it} is a vector of explanatory variables μ_i and η_t are the country and time specific effects and ε_{it} is the uncorrelated error term. Applying the threshold model to this study's export demand function to a given region where there are two thresholds for instance, can be parameterised as follows:

$$lnXP_{i,t} = lnXP_{i,t-1} + \xi lnY_{i,t} + \psi lnR_{i,t} + \zeta lnEX_{i,t} + \theta lnTE_{\kappa,t} + \phi lnTE_{\nu,t} + \lambda lnSV_{i,t} + \beta lnLQ_{i,t} I(q_{it} \leq \gamma_1) + \beta lnLQ_{i,t} I(\gamma_1 < q_{it} \leq \gamma_2) + \beta lnLQ_{i,t} I(q_{it} > \gamma_2) + \upsilon_t \quad (6.9)$$

Where γ_1 and γ_2 are the thresholds determined by the model, q_{it} is the ratio of illiquidity and exports at time t. υ_t represents the individual effects μ_i, η_t and ε_{it}. $lnXP_{i,t}$ represents exports at time t while $lnXP_{i,t-1}$ represents exports at time $t-1$ to the world or a given trading partner, foreign income to the world or a trading partner is represented by $lnY_{i,t}$ and $lnR_{i,t}$ represents relative prices, $lnEX_t$ is the exchange rate volatility whilst $nTE_{\kappa,t}$ and $nTE_{\nu,t}$ represent the third-country effects. Stock market illiquidity and stock market volatility are represented by $lnLQ_{i,t}$ and $lnSV_{i,t}$ respectively.

After estimation of South Africa's export demand functions to the world and to its trading partners, results that were obtained are presented in the following section.

6.4 Results

In this section, the results obtained from the analysis is presented starting with the summary statistics which involved descriptive statistics and correlation analysis. After the summary statistics were concluded, panel unit root tests were conducted as required by the PMG model to establish the integration orders of the variables and ensuring that they did not have an integration order greater than one. Panel data analysis ensued, starting with the PMG before concluding with the threshold panel data analysis.

6.4.1 Summary Statistics

Table 6.3 below presents the descriptive statistics of exports to the world and to five trading partners. In section A of Table 6.3, the descriptive statistics of all the combined exports to the world between January 2004 and December 2019 are presented first and then followed by the same exports now disaggregated by sectors (Agriculture, Chemicals, Manufactures, Resources and Others). The descriptive statistics summarised in section A show that the nominal growth of exports over the study period was 434% with a monthly export average of 64.98 billion Rands. The exports to the world were dominated by resources which contributed a monthly average of approximately 55.8% per month. Manufactures were the second largest contributor to total exports with 21.3% followed by agriculture and chemicals which had 10% and 7.9% respectively. There was a clear domination of exports by resources illustrating the concentration of exports which was earlier highlighted by Figure 6.1. All the sector-level exports were characterised by large standard deviations from their average monthly exports which was reconcilable with the observation made on total exports to the world.

Section B of Table 6.3 summarises the total exports to each of the trading partners between January 2010 and December 2018 while section C shows product category exports to the same trading partners during the same time. To aid with comparisons, total and sector-level exports to the world for the same period (January 2010 until December 2019) were included in the last row of section B. The descriptive statistics

in section B and C show that China was the largest recipient of South Africa's exports with a total of approximately 866.3 billion Rands, however, these exports were concentrated in resources which constituted approximately 89% of those exports. Germany on the other hand, which recorded the highest nominal growth of export receipts from South Africa, mainly received manufactures from South Africa which constituted 59%.

Table 6.3: Summary Statistics (Millions of Rands)

Section A. **Exports to Rest of the World (January 2004 – December 2019)**						
Export Destination	**Nominal Growth**	**Average Exports**	**Standard Deviation**	**Minimum**	**Maximum**	**Share of Total Exports**
WORLD	434%	64984.77	27973.46	19333.17	123353.34	100%
SECTOR						
AGRICULTURE	589%	6518.92	3871.82	1584.76	15730.98	10%
CHEMICALS	404%	5148.11	2432.20	1406.53	10045.16	7.9%
MANUFACTURES	570%	13837.41	7012.06	2623.85	30308.04	21.3%
RESOURCES	401%	36248.03	13708.70	11656.44	65716.89	55.8%
OTHERS	311%	3243.55	2833.55	873.70	35282.80	5%
Section B. **Exports to Trading Partners and World (January 2010 – December 2018)**						
Export Destination	**Nominal Growth**	**Average Exports**	**Standard Deviation**	**Minimum**	**Maximum**	**Total Exports for Period**
CHINA	156%	8020.815	1935.482	3211.187	12686.59	866 248
GERMANY	202%	4945.133	1923.607	2401.055	11366.02	534 074.4
JAPAN	48%	4321.833	704.5666	2694.686	6152.451	466 758
UK	60%	3130.455	1097.341	1240.021	8625.368	338 089.1
USA	140%	5857.178	1306.435	2671.36	10619.54	632 575.2
WORLD	**180%**	**77891.89**	**19708.74**	**36574.2**	**122087**	**8 412 324**
Section C. **Product Exports per Country Summary (January 2010 – December 2018)**						
SECTOR	**China**	**Japan**	**Germany**	**UK**	**USA**	**WORLD**
AGRICULTURE	3%	4%	5%	19%	5%	11%
CHEMICALS	2%	3%	4%	3%	11%	8%
MANUFACTURES	1%	11%	59%	22%	31%	21%
RESOURCES	89%	78%	28%	52%	52%	55%
OTHERS	5%	4%	4%	4%	1%	5%

It can be deduced from the descriptive statistics that total exports to trading partners and their subsequent sector-level exports had relatively lower standard deviations and low nominal growth rates compared to the total world exports for the same period (except for Germany). Product exports to the individual countries were largely not diversified with mining output tending to be the dominant contributor, except for those to Germany which were dominated by manufactures. Resources output had the greatest option for export destinations compared to export categories such as machinery and agriculture-based products which could mean that third-country effects and exchange rate volatility could be of greater influence when analysing resources output compared to manufactured output because more price prospects were available in the former compared to the latter. However, econometric analysis was required to evaluate this assertion because a counter argument could be that resources output had more established markets which would guarantee assimilation of all output thereby reducing the effect of exchange rate volatility. The concentration of exports in resources highlights that South Africa needs to pursue export growth of manufactured output (Edwards and Lawrence, 2012).

Table 6.3 provided a summary of the distribution of product-level exports to the world and trading partners which showed deviations and concentration of exports in the mining and manufacturing sectors. The variability of exports provided an opportunity for this chapter to explore these variations using the explanatory variables summarised in Table 6.1 in section 6.3.1. While total and product category exports' summary statistics were established, analysis of changes of the exports and the factors identified in Table 6.1 needed to be determined. This analysis began by conducting a correlation analysis and Table 6.4 provides the summary correlation matrix of total exports to the world and the identified macroeconomic factors.

Table 6.4: Correlation Analysis

Exports to the rest of the World 2004 - 2019								
	EXPORTS	**PRDN**	**RELP**	**EXCH**	**ZARUSD**	**CNYUSD**	**ALSI**	**ILLQ**
EXPORTS	1							
PRDN	**0.4127*** (0.0000)	1						
RELP	**-0.3579*** (0.0000)	**-0.525*** (0.0000)	1					
EXCH	-0.0111 (0.7305)	0.0005 (0.9874)	**0.1653*** (0.0000)	1				
ZARUSD	0.0433 (0.1804)	0.0274 (0.3961)	**-0.2445*** (0.0000)	**-0.8923*** (0.0000)	1			
CNYUSD	0.0293 (0.3652)	0.0289 (0.3719)	**-0.1988*** (0.0000)	**-0.2133*** (0.0000)	**0.2398*** (0.0000)	1		
ALSI	**-0.1048*** (0.0012)	**-0.0757**** (0.0189)	**0.1166*** (0.0003)	**0.0746**** (0.0208)	**-0.1479*** (0.0000)	**0.0595***** (0.0655)	1	
ILLQ	**-0.3247*** (0.0000)	**-0.6157*** (0.0000)	**0.2735*** (0.0000)	**-0.0925*** (0.0041)	**0.1079*** (0.0008)	-0.0339 (0.2935)	0.0034 (0.9165)	1

*(Where: *1%, **5% and ***10% significance levels and the [p-values are in parentheses()])*

Results from the correlation analysis show that none of the variables were highly and statistically significantly correlated; suggesting that each of the variables likely had a unique contribution in the export demand function. This meant that there was no multicollinearity amongst the variables employed in the econometric analysis. However, further tests of the integration order of the variables was required before the panel data analysis could be undertaken, and this meant undertaking panel unit root tests.

