Title: The impact of demographic structure on saving and the current account in South Africa

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Abstract

This paper examines the life-cycle hypothesis implications on the current account in South Africa. Using national and regional data from 1961 to 2016 and 2006 to 2011 respectively, the Johansen-Juselius multivariate cointegration procedure is used in cojunction with univariate autoregressive distributed lag (ARDL) bounds testing and panel ARDL (PARDL) approaches. The latter is used to comprehensively inspect the possible effect of regional disparities on the current account balance. Various stability checks are administered and the findings generally suggest that a reduction in age dependency is largely ineffectual on the current account balance, both nationally and provincially. Although the results obtained from the PARDL analysis are interpretable, the data shortage may be exceedingly constraining.

JEL classification: E21, E29, E69

Keywords: life-cycle hypothesis, current account, Johansen-Juselius multivariate cointegration, univariate ARDL bounds testing, PARDL

1. Introduction

The saving culture in South Africa is not only characterised by the monetary limitations of the poor but also by their low financial literacy levels. Zwane, Greyling and Maleka (2016:209) assert that domestic savings play an instrumental role in garnering economic prosperity that is essential in the world economy; particularly in the case of developing countries. The main channel through which this can be achieved is through the function of savings as the supply of loanable funds which can be used to facilitate investment opportunities. Over the last 40 years in South Africa, gross saving as a percentage of the gross domestic product (GDP) peaked at 37.89% in 1980 and has declined steadily to reach 19.72% in 2015; this observation is indicative of diminishing saving capability over a significant period of time notwithstanding the credible historical reasons for this trend. Indeed, this picture implies a clear fall in overall saving capability in South Africa. The magnitude of this decline prompts a curious look at the possible reasons for this tendency. In addition to deficient financial literacy levels, Odhiambo (2006:63-64) attributes low national saving rates to the instability of returns to saving, the inefficiency of financial intermediaries, growing investor uncertainty, as well as the prevailing age structure in many countries. Certainly, age structure can be deemed a key determinant in aggregate saving levels in a typical economy (Higgins & Williamson, 1998:274).

Since the 2008 financial crisis, there has been a global shift towards more concerted efforts to encourage household saving in particular. It follows that population growth trends become exceedingly important to analyse on the basis of the life-cycle hypothesis (Aizenman & Noy, 2015:147). In order to fully establish the theoretical premise under which this study will be based, the life-cycle theory is the ideal vantage point. Theoretically, the life-cycle hypothesis posits that demographic structure changes work to influence the aggregate saving behaviour of households and may indeed have an impact on public saving through domestic tax revenue collection and expenditure (Kim & Lee, 2008:237). Demographic structure, in this case, is described by Domeij and Flodén (2996:1013) as the age distribution which prevails in a society at a particular point in time; this term is therefore commonly interchangeably used with age structure. By extension, the life-cycle theory then implies that a supposed rise in the number of young and elderly citizens in a country increases their total burden in the economy as dependents of the workforce and therefore leads to relatively lower aggregate saving levels. Intuitively, as the proportion of the population that constitutes the workforce diminishes, saving capability is likely to be eroded. Furthermore, analogous elements related to a country's current account balance are at the forefront of contemporaneous discussions of national saving as a means to ease macroeconomic pressures (Kim & Roubini, 2008:364). Additionally, the link between saving and the current account is therefore important to glean conceptually.

By way of national account identity manipulation, the current account balance of a country can be reduced to and consequently defined as the sum of the difference between private saving and investment, and the government fiscal balance (Brissimis, Hondroyiannas, Papazoglou, Tsaveas & Varsadani, 2013:302). In a typical open economy, total investment equals the sum of private, public and foreign saving. Foreign saving reflects funds which are raised in foreign countries in order to finance investment possibilities within a certain country. To this end, saving can be viewed as being significantly instrumental in the determination of the current account. This is exemplified by South Africa showing significant current account imbalances in recent times, standing at -4.34% of GDP in 2015. Between 1986 and 1991, various international sanctions enacted by the country's major trading partners (the United States and United Kingdom amongst others) coincided with a 2.32% decline in the current account balance (as a percentage of GDP) (World Bank, 2017). By intuition, the absence of foreign capital from abroad hindered the current account balance and left South Africa heavily reliant on domestic saving which, in itself, was insufficient in yielding a positive current account balance (Levy, 1999:5). Given the complex historical background of South Africa, it is reasonable to contend that the regional disparities which exist amongst the nine provinces in terms of the different age spectrums and varying degrees of saving capability may yet inform current account imbalances across the provinces. Consequently, the role that national saving plays in improving the current account balance of a country is seemingly untenable not only at the aggregate level but also regionally. To this end, the link between demographic changes as well as domestic saving and the current account becomes an increasingly relevant economic relationship to explore.

In general, the current account of a country is often lauded as being a credible indicator of the health of an economy as expressed by Gruber and Kamin (2007:504). Kim and Kim (2006:374) suggest that an unfavourable change in the age structure – in other words, an increase in the overall dependence on the labour force - can cause a decline in domestic saving that may cause it to fall below the level of domestic investment. This set of circumstances is likely to worsen the current account balance in a country as the demand for funds used for investment opportunities exceeds the supply. Simply put, a fall in overall saving capability due to growing dependence on the workforce has the effect of yielding a deterioration of the current account. In light of this purported economic phenomenon, it is important to explore the extent to which South Africa is subjected to this theoretical prediction both nationally and regionally.

A modicum of seminal work demonstrating analyses around current account and domestic saving determinants have proven instrumental in securing a body of literature that not only theoretically addresses important linkages between demographic structure, saving and current account balances, but also investigates them empirically through the application of a variety of econometric techniques (see Debelle & Faruqee, 1996; Graff, Tang and Zhang 2012; Chinn & Prasad, 2003). The originality in these studies stemmed from the pertinent application of methodologies which aimed to make crucial deductions regarding the impact of dependency patterns and saving behaviour on current account dynamics. Moreover, the evolution of these studies saw the development of more robust methodological approaches with a view to introducing more systemic factors as being critically influential in the overall determination of current account balances in the world economy (Kim & Lee, 2008; Gruber & Kamin, 2007).

A plethora of approaches have been adopted in literary works that have attempted to capture the economic importance of the current account and the significance of saving behaviour as determined by age structure (see Graff et al., 2012). The exploration of the international importance of the current account through the observed global saving glut and the mitigating impact of financial institutions has, in the recent past, been an additionally key application (Chinn & Ito, 2007). The economic consequences of globalisation in encapsulating, more dependably, the diverse ways in which a country's current account can be affected have likewise been undertaken in a comprehensive study by Cooper (2008). Indeed, some literature has contended that age structure induces a long-term change in the current account based purely on saving-investment movements (Herbertsson & Zoega, 1999; Kuijs, 2006). These are crucial findings in light of the collaborative efforts of global bodies to ensure sustainable and effective policy directives that are able to foster favourable economic conditions.

Studies based on the relationship between a country's prevalent demographic structure, the resultant saving patterns and its current account are relatively uncommon. To the knowledge of the authors, there has been no such study in the South African context. Additionally, most studies under this far-reaching umbrella of literature have focused simply on gleaning the determinants of domestic savings as well as their impact on economic growth and development (Larbi, 2013; Chamon, Liu & Prasad, 2013; Zwane et al., 2016). These studies are sparse and indeed do not fully explore the full impact of varying demographic structure with its pertinent links to the current account balance (Zwane et al., 2016 ; Chinn & Prasad, 2003). Evidently, viable research on the demographic structure, saving and current account nexus is few and far between globally. This presents a prospect of novelty that the apparent trends in the demographic structure of South Africa can be better explored with a fine-toothed comb using effective econometric methods. The developmental history of South Africa is a key consideration for this choice because it may indeed provide a sufficient basis upon which the postulation presented by the life-cycle theory and its impact on the current account may or may not hold. Another justification of a study of this nature is to the extent that a particular saving culture may be deeply anchored by demographic variability in more diverse societies (Horioka & Terada-Hagiwara, 2016). Analysing different regions may provide a better understanding of such a contention by providing the platform for a more robust investigation. Savings and current account balances have previously been dealt with separately or in relation to other, more economic and calculable variables in the South African context (Shawa, 2016). This is an illuminating observation in that differences in demographic structure are likely to play an indispensable role in anchoring savings and investment and by implication, current account balances. From a policymaking perspective, the prospective advantage of a savings culture that is able to seep into other domestic markets makes it essential to undertake a study of this nature.

This research article aims to fully unpack the savings and current account nexus in South Africa by recognising the importance of the prevailing demographic structure in the country as a whole. A regional analysis will additionally be used to supplement the study in attempting to dissect the viability of the life-cycle hypothesis and its relation to the current account across different domestic regions. This approach is exceedingly important in modern times because the consistency of the life-cycle hypothesis in different regions can be interrogated more closely. The purpose is therefore two-fold. Firstly, it is to gauge the extent to which demographic structure in South Africa impacts saving and the current account; this will be achieved through the use of comprehensive autoregressive distributed lag (ARDL) and panel ARDL (PARDL) bounds testing approaches to cointegration. Secondly, salient deductions for family planning and economic outlook policymakers will be made in relation to the results obtained. The model to be specified will attempt to detect any long-run relationship amongst total dependency, saving and the current account using relevant literature as a credible foundation.

For the aggregate level analysis, annual data was obtained from the World Bank from 1961 to 2016 for the total dependency ratio, real interest rate, real GDP, gross saving, current account (the latter two as a percentage of GDP) figures. Furthermore, Quantec offered various provincial indicators from 1995 to 2014 across the nine provinces. These variables include the trade balance (as a proxy for the current account due to data restrictions), gross saving (both as a percentage of GDP) and the total dependency ratios.

Besides the spatial contribution of a multifaceted study of this kind in South Africa, the application of the ARDL and PARDL models is the most distinctive and sophisticated feature proposed. In a related study, Kim and Lee (2008) employ a panel vector autoregressive (PVAR) model and cite that it is highly effective in assuming complete endogeneity as well as finding the residual impact of and forecasting variable trends. The empirical justification of using the ARDL and PARDL models in this study is based on the theoretical premise that the current account of a country is most likely to be influenced by the life-cycle theory and can be represented in a rigid, single-form equation. To this end, this paper sets out to practically test the theoretical prediction without the consideration of possible long-run bi-causality properties.

This paper is comprised of six sections. The next section provides an informative analysis of the prevailing trends in demographic structure, saving levels and the current account in both South Africa both nationally and provincially, from 1960 to 2015 and 1995 and 2014 respectively. Section 3 takes a concise and clear approach to describing an extensive array of literature relating to the age structure, saving and current account nexus. Section 4 maps out the methodological ARDL approaches to cointegration to be employed in this study with accompanying explanations; furthermore, this section shows the estimation results for the study with related interpretations in the form of a discussion. Finally, Section 6 discusses the policy implications for South Africa and concludes the study.

2. Demographic structure, saving levels and the current account in South Africa

Over the past 50 years, South Africa has experienced notable changes in age structure, saving capability and the current account balance. Of most alarming concern is the persistence of the current account deficit and repressed levels of gross saving. A positive shift in the general population age spectrum has been a desirable outcome and will be the point of departure for this analysis.

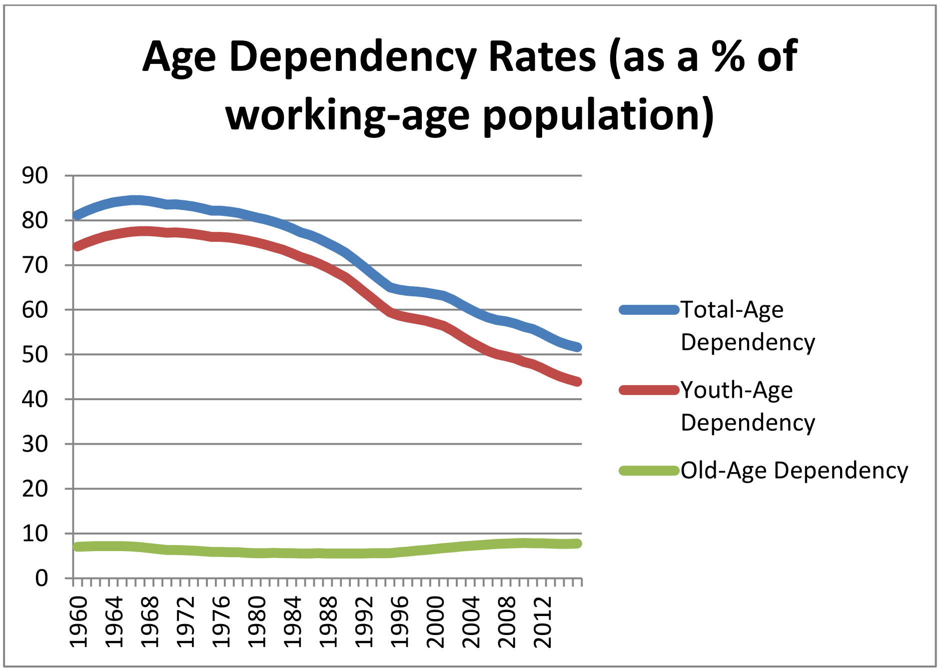
2.1. Age structure in South Africa

The past few decades have seen dwindling fertility rates being accompanied by rising labour force numbers in South Africa. Whilst a multitude of reasons can be advanced in this regard, the overall effect has been two-fold: a rise in the elderly population has coincided with a diminishing number of young dependents. An aggregate and regional view of the demographic structure elements which affect South Africa is useful in a preliminary assessment of the historical tendencies of the prevailing population trends.