6.4.2 Panel Unit Root Tests

Panel unit root tests were undertaken as required by the PMG model to ensure that the panel did not possess more than one unit root. The panel unit root tests were conducted using the Im-Pesaran-Shin (IPS), Levin, Lin and Chu, ADF and PP unit root tests for stationarity. All the stationarity tests were undertaken with a null hypothesis which assumed a unit root process while the alternative hypothesis charged that the panel was stationary. The results from the panel unit root tests are displayed in Table 6.5 where the first two columns display results for the panel of exports to the world firstly disaggregated into twenty product categories (“20 Cross-sections”) and secondly, into five product categories (“5 Cross-sections”).

Table 6.5: Panel Unit Root Tests

Panel Unit Root Test	WORLD (20 Cross-sections) t-stat	WORLD (5 Cross-sections) t-stat	CHINA t-stat	GERMANY t-stat	JAPAN t-stat	UK t-stat	USA t-stat
Levin, Lin & Chu t*	-4.5909*	-4.4717*	-1.88939**	0.81401	-2.76060*	2.57051	-3.32136*
Breitung t-stat	-2.9281*	-1.7677**	-2.03043**	-1.38727***	-2.01537**	-2.11960**	-0.38230
Im, Pesaran and Shin W-stat	-6.87853*	-4.2666*	-4.94668*	-2.95905*	-6.86027*	-4.52190*	-7.56456*
ADF - Fisher Chi-square	132.554*	39.5155*	48.3680*	26.8702*	64.1618*	44.4679*	78.6530*
PP - Fisher Chi-square	846.296*	223.4090*	114.447*	122.000*	204.085*	203.620*	222.727*

*(Where: *1%, **5% and ***10% significance levels and t-stat is the Test Statistic)*

Results from the unit root tests strongly suggested that all the balanced panel data models were stationary. This crucially meant that the PMG model could be validly applied to the dataset since none of the integration orders exceeded one unit root. After establishing that the panel data models were stationary, regression analysis using the PMG ensued. The following section details the results obtained from the PMG model.

6.4.3 Pooled Mean Group Analysis

The PMG model was applied on total product exports to the rest of the world between January 2004 and December 2019; beginning with exports to the world by twenty product categories before analysing them in the five categories. After analysing exports to the world in section 6.4.3.1, the panel data analysis was extended to product exports to the five trading partners whose results are presented in section 6.4.3.2.

6.4.3.1 Product Exports to the World

Table 6.6 summarises the results obtained from the PMG models of product exports to the rest of the world. In that table, Section A displays the summary results of the short-run coefficients and error correction terms while Section B of the table shows the long-run coefficient estimates. Since the PMG assumes a short-term heterogeneity and a long-term homogeneity, the individual product cross-section short-run coefficients were obtained. In Section A of the table the column “20 Products” shows the pooled short-run coefficients where the panel had twenty cross-sections on products that are listed in Appendix A1. In contrast, the “5 Categories” column shows the pooled short-run coefficients when the panel had five cross-sections of product categories as given in Table 6.2. the remaining columns of the table display the short-run coefficients of the five product categories: Agriculture, Chemicals, Manufactures, Resources and Others.

In Table 6.6, the first row of Section A shows the pooled short-run coefficients where, the column of the “20 Products” highlight that export lags dominated current export variability in the short-run; this remained similar with the pooled short-run coefficients for “5 Categories”. This observation was replicated across the cross-section short-run coefficients of the five sectors which could be interpreted as the existence of a short-run relationship between exports and their own lags whose influence declined with each lag. The observation was similar with what was observed in Table 3.7 of Chapter 3 where the PMG on total exports to regions was examined. This reaffirmed that future short-run export growth was contingent on current exports, meaning that for South Africa to realise increased future exports, policy makers must ensure that the current export share does not diminish.

Table 6.6: Short-run Model – Product Exports to the World

Section A: Short-run Coefficients							
	Pooled Short-run Coefficients		Cross-section Short-run Coefficients				
Variables	**20 Products**	**5 Categories**	**Agriculture**	**Chemicals**	**Manufactures**	**Resources**	**Others**
Export Lags							
D(EXPORTS(-1))	**-0.3676***	**-0.3855***	**-0.1356***	**-0.5902***	**-0.2704***	**-0.5448***	**-0.3866***
D(EXPORTS(-2))	**-0.2797***	**-0.2575***	**0.0047***	**-0.4119***	**-0.3450***	**-0.3006***	**-0.2349***
D(EXPORTS(-3))	**-0.0846***	-0.0317	0.1484	**-0.1551***	**-0.0827***	**-0.0564***	**-0.0129*****
Economic							
Foreign Income	**0.1034****	0.0242	**-0.0567*****	**0.1099****	**0.0362***	**0.1810***	**-0.1495*****
Relative Prices	-0.1733	-0.1802	0.2072	**-0.6807****	-0.3873	**-0.5190***	0.4788
Exchange Rates							
Exchange Rate Volatility	0.0018	0.0022	**0.0019***	**0.0027***	**0.0048***	**0.0145***	**-0.0131***
ZARUSD Volatility	-0.0049	-0.0028	**0.0031***	**-0.0079***	**-0.0056***	**0.0068***	**-0.0106***
CNYUSD Volatility	-0.0006	-0.0020	**-0.0022***	**-0.0073***	**-0.0006***	**-0.0016***	**0.0017***
Financial							
Stock Market Volatility	**0.0104***	**0.0122***	**0.0097***	**0.0091***	**0.0167***	**0.0033***	**0.0221***
Stock Market Illiquidity	**0.5113***	**0.2842***	**0.2348*****	**0.5091****	**0.3895*****	**0.3035****	-0.0157
Intercept Term	-0.2203*	**1.2335***	0.9811*	1.1941*	1.6747*	0.6909*	1.6269*
Error Correction Term	**-0.220915***	**-0.2240***	**-0.180455***	**-0.2223***	**-0.2895***	**-0.1105***	**-0.31702***

Section B: Long-run Coefficients		
Variables	**20 Products**	**5 Categories**
Economic		
Foreign Income	**0.277453***	**0.297107***
Relative prices	**-0.972158***	**-0.802863***
Exchange Rates		
Exchange Rate Volatility	0.032336	0.037778
ZARUSD Volatility	**0.050390****	**0.062934*****
CNYUSD Volatility	-0.009289	-0.008010
Financial		
Stock Market Volatility	**-0.097160***	**-0.114904***
Stock Market Illiquidity	**-4.816798***	**-4.682449***

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

Short-run coefficients of the real economic variables, foreign income and relative prices, suggested that the former real economic variable was more influential across the cross-section of product categories. In one hand, foreign income was significant in the pooled twenty products but not pooled five categories and this variation was

evident amongst the individual product categories where it was significant in all the demand functions. On the other hand, Relative prices were not significant in neither pooled short-run models but were significant for Chemicals and Resources. Exchange rate volatility and third-country effects were not significant in the pooled short-run models but were significant in all the individual product categories. These results concurred with those obtained in Chapter 3 which suggested that exchange rate volatility and third-country effects tended to affect exports in the short-run and not necessarily in the long-run; however, where significant, their coefficient estimates show that their impact on product-level exports was not large.

The financial economic factors of stock market volatility and stock market illiquidity were significant in both pooled short-run models (five and twenty product categories). Their significance was also observed across the product categories except for Others where illiquidity was not significant. The coefficients on illiquidity suggested manufactured output (Manufactures and Chemicals) were most responsive to changes of this factor which implied that financial market participants were more sensitive to changes in the volume of manufactured goods compared to Resources and Agriculture in the short-run. In all short-run models, the statistically significant error terms suggested that there was a convergence to a long-run equilibrium relationship between exports and the variables employed in the model once deviations in the short-run occurred.

Importantly, error correction terms were significant and similar suggesting a convergence to a long-run equilibrium after deviations in the short-run. Specifically, the for the pooled “20 Products” cross-sections, the model suggested that there was approximately a 22.1% correction whilst the pooled “5 Categories” suggested a 22.4% return to equilibrium. As highlighted earlier, the key theoretical position of the endogenous growth model by Levine and Zervos (1996) was that the financial economy fosters long-term real economic growth. In addition, it was in this thesis’ interest to understand the long-term effects of financial economic factors on South African export growth. As such, it was imperative for this thesis to focus on the long-run relationships between exports and the real and financial economic factors. The long-run coefficients obtained from the PMG are displayed in Section B of Table 6.6.

The long-run coefficients for the economic factors of foreign income and relative prices were significant for both the “20 Products” and “5 Categories” cross-sections with the expected signs. Foreign income in the “20 Products” column suggested a percentage increase of foreign income was associated with a 0.28% increase in exports while a similar change of foreign income was predicted to increase exports by approximately 0.3% for the “5 Categories” column in the long-run. Further, the results obtained suggested that a percentage increase of relative prices was estimated to lower exports in the long-run by 0.97% and 0.80% under “20 Products” and “5 Categories” columns respectively. There was consensus from the two columns that an increase in foreign incomes of trading partners meant that exports would be boosted in the long-run whilst a decline in the relative cost of South African exported products increased exports in the long-run. While foreign incomes may be beyond the influence for South Africa’s trade policy, relative prices which affect the cost of South African goods can be influenced by relevant monetary policy.