2.1.1. Aggregate Level

Figure 1 accurately illustrates this observation between 1960 and 2015 with a steady fall in young-age (or child) dependency coinciding with an increase in the old-age dependency ratio. Since the proportion of the elderly is relatively small in relation to both the young-age population and the labour force, the contemporary rise seems negligible.

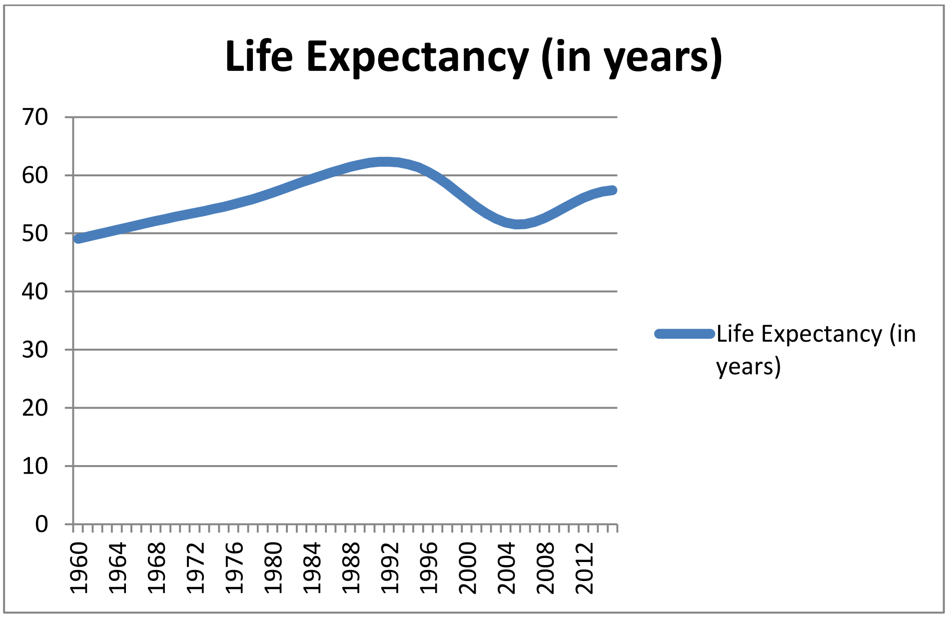
Figure 1: Age dependency rates in South Africa



Source: Own development from World Bank (2017)

On closer inspection however, the old-age dependency ratio has increased by 40.82% since 1990 after gradually falling over the 30 years preceding 1990. Child dependency has been decidedly declining since the early 1960s and has unequivocally reduced the total-age dependency ratio as a result. Figure 2 gives a historical account of life expectancy in South Africa. There is a weak symmetry in old-age dependency over the period of interest; an upward trend seems to have rightly yielded a rise in population aging in recent times.

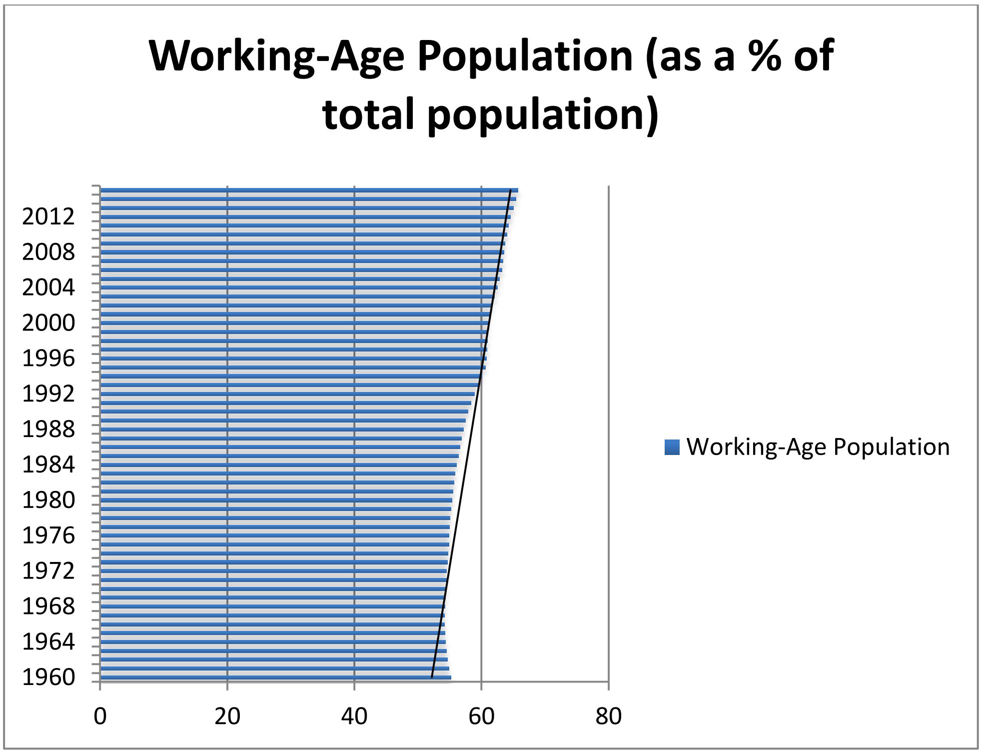
Figure 2: Life expectancy in South Africa



Source: Own development from World Bank (2017)

Figures 1 and 2 suggest the prevalence of a discernible population age shift towards an older population with less reliance on the labour force. Figure 3 further consolidates this view and shows a growing working-age population (as a percentage of the total population) between 1960 and 2015; this was an additional reason for the decline in age dependency rates as shown in Figure 1.

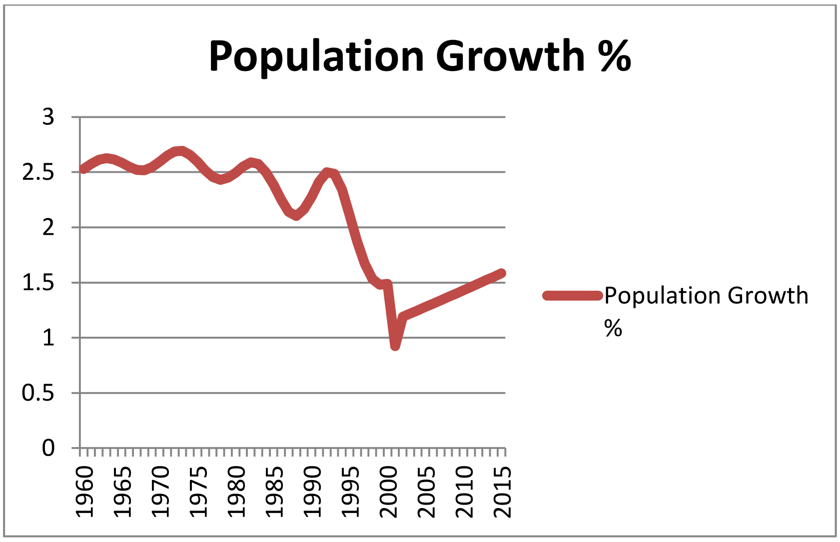
Figure 3: Working-age population in South Africa



Source: Own development from World Bank (2017)

Population dynamics in South Africa are displayed in Figure 4 and reflect a consistently positive growth trend throughout the period 1960-2015. Furthermore, whilst the population growth rate hovered persistently around 2.5% between 1960 and 1992, it experienced a sharp decline between 1993 and 2001 and has subsequently begun to resume an upward trend since then. In spite of the general picture being a fair representation of age structure at a national level, a regional decomposition of these prevalent age trends can be used as an additional aid.

Figure 4: Population Growth Rate



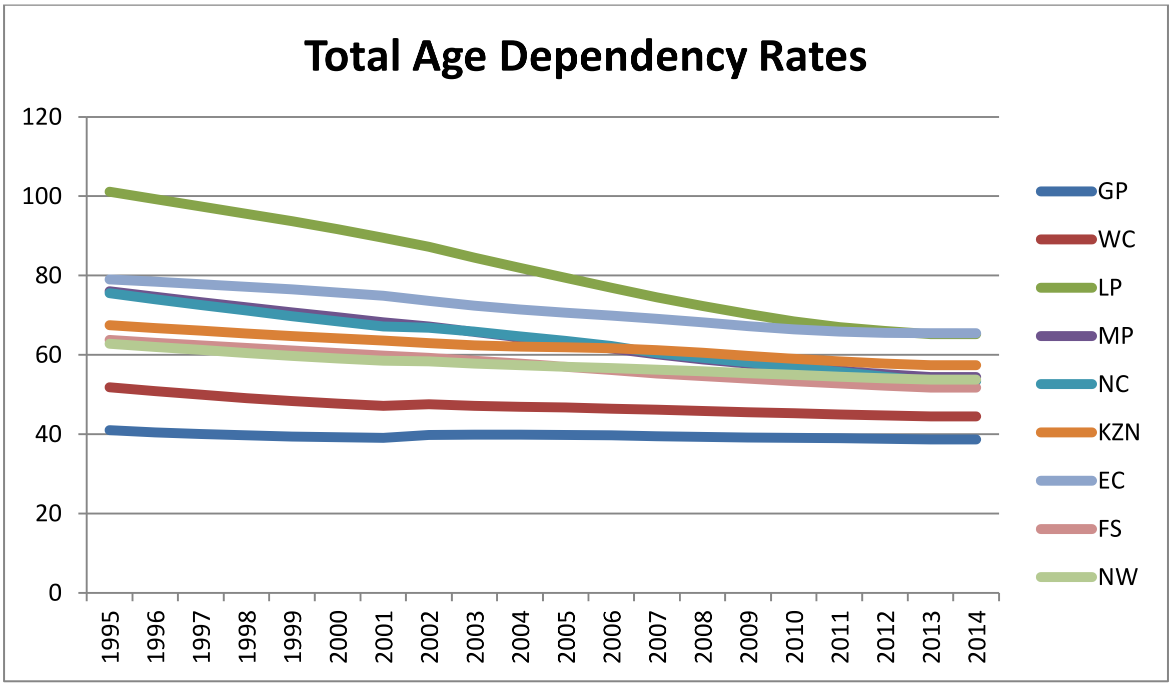
Source: Own development from World Bank (2017)

2.1.2. Provincial Level

Figures 5a to 5c depict the total, young-age and old-age dependency rates across the nine provinces between 1995 and 2014. In the figures, the following labels apply: Gauteng (GP), Western Cape (WC), Limpopo (LP), Mpumalanga (MP), Northern Cape (NC), Kwazulu Natal (KZN), Eastern Cape (EC), Free State (FS) and North West (NW). In panel a), Limpopo is shown to have historically suffered exceptionally high dependency rates since 1995 whilst Gauteng and the Western Cape have exhibited relatively stable dependency figures. In general, there has been a marked decline in total dependency across the board; this is largely attributable to falling child dependency rates regionally as shown in panel b).

Figures 5a-5c: Provincial Age Dependency Rates

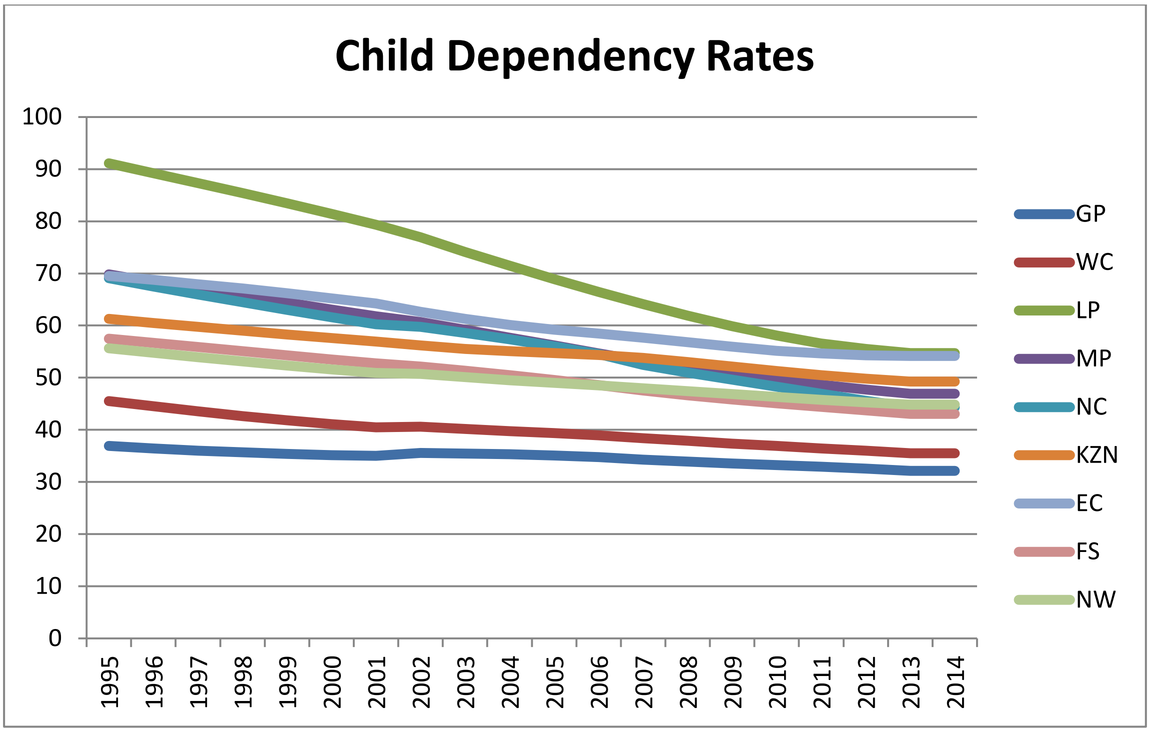
a) Total Age Dependency Rates by Province