These results complemented the findings in Chapter 3 which employed the ARDL on world exports and subsequently used the PMG on exports to world regions (Africa, America, Asia and Europe) where it was established that a percentage increase of foreign incomes in those regions raised South Africa’s exports by 0.43% in the long-run and a one percent increase of relative prices increased exports by 0.78%. These results were reconcilable with findings by Todani and Munyama (2005), Sekansti (2011) and Wesseh and Niu (2012) after analysing South Africa’s exports to the world, the USA and China respectively. In addition, they were reconcilable with the position taken by Schaling (2007) and Fowkes *et al*. (2016) who stated that South Africa’s price level should be part of the trade policy by ensuring that the price level did not rise faster than those of key trading partners to maintain competitiveness.

Factors from exchange rates suggested that only the exchange rate volatility between the US Dollar and the Rand was significant and positive. This observation suggested that in the long-run South African product exports to the world were not hindered by exchange rate volatility. This means that South Africa’s trade policy should not be concerned with the volatility of the Rand in the long-term because the volatility did not inhibit export growth in the long-term and as such, attempting to manage the Rand’s

volatility would not bring any meaningful benefits towards boosting export growth. This was consistent with the findings made in Chapter 3 as well as South African studies conducted by Todani and Munyama (2005), Nyahokwe and Ncwadi (2013) and Wesseh and Niu (2012) who established the effect of exchange rate volatility on South Africa's exports to be weak or undetectable. In addition, Fowkes *et al*. (2016) arrived at a similar recommendation after analysing South Africa's exports.

The statistically significant coefficients of the financial economic factors of stock market volatility and stock market illiquidity suggested that the financial economy was indeed important for exports in the long-run. Increased stock market volatility discouraged exports to the world in the long-run whilst increased illiquidity was associated with a decrease of South African export quantities to the world in the long-run. The observation on these two factors was replicated on both twenty and five cross-sections which confirmed this study's hypothesis that higher liquidity costs and increased stock market volatility discouraged exports. Further, the findings on the long-run coefficients of the financial economic variables from the PMG in Table 6.6 dovetailed with those obtained by Chapters 3, 4 and 5 notwithstanding the varied methods of analysis. The results were also consistent with the endogenous growth theory by Levine and Zervos (1996) together with Giannellis and Papadopoulos (2016) and Fufa and Kim (2018) who have subscribed to this theory.

6.4.3.2 Product Level Exports to Key Trading Partners

The PMG estimates on product exports to the key trading partners are summarised in Table 6.7 where, Panel A shows the pooled short-run coefficient estimates and error correction terms while panel B displays the long-run coefficients.[8] The pooled short-run coefficients showed that coefficients of export lags to Germany, UK and the USA were the only partners where current export levels were influenced by previous exports. The short-run coefficients of foreign income were only significant foe China and the USA where, they were associated with increased exports in the former and decreased exports in the latter. The signs and sizes of the coefficients suggested that

[8] The sector-level heterogeneous short-run coefficients are presented in full in appendix A2.

the influence of the factor was miniscule in the short-run and tended not to exert a large influence on export quantities.

Relative prices were significant for all export demand functions except for China; signs on these coefficients suggested that exports to these trading partners increased in the short-run regardless of an increase in the relative prices. In addition, exchange rate volatility exhibited a short-run positive relationship with exports to all trading partners except the UK; however, the volatility between the Rand and Pound had a short-run negative coefficient. The exchange rates between the Rand and the Japanese Yen as well as the dollar had negative short-run effects to product exports to these destinations. Short-run coefficients for the financial economic variables were not highly influential to the export categories to the trading partners. All the short-run models for export demand to the trading partners suggested the existence of a long-run equilibrium as suggested by the statistically significant error correction terms. The Japan export demand function had the highest readjustment to deviations in the short-run of approximately 56% towards a long-run equilibrium while the lowest readjustment was 23.8% for exports to China. This meant that the long-run model could be validly estimated for all export demand functions.

In line with this study's objective of ascertaining the influence of the selected macroeconomic variables on product exports to the trading partners, the long-run model was estimated. Panel B of Table 6.7 summarises the long-run coefficients for each of the export demand functions to the trading partners. The long-run coefficients for the traditional economic factors of foreign income and relative prices suggested that relative prices were more dominant in dictating exports in the long-run. Exports to the trading partners were more sensitive to the relative prices compared to what was observed in Table 6.6 because for all the export demand functions, a percentage increase of the relative prices resulted in a decrease of exports by greater than 1% in the long-run.

Table 6.7: Short-run and Long-Run Models – Exports to Trading Partners

Variables	China	Germany	Japan	UK	USA
Panel A: Short-run Coefficients					
Exports					
D(EXPORT(-1))	-0.2523	**-0.2881***	-0.2108	-0.1651	**-0.3059*****
D(EXPORT(-2))	-0.1410	**-0.218265***	-0.0398	**-0.1263*****	-0.1299
D(EXPORT(-3))	0.0237		0.0214		-0.0503
Real Economic					
Foreign Income	**0.0059****	-0.0020	0.0036	-0.0018	**-0.0059***
Relative Prices	4.1332	**4.7370*****	**11.2338***	**4.5882***	**5.7623****
Exchange Rates and third-country					
Exchange Rate Volatility	**0.0083*****	**0.0107***	**0.0189****	0.00302	**0.0138***
D(ZARCNY Volatility)	-0.0002	-	-	-	-
D(CNYUSD Volatility)	-0.0044	-	-	-	-
D(ZAREUR Volatility)	-	0.0001	-	-	-
D(CNYEUR Volatility)	-	-0.0009	-	-	-
D(ZARJPY Volatility)	-	-	**-0.0140***	-	-
D(CNYJPY Volatility)	-	-	0.0027	-	-
D(ZARGBP Volatility)	-	-	-	**-0.0280***	-
D(GBPCNY Volatility)	-	-	-	-0.0007	-
D(ZARUSD Volatility)	-	-	-	-	**-0.0165****
D(CNYUSD Volatility)	-	-	-	-	0.0037
Financial Economic					
D(Stock Market Volatility)	-0.0023	0.0021	0.0023	-0.0011	-0.0014
D(Stock Market Illiquidity)	0.2189	-0.2635	0.9231	-0.5302	**0.9369*****
C	3.15861**	3.121694*	5.678698*	5.653819*	4.8944*
Error Correction Term	**-0.238244****	**-0.267452***	**-0.559956***	**-0.530666***	**-0.4115***
Panel B: Long-Run Coefficients					
Real Economic					
Foreign Income	0.0026	**0.0128***	**0.0163***	0.0050	0.0050
Relative Prices	**-2.5013***	**-1.5785***	**-0.9020***	**-1.0632***	**-1.8199***
Exchange Rate and Third-country					
Exchange Rate Volatility	**-0.2847****	**-0.2397***	**-0.2398****	-0.0690	**-0.1679****
ZARCNY Volatility	0.0304	-	-	-	-
CNYUSD Volatility	0.0051	-	-	-	-0.0219
ZAREUR Volatility	-	0.0343	-	-	-
CNYEUR Volatility	-	-0.0167	-	-	-
ZARJPY Volatility	-	-	0.0542	-	-
CNYJPY Volatility	-	-	-0.0318	-	-
ZARGBP Volatility	-	-	-	**0.1062***	-
GBPCNY Volatility	-	-	-	0.0211	-
ZARUSD Volatility	-	-	-	-	**0.0639****
Financial					
Stock Market Volatility	-0.0166	**-0.0366****	**-0.0387*****	-0.0199	-0.0198
Stock Market Illiquidity	**-5.6972***	**-1.8481*****	**-3.2386****	**-2.6222***	**-3.2706***

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

Foreign income significantly influenced export quantities to Germany and Japan however, their coefficients suggested that a percentage increase of foreign incomes increased exports to those partners by 0.01% and 0.02% respectively. This meant that South Africa's exports to Germany and Japan rose as the two countries' incomes increased however, higher incomes in China, UK and the USA did not translate to more exports to those countries which meant their demand may be limited in the long-run.

The negative relationships for exports to the trading partners and relative prices showed the price sensitivity of exports. The coefficients meant that higher relative cost of South African goods discouraged exports in line with this thesis' expectation. The implication of the findings on relative prices are that managing the price level can be an effective trade policy intervention to improve exports in the long-run especially considering that the trading partners were more sensitive to the price level compared to overall exports to the world as presented in Table 6.6. These findings on relative prices, which are similar to those obtained in Table 6.6 and Chapter 3, complement South African studies by Schaling (2007) and Fowkes *et al*. (2016) who earlier recommended that export competitiveness could be the most important factor that the existing trade policy ought to consider. The long-run coefficient estimates on the Rand's exchange rate volatility suggested that the volatility discouraged exports for all exports to the partners except for those to the UK. However, the bilateral exchange rate volatilities of the Pound and the Rand together with Dollar and Rand were significant and positive suggesting that higher volatility of between the Rand and these currencies was associated with more exports to these countries in the long-run.