Source: Own development from Quantec (2017)

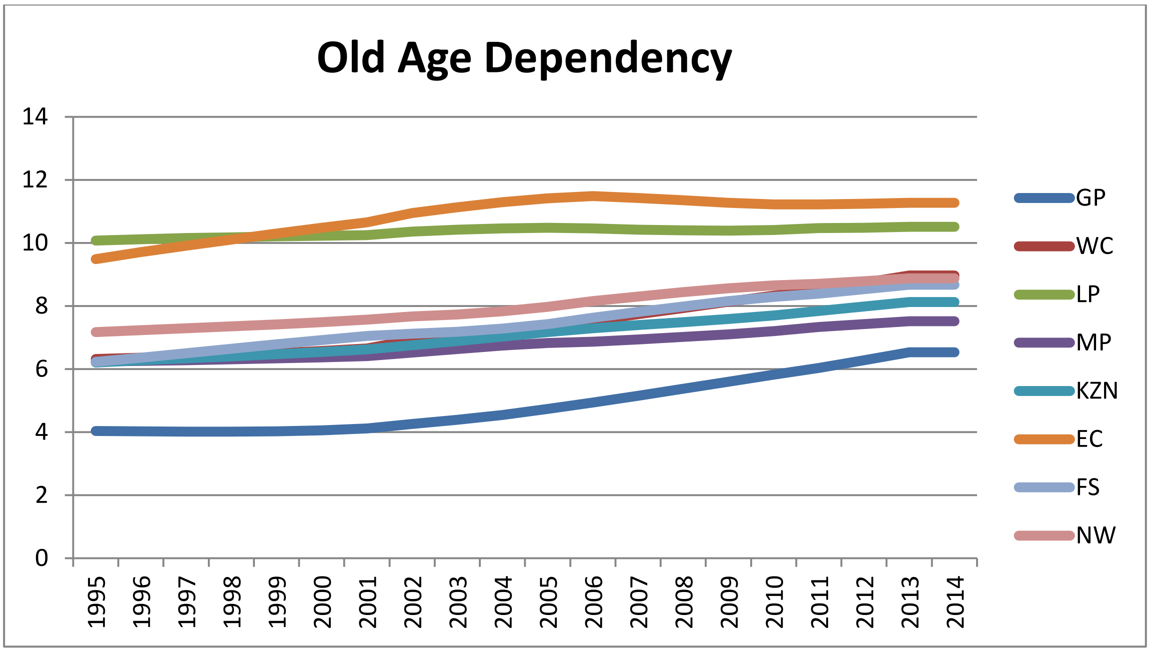
Limpopo was the most sizeable contributor to high child dependency rates, particularly between 1995 and 2011, notwithstanding that it declined significantly from 91.09% to 56.56% along the same period. Notably, Gauteng and the Western Cape as the commercial hubs of South Africa, contributed the least to overall child dependency for the period 1995-2014. Both these provinces have seen steady declines in child dependency over time. The population aging trends displayed in panel c) suggest that the greatest portion of the elderly have, since the early 2000s, been concentrated in the Eastern Cape. Furthermore, the number of elderly dependents in Gauteng has climbed by approximately a third from 2001 to 2014. Each province seems to have contributed reasonably to the growing dependence of the elderly on the working force.

b) Child Dependency Rates by Province



Source: Own development from Quantec (2017)

c) Old-age Dependency Rates by Province



Source: Own development from Quantec (2017)

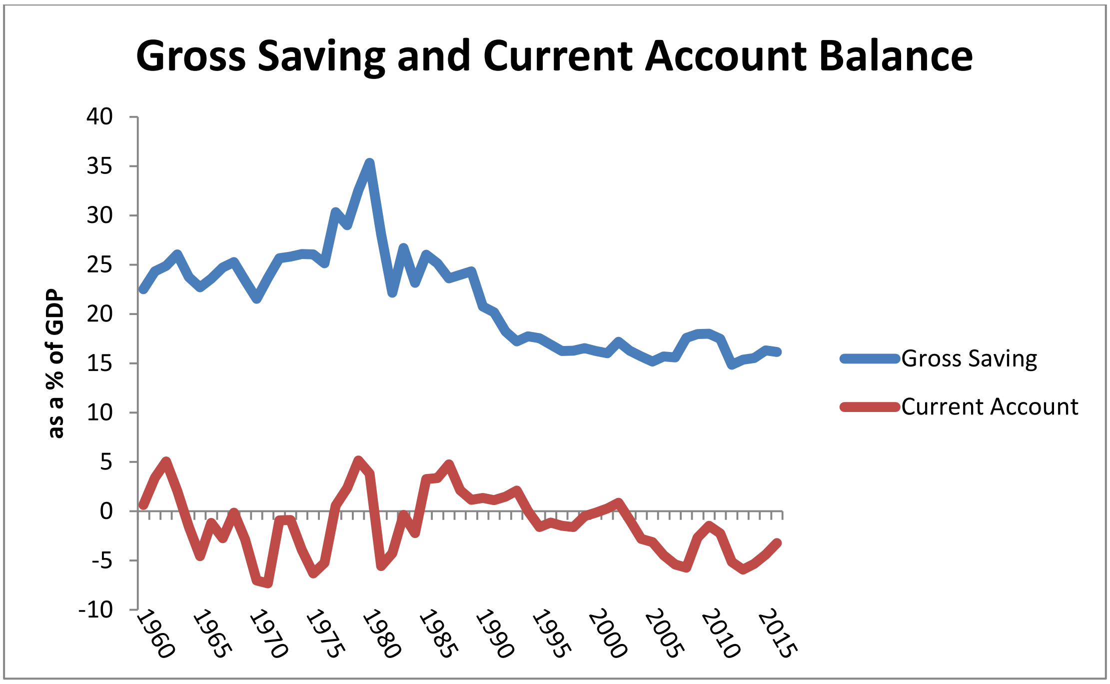
2.2. Saving and current account trends in South Africa

Zwane et al. (2016:210) assert that a deficiency in private saving levels in recent times has been the main culprit for chronically low gross saving in South Africa. Moreover, trends in gross saving volatility have seemingly been accompanied by movements in the current account balance; this is typically the case at the aggregate level. At the provincial level, this observation is more cumbersome to make.

2.2.1. National Level

Gross saving and the current account balance can be simultaneously examined on the same set of axes. In Figure 6, the seemingly incidental course of gross saving and the current account balance (both as a percentage of GDP) form the intuitive possibility that saving levels may indeed be a strong determinant of the current account balance. Between 1960 and 2016, the trends are characterised by varying degrees of fluctuation which seem to weakly coincide. Granted, the current account balance comprises other elements which are not analysed as explicitly in this study. As an illustration of the observed close relationship between saving levels and the current account, a few salient points can be exemplified. In 1980, gross saving (as a percentage of GDP) reached its highest point of 35.32% and was duly met by a 5.14% current account surplus (as a percentage of GDP). Similarly, a persistent savings rate drop from 1989 to 2007 oversaw the transition of the South African current account balance into a stubborn deficit.

Figure 6: Gross saving and the current account balance in South Africa

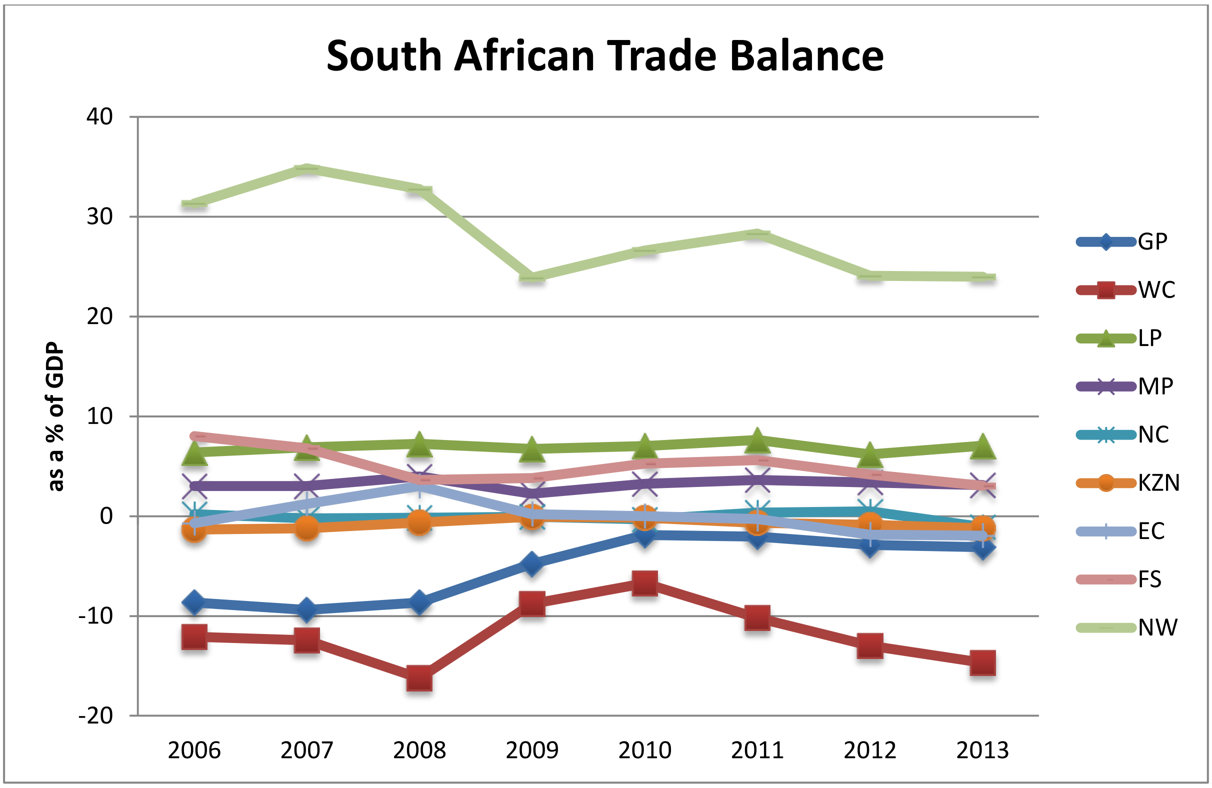


Source: Own development from World Bank (2017)

2.2.2. Provincial Level

The trade balance (as a percentage of GDP) can be used as an approximation in Figure 7 to analyse current account dynamics amongst the nine provinces from 2006 to 2016; this is purely due to data constraints. By observation, most of the provinces reveal consistently positive trade balances over this period with the North West leading in the way of regional exports being in excess of imports. For Kwazulu Natal, the Eastern Cape and the Northern Cape, the trend has been largely invariant across time. Whilst the latter is an effectively landlocked province, Kwazulu Natal and the Eastern Cape, as coastal regions of the country, are more prone to robust cross-border trade in both directions. Moreover, Gauteng and the Western Cape bear seemingly considerable amounts of trade deficits.

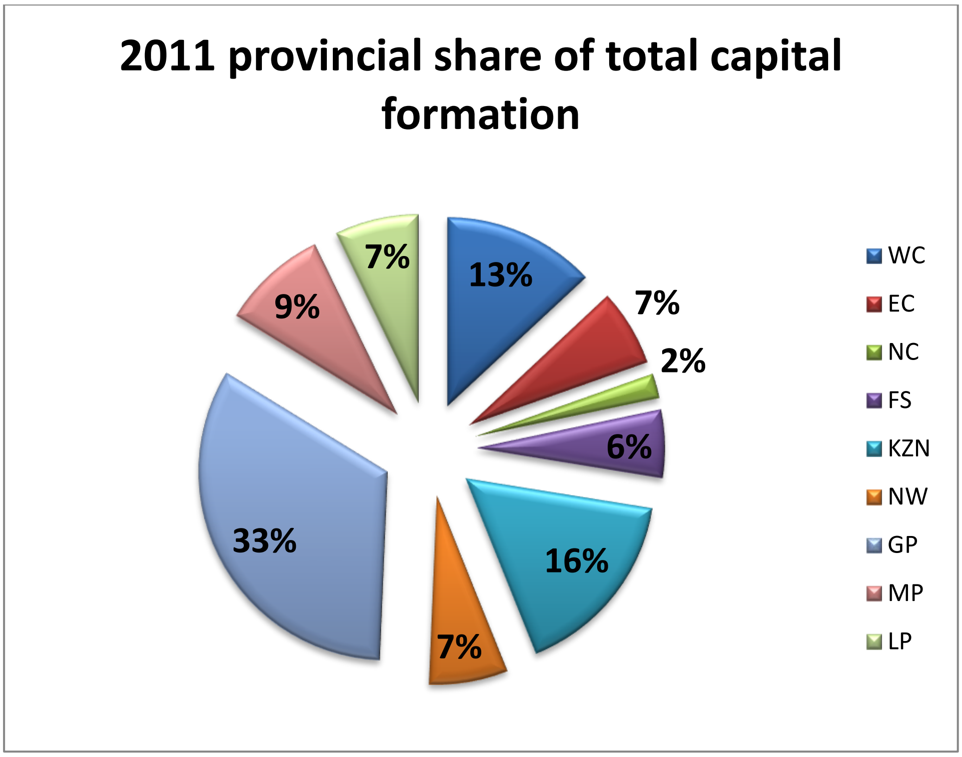
Figure 7: Trade balances (as a percentage of GDP) by province



Source: Own development from Quantec (2017)

Based on the most recent data, Figure 8 presents gross fixed capital formation figures in 2011. It is apparent that a disproportionate share of investor resources had flocked towards Gauteng, Kwazulu Natal and the Western Cape. Collectively, these provinces accounted for over 60% of the total share of gross fixed capital formation in 2011. A provincial surveying of the gross fixed capital formation information points out a deficiency in the extent to which total saving as the supply of funds towards sustainable development was done geographically. For instance, the Northern Cape accounted for only a 2% share of total gross fixed asset purchases in the country; this is doubly indicative of diminished saving capability for investment opportunities as well as a potential geographical bias.

Figure 8: Gross Capital Formation by province



Source: Own development from Quantec (2017)

The next section provides a thorough account of studies which have explored the life-cycle hypothesis in relation to the current account. It is notable that whilst numerous studies have focused on unpacking the validity of the life-cycle from varying perspectives, those related to the current account effects are scarce.

3. Literature Review

Over the past 60 years, an abundance of literary work exploring the effect of age structure on saving has been done. Coale and Hoover (1958) set the premise for the development of the life-cycle hypothesis by using robust trend analysis of population growth and the impact it has on economic development through the saving channel. Leff (1969) then extended this more directly by securing the decomposition of the population into age groups and applying cross-sectional ordinary least square (OLS) estimation for 74 countries using data from 1964. The author found that both developed and less developed economies exhibited the life-cycle model fairly in that population dependency had an inverse relationship with aggregate saving levels. In more recent times, Higgins (1998) fused the prediction of the life-cycle hypothesis with its purported effect on the current account for 100 countries between 1950 and 1989. The novelty of Higgins' (1998) study was based on incorporating the influence of globalisation on integrating capital markets between countries for a view on the possible current account dynamics. The study used pooled panel data between 1950 and 1989 which accounted for fixed effects as the effects of age structure were deemed non-random in the determination of saving, investment and the current account balance. The findings were strongly suggestive of the contention that favourable demographic conditions improve the current account based on accompanying saving and investment level increases. The studies presented thus far provide a general idea of most of the literary findings dominating this topic. These studies provided the platform for numerous other studies which, whilst limited, attempted to isolate the impact of age structure on the current account through the savings medium.

Gudmundsson and Zoega (2014) assessed the effect of age structure on the current account between 1980 and 2009 for a panel of 57 countries. The authors used pooled OLS, as well as within-group estimation. Furthermore, 12 different age groups were utilised to find that higher levels of dependency ultimately yielded lower current account levels through depressed aggregate saving levels; this is in direct consensus with the postulation that greater dependence on the labour force coincides with poorer current account positions for countries in general. Similarly, Brissimis et al. (2013) examined 12 European economies for the period 1980-2008 in order to find the most influential determinant of current account positions through the saving-investment channel. Amongst these were age structure, institutional stability and credit extension. All these, including demographic structure, were fairly influential in determining the current account level. An extended model for 17 European countries was also estimated and yielded similar results. Chinn and Prasad (2003) investigated the structural impact of demographics on saving and investment decisions and on the current account. This was conducted for 17 industrial and 81 developing nations over 25 years between 1971 and 1995. This investigation was comprehensive in using both cross-sectional and panel analyses for comparison purposes. Summarily, the findings were that the cross-sectional regressions for age structure on national saving had a more prominent effect on the current account balance than that of the panel regression. Moreover, this led the authors to conclude that demography is more instrumental in the determination of saving when looked at on a contemporaneous basis as opposed to when additional time series observations are analysed (Chinn & Prasad, 2003:62). There are many other literary approaches that have been taken to analyse the relationship between saving and the current account as anchored by demographic structure.

For instance, Sahoo, Babu and Dash (2017) analysed China and India from 1980 to 2014 given their high spurts of population growth during this period. Using various cointegration techniques, a long-term positive trend between saving and the current account could be established for a given age structure in both countries. In the context of China, Zhang, Zhang and Zhang (2015) found that age structure was dominant in determining economic growth by using panel fixed effects estimation;

this was done for the time period between 1990 and 2005 across four census periods. Demographic structure was thereafter shown to play a prominent role in current account determination for both countries through domestic saving.

Domeij and Flodén (2006) focused exclusively on the effects of demographic structure on cross-border capital movements. Whilst conceding that many other factors may influence the current account, their research attempted to identify the impact caused by age structure. In their more thorough study, they looked to ascertain how accurately pooled OLS and fixed effects models on 18 Organisation for Economic Cooperation and Development (OECD) countries predicted the actual current account trend from 1960 to 2002. Their approach was based on the premise that any change in saving and investment rates would yield current account shocks. It was found that the model was fairly consistent in predicting current account movements caused by age structure through saving behaviour. In a related study, Aristovnik (2008) used data from 15 European countries between 1992 and 2003 for pooled analysis using both cross-sectional and time-series components. Whilst an unbalanced panel data set was used due to data availability issues, the results suggested that the life-cycle theory was moderately influential in the determination of the current account. In a parallel study, the IMF (2004) employed a panel of 115 countries to explore the life-cycle theory and its purported influence on current account balances. Using the fixed-effects regression method, the authors found that greater population dependency was statistically shown to be associated with lower domestic saving rates and deteriorating current account balances. Moreover, whilst the majority of studies looking at the life-cycle theory as a determinant of the current account balance are fairly consistent in focusing on the retrospective elements of the prevailing data trends, some studies focus more on the forecasting benefits that this data may provide.

In a departure from more conventional estimation methods, Backus, Cooley and Henriksen (2014) examine the effect of demography on international capital flows and its resultant influence on current account balances using a general equilibrium model (GEM). Looking specifically at China, Germany, Japan, and the United States, the authors develop an overlapping-generations model based on certain stylised facts on immigration, fertility and mortality for the period 1980-2030. For the United States and Japan, the current account balances were accounted for relatively accurately as shown by capital inflows and outflows characterising each respective country over time. In the case of China, the model returned notable salient observations in that China's ever-changing population trends were shown through its capital flows as being empirically compatible with the general postulation from the life-cycle theory and its impact on the current account. For Germany, the model failed to validate the stylised facts of the 1990s in particular and therefore fails to correctly anticipate the current account position over time. In a similar approach with respect to China, Zhu (2011) looks at data from 1978 to 2007 in order to yield forecasts up to 2050. The author assuredly endorses the assertion that increased levels of dependence in the population lead to current account deterioration by eroding the capability of the working population to save during periods of high aggregate dependence. Based on this presentation of past research, dissecting the role of demographic structure on saving and therefore the current account is a vital avenue. In general, a wealth of economic studies has found evidence confirming the proposition that the life-cycle hypothesis is an empirically justifiable phenomenon (Kandil, 2015; Shawa, 2016; Fan & Kalemli-Özcan, 2014; Cooper, 2008). To this end, others have augmented this contention to prove that current account balances are connected to this experience (Gudmundsson & Zoega, 2014). It is noteworthy however, that one study by Graff et al. (2012) is a red herring by suggesting that demographic changes can, in fact, not be definitively proven to influence the current account by altering national saving rates. Using assumptions informed by literature, the authors tested a variety of current account determinants using an unbalanced panel of 84 countries and data ranging from 1960 to 2006 depending on data constraints. Graff et al. (2012) found that a general method of moments (GMM) approach refutes the assertion presented by most literature as has been discussed in this section. This study concludes that current account changes provoked by age structure changes by changes in saving levels are relatively idle and not at all significant.

Contrary to Kim and Lee (2008), who used a PVAR procedure for the G-7 countries between 1979 and 2001, this research paper will solely focus on an emerging country in the case of South Africa. Kim and Lee (2008:247), in their basic model, use the total dependency rate, various saving and investment rates, as well as real GDP per capita in order to show the result of an imminent shock on the different variables under conditions of system endogeneity. Their study finds compelling evidence that a rise in the dependency rate is accompanied by an improvement in the current account which is motivated by increased saving levels for the seven countries. This paper will similarly examine the viability of the life-cycle hypothesis and show its effects on the current account. It will however employ ARDL techniques for national-level and regional analyses. By extension, the findings will enable a view of whether or not there are noteworthy differences between the life-cycle hypothesis' implications on the current account based on regional disparities. The following section fully unpacks the methodological ARDL procedures and defines the data over their relevant time periods.

4. Methodology and Data

Following the pioneering work of Pesaran and Shin (1999), Pesaran, Shin and Smith (2001) and Johansen and Juselius (1990), this paper will predominantly enlist the use of the three cointegration modelling approaches in order to ascertain the extent to which demographic structure and saving shapes the current account balance. For the aggregate level analysis, a Johansen-Juselius multivariate approach will be used in conjunction with a univariate ARDL model. For a better view of the regional heterogeneity amongst the different provinces, a related PARDL model will be implemented. The PARDL method, as a related application for panel data, is subject to minor specification differences which will reflect both the cross-sectional and time series components of the data set. The Johansen-Juselius multivariate cointegration procedure will be deployed within a constrained vector error correction model (VECM). Moreover, ARDL techniques are an increasingly important application in modern economic discourse.

The fitness of employing the two ARDL techniques in a macroeconomic context lies in the premise that they are able to dependably yield estimates that are unbiased and fairly easy to interpret even in a data-constrained study (Jalil, Feridun & Ma, 2010:192). Litsios and Pilbeam (2017:147) add that this sets it apart from more conventional cointegration techniques like the Johansen-Juselius cointegration approach which demands the use of larger samples and a uniform optimal lag length across the variables used. Additionally, Mannaseh, Mathew and Ogbuabor (2017:280) point to the short- and long-run credibility of the models in gauging the true nature of underlying economic relationships. Finally, and indeed most compelling, is that ARDL techniques are applicable in instances where the variables of interest are found to be I(0), I(1) or a blend of both of the level or first orders of integration; this is an exceedingly accommodative advantage.

The suitability of using these three empirical techniques augurs well for the credibility of our analysis in approaching the topic from both a multivariate and univariate perspective. All three procedures therefore play an indispensable role in unpacking the complex relationship amongst demographic structure, saving and the current account. Before the methodological approach is mapped out, it is imperative to revisit the theoretical plausibility of this economic relationship.

4.1. Theoretical Considerations

Whilst Modigliani and Brumberg (1954) crucially formalised the foundation of the life-cycle hypothesis by analysing the effect of population aging on saving levels, Higgins (1998:344) intimated that the observed existence of the life-cycle theory might credibly be seen to have significant current account effects. More specifically, that a rise in total age dependency might negatively affect aggregate saving and therefore depress the current account balance. Based on past literature, the current account balance of a country can be specified as being determined by total dependency on the labour force, gross saving levels, the real interest rate and GDP in some or other manner (see Kim & Lee, 2008; Uddin, Alam & Gow, 2016).

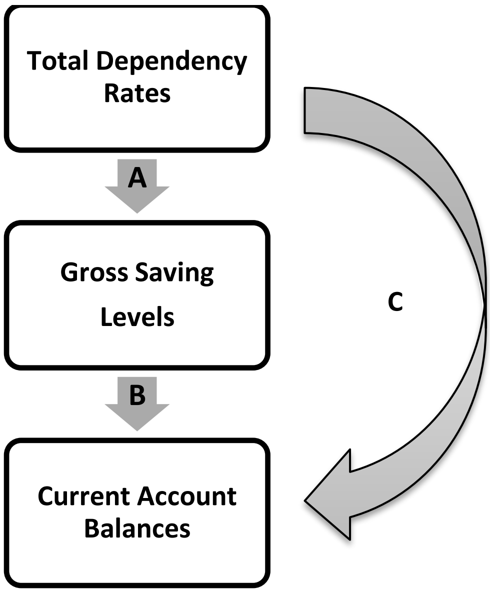
The proposed method of estimation inherently proposes a dynamic view of bypassing the possible empirical caveats which might undermine the theoretical underpinning of the model. Crucially, (1a) and (1b) formalise the theoretical postulation of the relationship of interest at aggregate and provincial level respectively:

$$CA = f(\overbrace{TDR}^{-},\ \overbrace{GS}^{+},\ \overbrace{RIR}^{+},\overbrace{LGDP}^{+}) \qquad (1\text{a})$$

where CA is the current account-to-GDP ratio, TDR is the total dependency ratio, GS is the gross saving-to-GDP ratio, RIR is the real interest rate and LGDP is the natural logarithm of real GDP. Similarly, the PARDL model retains some of the aspects presented in (1a). Due to data constraints and variable invalidity however, only the variables of interest will be kept in a condensed version of the ARDL. The CA variable is now replaced by a proxy variable - the trade balance (as a percentage of GDP), which is denoted as TB. Household saving as a percentage of GDP (denoted by HS) is included to capture the savings component of the relationship of interest. RIR is also rendered invalid in a provincial analysis. The theoretical structure is as follows in the PARDL procedure:

$$TB = f(\overbrace{TDR}^{-},\overbrace{HS}^{+}) \qquad (1\text{b})$$

Figure 9: The main relationship of interest



Source: Own development

In Figure 9, flows A and B indicate the direct impact of demographic changes on saving levels, as well as saving levels on the current account, respectively. Flow C however, shows the purported indirect effect of demographic structure on the current account. The present paper will now discuss the various cointegration techniques to be deployed for our analysis.