A key consideration of this study centred on investigating and evaluating the financial economic impact on South Africa's exports. The long-run coefficients on stock market volatility and stock market illiquidity showed that the financial economy had an impact on South Africa's exports to its trading partners. With regards to exports to Germany and Japan, increased stock market volatility meant lower exports to these two trading partners. On the other hand, stock market illiquidity had a statistically significant long-run relationship with exports to all the trading partners. In line with the *a-priori* expectation, increasing liquidity costs on the market discouraged exports to all the

trading partners in the long-run. These results were reconcilable with those obtained from the PMG analysis in Chapter 3 as well as what was obtained in Table 6.6.

Results from the PMG showed that stock market illiquidity and volatility were negatively associated with exports and that this relationship was resilient regardless of the export destination. This observation, which was consistently shown by results in Chapters 3, 4 and 5 validated the proposals of the interrelationships between the real and financial economies. Although these findings are a major contribution, more could be understood about the export relationships by testing how they held at various levels or thresholds of a given risk factor. As motivated earlier, there is merit in considering that economic and financial relationships may be non-linear and this required models that consider asymmetries. Consequently, the study proceeded to analyse the export demand function in a panel threshold model.

6.4.4 Threshold Panel Data Analysis

Threshold panel data analysis afforded an opportunity to evaluate the export demand functions in a non-linear fashion because export relationships could be evaluated at various levels of a chosen state variable. The panel threshold model of Hansen (1999) tested the existence and optimal number of thresholds of a given state variable. The analysis began by evaluating the product export demand functions to the world before analysis on the five trading partners. In line with this study's objective to ascertain the effect of third-country effects and stock market illiquidity, these two factors were used as state variables. In addition, the factor of stock market volatility was added as a threshold variable after consideration of the endogenous growth theory. The results from the threshold panel data analysis on exports to the world are summarised in Table 6.8.

The threshold panel model was applied on South Africa's exports under both the "20 Products" panel with twenty cross-sections listed in Appendix A1 and "5 Categories" panel which had five cross-sections of product categories as given in Table 6.2. In Table 6.8 the threshold variables were the volatility between the Dollar and the Yuan (third-country effects), stock market volatility and stock market illiquidity. The results

obtained, which were reconcilable with those obtained from the PMG's long-run model coefficients in Table 6.6, established the existence of thresholds in addition to the long-run relationships.

Table 6.8: Threshold Model Regression of Product Exports to the World

	20 Products			**5 Categories**		
	Threshold Variables			Threshold Variables		
	CNYUSD Volatility	**Stock Market Volatility**	**Stock Market Illiquidity**	**CNYUSD Volatility**	**Stock Market Volatility**	**Stock Market Illiquidity**
Below Threshold	***t*** ≤ 2.0537	***t*** ≤ 1.2607	***t*** ≤ 0.0409	***t*** ≤ 1.6959	***t*** ≤ 1.2607	***t*** ≤ 0.0409
Coefficient	-0.0015	**-0.0371***	**-1.0395****	-0.0015	**-0.0374***	-0.35745
Between Thresholds	-	1.2617 < ***t*** ≤ 1.4475	0.0409 < ***t*** ≤ 0.0486	-	1.2607 < ***t*** ≤ 1.4475	0.0409 < ***t*** ≤ 0.0486
Coefficient	-	**0.0224*****	**-3.8668***	-	**0.0324*****	**-3.1737***
Above Threshold	***t*** > 2.0537	***t*** > 1.4475	***t*** > 0.0486	***t*** > 1.6959	***t*** > 1.4475	***t*** > 0.0486
Coefficient	**-0.0529***	-0.0051	**-2.1453***	**-0.0396***	-0.0105	**-1.7260***
Long-Run Coefficients						
Real Economic						
Foreign Income	**0.4457***	**0.4437***	**0.4268***	**0.3996***	**0.4042***	**0.3888***
Relative Prices	**-1.1484***	**-1.1541***	**-1.0875***	**-1.0423***	**-1.0467***	**-0.9844***
Exchange Rates						
EXCH	**0.0385***	**0.0436***	**0.0458***	**0.0359***	**0.0409***	**0.0424***
ZARUSD Volatility	**0.0308***	**0.0330***	**0.0376***	**0.0357***	**0.0367***	**0.0401***
CNYUSD Volatility	-	**-0.0051*****	**-0.0071****	-	**-0.0075*****	**-0.0095****
Financial Economic						
Stock Market Volatility	**-0.0282***	-	**-0.0256***	**-0.0289***	-	**-0.0268***
Stock Market Illiquidity	**-2.4873***	**-2.5170***	-	**-2.2491***	**-2.2197***	-
Constant	5.0352*	5.0682*	4.8741*	5.8031*	5.7786*	5.5809*
R^2 Within	0.6255	0.6258	0.6377	0.7401	0.7409	0.7561

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

The results show that when the threshold variable was the volatility between the US Dollar and the Chinese Yuan, only one threshold was optimal; this remained the case for both twenty products and five product categories. The implication was that there were two regions where the relationships held; a lower exchange rate volatility and a

higher exchange rate volatility region. However, only the coefficient above the threshold was statistically significant which implied that the volatility was negatively impacting South African total exports when it increased. The implication of this observation was that as the volatility between the Chinese and American currencies increased, South Africa's exports would decline in the long-run. The results also suggested that since the USA and China are the global leaders of international trade, stability of their currencies was paramount for increased South African trade in the long-run.

Where the threshold variable was stock market volatility, two thresholds were established which suggested the existence of three regions around the threshold where the relationships could be analysed. However, the coefficients for the thresholds showed that volatility tended to be significantly impactful below the lower threshold and between the higher and lower thresholds. This meant that stock market volatility impact on real export output tended to wane as it became too high; where, it no longer reflected the actual underlying real economic activity. There was evidence to suggest that stock market illiquidity as the threshold variable had two statistically significant thresholds; under the twenty product panel data analysis all three regions were significant, but these became two when the panel data model had five export categories. The coefficients showed that illiquidity exerted a more negative impact on South Africa's exports to the world as illiquidity in the stock market worsened. The significance of illiquidity suggested the robustness of this factor but also suggested that the grouping of exports by sector may have an influence on the observed relationships.

The long-run coefficients tended to remain consistent regardless of the choice of the threshold variable. The real economic variables of foreign income and relative prices confirmed the expectation that increased foreign incomes and lower relative prices improved export prospects. This strengthened the position espoused by Fowkes *et al*. (2016) that managing the South Africa's price level could be a favourable policy position to boost exports in the long-run. The observation around exchange rates suggested that the Rand volatility together with the exchange rate between the Rand and the US Dollar had a positive long-run relationship with South Africa's exports. The

exchange rate volatility between the US Dollar and the Chinese Yuan had negative long-run relationships with South Africa's exports suggesting the existence of the third-country effects phenomenon.

The financial economic factors of stock market volatility and stock market illiquidity exhibited a long-run negative relationship with South Africa's exports as expected. This meant that adverse stock market conditions were associated with poorer export performance for South Africa in the long-run which is in line with the finance-growth hypothesis as well as the endogenous growth theory. These observations were consistent and reconcilable with those established by the PMG in Tables 6.6 and 6.7. In addition, this finding makes a novel contribution by illustrating that not only are financial economic factors significant in explaining South African growth, their relationship remained robust across a cross-section of export categories where; lower stock market volatility and illiquidity harboured South Africa's long-run economic growth. Panel threshold analysis was extended to the five trading partners. However, after testing for the existence of threshold effects of the factors of interest as in Table 6.8, only export demand functions to China and the USA had statistically significant threshold effects. The non-existence of threshold effects for all the other export demand functions meant that a fixed effects panel would suffice, but since the PMG was already estimated, it was no longer essential to estimate the fixed effects panel. Table 6.9 summarises the results for the significant threshold effects on export demand functions to China and the USA.

The Chinese export demand function only had exchange rate volatility as the significant threshold variable with one significant threshold. It showed that at the higher level of exchange rate volatility, it decreased exports to China in the long-run; however, below the threshold, exchange rate volatility had no relationship with exports at all. Only the real economic factor of relative prices was significant and negative which meant that declining cost of South African goods on the market boosted exports in the long-run. Stock market illiquidity was shown to have a negative impact on exports in the long-run, however, stock market volatility was not significant.