4.2. Johansen-Juselius Cointegration Approach

In the context of this study, the modelling approach should first be contingent on the contention proposed in Figure 9. That is to say that demographic structure can indeed motivate indirect current account movements. To this end, we must first affirm the existence of various long-term associations amongst the variables; one of which has to be in the suggested direction. In a multivariate analysis of this nature, the Johansen-Juselius approach (see Johansen, 1988, 1991 and Johansen & Juselius, 1990) is fitting to use in discerning the state of cointegration within the model (Iwayemi, Adenikinju & Babatunde, 2010:75).

The Johansen-Juselius application necessarily stipulates the use of the VAR framework to ascertain the cointegration rank. This paper will implement a restricted VECM which will allow us to view the indirect effect of demographic changes on the current account. More specifically, changes in demographics affect saving which in turn would affect the current account. Whilst there is a direct relationship between age structure and saving, the relationship between age structure and the current account is an indirect one. Moreover, whilst consensus regarding the validity of the Johansen-Juselius application under certain stationarity conditions has not been reached, Lütkepohl and Krätzig (2004) accept that a system containing both I(0) and I(1) variables is a permissible circumstance. Furthermore, Kanjilal and Ghosh (2014:138) concede that the stationarity of the variables remains the paramount consideration to make when executing this estimation method. Moreover, a constrained VAR (CVAR) of order d can be shown as:

$$Y_t = q_0 + q_1 t + \sum_{i=1}^{d} \gamma_i Y_{t-i} + \psi X_t + e_t \tag{2}$$

where Y_t is a (k × 1) vector for the endogenous I(0) variables (from stationarity testing), e_t, q_0 and q_1 are similarly (k × 1) vectors, X_t is a (r × 1) vector of extraneous variables, and t is the trend term (where $t = 1, 2, \dots, T$) . It is also noteworthy that e_t is in fact, a vector of error terms which are unobserved and unambiguously white noise. A restructuring of (2) enables a more interactive look at the long- and short-run properties of the Johansen-Juselius cointegration process:

$$\Delta Y_t = q_0 + q_1 t + \sum_{i=1}^{d-1} \pi_i^* \Delta Y_{t-i} - \pi^* Y_{t-1} + \psi X_t + e_t \tag{3}$$

where π_i^* and π^* are (k × k) matrices which capture the short- and long-term characteristics of a given economic relationship respectively. Summarily, (4) and (5) give a clearer indication of the restrictions imposed on matrix A which are considered under this procedure in AB format. Matrix A shows the restrictions in a (5 × 5) form whilst B is a (5 × 5) diagonal matrix:

$$Ae_t = Bu_t \tag{4}$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a & 1 & 0 & 0 & 0 \\ 0 & b & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} . \begin{bmatrix} e_t^{CA} \\ e_t^{TDR} \\ e_t^{GS} \\ e_t^{RIR} \\ e_t^{LGDP} \end{bmatrix} = \begin{bmatrix} c & 0 & 0 & 0 & 0 \\ 0 & d & 0 & 0 & 0 \\ 0 & 0 & e & 0 & 0 \\ 0 & 0 & 0 & f & 0 \\ 0 & 0 & 0 & 0 & g \end{bmatrix} . \begin{bmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \\ u_{4t} \\ u_{5t} \end{bmatrix} \tag{5}$$

This specification automatically imposes restrictions on the model in order to facilitate the role of saving as a means through which demographic structure can influence the current account. In other words, it essentially captures the indirect impact of demographic changes on the current account. Once the cointegration rank is determined, the nature of the various endogenous relationships can be inspected with a view to determining whether or not the aforementioned theoretical assertion holds true empirically. The rank of π^* will essentially determine the number of cointegrating vectors because the stationarity of e_t presents evidence of some cointegrating relation amongst the variables (Giles & Godwin, 2012:1562). Two test criteria are commonly analysed in the maximum eigenvalue (denoted as λ_{max}) and the trace statistic (denoted as τ_x) to make this determination:

$$\lambda_{max} = -T\log(1-\lambda^*_{r+1}) \quad (6)$$

$$\tau_x = -\sum_{i=r+1}^{n} T\log(1-\lambda^*_i) \quad (7)$$

The findings of this multivariate cointegration analysis will inform the use of the ARDL and PARDL estimations when the long-run vectors are found to exist even with the applied constraints.

4.3. ARDL Bounds Testing Approach

Whilst the theoretical outline provided gives a sufficient account of the relationship of interest, Equations (8a) to (8e) below present a veracious representation of the level ARDL possibilities under the proposed ARDL (j, k_1, k_2, k_3, k_4) framework:

$$CA_t = \beta_{10} + \sum_{i=1}^{j}\rho_i\,CA_{t-i} + \sum_{i=0}^{k1}\delta_{1i}\,TDR_{t-i} + \sum_{i=0}^{k2}\delta_{2i}\,GS_{t-i} + \sum_{i=0}^{k3}\delta_{3i}\,RIR_{t-i} + \sum_{i=0}^{k4}\delta_{4i}\,LGDP_{t-i} + u_t \quad (8a)$$

$$TDR_t = \beta_{11} + \sum_{i=1}^{j}\alpha_i\,TDR_{t-i} + \sum_{i=0}^{k1}\gamma_{1i}\,CA_{t-i} + \sum_{i=0}^{k2}\gamma_{2i}\,GS_{t-i} + \sum_{i=0}^{k3}\gamma_{3i}\,RIR_{t-i} + \sum_{i=0}^{k4}\gamma_{4i}\,LGDP_{t-i} + \varepsilon_t \quad (8b)$$

$$GS_t = \beta_{12} + \sum_{i=1}^{j}\partial_i\,GS_{t-i} + \sum_{i=0}^{k1}\sigma_{1i}\,CA_{t-i} + \sum_{i=0}^{k2}\sigma_{2i}\,TDR_{t-i} + \sum_{i=0}^{k3}\delta_{3i}\,RIR_{t-i} + \sum_{i=0}^{k4}\delta_{4i}\,LGDP_{t-i} + \epsilon_t \quad (8c)$$

$$RIR_t = \beta_{13} + \sum_{i=1}^{j}\eta_i\,RIR_{t-1} + \sum_{i=0}^{k1}\psi_{1i}\,CA_{t-i} + \sum_{i=0}^{k2}\psi_{2i}\,TDR_{t-i} + \sum_{i=0}^{k3}\psi_{3i}\,GS_{t-i} + \sum_{i=0}^{k4}\delta_{4i}\,LGDP_{t-i} + \omega_t \quad (8d)$$

$$LGDP_t = \beta_{14} + \sum_{i=1}^{j}\phi_i\,LGDP_{t-i} + \sum_{i=0}^{k1}\nu_{1i}\,CA_{t-i} + \sum_{i=0}^{k2}\nu_{2i}\,TDR_{t-i} + \sum_{i=0}^{k3}\nu_{3i}\,GS_{t-i} + \sum_{i=0}^{k4}\nu_{4i}\,RIR_{t-i} + \mu_t \quad (8e)$$

Given the system depicted from (8a) to (8e), an empirical declaration on the potential for other cointegrating relationships is pivotal and follows from the Johansen-Juselius approach. Consequently, these methods are applied in conjunction with one another. Since Figure 9 is a graphical consolidation of the proposed economic relationship, the current account is therefore specified as in (8a), as the dependent variable such that it is influenced by past values of itself, as well as the lagged and contemporaneous values of the other variables in the arrangement (namely, TDR, GS, RIR and LGDP). Depending on whether or not the multivariate cointegration estimation deems it credible that such a relationship exists, the analysis of (8a) becomes the focal point for the ARDL process. An additional parametisation of (8a) becomes a necessary point of departure so that the short- and long-run dynamics of the ARDL approach are clearly defined.

In (9) below, Δ, which refers to the first difference, and the γ_{xi} (where x=1, 2, 3, 4, 5) parameters jointly form the interpretable short-term forces of the model. (9) is deliberately used to detect any semblance of a long-term association amongst the variables by testing the null hypothesis of no cointegrating relationship existing amongst these variables such that every θ_x coefficient (where x=1, 2, 3, 4, 5) is the same and equates to zero. The representation in (9) is aptly known as the unconditional ECM (UECM) because it forms the basis for the ARDL approach to cointegration. The null and alternate hypotheses can more formally be delineated as:

$H_0: \theta_1 = \theta_2 = \theta_3 = \theta_4 = \theta_5 = 0$ (No cointegrating relationship amongst the variables)

$H_a: \theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq \theta_5 \neq 0$ (Cointegration exists amongst the variables)

$$\Delta CA_t = \beta_0 + \sum_{i=1}^{j} \gamma_{1i}\, \Delta CA_{t-i} + \sum_{i=1}^{k1} \gamma_{2i}\, \Delta TDR_{t-i} + \sum_{i=1}^{k2} \gamma_{3i}\, \Delta GS_{t-i} + \sum_{i=1}^{k3} \gamma_{4i}\, \Delta RIR_{t-i} + \sum_{i=1}^{k4} \gamma_{5i}\, \Delta LGDP_{t-i} + \theta_1 CA_{t-1} + \theta_2 TDR_{t-1} + \theta_3 GS_{t-1} + \theta_4 RIR_{t-1} + \theta_5 LGDP_{t-1} + \mu_t \tag{9}$$

Furthermore, a restructuring of (9) yields (10) which directly forms the basis for applying the bounds testing procedure (Odhiambo, 2009:620). The acceptance of the alternate hypothesis presents the possibility that there is indeed a long-run relationship amongst the variables. More specifically, the rejection of the null hypothesis adds credence to the estimation of the ECM as shown in (10):

$$\Delta CA_t = \beta_0 + \sum_{i=1}^{j} \gamma_{1i} \Delta CA_{t-i} + \sum_{i=1}^{k1} \gamma_{2i} \Delta TDR_{t-i} + \sum_{i=1}^{k2} \gamma_{3i} \Delta GS_{t-i} + \sum_{i=1}^{k3} \gamma_{4i} \Delta RIR_{t-i} + \sum_{i=1}^{k4} \gamma_{5i} \Delta LGDP_{t-i} + \lambda EC_{t-1} + \omega_t \tag{10}$$

where λ is the speed of adjustment coefficient which allows for an interpretation on the short-term relation amongst the variables and EC_{t-1} is the cointegrating vector connecting the relationship. Kandil (2015:335) explains that λ authentically reflects the extent to which complete equilibrium is gradually regained following a shock to the system.

4.4. PARDL Cointegration Approach

The rationale for using the PARDL technique is based on our belief that whilst both the Johansen-Juselius multivariate and ARDL univariate cointegration procedures comprehensively account for the direct and indirect effects suggested by the model, the regional disparities amongst the nine provinces in South Africa cannot be ignored. More specifically, it is necessary to account for the heterogeneity amongst the provinces in terms of the main variables of interest.

The PARDL procedure will be similarly delineated based on Figure 9 and (1b) with the relevant amendments required to achieve a full PARDL (j_i, k_i, l_i) representation. Based on Figure 9, the current account determination model being employed in this study can be conveyed as in (11) where i and t are the respective cross-sectional and time series components of the model:

$$TB_{it} = \varpi_{it} + \sum_{p=1}^{ji} \pi_{ip} TB_{i,t-p} + \sum_{p=0}^{ki} \eta_{ip} TDR_{i,t-p} + \sum_{p=0}^{li} \psi_{ip} HS_{i,t-p} + \epsilon_{it} \tag{11}$$

Following on from (11), Pesaran and Shin (1999) suggest that a restructure of the panel model will best-represent the model:

$$\Delta TB_{it} = \varpi_{it} + \sum_{p=1}^{ji} \pi_{ip}^{*} \Delta TB_{i,t-p} + \sum_{p=1}^{ki} \eta_{ip}^{*} \Delta TDR_{i,t-p} + \sum_{p=1}^{li} \psi_{ip}^{*} \Delta HS_{i,t-p} + \sum_{p=1}^{mi} \theta_{ip}^{*} \Delta CF_{ip} + \sum_{p=1}^{ni} \phi_{ip}^{*} \Delta LGDP_{i,t-p} + \delta_i TB_{i,t-1} + \rho_i TDR_{i,t-1} + \varrho_i HS_{i,t-1} + \kappa_i CF_{i,t-1} + \chi_i LGDP_{i,t-1} + \epsilon_{it}$$

(12)

If no cointegrating vector is detected in cointegration testing (i.e. that the null hypothesis is rejected), the representation in (12) can be reduced down to that in (13) to allude to the ECT:

$$\Delta TB_{it} = \varpi_{it} + \sum_{p=1}^{ji} \pi_{ip}^{*} \Delta TB_{i,t-p} + \sum_{p=1}^{ki} \eta_{ip}^{*} \Delta TDR_{i,t-p} + \sum_{p=1}^{li} \psi_{ip}^{*} \Delta HS_{i,t-p} + \sum_{p=1}^{mi} \theta_{ip}^{*} \Delta CF_{ip} + \sum_{p=1}^{ni} \phi_{ip}^{*} \Delta LGDP_{i,t-p} + \lambda^{*} EC_{i,t-1} + e_{it}$$

(13)

where λ^{*} distinctively represents the speed of adjustment coefficient and $EC_{i,t-1}$ is essentially the cointegrating vector in the panel context.

Prior to the implementation of this hybrid methodology, this paper will fully assess the stationarity properties of the variables. In general, econometric applications with time series considerations deem it exceedingly important to ensure that the variables used are stationary in order to avoid statistically misleading and spurious results (Uddin et al., 2016:26). For the proposed multivariate and ARDL cointegration approaches, stationarity analysis is a useful point of departure albeit that Pesaran et al. (2001:315) declare it a supplementary step in the ARDL bounds testing approach. To this end, two different tests for the presence of unit roots will be applied to avoid the presence of second order integrated variables which might be problematic (Sunde, 2017:440). The augmented Dickey Fuller (ADF) test was developed by Dickey and Fuller (1979) and has been used customarily in economic literature (see Uddin et al., 2014; Cavaliere & Taylor, 2007). In conjunction with this widely-accepted test, a more robust and comprehensive stationarity analysis will include the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. Advanced by Kwiatkowski, Phillips, Schmidt and Shin (1992), this stationarity test is performed with the null hypothesis that there are no unit roots in a given variable about a deterministic trend. Conversely, the ADF test rests on the null hypothesis that a given series is non-stationary which will add credibility to the overall stationarity analysis of this study with the expectation that results from both tests will serve as confirmation of the stationarity properties of the series of variables (Horváth, Kokoszka & Rice, 2014:67). The ADF test administered by this paper is given by the following equations:

$$y_t = \delta y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta y_{t-1} + u_t$$

(14)

$$y_t = \alpha_0 + \delta y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta y_{t-1} + u_t \tag{15}$$

$$y_t = \alpha_0 + \delta y_{t-1} + \alpha_1 t + \sum_{i=1}^{p} \gamma_i \Delta y_{t-1} + u_t \tag{16}$$

The KPSS statistic can generally be specified in a way similar to Lee and Schmidt (1996:287) and mainly probes the trend stationarity aspect of a series. Moreover, it is an accommodative stationarity test because it is able to dependably distinguish between varying finite sample properties. (17) represents the KPSS statistic where T is the sample size; as T approaches infinity, the test becomes a more robust indicator:

$$\sigma = T^{-2} \sum_{t=1}^{T} x_t^2 / \varphi^2 \tag{17}$$

According to Kwiatkowski et al. (1992), in (17), x_t^2 is the squared partial sums and φ^2 is the long-run estimate of the variance.

4.5. Data

In order to enable the estimation of the Johansen-Juselius cointegration test as well as the country-level ARDL procedure for South Africa, this paper utilises annual data from 1961 to 2016 which is collected from one comprehensive dataset. For South Africa, data on the total dependency ratio (those under 14 years and above 65 years of age as a portion of the labour force shown as TDR), the current account balance and gross saving (both as a percentage of GDP and shown as CA and GS respectively), the actual real interest rate (RIR) as well as real GDP (at constant local currency unit of South African rands) are all collected from the World Development Indicator which is offered by the World Bank. It is noteworthy that real GDP is subsequently logged to construct a more relatable variable in showing the dynamics of real GDP from year-to-year and is therefore denoted as LGDP. That the data is collected from a single source bodes well for the dependability of the estimation results and the consistency of the collection methods. A full statistical summary of the variables is presented in Table 1 below.

For the regional analysis, provincial data is available from Quantec. Due to the unavailability of certain variables at provincial level, a few compromises were made. The variables for total dependency rate (also TDR in the panel analysis), private saving, imports (X), exports (M) and real GDP were collected from 2006 to 2011. A few variable transformations were made necessary; this was for private saving and the trade balance. The trade balance was computed by simply subtracting imports from exports for each province, this was then expressed as a percentage of real GDP. Similarly, household saving is converted to a percentage of GDP so that:

$$TB = \left(X - M /_{Real\ GDP} \right) \times 100 \tag{18a}$$

$$HS = \left(Household\ saving /_{Real\ GDP} \right) \times 100 \tag{18b}$$

Next, the preliminary unit root tests, full estimation and results section will be presented.

Table 1: Summary statistics for country-level analysis

Variable	CA	TDR	GS	RIR	LGDP
Mean	-1.281	71.475	21.390	3.152	25.948
Median	-1.325	74.441	21.860	3.724	26.192
Maximum	5.143	84.491	35.320	13.012	29.098
Minimum	-7.318	51.648	14.840	-12.315	22.462
Standard Deviation	3.247	11.199	5.016	4.366	2.143
Jarque-Bera (JB)	1.628 (0.443)	5.743 (0.057)	2.926 (0.231)	23.539 (0.000)	4.439 (0.109)

5. Estimation and Results

The estimation results include the outcome of the stationarity testing process, the Johansen-Juselius system cointegration as well as the country-level ARDL and the PARDL results.

5.1. Unit Root Tests

Based on the aforementioned specifications, Asteriou and Hall (2011:344) assert that the ADF test can be done without the consideration of a constant term as shown by (14), with an intercept as in (15) and with both an intercept and a deterministic element as shown in (16). The estimation procedure begins by testing the defined variables for stationarity in the South African case. The results for the ADF test are shown in Table 2 below:

Table 2: Summary of ADF unit root test for South Africa

Variables	At Level			At first difference			Remarks
	No constant	Intercept	Trend & intercept	No constant	Intercept	Trend & intercept	
CA	-2.986***	-4.340***	-4.314***	-	-	-	I(0)
TDR	-2.518**	-0.151	-2.531	-	-	-	I(0)
GS	-0.832	-1.441	-2.624	-8.274***	-8.250***	-8.176***	I(1)
RIR	-2.923***	-3.658**	-3.936***	-	-	-	I(0)
LGDP	3.019	-1.690	-1.078	-1.080	-3.767***	-4.119**	I(1)

*10%, **5%, ***1%

In this regard, the integration level decision is taken at the level at which stationarity presents the foremost result at any of the significance levels. CA, TDR and RIR are found to be stationary at level (I(0)) whilst GS and LGDP are integrated of order one (I(1)). At face value, the ARDL approach chosen for this investigation is therefore a valid application; the suggested Johansen-Juselius approach by a CVAR is however only applicable if the variables are wholly integrated of the same order. Furthermore, the KPSS test mostly verifies the results obtained by the ADF tests in a complementary method as shown in Table 3 below. Tellingly, in this instance, the KPSS test seemingly finds that all the variables are stationary at level whilst the ADF test contradicts this result by finding that GS and LGDP are integrated of order one. It is notable that the KPSS test rejects the null hypothesis more often than other stationarity tests because it anchors a much wider scope for stationarity and tests more directly for the presence of unit roots (Horváth et al., 2014:67). Whilst these conflicting results are common in past literature, the healthy consistency overall between the two tests is sufficient evidence to employ both the Johansen-Juselius cointegration test and the ensuing ARDL cointegration approaches. The orders of integration detected (I(0) or a combination of I(0) and I(1)) suggest that the stationarity requirements demanded by the ARDL model are satisfactorily met.

Table 3: Summary of KPSS unit root test for South Africa

Variables	At Level		At first difference		Remarks
	Intercept	Trend & intercept	Intercept	Trend & intercept	
CA	0.252***	0.171*	-	-	I(0)
TDR	0.874	0.209*	-	-	I(0)
GS	0.673*	0.133*	-	-	I(0)
RIR	0.335***	0.123*	-	-	I(0)
LGDP	0.902	0.206*	-	-	I(0)

*10%, **5%, ***1%

5.2. Johansen-Juselius Multivariate Cointegration Results

As a starting point, the CVAR framework allows the imposition of crucial restrictions in order to determine the degree to which the theoretical postulation is empirically justifiable. In order to select an appropriate lag length for the CVAR, there are various criteria options to select from. Table 4 reports only the Akaike Information Criterion (AIC), Hannan-Quinn (HQ) Criterion and the Schwarz Information Criterion (SIC). This paper adopts an approach similar to Bentzen (2001:51) by using the latter to determine the number of lags which are best-suited. In the case of the CVAR, an optimal lag length of one is selected.

Table 4: CVAR lag length selection criteria summary

Lag length	HQ	AIC	SIC
0	23.361	23.288	23.478
1	9.327	8.893	10.029*
2	9.057*	8.261	10.344
3	9.554	8.396	11.427
4	9.512	7.992*	11.969
5	9.925	8.043	12.968

*indicates the lag length chosen by each criterion

To this end, the Johansen-Juselius approach is a concise manner in which the number of cointegrating vectors can be determined. The null hypothesis continually looks to test for a cointegration rank (r) so that it is able settle on a maximum number of cointegrating relationships that a system is likely to possess (Beckmann & Czudaj, 2013:460). Using the maximum eigenvalue as well as the trace statistic, Table 5 shows that the variable system has at most, two cointegrating (or long-run) relationships.

Table 5: Johansen-Juselius maximum likelihood likelihood cointegration test results

H_0	λ_{max}	$p_{\lambda\ at\ 0.05}$	τ_x	$\tau_{0.05}$
r=0	0.554	0.000	112.103	69.819
r≤1	0.518	0.000	68.551	47.856
r≤2	0.323*	0.060*	29.091	29.797
r≤3	0.112	0.461	8.043	15.495

*both statistics suggest the presence of two cointegrating vectors at 5% level based on their respective decision criteria

Based on Table 5, the imposition of restrictions to capture the indirect effect of age structure on the current account in a VECM can be determined from the prior knowledge of two cointegrating relations. Table 6 records the outcome of the two cointegrating vectors proposed by the trace statistics and eigenvalues:

Table 6: Johansen-Juselius maximum likelihood cointegrating equation output

Cointegration Equation	ΔCA	ΔTDR	ΔGS	ΔRIR	ΔLGDP
f_1	-1.194***	-0.093***	-0.257	0.451	0.008*
f_2	-1.606***	-0.051*	-0.230	0.210	-0.004
ΔCA(-1)	0.248*	0.002	0.548***	-0.693***	0.004*
ΔTDR(-1)	0.603	0.639***	1.106*	-0.038	0.011
ΔGS(-1)	-0.057	-0.000	-0.304*	0.688***	0.000
ΔRIR(-1)	0.005	-0.016	0.096	-0.040	0.001
ΔLGDP(-1)	-18.446	3.558***	9.269	38.440*	0.118
c	2.452	-0.657**	-0.639	-4.738*	0.114***
		Diagnostic Analysis			
Adjusted R^2	0.516	0.847	0.239	0.362	0.528
Log likelihood	-104.484	16.062	-105.194	-134.015	120.319

statistical significance determined by t-statistics, *10%, **5%, ***1%

Our analysis of Table 6 reveals that 9% of the disequilibrium is rectified by changes in TDR per annum for the first cointegrating vector. Furthermore, in this cointegrating vector, 25% of the disequilibrium is corrected for by alterations in GS; this observation however fails to attain statistical significance. In the second cointegrating vector, LGDP changes account for 4% of the recovery on equilibrium in each successive year. In terms of the relation between TDR and CA, the results bode well for a long-run relationship between these two variables in the context of the system of variables. Moreover, the exogenous variables provide a supplementary interpretation of the multivariate cointegration estimation.

The exogenous impact of each variable on ΔCA – barring the lagged ΔCA variable - fails to return statistical significance for each variable. To this end, the exogenous effect considerations are proven to be less important for our analysis. Moreover, increases in TDR look likely to yield a positive impact on GS whilst LGDP seems to encourage greater values of TDR.

It is decidedly apparent that there is very little scope for the semblance of the indirect impact of TDR on CA. In any event, the possibility would still reject the theoretical postulation in most past work on this topic due to the inconsistency of the signs from our output (see Higgins, 1998; Gudmundsson & Zoega, 2014). Inasmuch as the Johansen-Juselius procedure provides clarity on the decomposition of the direct and indirect effects prevalent within an economic system, the ARDL cointegration method can be implemented to obtain a view of a cointegration outcome which does not necessarily distinguish between these effects. The usefulness of this dynamic single-equation application has been well-explained in various papers (see Pesaran et al., 2001; Litsios & Pilbeam, 2016; Sunde, 2017).

5.3. ARDL Estimation Results

In order to extract the potential long-run association amongst the variables of interest, the ARDL bounds testing procedure has also been proven as methodologically appropriate to use. To assist this analysis, Granger causality will be used to interrogate the causal relationship. Additionally, the traditional Granger causality procedure has previously been criticised by Toda and Phillips (1993:1387) in the context of VAR and cointegration applications. Indeed, Toda and Yamamoto (1995:227) present the possibility that this test may be afflicted by bias stemming from a predetermined number of linear associations which may not suffer from unit roots. This paper will therefore employ the Toda-Yamamoto (TY) procedure. The application of this test is purely to assess the proposed direction of long-term causality as gleaned from past literature (see Kim & Lee, 2008; Chinn & Prasad, 2003; Higgins, 1998). More specifically, the dependency ratio (as a proxy for demographic structure) for given saving levels, real returns to saving and investment as well as economic growth are all considered to be the main components in the determination of the current account. Albeit a supplementary step, the empirical validity of this theory will be assessed.