Table 6.9: Threshold Model Regression of Product Exports to Countries

	China	**USA**	
	Threshold Variable	Threshold Variables	
	Exchange Rate Volatility	**Exchange Rate Volatility**	**CNYUSD Volatility**
Below Threshold	***t*** ≤ -0.9044	***t*** ≤ -1.9373	***t*** ≤ 1.9853
Coefficient	0.0268	**0.0472***	-0.0099
Between Thresholds			1.9853 < ***t*** ≤ 1.3442
Coefficient			**-0.0905***
Above Threshold	***t*** > -0.9044	***t*** > -2.5904	***t*** > 1.3442
Coefficient	**-0.0545***	**-0.0193****	-0.0053
Long-run Coefficients			
Real Economic			
Foreign Income	-0.0047	-0.0022	-0.0019
Relative Prices	**-1.1428***	**-1.0939***	**-1.1122***
Exchange Rates			
Exchange Rate Volatility	-	-	-0.0045
ZARCNY Volatility	-0.0054	-	-
CNYUSD Volatility	-0.0018	-	-
ZARUSD Volatility	-	-0.0093	-0.0007
CNYUSD Volatility	-	-0.0067	
Financial Economic			
Stock Market Volatility	-0.0050	**-0.0148***	-0.0091
Stock Market Illiquidity	**-1.7799****	-0.5715	-0.4814
Constant	10.76159*	10.81837*	10.84681*
R2 Within	0.2125	0.3114	0.3059

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

There was evidence from the results to suggest that South Africa's exports to the USA showed that the Rand volatility and the third-country effects of the exchange rate between the Chinese Yuan and the US Dollar had statistically significant threshold effects. The threshold coefficients of exchange rate volatility in the USA export demand function showed that the effects of exchange rate volatility exerted a more negative influence on exports as the volatility increased. However, the third-country effects were negative between the two thresholds while not significant on either ends of the two thresholds. Relative prices were significantly affecting exports to the USA, but foreign income was not significant. The other significant factor was stock market volatility which was only significant when the Rand exchange rate volatility was the threshold variable.

The results from the threshold panel data models indicated that threshold effects were more significant when the product-level exports to the world were analysed as opposed to individual trading partners. In addition, the threshold effects suggested the exchange rate volatility and third country effects tended to affect exports above the higher threshold. According to the threshold model, this meant that exports would get affected if the volatility drastically increased; hence, South Africa's exports would benefit in the long-run if exchange rate volatility was lower. There was evidence to suggest that increased volatility between the Chinese and American currencies was detrimental towards South Africa's exports in the long-run which meant that stability for the two currencies was paramount for increased exports. The findings on the threshold effects of stock market illiquidity and volatility showed that financial market stability was important for South Africa's exports in the long-run. Both financial economic factors had two thresholds which showed the pervasiveness of these factors.

6.5 Summary and Conclusion

In line with this chapter's research objective, a cross-section of product category exports to the world and to trading partners was analysed. The study addressed a research gap in existing studies by introducing the financial economic variables of stock market volatility and illiquidity based on the endogenous growth theory to export category analysis. In addition, it tested for the existence of threshold relationships in the cross-section of exports to better understand the pervasiveness of the financial economic variables. Both the PMG's short-run and long-run models showed that South African product-level exports to the world were negatively impacted by both stock market illiquidity and stock market volatility. The findings confirmed the symbiotic relationship between the real and financial economies as earlier suggested by Levine and Zervos (1996). This relationship was further confirmed by the threshold panel data analysis which showed improving liquidity and declining volatility positively impacted long-run export growth.

The negative relationship of the financial economic variables and exports showed that deteriorating liquidity and increasing volatility on the JSE was associated with poorer

exports. This observation was reconcilable with similar studies by Kayacetin and Kaul (2009), Næs *et al*. (2011) and Kim (2013) and Matthee, Rankin, Webb and Bezuidenhout (2018) who found that stocks of firms with poorer prospects tended to decline in liquidity once investors became aware of the impending negative outlook. In addition, this chapter showed that the popular real economic factors of foreign income and relative prices were the most consistent factors influencing export behaviour across a range of export categories. Between the two popular economic variables, relative prices were the most consistent factor, consequently, policy makers ought to ensure product exports are priced competitively in the market (Fowkes *et al*., 2016).

The results obtained on the coefficients for exchange rate volatility and third-country effects were not consistently significant which suggested that policies aimed at stabilising the Rand's volatility maybe may not have a tangible result towards boosting South Africa's exports in the long-run. It is important to note nonetheless, that there were some threshold effects of exchange rate volatility which suggested that this variable may have some negative impact of exports. However, the exchange volatility factors did not dominate or consistently exhibit strong relationships with exports from the evidence in this chapter. This means that a while a reduction in the volatility of the Rand may seem desirable, policies aimed at stabilising the Rand may not yield any meaningful benefits towards export growth.

The findings around the financial economic variables imply that policy makers ought to be cognisant of the financial economic developments because that have a long-term effect on South African export growth. There are potential long-term export growth benefits from formulating polices that are aimed at reducing liquidity costs for investors while stabilising the financial markets. These findings are an essential contribution to South African economic discourse and the country attempts to chart a path forward to sustainable economic growth.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

After identifying a research gap on the modelling of South African export growth, this thesis analysed South Africa's exports, primarily motivated for due to this economic variable being a potential source for stimulating economic growth in South Africa. Economic growth is a key area for study as it remains subdued; the prediction by Fedderke and Mengisteab (2017) that South African economic growth was to remain subdued below 1% per annum for the foreseeable future remains true. Recently, the SARB (2020) disclosed that in the first quarter of 2020, annual GDP growth had contracted by 2% with an expectation of that trend continuing into the third quarter of 2020. These economic growth statistics which are being exacerbated by the COVID-19 pandemic whose negative effects include disruption of labour markets, supply chains and consumption behaviour is still unravelling. The DTI (2019) acknowledged that domestic growth was significantly below the target of 5.4% per annum as required by the NDP – a particularly pertinent issue in a country already in the throes of high unemployment and non-performance of key SOEs such as Eskom and South African Airways which require financial bailouts within a limited fiscal space. These set of circumstances made analysing South Africa's exports, a key avenue for economic growth, an urgent consideration because improving exports will help the country extricate itself from depressed economic growth in the long-run.

A preliminary analysis of South Africa's exports showed that although they had high nominal growth over the study period considered, the contribution of these exports towards South Africa's economic growth (as measured by GDP) had remained largely constant, averaging 5.6% per annum with a standard deviation of 0.65%. Further, South Africa's share of global trade was shown to be on a decline; highlighting a worrying trend in South Africa's foothold in international trade. Significantly, these proportions are against the backdrop of South Africa maintaining a trade policy which is specifically centred on export growth contributing more towards real economic growth. Erstwhile literature analysing South African trade and export behaviour primarily focused on factors emanating from the real economy as explanatory

variables in export demand functions; something reconcilable with the export-led growth and growth-led export propositions.

The empirical focus on real economic variables however, had a consequence of leaving a gap in knowledge with regards to the impact and relationships that the financial economy had with South Africa's exports in both the short-run and long-run. The reason that the exclusion of the financial economy was identified as a potentially relevant and consequential gap to the South African export growth context was motivated by consideration of the endogenous growth theory propounded by Levine and Zervos (1996). This theory postulates that the depth of a stock market fosters long-run economic growth because it facilitates efficient allocation of resources, capital accumulation and technological innovation. In addition, investors tended to change their portfolio holdings in accordance with business cycles, or in anticipation of future real economic output with studies such as Kim (2013) noting that declines in real output was associated with a decline in stock market liquidity. Therefore, it was reasonable to expect some relationship between South Africa's exports and the financial economy in the long-run; although this relationship was not yet known. Addressing this gap and contributing to the understanding of South Africa's exports and their relationship with the financial economy is subsequently one of the key original contributions that this doctoral thesis makes.

In addition to real economic variables, existing South African studies tended to consider exchange rate volatility as the main factor of importance; however, it had previously proved to be an unreliable explanatory variable in export demand functions which had led to the exchange disconnect puzzle phenomenon. The view of exchange rate volatility which took hold after the collapse of the Bretton-Woods system of fixed exchange rates, influenced studies to view exchange rate volatility as a central factor influencing international trade but this thesis' review showed mixed empirical results, confirming what previous authors have noted about the unreliability of this variable as a core explanation of export behaviour – even when more nuanced empirical models were employed. This observation made by this thesis after employing multiple econometric models was an important contribution to the discourse because it showed

that exchange rate volatility was not supposed to be a concern when crafting South African trade policy.

The lack of reliability of exchange rate volatility resulted in a research gap which more recent international literature proposed to fill by considering third-country effects. Consequently, this thesis considered third-country effects as additional variables which was an area South African studies tended to overlook. By accounting for third-country effects, this thesis made a significant contribution to the modelling of South African export demand. However, third-country effects (which were formulated from exchange rate volatilities of trade competitors) were shown to be varied amongst exports to the trading partners and needed to be analysed per scenario. These observations were significant as it showed that exchange rate volatility effects were not highly consequential in South Africa's exports determination. This was further evidence supporting the position that policy makers may not need to extensively invest in managing exchange rate volatility because the Rand leveraged firms were able to manage their own exchange rate exposure (Aye *et al*., 2015).