As a precursor to the ARDL F-bounds test results, the focus relationship tested is executed using the TY procedure. The test essentially uses a robust variation of the Wald test to determine the possibility of a suggested causal relationship (Adriana, 2014:230). Table 7 shows the results of the test and provides an interesting supposition of the nature of any underlying causal relationship. According to Table 7, the individual causality results suggest that only TDR (at 5% significance) and GS (at 10% significance) share links to CA individually. The joint causal relationship however efficaciously shows evidence of a definite long-run association in the prospect proposed in (8a).

Table 7: Toda-Yamamoto results for Granger causality

Causal Direction	χ^2 statistic	p-value	Determination
TDR → CA	18.067	0.006*	Causality at all levels of significance
GS → CA	11.619	0.071**	Causality at 10*
RIR → CA	4.338	0.631	No causal relationship
LGDP → CA	10.233	0.115	No causal relationship
TDR + GS + RIR + LGDP → CA	71.384	0.000***	Causality at all levels
Highest individual order of integration	1		
VAR autocorrelation lag selection based on SIC	6		

→implies Granger cause, *10%, 5%**, 1%***

For a more comprehensive view of the likeliest cointegrating vectors as determined in Table 6, Table 8 provides a summary of the other possible causal relationships tested by the TY procedure. This analysis provides better clarity on which relationships are cointegrated; it is therefore a definite test of causality but only a probabilistic one for cointegration.

Table 8: Summarised Granger causality results based on Toda-Yamamoto procedure

Causal Direction	χ^2 statistic	p-value	Determination
TDR + GS + RIR + LGDP → CA	71.384	0.000***	Joint causality
CA + GS + RIR + LGDP → TDR	25.487	0.380	No causal relationship
CA + TDR + RIR + LGDP → GS	19.544	0.7224	No causal relationship
CA + TDR + GS + LGDP → RIR	103.491	0.000***	Joint causality
TDR + GS + RIR + CA → LGDP	27.307	0.290	No causal relationship
Highest individual order of integration	1		
VAR autocorrelation lag selection based on SIC	6		

*10%, 5%**, 1%***

According to Table 7, the likeliest long-run relationships are those anchored by either CA or RIR in two cointegrating relationships. Table 8 provides the benchmark estimation results. The F-Bounds test is an essential step next because whilst the TY procedure provided a symptomatic view on causality, it did not necessarily imply the presence of cointegration. In contrast to the Johansen-Juselius cointegration test, the ARDL procedure is fairly robust and does not possess the empirical caveat of retaining instability when series are found to not be definitively found be stationary (Hjalmarsson & Österholm (2010:54-55). Table 8 below provides the bounds test results in order to assess the cointegration status of the model. As previously alluded to, this present paper adopts the SIC to determine the number of lags and will do this for the ARDL procedure as well. Upon this basis, the most efficient long-run ARDL model is (1, 0, 0, 1, 1) as chosen from 16 possible models.

Table 8: F-Bounds test results

Estimated Equation		$\boldsymbol{CA = f(TDR, GS, RIR, LGDP)}$		
Selected lag structure		(1, 0, 0, 1, 1)		
Test statistic	**Value**	**I(0)**	**I(1)**	**Significance level**
F-statistic	8.397****	2.68	3.01	10%
k	4	3.05	3.97	5%
		3.40	3.90	2.5%
		3.81	4.44	1%

*10%, 5%**, 2.5%***,1%****

The outcome of the bounds testing procedure augurs well for the contention that the proposed model retains a long-run association amongst the five variables of CA, TDR, GS, RIR and LGDP. The F-statistic of 8.397 is substantially greater than the critical values at each significance level; this leads to the rejection of the null hypothesis of the absence of a cointegrating relationship amongst the variables in the suggested direction. Consequently, the long-run ARDL cointegration results can be extracted by estimation. Table 9 shows the long-run cointegration model results from the ARDL application. It is noteworthy that whilst the presence of a deterministic element impedes on the robustness of the model, no limitations on the constant and trend terms will be imposed. An ad hoc estimation determined that the deterministic terms were significant and should therefore feature in the estimation:

Table 9: The long-run ARDL cointegrating estimation outcome (1, 0, 0, 1, 1)

Variable	Coefficient	Standard Error	t-statistic	p-value
TDR	0.264	0.387	0.683	0.498
GS	0.928	0.283	3.280	0.002***
RIR	0.118	0.273	0.432	0.668
LGDP	14.565	4.112	3.542	0.000***
t	-1.590	0.590	-2.693	0.010***
		Diagnostic Analysis		
	Statistic	**Interpretation**		
Adjusted R^2	0.792	TDR, GS, RIR and LGDP explain 79.20% of the variation in CA		
JB statistic	1.617 (0.446)	Error term distribution is normal		
Breusch-Pagan-Godfrey F-test	1.914 (0.08*)	No symptoms of heteroscedasticity found at 5%		
Breusch-Godfrey F-test	0.001 (0.973)	No symptoms of autocorrelation found at all levels		

p-values in parentheses, *10%, 5%**, 1%***

Table 9 summarily provides compelling evidence of the long-run composition of the economic relationship of interest. CA is found to be dependably determined by the observed behaviour of GS and LGDP as these coefficients all show reliable signs of statistical significance. TDR and RIR are however less convincing and fail to attain statistical significance. Furthermore, there is theoretical consistency insofar as the various postulations of GS, RIR and LGDP on the current account are concerned; this is shown by the signs of the coefficients. TDR, GS, RIR and LGDP are all found to positively affect CA. Whilst GS, RIR and LGDP largely exhibit the expected signs, TDR requires further inspection. Intuitively, the positive effect of TDR on CA means that greater dependency does indeed yield favourable current account outcomes; this is contrary to most findings in past literature (see Kim & Lee, 2008; Brissimis et al.; 2013). LGDP could have exhibited either a positive or negative sign because whilst the trade balance forms a significant part of the current account balance, its recent sluggishness simply exposes that of the financial account component. Since 2004, persistent current account deficits could be attributed to a greater reliance on outgoing payments to investors from abroad as well as an ominous reliance on foreign goods (Strauss, 2017:54). In theory, during periods of favourable economic conditions, a country will tend to afford imports which might swell the trade balance deficit depending on the trend in exports. The short-term dynamics of the model will be discussed next. In Table 10, the short-run ECM results are shown:

Table 10: ARDL cointegrating short-run dynamics from ECM (1, 0, 0, 1, 1)

Variable	Coefficient	Std. Error	t-statistics	p-values
ΔRIR	-0.352	0.053	-6.628	0.000***
ΔLGDP	-23.887	5.134	-4.653	0.000***
c	-169.322	22.873	-7.403	0.000***
ECT(-1)	-0.460	0.061	-7.474	0.000***
		Diagnostic Analysis		
Adjusted R^2	0.670	The short-run dynamics of the model are well-specified and fitting.		
Durbin-Watson	1.898	There is weak autocorrelation detected albeit that this value can be approximated to 2.		

*10%, 5%**, 1%***

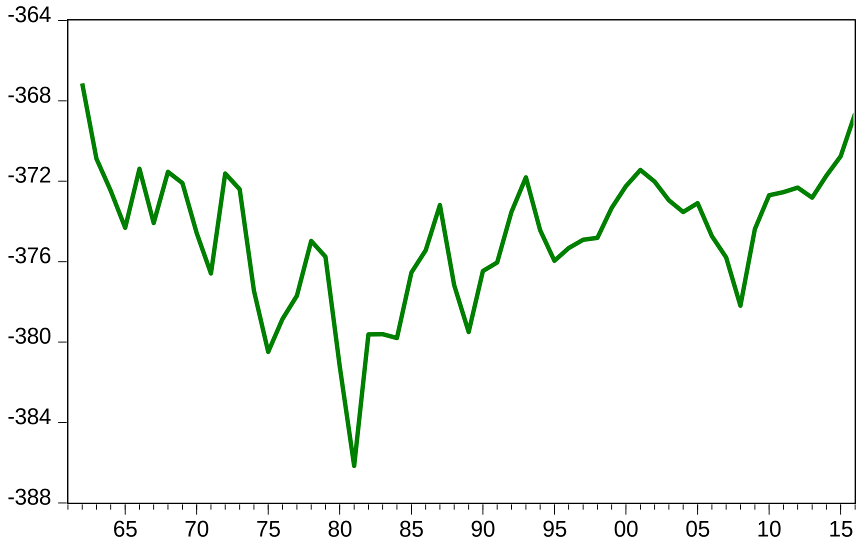
The negative sign of the error correction term (ECT) endorses the presumption that there is a convergent relationship amongst the variables. Moreover, the model adjusts by approximately 46% towards long-run parity per annum following a disturbance from the previous year. Importantly, the ΔRIR parameter relates a negative short-run impact of RIR on CA which reveals an important aspect of saving and investment decision-making at the aggregate level in South Africa. Siddiqui, Waheed and Mahmood (2016:1776) may provide a credible explanation for this observation in the form of the prevalence of social uncertainty in developing nations; albeit purely from the perspective of deficient saving levels. Their paper contends that social instability plays a prominent role in curtailing saving and investment behaviour. Whilst the rationale that greater returns on savings and investments are likely to improve the current account balance is disputed, less developed economies may be an exception.

In summary, our results refute the possibility that economic dependency is indirectly linked to current account imbalances through better saving behaviour. In fact, there is little credibility to the suggestion that the life-cycle hypothesis itself holds in the case of South Africa.

5.4. Stability Analysis of ARDL Estimation

In addition to the various intermittent tests that were implemented for the ARDL estimation, various checks can be undertaken to ascertain the overall stability of the model used. As an aid, the cointegration, cumulative sum of recursive residuals (CUSUM) and CUSUMSQ of squares graphs can be presented. Figure 10 reflects the apparent tendency of the long-term relationship to normalise over time under the consideration of a constant.

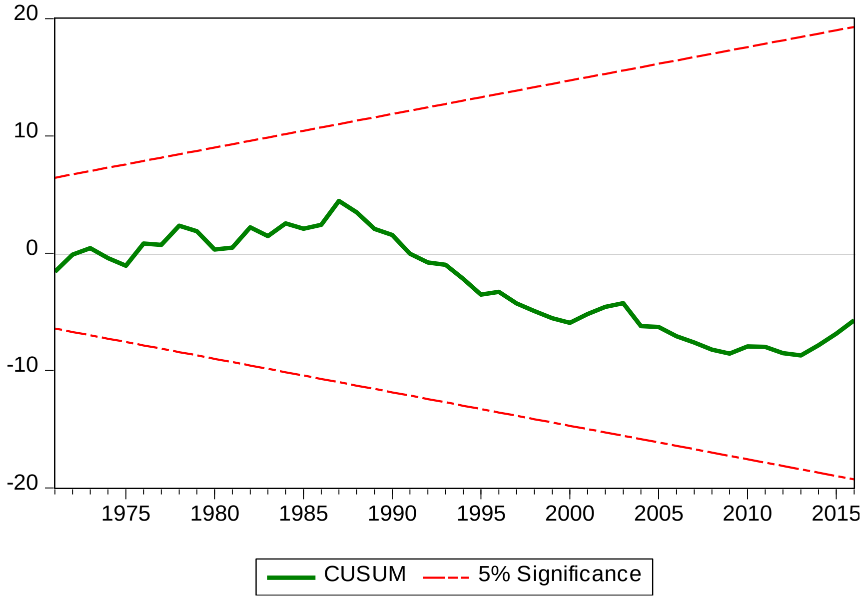
Figure 10: Cointegration Graph



Source: Own development

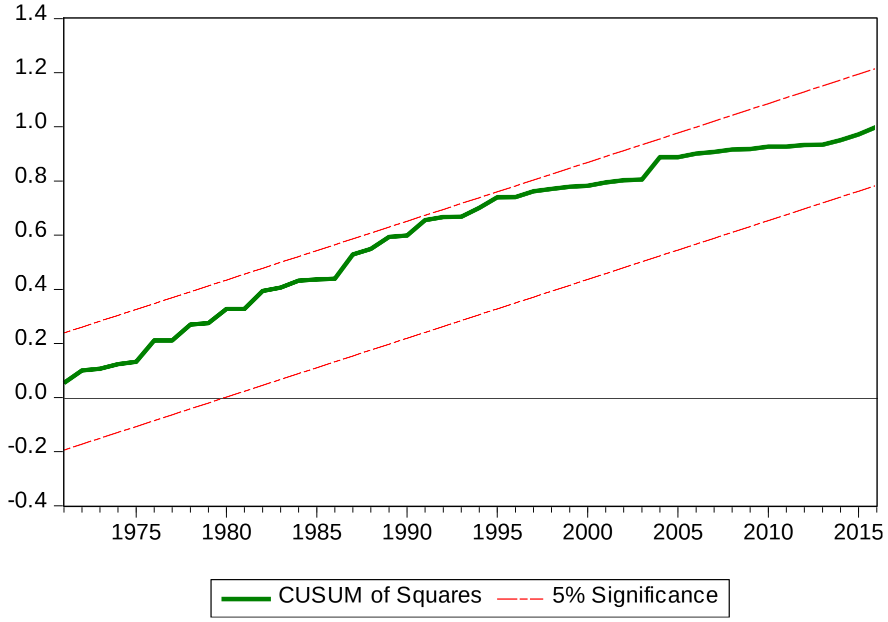
Figures 11 and 12 below depict the CUSUM and CUSUMSQ results which are relevant in interrogating the reliability of the model (Belloumi, 2014:281). It bodes well that both distributions lie within the 5% critical bounds (set by 95% confidence interval default); it is strong evidence that the coefficients of the model are statistically stable insofar as representing the underlying economic relationship is concerned.

Figure 11: Illustration of CUSUM test



Source: Own development

Figure 12: Illustration of CUSUM Squared test



Source: Own development

On the basis of the national level analysis, the South African case seems to invalidate the notion that the life-cycle theory can indeed generate current account implications. The life-cycle theory itself seems to be weakly disproved by the aggregate level analysis. Moreover, these outcomes do not necessarily provide a compelling view on any temporal countervailing effects of the life-cycle hypothesis on current account dynamics in both the long and short run. In a country with distinguishable regional differences in both its socioeconomic and commercial make-up, a closer examination of any potential differences across the nine provinces is necessary.

5.5. PARDL Estimation Results

The PARDL estimation in this case poses a few estimation challenges which require the model to drop two of the variables used for the aggregate analysis; these are RIR and LGDP. Of course, the results gleaned from this estimation will serve merely as benchmark outcomes owing to a restrictive number of observations. In total, 54 observations were available; the nine provinces could only be tracked between 2006 and 2011. Indeed, the short time period is an important empirical consideration but the availability of the data is immensely helpful in constructing our analysis. As with the ARDL, stationarity testing forms an important part of the estimation process albeit in a panel context.

According to Papageorgiou, Michaelides and Tsionas (2016:59), there are various stationarity tests which can be applied as an initial step in facilitating the PARDL estimation. This investigation will however only enlist the use of the Levin, Lin and Chu (LLC) test as well ADF Fisher (ADFF) test as an accompanying verification test. These tests were developed by Levin, Lin and Chu (2002) and Maddala and Wu (1999) respectively. Tables 11 and 12 offer the results on stationarity. All the variables are discovered to be I(0) processes.

Table 11: LLC Unit Root Test

Variables	At Level			At first difference			Remarks
	None	Intercept	Trend & intercept	None	Intercept	Trend & intercept	
TB	-0.179	-3.214***	-4.535***	-	-	-	I(0)
TDR	-15.147***	-39.165***	-5.077***	-	-	-	I(0)
HS	-1.860**	-3.604***	-14.016***	-	-	-	I(0)

*10%, **5%, ***1%

Table 12: ADFF Unit Root Test

Variables	At Level			At first difference		Remarks
	None	Intercept	Trend & intercept	Intercept	Trend & intercept	
TB	27.805***	20.185	9.881	-	-	I(0)

TDR	162.405***	54.393***	37.951***	-	-	I(0)
HS	19.823	29.299**	29.693**	-	-	I(0)

*10%, **5%, ***1%

With careful consideration of a shorter time component, a lag length of one is arbitrarily chosen in order to carry out the full estimation. The long-term results are shown in Table 13 below. It is observed that there is a theoretically-inconsistent relationship amongst TB, TDR and HS in the long-run. Specifically, TDR retains a positive relationship with TB whilst HS retains a negative one. Both these observations are strongly significant. The short-run dynamics are less compelling but can further be decomposed into their respective regional outcomes.

Table 13: The long-run PARDL cointegrating estimation outcome (1, 1, 1)

Variable	Coefficient	Standard Error	t-statistic	p-value
HS	-7.562	0.909	-8.318	0.000
TDR	0.051	0.010	5.213	0.000
		Diagnostic Analysis		
JB statistic	5.011 (0.082)	Error term distribution is normal		

*10%, **5%, ***1%

Based on Table 14, the short-run results of the estimation reveal the view that greater dependency might be linked with greater saving even in the provincial analysis. Important to note is that whilst the ECT is negative and significant, the other variables seem largely invalid insofar as statistical significance is concerned in the immediate term. The ECT suggests that any disturbance to the long-run equilibrium of the model is adjusted by 59.52% per annum. Moreover, the invalidity of the short-run coefficients could be as a result of a deficient number of time series components. The ECT can be said to weakly indicate a potential short-term association amongst the TB, TDR and HS because it is strongly significant. For a more direct interrogation of the individual province results, the short-run results can be presented as in Table 15 (a-i).

Table 14: Provincial ARDL cointegrating short-run dynamics from ECM (1, 1, 1)

Variable	Coefficient	Std. Error	t-statistics	p-values
ΔTDR	9.079	7.444	1.220	0.234
ΔHS	7.367	6.842	1.077	0.292
ECT(-1)	-0.595	0.176	-3.380	0.002

*10%, **5%, ***1%

In summary, Table 15 (a-i) reveals some interesting points pertaining to the age structure, private saving and trade balance relationship from a regional perspective. This is notwithstanding the data difficulties under which this estimation was conducted. Firstly, Kwazulu Natal displays evidence which is contrary to the conventional life-cycle hypothesis prediction in that, sporadic increases in age dependency were associated with rises in household saving; these two effects are jointly revealed to have improved the trade balance. Conversely, increased tendencies in private saving and greater dependency on the labour force in the North West led to a supposed fall in the trade balance. In Limpopo, higher levels of age dependency were found to yield a greater trade balance albeit that the ECT is positive and may indeed suggest long-run divergence in the proposed relationship.

In any event, these results are largely ad hoc and are thus prone to statistical irregularities. Admittedly, the life-cycle hypothesis implications on the current account have mostly been explored in country-specific and country-panel analyses with a substantial amount of data (Hassan, Salim & Bloch, 2011). It is likely that the realities of the regional demographic structure, saving level and current account bond is made more complex on account of the historical background of South Africa.

Table 15: Provincial ARDL cointegrating short-run dynamics from ECM (1, 1, 1)

a) **Gauteng**

Variable	Coefficient	p-values
ΔTDR	28.203	0.745
ΔHS	15.653	0.630
ECT(-1)	-0.361	0.000***

b) **Western Cape**

Variable	Coefficient	p-values
ΔTDR	60.114	0.620
ΔHS	54.454	0.705
ECT(-1)	-0.942	0.000***

c) **Limpopo**

Variable	Coefficient	p-values
ΔTDR	0.321	0.023**
ΔHS	-3.408	0.208
ECT(-1)	0.154	0.000***

d) **Mpumalanga**

Variable	Coefficient	p-values
ΔTDR	1.647	0.049**

ΔHS	1.674	0.714
ECT(-1)	-1.395	0.000***

e) **Northern Cape**

Variable	**Coefficient**	**p-values**
ΔTDR	-0.092	0.981
ΔHS	-2.719	0.494
ECT(-1)	0.000	0.864

f) **Kwazulu Natal**

Variable	**Coefficient**	**p-values**
ΔTDR	2.391	0.001***
ΔHS	5.997	0.005**
ECT(-1)	-0.351	0.000***

g) **Eastern Cape**

Variable	**Coefficient**	**p-values**
ΔTDR	2.719	0.028**
ΔHS	13.885	0.086*
ECT(-1)	-1.157	0.000***

h) **Free State**

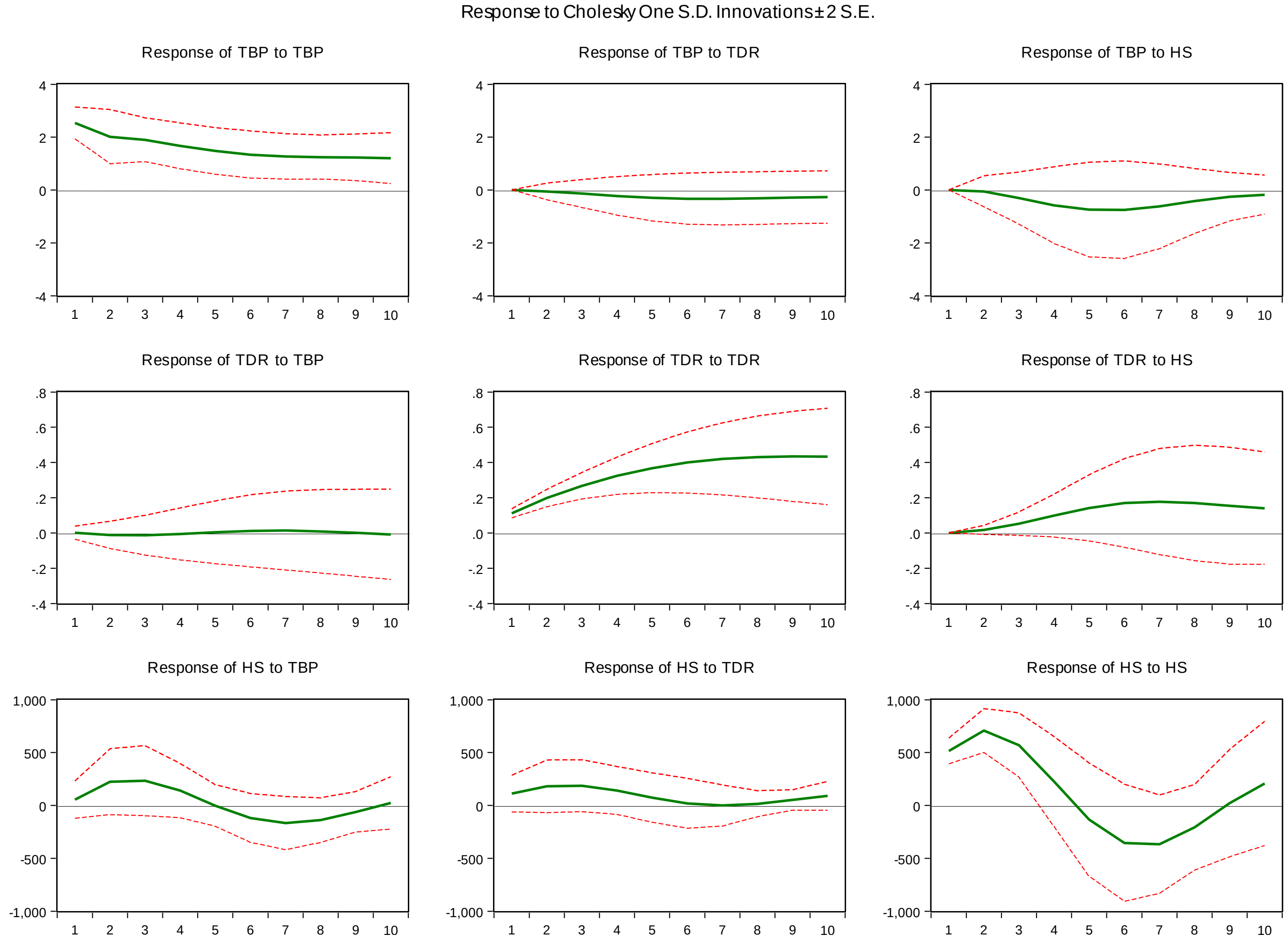
Variable	**Coefficient**	**p-values**
ΔTDR	2.169	0.469
ΔHS	-5.507	0.901
ECT(-1)	-0.899	0.029**

i) **North West**

Variable	**Coefficient**	**p-values**
ΔTDR	0-16.359	0.315
ΔHS	-19.166	0013
ECT(-1)	-0.406	0.000***

Finally, the impulse response functions of TB from HS and TDR shocks are seemingly revealing of the theoretical expectation posited by past literature. Figure 13 suggests that a disturbance to TDR (shown as TDR) will negatively influence TB (TBP) whilst a HS (HSP) shock will lead to a positive outcome on TB. HS can be viewed to have a more direct impact on TB whilst TDR is less amplified and possibly more indirect (through saving for instance). Granted, a less constrained model is likely to clearly show the full extent of the shocks and how persistent they are on a year-on-year basis.

Figure 13: Impulse Responses for the variable list



6. Conclusion

This research paper endeavoured to ascertain the influence of age structure on saving capability and the current account balance in South Africa. This was done by applying a range of cointegration-centric models. In order to assess this topic on an aggregate and regional level, the multivariate Johansen-Juselius and univariate ARDL and PARDL techniques were applied. From an aggregate level, the findings do not bode well for the tendency of diminishing population dependency on the labour force to improve the current account balance in South Africa. Whilst these trends might well be attributable to other, more direct factors, the scope of this study is able to deny that aggregate saving is an instrumental determinant of the current account. This is particularly the case in the long run.

The results obtained through the regional analysis using the PARDL technique were more suggestive of a relationship which is wholly contrary to the theoretical prediction amongst the variables in the long run. The short-run analysis was statistically more non-committal on the relationship of interest. Furthermore, the decomposition of the short-run model amongst the nine provinces provided a mixed and largely contradictory view of the proposed effect of age structure on saving and the current account. In Kwazulu Natal for instance, the results suggest that the current account improved by greater private saving and greater regional age dependency. Due to data availability issues however, a more comprehensive assessment of the prevailing regional conditions could not be robustly undertaken.

From a policymaking perspective, it is seemingly not possible to attempt to improve the current account by investing in research and initiatives centred more on inflating the share of the population that are economically active as well as arresting the persistently high population growth rate. Whilst the effectiveness of these strategies in a country as complex as South Africa is, at best, a counterfactual possibility, it might prove instrumental in the improvement of the domestic socioeconomic issues. The most desirable policy designs in South Africa should not consider demographic structure as an indirect determinant of the current account balance. Future research could more accurately analyse the regional realities contingent on the existence of better and indeed more reflective information.

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