In addition to the gap of overlooking the financial economy, it was noted that extant literature on South Africa's exports tended to rely on linear modelling techniques, neglecting to account for non-linearity in the data, which has been known to be a characteristic of various macroeconomic relationships. The assumption of linearity of economic relationships was viewed as a potential source of model risk and latter South African studies such as Aye *et al*. (2015) and Ajmi *et al*. (2015) alluded to the fact that business cycles cause non-linear behaviour for economic variables which would likely cause asymmetric reactions to positive and negative shocks. The phenomenon of non-linearity and regime-switching was expected because Bergholt, Larsen and Seneca (2019) had highlighted that commodity prices tended to fluctuate on the global market and South Africa's exports being dominated by resources, necessitated the use of models that accounted for non-linearity.

Recognising the truth of this, this thesis consequently considered the modelling of South Africa's exports in a more comprehensive and exhaustive fashion – specifically seeking to address this gap by accounting for non-linearity and utilising various

econometric models which allow for asymmetries to be described. To this end, Chapters 4, 5 and 6 methodically addressed non-linearity in an exhaustive fashion. Chapter 4 focused on short-run, long-run and location asymmetries of export relationships to establish the effects of the select real and financial economic variables. In chapter 5, non-linearity was accounted for by considering business cycle influences captured through regime-switching and threshold models. Lastly, Chapter 6 accounted for no-linearity by considering threshold effects on product and sector-level exports to the world and to trading partners. This analysis was in line with this thesis's topic of modelling South Africa's exports with a focus on third-country effects and stock market liquidity.

While Chapter 3 employed the ARDL and PMG models which were linear, it provided the required foundational background to making the contribution of analysing financial economic factors and third-country effects on exports while providing a lead-in for the non-linear analysis which provided a more nuanced comprehension of South African export behaviour. Chapter 4 which employed two non-linear models, namely the NARDL for short-run and long-run non-linear relationships and the QARDL for accounting for quantile or location asymmetries. These two models made significant contributions by showing the existence of an asymmetric relationship of exports mainly with the financial economic variables and the QARDL highlighted that the location asymmetries occurred mainly in the short-run. The Markov-Switching and threshold models employed in Chapter 5 cater for non-linearity arising from business cycle influences after considering that economic relationships tended to change their mean and volatility in varying stages of the business cycle. The results from both the Markov-Switching and threshold models, which confirmed non-linear behaviour, showed that the financial economic factors of stock market volatility and illiquidity tended to have a negative relationship with exports which strengthened when the business cycle was in the decline phase.

Lastly, Chapter 6 employed the panel threshold regression model in addition to the PMG to analyse product-level and sector-level export demand. After the PMG's results complemented the expected long-run and short-run relationships between exports and the real and financial economic variables, the threshold panel data model significantly

contributed by establishing statistically significant threshold effects on product-level exports which showed that improving liquidity and declining volatility positively impacted long-run export growth on a cross-section of products and sector-level exports.

After analysing total as well as product-level exports to the world and to five major trading partners namely: China, Germany, Japan, UK and the USA, results obtained by this thesis strongly suggested that stock market volatility and stock market illiquidity significantly affected South Africa's exports in both the long-run and the short-run. The relationships for these two financial economic variables showed that an increase in volatility and an increase in illiquidity on the stock market were associated with a deterioration of exports, meaning; a stable financial market and high stock market liquidity galvanised export growth. The findings were reconcilable with the proposition that stock market depth is an anchor for long-term economic growth because although these two financial factors were significant in the short-run, they tended to be more dominant in the long-run relationships.

7.2 Review of Research Objectives and Contribution of the Study

Addressing gaps in existing South African studies which emanated from issues relating to overlooking of the financial economic variables, usage of linear methodologies and the exchange disconnect puzzle helped achieve this thesis's research objectives. Achieving the research objectives of this thesis contributed to existing knowledge on the subject of export growth and behaviour in the South African context. Importantly, it provided ideas on improving South Africa's trade policy in an environment where economic growth remains subdued.

The section below summarises the research objectives and how the results obtained addressed specific gaps in the literature and contributed to existing knowledge, and a deeper understanding of South Africa's exports.

Objective 1. To investigate short-run and long-run relationships and analyse symmetric or asymmetric responses of exports to shocks of exchange rate volatility, third-country effects and stock market illiquidity.

Achieving this first objective made a novel contribution by incorporating financial economic variables of stock market illiquidity and stock market volatility into South African export demand functions. The thesis found that not only were the financial economic factors significant, they possessed asymmetric relationships with exports where, worsening stock market liquidity and volatility had a more negative impact on exports compared to improving stock market liquidity and volatility of the same magnitude.

In addition, there were location asymmetries particularly in the long-run; exports in the lower quantiles were more affected by illiquidity and stock market volatility compared to exports in the higher quantiles. The novel findings on the financial economic variables were robust as they held under both linear and non-linear methods of analysis. These observations were profound because they showed that deteriorating financial economic conditions did weigh negatively on South Africa's export prospects. These results were essential considering the reasonable expectation that real economic output is expected to be subdued, thus, financial economic impact on the real economy could become more amplified. There is scope to refine South Africa's current trade policy whose current focus revolves around searching for new trade opportunities and partnerships, reducing tariffs, maximisation of existing partnerships and the financing of trade-enabling infrastructure (Economic Development, 2011). The need for South African trade policy refinement was recently highlighted by Udeagha and Ngepha (2020) who motivated for enhancement through the financing of new investment and improvement of financial institutions and enhancement of technological skills.

This thesis' proposed policy refinement is that South Africa's trade policy should focus on further enhancement of the financial economy because Chapter 3 and 4 respectively showed long-run and asymmetric effects of the financial economic variables on export; Chapter 5 proved that these factors remained consistently

affecting exports during business cycles while Chapter 6 found them to be consistent on a cross-section of product categories. The findings on asymmetric effects suggested that the negative effects of financial economic variables weighed more negatively than positive effects of a similar magnitude and showed their pervasiveness. This evidence overwhelmingly supported the enhancement of the trade policy to consider the impact of stock market stability and liquidity in the long-run.

The findings suggested that it was more likely that domestic financial and capital markets may have a more profound effect on the ability to export as opposed to risk arising from a volatile exchange rate. Another contribution of this finding is that it provided a foundational background from which export growth may be modelled. Although a contribution was made on establishing the export relationships with both linear and asymmetric modelling, there was value in understanding the effects of business cycles and the nuances of the relationships from one export product category to the next. Unravelling these types of relationships gave further contextual information on how investors and market participants reacted to changes in export output.

Objective 2. To investigate the existence and significance of regime switches in the period of study and evaluate their effect on both aggregated and disaggregated South African exports.

The second objective of the study centred on investigating the existence and significance of regime switches in the period of study and evaluate their effect on both aggregated and disaggregated South African exports. Having noted that South African studies by Ajmi *et al*. (2015) and Aye *et al*. (2015) considered non-linear modelling of South African export behaviour and Pretorius and Botha (2007) found that the STAR model produced more accurate forecasts compared to purely linear models, this thesis employed the Markov-Switching and threshold regression models to assess the regime-switching effects.

While the Markov-Switching model showed that it was more likely for South African nominal export growth to continue on the high growth path, it showed that when

exports were in the low growth state stock market volatility was the main financial economic factor of concern. The threshold model to a greater extent, concurred with the findings of the Markov-Switching model by showing that the influence of the financial economy on exports tended to strengthen when South Africa's exports to the world deteriorated. These novel findings showed that long-term export growth had a relationship with exports and holders of Rand leveraged stocks changed their behaviour based on their assessment of the future of South African export growth. the threshold model showed that at higher thresholds of illiquidity, investors were more sensitive to changes of export output; this was complemented by stock market volatility when it was the threshold variable.

The findings on threshold modelling and the Markov-Switching model showed that South African export growth would be spurred if the financial markets were stable. This suggested that the issue of financial incentives that are focused on harbouring an export-orientated industry may play a crucial role in promoting South Africa's export growth in the long-run. After making the findings on regime-switching on aggregated South African exports, the thesis assessed their effects on disaggregated exports, and this required conducting a cross-sectional analysis using panel data modelling.

Objective 3. To undertake a cross-sectional analysis of both aggregated and disaggregated exports to evaluate the effect of illiquidity on long-run export growth.

The third objective of the study was concerned with undertaking a cross-sectional analysis of both aggregated and disaggregated exports to evaluate the effect of illiquidity on exports. To achieve this objective, panel data analysis was undertaken using the PMG and the threshold panel data model by Hansen (1999). Both the PMG and the threshold panel data model concurred on the original contribution of this thesis that stock market illiquidity and volatility had a negative long-run relationship with South Africa's exports. The PMG, which estimated a short-run model, showed that regardless of the product categories having heterogeneity, the financial economic factors were consistent. Similar to the aggregated exports, the panel threshold model concurred that at higher thresholds of the financial economic variables, exports

became more sensitive to changes of illiquidity and stock market volatility. These original findings on modelling South African export growth strengthen the position that South Africa's trade policy must also be concerned with financial market developments in addition to focusing on the price level. This thesis' findings on exchange rate volatility were reconcilable with the position taken by Meniago and Eita (2017) who suggested that the impact of exchange rate volatility on South African trade was minimal; implying that interventions to reduce the volatility, it would be of little value.

Although all models supported the view that the financial economic variables had a strong relationship with exports, especially in the long-run, results on exchange rate volatility and third-country effects were not highly consistent. Although the Rand's volatility tended to be negatively associated with exports when it was significant, third-country effects tended to vary and dependent upon the export demand function being analysed. It was noted that the popular real economic factors of foreign income and relative prices were consistently positively related with South Africa's exports in the long-run. This observation was in line with the a-priori expectation of the study; they showed that higher incomes for trading partners and lower relative prices of South African goods had a positive impact on exports.

The contributions to knowledge made by this thesis are vital and relevant given the current state of dire economic growth prospects. Policy makers, investors and scholars stand to benefit from these contributions because, policy makers can use these findings to enhance the trade policy by incorporating the financial economic impact on exports in the long-run as well as understand the level of interventions by acknowledging asymmetries and business cycle influences. This thesis has laid the foundation for more comprehensive modelling of export growth by utilising the endogenous growth theory, the finance-led growth hypothesis and the feedback hypothesis in addition to the non-linear modelling to provide a framework through which the nuances of South African export behaviour can be better understood. Existing and potential investors of rand leveraged stocks are better informed on how performance of real economic output in the form of exports translate into illiquidity or volatility of their holdings as shown by the non-linear methods which accounted for

asymmetries and threshold effects; this impacts on whether they will be more enticed to increase or curtail investments given the current growth prospects South Africa has.

7.3 Conclusion and Recommendations

The findings made by this thesis indicate that South Africa's exports are sensitive to changes of both real and financial economic variables, and these findings are validated by results from linear and multiple non-linear methodologies. This is a novel finding that has huge significance in the South African context. Significantly, this thesis has validated the endogenous growth theory and the finance-growth hypothesis previously overlooked by related studies. In addition, they give credence to the likelihood of the feedback hypothesis presented in section 2.2.3 which suggests that since stock market depth is an indispensable aspect of economic growth, there must be an interrelationship between economic growth and stock market depth which is bidirectional in nature (Hou and Cheng, 2010; Cheng, 2012 and Pradhan *et al*., 2019). Further, the findings made in this thesis align with the observations made by Matthee *et al*. (2018) who found that in South Africa, highly productive firms with prospects of producing real output would attract more institutional investment which would increase the stock's liquidity whilst poor real performance would reduce liquidity. It was noted that several relatable international studies analysing stock market behaviour and the real economy which include Ogunmuyiwa (2010), Kim (2013) and Holmes and Maghrebi (2016) found economic growth as measured by GDP to be positively impacted by liquidity in the stock market in Nigeria, South Korea, and the USA while Kayacetin and Kaul (2009) found that aggregate stock market order flows contributed to forecasting changes in real industrial production in the USA.

While the findings on the real economic variables of foreign income, relative prices, stock market illiquidity and stock market volatility were expected, findings on exchange rate volatility and third-country effects were mixed. Exchange rate volatility where significant, had a negative impact on exports, however, relative prices were shown to have a more consistently negative impact on exports which meant that exports were more discouraged by the exchange rate level as opposed to the volatility itself. This

observation was echoed by third-country effects which suggested that the volatility of competitors was not a consistent factor on South Africa's exports.

The findings around exchange rate volatility were explained by the point that exporters tended to manage their own currency exposures. As markets have developed, managing exchange rate risk using operational and financial hedges has become common and more effective (Ito, Koibuchi, Sato and Shimizu, 2016). This was highlighted by Aye *et al*. (2015) who suggested that there was evidence that South African exporters employed various financial hedges to mitigate downside risk from currency movements. If the hedging was highly successful, export quantities were unlikely to be highly sensitive to exchange rate volatility, however, there was scope for the exports to be sensitive to the price level. This was complemented by the proposition made by Fowkes *et al*. (2016) that South Africa's current trade policy was supposed to be focused on trade competitiveness by ensuring that the growth of the domestic price level was similar to those of key trading partners. The results and the theoretical arguments against exchange volatility being a factor affecting exports led this thesis to conclude that South African policy makers ought to be concerned with the price level as opposed to the Rand's volatility.

Although South Africa's current trade policy is outward-looking and targets export growth with price stability, the exports have not contributed towards economic growth in a significant manner. This scenario motivated this thesis to suggest broadening the scope of the current trade policy to consider the financial economic factors because they have the ability to weigh negatively on exports. To that end, this thesis managed to show a clear negative relationship between illiquidity and volatility of the JSE and South Africa's exports to the rest of the world; which means the current policy can be bolstered by considering this thesis' findings on the financial economy. This is consistent with the trade policy's aim of remaining pragmatic and evidence based. Stock market liquidity galvanises both domestic and international financial flows hence, incentives into export promotion should be accompanied by more financial flow liberalisation to allow investors to withdraw capital investments when they decide to do so.

The financial economy has been shown to be linked with the real economy through both direct and indirect channels hence, when formulating an investment decision these must be considered. Although South African literature in this subject area put weight on exchange rate volatility as a major risk factor affecting export, this factor can be hedged against by firms through the use of various derivative instruments such as currency forwards, futures and options amongst others. In addition, hedging against an investment's illiquidity is often difficult to efficiently undertake. As such, investors are more concerned about liquidity risk in the capital market and this fact is confirmed by this thesis' findings which were suggestive of the fact that investors in South African rand hedged stocks were exposed to higher liquidity risk once exporting prospects diminished.

This means that when formulating export demand functions for South Africa, practitioners need to account for the financial economic variables as they capture the investor perspective on the real economic prospects. This consideration remains relevant because although South Africa has a relatively developed stock market compared to other emerging markets, its export share on the global stage has not accelerated. This thesis showed that there was value in modelling export demand functions using non-linear methods of analysis. The threshold models specifically highlighted that illiquidity costs increased when exports were close to their lowest levels compared to when they were at their highest levels. These findings were complemented by those of the non-linear ARDL model which showed negative effects to loom greater than positive effects. The key implication of this is that non-linearity must be given strong consideration if one is to model South African export demand functions. In addition, South Africa's exports can be enhanced under the current trade policy if exports were diversified by both sector and destination to mitigate the adverse effects of commodity price cycles (Botha and Schaling, 2020).

In conclusion, the findings made by this thesis can be summarised into three key implications. The first being that research on export behaviour and real economic factors in general, must consider the effects of the financial economy. This implication stems from the evidence showing that investors in financial markets had a vested interest in establishing the changing liquidity costs and increased risk on their

investments induced by diminishing exports and economic growth. The second implication for researchers and scholars is that non-linearity must be considered in export demand functions because they capture the nuances of export relationships during the different stages of the business cycle. Lastly, policy makers must be aware that South Africa's policy of boosting exports can be galvanised by ensuring that the ease of capital is incentivised into projects that increase exports to encourage investment into this sector.

7.4 Limitations and Areas for Future Research

Although this thesis made several original contributions to existing South African literature, there were some limitations that were encountered. One of the major limitations emanating from the novelty of the study was that the ability to make empirical comparisons with other South African studies was limited. The comparative analysis would have enabled this thesis to assess commonality and improve the robustness of the findings on financial economic variables as was the case with real economic variables and exchange rate volatility. However, this limitation creates an opportunity for future South African research to delve into this area of research and evaluate the econometric relationships between exports and the financial economy.

Another limitation the study encountered was accessing monthly export data for a longer duration. Although total monthly export data was available for a reasonably long time of fifteen years, similar data for country-level exports was only available for nine years which limited the latter's ability to be properly analysed during various business cycles. Nonetheless, the period analysed, and the results subsequently obtained gave this thesis view into export demand functions from a unique perspective. With better export data availability particularly at the sector level to trading partners, future researchers can better evaluate the heterogeneity of the sectors. This will help inform trade policy particularly on the issue of focusing on sectors that will help South African economic growth specialising in exports.

Notwithstanding the fact that there were limitations in undertaking this study, there was clear and compelling evidence suggesting that its findings laid a foundation from which

future research on the nuances of South African export behaviour can be modelled. This is especially relevant as South African economic growth remains subdued with interventions urgently required to stimulate economic growth. This thesis was completed as the COVID-19 pandemic was unravelling which would most likely cause a further depression and regime-switching of macroeconomic variables. There are indications that international financial flows are depressed whilst the financial markets remain uneasy especially in the first half of 2020 with cautious optimism that a gradual return to normalcy would give both the real and financial economies the needed boost once the health crisis is curtailed. Similar research on real and financial economic interaction will become more important going forward to better understand export behaviour during this time to formulate economic strategies to put South Africa on a strong long-run economic growth footing in the post-pandemic period.

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APPENDIX

A1 – Export Product Categories

Product Category	SARS Code	Description
1	I (1-5)	Live animals, animal products
2	II (6-14)	Vegetable products
3	III(15)	Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal and vegetable waxes
4	IV (16-24)	Prepared foodstuffs; beverages, spirits and vinegar; tobacco and manufactured tobacco substitutes
9	IX (44-46)	Wood and articles of wood; wood charcoal; cork and articles of cork; manufactures of straw, of esparto or of other plaiting materials; basket ware and wickerwork
5	V (25-27)	Mineral products
6	VI (28-38)	Products of the chemical or allied industries
7	VII (39-40)	Plastics and articles thereof; rubber and articles thereof
8	VIII (41-43)	Raw hides and skins, leather, fur skins and articles thereof; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silkworm gut)
10	X (47-49)	Pulp of wood or of other fibrous cellulosic material; waste and scrap of paper or paperboard; paper and paperboard of paper or paperboard; paper and paperboard and articles thereof
11	XI (50-63)	Textiles and textile articles
12	XII (64-67)	Footwear, headgear, umbrellas, sun umbrellas, walking sticks, seat-sticks, whips, riding-crops and parts thereof; prepared feathers and articles made therewith; artificial flowers; articles of human hair
13	XIII (68-70)	Articles of stone, plaster, cement, asbestos, mica or similar materials; ceramic products; glass and glassware
14	XIV (71)	Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal and articles thereof; imitation jewellery; coin
15	XV (72-83)	Base metals and articles of base metal
16	XVI (84-85)	Machinery and mechanical appliances; electrical equipment; parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, and parts and accessories of such articles
17	XVII (86-89)	Vehicles, aircraft, vessels and associated transport equipment
18	XVIII (90-92)	Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; clocks and watches; musical instruments; parts and accessories thereof
20	XX (94-96)	Miscellaneous manufactured articles
21	XXI (97)	Works of art, collector's pieces and antiques
22	XXII	Other unclassified goods
23	XXIII (98)	Special classification provisions Original equipment components/parts for motor vehicles

A2 – Short-run Coefficient for Product-Level Exports to Trading Partners

	CHINA					GERMANY				
VARIABLES	Resources	Manufactures	Chemicals	Agriculture	Other	Resources	Manufactures	Chemicals	Agriculture	Other
D(EXP(-1))	-0.4520*	-0.4461	-0.6847*	0.2186*	0.1028*	-0.3106*	-0.1490*	-0.4840*	0.0427*	-0.5395*
D(EXP(-2))	-0.1830*	-0.3010*	-0.3519*	0.0699*	0.0609**	-0.2750*	-0.3366*	-0.1361*	0.0300*	-0.3736*
D(EXP(-3))	-0.0453**	-0.1939*	-0.0612*	0.2449*	0.1742*					
Economic										
D(PRDN)	0.0030*	0.0150*	-0.0005	0.0058*	0.0060	-0.0131*	-0.0093*	-0.0013*	0.0047*	0.0089*
D(RELP)	-0.7862	-0.4144	-0.1732	10.8952	11.1447	5.2697	3.4820	2.9550	13.7204	-1.7423
Exchange										
D(EXCH)	0.0170*	0.0022**	0.0129*	0.0177*	-0.0084*	0.0211*	0.0070*	-0.0021*	0.0101*	0.0173*
D(ZARCNY)	0.0010*	0.0042*	-0.0108*	0.0046*	0.0000					
D(CNYUSD)	-0.0003**	-0.0251*	0.0084*	-0.0097*	0.0047*					
D(ZAREUR)						-0.0031*	0.0059*	-0.0030*	-0.0109*	0.0116*
D(CNYEUR)						0.0005*	-0.0121*	0.0057*	0.0031*	-0.0016*
Financial										
D(ALSI)	0.0145*	-0.0108*	-0.0215*	0.0006***	0.0059*	0.0216*	-0.0047*	0.0086*	0.0040*	-0.0191*
D(ILLQ)	0.4495	-1.0532	0.6265	1.3529	-0.2814	0.3924	-0.6744	-0.4953	-0.0014	-0.5387
C	0.2714	0.9728	1.0006***	6.6180*	6.9303**	3.6947**	2.2647***	1.6982***	7.4568**	0.4940**
ECT	-0.0182*	-0.0761*	-0.0765*	-0.5052**	-0.5152*	-0.3047*	-0.1817*	-0.1503*	-0.6552*	-0.0453*
	JAPAN					**UK**				
VARIABLE	Resources	Manufactures	Chemicals	Agriculture	Other	Resources	Manufactures	Chemicals	Agriculture	Other
D(EXP(-1))	-0.7113*	-0.0976*	-0.2973*	0.1698*	-0.1175**	-0.0407***	-0.3438*	-0.2907*	0.2894*	-0.4397*
D(EXP(-2))	-0.3735*	0.0033	-0.1756*	0.4759*	-0.1291*	-0.0360**	-0.3780*	-0.0628*	0.0197	-0.1740*
D(EXP(-3))	-0.1787*	0.0795*	-0.1117*	0.3675*	-0.0499**					
Economic										
D(INC)	-0.0239*	0.0469*	-0.0345*	0.0086*	0.0211*	0.0092*	-0.0069*	0.0034*	-0.0003	-0.0142*
D(RELP)	2.9887	12.3548	4.5559	12.3510	23.9186	3.9343	1.9756	6.4202	7.7555	2.8554
Exchange										
D(EXCH)	0.0065*	-0.0053*	0.0276*	0.0352*	0.0305*	-0.0087*	0.0052*	0.0053*	0.0084*	0.0048*
D(ZARJPY)	-0.0125*	-0.0092*	-0.0196*	-0.0167*	-0.0122*					
D(CNYJPY)	0.0024*	-0.0206*	0.0106*	0.0214*	-0.0002					
D(ZARGBP)						-0.0353*	-0.0123*	-0.0348*	-0.0303*	-0.0272*
D(GBPCNY)						-0.0012*	-0.0070*	0.0043*	-0.0009*	0.0011*
Financial										
D(ALSI)	-0.0046*	-0.0128*	0.0252*	0.0127*	-0.0091*	0.0057*	-0.0156*	0.0002***	-0.0006*	0.0050*
D(ILLQ)	1.5347**	1.4348	2.1413	0.9109	-1.4065	-1.1907	-0.8870	-1.7194***	1.3794	-0.2333
C	2.0963**	6.7156**	3.1062***	7.2377*	9.2377	7.8367*	2.6830**	6.3041**	7.1732**	4.2721**
ECT	-0.1854*	-0.6448*	-0.3192*	-0.7251*	-0.9253*	-0.6969*	-0.2461*	-0.6275*	-0.6621*	-0.4206*
	USA									
VARIABLE	Resources	Manufactures	Chemicals	Agriculture	Other	AGRIC	CHEM	MANU	RESOU	OTHER
D(EXP(-1))	-0.6580*	-0.3810*	-0.6888*	0.1986*	-0.0003	-	-	-	-	-
D(EXP(-2))	-0.3611*	-0.2740*	-0.5523*	0.5335*	0.0042	-	-	-	-	-

D(EXP(-3))	-0.2652*	-0.1476*	-0.3102*	0.4911*	-0.0197	-	-	-	-	-
Economic										
D(INC)	-0.0058*	-0.0007	-0.0137*	-0.0045*	-0.0050*	-	-	-	-	-
D(RELP)	0.5762	0.3043	2.3247	12.3914	13.2144	-	-	-	-	-
Exchange										
D(EXCH)	0.0080*	0.0213*	0.0209*	0.0132*	0.0055*	-	-	-	-	-
D(ZARUSD)	-0.0150*	-0.0040*	0.0020*	-0.0336*	-0.0316*	-	-	-	-	-
D(CNYUSD)	-0.0010*	0.0175*	-0.0054*	-0.0050*	0.0123*	-	-	-	-	-
Financial										
D(ALSI)	0.0020*	-0.0091*	0.0091*	-0.0176*	0.0083*	-	-	-	-	-
D(ILLQ)	0.9130	-0.5477	2.6904	0.5065	1.1226	-	-	-	-	-
C	1.8090	2.0203	2.4864	8.8681*	9.2884***					
ECT	-0.1389*	-0.1588*	-0.2019*	-0.7470*	-0.8107*	-	-	-	-	-